The Fertility Race Between Technology and Social Norms*

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Abstract

This paper studies fertility as the outcome of a tug-of-war between gender-biased technological progress and social norms governing the gender division of childcare. We first document that fertility declines more rapidly in economies experiencing rapid structural transformation, even when controlling for income growth, and this trend is more pronounced in societies with rigid social norms. To explain these findings, we develop a quantitative model of childcare bargaining, incorporating the novel feature of endogenously evolving social norms shaped by the collective opinions of all cohorts, which are influenced by past childcare choices. Calibrated to South Korean data, the model reveals that intense social pressure and resistance from older cohorts to adapt hinder equitable childcare adjustments, exacerbating fertility declines and reinforcing rigid norms. Furthermore, while subsidy for female childcare yields greater short-run increases in fertility, subsidy for male childcare results in much larger long-term fertility gains because the latter accelerates the transition towards a more egalitarian steady state.

JEL classification: J12, J13, O11

Keywords: Fertility, Structural Change, Social Norm

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1. Introduction

The drastic decline in fertility rates below the replacement level poses an imminent challenge for many economies over the coming decades, threatening fiscal sustainability and economic growth (Jones 2022). This challenge is especially conspicuous in nations "getting old before getting rich" where low fertility imperils economic stability and catching-up prospects. Uncovering the causes of low fertility, forecasting its path, and pinpointing effective policy solutions are thus critical questions for researchers and policymakers.

In this paper, we document that countries undergoing rapid structural change experience a more pronounced decline in fertility rates. This relationship is particularly evident in societies with stringent social norms. Specifically, our cross-country regression analysis reveals that a 1-percentage-point increase in the pace of service sector expansion per year is associated with an annual fertility decline of 0.1 children per woman. This correlation is 50% stronger in societies exhibiting above-median cultural rigidity, as measured by the tightness index from Uz (2015). The pattern persists even after accounting for GDP per capita growth and remains consistent when we substitute agricultural sector decline as a measure of structural change.

These facts motivate us to construct a quantitative model in which fertility emerges from the interplay between gender-biased technological progress, e.g., structural change (Ngai and Petrongolo (2017)), and evolving social norms on the gender division of childcare responsibilities. In this model, fertility decisions require mutual agreement of both parents, who negotiate childcare responsibilities and consumption within a bargaining framework with limited commitment, following Doepke and Kindermann (2019). Since parents cannot pre-commit to how consumption will be divided after childbirth, the allocation of childcare duties becomes pivotal in shaping each parent's welfare and, consequently, their willingness to have children. Parents determine the childcare allocation by balancing the opportunity costs of childcare against the psychic costs of deviating from the prevailing social norm. For example, in a society with traditional gender expectations, assigning more childcare to men might lower costs if women earn higher wages, yet it could provoke social disapproval, adding psychic costs. Thus, social norms create a gap between the actual childcare arrangement and the one that would minimize opportunity costs alone, raising the shadow price of children for parents. As a result, these norms significantly influence fertility, labor supply, and gender welfare disparities in the model.

Different from prior studies that treat social norms as exogenously given, our key contribution is to explicitly model how social norm is endogenously formed. Inspired by the insights from the sociology literature (e.g., Brooks and Bolzendahl 2004), we hypothesize that the prevailing norm reflects a weighted average of the *opinions* expressed by the other members in the society. These opinions, in turn, are formed in a re-evaluation stage and depend on the current economic conditions as well as the childcare practices that these members adopted in the past. Therefore, the evolution of the social norm in the economy stems from two sources. On the one hand, when new cohorts enter the economy and adopt childcare practices that are different from the past, they shift future norms, reflecting *between-cohort effects* (also known as cohort replacement effects). On the other hand, older cohorts re-evaluate the current situation and weigh it against their past practices. As a result, changing economic conditions affect the opinions expressed by older cohorts, reflecting *within-cohort effects* (also known as social structural effects). Furthermore, the influence of the two effects depends on the population weight of the corresponding cohort, which in turn hinges on past fertility choices.

The model suggests that strong social pressure and older cohorts' reluctance to re-evaluate impose rigid constraints on young parents' choices, fostering cultural inertia. If technological advancements necessitate a shift in childcare allocation, this inertia prevents adjustment, increasing the burden on one side of the parents and making child-bearing costlier for them. Given that fertility requires both parents' consent, this added cost can sharply reduce fertility rates, a pattern consistent with our empirical evidence. Our model also predicts a non-monotonic fertility trajectory: an initial drop followed by a recovery as norms adapt to economic realities, in line with the arguments in Feyrer et al. (2008) and Doepke et al. (2023). More importantly, it also offers quantitative predictions about the timing of this fertility recovery and the pace of norm evolution, driven by both within- and between-cohort effects.

To evaluate the model's quantitative predictions, we calibrate the model to South Korean data from 1999 to 2014. Gender-specific wage paths are set to align with trends in total factor productivity and gender wage gaps. Preference parameters are adjusted to match fertility trends, while the substitutability of childcare between genders reflects the initial allocation. The strength of social pressure is calibrated to fit gender disparities in childcare time from the Korean Time Use Survey (KTUS), yielding estimates consistent with prior research (e.g., Myong et al. 2021). The weight that old cohorts put on their past childcare practices when they re-evaluate the current condition is calibrated to match the share of within-cohort changes in driving the overall social norm evolution, calculated using data from the Korean General Social Survey (KGSS).

Using the calibrated model, we conduct five counterfactual experiments. In the first counterfactual, we adjust the pace of structural change in the economy. We find that faster structural change accelerates the fertility decline, aligning with empirical evidence. However, the transition paths of childcare and social norms remain largely unchanged, as strong social pressure limits shifts in childcare allocation during this transformation.

We then experiment with the roles of social norms. In the second counterfactual, we vary the intensity of social pressure while holding the structural change constant. Here, economies with weaker social pressure exhibit a smaller fertility drop and a faster social norm transition toward a new steady state, consistent with our empirical findings. In the third counterfactual, we vary the weight that older cohorts put on their past childcare practices when they re-evaluate the current situation. We find that a smaller weight accelerates the social norm convergence towards the new steady state and raises fertility rates along the transition path.

In the fourth counterfactual, we examine the hypothetical fertility transition that would occur if we adjust the parameters calibrated for South Korea to those of the U.S.. We find lower social pressure and resistance to change in the U.S. compared to South Korea. Using the U.S. parameters, we estimate that South Korea would have experienced a less severe fertility decline—to 1.35 rather than 1.33—and a more rapid recovery, with accelerated adjustment of social norms.

In our last counterfactual experiment, we evaluate the impacts of gender-specific childcare subsidies. Our findings indicate that while subsidies for female childcare yield greater short-term increases in fertility, subsidies for male childcare produce significantly larger long-term fertility gains. This is because male childcare subsidies accelerate the transition to a more egalitarian long-run steady state, leading to increased policy exposure over time and higher desired fertility among females due to improved social norms.

To summarize, this paper establishes that faster structural change or more rigid social norms exacerbate fertility decline, a fact we explain with a novel model of endogenous norms and household bargaining. Calibrated to South Korea, it matches observed trends, delivers new predictions—non-monotonic fertility and policy-driven recovery—and enriches the fertility literature with dynamic theory and actionable insights for a pressing global issue.

Related Literature

This paper contributes to the growing body of literature examining the effects of technological change on fertility and female labor supply. The most closely related studies in this domain are Goldin (2024), Doepke and Kindermann (2019), Myong et al. (2021), and Fogli and Veldkamp (2011).[1]

The study by Goldin (2024) illustrates that countries with "lowest-low" fertility rates experienced rapid per capita GNP growth alongside gradually evolving cultural traditions. The author proposes a theoretical framework in which generational and gender-based conflicts drive a significant decline in total fertility rates. Our research aligns with this perspective, arguing that fertility rates result from a dynamic interplay between gender-biased technological progress and societal norms. However, our work differs from Goldin (2024) in several key aspects. First, we establish a new empirical finding by demonstrating a strong correlation between structural economic change and fertility decline, even after controlling for GNP growth, which is the primary focus of Goldin (2024). Second, in contrast to Goldin (2024), which assumes gender-specific desired

[1] See Doepke et al. (2023) for an excellent summary of the recent literature.

fertility levels, our model derives fertility decisions and bargaining dynamics between women and men from microeconomic principles. Third, we develop a model of social norms that incorporates both within- and between-cohort effects, allowing economic agents to adapt flexibly to changing economic conditions rather than adhering strictly to traditional norms. Finally, while Goldin (2024) suggests that men prioritize inherited traditions more than women, resulting in a higher desired number of children, we assume uniform preferences across genders and attribute differences in desired fertility to negotiations over childcare responsibilities and initial technological conditions.

Doepke and Kindermann (2019) find that countries with more equitable childcare practices exhibit fewer discrepancies between men and women regarding desired fertility, resulting in higher birth rates. They explain this pattern with a bargaining model with limited commitment. We build on and extend their framework by incorporating the influence of social norms and modeling the norms' endogenous evolution. This additional element allows our model to address how economies adjust to technological changes over time through social norm adaptation.

The study by Myong et al. (2021) explores fertility and marriage patterns in East Asian societies, analyzing the effects of two social norms: one related to the stigma of out-of-wedlock births and another concerning the gender division of childcare. Estimating their model with South Korean data, they conclude that the latter norm exerts a stronger influence on fertility outcomes. This finding inspires our focus on the childcare social norm, abstracting from marriage norm considerations.[2] While Myong et al. (2021) treat the childcare social norm as exogenous and estimate it empirically, we micro-found the endogenous formation of such norms. Consequently, our approach enables predictions about future fertility trends and facilitates counterfactual analyses based on structural parameters of norm formation.

Our research complements studies on the evolution and transmission of social norms, such as Bisin and Verdier (2001) and Bisin and Verdier (2011). Notably, several influential papers have explored social learning as a key mechanism driving the increase in fe-

[2]Similar to Myong et al. (2021), we also abstract away from status externalities in Kim et al. (2024) or the fertility norm in De Silva and Tenreyro (2020).

male labor force participation and marriage patterns amid technological advancements (e.g., Fernández et al. (2004), Fernández and Fogli (2009), Fogli and Veldkamp (2011), Fernández (2013), Bertrand et al. (2021)). These studies highlight how individuals learn about the effects of female labor force participation on child outcomes and how this knowledge is transmitted across generations (vertical socialization) and within neighborhoods or peer groups (horizontal socialization). Complementing their approach, we investigate the role of social norms surrounding childcare responsibilities, examining their impact on household decisions and their evolution through both within-cohort and between-cohort adjustments, ultimately driven by technological changes.

The remainder of the paper is structured as follows. Section 2 presents the motivating empirical evidence. Section 3 outlines the theoretical model. Section 4 details the calibration strategy and results. Section 5 conducts the primary counterfactual exercises. Section 6 evaluates the model's robustness. Finally, Section 7 offers concluding remarks.

2. Motivating Facts

This section presents cross-country evidence on the relationship between fertility, structural change, and social norms, drawing data from multiple sources. We document the following two empirical regularities:

Fact 1: Economies experiencing faster structural change, i.e., expansions of the service sector or declines of the agriculture sector, exhibit more rapid fertility declines.

Fact 2: The correlation between structural change and fertility is stronger in societies with more stringent social norms.

To examine these relationships, we combine different sources of data. Data on total fertility rate is obtained from the United Nations Population Division. Sectoral employment data are from the Groningen Growth and Development Centre (GGDC) 10-Sector Database (Timmer et al., 2015). This database offers long-term, internationally comparable data on value added and employment across ten sectors for more than 40 economies, including both developing and developed ones.[3] Data on gross national product (GDP) is collected from the Penn World Table 10.01. Lastly, we follow the literature on sociology and cultural studies in measuring the stringency of social norms. In particular, we obtain the tightness/looseness index from Uz (2015), where the author measures the tightness of social norms using the dispersion of opinions. The motivation of this measure is that in a tight culture, people's values, norms, and behavior are similar to each other because deviations are sanctioned. The merged sample includes 23 countries from all levels of economic development, with observations from the 1950s to 2010.

To construct the speed of fertility change for country i, we run the regression

$$\text{tfr}_{i,\text{year}} = \alpha_i^{\text{tfr}} + \text{speed\_tfr}_i \times \text{year} + u_i \tag{1}$$

where speed_tfr_i measures the average annual change of the total fertility rate for country i during the sample period.

Likewise, we measure the speed of structural change for country i using

$$\text{service share}_{i,\text{year}} = \alpha_i^{\text{ser}} + \text{speed\_ser}_i \times \text{year} + v_i \tag{2}$$

where service share measures the fraction of service employment, and

$$\text{agriculture share}_{i,\text{year}} = \alpha_i^{\text{agr}} + \text{speed\_agr}_i \times \text{year} + v_i \tag{3}$$

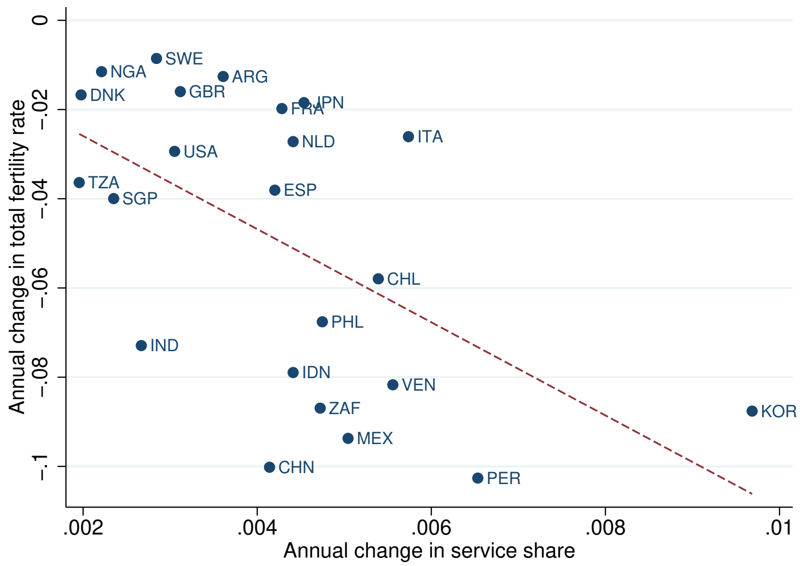
where agriculture share measures the fraction of agricultural employment. Therefore, speed_ser_i and speed_agr_i measures the average annual change of sectoral employment for country i during the sample period.

Figure 1a plots the correlation between speed_tfr_i and speed_ser_i. As can be seen, countries that have experienced faster expansion of the service sector, e.g., South Korea and Peru, also witnessed more rapid fertility declines. Similarly, Figure 1b indicates that

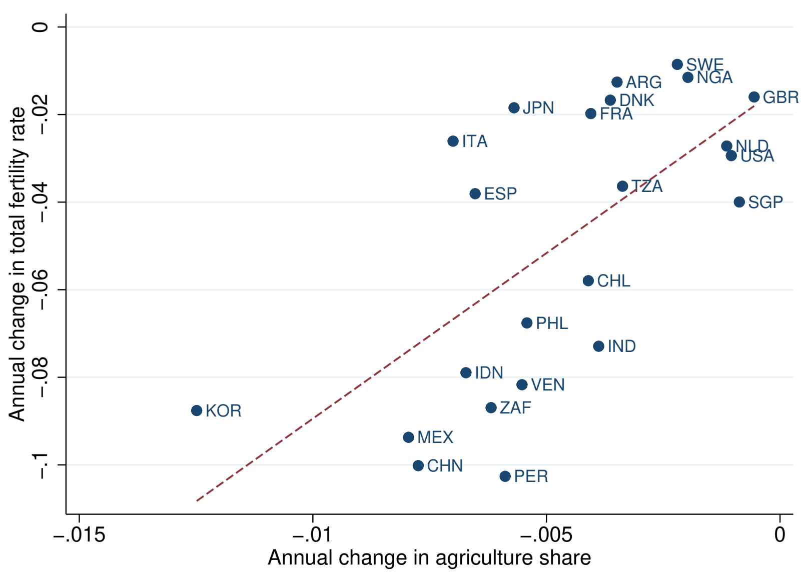
[3] We follow Herrendorf et al. (2014) in the sector assignments. In particular, Agriculture corresponds to the sum of International Standard Industrial Classification (ISIC) sections A–B, Manufacturing corresponds to the sum of ISIC sections C, D, F, and Services correspond to the sum of ISIC sections E, G–P.

Figure 1: Fertility Change and Structural Change

(a) Service Expansion and Fertility Decline



(b) Agriculture Shrinkage and Fertiltiy Decline



Notes: “speed_tfr” is defined as the average annual change in total fertility rate for each country in the sample period, using data from the United Nations Population Division. “speed_ser” and “speed_agr” are the average annual change in the fraction of employment in service and agriculture sectors respectively, using data from the Groningen Growth and Development Centre (GGDC).

countries that have experienced faster shrinkage of the agriculture sector, e.g., South Korea, China, and Mexico, also experienced more rapid fertility declines. The latter finding complements Ager et al. (2020) who document the relationship between agriculture decline and fertility transition in the American South.

To examine the relationship between structural change and fertility decline more systematically, we run a set of OLS regressions where we regress speed_tfr_i on speed_SC_i where SC (structural change) takes the value of speed_ser_i or speed_agr_i, after controlling for the growth rate of GDP per capita speed_gdp_i. We also interact the speed of structural change with a dummy variable "tight", which takes the value of 1 if the country's opinion dispersion, measured by Uz (2015), is below the median.

The regression results, presented in Table 1, reveal key insights. Column (1) shows that a 1-percentage-point increase in the speed of service sector expansion per year corresponds to an annual fertility decline of 0.1, a statistically and economically significant correlation. This relationship holds after controlling for GDP per capita growth in Column (2). In Column (3), we observe that the link between service sector expansion and fertility decline is predominantly driven by countries with rigid social norms. Specifically, countries with above-median cultural tightness exhibit a coefficient on service sector expansion speed nearly 50% larger than those below the median. Column (4) confirms that this heterogeneity persists even after adjusting for GDP per capita growth. Columns (5) through (8) replicate the analysis using the decline in agricultural employment as an alternative measure, yielding findings consistent with those for service sector expansion.

In addition, panel data regressions were performed to examine the relationships between fertility change, structural change speed, and evolving social norms. Fertility and structural change speed were calculated as 10-year changes, based on the previously described datasets. Social norm (gender attitudes) changes were quantified using data from the 2002 and 2012 International Social Survey Programme (ISSP) Family and Changing Gender Roles modules. Specifically, we analyzed responses to the statement, "A man's job is to earn money; a woman's job is to look after the home and family." Two measures were created: "Norm Change: Total" captures the difference in average scores

Table 1: Regression Results: Cross-Sectional Data

	Dependent Variable: Fertility Change							
	Service				Agriculture			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
speed_SC	-10.44***	-11.82***	-5.48	-6.89	7.56***	8.39***	5.03**	5.80**
	(3.38)	(3.78)	(4.02)	(4.27)	(1.90)	(2.06)	(2.38)	(2.41)
tight×speed_SC			-5.11*	-5.23*			3.23	3.51*
			(2.56)	(2.56)			(1.95)	(1.93)
speed_gdp		0.30		0.33		0.32		0.38
		(0.35)		(0.33)		(0.31)		(0.30)
Observations	23	23	23	23	23	23	23	23
R-squared	0.31	0.34	0.43	0.46	0.43	0.46	0.50	0.54

Notes: "speed_tfr" is defined as the average annual change in total fertility rate for each country in the sample period, using data from the United Nations Population Division. "speed_SC" where SC $\in \{ser, agr\}$ are the average annual change in the fraction of employment in service and agriculture sectors respectively, using data from the Groningen Growth and Development Centre (GGDC). "speed_gdp" is calculated as the annual change in GDP per capita in the sample period, using data from the Penn World Table. "tight" is a dummy variable that takes the value of 1 if the tightness index is above the sample median, reflecting stronger constraints imposed by social norms on individual behavior. The index is developed by Uz (2015).

between the 1980 and 1920 birth cohorts, while "Norm Change Recent" reflects the 10-year inter-cohort change in gender attitudes. For instance, the change between 1960-1969 is determined by comparing the 1940-1949 and 1930-1939 birth cohorts. GDP per capita level and growth were included as control variables.

The panel regression results, summarized in Table 2, corroborate our cross-sectional observations. We find that accelerated growth in service sector employment and a corresponding reduction in agricultural employment are significantly correlated with faster fertility declines, even after accounting for country fixed effects and year trends. Notably, a one-percentage-point increase in service sector share over a 10-year period is associated with a 0.07 decrease in the total fertility rate over the same time frame, a

Table 2: Regression Results: Panel Data

	Dependent Variable: Fertility Change							
	Service				Agriculture			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Speed_SC	-6.64***	-7.32***	-10.40***	-7.23***	7.66***	8.91***	9.58***	9.61**
	(0.70)	(0.74)	(1.57)	(0.91)	(0.53)	(0.62)	(0.92)	(0.63)
Speed_SC×Norm Change Total			5.35**				-1.94	
			(2.40)				(1.98)	
Speed_SC×Norm Change Recent				0.59				-0.49
				(0.38)				(0.31)
Norm Change Recent				0.59				-19.42***
				(0.38)				(4.09)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Trend	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	785	785	785	785	785	785	785	785
R-squared	0.26	0.38	0.39	0.39	0.35	0.45	0.45	0.47

Notes: Fertility change is defined as the 10-year change in total fertility rate for each country in the sample period, using data from the United Nations Population Division. Structural change speed (”Speed_SC”) is measured as the 10-year change in the service and agricultural employment shares, respectively, calculated using the Groningen Growth and Development Centre (GGDC) 10-sector database for years after 1950 and Mitchell (2007) for years before 1950. The variables ”Norm Change Total” and ”Norm Change Recent” are constructed from data obtained from the International Social Survey Programme: Family and Changing Gender Roles III (ISSP) 2002 and 2012. Both variables are based on responses to the question, ”To what extent do you agree or disagree: A man’s job is to earn money; a woman’s job is to look after the home and family. ” Responses are coded as -1 if disagree, 1 if agree, and 0 if neutral. ”Norm Change Total” represents the difference in average scores between the 1980 and 1920 birth cohorts. ”Norm Change Recent” measures the change in gender attitude of each birth cohort in a country compared to the cohort from 10 years prior. For example, if we examine the change between 1960-1969, then we are looking at the change in attitudes of the 1940-1949 birth cohort compared to the 1930-1939 birth cohort.. Control variables include GDP per capita level and growth.

result consistent in magnitude with our cross-sectional analysis. Additionally, the interaction term between structural change speed and gender norm changes exhibits a positive sign for service sector growth, suggesting that the relationship between structural change and fertility is mitigated in societies with more adaptable social norms, consistent with the cross-sectional findings. The interaction term for agricultural share decline is negative, as the share of agriculture in the aggregate economy declines with economic development.

To summarize, we find that countries that have experienced faster structural change, i.e., service expansion or agriculture decline, witnessed more rapid decline in fertility. Furthermore, this correlation is robust to controlling for the growth in GDP per capita, and is stronger in societies with rigid social norms. In the next section, we propose a structural model to understand these relationship.

3. Model

This section introduces an overlapping generations model where parents bargain over fertility and childcare responsibilities under the influence of social norm. Moreover, the prevailing social norm in the economy is endogenously determined by older cohorts' opinions which depend on past childcare practices.

3.1 Household Problem

We analyze an overlapping generations economy where women and men live until age J. Each cohort consists of women and men of equal mass.[4] To examine generational conflicts and fertility dynamics, we assume homogeneity among agents of the same gender within each cohort. To emphasize fertility and childcare decisions, we model individuals as consuming their labor income before and after age J_f, the period during which individuals form couples and engage in a bargaining problem.

A couple comprises a woman and a man, indexed by gender $g \in \{♀, ♂\}$. They choose individual consumption c^g, childcare contributions l^g, and the number of children n, which is a household-shared decision. We use t to denote time. Gender-specific market wages, denoted w_t^g, are exogenous and reflect technological changes impacting labor demand differentially by gender (Ngai and Petrongolo 2017).[5]

[4] The size of each incoming cohort may vary over time due to endogenous fertility decisions.

[5] Alternatively, we can model structural change via time-varying, gender-specific labor demand shifters, with equilibrium wages determined by market clearing. In the calibration, these shifters can be backed out given that we observe equilibrium wages and generate hours worked from the model. However, as this paper focuses on household-side responses to technological changes and the role of en-

Individual's preference over fertility and consumption is given by:

$$u^g(c^g, n) = c^g + \gamma \cdot \frac{n^{1-\rho} - 1}{1-\rho} \qquad \rho > 0 \tag{4}$$

where c^g represents personal consumption and n the number of children. The parameters γ and ρ control the weight and curvature of fertility n in the utility function, respectively.

Raising each child incurs a time cost ϕ. Thus, to support n children, the couple must satisfy the childcare provision constraint:

$$n\phi = \left((l^{♀})^{\frac{\sigma-1}{\sigma}} + (l^{♂})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1 \tag{5}$$

where $l^{♀}$ and $l^{♂}$ denote childcare time from the woman and man, respectively, and σ governs the substitutability of their contributions.

Following Doepke and Kindermann (2019), we assume that spouses bargain over fertility and childcare under partial commitment. The decision-making timeline is outlined below.

First Stage: Childcare Arrangements

The couple first determines a plan for childcare allocation, conditional on having n children, and commits to this decision post-childbirth.[6] For all n, the couple solves:

$$\min_{l^{♀}, l^{♂}} \quad w_t^{♀} l^{♀} + w_t^{♂} l^{♂} + \lambda \cdot w_t^{♂} \cdot \left(\frac{l^{♀}}{l^{♂}} - \eta_t \right)^2, \tag{6}$$

subject to the childcare constraint (5). Here, $w_t^{♀} l^{♀} + w_t^{♂} l^{♂}$ represents the opportunity cost of childcare in the units of consumption goods, while $\lambda \cdot w_t^{♂} \cdot \left(\frac{l^{♀}}{l^{♂}} - \eta_t \right)^2$ captures psychic costs from deviating from the prevailing social norm, η_t, which is taken as given

dogenous social norms, we adopt the simpler exogenous wage approach. We also abstract away from the causality in the reverse direct, i.e., declining fertility and rising female labor supply stimulates structural transformation, a possibility discussed by Kuhn et al. (2024) in line with the Rybczynski theorem.

[6] Doepke and Kindermann (2019) justifies this commitment by noting that childcare decisions involve significant switching costs and advance planning (e.g., securing daycare slots before birth) and interact with persistent choices like residential location, which affects childcare availability.

by parents at time t. The parameter λ governs the intensity of these social pressure costs. We scale the psychic cost by $w_t^{♂}$ so that what matters for the childcare allocation is the gender wage gap $w_t^{♀}/w_t^{♂}$ rather than the universal wage levels. The solutions to this cost-minimization problem, denoted $l_t^{♀}(n)$ and $l_t^{♂}(n)$, represent optimal childcare allocation under the influence of the social norm.

Second Stage: Bargaining over Fertility

Next, the couple negotiates the number of children, n_t. Only mutually agreed-upon fertility is realized, defined as:

$$n_t = \min\{n_t^{♀}, n_t^{♂}\}, \tag{7}$$

where n_t^g is the fertility level that maximizes the ex-post utility of gender $g \in \{♀, ♂\}$ in the third stage. In other words, if we denote the solution to the consumption bargaining problem as $c_t^g(n)$ for $g \in \{♀, ♂\}$, the ex ante desired fertility level for each gender is given by

$$n_t^g = \arg\max_n \quad u^g(c_t^g(n), n). \tag{8}$$

Combining Equations (7) and (8), it is evident that when men and women exhibit differing desired fertility levels, the lower level predominates. Consequently, factors that exacerbate the disparity in desired fertility between genders, such as social norms that impede equitable childcare responsibilities, lead to reduced fertility in the equilibrium.

Third Stage: Bargaining over Consumption

Post-childbirth, the couple implements the agreed childcare arrangement $l_t^g(n)$ and bargains over consumption $c^g(n)$. If the couple ends up having n children, each gender's outside option in the non-cooperative case is:

$$\overline{u}^g(n) = w_t^g(1 - l_t^g(n)) + \gamma \cdot \frac{n^{1-\rho} - 1}{1-\rho}, \qquad \rho > 0, \tag{9}$$

reflecting consumption of residual labor income after childcare. Following Doepke and Kindermann (2019), the non-cooperative state is modeled as a continuing relationship along the lines of the separate-spheres bargaining model of Lundberg and Pollak (1993). That is, the couple is still together and both partners still derive utility from the child, but bargaining regarding the allocation of consumption breaks down, the division of child care duties follows the ex-ante commitment $l_t^g(n)$, and the couple no longer benefits from returns to scale in joint consumption.

If they cooperate, the Nash bargaining problem is:

$$\max_{c^{♀}, c^{♂}} \quad \Big(u^{♀}(c^{♀}, n) - \overline{u}^{♀}(n)\Big)^{1/2} \cdot \Big(u^{♂}(c^{♂}, n) - \overline{u}^{♂}(n)\Big)^{1/2}, \tag{10}$$

subject to the budget constraint:

$$c^{♀} + c^{♂} = (1+\alpha) \cdot [w_t^{♀}(1 - l_t^{♀}(n)) + w_t^{♂}(1 - l_t^{♂}(n))], \tag{11}$$

where α captures economies of scale from cooperation. Following Doepke and Kindermann (2019), we assign each spouse equal bargaining power (one-half).

3.2 Endogenous Social Norm

A novel feature of this model is that the prevailing social norm is endogenously determined. Unlike the exogenous social norm assumption used in the literature, we posit that the social norm at time t, denoted η_t, emerges as a weighted average of the *opinions* expressed by the other members of the society, which in turn depends on the childcare practices in the past. This dynamic process ties current norms to historical household decisions, capturing both social pressure and reevaluation by older cohorts.

Specifically, the prevailing social norm at time t is defined as:

$$\eta_t = \sum_{j=1}^{J-J_f} \phi_{J_f+j,t} \cdot \tilde{\eta}_{J_f+j}, \qquad \sum_{j=1}^{J-J_f} \phi_{J_f+j,t} = 1, \tag{12}$$

where $\tilde{\eta}_{J_f+j}$ represents the opinions of childcare allocation expressed by the cohort at age $J_f + j$ at time t, and $\phi_{J_f+j,t}$ is the weight assigned to that cohort's influence.[7] This weight reflects the share of households aged $J_f + j$ at time t among the subpopulation

[7]By assuming away heterogeneity with cohorts, this paper abstracts away from the horizontal socialization discussed in Bisin and Verdier (2011).

older than J_f, calculated as:

$$\phi_{j,t} = \frac{\pi_{j,t}}{\sum_{k=J_f+1}^{J} \pi_{k,t}}, \tag{13}$$

where $\pi_{j,t}$ denotes the population share of the cohort aged j at time t. These weights ensure that the influence of past decisions is proportional to the relative size of each cohort.

We assume that older cohorts form opinions by solving the following minimization problem:

$$\tilde{\eta}_{J_f+j} = \arg\min_{\eta} \quad w_t^{♀} \cdot \eta + w_t^{♂} + \psi \cdot w_t^{♂} \left(\eta - \frac{l_{t-j}^{♀}}{l_{t-j}^{♂}} \right)^2 \tag{14}$$

where $\frac{l_{t-j}^{♀}}{l_{t-j}^{♂}}$ measures the childcare practice adopted by these agents j periods ago. Like the parents' problem in (6), the psychic cost is scaled by $w_t^{♂}$ so that what matters for the opinion expression problem is the gender wage gap $w_t^{♀}/w_t^{♂}$. The solution to this problem reflects the *desired gender ratio of childcare* that balances the economic and psychic costs by cohort $J_f + j$.

This minimization problem reflects changes in social norms within cohorts, where older generations re-evaluate the situation given the prevailing market wage and choose the opinion they express to the current parents. Parameter ψ governs the utility costs of deviating from their own past choice, i.e., stubbornness. If they are perfectly altruistic towards the current parents, they would simply discard their own past decisions and minimize the opportunity costs of childcare, i.e., $\psi = 0$. However, if ψ is high, they will express opinions that are more in line with how they brought up their own children j periods ago.

3.3 Population Dynamics

The demographic structure of this economy, denoted $\{\pi_{j,t}\}_{j=1}^{J}$, evolves endogenously according to a law of motion driven by the fertility rate n_t.

Let $\boldsymbol{\pi_t} = (\pi_{1,t}, \ldots, \pi_{J,t})^T$ represent the population distribution across age groups at time t, where $\pi_{j,t}$ is the share of individuals aged j. The population dynamics are governed by:

$$\boldsymbol{\pi_{t+1}} = \frac{\boldsymbol{\Pi_t} \cdot \boldsymbol{\pi_t}}{\|\boldsymbol{\Pi_t} \cdot \boldsymbol{\pi_t}\|_{L^2}}, \tag{15}$$

where $\boldsymbol{\Pi_t}$ is a $J \times J$ demographic transition matrix.

The matrix $\boldsymbol{\Pi_t}$ has two key features: (1) elements in the j-th row and $(j+1)$-th column equal 1, reflecting aging from age j to $j+1$, and (2) the element in the first row and J_f-th column equals $n_t/2.1$, representing births from couples at age J_f, normalized by the replacement fertility rate (approximately 2.1 children per couple). The L^2-norm ensures the population shares sum to 1, maintaining a normalized distribution over time.

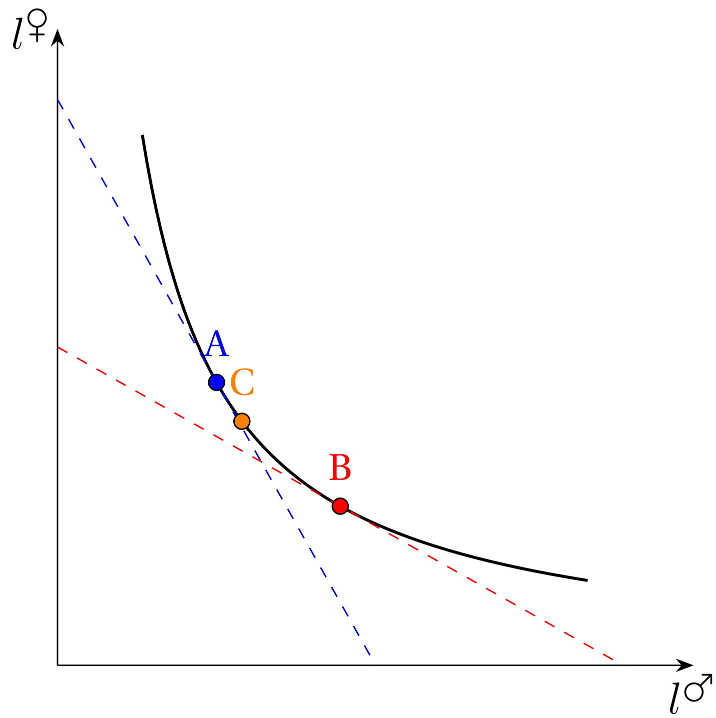
3.4 Mechanisms

The central prediction of this model is that fertility emerges from a dynamic tension between gender-biased technological progress and evolving social norms. Technological change, by increasing women's relative wages, shifts the optimal childcare division toward greater gender equality for young couples making fertility decisions—absent social norm pressures (see Equation (6)). However, when social norms enforce traditional roles, they act as a form of "adjustment costs," generating a gap between the actual childcare arrangement and the one that would minimize opportunity costs alone, leading to a higher shadow price of children from the parents' perspective. As a result, couples prefer fewer children ex ante. Figure 2 illustrates the intuition of this mechanism.

Conversely, social norms in this economy are endogenous, shaped by changes within- and between-cohort (see Equation (12)). Entering cohorts, influenced by improved labor market opportunities for women, may favor more equitable childcare arrangements. Older cohorts, aware of the changes in the gender wage gap, may also shift their positions and choose which opinions to express (see Equation (14)).

The evolution of the social norm thus stems from two sources. First, when new cohorts enter at age J_f and choose childcare contributions $l^{♀}$ and $l^{♂}$ that diverge from established practices, they shift future norms toward their preferences. For instance, a cohort opting for more egalitarian childcare ratios will incrementally reduce η_t in subsequent periods. This channel reflects between-cohort changes, also known as the cohort

Figure 2: The Childcare Allocation Problem with Social Norms



Notes: This figure plots the childcare minimization problem faced by the household in the presence of social norms. The isoquant curve ABC represents combinations of male and female childcare hours that produce one unit of childcare. The slopes of budget lines reflect prevailing gender wage gap $l^{♂}/l^{♀}$. Point A is the original steady state where females shoulder a greater share of childcare responsibilities under a large gender wage gap. Gender-biased structural change alters the relative wage, shifting the cost-minimizing point to B in the long-run equilibrium. Due to pressures of social norms, however, the household chooses point C, closer to A, which is more costly than B under the new relative wage. This increases the shadow price of childcare and reduces fertility. As social norm evolves, the household choice converges to point B and hence fertility recovers.

replacement effects.

Second, older cohorts choose the opinions they would like to express. This decision hinges on their past experiences, but also reflects their re-evaluation of the situation given the current conditions. This channel reflects within-cohort changes, also known as the social structural effects.

The influence of these two effects depends on the population weight of the corresponding cohort, $\phi_{j,t}$, which is itself an endogenous outcome of fertility decisions made by their parents' generation. Higher past fertility increases a cohort's size, amplifying its impact on η_t. This interplay between fertility, demographic structure, childcare choices, and opinions drives the norm's gradual adaptation over time.

Note that even though the social norm adjusts through both within- and between-cohort effects, the adaptation speed might still be slower than the rapid changes in technology. Therefore, the model predicts a non-monotonic fertility response to technological change that boosts women's wages. Initially, fertility declines sharply as the social norm lags, reflecting entrenched gender roles. Over time, as the social norm adjusts toward equality, fertility recovers. This transition highlights the interplay between short-term path-dependence and long-term adaptation.

The advantage of explicitly modeling the social norm is that we can quantify the above-mentioned channels and make numerical predictions. In the next section, we calibrate the model and conduct counterfactual analyses in the subsequent sections.

4. Calibration

This section outlines the solution algorithm for the model, the calibration strategy, and presents the calibrated parameter values.

4.1 Model Solution

We first outline the solution algorithms for the steady state and the transition path.

Steady-State Solution The steady state is computed using an iterative method that converges to a social norm consistent with household decisions:

1. Guess an initial social norm η.
2. Given η, solve the childcare arrangement problem (6) subject to the childcare constraint (5), yielding optimal childcare functions $l^{♀}(n)$ and $l^{♂}(n)$.
3. Using $l^{♀}(n)$ and $l^{♂}(n)$, calculate each gender's outside option utility, $\overline{u}^g(n)$, for $g \in \{♀, ♂\}$.

4. With the outside options, solve the Nash bargaining problem for consumption $c^g(n)$ and utility $u^g(n)$, conditional on n.

5. Maximize each gender's utility, $n^g = \arg\max_n u^g(n)$, to determine desired fertility. The realized fertility is $n = \min\{n^{♀}, n^{♂}\}$, with associated childcare arrangements $l^{♀}(n)$ and $l^{♂}(n)$.

6. Compute the implied social norm, $\tilde{\eta} = l^{♀}(n)/l^{♂}(n)$. Update η and iterate until $|\eta - \tilde{\eta}| < \epsilon$, for a small tolerance $\epsilon > 0$.

Transition Path To compute the economy's dynamics, starting from any initial state (not necessarily the steady state), we use forward iteration:

1. Given the current social norm η_t, solve the static household optimization problem to obtain n_t, $l^{♀}(n_t)$, and $l^{♂}(n_t)$.

2. Using the current demographic structure $\boldsymbol{\pi_t}$ and fertility rate n_t, update the population distribution to $\boldsymbol{\pi_{t+1}}$ via Equation (15).

3. With $\boldsymbol{\pi_{t+1}}$ and the history of childcare arrangements $\{l^{♀}_{t-j}, l^{♂}_{t-j}\}_{j=0}^{J-J_f}$, calculate tomorrow's social norm η_{t+1} using Equation (12) after solving the every older cohorts' minimization problem (14). Repeat from step 1 for the next period.

This iterative process captures the co-evolution of fertility, childcare norms, and population structure over time.

4.2 Identification Strategy

We calibrate the model to replicate key data moments from South Korea over the period 1999–2014. The parameters to be calibrated are:

$$\underbrace{J, J_f}_{\text{demographics}}, \quad \underbrace{\gamma, \rho, \psi, \lambda}_{\text{preferences}}, \quad \underbrace{\phi, \sigma, \alpha}_{\text{technologies}}.$$

Several parameters are directly sourced from the literature. The economy of scale from spousal cooperation, α, is set to 1.2, following Doepke and Kindermann (2019).

The time cost per child, ϕ, is fixed at 0.15, based on de La Croix and Doepke (2003). We define each period as 5 years, setting $J = 16$ (total lifespan of 80 years) and $J_f = 6$ (child-bearing between 25 to 30) to align with South Korea's life expectancy of approximately 80 years and a mean childbirth age of 25–30 during the study period.

The remaining parameters are calibrated to match the transition path of the South Korean economy from 1999 to 2014. In particular, we choose the exogenous time series for gender-specific wages, $w_t^{♀}$ and $w_t^{♂}$ to match the GDP per capita and gender wage gap statistics collected from the OECD database. Then, we simulate the path of the economy and ask the model to fit the observed trajectories of fertility, gender gaps in childcare responsibilities, and the share of within-cohort effects in social norm changes.[8]

We collect fertility data from the United Nations. Gender-specific childcare time is computed using the micro-level data from the Korea Time Use Survey (KTUS) following the strategy of Park (2021). Lastly, we use the micro-level data from the Korean General Social Survey (KGSS) to compute the share of within-cohort effects in driving social norm changes. To be more specific, for any variable Y, we first compute the change in average over time, i.e., the gap between $\overline{Y}_{\text{start time}}$ and $\overline{Y}_{\text{end time}}$. To compute within-cohort changes, we identify the cohorts that have more than N observations both at the start time and the end time. Then, we restrict the samples to the individuals from these cohorts, and compute how much Y changes over time in this sample, i.e., the gap between $\overline{Y}^{\text{subsample}}_{\text{start time}}$ and $\overline{Y}^{\text{subsample}}_{\text{end time}}$. The ratio between these two gaps measures the importance of within-cohort effects and is used as a targeted moment. In the KGSS data, we evaluate this ratio for three variables as Y:

1. SEXROLE1: Opinions on gender roles: It is more important for a wife to help her husband's career than to pursue her own career,

2. SEXROLE2: Opinions on gender roles: A husband's job is to earn money; a wife's job is to look after the home and family, and

[8] We also examined the ideal number of children by gender in the data (see Appendix C). We opted not to use these as target moments for two reasons. First, the survey question, 'What is the ideal number of children for a family to have?' may reflect respondents' views on societal norms or expectations for others rather than their personal fertility plans. Second, the responses markedly diverge from actual fertility outcomes in both magnitude and trajectory. Nevertheless, we do observe a widening gender gap in the ideal number of children during periods of rapid structural transformation.

3. HBBYWK08: Agree or disagree: Husband's job is to earn money; wife's job is to look after the home and family.

For all three cases, we find that the ratio is close to 0.8, implying an important role for within-cohort effects in driving the broader social norm change in South Korea in the study period.[9]

Although all parameters jointly influence the model's moments, certain moments provide stronger identification for specific parameters. Below, we outline the identification logic:

- The fertility weight, γ, is inferred from the initial fertility level in 1999, reflecting baseline preferences for children.
- The fertility curvature, ρ, governs the trade-off between consumption and fertility, identified by the fertility response to rising opportunity costs as wages increase for both genders.
- The childcare substitutability, σ, is determined by the initial gender gap in childcare time. Higher substitutability amplifies the initial gender gap by allowing greater specialization.
- The weight of individual's own experience in the formation of opinions, i.e., "stubbornness", ψ, is calibrated to match the share of between-cohort component in driving social norm changes. Smaller ψ leads to larger within-cohort effects.
- The social pressure parameter, λ, is calibrated to the persistence of gender gaps in childcare over time. A higher λ implies stronger resistance to change, as young couples face greater pressure from older cohorts' norms.

This strategy ensures the model captures both the levels and dynamics of fertility and childcare in South Korea over the calibration period.

[9] One concern is that these opinion measures are ordinal, not cardinal, complicating the mapping between the model's social norms and the data. We address this in multiple ways. First, we calibrate using the ratio of between-cohort changes to total changes, rather than opinion levels. Second, all three variables yield consistent results (around 0.8), reducing concerns about individual biases. Finally, sensitivity analysis with ratios from 0.6 to 1.0 shows the paper's main findings remain robust.

4.3 Calibration Results

Table 3 presents the calibrated parameters alongside the corresponding data moments. The model closely replicates the observed trajectories of fertility and gender gaps in childcare responsibilities in South Korea from 1999 to 2014.

Table 3: Calibrated Parameters

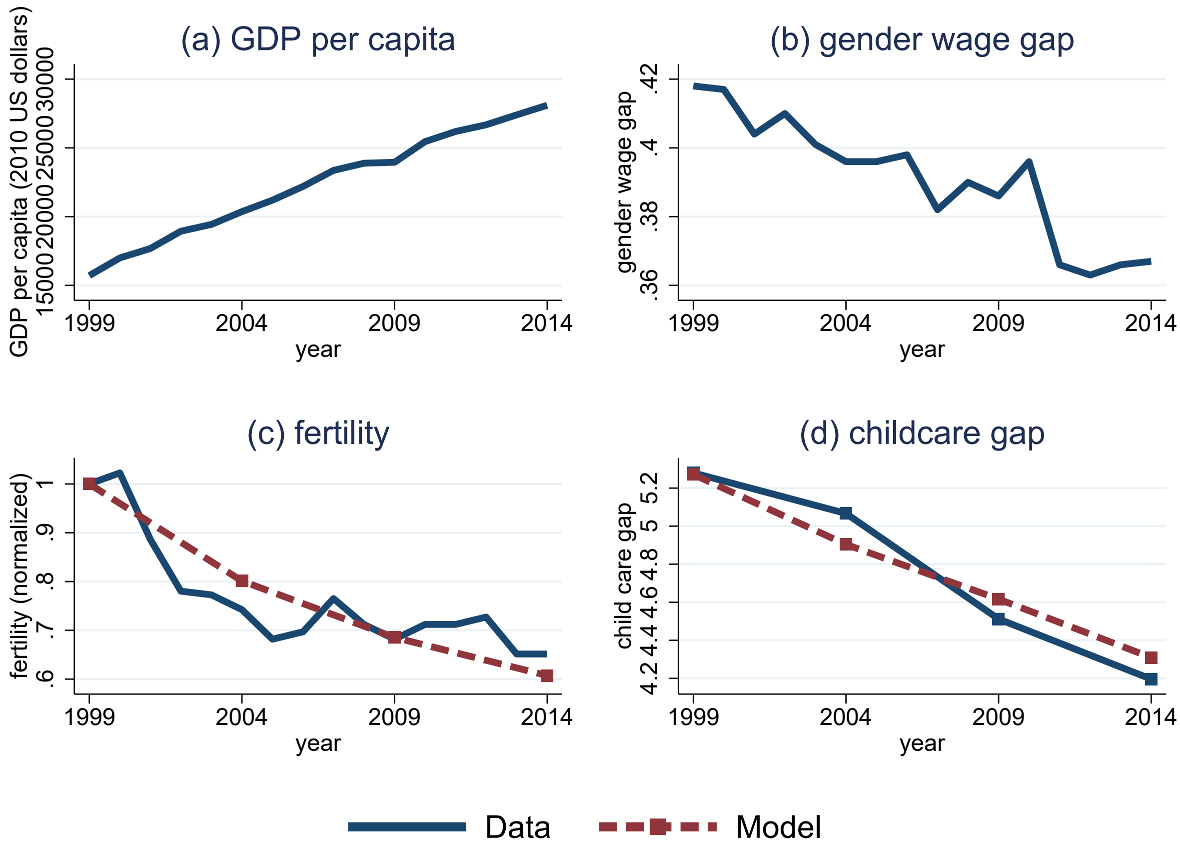
	Parameter	Value	Data moment	Source	Model fit
γ	Fertility weight	0.24	$n_{1999} = 1.42$	United Nations	1.42
σ	Childcare substitutability	3.05	$\eta_{1999} = 5.25$	Park (2021)	5.25
ρ	Fertility curvature	2.4	$n_{1999} \sim n_{2014}$	United Nations	See Figure 3
ψ	Stubbornness	3.0	Within-cohort effects	KGSS	80%
λ	Social pressure	0.0006	$\eta_{1999} \sim \eta_{2014}$	Park (2021)	See Figure 3
α	Economies of scale	1.2	Doepke and Kindermann (2019)		
ϕ	Time costs per child	0.15	de La Croix and Doepke (2003)		
J	Total number of periods	16	80 years	World Health Organization	
J_f	The fertile period	6	25 to 30 yo	Statista	

The calibrated childcare substitutability, $\sigma = 3.05$, aligns closely with the value of 3.03 reported by Knowles (2013). Similarly, the social pressure parameter, $\lambda = 0.0006$, yields psychic costs comparable to those in Myong et al. (2021) and Kim et al. (2024). To illustrate these parameters' implications and the model's mechanisms, Table 4 compares childcare gaps and fertility across three scenarios.

The first scenario "old tech. & old norm" depicts a steady-state economy with a large gender wage gap ($w^{♀}/w^{♂} = 0.58$). Here, women shoulder 5.25 times more childcare than men, consistent with the prevailing social norm ($\eta = 5.25$). Young couples' choices align with this norm, resulting in a fertility rate of $n = 1.43$.

The second scenario "new tech. & new norm" represents a new steady state with a narrower wage gap ($w^{♀}/w^{♂} = 0.74$). Reduced wage disparity lowers the opportunity cost of men's childcare time, shifting the optimal allocation to a more equitable $l^{♀}/l^{♂} = 2.53$, which matches the updated norm ($\eta = 2.53$). Fertility dips slightly to $n = 1.37$, driven by the substitution effect between consumption and children, as parameterized by ρ.

Figure 3: Calibration and Model Fit



The third scenario "new tech. & old norm" explores a transitional case where technology narrows the wage gap to $w^{♀}/w^{♂} = 0.74$, but the social norm remains fixed at $\eta = 5.25$. Young couples, constrained by this norm, settle on a childcare division of $l^{♀}/l^{♂} = 4.66$, balancing monetary and psychic costs. The unequal allocation worsens women's outside option, leading them to favor fewer children. With fertility determined by mutual agreement, the result is $n = 1.32$—notably lower than the long-run equilibrium in the second scenario. The psychic cost of adopting the egalitarian allocation ($l^{♀}/l^{♂} = 2.53$) under the old norm amounts to 3.48% of child-rearing costs, similar to the 4.3% estimated by Myong et al. (2021) and Kim et al. (2024).

These results highlight the model's ability to capture both steady-state outcomes and transitional dynamics driven by technology and social norms.

Table 4: Three Different Cases

	Old tech. & old norm	New tech. & new norm	New tech. & old norm
$w^{♀}/w^{♂}$	0.58	0.74	0.74
η	5.25	2.53	5.25
$l^{♀}/l^{♂}$	5.25	2.53	4.66
n	1.43	1.37	1.32

5. Counterfactual Analysis

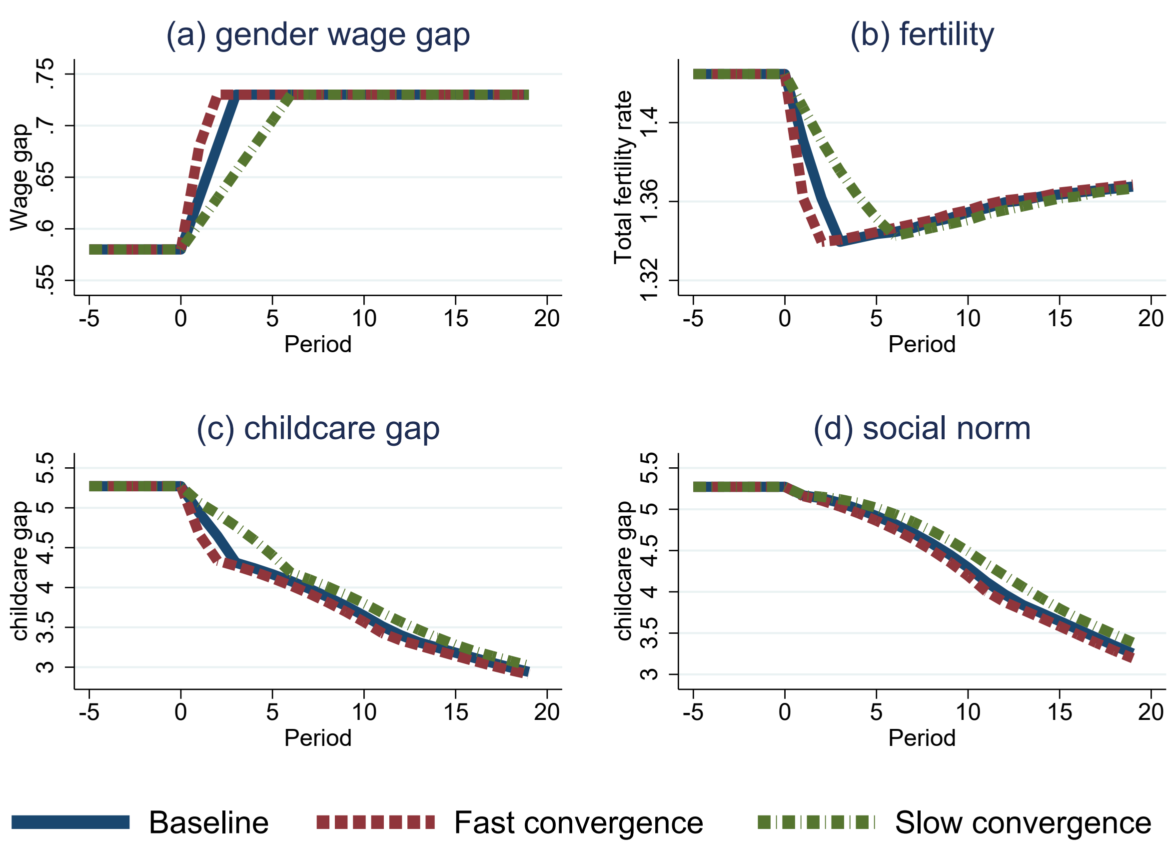
This section conducts counterfactual experiments to explore how technological change, social norms, and policy interventions affect fertility, childcare allocation, and social norms. To focus on technological impacts via the gender wage gap, we hold men's wages, $w_t^{♂}$, constant, letting variations in $w_t^{♀}$ drive the results. We analyze five scenarios, with outcomes depicted in Figures 4, 5, 6, 7, and 8, each plotting the trajectories of (a) gender wage gap, (b) fertility, (c) childcare gap, and (d) social norm.

5.1 Speed of Structural Change

We first examine how the pace of structural change influences the economy's dynamics, comparing a baseline path to fast and slow convergence scenarios. Starting from the 1999 steady state (gender wage gap of 42% ($w_t^{♀}/w_t^{♂} = 0.58$), we simulate a reduction to 27% ($w_t^{♀}/w_t^{♂} = 0.73$), as observed in South Korea by 2014. In the baseline, this convergence occurs over 15 years (1999–2014). The fast convergence scenario compresses it to 10 years (1999–2009), while the slow convergence scenario extends it to 25 years (1999–2024). Figure 4 presents these results.

In the fast convergence case, the gender wage gap (panel a) declines sharply, outpacing the adjustment of the social norm (panel d), which remains near its initial value of 5.25 for several years due to cohort replacement lags and limited re-evaluation by older cohorts. This mismatch drives a rapid fertility decline (panel b), dropping from 1.43 to approximately 1.33 within a decade, as women, facing higher opportunity costs, prefer fewer children under a norm favoring unequal childcare (panel c, $l_t^{♀}/l_t^{♂} \approx 5.0$). Over time, as entering cohorts adopt more equitable allocations, the childcare gap and norm converge toward 3, and fertility recovers to 1.37 by 2024. The slow convergence case shows a smoother transition: the gender wage gap declines gradually, allowing the social norm and childcare gap to adjust in tandem (e.g., η_t and $l_t^{♀}/l_t^{♂}$ fall steadily to 5 and 4.3 by 2014 respectively), with fertility dipping only to 1.34 before stabilizing. The baseline lies between these, with fertility falling to 1.33 by 2014, consistent with calibration.

Figure 4: The Role of Structural Change



Notably, the paths of the childcare gap ($l_t^{♀}/l_t^{♂}$) and social norm (η_t) remain broadly similar across scenarios and to the calibrated baseline. This stability reflects the strong social pressure parameter ($\lambda = 0.0006$), which penalizes deviations from traditional practices, and limited re-evaluation by older cohorts ($\psi = 3$). Even as women's wages rise, young couples adjust childcare allocations incrementally, constrained by the psychic costs of defying a norm shaped by older generations, who express opinions that are similar to their own past practices. The primary divergence thus lies in fertility, underscoring its sensitivity to the timing of structural change relative to norm evolution.

These results, depicted in Figure 4, highlight a non-monotonic fertility response consistent with the model's mechanisms: rapid technological shifts exacerbate short-term fertility declines by amplifying the tension between economic opportunities and social constraints, while slower changes allow for smoother transitions in fertility.

5.2 The Role of Social Pressure

Next, we assess how social pressure modulates the response to structural change. We simulate the baseline 15-year wage gap convergence (42% to 27%) under three levels of social pressure: the calibrated $\lambda = 0.0006$ (baseline), a lower $\lambda = 0.0002$ (weak pressure), and a higher $\lambda = 0.0018$ (strong pressure). Figure 5 displays the outcomes.

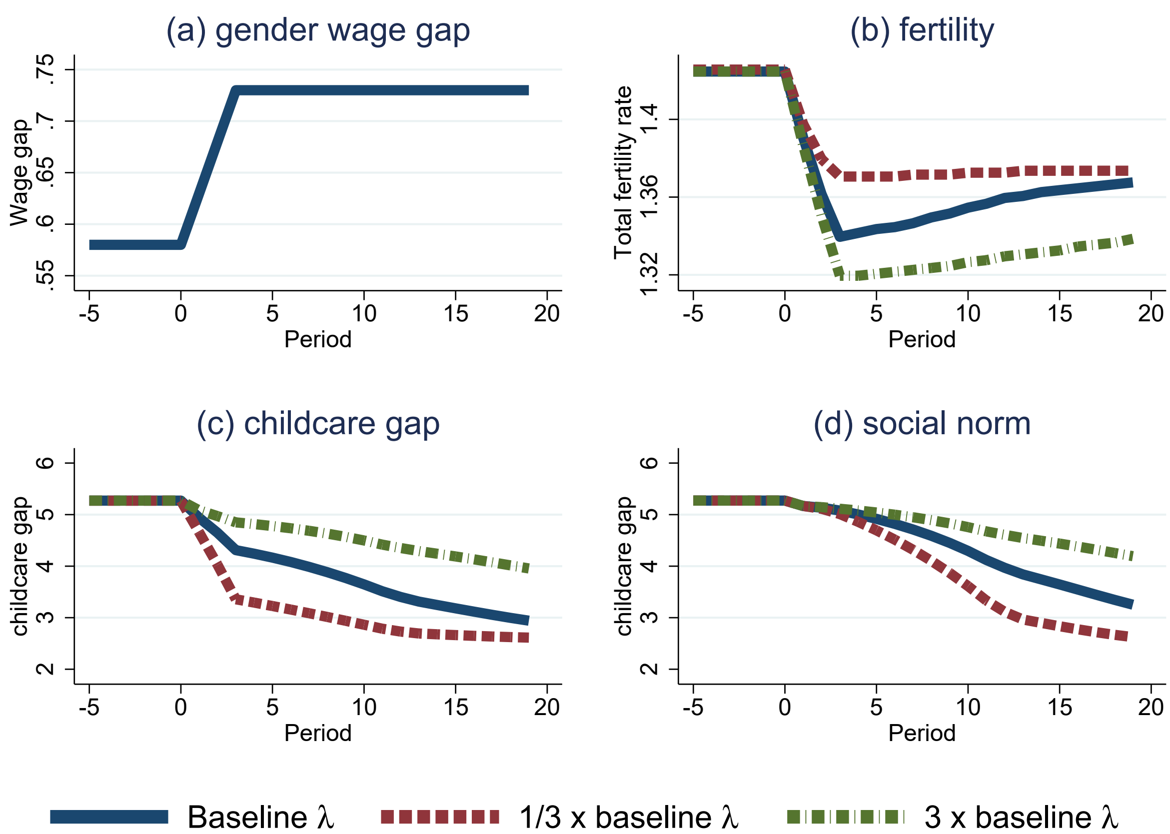
With weak social pressure, the gender wage gap's decline (panel a) prompts a swift reduction in the childcare gap (panel c), falling from 5.25 to 3.3 within 15 years, as couples face lower psychic costs for equitable allocations. The social norm (panel d) follows suit, dropping to 4.8 by 2014, accelerating fertility convergence (panel b) to the long-run level of 1.37. Strong pressure, conversely, locks the childcare gap near 5.0 and the norm near 5.25 for longer, deepening the fertility drop to 1.32 by 2014, with minimal recovery thereafter. The baseline case shows intermediate dynamics: the childcare gap declines to 4.4 and the norm to 4.9 by 2014, with fertility at 1.33.

These findings, shown in Figure 5, underscore social pressure as a critical amplifier of technological shocks. Lower λ facilitates a smoother transition by reducing the tension between rising female wages and lagging norms, while higher λ intensifies short-term fertility losses and prolongs inequitable childcare burdens.

5.3 The Role of Older Cohorts' Re-evaluation

Next, we assess how the re-evaluation by older cohorts when they form social opinions affect the economy's response to structural change. We simulate the baseline 15-year

Figure 5: The Role of Social Pressure

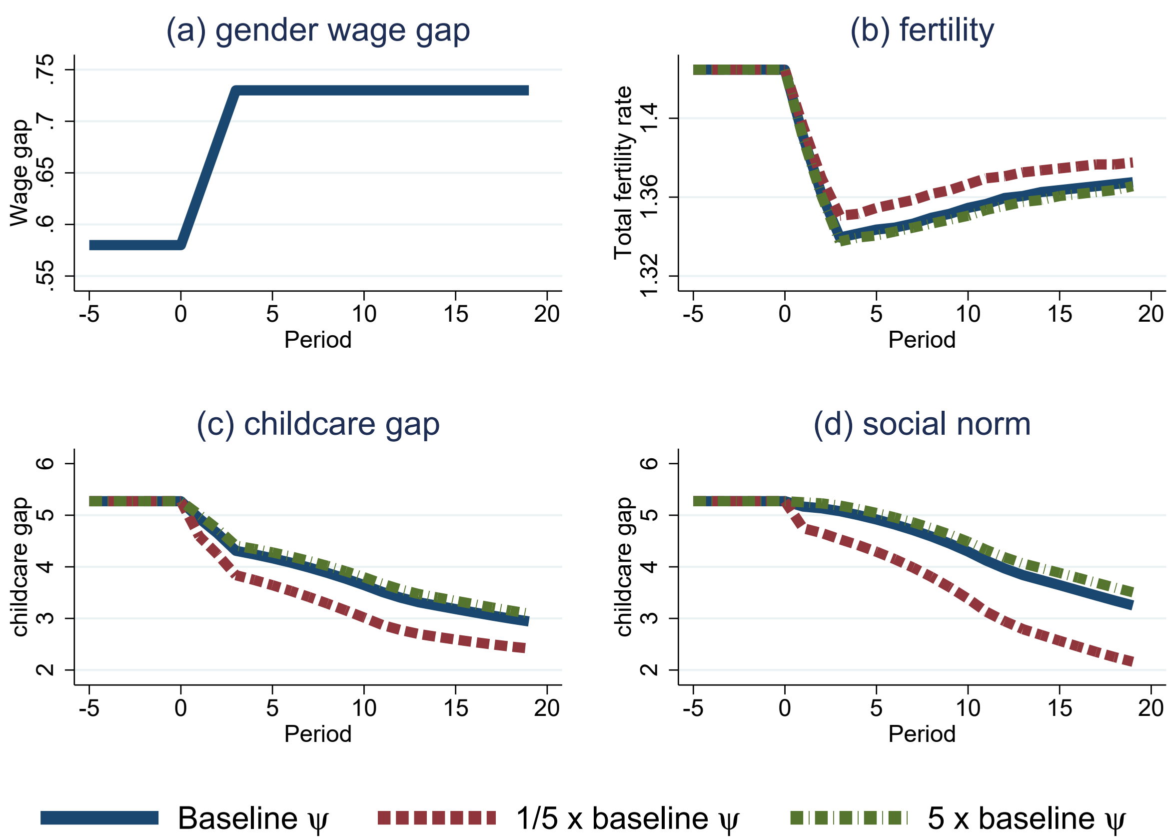


wage gap convergence (42% to 27%) under three levels of "stubbornness": the calibrated $\psi = 3.0$ (baseline), a lower $\psi = 1.0$ (low "stubbornness"), and a higher $\psi = 9.0$ (high "stubbornness"). Figure 6 displays the outcomes.

With low "stubbornness", the gender wage gap's decline (panel a) prompts a faster reduction in the childcare gap (panel c), as older cohorts express more egalitarian opinions and exert lower psychic costs for young couples. The social norm (panel d) converges faster to the new steady state, accelerating fertility convergence (panel b) to the long-run level of 1.37. High "stubbornness", conversely, locks the childcare gap and the social norm at the original level for longer. The baseline case shows intermediate dynamics: the childcare gap declines to 4.4 and the norm to 4.9 by 2014, with fertility at 1.33.

These findings, shown in Figure 6, underscore the re-evaluation by older cohorts as

Figure 6: The Role of Older Cohorts' Reevaluation



another important amplifier of technological shocks. Lower ψ facilitates a smoother transition by reducing the tension between rising female wages and lagging norms, while higher λ intensifies short-term fertility losses and prolongs inequitable childcare burdens.

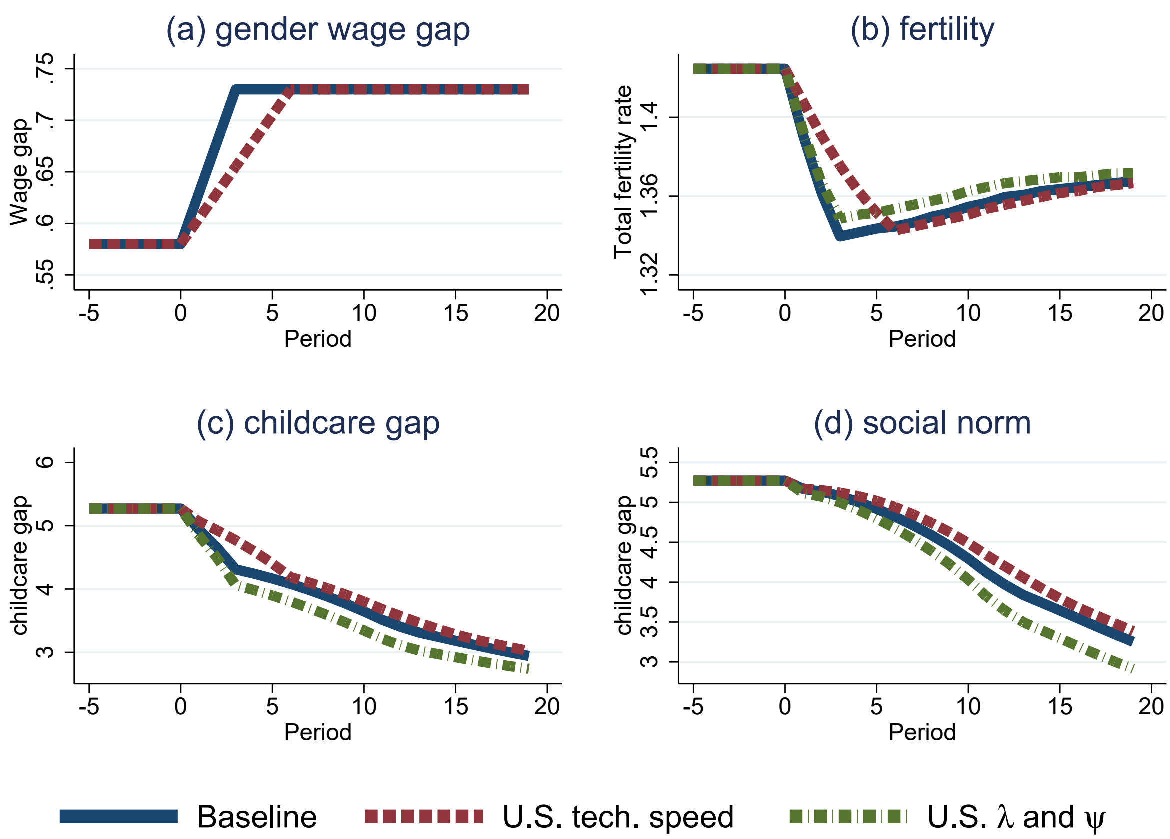
5.4 U.S. Parameters

We also examine the hypothetical fertility transition that would occur if we adjust the parameters calibrated for South Korea to those calibrated for the U.S. economy's transition from 1965 to 2015.[10] We explore two counterfactual scenarios and compare them to the baseline case. In the first counterfactual, we adopt the speed of gender wage gap

[10] For details on the calibration process, refer to Section A.

convergence observed in the U.S., which is half that of South Korea. In the second counterfactual, we modify the parameters to $\lambda = 0.0005$ and $\psi = 2.0$, reflecting lower social pressure and stubbornness, to align with U.S. estimates.[11] The results are presented in Figure 6.

Figure 7: Using U.S. Parameters



On the one hand, with a slower convergence of the gender wage gap, the economy experiences a delayed and more gradual transition in fertility, childcare gap, and social norms, aligning with the findings in Section 5.1.

On the other hand, with reduced social pressure (λ) and lower stubbornness among older cohorts (ψ), the economy avoids a sharp fertility decline—dropping to 1.35 rather than 1.33—while achieving a faster fertility recovery. This scenario also accelerates the

[11]In particular, we find that λ and ψ in the U.S. are 17% and 33% smaller than that in South Korea respectively.

transition of the childcare gap (panel c) and social norms (panel d) toward a new steady state, consistent with the findings in Sections 5.2 and 5.3.

5.5 Gender-Specific Childcare Subsidy

Many developed economies, such as the Nordic countries, have implemented policies like explicit childcare subsidies and paid parental leave to promote gender equality in the workplace and boost fertility (Duvander and Andersson (2006), Lalive and Zweimüller (2009), Farré and González (2019)). Our model is well suited to analyze both the short- and long-run effects of these policies on fertility. In this subsection, we analyze a policy that reimburses the opportunity cost of childcare, funded through lump-sum taxes on all households. Specifically, we compare outcomes when the policymaker subsidizes childcare provided by females versus males. The objective function for the childcare allocation problem, as shown in Equation (6), is modified as follows: When female childcare is subsidized, the objective function becomes:

$$\min_{l^{♀}, l^{♂}} \quad (1-\tau) \cdot w_t^{♀} l^{♀} + w_t^{♂} l^{♂} + \lambda \cdot w_t^{♂} \cdot \left(\frac{l^{♀}}{l^{♂}} - \eta_t \right)^2, \tag{16}$$

whereas for male childcare subsidies, it is:

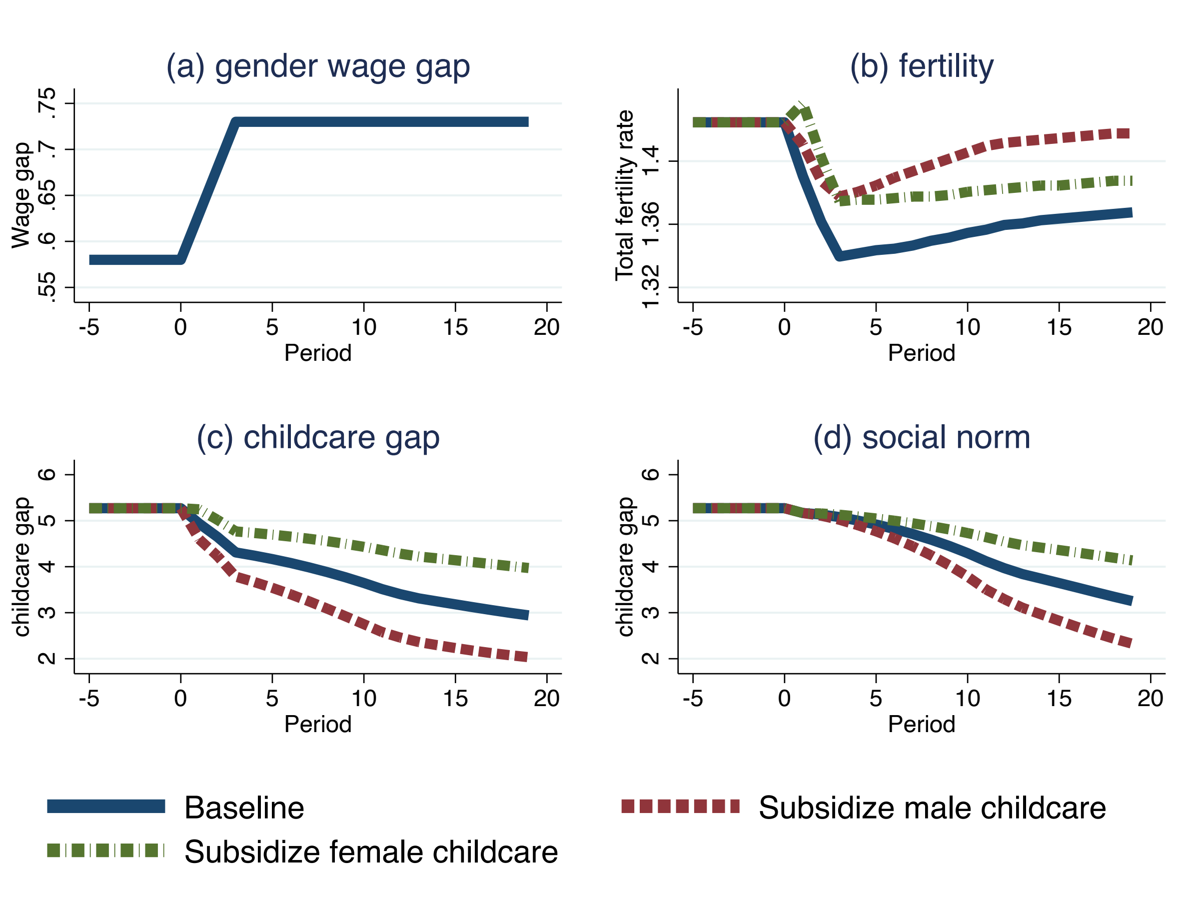
$$\min_{l^{♀}, l^{♂}} \quad w_t^{♀} l^{♀} + (1-\tau) \cdot w_t^{♂} l^{♂} + \lambda \cdot w_t^{♂} \cdot \left(\frac{l^{♀}}{l^{♂}} - \eta_t \right)^2, \tag{17}$$

where the subsidy rate τ is set at 10% in the counterfactual. Figure 8 compares these policies against a no-policy baseline.

Both policies increase fertility compared to the baseline (panel b), but their mechanisms and long-term effects differ. Subsidizing female childcare leads to a substantial initial fertility increase, sufficient to counteract gender-biased technological change. However, this policy reinforces the gender childcare gap, as increased female childcare time entrenches traditional social norms, slowing their transition (panel c and d). Consequently, as the gender wage gap narrows, the initial fertility gains diminish over time.

In contrast, subsidizing male childcare results in a smaller initial fertility increase

Figure 8: Gender-specific Childcare Subsidies



due to the lower baseline male childcare time, which limits the reduction in the shadow price of children. Nevertheless, this policy narrows the gender childcare gap, directly benefiting the current generation and promoting a transition to a more egalitarian long-run steady state for future generations by influencing social norms.

Notably, the fertility effects of male childcare subsidies surpass those of female subsidies after three periods (panel b). This outcome stems from two reasons: First, childcare subsidies lower the shadow price of children. This effect increases over time for male subsidies but diminishes for female subsidies, as men increasingly share childcare responsibilities along the transition path under male subsidies. Second, male childcare subsidies accelerate the transition of social norms, and the shadow price of children is lower under such social norms as women's relative wage rises (see Figure 2).

The results, illustrated in Figure 8, highlight the critical need to model fertility transitions in the context of evolving social norms. A key insight is that while short-term outcomes may suggest that subsidizing female childcare is more effective in boosting fertility, the long-term impacts of subsidizing male childcare are significantly greater. Policymakers must look beyond the immediate effects on the shadow price of children and account for the dynamic consequences driven by endogenous social norms and the evolving childcare decisions of new cohorts.

Interestingly, these predictions are in line with a recent paper by Lee and Lee (2025). In their analysis of a South Korean corporate policy reform, a major conglomerate introduced fully paid parental leave for male employees. The authors found that this mandate significantly increased male participation in parental leave, overcoming entrenched social norms around childcare responsibilities, and led to a substantial positive impact on fertility rates. Notably, the fertility effects were more pronounced in households where wives had higher baseline earnings and longer job tenure. This supports our prediction that policies facilitating a shift in social norms can significantly boost fertility when women face improved labor market opportunities.[12]

6. Robustness

This section discusses the robustness of our calibration and model specification.

6.1 Initial State

One limitation of our baseline calibration is the assumption that the initial gender gap in childcare responsibilities among young couples in 1999 (i.e., $l^{♀}_{1999}/l^{♂}_{1999} = 5.25$) reflects the prevailing social norm, η_{1999}. Ideally, η_t should aggregate the opinions of old cohorts, as specified in Equation (12), which depends on historical childcare practices before 1999, but such data are unavailable to the best of our knowledge.

[12]Another related study in the South Korean context is by Kim and Yum (2025). The authors examine the effects of parental leave policies on fertility and labor supply using a quantitative life-cycle model that incorporates job security but abstracts away from endogenous social norms. In one policy counterfactual, they find that incentivizing men to take parental leave leads to larger positive effects on fertility, consistent with our findings.

To test the sensitivity of our results to this assumption, we experimented with initial norms more unequal than the observed 1999 value—e.g., setting $\eta_{1999} = 6.0$ or 6.5, implying greater gender gaps among older generations. Alternatively, we have experimented with a specification where we assume the economy was in the steady state in 1950 with a gender wage gap $w^{♀}/w^{♂} = 0.3$, whereas the episode we observe between 1999 to 2014 is part of the transition path. Recalibrating the model under these conditions and re-evaluating the counterfactual, we find that the quantitative outcomes, including fertility paths (n_t), childcare allocations ($l_t^{♀}/l_t^{♂}$), and norm evolution (η_t), remain consistent with the baseline.

6.2 Rising Childcare Cost

A second concern is the potential rise in childcare costs over time, which could confound the effects of wage convergence on fertility. For instance, Kim et al. (2024) document increasing parental investment due to status competition, a trend that may elevate the time cost per child, ϕ. To explore this potential, we modify the model to allow ϕ to vary over the calibration period (1999–2014), calibrating its increase to match the rising parental childcare time reported by Park (2021).

Specifically, we assume ϕ_t grows linearly from 0.15 in 1999 to 0.20 by 2014, reflecting intensified child-rearing demands. Incorporating this time-varying ϕ_t requires adjustments to two parameters. First, the fertility curvature, ρ, rises from 2.4 to 3.4, as the observed fertility decline (e.g., from 1.42 to below 1.3) stems not only from productivity gains and wage gap convergence but also from higher childcare costs reducing the substitutability between consumption and children. Second, the fertility weight, γ, increases from 0.24 to 0.34 to maintain the initial fertility level ($n_{1999} = 1.42$) to compensate for the changes in ρ. The value of other parameters—such as σ, ψ, and λ—remains unaffected. Critically, the model's fit to the 1999–2014 fertility and childcare gap trajectories, as well as the counterfactual predictions (e.g., non-monotonic fertility responses), remains quantitatively similar to the baseline. The slightly higher ρ and γ amplify the fertility response to cost increases, but the core mechanisms—driven by wage gaps and norm dynamics—persist. Appendix B reports the model fit and counterfactual results.

These robustness checks affirm that our calibration and counterfactual results are not overly sensitive to the initial norm specification or the assumption of constant childcare costs. The model's ability to accommodate these variations while preserving its predictive power underscores its reliability for analyzing the interplay of technology, norms, and fertility.

7. Conclusion

Fertility rates are declining globally, posing significant economic and demographic challenges. This paper documents an important pattern: fertility falls more precipitously in economies undergoing rapid structural change, with the decline amplified in societies where rigid social norms govern childcare responsibilities. To unpack this relationship, we develop a novel quantitative model of fertility bargaining, where equilibrium outcomes emerge from the interplay between gender-biased technological progress—manifested as rising female wages—and endogenous social norms shaped by past cohorts' opinions, which hinge on the historical childcare practices.

Calibrated to South Korea's experience from 1999 to 2014, our model closely matches the observed trajectories of fertility and childcare gaps, capturing the tension between wage convergence and norm inertia. Counterfactual analyses highlight the pivotal role of adjustment speed: rapid technological change outpaces norm evolution, driving sharper fertility drops, while weaker social pressure, more re-evaluation by older cohorts, or norm-shifting policies (e.g., subsidies to male childcare) mitigate these declines and expedite fertility recovery.

While the model is calibrated to match South Korea's growth experience, we argue that its lessons offer valuable guidance for many developing countries navigating, or on the cusp of, rapid structural transformation. Reconciling gender-biased technological progress with entrenched social norms is essential to tackling the "getting old before getting rich' dilemma these countries face.

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A. Calibration for the United States

In this section, we calibrate the model to match the transition path of fertility and the gender childcare gap observed in the United States from 1965 to 2015. The identification strategy follows from Section 4.2.

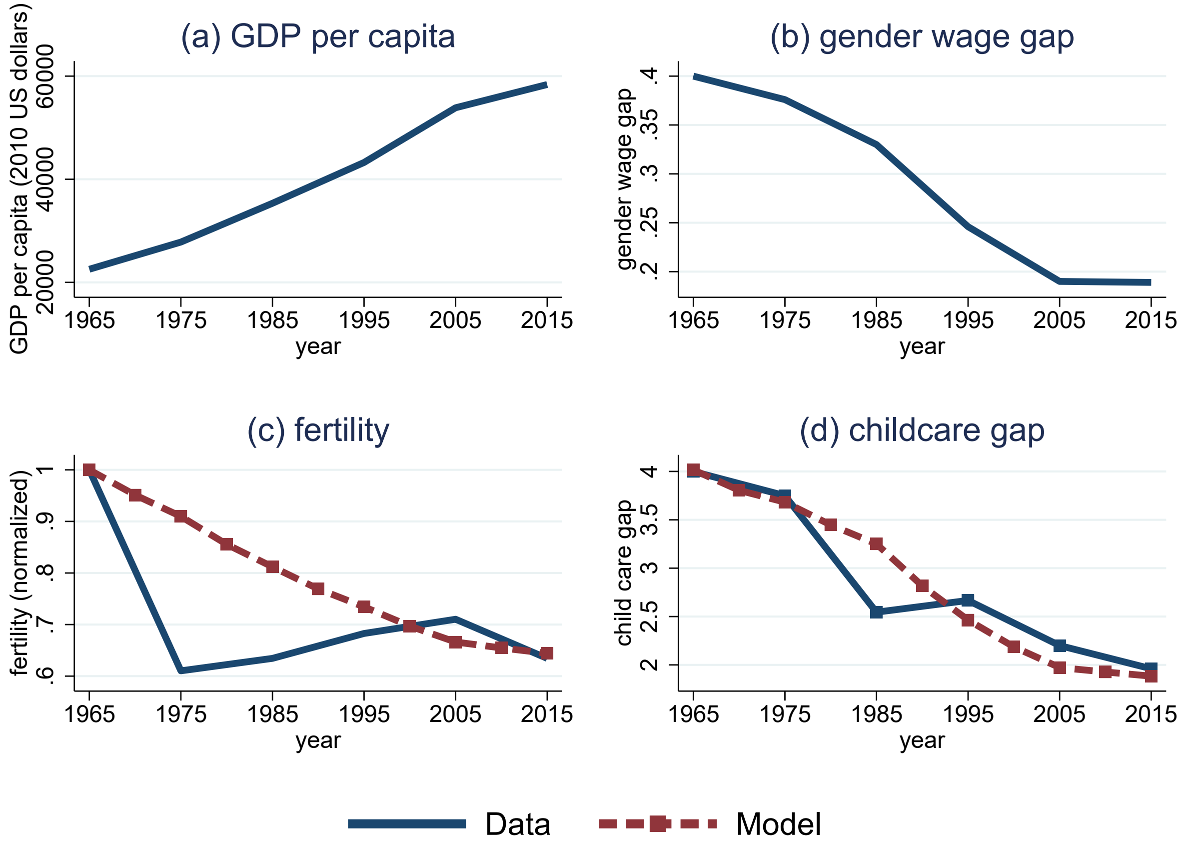
We collect fertility data from the United Nations. Gender-specific childcare time between 1965 and 1995 is collected from Egerton et al. (2005) who utilizes the micro-level data from the American Heritage Time Use Study (AHTUS). After 2003, gender-specific childcare time is calculated using the micro-level data from the American Time Use Survey (ATUS) following the strategy of Milkie et al. (2025). Lastly, we use the micro-level data from the General Social Survey (GSS) to compute the share of within-cohort effects in driving social norm changes. We adopt the same method as described in Section 4.2 and examine the variable "*fefam*: It is much better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family." We find that the ratio of within-cohort change divided by total change is close to 0.3 over the course of 50 years, similar to the decomposition result by Brooks and Bolzendahl (2004).

Table 5: Calibrated Parameters - USA

	Parameter	Value	Data moment	Source	Model fit
γ	Fertility weight	1.27	$n_{1965} = 2.90$	United Nations	2.90
σ	Childcare substitutability	2.73	$\eta_{1965} = 4.0$	Egerton et al. (2005)	4.0
ρ	Fertility curvature	2.4	$n_{1965} \sim n_{2015}$	United Nations	See Figure 9
ψ	Stubbornness	2.0	Within-cohort effects	GSS	30%
λ	Social pressure	0.0005	$\eta_{1965} \sim \eta_{2015}$	Egerton et al. (2005)	See Figure 9
α	Economies of scale	1.2	Doepke and Kindermann (2019)		
ϕ	Time costs per child	0.15	de La Croix and Doepke (2003)		
J	Total number of periods	16	80 years	World Health Organization	
J_f	The fertile period	6	25 to 30 yo	Statista	

Figure 9 plots the time path of GDP per capita and the gender wage gap as inputs into the transition path calibration. Panels (c) and (d) of 9 present the data and model-

Figure 9: Calibration and Model Fit - USA



generated path of fertility and the childcare gap. As can be seen, while the model does not fully account for the decline and recovery of fertility after the baby boom, it fits the overall decline in fertility and the path of the childcare gap in the study period well.[13]

Table 5 displays the calibrated parameters for the U.S. economy. Except for the parameter γ which governs the level of fertility, parameters σ and ρ are very similar to the results in South Korea (see Table 3). The parameters governing the social norm evolution, however, are quite different. The value for λ in the U.S. is 17% smaller than that in South Korea, indicating a smaller magnitude of social pressure. In addition, the value for ψ in the U.S. is 33% smaller than that in South Korea, implying a smaller degree of stubbornness and hence greater re-evaluation by older cohorts.

[13] See Greenwood et al. (2005) for an in-depth study of the U.S. baby boom. The rising immigration from sending countries with high fertility, e.g., Mexico, has also contributed to the fertility recovery since the 1970s (Jonsson and Rendall (2004)).

B. Rising Childcare Cost

This section reports the model fit and the first two counterfactual results when we consider rising childcare costs over time. See Section 6.2 for detailed discussions.

Figure 10: Calibration and Model Fit w/ Rising Childcare Cost

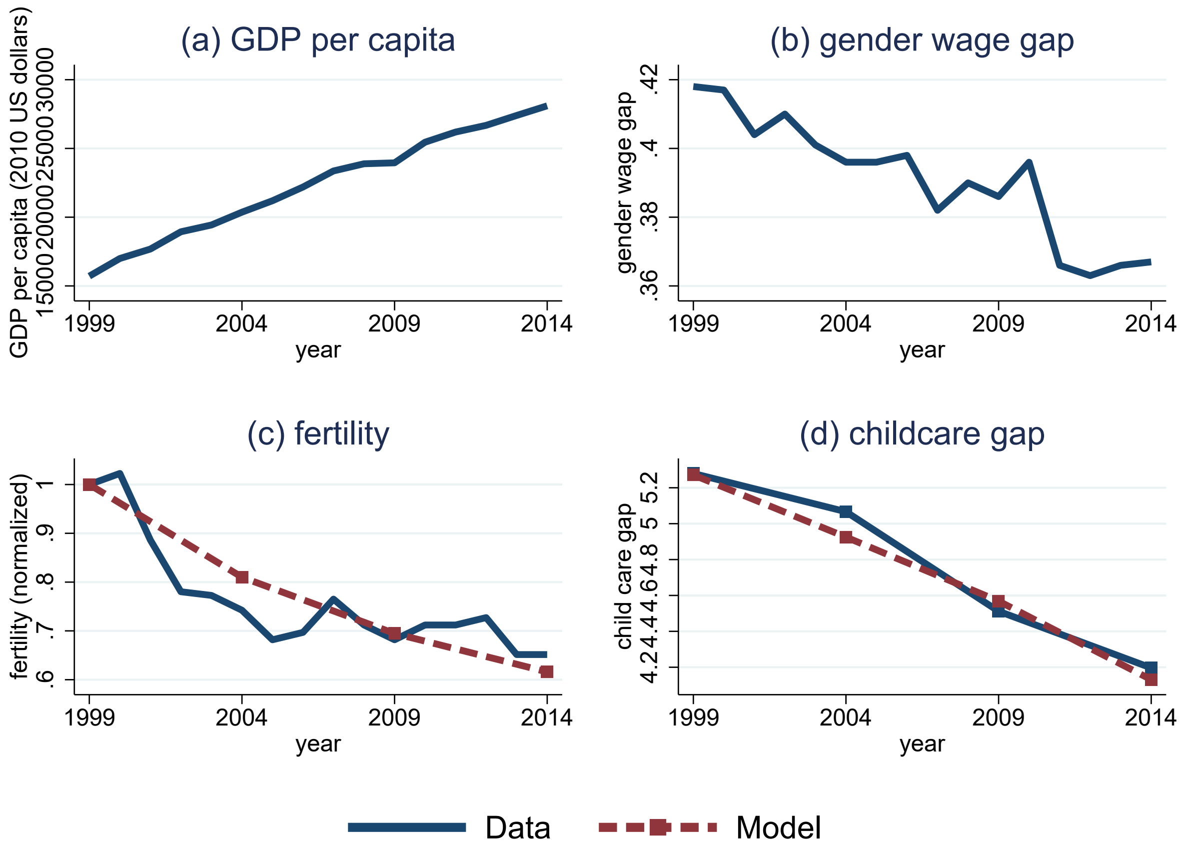


Figure 11: The Role of Structural Change w/ Rising Childcare Cost

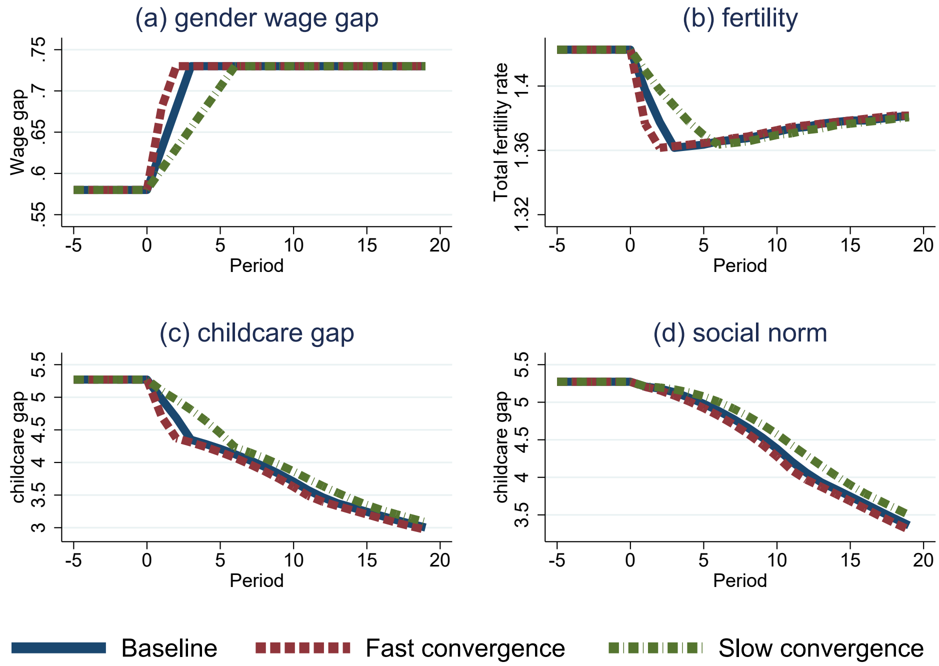
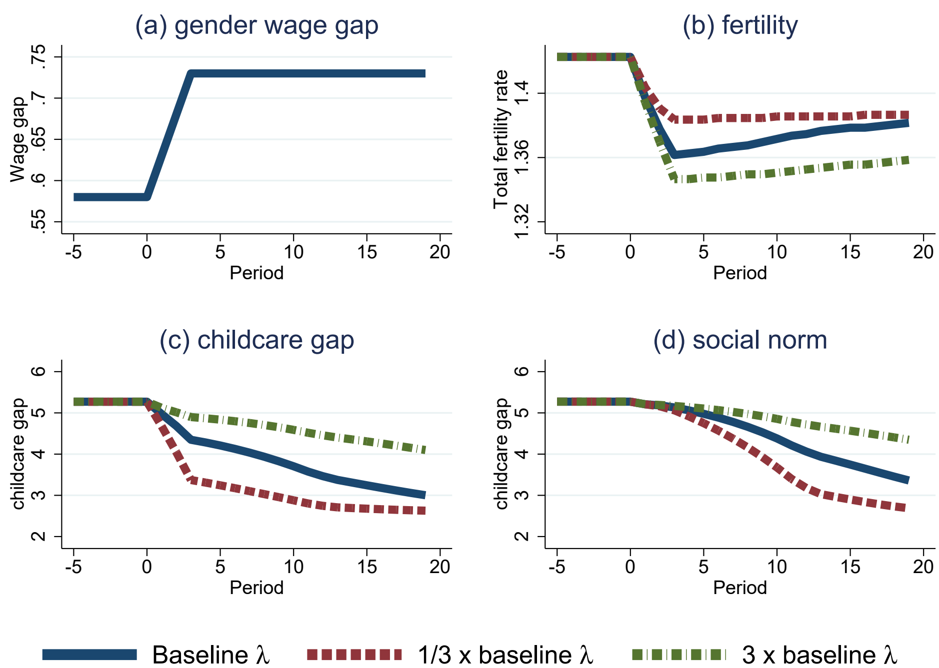


Figure 12: The Role of Social Pressure w/ Rising Childcare Cost



C. Ideal Number of Children by Gender

This section displays the average responses to the question, IDLCHDN: ”What is the ideal number of children for a family to have?” from the Korean General Social Survey (KGSS), broken down by survey year and respondent gender. The sample includes only respondents aged 24 to 34, a 10-year range centered on the median age of first birth.

Table 6: Ideal Number of Children

Survey Year	Male respondents	Female respondents
2006	2.41	2.38
2008	2.52	2.45
2012	2.64	2.41

Notes: This table displays the average responses to the question, IDLCHDN: ”What is the ideal number of children for a family to have?” from the Korean General Social Survey (KGSS), broken down by survey year and respondent gender. The sample includes only respondents aged 24 to 34, a 10-year range centered on the median age of first birth.