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GENDER NORMS LIMIT GROWTH

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Gender Norms Limit Growth

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Gender equality plays a pivotal role in fostering human prosperity, shaping labor markets, fertility decisions, and the sustainability of social institutions. This study investigates how the prevailing gender norms in a country influence the fertility rate and long-term economic growth. To this end, we develop an overlapping generations model featuring endogenous fertility and labor supply in which both gender norms and research and development activities are explicitly incorporated. We show that conservative gender norms reduce both the fertility rate and the rate of income growth in the steady state. We further explore the impact of a policy intervention that relaxes gender norms and analyze the ensuing transition dynamics, deriving implications for policy design and welfare. Finally, we extend the model to examine how a gradual evolution in gender norms affects the long-run development of the economy.

Keywords: Gender Norms, Economic Growth, Fertility, R&D

JEL classifications: J13, J16, O40

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1 Introduction

Progressive policies such as gender equality, tolerance and diversity are all the key for human prosperity.
— Oded Galor (2022)

This observation underscores the growing recognition in both economics and public policy that social values are not merely normative ideals but also powerful determinants of long-run development. Among these values, gender equality has emerged as a salient factor shaping labor markets, fertility decisions, and the sustainability of social institutions (Bertrand *et al.*, 2010; Goldin, 2014; Blau and Kahn, 2017; Galor, 2022; Doepke *et al.*, 2023). These dynamics are closely tied to pressing social challenges, including declining fertility, labor shortages, and the fiscal sustainability of social security systems. In this context, it is essential to identify the underlying drivers of gender disparities across domains and understand how they influence individuals' decision-making and, ultimately, aggregate economic outcomes.

Among the key explanatory factors, in this study, we focus on a conservative gender norm prescribing that women should assume greater responsibility for housework and childcare than men. An expanding body of research has examined the impact of conservative gender norms on women's labor market outcomes and political participation as well as men's involvement in domestic tasks (Fernández *et al.*, 2004; Alesina *et al.*, 2013; Bertrand *et al.*, 2015; Bursztyn *et al.*, 2020; Jessen *et al.*, 2024). Studies have also shown that more conservative gender norms suppress marriage and fertility rates (Feyrer *et al.*, 2008; Fernández and Fogli, 2009; Bertrand *et al.*, 2021; Myong *et al.*, 2021). Because women's empowerment, household formation, and population dynamics are closely tied to macroeconomic performance, gender norms may thus constrain economic growth and overall welfare. Given this, a deeper understanding of these mechanisms is critical for designing effective policy interventions.

Based on the foregoing, this study examines whether and how gender norms affect fertility, economic growth, and welfare. To this end, we develop an overlapping generations

model with endogenous fertility and labor supply. We explicitly incorporate conservative gender norms into a framework of research and development (R&D)-based growth. Our analysis proceeds in three steps. First, assuming that gender norms are time-invariant, we examine their long-run effects on population dynamics and income growth in the steady state. Second, we explore the transition dynamics and welfare implications of an immediate policy intervention that relaxes gender norms. Third, we extend the model to allow for the gradual evolution of gender norms and analyze the resulting transition paths of income growth and generational welfare as the economy moves toward greater gender equality.

In the first step, we show that conservative gender norms decrease both the birth rate and the growth rate of income per capita in the steady state. The key mechanism is that these norms distort the intrahousehold time allocation, thereby reducing the efficiency of home production. In the second step, we derive a sufficient and necessary condition under which the proposed policy intervention leads to a Pareto improvement. Our numerical simulations, using empirically plausible parameter values, suggest that such a Pareto improvement is likely achievable. In the final step, we find that when gender norms gradually evolve, an intergenerational trade-off may emerge during the transition. Overall, our findings underscore the significance of the speed at which gender norms change and highlight the importance of policy measures that accelerate this process to minimize welfare losses and sustain economic growth.

Our study builds on and contributes to two main strands of the literature. The first examines how social norms affect the intrahousehold resource allocation, household formation, and fertility behavior. The motivation for focusing on social norms arises from the recognition that standard economic models—centered exclusively on financial incentives—often fail to account for the key features of household decision-making. To address this issue, [Akerlof and Kranton \(2000\)](#) introduce notions of identity from sociology and social psychology into economics, providing a framework that has since been widely applied to analyze the interplay between social norms and household behavior ([Fernández *et al.*](#),

2004; Feyrer *et al.*, 2008; Fernández and Fogli, 2009; Alesina *et al.*, 2013; Hiller, 2014; Bertrand *et al.*, 2015; Booth *et al.*, 2019; Bertrand *et al.*, 2021; Hauge *et al.*, 2023). This body of research suggests that conservative gender norms hinder women’s labor market and political participation by placing a disproportionate burden of housework and child-care on them (Goussé *et al.*, 2017; Sakamoto and Kohara, 2025). Moreover, these effects reduce the efficiency of the intrahousehold resource allocation and diminish the surplus from household formation, thereby reducing marriage and fertility rates (Gimenez-Nadal *et al.*, 2012; Myong *et al.*, 2021). We extend these findings by embedding social norms within an R&D-based growth framework and showing their long-run detrimental effects on population and income growth. In particular, our policy analysis advances the literature by formally quantifying the welfare consequences of shifting gender norms.

Second, our study contributes to the literature on the relationship between fertility and economic growth. A large body of research has explored this connection by emphasizing altruism toward children (Becker and Barro, 1988; Barro and Becker, 1989), inequality (De La Croix and Doepke, 2003), the quantity–quality trade-off (Becker *et al.*, 1990), and technological progress (Galor and Weil, 1996, 2000). A key implication from this line of work is that while rising income can raise fertility through income effects, population growth can in turn foster economic growth by increasing the number of researchers and enhancing R&D activity (Jones, 1995). However, as empirical studies show, many developed countries have fertility rates below the replacement level (Chatterjee and Vogl, 2018; Delventhal *et al.*, 2021). In light of this evidence, Sasaki and Hoshida (2017) and Jones (2022) investigate the interaction between population dynamics and long-run economic growth under negative population growth. Moreover, recent studies have examined how women’s empowerment—through political and property rights, greater intrahousehold bargaining power, and health—shapes both fertility behavior and growth outcomes (Doepke and Tertilt, 2009; De la Croix and Vander Donckt, 2010; Fernández, 2014; Doepke and Tertilt, 2019; Bloom *et al.*, 2020). Our study complements this strand of the literature by demonstrating how the presence and evolution of gender norms influence population dynamics

and income growth. Most importantly, we identify the condition under which a policy that relaxes gender norms can instantaneously lead to a Pareto improvement.

The remainder of this paper is organized as follows. Section 2 presents the theoretical model. Section 3 characterizes the market equilibrium and investigates how gender norms affect fertility and income growth rates in the steady state. Section 4 examines the impact of a policy intervention and the associated transition dynamics. Section 5 extends the baseline framework to incorporate the gradual evolution of gender norms. Section 6 concludes.

2 Model

2.1 Households

2.1.1 Structure

We consider an overlapping generations model with two genders, men and women.¹ Time is continuous. In period j , the economy consists of male and female agents from generations $-\infty$ to j . Immediately after birth, each agent enters the marriage market and is exogenously matched with a member of the opposite sex. The couple (i.e., household) then determine the consumption plan, number of children, and labor supply. As in Blanchard (1985), each agent faces a constant probability of death μ throughout their life.

The preference of each couple of generation j in period t is given by

$$U_j = \int_j^\infty e^{-(\rho+\mu)(t-j)} (\ln c_{j,t} + \gamma \ln \beta_{j,t}) dt, \quad (1)$$

where ρ denotes the subjective discount rate, $c_{j,t}$ is the consumption of generation j in period t , and $\beta_{j,t}$ is the number of children. $\gamma \in (0, 1)$ represents the preference for children. Here, $\gamma < 1$ is a simplifying assumption to avoid population divergence. Notably, because the couple have joint consumption, children are public goods, and preferences are

¹All the derivations of equations in Section 2.1 are presented in Appendix A.

homogeneous between the genders, the household utility function coincides with that of each agent.

The couple's budget constraint is given by

$$\dot{k}_{j,t} = (r_t + \mu)k_{j,t} + (1 - h_{j,t}^f - h_{j,t}^m)w_t - c_{j,t} - e_{j,t}, \quad (2)$$

where $k_{j,t}$ denotes each couple's asset holdings, r_t is the interest rate, $h_{j,t}^f$ ($h_{j,t}^m$) is the wife's (husband's) home production time, w_t is the wage rate, and $e_{j,t}$ is monetary investment in children. Following [Yaari \(1965\)](#), we assume that the couple contract with a life insurance company to make (or receive) a payment contingent on their death. Consequently, interest income is represented by the sum of r_t and μ multiplied by each couple's asset holdings. In addition, because the couple's descendants do not inherit their assets, a newborn generation has no asset holdings (i.e., $k_{j,j} = 0$ for all j). The couple is endowed with one unit of time allocated to home production and market work. The productivity in the labor market is homogeneous between the genders; hence, there is no gender wage gap. Interest income and labor income are allocated to the couple's consumption $c_{j,t}$, monetary investment in children $e_{j,t}$, and savings $k_{j,t}$.

The number of children is determined by the following home production function:

$$\beta_{j,t} = \xi \left\{ (\eta_f + \eta_m) \left[\eta_f (h_{j,t})^\eta + \eta_m (h_{j,t})^\eta \right]^{\frac{\sigma}{\eta}} + (1 - \eta_f - \eta_m) \left(\frac{e_t}{w_t} \right)^\sigma \right\}^{\frac{1}{\sigma}}, \quad (3)$$

where $\xi > 0$ is a scale parameter. $\eta_f \in (0, 1)$ and $\eta_m \in (0, 1)$ represent the wife's and husband's productivity in home production, respectively. $\eta \in (-\infty, 1]$ and $\sigma \in (-\infty, 1]$ represent the degree of substitution between the wife's and husband's home production time as well as between the time and monetary inputs, respectively. When η and σ tend to zero, Equation (3) becomes the following Cobb–Douglas form:

$$\beta_{j,t} = \xi (h_{j,t})^{\eta_f} (h_{j,t})^{\eta_m} \left(\frac{e_t}{w_t} \right)^{1-\eta_f-\eta_m}. \quad (4)$$

To simplify the discussion, we use Equation (4) instead of (3).²

We represent a gender norm by the following expression:

$$h_{j,t}^f = s h_{j,t}^m, \quad (5)$$

indicating that women should do $s \in (0, \infty)$ times more housework and childcare than men. A higher s indicates a more male-dominant social norm. Because this time constraint is required in the society in which the couple lives, they cannot freely choose the ratio $h_{j,t}^f/h_{j,t}^m$ (Myong *et al.*, 2021; Sakamoto and Kohara, 2025). However, the couple can choose the sum of $h_{j,t}^f$ and $h_{j,t}^m$.

2.1.2 Cost minimization problem associated with home production

To determine the ratio between the time and monetary inputs of home production, the couple solves the following problem:

$$\begin{aligned} \min_{h_{j,t}^f, h_{j,t}^m, e_{j,t}} \quad & w_t h_{j,t}^f + w_t h_{j,t}^m + e_{j,t}, \\ \text{s.t.} \quad & \beta_{j,t} = \xi (h_{j,t}^f)^{\eta_f} (h_{j,t}^m)^{\eta_m} \left(\frac{e_t}{w_t} \right)^{1-\eta_f-\eta_m}, \\ & h_{j,t}^f = s h_{j,t}^m. \end{aligned}$$

Solving the problem yields the following cost function of having children:

$$\widehat{C}(\beta_{j,t}) = \chi w_t \beta_{j,t}, \quad (6)$$

where

$$\chi \equiv \frac{s^{-\eta_f} (1+s)^{\eta_f+\eta_m}}{\xi (\eta_f + \eta_m)^{\eta_f+\eta_m} (1-\eta_f-\eta_m)^{1-\eta_f-\eta_m}}. \quad (7)$$

²Using the Cobb–Douglas form instead of the constant elasticity of substitution (CES) form does not affect our qualitative results.

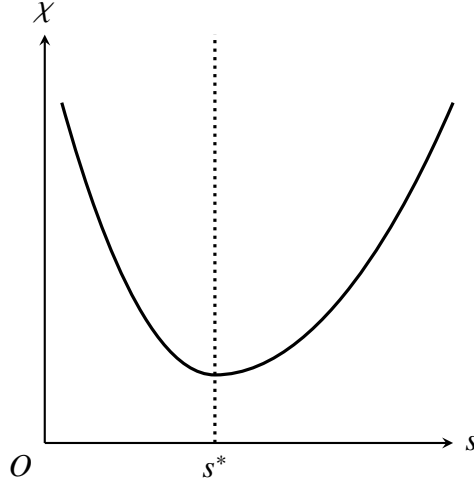


Fig. 1 Relationships between the gender norm and shadow price of having children

We can interpret χw_t as the shadow price of having children and χ depends on the gender norm s . Figure 1 illustrates Equation (7) and displays the U-shaped relationship between χ and s . Specifically, χ decreases with s when s is below s^* , while increasing with s when s is above s^* , where $s^* \equiv \eta^f / \eta^m$. Importantly, the couple chooses the home production inputs such that $h_{j,t}^f / h_{j,t}^m = s^*$ without the gender norm. Hence, we interpret that the economy is characterized by a male-dominant social norm when $s > s^*$, whereas a female-dominant social norm is present when $s < s^*$. Because we focus on the former case (which is consistent with reality), we assume $s > s^*$; consequently, χ increases with s .³

³As illustrated in Figure 1, the female-dominant social norm also matters: a more female-dominant social norm increases χ .

2.1.3 Utility maximization problem

Substituting the cost function in (6) into the budget constraint in (2), the couple's utility maximization problem is expressed as follows:

$$\begin{aligned} \max_{c_{j,t}, \beta_{j,t}} \quad & U_j = \int_j^\infty e^{-(\rho+\mu)(t-j)} (\ln c_{j,t} + \gamma \ln \beta_{j,t}) dt, \\ \text{s.t.} \quad & \dot{k}_{j,t} = (r_t + \mu)k_{j,t} + (1 - \chi\beta_{j,t})w_t - c_{j,t}, \end{aligned} \quad (8)$$

$$\text{T.V.C.} \quad \lim_{T \rightarrow \infty} e^{-(\rho+\mu)T} \psi_{j,T} k_{j,T} \leq 0, \quad (9)$$

$$\text{given} \quad k_{j,0}, \quad (10)$$

where $\psi_{j,T}$ represents the co-state variable. Arranging the first-order conditions yields the following intratemporal condition:

$$\beta_{j,t} = \frac{\gamma c_{j,t}}{\chi w_t}, \quad (11)$$

implying that the marginal rate of substitution between consumption and having children must equal their price ratio. A higher s decreases the ratio $\beta_{j,t}/c_{j,t}$ by increasing the shadow price of having children, χ . Combining this equation with the input demand function of $e_{j,t}$ yields another intratemporal condition:

$$e_{j,t} = \gamma(1 - \eta_f - \eta_m)c_{j,t}, \quad (12)$$

implying no relationship between the ratio $e_{j,t}/c_{j,t}$ and gender norm s . This is because the gender norm does not affect monetary investment in children.

Additionally, we obtain the Euler equation (i.e., the intertemporal condition) as follows:

$$\dot{c}_{j,t} = (r_t - \rho)c_{j,t}, \quad (13)$$

indicating that the per-couple consumption growth rate equals $r_t - \rho$.

Moreover, combining Equation (8) with the non-Ponzi game condition yields the following intertemporal budget constraint:

$$\int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} c_{j,\tau} d\tau = \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (1 - \chi \beta_{j,t}) w_\tau d\tau + k_{j,t}. \quad (14)$$

Arranging Equations (13) and (14), we obtain

$$c_{j,t} = (\rho + \mu)(k_{j,t} + \omega_{j,t}), \quad (15)$$

where

$$\omega_{j,t} \equiv \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (1 - \chi \beta_{j,t}) w_\tau d\tau. \quad (16)$$

Here, $\omega_{j,t}$ represents the *human wealth* (i.e., the present discounted value of lifetime labor income) subtracted from the cost associated with childrearing (Blanchard, 1985). Hence, Equation (15) indicates that the couple's consumption propensity equals $\rho + \mu$. Differentiating Equation (16) with respect to t , we obtain the following dynamics of the human wealth:

$$\dot{\omega}_{j,t} = (r_t + \mu)\omega_{j,t} - (1 - \chi \beta_{j,t}) w_t. \quad (17)$$

2.1.4 Population

Let $N_{j,t}$ denote the population of generation j in period t . Then, the total population in period t is expressed as

$$N_t \equiv \int_{-\infty}^t N_{j,t} dj. \quad (18)$$

Additionally, because each couple of generation j produces $\beta_{j,t}$ children in period t , the population of a newborn generation (i.e., generation t) is given by

$$N_{t,t} = \int_{-\infty}^t \beta_{j,t} N_{j,t} dj. \quad (19)$$

Furthermore, because agents die at the rate μ in each period, the population of generation j in period t satisfies the following relationship:

$$N_{j,t} = N_{j,j} e^{-\mu(t-j)}. \quad (20)$$

Differentiating the total population in (18) with respect to t , we obtain the population growth rate as follows:

$$n_t \equiv \frac{\dot{N}_t}{N_t} = \beta_t - \mu, \quad (21)$$

where $\beta_t \equiv N_{t,t}/N_t$, representing the birth rate.

2.1.5 Aggregate behavior

Let $L_{j,t}$ be the labor supply of a couple of generation j in period t (i.e., $L_{j,t} = 1 - h_{j,t}^f - h_{j,t}^m$). Then, the aggregate labor supply in period t is given by

$$L_t \equiv \int_{-\infty}^t L_{j,t} N_{j,t} dj. \quad (22)$$

Similarly, aggregate consumption, monetary investment in children, and asset holdings in period t are defined as follows:

$$C_t = \int_{-\infty}^t c_{j,t} N_{j,t} dj, \quad E_t = \int_{-\infty}^t e_{j,t} N_{j,t} dj, \quad K_t = \int_{-\infty}^t k_{j,t} N_{j,t} dj. \quad (23)$$

Using these definitions, we examine the dynamics of aggregate consumption and the birth rate.

First, using Equations (11), (19), and (23) yields the following relationship between the birth rate and aggregate consumption:

$$\beta_t = \frac{\gamma}{\chi} \cdot \frac{C_t}{w_t N_t}. \quad (24)$$

We next characterize the birth rate β_t . Using Equations (23) and (24), we obtain

$$L_t = [1 - (\eta_f + \eta_m)\chi\beta_t] N_t. \quad (25)$$

Dividing both sides of this equation by N_t , we obtain the labor-to-population ratio as follows:

$$\ell_t \equiv \frac{L_t}{N_t} = 1 - (\eta_f + \eta_m)\chi\beta_t. \quad (26)$$

The following lemma characterizes the upper bound of the birth rate.

Lemma 1. $\beta_t \leq \bar{\beta}_0$ holds for all t , where

$$\bar{\beta}_0 \equiv \frac{1}{(\eta_f + \eta_m)\chi}. \quad (27)$$

The interpretation is that when $\ell_t = 0$ (i.e., when no couples participate in the labor market and instead allocate their entire time endowment to childcare), the birth rate peaks, $\bar{\beta}_0$. Hence, β_t cannot exceed $\bar{\beta}_0$.

Subsequently, the dynamics of aggregate consumption are as follows:

$$\dot{C}_t = (r_t - \rho + \beta_t - \mu)C_t - \frac{\beta_t(\rho + \mu)}{1 + \gamma}K_t. \quad (28)$$

Regarding the first term, $r_t - \rho$ corresponds to the Keynes–Ramsey condition, while $\beta_t - \mu = n_t$ represents the population growth rate. Consequently, aggregate consumption

grows at the rate of $r_t - \rho + n_t$ without the alternation of generations. By contrast, the second term captures the *turnover effect*: the alternation of generations depresses consumption growth because newborn generations begin life with no assets (Blanchard, 1985).

Finally, combining Equation (12) with (23) yields the following relationship:

$$E_t = \gamma(1 - \eta_f - \eta_m)C_t, \quad (29)$$

implying that aggregate monetary investment in children and aggregate consumption grow at the same rate.

2.2 Firms

Following Jones (1995), we consider three sectors: the final goods, intermediate goods, and R&D sectors. The first sector produces final goods that use intermediate goods. The second sector produces intermediate goods using labor. However, firms in this sector exit the market (or go bankrupt) at a Poisson rate δ over time. Once a firm goes bankrupt, the intermediate goods it produced are no longer available for use in the production of final goods. Finally, the third sector generates new ideas by integrating labor with existing knowledge and earns profits by selling these new ideas to entrepreneurs.

2.2.1 Final goods sector

Firms in the final goods sector face a perfectly competitive market. Each firm produces a final good, X_t , using intermediate goods. The production function is given by

$$X_t = \left(\int_0^{A_t} x_{i,t}^\alpha di \right)^{\frac{1}{\alpha}}, \quad (30)$$

where $x_{i,t}$ denotes the quantity of the intermediate good produced by firm $i \in [0, A_t]$ in the intermediate goods sector. Let $p_{i,t}$ be its price. Then, each firm solves the following

profit maximization problem:

$$\max_{x_{i,t}} \left(\int_0^{A_t} x_{i,t}^\alpha di \right)^{\frac{1}{\alpha}} - \int_0^{A_t} p_{i,t} x_{i,t} di. \quad (31)$$

Arranging the first-order condition yields the following input demand function:

$$x_{i,t} = p_{i,t}^{-\frac{1}{1-\alpha}} X_t. \quad (32)$$

2.2.2 Intermediate goods sector

There are A_t types of intermediate goods, each monopolistically produced and sold to the final goods sector by one of the A_t intermediate goods firms. Each firm produces one unit of intermediate goods using one unit of labor. Hence, each firm solves the following profit maximization problem:

$$\begin{aligned} \max_{x_{i,t}} \quad & \pi_{i,t} = p_{i,t} x_{i,t} - w_t x_{i,t}, \\ \text{s.t.} \quad & x_{i,t} = p_{i,t}^{-\frac{1}{1-\alpha}} X_t. \end{aligned}$$

Arranging the first-order conditions, we obtain the following relationship:

$$p_{i,t} = \frac{w_t}{\alpha}, \quad x_{i,t} = \left(\frac{\alpha}{w_t} \right)^{\frac{1}{1-\alpha}} X_t, \quad \pi_{i,t} = (1 - \alpha) \left(\frac{\alpha}{w_t} \right)^{\frac{\alpha}{1-\alpha}} X_t. \quad (33)$$

Given the symmetry among intermediate goods firms, all such firms produce identical quantities of intermediate goods traded at a uniform equilibrium price. Therefore, we denote these quantities and price by $x_t = x_{i,t}$ and $p_t = p_{i,t}$, respectively. Using these and substituting Equation (33) into the production function in the final goods sector in (30) yields

$$X_t = A_t^{\frac{1-\alpha}{\alpha}} L_t^P, \quad (34)$$

where L_t^P denotes labor demand in the production sector.

2.2.3 R&D sector

In the R&D sector, each firm produces new blueprints by integrating labor (i.e., researchers), L_t^R , and existing knowledge in period t , A_t . These blueprints are then traded in a perfectly competitive market. The R&D process is expressed as

$$\dot{A}_t = \lambda A_t^\phi L_t^R - \delta A_t, \quad (35)$$

where $\lambda > 0$ is a parameter. Additionally, $\phi < 1$ measures the *knowledge spillover*. Specifically, we focus on the case in which existing knowledge is not perfectly used to produce new blueprints to avoid the *scale effect* (Jones, 1995). As aforementioned, the stock of existing knowledge depreciates at a Poisson rate $\delta > 0$ over time. The revenue and cost of producing one unit of new blueprints are represented by v_t and $w_t/\lambda A_t^\phi$, respectively. Here, v_t represents the price of new blueprints and must equal the present value of intermediate goods firms in equilibrium.

The free-entry condition is given by

$$v_t \leq \frac{w_t}{\lambda A_t^\phi} \text{ with equality when } L_t^R > 0. \quad (36)$$

When wages are sufficiently high relative to revenue from R&D activities, the free-entry condition does not hold with equality. In what follows, we focus on the case in which the free-entry condition holds with equality, and thus R&D activities are undertaken.⁴

⁴The opposing case is analyzed in Appendix C.

2.3 Equilibrium

2.3.1 Factor prices

We examine wages and the interest rate. Because final goods firms face a perfectly competitive market and their production technology exhibits homogeneity of degree one, their profit must equal zero. Using this fact and substituting Equation (33) into (31), we obtain the following equilibrium wage:

$$w_t = \alpha A_t^{\frac{1-\alpha}{\alpha}}. \quad (37)$$

Subsequently, from the no-arbitrage condition, the interest rate satisfies the following relationship:

$$r_t = \frac{\pi_t + \dot{v}_t}{v_t} - \delta. \quad (38)$$

Combined with the profit of intermediate goods firms in (33), the production technology in the R&D sector in (35), the free-entry condition in (36), and the equilibrium wage in (37), we obtain the following equilibrium interest rate:⁵

$$r_t = \frac{\lambda(1-\alpha)}{\alpha} \cdot \frac{L_t^P}{A_t^{1-\phi}} + \lambda \left(\frac{1-\alpha}{\alpha} - \phi \right) \frac{L_t^R}{A_t^{1-\phi}} - \left(\frac{1-\alpha\phi}{\alpha} \right) \delta, \quad (39)$$

where the first term corresponds to the dividend π_t/v_t , while the second term represents the dynamics of the present value of intermediate goods firms $\dot{v}_t/v_t$. Importantly, the accumulation of knowledge capital (i.e., economic growth) increases firm value while intensifying competition, consequently reducing the profit of each intermediate goods firm.

⁵Taking the logarithm of both sides of Equation (36) and differentiating with respect to t , we obtain $\dot{v}_t/v_t = \dot{w}/w_t - \phi \dot{A}_t/A_t$. In addition, from Equation (37), the wage growth rate equals $[(1-\alpha)/\alpha] \dot{A}_t/A_t$. Combined with the production technology in (35), the growth rate of the present value of an intermediate goods firm is $\dot{v}_t/v_t = \{[(1-\alpha)/\alpha] - \phi\} \lambda A_t^\phi L_t^R$. Furthermore, Using Equations (33), (34), (36), and (37), we obtain $\pi_t/v_t = \lambda[(1-\alpha)/\alpha] L_t^P A_t^{\phi-1}$. Substituting these equations into Equation (38) yields the equilibrium interest rate in (39).

2.3.2 Market clearing conditions

The goods market clearing condition is given by

$$X_t = C_t + E_t,$$

implying that the quantity of final goods produced must equal demand for aggregate consumption and monetary investment in children. Combined with Equation (29), we obtain

$$X_t = [1 + \gamma(1 - \eta_f - \eta_m)] C_t. \quad (40)$$

Subsequently, the asset market clearing condition is given by

$$K_t = v_t A_t, \quad (41)$$

indicating that the aggregate supply of assets from households, K_t , must equal the sum of the values of intermediate goods firms, $v_t A_t$.

Finally, the labor market clearing condition is expressed as

$$L_t = L_t^P + L_t^R, \quad (42)$$

indicating that the aggregate labor supply from households must equal labor demand from the final and intermediate goods sectors.

2.3.3 Labor-to-population ratio and birth rates in equilibrium

Using the market clearing conditions above, we derive the labor-to-population ratio and examine the birth rate in equilibrium.

First, combining Equation (34) with (40), we derive the following relationship:

$$L_t^P = [1 + \gamma(1 - \eta_f - \eta_m)] \frac{C_t}{A_t^{\frac{1-\alpha}{\alpha}}}. \quad (43)$$

In addition, substituting Equations (24) and (37) into (43) yields the production labor-to-population ratio as follows:

$$\ell_t^P \equiv \frac{L_t^P}{N_t} = \zeta \chi \beta_t, \quad (44)$$

where

$$\zeta \equiv \frac{\alpha [1 + \gamma(1 - \eta_f - \eta_m)]}{\gamma} > 0.$$

Equation (44) reveals that ℓ_t^P is proportional to the birth rate, β_t . Having more children requires more final goods, increasing demand for production labor.

Subsequently, combining Equation (42) with (44), we derive the R&D labor-to-population ratio as follows:

$$\ell_t^R \equiv \frac{L_t^R}{N_t} = 1 - (\zeta + \eta_f + \eta_m) \chi \beta_t. \quad (45)$$

Regarding the birth rate, we obtain the following result.

Lemma 2. $\beta_t \leq \bar{\beta}$ holds for all t , where

$$\bar{\beta} \equiv \frac{1}{(\zeta + \eta_f + \eta_m) \chi}.$$

This relation follows from the fact that the R&D labor-to-population ratio must be non-zero (i.e., $\ell_t^R \geq 0$). This lemma implies the presence of the upper bound of the birth rate, $\bar{\beta}$, and that the gender norm affects the bound through the shadow price of having

children, χ . Figure 2 illustrates the hump-shaped relationship between them: $\bar{\beta}$ increases with s when $s < s^*$ but decreases with s when $s > s^*$. In particular, when focusing on the male-dominant social norm (i.e., $s > s^*$), a higher s increases the shadow price of having children, χ , thereby reducing $\bar{\beta}$. Notably, because $\bar{\beta}$ is less than $\bar{\beta}_0$ (defined in Lemma 1) for all the parameter values, the former serves as the effective upper bound of the birth rate.

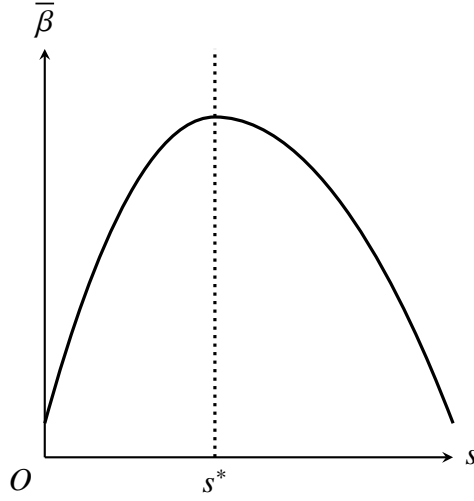


Fig. 2 Upper bound of the birth rate and the gender norm

In addition, when $\beta_t = \bar{\beta}$ holds, the R&D labor-to-population ratio equals zero, implying that no researchers engage in R&D activities (i.e., $L_t^R = 0$). Consequently, the free-entry condition in (36) does not hold with equality in this case. Moreover, as shown below, if $\bar{\beta}$ is lower than $\mu - (1 - \phi)\delta$, there is no saddle point. Therefore, we exclude this case.

Assumption 1. Assume $\bar{\beta} > \mu - (1 - \phi)\delta$.

3 Dynamics

3.1 Dynamic systems

To examine the dynamics of this economy, we use the following two variables:

$$a_t = \frac{A_t^{1-\phi}}{N_t} \quad \text{and} \quad \beta_t = n_t + \mu, \quad (46)$$

where we refer to a_t as the knowledge stock per capita. Differentiating Equation (21) with respect to t yields

$$\frac{\dot{\beta}_t}{\beta_t} = \frac{\dot{C}_t}{C_t} - \frac{\dot{w}_t}{w_t} - (\beta_t - \mu). \quad (47)$$

Here, combining Equation (45) with the fact that the wage growth rate, $\dot{w}_t/w_t$, is proportional to the technological progress rate, we obtain

$$g_t^w \equiv \frac{\dot{w}_t}{w_t} = \frac{1-\alpha}{\alpha} \left[\lambda \cdot \frac{1 - (\zeta + \eta_f + \eta_m)\chi\beta_t}{a_t} - \delta \right]. \quad (48)$$

Additionally, substituting Equations (25), (42), (44), and (45) into Equation (39), the interest rate is described as a function of a_t and β_t as follows:

$$r_t = \frac{\lambda(1-\alpha)}{\alpha} \cdot \frac{\zeta\chi\beta_t}{a_t} + \lambda \left(\frac{1-\alpha}{\alpha} - \phi \right) \frac{1 - (\zeta + \eta_f + \eta_m)\chi\beta_t}{a_t} - \left(\frac{1-\alpha\phi}{\alpha} \right) \delta. \quad (49)$$

Furthermore, substituting Equations (24), (36), (41), and (49) into Equation (28), we derive the following dynamics of aggregate consumption:

$$\begin{aligned} \frac{\dot{C}_t}{C_t} = & \frac{\lambda(1-\alpha)}{\alpha} \cdot \frac{\zeta\chi\beta_t}{a_t} + \lambda \left(\frac{1-\alpha}{\alpha} - \phi \right) \frac{1 - (\zeta + \eta_f + \eta_m)\chi\beta_t}{a_t} - \left(\frac{1-\alpha\phi}{\alpha} \right) \delta \\ & - \rho + \beta_t - \mu - \frac{\gamma(\rho + \mu)}{(1+\gamma)\chi\lambda} a_t. \end{aligned} \quad (50)$$

Using Equations (47), (48), and (50) yields the following dynamics of β_t :

$$\dot{\beta}_t = \left\{ \left[\frac{1-\alpha}{\alpha} \zeta + \phi(\zeta + \eta_f + \eta_m) \right] \lambda \chi \frac{\beta_t}{a_t} - \frac{\phi \lambda}{a_t} - (1-\phi)\delta - \rho - \frac{\gamma(\rho + \mu)}{(1+\gamma)\chi\lambda} a_t \right\} \beta_t. \quad (51)$$

Subsequently, differentiating the definition of a_t with respect to t , we obtain the growth rate of a_t as follows:

$$\frac{\dot{a}_t}{a_t} = (1-\phi) \frac{\dot{A}_t}{A_t} - (\beta_t - \mu), \quad (52)$$

indicating that the growth rate of the knowledge stock per capita is determined by the technological growth rate, $\dot{A}_t/A_t$, and the population growth rate, $\beta_t - \mu$. Because both the knowledge stock and the population grow along the balanced growth path at constant rates, a_t also grows at a constant rate. Substituting Equations (35), (40), and (44) into Equation (52), the dynamics of a_t can be rewritten as

$$\dot{a}_t = (1-\phi)\lambda \left[1 - (\zeta + \eta_f + \eta_m)\chi\beta_t \right] - [\beta_t - \mu + (1-\phi)\delta] a_t. \quad (53)$$

The system of equations in (51) and (53) describes the dynamic behavior of this economy.

We next examine the $\dot{\beta}_t = 0$ and $\dot{a}_t = 0$ loci. From Equation (51), the $\dot{\beta}_t = 0$ locus is derived as follows:

$$\beta_t = \frac{\frac{\gamma(\rho+\mu)}{(1+\gamma)\chi\lambda} a_t^2 + [\rho + (1-\phi)\delta] a_t}{\left[\frac{1-\alpha}{\alpha} \zeta + \phi(\zeta + \eta_f + \eta_m) \right] \lambda \chi} + \frac{\phi}{\left[\frac{1-\alpha}{\alpha} \zeta + \phi(\zeta + \eta_f + \eta_m) \right] \chi}, \quad (54)$$

implying that along the $\dot{\beta}_t = 0$ locus, β_t is a quadratic function of a_t . Furthermore, whether this function is concave or convex depends on the knowledge spillover, ϕ . When $\phi \in [0, 1)$, this function is convex for all the parameter values. By contrast, when ϕ is negative and sufficiently small, the coefficient of a_t^2 becomes negative, causing the function to be concave. The following lemma addresses this issue in more detail.

Lemma 3. *Along the $\dot{\beta}_t = 0$ locus, β_t is a concave function of a_t if and only if $\phi < \bar{\phi}$,*

where

$$\bar{\phi} \equiv -\frac{1-\alpha}{\alpha} \cdot \frac{\zeta}{\zeta + \eta_f + \eta_m} \in (-\infty, 0). \quad (55)$$

Proof. The proof is presented in Appendix D. $\square$

Studies analyze and discuss the knowledge spillover. For instance, Jones (2022) point out that ϕ ranges from approximately -2 to approximately -1 . Therefore, it is important to carefully analyze the shape of the function in (54). The constant term (i.e., the second term on the right-hand side of Equation (54)) is lower than $\bar{\beta}$ when β_t is convex. Conversely, the opposite holds when β_t is concave.

From Equation (53), the $\dot{a}_t = 0$ locus is given by

$$a_t = \lambda(1-\phi) \frac{1 - (\zeta + \eta_f + \eta_m)\chi\beta_t}{\beta_t - \mu + (1-\phi)\delta}. \quad (56)$$

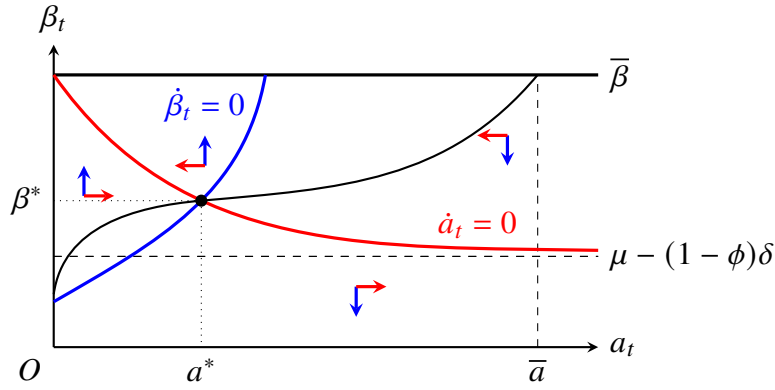
Evaluating this equation at $\beta_t = \bar{\beta}$ yields $a_t = 0$.

The phase diagram of this economy is illustrated in Figure 3. The horizontal axis represents the knowledge stock per capita, a_t , while the vertical axis corresponds to the birth rate, β_t . In addition, the blue and red lines present the $\dot{\beta}_t = 0$ and $\dot{a}_t = 0$ loci, respectively. As Lemma 2 shows, there exists an upper bound of the birth rate, as illustrated by the black horizontal line $\beta_t = \bar{\beta}$.

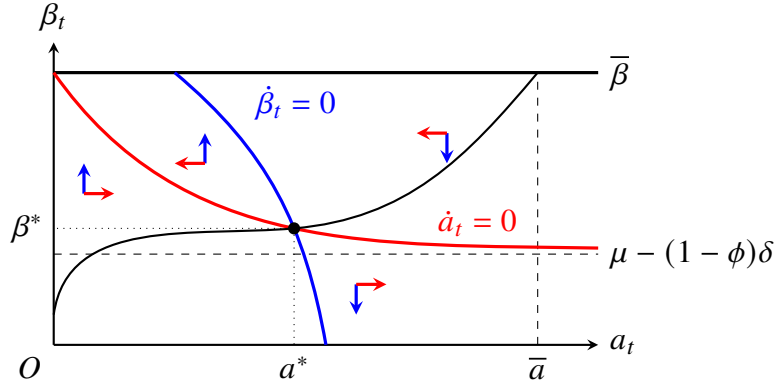
In what follows, using Figure 3, we first analyze the existence, uniqueness, and stability of a steady state. We then examine the influence of the gender norm on fertility and economic growth in the steady state.

3.2 Existence, uniqueness, and stability of a steady state

The steady state of this economy must satisfy $\dot{\beta}_t = 0$ and $\dot{a}_t = 0$, and is denoted by (β^*, a^*) . Using Equations (54) and (56), we derive the following result.



(a) When $\bar{\phi} < \phi < 1$



(b) When $\phi < \bar{\phi}$

Fig. 3 Phase diagram

Proposition 1. For any initial state $a_0 \in (0, \bar{a})$, there exists a globally stable steady state (a^*, β^*) in which it holds that $\beta^* \in (0, \bar{\beta})$ and $a^* \in (0, \bar{a})$, and $\bar{a}$ is defined in the proof.

Proof. The proof is presented in Appendix E. □

In either of the cases in which $\bar{\phi} < \phi < 1$ or $\phi > 1$, there exists a unique steady state (β^*, a^*) . Moreover, the economy follows a unique saddle path, as depicted by the black curve in Figure 3. Hence, for any initial state $a_0 \in (0, \bar{a})$, households choose β_0^* along the saddle path, which leads the economy to converge to the steady state. However, if a_0 exceeds $\bar{a}$, the economy diverges: as $t \rightarrow \infty$, $\beta_t \rightarrow 0$ and $a_t \rightarrow \infty$. In this case, the population growth rate continues to decline, thereby increasing the knowledge stock per capita. In what follows, we focus on the case in which $a_0 \in (0, \bar{a})$.

Importantly, Proposition 1 establishes that the market equilibrium is unique. To better understand this result, we address the following question: Given the initial state a_0 , how do households determine $\beta_{j,0}$? A higher $\beta_{j,0}$ implies that households choose to have more children in period 0. In this case, the intratemporal condition in (11) implies higher consumption, $c_{j,t}$, because of the quasi-concavity of the instantaneous utility function. Additionally, a higher $\beta_{j,0}$ requires greater time and monetary inputs for home production. Consequently, a higher $\beta_{j,0}$ increases demand for final goods, $c_{j,t} + e_{j,t}$, while reducing the labor supply, $\ell_{j,t}^f + \ell_{j,t}^m$, and savings, $k_{j,0}$, thereby constraining R&D activities. The simultaneous occurrence of higher population growth and lower knowledge accumulation causes the economy to move toward the top-left of the phase diagram. Eventually, the birth rate reaches $\bar{\beta}$, beyond which the consumption path fails to satisfy the Euler equation (13). Clearly, this path does not constitute an equilibrium and can be interpreted as a situation of *excessive fertility* or, equivalently, *insufficient savings* (i.e., underinvestment in R&D activities).

Conversely, when households opt to have fewer children in period 0, the opposite dynamics unfold. Lower demand for final goods, coupled with the higher labor and asset supply, initially accelerates R&D activities, thereby pushing the economy toward the bottom-right of the phase diagram. As the economy shrinks, the growth rate of the knowledge stock converges to zero, which in turn causes the per capita income growth rate to approach zero. Notably, this path does not satisfy the transversality condition.⁶ Therefore, this path also fails to constitute an equilibrium and can be interpreted as a situation of *insufficient fertility* or *excessive savings* (i.e., overinvestment in R&D activities). This discussion highlights that there exists an optimal $\beta_{j,0}^*$ that is neither too high nor too low (i.e., satisfies the relation $\beta_0^* = N_{0,0}/N_0 = \int_{-\infty}^0 \beta_{j,0}^* N_{j,0} dj / N_0$), ensuring that the economy converges to the steady state.

⁶The proof is presented in Appendix B.

3.3 Effects of the gender norm on fertility and growth

First, we examine the effects of the gender norm on our focal variables, the birth rate and knowledge stock per capita, in the steady state.

Proposition 2. *A higher s decreases β^* but increases a^* if and only if $s > s^*$.*

Proof. The proof is presented in Appendix F. □

Panels (a) and (b) of Figure 4 illustrate the result of Proposition 2. The interpretation is that a more conservative gender norm reduces the steady-state birth rate, β^* , which is maximized when $s = s^*$. This is because a higher value of s (i.e., $s > s^*$) lowers the efficiency of home production by distorting the time input ratios. Therefore, as shown in Figure 1, the shadow price of having children rises with s , which in turn reduces the number of children for all generations, $\beta_{j,t}$, thereby lowering the birth rate. When $s = s^*$, households can choose the most efficient time allocation, leading to the highest birth rate. Accordingly, the relationship between β^* and s is hump-shaped, peaking at $s = s^*$, as shown in Panel (a) of Figure 4.

Conversely, Proposition 2 suggests that the relationship between the knowledge stock per capita, a^* , and s is U-shaped, with the minimum attained at $s = s^*$ (see Panel (b) of Figure 4). That is, a^* increases as s deviates from s^* in either direction. For our purpose, consider the case in which $s > s^*$. In this case, a higher value of s raises the shadow price of having children, thereby reducing fertility and decreasing the population size, N_t . While the gender norm distorts the intrahousehold time allocation between genders in terms of home production (i.e., $h_{j,t}^f/h_{j,t}^m$), it does not affect the total time input (i.e., $h_{j,t}^f + h_{j,t}^m$). Hence, the labor supply per household remains unchanged. Nevertheless, the reduced population size leads to a decline in the aggregate labor supply, which can in turn impede R&D activities. Therefore, the rate of accumulation of knowledge capital, A_t , is likely to decline. Because a more conservative gender norm slows the growth of both N_t and A_t , the net effect on $a_t = A_t^{1-\phi}/N_t$ is ambiguous. Notably, however, Proposition 2 shows that a higher value of s unambiguously increases a^* .

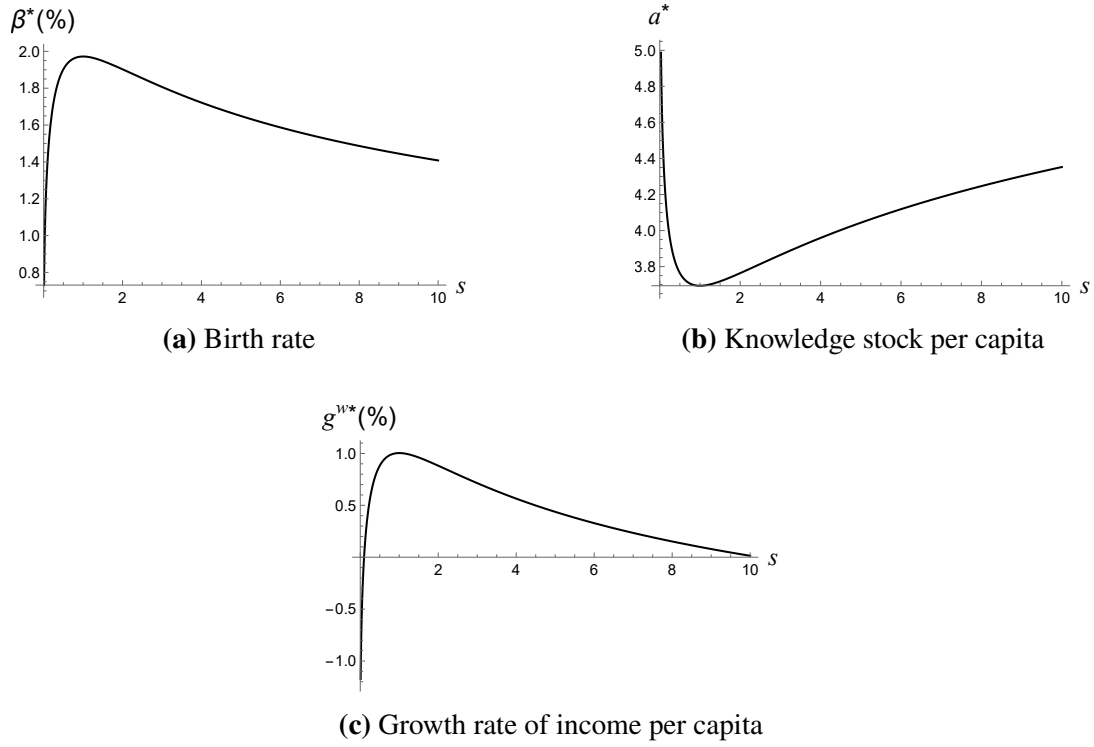


Fig. 4 Effects of gender norms on the focal variables in the steady state

Next, we investigate the effect of the gender norm on the growth rate of income per capita in the steady state.

Proposition 3. *A higher s decreases g_w^* if and only if $s > s^*$.*

Proof. The proof is presented in Appendix G. □

Proposition 3 implies that the growth rate of income per capita peaks when $s = s^*$ and declines as s increases beyond s^* , as shown in Panel (c) of Figure 4. This result has two important implications. First, the presence of a male-dominant gender norm impedes economic growth and reduces welfare. This is because the gender norm distorts the allocation of housework between genders, leading to a lower birth rate and a smaller population. The resulting decline in the number of researchers relaxes R&D activities, thereby slowing the growth rate of income per capita. Consequently, the gender norm reduces the welfare of all generations in the steady state.

The second implication is that when a male-dominant gender norm prevails, the economy accumulates knowledge capital excessively relative to the population size. Proposition

2 suggests that the knowledge stock per capita reaches its minimum when the gender norm does not distort households' time allocation decisions (i.e., $s = s^*$). Combined with Proposition 3, this minimum level of per capita knowledge stock is optimal for maximizing growth. In other words, a higher value of s leads to an overaccumulation of knowledge capital. Because the shadow price of having children is higher, households choose to have fewer children than they would in the absence of gender norms. However, gender norms do not affect the labor supply or asset supply at the household level. Therefore, knowledge capital accumulates at a faster rate than population growth.

The following proposition summarizes our results.

Proposition 4. *There exists $\widehat{s} \in (s^*, \infty)$ such that $\beta^* > \mu$ if and only if $s < \widehat{s}$. Consequently, when $s < \widehat{s}$, the economy can exhibit sustained population growth and income per capita growth along the balanced growth path.*

Proof. This is the immediate result of Propositions 2 and 3. □

4 Policy analysis and transition dynamics

The preceding section implies that a male-dominant gender norm (i.e., $s > s^*$) hinders economic growth and welfare. Accordingly, a reduction in s toward s^* is expected to promote growth and welfare in the steady state. However, when gender norms evolve, the economy cannot instantaneously transition to the new steady state; instead, it undergoes a dynamic adjustment process and gradually converges to the new steady state. Therefore, whether a reduction in s constitutes a Pareto improvement remains a key issue, which we investigate in this section.

4.1 Analytical characterization

Consider the case in which a male-dominant gender norm prevails (i.e., $s > s^*$) and the economy is in the steady state. In this case, the $\dot{\beta} = 0$ and $\dot{a} = 0$ loci are represented

by the blue and red dotted curves in Figure 5, respectively. Moreover, their intersection, denoted by (a_M^*, β_M^*) , indicates the steady state. Here, as a benchmark, we consider the case in which $\beta_M^* = \mu$, namely, we posit a value of s such that the relation that the birth rate equals the mortality rate holds in the steady state.

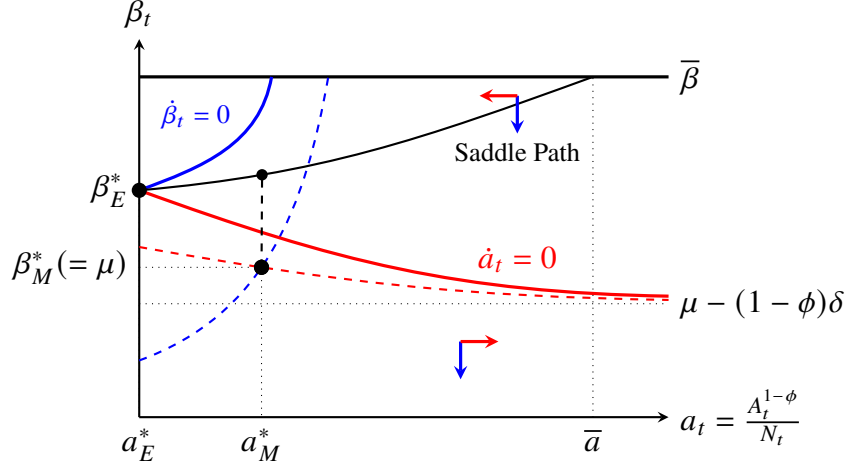


Fig. 5 Phase diagram when gender norms become less conservative

Suppose that an exogenous policy intervention affects attitudes toward gender roles and reduces the gender norm, s . In this case, Equations (54) and (56) indicate that both the $\dot{\beta} = 0$ and the $\dot{a} = 0$ loci shift upward. Accordingly, the blue and red solid curves in Figure 5 represent the ex-post $\dot{\beta} = 0$ and $\dot{a} = 0$ loci, respectively. The figure illustrates that the ex-post steady state, denoted by (a_E^*, β_E^*) , is located to the top-left of the ex-ante steady state. This indicates that relative to the ex-ante steady state, the birth rate increases, while the knowledge stock per capita decreases, which is consistent with Proposition 2. Furthermore, the economy in the ex-post steady state exhibits a higher growth rate of income per capita (Proposition 3).

However, in response to the policy intervention, the economy cannot instantaneously transition from the ex-ante to the ex-post steady state. Specifically, the birth rate is a jump variable, while the knowledge stock per capita is a state variable. Accordingly, when the policy is introduced, the birth rate rises discontinuously to a point on the new saddle path (depicted as the black solid curve in Figure 5), whereas the knowledge stock per capita remains unchanged. Intuitively, a reduction in s lowers the shadow price of having

children, thereby enhancing fertility. Moreover, as Proposition 1 suggests, because the market equilibrium is uniquely determined for each value of s , the economy necessarily jumps to a point on the new saddle path. Ultimately, the economy converges to the ex-post steady state, (a_E^*, β_E^*) , along this path.

The important question is whether a reduction in s and the resulting transition dynamics constitute a Pareto improvement. The following proposition addresses this issue.

Proposition 5. *A decrease in s constitutes a Pareto improvement if and only if*

$$-\frac{d\beta_t}{d\chi} \cdot \frac{\chi}{\beta_t} > 1. \quad (57)$$

Proof. The proof is presented in Appendix H. □

There are two key points. The first concerns why a reduction in s may decrease the lifetime utility of certain generations, even though the economy in the ex-post steady state exhibits a higher growth rate of income per capita. This occurs because the growth rate of income per capita immediately following the policy intervention can be lower than that in the ex-ante steady state. In such a case, an intergenerational trade-off arises: generations alive at the time of the policy intervention experience lower lifetime income (relative to the no-intervention scenario), while generations born in the more distant future benefit from higher lifetime income. Proposition 5 demonstrates that such an intergenerational trade-off is absent if and only if inequality (57) is satisfied.

Second, for a Pareto improvement to be feasible, the elasticity of the birth rate with respect to the shadow price of having children must exceed one. This condition implies that the total expenditure for raising children, $\chi\beta_t$, decreases with χ . In other words, a reduction in χ (induced by a decrease in s) raises $\chi\beta_t$. Because, in this economy, the number of researchers drives income growth, the policy intervention must induce a sufficiently strong increase in fertility to generate a Pareto improvement.

4.2 Numerical exercises

A natural question, then, is whether a Pareto improvement is possible under empirically plausible parameter values. To investigate this, we perform a numerical exercise. Table 1 reports the parameter values, which are chosen to reflect the characteristics of the real-world economy.

Table 1 Parameter values

Description	Parameter	Value	Comment
Subjective discount rate	ρ	0.014	$90 - 18 = 1/\mu$, from Jones (2022)
Mortality rate	μ	0.014	Assumed equal to ρ , from Jones (2022)
Efficiency of women's housework	η_f	0.33	Normalized
Efficiency of men's housework	η_m	0.33	Assumed equal to η_f
Optimal housework ratio	s^*	1	Implied by $s^* = \eta_f/\eta_m$
Preference for children	γ	1	Baudin <i>et al.</i> (2015)
Inverse of markup	α	0.6	De Loecker <i>et al.</i> (2020)
Knowledge obsolescence rate	δ	0.05	De Rassenfosse and Jaffe (2018)
Scale parameter of R&D	λ	1	Normalized
Scale parameter of home production	ξ	0.114	Calibrated so that $n_t = 0$ when $s = 10$
Spillover effect	ϕ	0.62	Calibrated so that $g_t^w = 1\%$ when $s = s^*$

The model incorporates the following exogenous parameters. The subjective discount rate, ρ , is set to 0.014, a standard value in macroeconomic analyses. Following Jones (2022), the mortality rate, μ , is set to ρ , implying a life expectancy of 90 years.⁷ As a benchmark, we consider the case in which $\eta_f = \eta_m = 0.33$, implying no gender gap in the efficiency of performing housework and childcare. Consequently, the optimal housework ratio between genders, $s^* = \eta_f/\eta_m$, equals one. This implies that for any $s > 1$, gender norms distort the intrahousehold time allocation, thereby increasing the shadow price of having children. Following Baudin *et al.* (2015), the preference parameter for children, γ , is set to 1.

According to De Loecker *et al.* (2020), the markup rate in the U.S. economy reached 61% in 2016 (corresponding to $\alpha \approx 0.62$) and has since continued to increase. For simplicity, we set $\alpha = 0.6$. The knowledge obsolescence rate, δ , is set to 0.05, which

⁷We assume that individuals become adults and enter the market at age 18. Thus, $90 - 18 = 1/\mu$.

corresponds to an average firm lifespan of 20 years (De Rassenfosse and Jaffe, 2018).⁸ As a normalization, the scale parameter of the R&D process, λ , is set to 1.

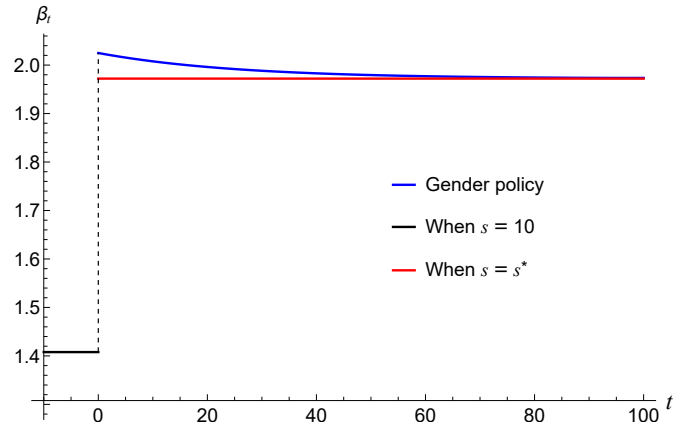
Two parameters are calibrated: the scale parameter of the home production function, ξ , and the parameter capturing the knowledge spillover, ϕ . The former is calibrated such that $n_t = 0$ when $s = 10$; that is, the population growth rate is zero under a strongly male-dominant gender norm. The latter is set so that the growth rate of income per capita equals 1% when $s = s^*$.

Figures 6 and 7 illustrate the policy effects and transitional dynamics of the key variables. Specifically, Panels (a), (b), and (c) of Figure 6 display the birth rate, the growth rate of income per capita, and income per capita, respectively. In Figure 7, Panels (a) and (b) illustrate the trend of the population size and amount of final goods produced. In all the panels, the horizontal axis represents the time in years. In period $t = 0$, the economy is in the ex-ante steady state. The policy intervention is introduced at this point, after which the economy transitions along the new saddle path and gradually converges to the ex-post steady state.

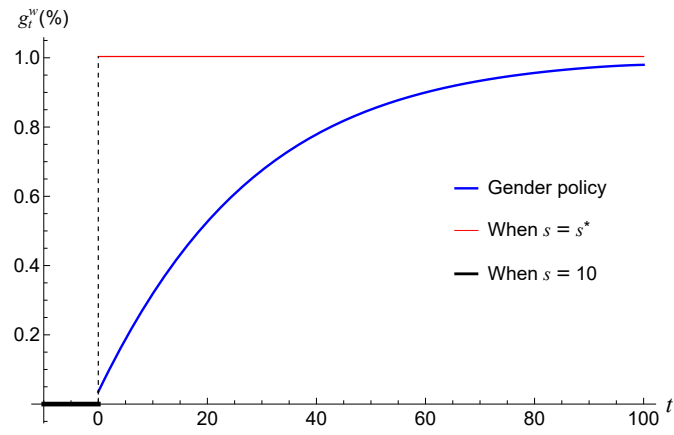
Panel (a) of Figure 6 illustrates the transition dynamics of the birth rate. As shown by the black line, the birth rate remains steady at 1.4 (which equals the mortality rate, μ) until period $t = 0$. The blue curve traces the response to the policy intervention and subsequent transitional dynamics, while the red line, shown for reference, depicts the hypothetical case in which the economy immediately jumps to the ex-post steady state following the policy intervention. Consistent with Figure 5, the birth rate initially overshoots the ex-post steady state and then gradually converges to it.

Panel (b) of Figure 6 provides a direct answer to our central question: whether a Pareto improvement is possible. The answer is affirmative. As indicated by the black line, the growth rate of income per capita is zero until period $t = 0$, implying that in the absence of the policy intervention, income per capita does not grow at any point in time. As in Panel (a), the blue curve represents the transitional path, while the red line serves as a reference,

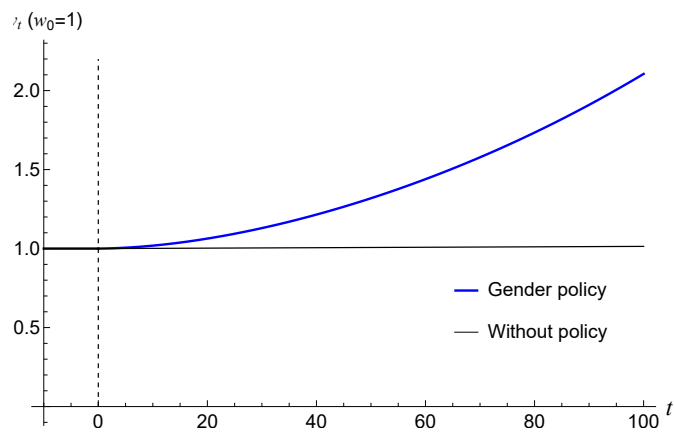
⁸De Rassenfosse and Jaffe (2018) estimate the depreciation rate of innovation in Australia to be between 2% and 7%.



(a) Birth rate

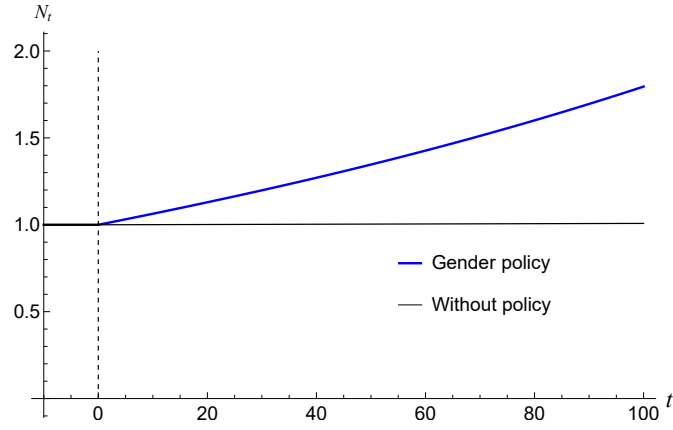


(b) Growth rate of income per capita

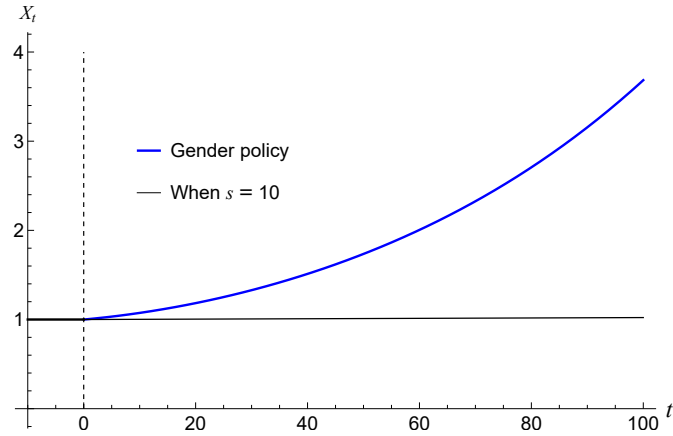


(c) Income per capita

Fig. 6 Transition dynamics: Birth rate and income growth



(a) Population



(b) Final goods output

Fig. 7 Transition dynamics: Population and final goods output

namely, the outcome if the economy were to jump immediately to the ex-post steady state. Notably, in period $t = 0$, the blue curve rises above the baseline, continues to grow over time, and eventually converges to the red line. This trajectory demonstrates that the policy intervention raises the growth rate of income per capita for all $t \geq 0$, thereby improving the welfare of all generations. Panel (c) of Figure 6 corroborates this result by showing the corresponding dynamics of income per capita. This panel indicates that income per capita grows exponentially following the policy intervention and never falls below the baseline level (i.e., $w_0 = 1$).

Finally, Figure 7 depicts the transition dynamics of aggregate behavior. Panel (a)

presents the trend of the population size. The black line indicates that in the absence of the policy intervention, the population remains constant. The blue curve shows that after period $t = 0$, the population size grows steadily over time, consistent with the observed rise in the birth rate in Figure 6. In addition, Panel (b) shows that final goods production increases continuously, indicating that the economy is entering a stage of sustained growth.

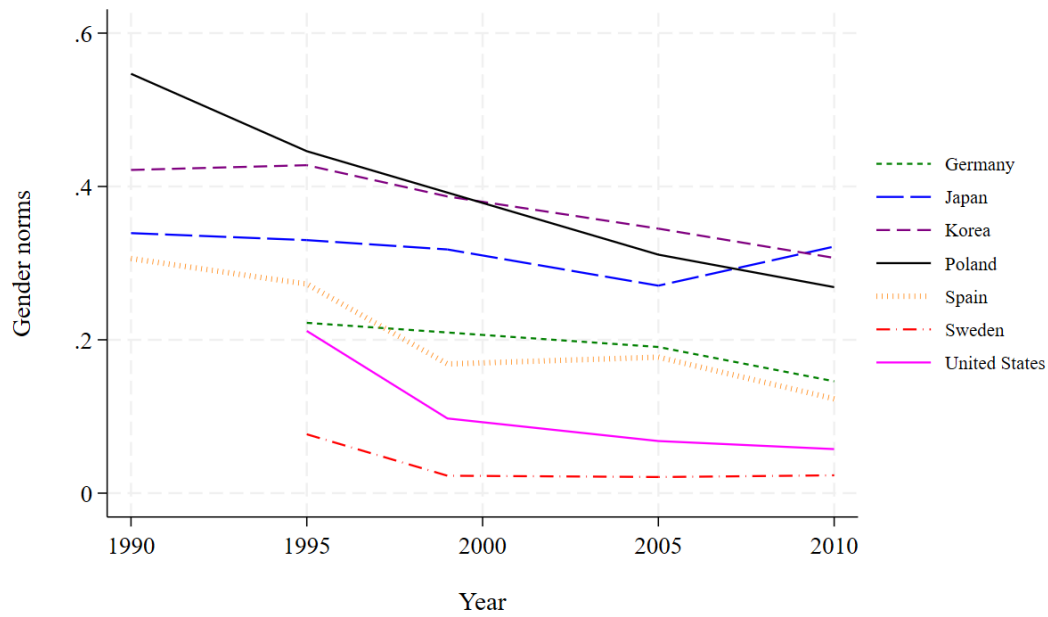
In summary, under plausible parameter values, the condition stated in Proposition 5 is likely to hold. Therefore, a policy intervention that exogenously alleviates the influence of male-dominant gender norms can achieve a Pareto improvement.

5 Evolution of gender norms

Thus far, our analysis has examined the influence of male-dominant gender norms on economic growth, effects of policy interventions, and resulting transition dynamics under the assumption of a static gender norm. This assumption is justified not only by the well-documented persistence of gender norms (Feyrer *et al.*, 2008; Alesina *et al.*, 2013; Myong *et al.*, 2021), but also by recent evidence that such norms, while potentially malleable, tend to shift only in response to deliberate informational interventions that resolve pluralistic ignorance (Bursztyn *et al.*, 2020, 2023), rather than evolving spontaneously. Nevertheless, as Fernández (2013) argues, gender norms may also change gradually over time through processes of social learning. Accounting for the gradual, spontaneous change in gender norms may alter the model’s dynamic implications and associated policy and welfare evaluations. Therefore, we extend our framework to account for the gradual evolution of gender norms and examine how our conclusions differ from the benchmark static norm case.⁹

Before turning to the theoretical analysis, we examine recent trends in gender norms in developed countries using data from the 1990–1994 through 2010–2014 waves of the

⁹Our aim here is not to endogenize the evolution of gender norms, but rather to incorporate the possibility that they change gradually over time. While modeling the underlying mechanism of the evolution of gender norms is certainly important, doing so would considerably complicate the model and distract from our primary focus: analyzing the impact of gender norms on economic growth.



Notes. The figure illustrates the trends of gender norms from 1990 to 2010 across countries. The gender norm measure is from the World Values Survey.

Fig. 8 Trends of gender norms across countries

World Values Survey. Following [Bertrand *et al.* \(2021\)](#), we use participants' responses (agree, disagree, or neither) to the question: "When jobs are scarce, men have more right to a job than women." Based on these responses, we construct a variable representing the proportion of respondents who answered "agree." A higher value of this variable reflects more conservative gender norms.

Figure 8 illustrates the trends in gender norms from 1990 to 2010 for Germany, Japan, Korea, Poland, Spain, Sweden, and the United States. Three key observations emerge. First, although most countries exhibit a noticeable downward trend, substantial international differences in the overall level of agreement with conservative gender roles remain. For example, nearly all respondents in Sweden reject such roles, whereas Japan continues to reflect deeply rooted gender norms. Second, the rate of change differs across countries. In particular, gender norms in Poland have weakened considerably over the past two decades, while Korea shows a relatively flat trajectory. Therefore, their relative rankings are reversed in 2000. Third, the rate of change also varies across periods. In the United States, gender norms shifted markedly during 1995–2000, but the trend flattened

over 2005–2010. A similar pattern is observed in Sweden.

Building on these observations, we extend our model to incorporate the spontaneous evolution of gender norms. Specifically, we assume that the gender norm defined in Equation (5) evolves according to the following differential equation:

$$\dot{s}_t = \sigma s_t (s^* - s_t), \quad (58)$$

where $\sigma > 0$ is the parameter that governs the rate of convergence (or, equivalently, the persistence of the gender norm). As an extreme case, when $\sigma = 0$, it holds that $\dot{s}_t = 0$, indicating that s_t takes the value of s_0 for all periods.

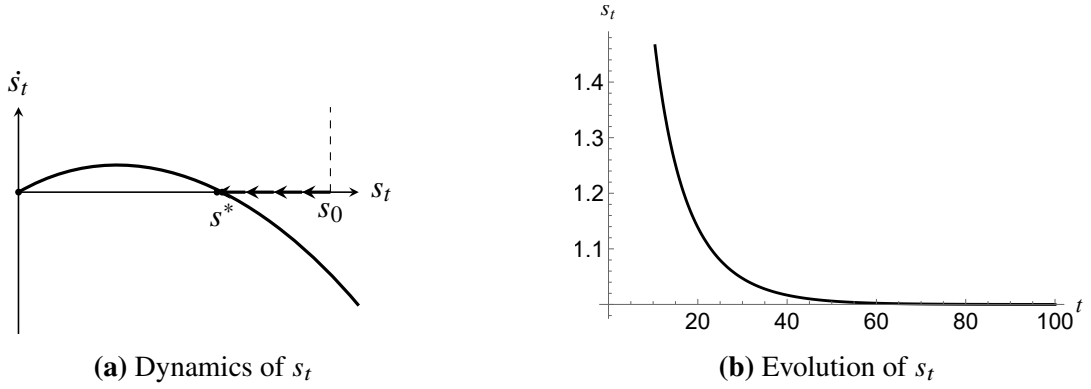


Fig. 9 Evolution of gender norms

Panel (a) of Figure 9 depicts the trajectory of the sequence $\{s_t\}_{t=0}^{\infty}$ over time. Suppose $s_0 > s^*$, meaning that the initial level of gender norms exceeds the optimal ratio of housework between genders. The value of s_t gradually declines and eventually converges to s^* . Consistent with the preceding discussion, the rate of decline slows as s_t approaches the limit, s^* . Panel (b) then illustrates the numerical simulation of the evolution of the gender norm. Specifically, we set $s_0 = 10$, $s^* = 1$, and $\sigma = 0.1$, and analyze the resulting path of the sequence $\{s_t\}_{t=0}^{\infty}$. The simulation shown in Panel (b) indicates that the sequence nearly converges to s^* within 60 years under these parameters.

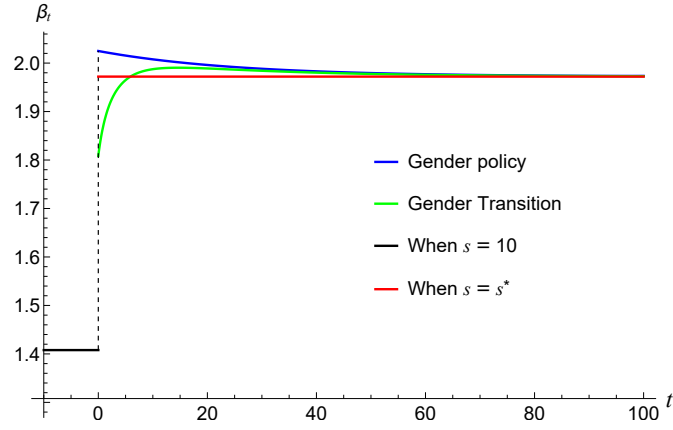
Under this setup, we examine the influence of a male-dominant gender norm on economic growth by comparing two scenarios. In the first scenario, the gender norm is

static and a policy intervention is implemented in period $t = 0$, causing an immediate shift in the gender norm from $s_0 = 10$ to $s_0 = 1$ (Section 4). By contrast, the second scenario assumes a dynamic gender norm: starting at $t = 0$, the sequence $\{s_t\}_{t=0}^{\infty}$ evolves according to the differential equation (58). Importantly, agents are aware of this law of motion and make decisions accordingly. The parameter values used are identical to those in Table 1.

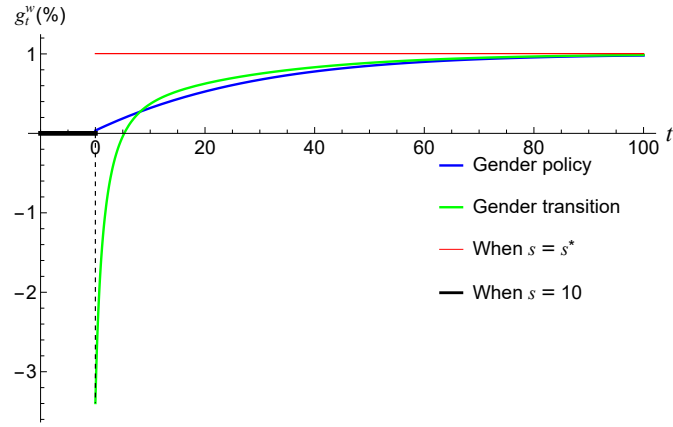
Figure 10 presents the results. Panel (a) illustrates the transition dynamics of the birth rate. The interpretations of the blue curve and red line are consistent with those in Figure 6 in Section 4. The green curve depicts the transition path of the birth rate under the second scenario. Unlike the first scenario, the birth rate does not overshoot the ex-post steady state in period $t = 0$; instead, it jumps to a level below the steady state, reaching approximately 1.8. The birth rate continues to increase over time and surpasses the steady state within 10 years, gradually converging to it from above.

In the second scenario, because the gender norm does not change immediately, the decline in the shadow price of having children is more gradual. Therefore, the green curve exhibits a smaller jump at $t = 0$ than the blue curve. Nevertheless, the birth rate still overshoots the steady state within 10 years, even though it takes about 60 years for the sequence $\{s_t\}_{t=0}^{\infty}$ to nearly converge to its long-run value (Figure 9). This result reflects that households, being forward-looking, make fertility decisions based on the anticipated erosion of male-dominant gender norms over time. This highlights the importance of household expectations of the evolution of gender norms for understanding and forecasting population dynamics.

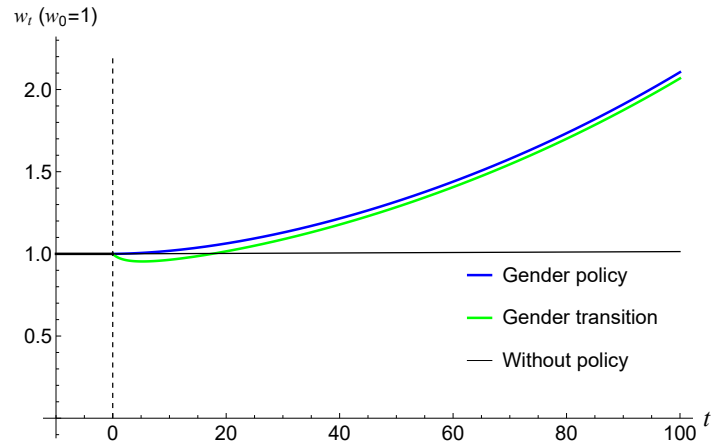
Panel (b) illustrates the transition dynamics of the growth rate of income per capita. As shown in Section 4, the blue curve never falls below the horizontal axis, which represents the baseline growth rate ($g_t^w = 0$). By contrast, as shown by the green curve, the growth rate temporarily declines to approximately -3% under the second scenario, falling below the baseline. Nevertheless, it subsequently recovers, reaching the baseline within five years and eventually converging to 1% . This pattern suggests the emergence of an intergenerational trade-off when the male-dominant gender norm begins to fade—a



(a) Birth rate



(b) Growth rate of income per capita



(c) Income per capita

Fig. 10 Transition dynamics when gender norms evolve over time

clear contrast to the first scenario in which a Pareto improvement is attainable.

Panel (c) complements this finding by depicting the transition dynamics of income per

capita. Consistent with Panel (b), income per capita initially falls below the baseline level (i.e., $w_0 = 1$), returns to it within 20 years, and ultimately exhibits exponential growth. Naturally, the size of the intergenerational trade-off depends critically on the persistence parameter, σ . A more persistent gender norm (i.e., a smaller σ) entails a longer period before income per capita recovers to the baseline level.

What can we learn from this series of analyses? First, the real-world economy likely lies somewhere between the two benchmark scenarios discussed above. This is because gender norms can evolve gradually and endogenously through social learning (Bisin and Verdier, 2000, 2001; Fernández, 2013), while they may also shift rapidly in response to exogenous policy interventions (Bursztyn *et al.*, 2020, 2023). Consequently, during the transition toward more egalitarian norms, welfare losses may arise for certain generations, potentially hindering the evolution of gender norms or complicating the implementation of gender equality-enhancing policies.

Given these dynamics, how should policymakers address the adverse effects of gender norms on fertility and economic growth? Figure 10 highlights the importance of the convergence rate, namely, the speed at which gender norms evolve. A proactive application of Bursztyn-type informational interventions may accelerate changes in norms, thereby bringing the economy closer to the first scenario. In parallel, complementary policies that promote attitudinal shifts toward a more equitable division of labor are essential to gradually transform societal mindsets. Such policies help lower the persistence of gender norms (i.e., increasing σ) and reshape individuals' expectations of future norms over time. These evolving expectations help mitigate the intergenerational trade-off, fostering both higher fertility and sustainable economic growth.

6 Conclusions

We examine the influence of gender norms on economic growth, along with the associated policy and welfare implications. To this end, we construct an overlapping generations

model with endogenous fertility and labor supply, incorporating both gender norms and R&D activities. Using this framework, we analyze the impact of gender norms on the economy, focusing on both the steady state and the transition dynamics.

Our findings are threefold. First, conservative gender norms depress both the birth rate and the growth rate of income per capita in the steady state. The underlying mechanism is that such norms distort the intrahousehold allocation of housework, thereby reducing the efficiency of home production. The resulting rise in the shadow price of having children discourages households from having large families, which in turn lowers the population growth rate. This decline in population growth reduces the number of researchers, thereby inhibiting R&D activities and the accumulation of knowledge capital. However, because the increased shadow price does not affect the labor or asset supply per household, knowledge capital accumulates at a faster rate than population growth. Therefore, conservative gender norms lead to an excessive per capita accumulation of knowledge capital.

Second, based on the transition dynamics, we derive policy and welfare implications. Assuming a policy intervention that mitigates gender norms instantaneously, we characterize the transitional path of the economy. We identify a sufficient and necessary condition under which such a policy yields a Pareto improvement. Furthermore, our numerical exercises suggest that a Pareto improvement is indeed attainable under empirically plausible parameter values.

Third, we extend our model by incorporating the spontaneous evolution of gender norms observed in developed economies. We find that when norms gradually shift toward gender equality, intergenerational trade-offs may arise: some generations may experience lower lifetime income than in a scenario in which gender norms remain unchanged. Moreover, the speed of norm convergence plays a crucial role in determining the welfare losses. Taken together with our second finding, the results underscore the importance of jointly implementing Bursztyn-type informational interventions and complementary policies that promote attitudinal changes toward a more equitable division of labor to accelerate the evolution of gender norms.

Future research could aim to endogenize the evolution of gender norms. While gender norms influence households' time allocation and fertility behavior, the resulting individual and aggregate behaviors may in turn reshape gender norms. Investigating this bidirectional relationship would help explain the international variation in gender norms. Moreover, given the persistence of such norms, evaluating the effectiveness of public policies, including childcare provision, parental leave schemes, and social security systems, is essential for offering detailed policy and welfare recommendations.

Appendix A Couples' problem and aggregation

A.1 Couples' consumption and fertility

A couple of generation j in period t solves the following utility maximization problem:

$$\max_{c_{j,t}, \beta_{j,t}, k_{j,t}, h_{j,t}^f, h_{j,t}^m, e_{j,t}} u_j = \int_s^\infty e^{-(\rho+\mu)(t-j)} [\ln c_{j,t} + \gamma \ln \beta_{j,t}] dt, \quad (\text{A.1})$$

$$\text{s.t. } \dot{k}_{j,t} = (r_t + \mu)k_{j,t} + (1 - h_{j,t}^f - h_{j,t}^m)w_t - c_{j,t} - e_{j,t}, \quad (\text{A.2})$$

$$\beta_{j,t} = \xi (h_{j,t}^f)^{\eta_f} (h_{j,t}^m)^{\eta_m} \left(\frac{e_{j,t}}{w_t} \right)^{1-\eta_f-\eta_m}, \quad (\text{A.3})$$

$$h_{j,t}^f = s h_{j,t}^m, \quad (\text{A.4})$$

$$\text{given } k_{j,0}, \quad (\text{A.5})$$

Before solving this problem, we derive the cost function of home production. We consider the following cost-minimization problem:

$$\min_{h_{j,t}^f, h_{j,t}^m, e_{j,t}} w_t h_{j,t}^f + w_t h_{j,t}^m + e_{j,t} \quad (\text{A.6})$$

subject to Equations (A.3) and (A.4). Arranging the first-order conditions yields the

following input demand functions:

$$h_{j,t}^f(\beta_{j,t}) = s h_{j,t}^m(\beta_{j,t}), \quad (\text{A.7})$$

$$h_{j,t}^m(\beta_{j,t}) = \frac{\eta_f + \eta_m}{1 + s} \cdot \chi \beta_{j,t}, \quad (\text{A.8})$$

$$e_{j,t}(\beta_{j,t}) = (1 - \eta_f - \eta_m) \chi w_t \beta_{j,t}, \quad (\text{A.9})$$

where

$$\chi \equiv \frac{s^{-\eta_f} (1 + s)^{\eta_f + \eta_m}}{\xi(\eta_f + \eta_m)^{\eta_f + \eta_m} (1 - \eta_f - \eta_m)^{1 - \eta_f - \eta_m}}.$$

Substituting Equations (A.7)–(A.9) into (A.6), we obtain the following cost function of having children:

$$\widehat{C}(\beta_{j,t}) = \chi w_t \beta_{j,t}, \quad (\text{A.10})$$

indicating that χw_t is the unit cost of having children. We refer to χ as the shadow price of having children, which is time-invariant and hinges on the gender norm, s .

Substituting the cost function in (A.10) into the budget constraint in (A.2), the couple's utility maximization problem in (A.1)–(A.5) becomes

$$\begin{aligned} \max_{c_{j,t}, \beta_{j,t}, k_{j,t}} \quad & U_j = \int_j^\infty e^{-(\rho+\mu)(t-j)} (\ln c_{j,t} + \gamma \ln \beta_{j,t}) dt, \\ \text{s.t.} \quad & \dot{k}_{j,t} = (r_t + \mu)k_{j,t} + (1 - \chi \beta_{j,t})w_t - c_{j,t}, \\ \text{given} \quad & k_{j,0}. \end{aligned} \quad (\text{A.11})$$

Then, the current value Hamiltonian is given by

$$\mathcal{H}^C = \ln c_{j,t} + \gamma \ln \beta_{j,t} + \psi_{j,t} [(r_t + \mu)k_{j,t} + (1 - \chi \beta_{j,t})w_t - c_{j,t}],$$

where $\psi_{j,t}$ denotes the co-state variable. The optimality conditions are given by

$$\frac{\partial \mathcal{H}^C}{\partial c_{j,t}} = \frac{\partial \mathcal{H}^C}{\partial \beta_{j,t}} = 0 \iff \frac{1}{c_{j,t}} = \psi_{j,t}, \quad \frac{\gamma}{\beta_{j,t}} = \psi_{j,t} \chi w_t, \quad (\text{A.12})$$

$$\frac{\partial \mathcal{H}^C}{\partial k_{j,t}} - (\rho + \mu) \psi_{j,t} = \dot{\psi}_{j,t}, \quad (\text{A.13})$$

$$\text{T.V.C.} \quad \lim_{T \rightarrow \infty} e^{-(\rho+\mu)T} \psi_{j,T} k_{j,T} \leq 0.$$

Arranging the conditions in (A.12) yields the following intratemporal condition:

$$\beta_{j,t} = \frac{\gamma c_{j,t}}{\chi w_t}, \quad (\text{A.14})$$

implying that the marginal rate of substitution between consumption and having children must equal their price ratio. In addition, combining Equations (A.12) with (A.13), we obtain the Euler equation (i.e., the intertemporal condition) as follows:

$$\dot{c}_{j,t} = (r_t - \rho) c_{j,t}.$$

Differentiating this equation with respect to t yields consumption in period τ as follows:

$$c_{j,\tau} = c_{j,t} e^{\int_t^\tau (r_m - \rho) dm}. \quad (\text{A.15})$$

Integrating Equation (A.11) and using the no-Ponzi game condition, we obtain the following intertemporal budget constraint:

$$\int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} c_{j,\tau} d\tau = \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (1 - \chi \beta_{j,t}) w_\tau d\tau + k_{j,t}.$$

Combined with Equation (A.15), we obtain

$$c_{j,t} \int_t^\infty e^{-(\rho+\mu)(\tau-t)} d\tau = \omega_{j,t} + k_{j,t},$$

where

$$\omega_{j,t} \equiv \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (1 - \chi \beta_{j,t}) w_\tau d\tau. \quad (\text{A.16})$$

Here, $\omega_{j,t}$ is the present discounted value of the lifetime labor income (i.e., the human wealth) subtracted from the cost associated with child-rearing. Consequently, the couple's consumption propensity is derived as

$$c_{j,t} = (\rho + \mu)(k_{j,t} + \omega_{j,t}). \quad (\text{A.17})$$

Differentiating Equation (A.16) with respect to t yields

$$\dot{\omega}_{j,t} = \int_t^\infty \frac{d}{dt} e^{-\int_t^\tau (r_m + \mu) dm} (1 - \chi \beta_{j,t}) w_\tau d\tau - (1 - \chi \beta_{j,t}) w_t.$$

Let $\zeta_t \equiv -\int_t^\tau (r_m + \mu) dm$. Then, the first term on the right-hand side of the above equation is rewritten as

$$\int_t^\tau \frac{d}{dt} e^{-\int_t^\tau (r_m + \mu) dm} (1 - \chi \beta_{j,t}) w_\tau d\tau = \int_t^\tau \frac{d\zeta_t}{dt} \cdot \frac{de^{-\int_t^\tau (r_m + \mu) dm}}{d\zeta_t} (1 - \chi \beta_{j,t}) w_\tau d\tau.$$

Combined with Equation (A.16), the dynamics of the human wealth are given by

$$\dot{\omega}_{j,t} = (r_t + \mu)\omega_{j,t} - (1 - \chi \beta_{j,t}) w_t. \quad (\text{A.18})$$

The first term presents the increased wealth at the rate of the discount rate, $r_t + \mu$, while the second term represents the decreased wealth due to the passage of an infinitesimal amount of time.

A.2 Aggeregated variables

A.2.1 Aggregate consumption and monetary input into children

First, aggregate consumption, monetary input into children, and assets are defined as follows:

$$C_t = \int_{-\infty}^t c_{j,t} N_{j,t} dj, \quad E_t = \int_{-\infty}^t e_{j,t} N_{j,t} dj, \quad K_t = \int_{-\infty}^t k_{j,t} N_{j,t} dj. \quad (\text{A.19})$$

Substituting the input demand function of $e_{j,t}$ in (A.9) into the intratemporal condition in (A.14) yields the relationship between the monetary input and consumption as follows:

$$e_{j,t} = \gamma(1 - \eta_f - \eta_m) c_{j,t}. \quad (\text{A.20})$$

Combined with Equation (A.19), we derive the following relationship between C_t and E_t :

$$E_t = \gamma(1 - \eta_f - \eta_m) C_t, \quad (17)$$

implying that the aggregate monetary input is proportional to aggregate consumption. Hence, their growth rates are identical.

A.2.2 Population dynamics

Combining the definition of the population of generation t in period t , $N_{t,t}$, in (19), the intratemporal condition in (A.14), and the definition of the aggregate variables in (A.19) yields

$$N_{t,t} = \frac{\gamma}{\chi} \cdot \frac{C_t}{w_t}.$$

Substituting this equation into the definition of the population growth rate $n_t = \dot{N}_t/N_t$, we obtain

$$n_t = \beta_t - \mu, \quad (\text{A.21})$$

where

$$\beta_t \equiv \frac{\gamma}{\chi} \cdot \frac{C_t}{w_t N_t}.$$

The first and second terms on the right-hand side of Equation (A.21) represent the fertility and mortality rates, respectively. The former corresponds to the average number of children born to couples from generation $-\infty$ to t . Along the balanced growth path, the population growth rate remains constant because aggregate consumption (as well as aggregate income) grows at the sum of the technological progress and population growth rates.

In addition, arranging Equation (A.21) yields the population of generation t (i.e., the number of those born in period t) as follows:

$$N_{t,t} = (n_t + \mu)N_t = \beta_t N_t. \quad (\text{A.22})$$

A.2.3 Aggregate labor supply

Each couple is endowed with one unit of time. Combining this time constraint with the input demand functions in (A.7) and (A.8) yields the following relationship:

$$L_{j,t} = 1 - (\eta_f + \eta_m)\chi\beta_{j,t}. \quad (\text{A.23})$$

Combined with the definition of the aggregate variables in (22) and (23), we derive the aggregate labor supply function as follows:

$$L_t = [1 - (\eta_f + \eta_m)\chi\beta_t] N_t. \quad (20)$$

A.2.4 Dynamics of aggregate consumption

The aggregate human wealth in period t is denoted by

$$\Omega_t \equiv \int_{-\infty}^t \omega_{j,t} N_{j,t} dj. \quad (A.24)$$

Combining the couple's consumption propensity in (A.17) with Equations (A.19) and (A.24), we obtain

$$C_t = (\rho + \mu)(\Omega_t + K_t), \quad (A.25)$$

indicating that aggregate consumption equals the consumption propensity multiplied by the aggregate wealth, $\Omega_t + K_t$. Differentiating this equation with respect to t , we derive

$$\dot{C}_t = (\rho + \mu) (\dot{\Omega}_t + \dot{K}_t). \quad (A.26)$$

To elucidate the dynamics of aggregate consumption, $\dot{C}_t$, we next examine the dynamics of the aggregate human wealth and assets, $\dot{\Omega}_t$ and $\dot{K}_t$. First, differentiating the definition of aggregate assets in (A.19) with respect to t yields

$$\dot{K}_t = \int_{-\infty}^t \dot{k}_{j,t} N_{j,t} dj + \int_{-\infty}^t k_{j,t} \dot{N}_{j,t} dj,$$

where we use the relation $k_{j,j} = 0$ because a newborn generation possess no assets. Substituting the couple's budget constraint in (A.11), the dynamics of the population of generation j , $\dot{N}_{j,t} = -\mu N_{j,t}$, and the number of newborn children, $N_{t,t} = \int_{-\infty}^t \beta_{j,t} N_{j,t} dj$,

into the above equation yields

$$\dot{K}_t = r_t K_t + w_t N_t - C_t - \chi w_t N_{t,t}.$$

Combined with Equation (A.22), we derive the dynamics of aggregate assets as follows:

$$\dot{K}_t = r_t K_t + (1 - \chi \beta_t) w_t N_t - C_t. \quad (\text{A.27})$$

We next examine the dynamics of aggregate human wealth. Differentiating Equation (A.24) with respect to t and applying the Leibniz rule yields

$$\dot{\Omega}_t = \int_{-\infty}^t \dot{\omega}_{j,t} N_{j,t} dj + \int_{-\infty}^t \omega_{j,t} \dot{N}_{j,t} dj + \omega_{t,t} N_{t,t}.$$

Combining Equation (A.16) with Equation (A.14), we obtain

$$\begin{aligned} \omega_{j,t} &= \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (w_\tau - \gamma c_{j,\tau}) d\tau \\ &= \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (w_\tau - \gamma c_{t,\tau}) d\tau - \gamma \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (c_{j,\tau} - c_{t,\tau}) d\tau \\ &= \omega_{t,t} - \gamma \int_t^\infty e^{-\int_t^\tau (r_m + \mu) dm} (c_{j,\tau} - c_{t,\tau}) d\tau. \end{aligned} \quad (\text{A.28})$$

Let $j < t < \tau$. Then, Equation (A.15) implies

$$c_{j,\tau} = c_{j,t} e^{\int_t^\tau (r_m - \rho) dm} \quad \text{and} \quad c_{t,\tau} = c_{t,t} e^{\int_t^\tau (r_m - \rho) dm}.$$

Substituting these equations into Equation (A.28) yields

$$\begin{aligned} \omega_{j,t} &= \omega_{t,t} - \frac{\gamma}{\rho + \mu} (c_{j,t} - c_{t,t}) \\ &= (1 + \gamma) \omega_{t,t} - \frac{\gamma}{\rho + \mu} c_{j,t}, \end{aligned} \quad (\text{A.29})$$

where the second equality follows from the couple's consumption propensity in (A.17) and

the relation $k_{t,t} = 0$ (i.e., $c_{t,t} = (\rho + \mu)w_{t,t}$). Combining Equation (A.29) with Equation (A.24) yields

$$\omega_{t,t} = \frac{\gamma}{(\rho + \mu)(1 + \gamma)} \cdot \frac{C_t}{N_t} + \frac{1}{1 + \gamma} \cdot \frac{\Omega_t}{N_t}. \quad (\text{A.30})$$

Substituting the dynamics of the couple's human wealth in (A.18), the number of newborn children in (A.22), the aggregate consumption propensity in (A.25), and the human wealth of newborn children in (A.30), we derive the dynamics of the aggregate human wealth as follows:

$$\dot{\Omega}_t = \frac{(r_t + \beta_t)C_t}{\rho + \mu} - (1 - \chi\beta_t)w_tN_t - r_tK_t - \frac{\beta_tK_t}{1 + \gamma}. \quad (\text{A.31})$$

Finally, substituting Equations (A.27) and (A.31) into Equation (A.26) yields the dynamics of aggregate consumption as follows:

$$\dot{C}_t = (r_t - \rho + \beta_t - \mu)C_t - \frac{\beta_t(\rho + \mu)}{1 + \gamma}K_t.$$

Appendix B Transversality conditions

We show that the path starting from $\beta_0 < \beta_0^*$ violates the transversality condition (TVC), where β_0^* denotes the initial birth rate on the saddle path for the given a_0 . Importantly, along this path, $\beta_t \rightarrow 0$ and $a_t \rightarrow \infty$. The TVC is given by

$$\lim_{T \rightarrow \infty} e^{-(\rho + \mu)(T-t)} \psi_{j,T} k_{j,T} \leq 0. \quad (\text{B.1})$$

Notably, the following relationships hold:

$$c_{j,T} = c_{j,t} \exp \left[\int_t^T (r_m - \rho) dm \right], \quad (\text{B.2})$$

$$\psi_{j,T} = \psi_{j,t} \exp \left[- \int_t^T (r_m - \rho) dm \right], \quad (\text{B.3})$$

$$k_{j,T} = \frac{c_{j,T}}{\rho + \mu} - \omega_{j,T}. \quad (\text{B.4})$$

Substituting Equation (B.3) into (B.1) yields

$$\lim_{T \rightarrow \infty} \exp \left[- \int_t^T (r_m + \mu) dm \right] k_{j,T} \leq 0. \quad (\text{B.5})$$

In addition, the interest rate satisfies the following relationship:

$$r_t = \frac{\lambda(1-\alpha)}{\alpha} \cdot \frac{\zeta \chi \beta_t}{a_t} + \lambda \left(\frac{1-\alpha}{\alpha} - \phi \right) \frac{1 - (\zeta + \eta_f + \eta_m) \chi \beta_t}{a_t} - \left(\frac{1-\alpha\phi}{\alpha} \right) \delta.$$

When $\beta_t \rightarrow 0$ and $a_t \rightarrow \infty$, $r_t \rightarrow - \left(\frac{1-\alpha\phi}{\alpha} \right) \delta < 0$ and $g_t^w \rightarrow 0$. This means that $\lim_{t \rightarrow \infty} w_t$ is a constant value. Substituting these into the definition of $\omega_{j,t}$ yields

$$\lim_{t \rightarrow \infty} \omega_{j,t} = \lim_{t \rightarrow \infty} \frac{w_t}{r_t + \mu} < 0. \quad (\text{B.6})$$

Here, since $\lim_{t \rightarrow \infty} r_t$ is negative and $\lim_{t \rightarrow \infty} w_t$ is constant, $\lim_{t \rightarrow \infty} \omega_{j,t}$ takes a negative finite value. From Equation (B.4), it holds that $k_{j,T} \geq -\omega_{j,T}$. Hence, we obtain

$$\begin{aligned} \lim_{T \rightarrow \infty} \exp \left[- \int_t^T (r_m + \mu) dm \right] k_{j,T} &\geq \lim_{T \rightarrow \infty} \exp \left[- \int_t^T (r_m + \mu) dm \right] (-\omega_{j,T}) \\ &= \lim_{T \rightarrow \infty} \exp \left[- \int_t^T (r_m + \mu) dm \right] \frac{-w_T}{r_T + \mu} \\ &\geq 0, \end{aligned}$$

where, in the second line, we use the relationship in (B.6). The above inequality implies a violation of the TVC.

Subsequently, we verify whether the equilibrium path satisfies the TVC. From Equation (B.4), we obtain $k_{j,T} \leq c_{j,T}/(\rho + \mu)$. Substituting this into Equation (B.5) yields

$$\begin{aligned}
& \lim_{T \rightarrow \infty} \exp \left[- \int_t^T (r_m + \mu) dm \right] k_{j,T} \\
& \leq \lim_{T \rightarrow \infty} \exp \left[- \int_t^T (r_m + \mu) dm \right] \frac{c_{j,T}}{\rho + \mu} \\
& = \lim_{T \rightarrow \infty} \exp \left[- \int_t^T (r_m + \mu) dm \right] \frac{1}{\rho + \mu} \cdot c_{j,t} \exp \left[\int_t^T (r_m - \rho) dm \right] \\
& = \lim_{T \rightarrow \infty} e^{-(\rho+\mu)(T-t)} \frac{c_{j,t}}{\rho + \mu} \\
& = \frac{c_{j,t}}{\rho + \mu} \cdot \lim_{T \rightarrow \infty} e^{-(\rho+\mu)(T-t)} \\
& = 0,
\end{aligned}$$

where we use Equation (B.2) in the third line. This inequality implies that the equilibrium path satisfies the TVC.

Appendix C Equilibrium when R&D activities are undertaken

Consider the case in which the free entry condition in (36) does not hold with equality (i.e., $\dot{A}_t = 0$). In this case, because $L_t^R = 0$ holds, the labor market clearing condition in (42) implies $L_t^P = L_t$. In addition, because the R&D labor-to-population ratio, ℓ_t^R , equals zero, Equation (45) indicates that the birth rate is $\bar{\beta}$. Consequently, the population grows at a constant rate of $\bar{\beta} - \mu$. From Equation (25), when the population growth rate is constant, the aggregate labor supply grows at the same rate.

The fact that the knowledge stock remains constant over time, combined with the production technology for final goods in (34) and the good market equilibrium condition in (40), indicates that aggregate consumption grows at the same rate as population growth

in equilibrium. The interest rate is determined as follows:

$$\frac{\dot{C}_t}{C_t} = \bar{\beta} - \mu \quad \Longleftrightarrow \quad r_t = \rho + \frac{\bar{\beta}(\rho + \mu)}{1 + \gamma} \cdot \frac{K_t}{C_t}. \quad (\text{C.1})$$

Appendix D Proof of Lemma 3

First, we rewrite the $\dot{\beta}_t = 0$ locus in (54):

$$\beta_t = \frac{\frac{\gamma(\rho+\mu)}{(1+\gamma)\chi\lambda}a_t^2 + [\rho + (1-\phi)\delta]a_t}{\left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m)\right]\lambda\chi} + \frac{\phi}{\left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m)\right]\chi}.$$

Using this equation, we examine the concavity of the function $\beta_t(a_t)$ along the $\dot{\beta}_t = 0$ locus. Because all the parameters except for ϕ are positive, the quadratic function is concave if and only if the bracket in the denominator of the first term is negative. That is,

$$\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m) < 0 \quad \Longleftrightarrow \quad \phi < \bar{\phi} \equiv -\frac{1-\alpha}{\alpha} \cdot \frac{\zeta}{\zeta + \eta_f + \eta_m}.$$

The proof is complete.

Appendix E Proof of Proposition 1

We show that for any initial state a_0 , there exists a globally stable steady state (β^*, a^*) . From Equation (56), along the $\dot{a}_t = 0$ locus, β_t monotonically decreases with a_t for any $a_t \in (0, \infty)$. In addition, when $a_t \rightarrow \infty$, the locus asymptotically approaches the horizontal line $\beta_t = \mu - (1 - \phi)\delta$.

Regarding the $\dot{\beta}_t = 0$ locus, we have to consider the following two cases. First, when $\phi \in (\bar{\phi}, 1)$, β_t is a convex function of a_t along the $\dot{\beta}_t = 0$ locus (Lemma 3). However, because the function $\beta_t(a_t)$ attains the minimum at $a_t < 0$, β_t monotonically increases with a_t for any $a_t \in (0, \infty)$. Moreover, the intercept of $\dot{a}_t = 0$ locus is higher than that of $\dot{\beta}_t = 0$ locus, implying a single intersection with $\beta^* > 0$ and $a^* > 0$.

By contrast, when $\phi > 1$, β_t is a concave function of a_t along the $\dot{\beta}_t = 0$ locus (Lemma 3). A similar argument ensures that β_t monotonically decreases with a_t for any $a_t \in (0, \infty)$. Furthermore, the intercept of the $\dot{\beta}_t = 0$ locus is higher than that of the $\dot{a}_t = 0$ locus. Moreover, $\partial^2 \beta_t(a_t)/\partial a_t^2 > 0$ holds along the $\dot{\beta}_t = 0$ locus, whereas the opposite holds along the $\dot{a}_t = 0$ locus. Therefore, there is a single intersection with $\beta^* > 0$ and $a^* > 0$. Consequently, in either case in which $\phi \in (\bar{\phi}, 1)$ or $\phi > 1$, there exists a unique steady state $(\beta^*, a^*) \in \mathbb{R}_{++}^2$.

Finally, we demonstrate that the steady state is globally stable for any initial state $a_0 \in (0, \bar{a})$. When $\phi \in (\bar{\phi}, 1)$, the $\dot{\beta}_t = 0$ locus attains $\bar{\beta}$ at a_t that is less than $\bar{a}$, indicating $a^* < \bar{a}$. Because the $\dot{a}_t = 0$ locus ranges between 0 and $\bar{\beta}$, it holds that $\beta^* < \bar{\beta}$. Combined with the system of equations in (51) and (53), the steady state (β^*, a^*) where $\beta^* \in (0, \bar{\beta})$ and $a^* \in (0, \bar{a})$ is globally stable for any initial state $a_0 \in (0, \bar{a})$. A similar argument holds in the case of $\phi > 1$.

Appendix F Proof of Proposition 2

We examine the effects of the gender norm on the birth rate and knowledge stock per capita in the steady state. Because when $s > s^*$, χ monotonically increases with s , we investigate the above effects using χ instead of s . First, we reformulate Equations (54) and (56) (i.e., the $\dot{\beta} = 0$ and $\dot{a} = 0$ loci) as implicit functions, as follows:

$$F_{\dot{\beta}=0}(a_t, \beta_t) = \frac{\frac{\gamma(\rho+\mu)}{(1+\gamma)\chi\lambda}a_t^2 + [\rho + (1-\phi)\delta]a_t}{\left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m)\right]\lambda\chi} + \frac{\phi}{\left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m)\right]\chi} - \beta_t, \quad (\text{F.1})$$

$$F_{\dot{a}=0}(a_t, \beta_t) = [\beta_t - \mu + (1-\phi)\delta]a_t - \lambda(1-\phi) \left[1 - (\zeta + \eta_f + \eta_m)\chi\beta_t\right]. \quad (\text{F.2})$$

Because it holds that $F_{\dot{\beta}=0}(a_t, \beta_t : \chi) = F_{\dot{a}=0}(a_t, \beta_t : \chi) = 0$, $dF_{\dot{\beta}=0}(a_t, \beta_t : \chi) = dF_{\dot{a}=0}(a_t, \beta_t : \chi) = 0$ is also satisfied. Taking the total differential of Equations (F.1) and

(F.2) with respect to a_t , β_t , and χ yields

$$\begin{bmatrix} \left. \frac{\partial F_{\dot{a}=0}}{\partial a_t} \right|_{(a^*, \beta^*)} & \left. \frac{\partial F_{\dot{a}=0}}{\partial \beta_t} \right|_{(a^*, \beta^*)} \\ \left. \frac{\partial F_{\dot{\beta}=0}}{\partial a_t} \right|_{(a^*, \beta^*)} & \left. \frac{\partial F_{\dot{\beta}=0}}{\partial \beta_t} \right|_{(a^*, \beta^*)} \end{bmatrix} \begin{bmatrix} \frac{da_t}{d\chi} \\ \frac{d\beta_t}{d\chi} \end{bmatrix} = \begin{bmatrix} \left. \frac{\partial F_{\dot{a}=0}}{\partial \chi} \right|_{(a^*, \beta^*)} \\ \left. \frac{\partial F_{\dot{\beta}=0}}{\partial \chi} \right|_{(a^*, \beta^*)} \end{bmatrix},$$

or equivalently

$$\frac{d\beta}{d\chi} + \frac{\beta^*}{\chi} = -\frac{\beta^* - \mu + (1 - \phi)\delta}{\lambda(1 - \phi)(\zeta + \eta_f + \eta_m)\chi} \cdot \frac{da}{d\chi} - \frac{a^*}{\lambda(1 - \phi)(\zeta + \eta_f + \eta_m)\chi} \cdot \frac{d\beta}{d\chi} \quad (\text{F.3})$$

and

$$\begin{aligned} & \frac{\frac{2\gamma(\rho+\mu)}{(1+\gamma)\lambda\chi}a^* + (1 - \phi)\delta + \rho}{\lambda \left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m) \right] \chi} \cdot \frac{da}{d\chi} - \frac{d\beta}{d\chi} \\ &= \frac{\beta^*}{\chi} + \frac{1}{\left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m) \right] \chi} \cdot \frac{\gamma(\rho + \mu)(a^*)^2}{(1 + \gamma)\lambda^2\chi^2}. \end{aligned} \quad (\text{F.4})$$

Using Equations (F.3) and (F.4), we obtain

$$\frac{da}{d\chi} = \frac{\frac{a^*}{a^* + \lambda(1 - \phi)(\zeta + \eta_f + \eta_m)\chi} \cdot \frac{\beta^*}{\chi} + \frac{\frac{\gamma(\rho + \mu)(a^*)^2}{(1 + \gamma)\lambda^2\chi^2}}{\left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m) \right] \chi}}{\frac{[\beta^* - \mu + (1 - \phi)\delta]\chi}{a^* + \lambda(1 - \phi)(\zeta + \eta_f + \eta_m)\chi} + \frac{\frac{2\gamma(\rho + \mu)}{(1 + \gamma)\lambda\chi^2}a^* + (1 - \phi)\delta + \rho}{\lambda \left[\frac{1-\alpha}{\alpha}\zeta + \phi(\zeta + \eta_f + \eta_m) \right] \chi}}. \quad (\text{F.5})$$

Because $a^* > 0$ and $\beta^* \geq \mu - (1 - \phi)\delta$, it holds that $da/d\chi > 0$. Arranging Equation (F.3) yields

$$\left[1 + \frac{a^*}{\lambda(1 - \phi)(\zeta + \eta_f + \eta_m)\chi} \right] \frac{d\beta}{d\chi} = -\frac{\beta^* - \mu + (1 - \phi)\delta}{\lambda(1 - \phi)(\zeta + \eta_f + \eta_m)\chi} \cdot \frac{da}{d\chi} - \frac{\beta^*}{\chi},$$

which implies that $d\beta/d\chi < 0$ because $da/d\chi > 0$.

Appendix G Proof of Proposition 3

To examine the effect of the gender norm on the growth rate in income per capita, we take the total differential of Equation (48) to obtain

$$\frac{dg_t^w}{d\chi} = -\frac{1-\alpha}{\alpha} \cdot \frac{\lambda}{a^*} \left[\frac{1 - (\zeta + \eta_f + \eta_m)\chi\beta^*}{a^*} \cdot \frac{da^*}{d\chi} + (\zeta + \eta_f + \eta_m)\beta^* + (\zeta + \eta_f + \eta_m)\chi \frac{d\beta^*}{d\chi} \right]. \quad (\text{G.1})$$

Note that the entire expression is multiplied by -1 . The first, second, and third terms within the bracket represent the effects of the gender norm operating through changes in a^* , χ , and β^* , respectively. Consider the case in which $s > s^*$. In this case, the first term becomes negative, indicating that a more conservative gender norm reduces g_t^w via an increase in a^* .

By contrast, the sum of the second and third terms captures how the *total expenditure* associated with having children, $\chi\beta^*$, responds to a change in χ . On the one hand, an increase in χ directly raises the total expenditure. On the other hand, it lowers the birth rate, β^* , thereby reducing the total expenditure. Therefore, determining which effect dominates is crucial for understanding the impact on g_t^w .

Substituting Equation (F.3) into (G.1) yields

$$\begin{aligned} \frac{dg_t^w}{d\chi} &= -\frac{1-\alpha}{\alpha} \cdot \frac{\lambda}{a^*} \left[\frac{\lambda(1-\phi) [1 - (\zeta + \eta_f + \eta_m)\chi\beta_t] - [\beta_t - \mu + (1-\phi)\delta]a_t}{\lambda(1-\phi)a^*} \cdot \frac{da}{d\chi} - \frac{1-\alpha}{\alpha(1-\phi)} \cdot \frac{d\beta}{d\chi} \right] \\ &= \frac{(1-\alpha)^2\lambda}{\alpha^2(1-\phi)a^*} \cdot \frac{d\beta}{d\chi}, \end{aligned}$$

where for the second equality, we use the fact that $F_{\dot{a}=0}(a^*, \beta^*) = 0$ and Equation (F.2).

From Proposition 2, because $d\beta/d\chi < 0$ if and only if $s > s^*$, we obtain $dg_t^w/d\chi < 0$ if and only if $s > s^*$.

Appendix H Proof of Proposition 5

To investigate the effect of a decrease in s on welfare, we reformulate Equation (48) as follows:

$$\dot{w}_t = \frac{1-\alpha}{\alpha} \left[\lambda \cdot \frac{1 - (\zeta + \eta_f + \eta_m)\chi\beta_t}{a_t} - \delta \right] w_t. \quad (\text{H.1})$$

Notably, the policy intervention considered here decreases s , thereby decreasing χ . Additionally, the birth rate, β_t , responds to the decrease in χ , whereas the knowledge stock per capita, a_t , and wages, w_t , do not change instantaneously because they are state variables. Therefore, taking the total differential of Equation (H.1) with respect to β_t and χ , we obtain

$$d\dot{w}_t = -\lambda \frac{1-\alpha}{\alpha} \cdot \frac{w_t}{a_t} (\zeta + \eta_f + \eta_m) (\chi d\beta_t + \beta_t d\chi).$$

This equation implies that $d\dot{w}_t > 0$ if and only if

$$-\frac{d\beta_t}{d\chi} \cdot \frac{\chi}{\beta_t} > 1.$$

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