Career Choices, Timing of Childbirth, and Perceptions of Fecundity

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Abstract

How do perceptions of fecundity affect women's careers and childbearing decisions? We develop a quantitative life-cycle model of employment, marriage, and fertility in Japan that distinguishes subjective fecundity from the medical probabilities governing realized births. The model links employment histories to future earnings and incorporates the choice of infertility treatment. We calibrate the model for two cohorts of Japanese women using panel data on employment and marriage and national fertility statistics. Correcting fecundity beliefs brings marriage and childbirth forward and increases cumulative births but Increases in births at younger ages are largely offset by reductions at older ages. Eliminating out-of-pocket treatment costs instead increases births at older ages. Combining the two changes produces larger cumulative gains while preserving much of the shift toward earlier childbearing. Employment responses differ accordingly, with reductions concentrated earlier in the life cycle under belief correction and later under free treatment.

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1 Introduction

It is never too late to start, but sometimes it is. The timing of childbirth is closely intertwined with women's careers. Work experience shapes future earnings, so an interruption in employment around childbirth can have consequences beyond the income forgone during that period.[1] Postponing childbirth may allow women to accumulate experience and establish their careers before having children. In Japan, the mean maternal age at first birth rose from 26.7 years in 1985 to 31.0 years in 2024. Over the same period, the total fertility rate fell from 1.76 to 1.15. Longer periods of education and incentives to establish a career before having children may contribute to the postponement of marriage and childbearing.

Fecundity, the biological capacity to reproduce, declines with age.[2] Using data on Japanese couples trying to conceive their first child, Konishi, Sakata, Oba, and O'Connor (2018) estimate that the probability of conception within 12 months of discontinuing contraception is 80 percent among women aged 24–26, compared with 48 percent among those aged 36–38. Starting later can thus mean attempting conception when success is less likely, with less time remaining for further attempts and subsequent births. Postponement may consequently make it more difficult to achieve a desired family size. How women weigh this risk against the benefits of continued career investment depends on their beliefs about their future fecundity.

This paper asks how women's perceptions of fecundity shape their career, marriage, and childbearing decisions. These decisions reflect women's beliefs about their reproductive opportunities, which need not coincide with medical evidence.[3] Overestimating the chances of conceiving later in life may make postponement appear less costly, encouraging women to delay attempts to have children while pursuing their careers. The resulting choices may affect both when births occur and how many children women have. We examine how these decisions and outcomes change when subjective fecundity is aligned with a medical benchmark.

Evidence on these beliefs comes from a nationwide online survey conducted in 2021 by the Health and Global Policy Institute (2022), covering 10,000 men and women aged 25–49 in Japan. Respondents were asked to identify the age beyond which becoming pregnant

[1]See Kleven, Landais, and Søgaard (2019) for evidence on persistent child penalties in earnings, and Adda, Dustmann, and Stevens (2017) for a structural analysis of the career costs of children.

[2]See Dunson, Colombo, and Baird (2002) and Wesselink, Rothman, Hatch, Mikkelsen, Sørensen, and Wise (2017) for evidence on age-related declines in fecundity.

[3]See Lampic, Skoog Svanberg, Karlström, and Tydén (2006) and Peterson, Pirritano, Tucker, and Lampic (2012) for evidence of overly optimistic beliefs about reproductive aging and IVF success among university students.

is difficult, separately for natural conception and infertility treatment. Among female respondents, 39.1 percent selected age 35 and 27.5 percent selected age 40 for natural conception. When asked about pregnancy with infertility treatment, 44.8 percent selected age 40 and 23.2 percent selected age 45. These responses document variation in perceived reproductive age limits and motivate examining how beliefs about natural conception and infertility treatment shape childbearing decisions.[4]

As childbearing has shifted to older ages, infertility treatment has become increasingly important in Japan. The number of infants born following assisted reproductive technology (ART) increased from 28,945 in 2010 to 85,048 in 2023, according to the national registry of the Japan Society of Obstetrics and Gynecology (Katagiri, Jwa, Kuwahara, Iwasa, Ono, Kato, Kishi, Kuwabara, Taniguchi, Harada, Iwase, and Sugino, 2026). Public support has also expanded: in April 2022, Japan extended health insurance coverage to treatments including in vitro fertilization and intracytoplasmic sperm injection (Ministry of Health, Labour and Welfare, 2023). These developments motivate examining how the cost of treatment affects childbearing decisions and how its effects interact with women's beliefs about their future reproductive opportunities.

We develop a quantitative life-cycle model of women's employment, marriage, and childbearing decisions. Women choose between regular employment, contingent employment, and not in the labor force (NILF), with employment histories affecting future earnings and hence the opportunity cost of childbirth. Single women decide whether to marry, while married households decide whether to attempt a birth, with infertility treatment available after the loss of natural fecundity. A central feature of the model is the distinction between the subjective probabilities of natural conception used to evaluate choices and the medical probabilities governing realized births. We calibrate the model for two cohorts of Japanese women: those born between 1959 and 1969 (cohort A) and those born between 1985 and 1989 (cohort E). We combine employment and marriage data from the Japan Panel Survey of Consumers (JPSC) with national age-specific fertility rates compiled by the National Institute of Population and Social Security Research (IPSS). We then examine three counterfactual experiments: aligning subjective fecundity with the medical benchmark, eliminating out-of-pocket costs of infertility treatment, and combining these changes. These experiments allow us to assess how beliefs and treatment costs affect the timing and number of births and women's employment.

Our quantitative results show that correcting fecundity beliefs increases cumulative births and shifts childbearing toward younger ages. Cumulative births from age 25 through age 49 rise by approximately 0.2 percent in cohort A and 0.7 percent in cohort

[4]See Appendix A for the survey questions and Table 4 for the full distribution of responses.

E. Births increase at younger ages and decline at older ages, with the earlier increases exceeding the later reductions. Among births occurring between ages 26 and 49, mean maternal age falls by approximately six months in both cohorts. Belief correction also brings marriage forward and reduces employment around the early thirties. These results indicate that reproductive beliefs shape both the timing and number of births, with accompanying changes in marriage and women's employment profiles.

Eliminating out-of-pocket treatment costs increases births at older ages and raises cumulative births by approximately 0.7 percent in both cohorts. Unlike belief correction, this change slightly increases mean maternal age at birth. Combining the two interventions increases cumulative births by approximately 1.0 percent in cohort A and 1.3 percent in cohort E, while bringing mean maternal age at birth forward by about five months. The two interventions therefore affect different parts of the childbearing age profile: belief correction encourages earlier births, whereas lower treatment costs expand reproductive opportunities at older ages. Their combined effect increases cumulative births while preserving much of the shift toward earlier childbearing.

1.1 Literature Review

This paper relates to the literature on fertility, female labor supply, and family decisions over the life cycle. Becker and Barro (1988) and Barro and Becker (1989) develop dynamic models of endogenous fertility, while Becker, Murphy, and Tamura (1990) connect fertility, human capital investment, and economic growth. Doepke and Kindermann (2019) examine how disagreement between partners and the allocation of child-rearing costs shape fertility decisions. Doepke, Hannusch, Kindermann, and Tertilt (2023) review the economics of fertility in high-income countries and emphasize the importance of the conditions that allow women to combine careers and family life.

A closely related literature studies the links between childbirth and women's careers. Adda, Dustmann, and Stevens (2017) quantify the career costs of children in a dynamic model with occupational choice, employment interruptions, and skill accumulation and depreciation. Eckstein, Keane, and Lifshitz (2019) study changes in career and family outcomes across U.S. birth cohorts in a model with joint education, employment, marriage, divorce, and fertility decisions. Attanasio, Low, and Sánchez-Marcos (2008) examine cohort changes in female labor force participation using a life-cycle model with savings and human capital accumulation, highlighting the roles of childcare costs and the gender wage gap. More recently, Jakobsen, Jørgensen, and Low (2025) jointly model fertility, the labor supply of both partners, and human capital accumulation, allowing the timing and number of births to respond to economic incentives. These studies motivate accounting for the effects of employment histories on future earnings when analyzing childbirth decisions.

For Japan, Yamaguchi (2019) estimates a dynamic model of women's employment and fertility decisions to evaluate parental leave policies, explicitly distinguishing regular and nonregular employment. Kitao and Mikoshiba (2024) examine how fiscal policies shape women's participation, choices between regular and contingent employment, and earnings over the life cycle. Our model builds on this treatment of employment choices and earnings histories. It distinguishes regular employment, contingent employment, and nonparticipation, and allows marriage and childbearing decisions to interact with women's career choices across two Japanese cohorts. Kitao and Nakakuni (2026) examine how technological change shapes marriage, fertility, educational investment, and women's time allocation in Japan, highlighting the opportunity cost of childrearing. Nakakuni (2024) studies the fertility, demographic, and welfare effects of child benefits in a general equilibrium overlapping-generations model calibrated to Japan.

Our analysis also relates to research on childbearing under uncertainty and declining fecundity. Sommer (2016) studies how uninsurable earnings risk and age-dependent infertility risk jointly shape the timing and number of births. de la Croix and Pommeret (2021) analyze the option value of postponing childbearing when motherhood increases income risk. Both studies also examine the role of assisted reproduction. We contribute to this literature by distinguishing the subjective fecundity probabilities used to make decisions from the medical probabilities governing realized births. Within a model of endogenous employment, marriage, and childbearing, we examine how this distinction affects the timing of births and the number of children women have, and how these outcomes respond to changes in fecundity beliefs and the out-of-pocket cost of infertility treatment.

The rest of the paper is organized as follows. Section 2 presents the quantitative life-cycle model. Section 3 describes the calibration of the model. Section 4 presents the quantitative results and counterfactual experiments. Section 5 concludes.

2 Model

2.1 Overview

We develop a life-cycle model of women's employment, marriage, and childbearing decisions. Women choose consumption, saving, and employment throughout their working lives.[5] Before the end of the reproductive decision period, single women also decide

[5]After marriage, these choices are made by a unitary household that takes into account both spouses' incomes and utilities. The husband's labor supply and earnings are exogenous.

whether to marry, while married households decide whether to attempt to have a child. These choices depend on women's beliefs about their future fecundity. Births are subsequently realized according to a medical fecundity schedule, which need not coincide with the schedule used to make decisions.

The life cycle has three stages. During the first stage, women make employment, saving, and family-formation decisions. After marriage and fertility decisions are no longer available, they continue to choose employment and saving. In retirement, households choose consumption and saving and receive pension income. We compare cohorts $g \in \{A, E\}$, allowing preferences, selected employment costs, and initial conditions to differ across cohorts.

At each working age, a woman observes her state and chooses employment and saving and a married household also chooses a fertility action. Current employment determines earnings and updates employment history. Single women then observe preference shocks to marriage and remaining single and choose between these alternatives by comparing their values, including the realized shocks. A decision to marry takes effect in the following period. Married households instead realize birth outcomes and transitions in natural fecundity and the presence of a young child. These events determine next period's family state.

2.2 Demographics

One period is one year. Women enter at age $j_{\min}$, retire at j_{ret}, and live through age J. Survival is deterministic. Marriage decisions and attempts to have children are available through decision age j_F.

Marital status is denoted by $q \in \{S, M\}$, where S denotes single and M denotes married. Marriage is absorbing, and children can be born only within marriage.[6] Spouses are of the same age. A potential husband's permanent skill $s_m \in \{L, H\}$ is drawn from $\pi_g(s_m \mid s_f)$, conditional on the woman's skill s_f. His earnings, labor supply, and assets brought into marriage are exogenous. There is no separate optimization problem for single men.

The number of children born to a woman is $n \in \{0, \ldots, n_{\max}\}$. The indicator $k \in \{0, 1\}$ records whether the household has a young child. Parity n and the young-child indicator k are distinct. Parity does not fall when a child grows older. Natural fecundity is denoted by $f \in \{0, 1\}$, where $f = 1$ indicates the ability to conceive naturally and $f = 0$ indicates its irreversible loss.

[6] This assumption is motivated by the low prevalence of births outside marriage in Japan (Cabinet Office, 2023).

At age 25, women are initialized using cohort-specific empirical distributions of skills, marital status, employment histories, and family composition. Past employment and employment history are drawn jointly conditional on cohort, skill, and marital status. Initially married women may already have children and women who marry subsequently enter marriage childless. Initial assets are set to zero. Women also draw a permanent preference type z, described below.

2.3 Endowments and Employment Histories

Women are endowed with a permanent skill level $s_f \in \{L, H\}$.[7] Before retirement, they choose employment $e \in \mathcal{E} \equiv \{R, C, N\}$, corresponding to regular employment, contingent employment, and not in the labor force (NILF), respectively.

Let e^- denote employment in the preceding period. The history vector $X = (x_R, x_C, x_N)$ records years spent in regular employment, contingent employment, and NILF through the preceding period. During working life, histories evolve as

$$\begin{aligned} x_R^+ &= x_R + \mathbf{1}\{e = R\}, \\ x_C^+ &= x_C + \mathbf{1}\{e = C\}, \\ x_N^+ &= \min\{x_N + \mathbf{1}\{e = N\}, \bar{x}_N\}. \end{aligned} \tag{1}$$

We denote this transition by $X^+ = H(X, e)$. Next period's previous-employment state is e. Histories stop accumulating at retirement.

Female earnings $y^f(s_f, X, e^-, e)$ depend on permanent skill, current and previous employment, and accumulated employment history, following Yamaguchi (2019) and Kitao and Mikoshiba (2024). Earnings are zero for women in NILF. The earnings coefficients differ between regular and contingent employment but are common across cohorts. Employment choices therefore affect both current resources and future earnings opportunities. The functional form and parameter values are described in Section 3.

Male earnings $y_j^m(s_m)$ follow a deterministic age–skill profile that is common across cohorts. Husbands supply a fixed amount of work time before retirement. Their earnings do not depend on their wives' employment or fertility choices.

2.4 Preferences

Future utility is discounted by β. The consumption weight ω and curvature parameter σ are common to all adults.

[7] High skill denotes a bachelor's degree or higher; low skill denotes all other educational attainment levels.

2.4.1 Single Women

A single woman derives utility from consumption c and leisure ℓ_f. Her period utility is

$$v^S(c,\ell_f) = \frac{\left(c^\omega \ell_f^{1-\omega}\right)^{1-\sigma}}{1-\sigma}. \tag{2}$$

2.4.2 Married Households

Married households derive utility from consumption, both spouses' leisure, and children. Let c denote total household consumption expenditure and n the number of children at the beginning of the period. Consumption is adjusted for household size using the equivalence scale

$$\eta_{M,j,n} = \begin{cases} \eta_M(1+\eta_n n), & j < j_{\text{ret}}, \\ \eta_M, & j \geq j_{\text{ret}}. \end{cases} \tag{3}$$

This specification approximates the end of children's financial dependence at parental retirement. Utility from children continues throughout retirement.

Period utility for a married household in cohort g at age j is

$$\begin{aligned} v^M_{g,j}(c,\ell_f,\ell_m,n,z) = {} & \frac{\left[(c/\eta_{M,j,n})^\omega \ell_f^{1-\omega}\right]^{1-\sigma}}{1-\sigma} \\ & + \frac{\left[(c/\eta_{M,j,n})^\omega \ell_m^{1-\omega}\right]^{1-\sigma}}{1-\sigma} + zU_{g,j}(n). \end{aligned} \tag{4}$$

Married households maximize the sum of the two adults' utilities, with utility from children counted once. Each adult's utility depends on the consumption index $c/\eta_{M,j,n}$, while the household budget includes total consumption expenditure c once.

The permanent preference for children, z, is distributed as

$$z \sim \text{Uniform}[0,1]. \tag{5}$$

This distribution is common across cohorts. The draw is independent of initial skill and marital status and remains fixed throughout life.

Before scaling by z, utility from children is

$$U_{g,j}(n) = A_g S(j;\tau,s)\frac{(n+n_0)^{1-\rho_g} - n_0^{1-\rho_g}}{1-\rho_g}. \tag{6}$$

The scale A_g and curvature ρ_g may differ across cohorts, and $n_0 > 0$ is fixed. This specification normalizes utility from children to zero when $n = 0$ and allows the marginal utility of an additional child to decline with parity.

The multiplier $S(j;\tau,s)$ captures how the valuation of children varies with the mother's current age.[8] We specify

$$S(j;\tau,s) = \frac{1}{1+\exp[-(j-\tau)/s]}, \qquad s>0. \tag{7}$$

The parameter τ is the age at which the multiplier equals one-half, while s governs how gradually it increases with age. Both parameters are common across cohorts and preference types.

Utility from children is received each period, including during retirement, and depends on the beginning-of-period number of children and the mother's current age. A birth realized during the current period increases parity next period; its effects on child utility and the equivalence scale therefore begin next period.

Available time is normalized to one. A working-age woman's leisure is

$$\ell_f = 1 - \varpi_{g,q,e} - \kappa_{g,e^-,e} - \mathbf{1}\{q=M\}\mathbf{1}\{e\in\{R,C\}\}k\psi_g. \tag{8}$$

Participation costs are $\varpi_{g,q,e}$, and switching costs are $\kappa_{g,e^-,e}$. The childcare cost ψ_g applies when a married woman with a young child works. These costs are measured in units of leisure. Participation costs for nonparticipation are zero. Switching costs are allowed for $N\to R$, $N\to C$, and $C\to R$ and the remaining transitions have zero cost.

A husband's leisure is fixed $\hat{\ell}_m$ before retirement. At retirement, both adults have leisure one, and employment and childcare time costs cease.

2.5 Marriage Decisions

A single woman chooses employment and saving before observing the period's marriage shocks. After these choices, she compares remaining single with entering marriage next period. Let W_j^S and W_j^M denote the discounted continuation values of these alternatives, with the latter integrating over the potential husband's skill and the woman's natural fecundity at marriage entry. The married continuation value is obtained from the unitary household's optimization problem, whose period utility is given by equation (4).

Let $t_j = j - j_{\min}$. The deterministic component favoring marriage is

$$\begin{aligned}\mu(j,s_f,g,e) = \mu_0 + \mu_1 t_j + \mu_2 t_j^2 + \mu_3 t_j^3 + \mu_H\mathbf{1}\{s_f=H\}\\ + \mu_E\mathbf{1}\{g=E\} + \mu_C\mathbf{1}\{e=C\} + \mu_N\mathbf{1}\{e=N\}.\end{aligned} \tag{9}$$

[8] This age-dependent valuation of children is motivated by Guner, Kaya, and Sánchez-Marcos (2024), who incorporate a logistic age profile into utility from children.

Cohort A and regular employment are the reference categories. The employment argument is the current choice e, which becomes previous employment at marriage entry. This index enters the current marriage comparison without an additional discount factor.

Each alternative receives an independent type-I extreme-value shock with unit scale, centered to have mean zero.[9] The woman marries if

$$\mu(j, s_f, g, e) + W_j^M + \varepsilon_M \geq W_j^S + \varepsilon_S. \tag{10}$$

Consequently, conditional on employment and saving, the probability of marriage and the expected value of the comparison are

$$P_j^{\text{mar}} = \frac{\exp\{\mu(j, s_f, g, e) + W_j^M\}}{\exp\{W_j^S\} + \exp\{\mu(j, s_f, g, e) + W_j^M\}}, \tag{11}$$

$$\mathcal{M}_j = \log\Big[\exp\{W_j^S\} + \exp\{\mu(j, s_f, g, e) + W_j^M\}\Big]. \tag{12}$$

Because the shocks are centered to have mean zero, no additional constant appears in the expected maximum.

Upon marriage, the husband's skill and the woman's natural fecundity are drawn. The husband brings assets $\widetilde{a}_{g,j+1,s_m}$, which are added to the woman's saving.[10] She retains her skill, updated employment history, and preference type. Newly formed households enter with $n = k = 0$. Since a decision at age 49 can lead to marriage entry at age 50, the last possible marriage entry need not precede the last age at which a married household can attempt a birth.

2.6 Childbearing Decisions and Fecundity

A married household chooses a fertility action $b \in \{0, \text{nat}, \text{art}\}$, denoting no attempt, a natural attempt, or assisted reproductive technology (ART). Let $f \in \{0, 1\}$ indicate whether the woman retains natural fecundity. Birth attempts are feasible only when $j \leq j_F$ and $n < n_{\max}$. Women with $f = 1$ may attempt a natural birth, while those with $f = 0$ may use ART. No attempt is always available. We denote the feasible action set by $\mathcal{B}_j(n, f)$. Households choose among these actions based on current resources and expected future household values, without an action-specific preference shock.

Let q_j^{sub} and q_j^{med} denote the subjective and medical success probabilities of a natural attempt, conditional on natural fecundity, and let q_j^{art} denote the success probability of

[9] See Train (2009, Chapter 3) for the logit choice probabilities and the associated log-sum expression for expected maximum utility.

[10] The profile of assets brought into marriage is constructed from JPSC data.

ART. For feasible actions, define

$$Q_j^v(b,f) = \begin{cases} q_j^v, & b = \text{nat},\ f = 1, \\ q_j^{\text{art}}, & b = \text{art},\ f = 0, \\ 0, & b = 0, \end{cases} \qquad v \in \{\text{sub}, \text{med}\}. \tag{13}$$

Households evaluate their choices using Q_j^{sub}, while births are realized according to Q_j^{med}. The ART success probability is therefore the same in expectations and realizations. All three schedules vary with age and are common across cohorts. The subjective schedule varies with age but is not updated following an unsuccessful attempt.

Let $B_j \in \{0,1\}$ denote a birth realized during the period beginning at age j, and let $k \in \{0,1\}$ indicate the presence of a young child.[11] Birth outcomes and next-period family composition follow

$$B_j \sim \text{Bernoulli}\left(Q_j^{\text{med}}(b,f)\right), \tag{14}$$

$$n^+ = n + B_j, \tag{15}$$

$$\Pr(k^+ = 1 \mid k, B_j) = B_j + (1 - B_j)k(1 - d_j). \tag{16}$$

A birth increases parity and sets the young-child indicator to one in the following period. Without a birth, an existing young-child state ends with probability d_j, approximating children aging out of this state without tracking their individual ages.

Natural infertility is absorbing. During the reproductive decision period, its transition is

$$\Pr(f^+ = 0 \mid f = 1) = h_j^{\text{inf}}, \tag{17}$$

$$\Pr(f^+ = 0 \mid f = 0) = 1. \tag{18}$$

The transition occurs after the current attempt and is independent of the chosen action and birth outcome conditional on age and current fecundity. A woman may therefore give birth and lose natural fecundity in the same period.

Single women do not carry an individual fecundity state. Upon marriage entry at age j, natural infertility is drawn with probability F_j^{inf}, the age-specific cumulative infertile share. After j_F, fecundity remains fixed and no longer affects household choices. The probability schedules and transition parameters are specified in Section 3.

[11] A young child is defined as a child aged 0–6.

2.7 Government and Household Budgets

Households pay a consumption tax τ^c, and assets earn a return r. The government provides pensions after retirement and a resource-tested transfer. Policies and the interest rate are exogenous.

Household labor or pension income is

$$Y_j^S = \begin{cases} y^f(s_f, X, e^-, e), & j < j_{\text{ret}}, \\ p_{g,j}^f, & j \geq j_{\text{ret}}, \end{cases} \tag{19}$$

$$Y_j^M = \begin{cases} y^f(s_f, X, e^-, e) + y_j^m(s_m), & j < j_{\text{ret}}, \\ p_{g,j}^f + p_{g,j}^m, & j \geq j_{\text{ret}}. \end{cases} \tag{20}$$

Pension benefits are exogenous and do not depend on the woman's employment history.

A married household choosing ART incurs out-of-pocket expenditure

$$D(b) = \mathbf{1}\{b = \text{art}\}\Omega, \tag{21}$$

where Ω is the cost borne by the household per treatment attempt, net of existing public support. This expenditure is incurred whenever treatment is chosen, regardless of its outcome.

Let a denote beginning-of-period household assets. Resources available after treatment expenditure, but before transfers and saving, are

$$R_j^S = (1+r)a + Y_j^S, \qquad R_j^M = (1+r)a + Y_j^M - D(b). \tag{22}$$

For marital status $q \in \{S, M\}$, the government transfer is

$$T_j^q = \max\left\{0, (1+\tau_{g,j}^c)\underline{c}_q - R_j^q\right\}. \tag{23}$$

The transfer raises available resources to the amount needed to finance consumption $\underline{c}_q$, including consumption tax. Eligibility therefore depends on both income and assets and is assessed after deducting treatment expenditure.

The household budget constraint and feasibility restrictions are

$$(1+\tau_{g,j}^c)c + a^+ = R_j^q + T_j^q, \tag{24}$$

$$c > 0, \qquad a^+ \geq 0, \tag{25}$$

$$T_j^q > 0 \quad \Longrightarrow \quad a^+ = 0. \tag{26}$$

Households cannot borrow. Transfer recipients cannot save and therefore consume exactly $\underline{c}_q$. Households receiving no transfer choose consumption and saving subject to the budget constraint, with consumption required only to be strictly positive.

2.8 Recursive Formulation

Let V_j^S denote the value of a single woman and V_j^M the value of a married household. Their working-age states, with age indexed on the value functions, are

$$x^S = (g, s_f, a, X, e^-, z), \tag{27}$$
$$x^M = (g, s_f, s_m, a, X, e^-, n, k, f, z). \tag{28}$$

All maximizations below are subject to the household budget, feasible leisure, and the relevant fertility action set. The initial state distribution is taken as given. The expectation used in household decisions is subjective and the medical probabilities are used when generating realized outcomes.

Single women during the marriage decision period. After choosing (a^+, e), the state if the woman remains single is

$$x^{S,+} = (g, s_f, a^+, H(X,e), e, z). \tag{29}$$

If she marries a man with skill s_m and enters with fecundity f^+, the next-period married state is

$$x^{M,+}(s_m, f^+) = \big(g, s_f, s_m, a^+ + \widetilde{a}_{g,j+1,s_m}, H(X,e), e, 0, 0, f^+, z\big). \tag{30}$$

The discounted continuation values entering the marriage comparison are

$$W_j^S = \beta V_{j+1}^S(x^{S,+}), \tag{31}$$
$$W_j^M = \beta \sum_{s_m \in \{L,H\}} \pi_g(s_m \mid s_f) \Big[(1 - F_{j+1}^{\text{inf}}) V_{j+1}^M(x^{M,+}(s_m, 1)) + F_{j+1}^{\text{inf}} V_{j+1}^M(x^{M,+}(s_m, 0)) \Big]. \tag{32}$$

Employment and saving are chosen in anticipation of the marriage shocks:

$$V_j^S(x^S) = \max_{c, a^+, e} \left\{ v^S(c, \ell_f) + \mathcal{M}_j \right\}, \qquad j \le j_F. \tag{33}$$

Here $\mathcal{M}_j$ is given by equation (12). The continuation values W_j^S and W_j^M already include discounting.

Married households before retirement. Write the joint transition kernel under probability schedule v as

$$P_j^v(B, k^+, f^+ \mid b, k, f) = P_j^v(B \mid b, f)\, P_j(k^+ \mid k, B)\, P_j(f^+ \mid f). \tag{34}$$

For given outcomes, the next-period state is

$$x^{M,+}(B,k^+,f^+) = \big(g, s_f, s_m, a^+, H(X,e), e, n+B, k^+, f^+, z\big). \tag{35}$$

The household solves

$$\begin{aligned} V_j^M(x^M) = \max_{c,a^+,e,\,b\in\mathcal{B}_j(n,f)} \Big\{ & \nu_{g,j}^M(c,\ell_f,\ell_m,n,z) \\ & + \beta \sum_{B,k^+,f^+} P_j^{\text{sub}}(B,k^+,f^+ \mid b,k,f)\, V_{j+1}^M(x^{M,+}(B,k^+,f^+)) \Big\}. \end{aligned} \tag{36}$$

The action affects expected future family composition and, for ART, current resources. Current utility depends on beginning-of-period parity and the young-child state.

Working ages after family-formation decisions end. For $j_F < j < j_{\text{ret}}$, single women remain single and solve

$$V_j^S(x^S) = \max_{c,a^+,e} \left\{ \nu^S(c,\ell_f) + \beta V_{j+1}^S(x^{S,+}) \right\}. \tag{37}$$

Married households continue to solve equation (36) with $b = 0$ and fixed parity. The young-child state may still change, so childcare costs can continue to affect employment. At the retirement boundary, continuation values use the reduced retired states described next.

Retirement and the terminal condition. In retirement, employment histories, past employment, and natural fecundity no longer affect choices. For married households, parity and the permanent preference type remain relevant. The retirement problems are

$$V_j^{S,\text{ret}}(g,a) = \max_{c,a^+} \left\{ \nu^S(c,1) + \beta V_{j+1}^{S,\text{ret}}(g,a^+) \right\}, \tag{38}$$

$$\begin{aligned} V_j^{M,\text{ret}}(g,a,n,z) = \max_{c,a^+} \Big\{ & 2\nu_{g,j}^M(c/\eta_{M,j,n},1) + zU_{g,j}(n) \\ & + \beta V_{j+1}^{M,\text{ret}}(g,a^+,n,z) \Big\}. \end{aligned} \tag{39}$$

Both problems satisfy the budget and transfer rules above with pension income. The model has no bequest motive, and terminal continuation values are

$$V_{J+1}^{S,\text{ret}} = V_{J+1}^{M,\text{ret}} = 0. \tag{40}$$

We solve backward using subjective natural fecundity and then generate realized life-cycle outcomes using medical natural fecundity.[12] This distinction allows beliefs to affect employment, marriage, and the timing of attempts, while the medical schedule determines the success of those attempts.

3 Calibration

We calibrate the model to Japanese data for cohorts A and E, drawing primarily on the Japan Panel Survey of Consumers (JPSC). The parameters are divided into two groups. The first group is set using evidence from previous studies, institutional information, and estimates obtained directly from the data. The remaining parameters are calibrated internally to match selected moments of female earnings and age profiles of employment, marriage, and fertility. We distinguish between parameters that are common across cohorts and those that are allowed to differ. The following subsections describe the externally calibrated inputs and the internal calibration, respectively.

3.1 Externally Calibrated Parameters

The external calibration combines information from the JPSC and published studies with fixed assumptions about preferences and institutions. These inputs are not adjusted to match the employment, marriage, and fertility moments used in the internal calibration. Selected values are reported in Table 1, with common and cohort-specific inputs shown separately.

Demographics and initial conditions. One model period corresponds to one year. Women enter the model at age $j_{\min} = 25$, retire at age $j_{\text{ret}} = 65$, and live through age $J = 85$. Single women can choose to marry and married households can attempt a birth through age $j_F = 49$. Lifetime births are capped at $n_{\max} = 3$.

The age-25 population is initialized using cohort-specific JPSC distributions of education, marital status, employment histories, and family composition. Employment in the preceding year and accumulated experience are drawn jointly within cohort–education–marital-status groups. Women who are already married may enter with children; initially single women are childless. All households begin with zero assets.

Assortative mating is represented by the cohort-specific distribution $\pi_g(s_m \mid s_f)$ of husbands' education conditional on wives' education. We also fix the age-specific proba-

[12] The numerical implementation evaluates choices on finite grids.

bilities d_j governing transitions out of the young-child state in periods without a birth.

Preferences and normalizations. The annual discount factor is fixed at $\beta = 0.98$. We set the curvature of the consumption–leisure aggregate to $\sigma = 3$ and assign equal weights to consumption and leisure, $\omega = 0.5$.[13]

Based on the modified OECD equivalence scale, we assign a weight of 1.0 to the first adult, 0.5 to the second adult, and 0.3 to each child. Under our specification, we set $\eta_M = 1.5$ and $\eta_n = 0.2$.

The offset in utility from children is fixed at $n_0 = 1$. The permanent child-preference type follows $z \sim \text{Uniform}[0, 1]$, with the same distribution across cohorts. The scale of the marriage preference shocks is normalized to one. The remaining preference parameters are are calibrated internally, as described below.

Fecundity and beliefs. We assign separate age profiles to medical and subjective fecundity and use the same pair of profiles for both cohorts. The medical profile draws on the twelve-month conception probabilities reported by Konishi, Sakata, Oba, and O'Connor (2018). In the model, the probability is 0.80 at ages 25–26, 0.48 at ages 36–38, and 0.31 at ages 39–44. Beyond age 44, we impose a linear decline that reaches zero at age 50.

The survey reported by Health and Global Policy Institute (2022) provides evidence on beliefs about the age beyond which conception becomes difficult. It motivates the distinction between perceived and medical reproductive opportunities. For the subjective profile, we assume a success probability of 0.80 through age 38 and a linear decline thereafter, reaching zero at age 50. This numerical profile is a maintained assumption rather than a direct estimate from the survey, which does not elicit annual conception probabilities.

The cumulative profile of permanent loss of natural fecundity, F_j^{inf}, is informed by Trussell and Wilson (1985), who study age-related sterility in a historical English population. Since the loss of natural fecundity is an absorbing state, the probability of becoming infertile between ages j and $j+1$, conditional on retaining natural fecundity at age j, is

$$h_j^{\text{inf}} = \frac{F_{j+1}^{\text{inf}} - F_j^{\text{inf}}}{1 - F_j^{\text{inf}}}, \qquad j \leq 49. \tag{41}$$

The cumulative profile and its implied annual hazardsremain fixed throughout the calibration.

[13] De Nardi, Fella, and Paz-Pardo (2025) use an annual discount factor of 0.97, while Borella, De Nardi, and Yang (2023) estimate 0.990. The former treat consumption and leisure symmetrically, and the latter estimate a consumption weight of 0.407. French (2005) reports consumption weights between 0.533 and 0.615 across specifications. De Nardi, French, and Jones (2016) estimate nonmedical-consumption curvature of 2.83 in a specification with separable medical and nonmedical utility.

Infertility treatment. We obtain age-specific treatment success probabilities from the 2023 ART registry statistics published by the Japan Society of Obstetrics and Gynecology (2025). The relevant measure is the fraction of treatment cycles resulting in a live birth, with freeze-all cycles excluded from the denominator. Households use the same treatment success probabilities that govern realized outcomes, and the schedule is common across cohorts.

We set the household's out-of-pocket treatment cost to $\Omega = 300{,}000$ yen per treatment cycle.[14] This cost is incurred whenever treatment is chosen, regardless of its outcome.

Interest rate and policy environment. The annual return on assets is $r = 0.02$. Household consumption is taxed at $\tau_c = 0.10$. Each adult receives an annual pension of 820,000 yen from age 65. The transfer rule uses consumption thresholds of 870,000 yen for single households and 1,320,000 yen for married households. These values define a common policy environment for the two cohorts and remain fixed over their model life cycles, with pension payments beginning at retirement.

3.2 Internally Calibrated Parameters

We calibrate the remaining parameters internally to match observed patterns of employment, marriage, fertility, and female earnings. The externally calibrated inputs, including fecundity schedules, policy parameters, initial distributions, and the distribution of permanent preferences for children, are held fixed.

Employment costs. We calibrate participation costs $\varpi_{g,q,e}$, switching costs $\kappa_{g,e^-,e}$, and the childcare time cost ψ_g to match the age profiles of regular and contingent employment shares in the JPSC, separately by cohort and marital status. Participation costs vary by cohort, marital status, and employment type. Switching costs vary by cohort and employment transition, while the childcare time cost is cohort-specific. Together, these parameters govern the relative attractiveness of employment, the costs of changing employment status, and the incentives to work when a young child is present.

Employment shares are calculated relative to all women in each age–cohort–marital-status cell, including those in NILF. The NILF share is therefore the residual of the regular and contingent shares and is not an additional independent target.

[14] The magnitude of this cost is informed by NPO Fine (2013), whose survey identifies 300,000 to less than 500,000 yen as the most frequently reported charge for one IVF cycle. One model period corresponds to one year, and an ART choice represents one treatment cycle within that year. Treatment costs and success probabilities are therefore specified per cycle.

Table 1: Fixed Parameters and Selected Empirical Inputs

Panel A: Common across cohorts

Parameter	Description	Value/Source
$j_{\min}$	Initial age	25
j_F	Last age for marriage and fertility decisions	49
j_{ret}	Retirement age	65
J	Terminal age	85
$n_{\max}$	Maximum number of children	3
β	Annual discount factor	0.98
σ	Curvature of consumption–leisure utility	3.00
ω	Consumption weight in utility	0.50
η_M	Equivalence scale for a childless married household	1.50
η_n	Child adjustment in the equivalence scale	0.20
n_0	Offset in utility from children	1.00
F_z	Distribution of permanent child preferences	Uniform$[0, 1]$
r	Annual interest rate	0.02
$\tau^c_{g,j}$	Consumption tax rate	0.10
$\underline{c}_S$	Consumption floor: single household	870,000 yen
$\underline{c}_M$	Consumption floor: married household	1,320,000 yen
$p^f_{g,j}$, $p^m_{g,j}$	Annual pension benefit per adult	820,000 yen
Ω	Out-of-pocket ART cost per cycle	300,000 yen
q^{sub}_j	Subjective fecundity	See text
q^{med}_j	Medical fecundity	See text
q^{art}_j	ART live-birth probability per cycle	See text
d_j	Young-child state exit probability conditional on no birth	See text
F^{inf}_j	Cumulative share with natural infertility	See text
h^{inf}_j	Annual hazard of natural infertility	See text

Panel B: Cohort-specific inputs

Parameter	Description	Cohort A	Cohort E
$\Pr(s_f = H)$	Share of high-skill women at age 25	0.1373	0.4464
$\pi_g(H \mid H)$	Probability of a high-skill spouse: high-skill woman	0.8123	0.7252
$\pi_g(H \mid L)$	Probability of a high-skill spouse: low-skill woman	0.2905	0.2605

Notes: The equivalence-scale parameters imply $\eta_{M,n} = \eta_M(1 + \eta_n n) = 1.5 + 0.3n$, using the adult and child weights of the modified OECD scale. Cohort-specific inputs in Panel B are computed from the JPSC. Sources and construction of the age-specific fecundity and treatment success probabilities are described in the text.

Marriage incentives. We calibrate the marriage-index coefficients to match the age profiles of the married share in the JPSC for each cohort. The coefficients $\mu_0, \ldots, \mu_3$ govern the level and cubic age profile of the index, while μ_H, μ_C, and μ_N allow marriage incentives to vary with skill and current employment. These coefficients are common across cohorts, with μ_E allowing an additional shift for cohort E. They are calibrated to reproduce the aggregate marriage profiles generated by the model's state-dependent marriage decisions. The married share at age 25 is imposed through the initial conditions and is excluded from the marriage targets.

Preferences for children. We calibrate the cohort-specific child-utility parameters A_g and ρ_g, together with the common age-profile parameters s and τ, to match age-specific fertility rates from the National Institute of Population and Social Security Research (IPSS). The scale A_g governs the strength of preferences for children, and ρ_g governs how the marginal utility of an additional child declines with parity. The parameters s and τ determine how the valuation of children changes with the mother's age. These parameters jointly shape the level and age profile of births in each cohort.

Fertility targets are annual births per woman from age 26 onward, with all women included in the denominator regardless of marital or employment status. Cumulative births are reported to summarize the resulting fertility profiles and are not targeted separately.

Female earnings. We calibrate the female earnings coefficients to match mean annual earnings by age and current employment type for cohort A in the JPSC. The coefficients differ between regular and contingent employment and determine how earnings vary with permanent skill, accumulated employment histories, and previous employment status. The same coefficients are applied to cohort E, for which the corresponding earnings moments are unavailable. Appendix B presents the earnings specification, the calibrated coefficients, and the implied baseline earnings profiles.

Only cohort–age cells observed in the data enter the calibration. In particular, predictions for cohort E beyond its observed age range are not targeted. Although each parameter block is associated with a particular set of outcomes, employment, marriage, and fertility decisions interact within the model, so changes in one block can affect the fit of the others. Table 2 reports the marriage, child-preference, and employment-cost parameters, distinguishing coefficients common across cohorts from cohort-specific ones.

Table 2: Internally Calibrated Parameters

Panel A: Common across cohorts

Parameter	Description	Value
μ_0	Marriage index: intercept	-14.91
μ_1	Marriage index: linear age term	0.49
μ_2	Marriage index: quadratic age term	-0.009
μ_3	Marriage index: cubic age term	0.00005
μ_H	Marriage index: high-skill effect	3.12
μ_E	Marriage index: cohort E effect	2.90
μ_C	Marriage index: contingent-employment effect	-8.14
μ_N	Marriage index: NILF effect	-13.94
s	Child utility: age-profile scale	15.6
τ	Child utility: age-profile midpoint	18.0

Panel B: Cohort-specific parameters

Parameter	Description	Cohort A	Cohort E
A_g	Scale of utility from children	2.73	2.29
ρ_g	Curvature of utility from children	1.20	1.18
$\varpi_{g,S,R}$	Participation cost: single, regular	0.341	0.319
$\varpi_{g,S,C}$	Participation cost: single, contingent	0.056	0.069
$\varpi_{g,M,R}$	Participation cost: married, regular	0.194	0.240
$\varpi_{g,M,C}$	Participation cost: married, contingent	0.091	0.165
$\kappa_{g,N,R}$	Switching cost: NILF to regular	0.242	0.326
$\kappa_{g,N,C}$	Switching cost: NILF to contingent	0.118	0.196
$\kappa_{g,C,R}$	Switching cost: contingent to regular	0.325	0.375
ψ_g	Childcare time cost when working	0.235	0.083

Notes: The cohort index is $g \in \{A, E\}$. Marital status is denoted by S (single) and M (married); employment status is denoted by R (regular), C (contingent), and N (NILF). The age terms in the marriage index use $t_j = j - j_{\min}$. Cohort A, low skill, and regular employment are the reference categories in the marriage index.

4 Quantitative Results

This section evaluates the baseline model's fit to marriage, fertility, and employment, and then considers three counterfactuals: aligning subjective fecundity with the medical benchmark, eliminating out-of-pocket treatment costs, and combining the two. We report both cumulative outcomes and their distribution over age. Unless otherwise stated, changes in births are expressed relative to the baseline for the same cohort and age range; changes in marriage and employment shares are expressed in percentage points.[15]

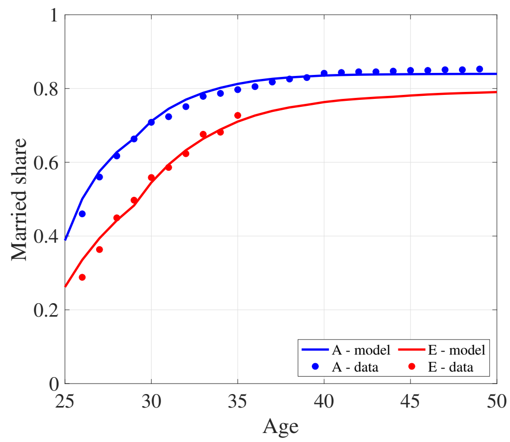
4.1 Baseline Fit

Figure 1 compares the baseline marriage and cumulative fertility profiles with the data. The model reproduces the lower married share in cohort E over the observed age range. At age 30, the married share is 71.1 percent in the model and 70.8 percent in the data for cohort A, compared with 54.5 and 55.9 percent for cohort E. The fit is not exact at older observed ages: at age 49, the model predicts a married share of 84.0 percent for cohort A, against 85.3 percent in the data; at age 35, the corresponding values for cohort E are 71.0 and 72.7 percent.

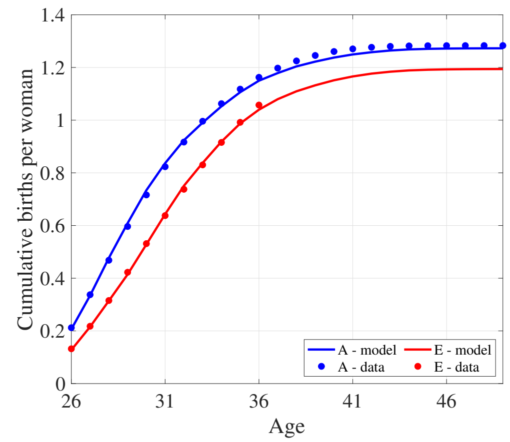
The cumulative fertility profiles also capture the main difference between cohorts. For cohort A, cumulative births from age 25 through age 49 are 1.273 per woman in the model, compared with 1.283 in the data. For cohort E, whose observed fertility series ends at age 36, the corresponding cumulative values through that age are 1.040 and 1.057. The baseline projection for cohort E reaches 1.194 births per woman by age 49. The model captures the cohort differences in cumulative fertility and closely matches cumulative births over the observed age ranges.

[15]Cumulative births follow the convention used in the figures: the observed age-25 birth rate, 0.0974 for cohort A and 0.0599 for cohort E, is added to simulated annual birth rates from age 26 onward. The age-25 contribution is common to the baseline and counterfactuals. These measures exclude births before age 25. Mean maternal age is calculated across all birth orders using annual birth rates at ages 26–49. Employment effects over an age band are averages of annual share differences.

4.1.1 Marriage and Fertility



(a) Share of Married



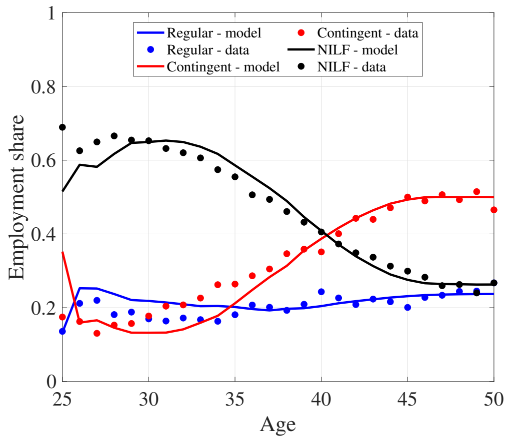
(b) Cumulative Births since Age 25

Figure 1: Baseline Fit: Marriage and Fertility

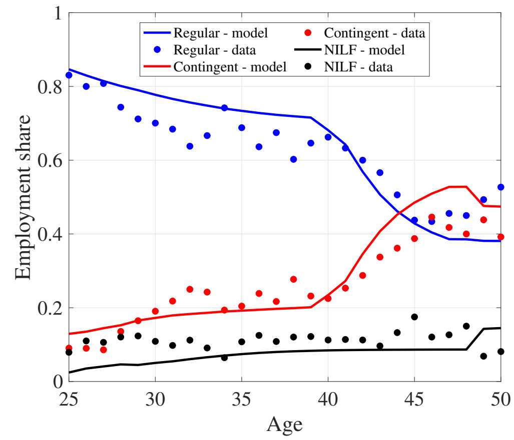
4.1.2 Employment

Figures 2 and 3 compare model-generated and observed employment shares by cohort and marital status. The model captures the broad differences in employment patterns across these groups.

Among married women in cohort A, the share in NILF is high during the thirties and declines at older ages as contingent employment becomes more prevalent. The model reproduces this shift in the composition of employment over the life cycle. It also captures the greater prevalence of regular employment among married women in cohort E relative to cohort A, as well as the higher regular employment shares among single women relative to married women. Employment data for cohort E are available through age 35.

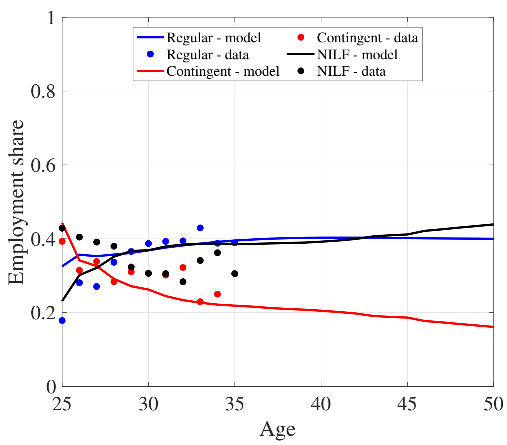


(a) Married

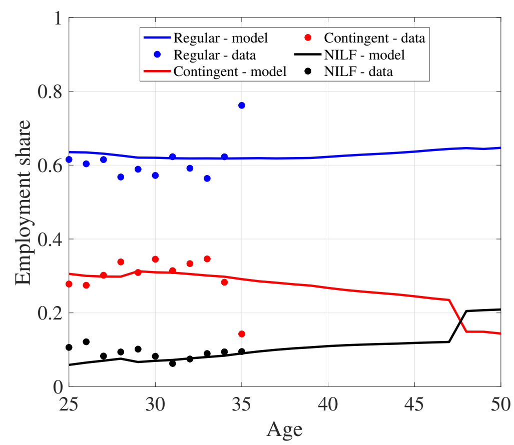


(b) Single

Figure 2: Baseline Fit: Employment, Cohort A



(a) Married



(b) Single

Figure 3: Baseline Fit: Employment, Cohort E

Having assessed the baseline fit, we now examine the three counterfactual experiments. Table 3 summarizes changes in birth rates over ages 26–34 and 35–49 and in married shares at ages 30 and 50, relative to the baseline for each cohort. The following subsections examine each experiment's effects on marriage, fertility, and employment.

Table 3: Counterfactual Changes in Fertility and Marriage

	Birth-rate change (%)		Married-share change (pp)	
	Ages 26–34	Ages 35–49	Age 30	Age 50
Panel A: Correcting Fecundity Beliefs				
Cohort A	+6.24	−25.82	+1.492	−0.132
Cohort E	+7.34	−19.81	+2.524	−0.281
Panel B: Free Fertility Treatment				
Cohort A	−0.35	+5.69	−0.005	+0.098
Cohort E	−0.45	+4.43	−0.052	+0.001
Panel C: Combined Intervention				
Cohort A	+6.03	−20.28	+1.423	−0.061
Cohort E	+6.97	−15.89	+2.484	−0.207

Notes: All changes are relative to the baseline for the same cohort. Birth-rate changes are percentage changes in average annual births per woman within each age interval, with all women included in the denominator. Married-share changes are counterfactual minus baseline differences in percentage points at the indicated ages. Married shares are measured at the beginning of each period. Marriage decisions are reoptimized in all three experiments.

4.2 Correcting Fecundity Beliefs

4.2.1 Marriage and Fertility

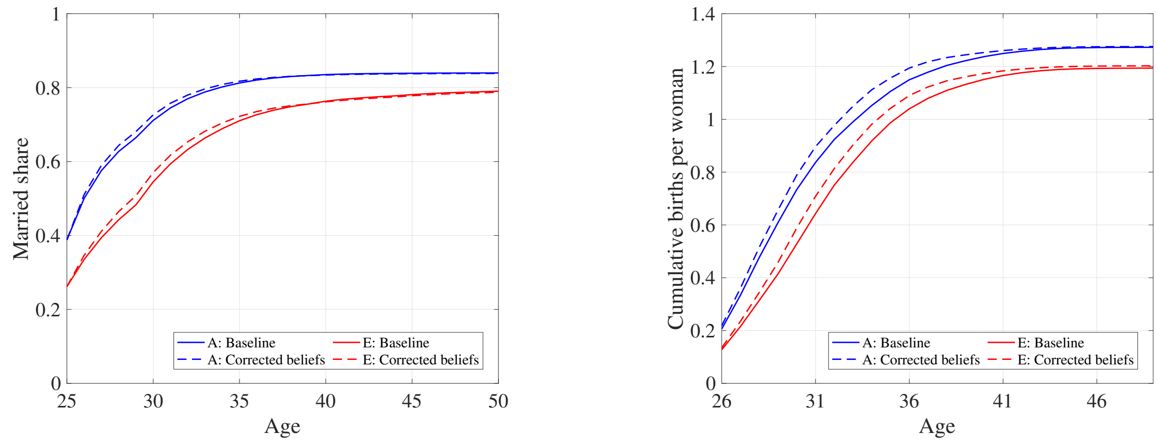
The first experiment aligns the natural-conception probabilities used in household decisions with the medical probabilities governing birth outcomes. Figure 4 shows that cumulative births by age 49 increase from 1.273 to 1.275 per woman in cohort A and from 1.194 to 1.202 in cohort E. Using the unrounded values, these are increases of 0.21 and 0.70 percent, respectively.

The changes over different age ranges are considerably larger than these net increases. As reported in Panel A of Table 3, births accumulated over ages 26–34 rise by 6.2 percent in cohort A and 7.3 percent in cohort E, equivalent to approximately 6.0 and 6.3 additional births per 100 women. Over ages 35–49, births decline by 25.8 and 19.8 percent, or approximately 5.7 and 5.5 births per 100 women. The early increases are therefore largely offset by later reductions. Mean maternal age at birth falls by 6.2 months in cohort A and 6.3 months in cohort E. Belief correction increases cumulative births while shifting childbearing toward younger ages.

Marriage also takes place earlier. Mean marriage-entry age falls by 3.6 months in cohort A and 5.3 months in cohort E.[16] Panel A of Table 3 also shows that, at age 30, married shares increase by 1.49 and 2.52 percentage points, respectively. By age 50, however, married shares are 83.84 percent in cohort A and 78.76 percent in cohort E, slightly below the baseline values of 83.97 and 79.04 percent. Earlier marriage therefore does not imply an increase in the proportion eventually married.

Belief correction affects marriage incentives through two channels. Recognizing the decline in future fecundity raises the perceived cost of postponing childbearing. Since births occur only within marriage in the model, this encourages earlier marriage and earlier birth attempts. At the same time, less optimistic beliefs about conception can reduce the expected child-related benefits of marriage, weakening the incentive to marry for some women. The marriage response therefore reflects both the incentive to form a family sooner and the change in the expected gains from marriage. These channels are consistent with earlier marriage among those who marry and a slightly lower eventual married share. Most of the fertility response takes the form of a redistribution of births toward younger ages.

[16]Marriage timing is calculated from age-to-age increases in simulated beginning-of-period married shares, conditional on entering marriage after the initial observation at age 25 and by age 50. Women already married at age 25 are excluded. This compares the timing of new marriages in each simulation, rather than the same set of women across simulations.



(a) Share of Married

(b) Cumulative Births since Age 25

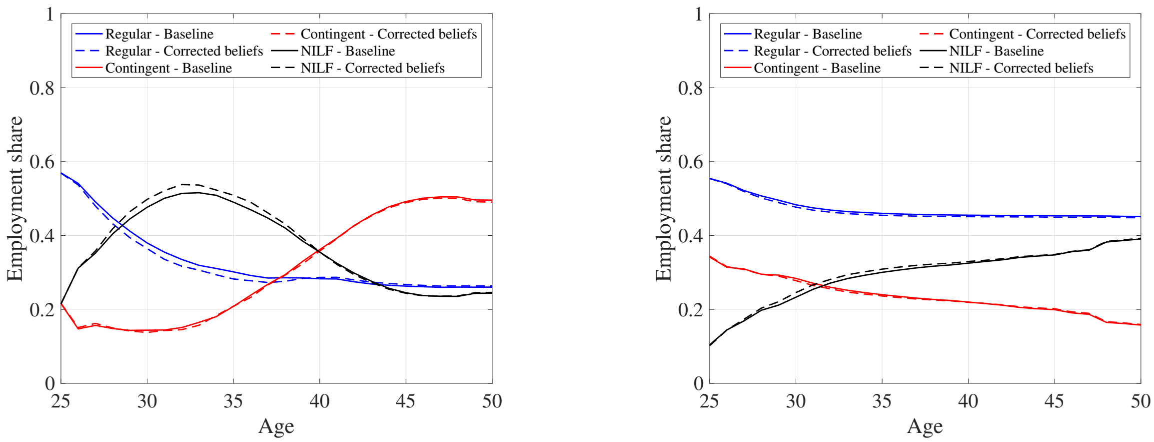
Figure 4: Correcting Fecundity Beliefs: Marriage and Fertility

4.2.2 Employment

Figure 5 shows employment shares among all women, weighting single and married women by their respective population shares.[17] Averaged over ages 30–34, nonparticipation rises by 2.02 percentage points in cohort A and 1.09 percentage points in cohort E. Regular employment falls by 1.66 and 0.59 percentage points, while contingent employment falls by 0.36 and 0.50 percentage points, respectively. This concentration of employment reductions in the early thirties is consistent with childbearing and the time costs of young children occurring earlier.

The employment response changes at older ages. In cohort A, regular employment exceeds the baseline from age 40 onward, and nonparticipation falls below the baseline during ages 41–46. In cohort E, regular employment remains lower, although higher contingent employment partly offsets this difference during the forties. Thus, earlier childbearing is associated with a changing age profile of employment rather than a uniform reduction in participation over the ages shown.

[17] Appendix C.1 reports the corresponding profiles separately for married and single women. Aggregate changes reflect both employment responses within these groups and changes in their relative sizes.



(a) Cohort A

(b) Cohort E

Figure 5: Correcting Fecundity Beliefs: Employment among All Women

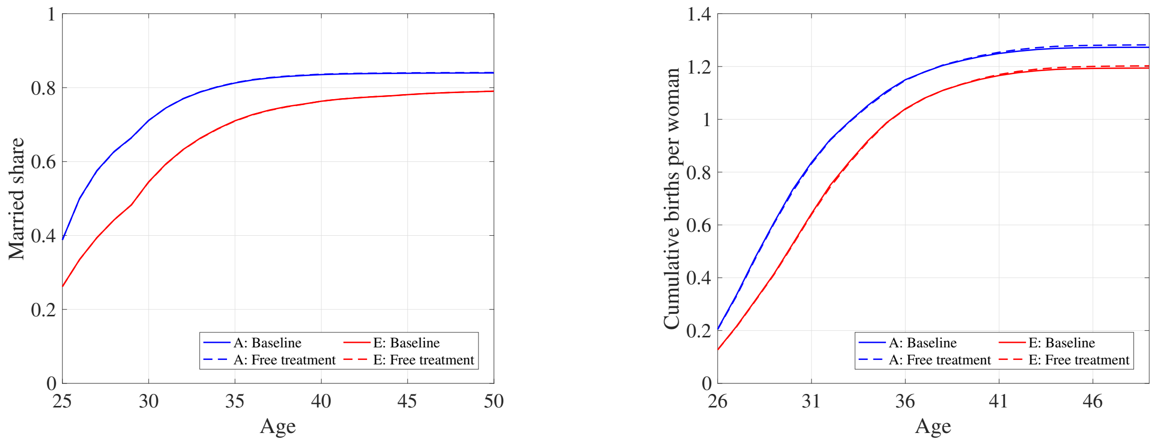
4.3 Eliminating Out-of-Pocket Treatment Costs

4.3.1 Marriage and Fertility

The second experiment eliminates the out-of-pocket cost of infertility treatment. As shown in Figure 6, cumulative births by age 49 rise from 1.273 to 1.282 per woman in cohort A and from 1.194 to 1.202 in cohort E. These are increases of 0.0092 and 0.0084 births per woman, or 0.72 and 0.70 percent, respectively.

The age pattern differs from that under belief correction. As reported in Panel B of Table 3, births over ages 26–34 decline by 0.35 percent in cohort A and 0.45 percent in cohort E. Over ages 35–49, they increase by 5.7 and 4.4 percent, equivalent to approximately 1.25 and 1.22 additional births per 100 women. Within this older age range, births at ages 40–49 rise by 13.7 and 12.4 percent. The latter increases correspond to only 0.69 and 0.76 additional births per 100 women, reflecting the low baseline birth rates at those ages. Mean maternal age increases by 1.4 months in cohort A and 1.3 months in cohort E.

Marriage outcomes change very little, as also indicated by the married-share changes in Panel B of Table 3. Mean marriage-entry age rises by approximately 0.2 months in cohort A and 0.1 months in cohort E. By age 50, married shares are 84.07 and 79.04 percent, compared with 83.97 and 79.04 percent in the baseline. The fertility response is therefore accompanied by little change in the marriage profile. Its concentration at older ages is consistent with lower treatment costs making additional attempts more attractive after natural fecundity has been lost. Treatment expands opportunities for later births, whereas correcting beliefs primarily brings births forward.



(a) Share of Married

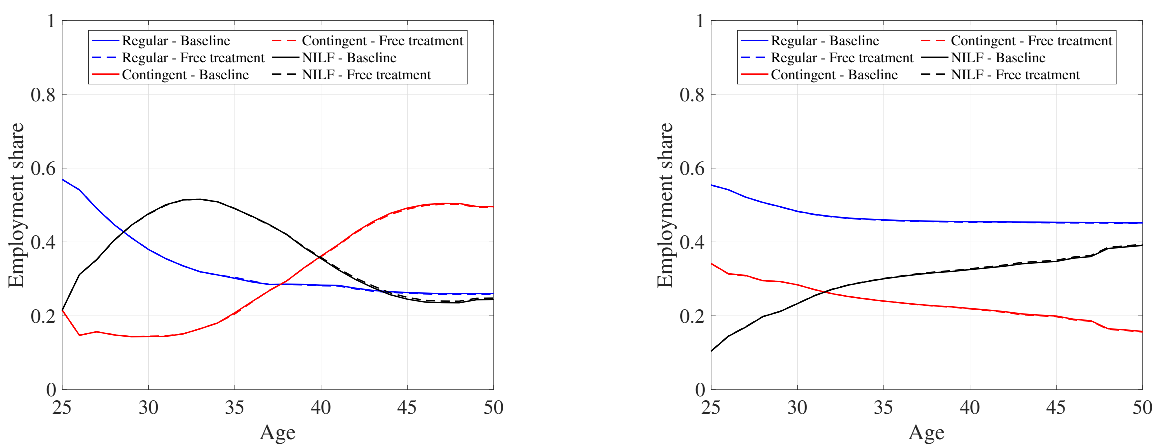
(b) Cumulative Births since Age 25

Figure 6: Free Fertility Treatment: Marriage and Fertility

4.3.2 Employment

Figure 7 shows relatively small employment changes at younger ages and a clearer response during the forties.[18] Averaged over ages 40–49, nonparticipation increases by 0.42 percentage points in cohort A and 0.30 percentage points in cohort E. Both regular and contingent employment decline over this age range. The largest increases in nonparticipation occur at age 43, reaching 0.50 and 0.36 percentage points, respectively.

The timing of this response is consistent with the increase in births at older ages and the associated employment costs of caring for young children. In contrast to belief correction, the main employment adjustment occurs later in the life cycle.



(a) Cohort A

(b) Cohort E

Figure 7: Free Fertility Treatment: Employment among All Women

[18] Appendix C.2 presents the corresponding results separately by marital status.

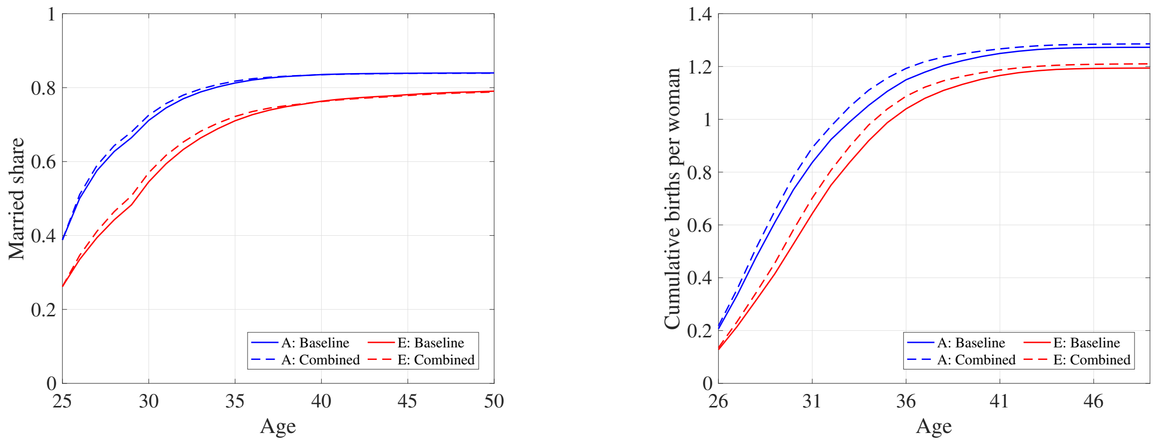
4.4 Combining Belief Correction and Free Fertility Treatment

4.4.1 Marriage and Fertility

The third experiment combines belief correction with the elimination of out-of-pocket treatment costs. Figure 8 shows that cumulative births by age 49 increase from 1.273 to 1.286 per woman in cohort A and from 1.194 to 1.210 in cohort E. The gains are 0.0130 and 0.0160 births per woman, or 1.02 and 1.34 percent, respectively. For both cohorts, the combined intervention produces a larger cumulative increase than either intervention on its own.

As reported in Panel C of Table 3, births over ages 26–34 increase by 6.0 percent in cohort A and 7.0 percent in cohort E, equivalent to approximately 5.8 and 6.0 additional births per 100 women. Births over ages 35–49 remain below the baseline, by 20.3 and 15.9 percent, or approximately 4.5 and 4.4 births per 100 women. These later reductions are smaller than under belief correction alone, so more of the early increase remains as a net addition to cumulative births. Mean maternal age falls by 4.8 months in cohort A and 5.0 months in cohort E, compared with reductions of 6.2 and 6.3 months under belief correction alone. Thus, free treatment partly moderates the shift toward earlier births while raising their cumulative number.

Marriage responses also resemble those under belief correction. Mean marriage-entry age falls by 3.3 months in cohort A and 5.1 months in cohort E. Panel C of Table 3 shows that married shares at age 30 increase by 1.42 and 2.48 percentage points, respectively. The terminal married shares are 83.91 and 78.84 percent, respectively, close to the baseline values of 83.97 and 79.04 percent. The combined experiment therefore retains the earlier family formation induced by belief correction while providing additional opportunities for births at older ages.



(a) Share of Married

(b) Cumulative Births since Age 25

Figure 8: Combined Intervention: Marriage and Fertility

4.4.2 Employment

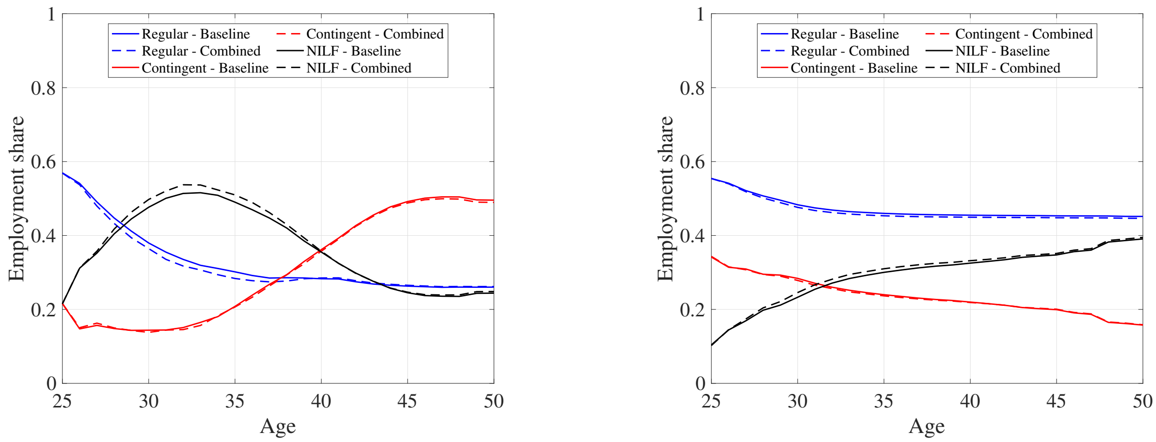
Figure 9 shows an early-age employment response similar to that under belief correction.[19] Averaged over ages 30–34, nonparticipation rises by 1.99 percentage points in cohort A and 1.13 percentage points in cohort E. Regular employment falls by 1.64 and 0.69 percentage points, while contingent employment falls by 0.35 and 0.44 percentage points, respectively. The earlier concentration of births is therefore accompanied by lower employment during the early thirties.

At older ages, free treatment adds to nonparticipation relative to belief correction alone. Over ages 40–49, the combined intervention raises nonparticipation relative to the baseline by an average of 0.18 percentage points in cohort A and 0.47 percentage points in cohort E. For comparison, belief correction alone reduces nonparticipation by 0.12 percentage points in cohort A and raises it by 0.20 percentage points in cohort E over the same age range. The employment results consequently reflect both the earlier timing of births under belief correction and the additional later births made possible by free treatment.

5 Conclusion

This paper examines how perceptions of age-related fecundity shape women's careers and family formation. We develop a quantitative life-cycle model of employment, marriage, and childbearing, calibrated to two cohorts of Japanese women. Employment histories affect future earnings, while subjective fecundity governs household decisions and medical fecundity determines realized birth outcomes. This framework allows us to examine how

[19] Appendix C.3 reports the results separately for married and single women.



(a) Cohort A

(b) Cohort E

Figure 9: Combined Intervention: Employment among All Women

reproductive beliefs interact with career incentives and the cost of infertility treatment.

Aligning subjective fecundity with the medical benchmark primarily changes the timing of births. Mean maternal age among births at ages 26–49 falls by approximately six months in both cohorts, while cumulative births from age 25 through age 49 increase by less than one percent. Higher birth rates at younger ages are largely offset by lower rates at older ages. These changes are accompanied by earlier marriage and adjustments in employment, including lower participation around the early thirties. The results therefore show that reproductive beliefs affect cumulative births, the timing of family formation, and women's employment profiles.

Eliminating out-of-pocket treatment costs has a different effect on the age profile of births. It increases births at older ages and raises cumulative births by approximately 0.7 percent in both cohorts. Combining free treatment with belief correction increases cumulative births by approximately 1.0 percent in cohort A and 1.3 percent in cohort E, while mean maternal age remains about five months below the baseline. Beliefs and treatment costs thus affect different parts of the childbearing age profile. Their combined effect illustrates the importance of distinguishing changes in birth timing from changes in cumulative births when evaluating reproductive interventions.

The quantitative effects depend on the assumed subjective fecundity schedule and the extent to which an intervention can change it. The belief-correction experiment represents an alignment with the medical benchmark, rather than an evaluation of a specific information program. Richer evidence on age-specific reproductive beliefs, their heterogeneity, and their evolution following unsuccessful attempts would help discipline this mechanism. Accounting explicitly for the financing of treatment subsidies would also allow an assessment of their fiscal and welfare consequences.

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Appendix

A Survey Evidence on Fecundity Beliefs

Table 4 summarizes survey evidence on perceived age limits for pregnancy in Japan. The nationwide online survey covered 10,000 men and women aged 25–49 and was conducted in August 2021 (Health and Global Policy Institute, 2022). Respondents selected an age to complete statements about the age up to which pregnancy is possible and beyond which it becomes extremely difficult. Separate questions concerned natural conception through intercourse and pregnancy with infertility treatment. Both questions referred to women's reproductive capacity; the columns distinguish the sex of the respondent.

The responses indicate considerable variation in perceived reproductive horizons. For natural conception, the most frequently selected age is 35 among women, accounting for 39.1 percent of responses, and 40 among men, accounting for 36.8 percent. For pregnancy with infertility treatment, the most frequently selected age is 40 for both women and men. The share selecting age 45 or older increases from 14.4 percent for natural conception to 32.8 percent for infertility treatment among women, and from 17.8 to 38.9 percent among men. Respondents thus generally associate infertility treatment with a longer reproductive horizon.

These perceptions are relevant to decisions about the timing of family formation. A longer perceived reproductive horizon may reduce the perceived cost of postponing attempts to have children while pursuing employment and accumulating experience. The survey elicits age thresholds rather than success probabilities at each age; the construction of the model's subjective fecundity schedule from this evidence is described in the calibration section. The quantitative analysis focuses on beliefs about natural fecundity. Treatment success probabilities are instead taken from medical evidence and are assumed to be the same in households' expectations and realized outcomes.

Table 4: Perceived Age Limits for Pregnancy

	Natural conception		Infertility treatment	
Age selected	Women	Men	Women	Men
25	5.0	3.7	1.9	2.2
30	14.1	10.2	4.0	4.3
35	39.1	31.5	16.5	13.3
40	27.5	36.8	44.8	41.4
45	9.3	10.8	23.2	24.6
50	3.6	4.6	7.4	10.4
55	0.4	0.5	0.8	1.2
60	1.1	1.9	1.4	2.7

Notes: Entries are percentages of respondents within each sex. Women and men refer to respondents; both questions concern women's ability to become pregnant. Respondents selected an age to complete statements about the age up to which pregnancy is possible and beyond which it becomes extremely difficult. Separate statements concerned natural conception through intercourse and pregnancy with infertility treatment. The nationwide online survey covered 10,000 men and women aged 25–49 in Japan and was conducted in August 2021. Percentages may not sum to 100 because of rounding.

Source: Health and Global Policy Institute (2022, Figures 27 and 29).

B Female Earnings

B.1 Earnings Specification

The female earnings specification draws on Yamaguchi (2019) and Kitao and Mikoshiba (2024). Annual earnings depend on permanent skill, current and previous employment, and accumulated employment histories. We specify separate earnings functions for regular and contingent employment. All coefficients are common across cohorts A and E.

Let $X = (x_R, x_C, x_N)$ denote accumulated years in regular employment, contingent employment, and NILF through the preceding period, and let e^- denote employment in that period. The histories entering current earnings are

$$\widetilde{x}_R = x_R + \mathbf{1}\{e = R\}, \qquad \widetilde{x}_C = x_C + \mathbf{1}\{e = C\}, \qquad \widetilde{x}_N = x_N. \tag{42}$$

Thus, current employment contributes one year of experience in the current employment type to current earnings.

Let $y^{f,\text{yen}}$ denote annual female labor earnings in yen. For $e \in \{R, C\}$, earnings satisfy

$$\begin{aligned}\log\left(y^f\right) &= \alpha_{0,e} + \alpha_{H,e}\mathbf{1}\{s_f = H\} + \alpha_{R,e}\widetilde{x}_R + \alpha_{R2,e}\frac{\widetilde{x}_R^2}{100} \\ &\quad + \alpha_{C,e}\widetilde{x}_C + \alpha_{C2,e}\frac{\widetilde{x}_C^2}{100} + \alpha_{N,e}\widetilde{x}_N \\ &\quad + \sum_{d\in\mathcal{E}} \alpha_{d,e}^{\text{lag}}\mathbf{1}\{e^- = d\}. \end{aligned} \tag{43}$$

Labor earnings are zero for women in NILF.

This specification allows experience in regular and contingent employment to have different associations with current earnings. It also captures earnings differences associated with time in NILF and employment in the preceding period. Quadratic experience terms are included for regular experience in the regular earnings function and contingent experience in the contingent earnings function; the other quadratic coefficients are set to zero. The reference category for previous employment is regular employment in the regular earnings function and contingent employment in the contingent earnings function.

Table 5 reports the baseline coefficients. The intercepts correspond to annual earnings measured in units of 10,000 yen. For use in the household budget, earnings are converted to yen and divided by mean annual earnings among regularly employed women aged 25, pooling the two JPSC cohorts. This common normalization is also applied to other monetary quantities in the model.

Table 5: Baseline Coefficients of the Female Earnings Functions

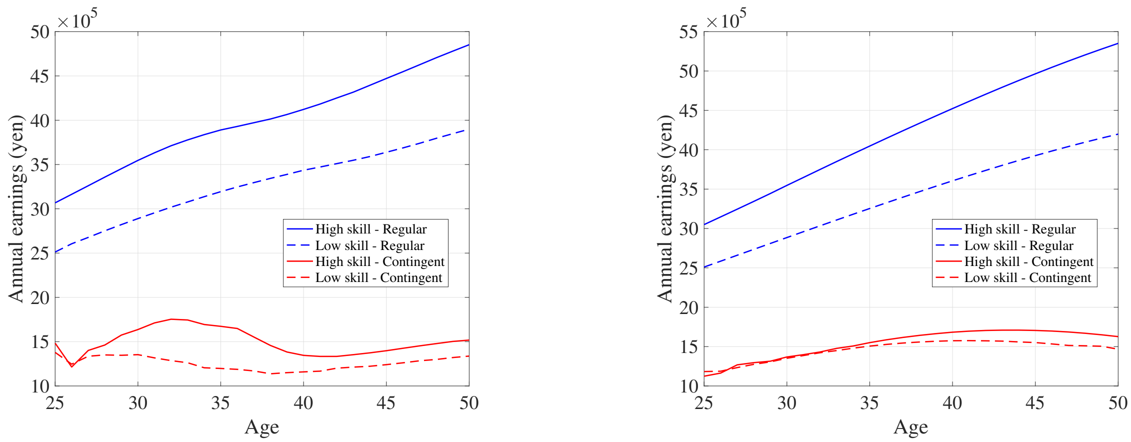
Parameter	Description	Regular	Contingent
$\alpha_{0,e}$	Intercept	5.10	4.21
$\alpha_{H,e}$	High-skill indicator	0.26	0.10
$\alpha_{R,e}$	Regular employment experience	0.03	0.02
$\alpha_{R2,e}$	Regular experience squared, divided by 100	-0.03	0.00
$\alpha_{C,e}$	Contingent employment experience	-0.006	0.07
$\alpha_{C2,e}$	Contingent experience squared, divided by 100	0.00	-0.15
$\alpha_{N,e}$	Accumulated years in NILF	-0.03	-0.03
$\alpha_{R,e}^{\text{lag}}$	Previous employment: regular	0.00	0.62
$\alpha_{C,e}^{\text{lag}}$	Previous employment: contingent	-0.52	0.00
$\alpha_{N,e}^{\text{lag}}$	Previous employment: NILF	-0.36	0.02

Notes: The dependent variable is the natural logarithm of annual earnings measured in units of 10,000 yen. Coefficients are common across cohorts A and E. Experience variables are defined in equation (42). The coefficients on previous regular employment in the regular earnings function and previous contingent employment in the contingent earnings function are normalized to zero.

B.2 Baseline Earnings Profiles

Figure 10 presents baseline mean annual female earnings by skill and current employment type. Each profile averages earnings among women in the corresponding skill–employment group at each age, pooling single and married women. The four groups are high- and low-skill women in regular and contingent employment.

We calibrate the female earnings coefficients using earnings moments for cohort A. Since comparable earnings data for cohort E are unavailable in our calibration sample, we apply the same coefficients to both cohorts. The earnings coefficients are common across cohorts, while the conditional earnings profiles can differ because employment choices and accumulated employment histories differ.



(a) Cohort A (b) Cohort E

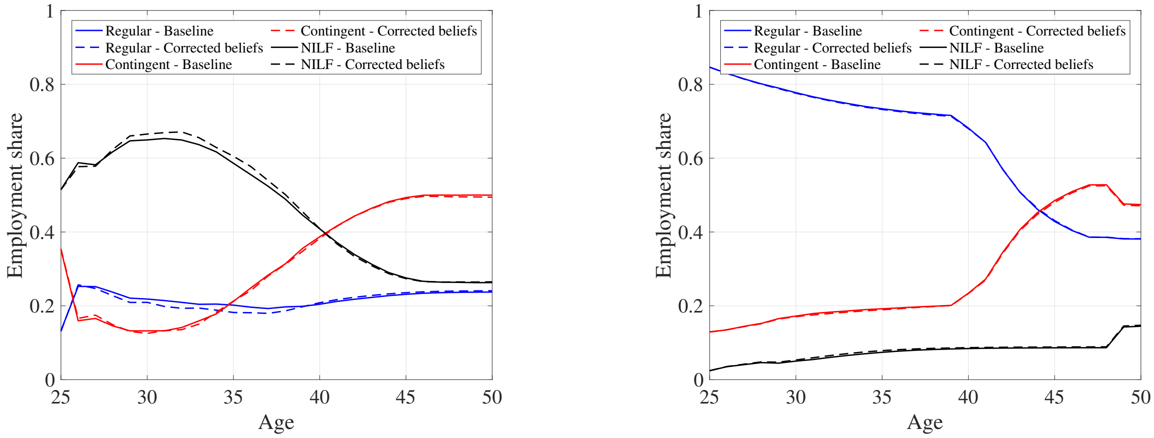
Figure 10: Baseline Female Earnings Profiles

Notes: Lines show model-generated mean annual labor earnings in yen, conditional on skill and current employment type. Each group includes both single and married women. Women in NILF have zero labor earnings and are not included in these conditional means.

C Employment Responses by Marital Status

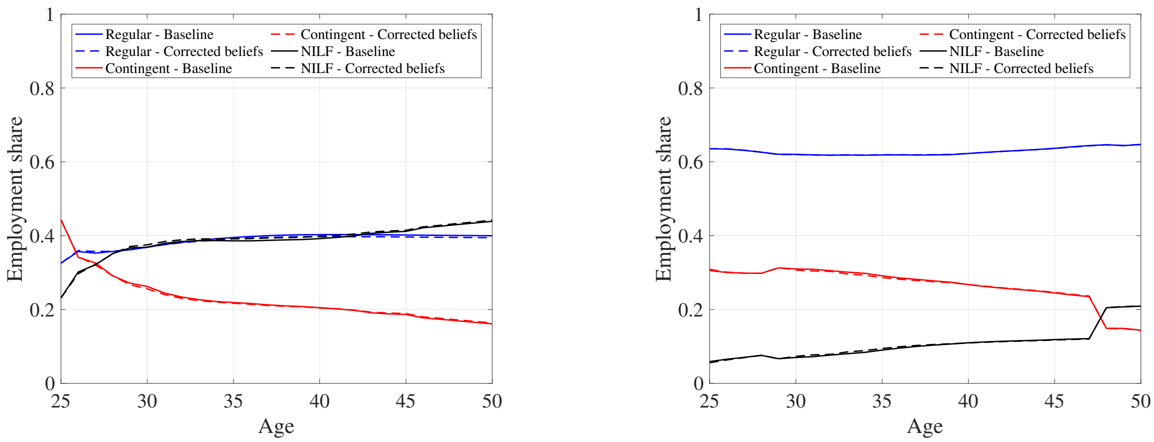
The following figures compare baseline and counterfactual employment shares conditional on cohort and current marital status. Solid lines represent the baseline, and dashed lines represent the counterfactual. Because marriage is endogenous, these comparisons reflect both changes in employment choices and changes in the composition of each marital-status group.

C.1 Correcting Fecundity Beliefs



(a) Married (b) Single

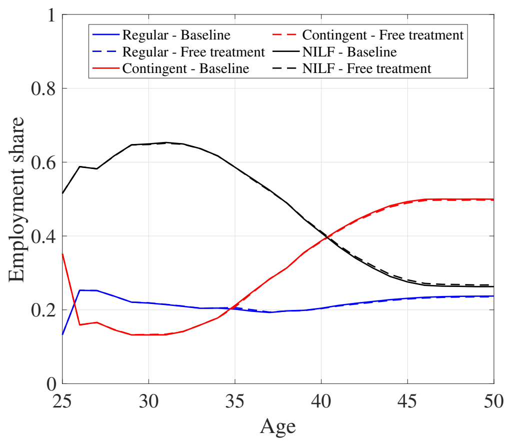
Figure 11: Correcting Fecundity Beliefs: Employment, Cohort A



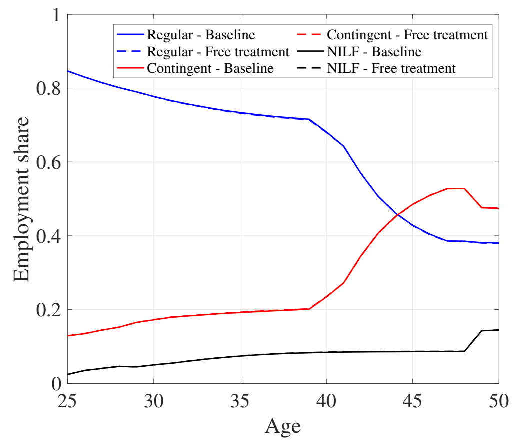
(a) Married (b) Single

Figure 12: Correcting Fecundity Beliefs: Employment, Cohort E

C.2 Eliminating Out-of-Pocket Treatment Costs

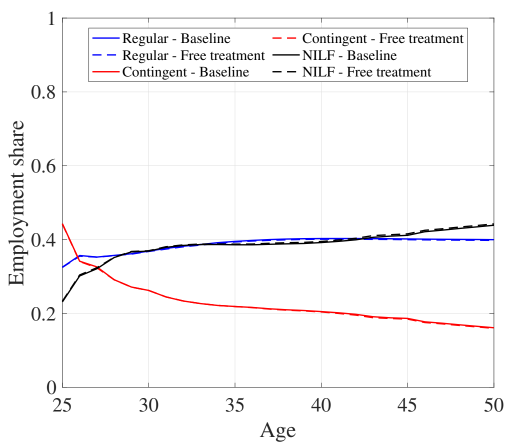


(a) Married

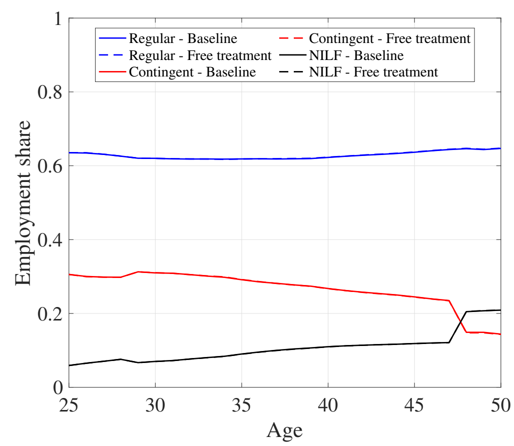


(b) Single

Figure 13: Free Fertility Treatment: Employment, Cohort A



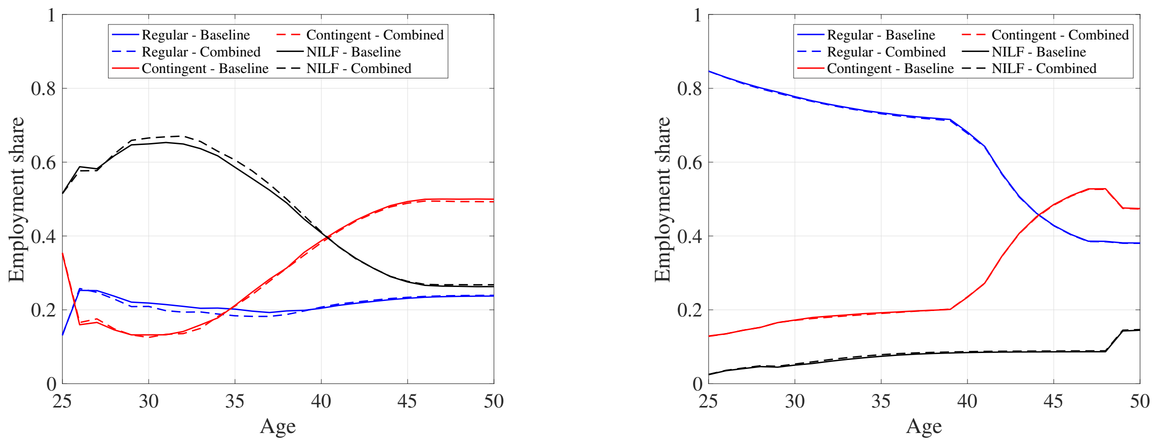
(a) Married



(b) Single

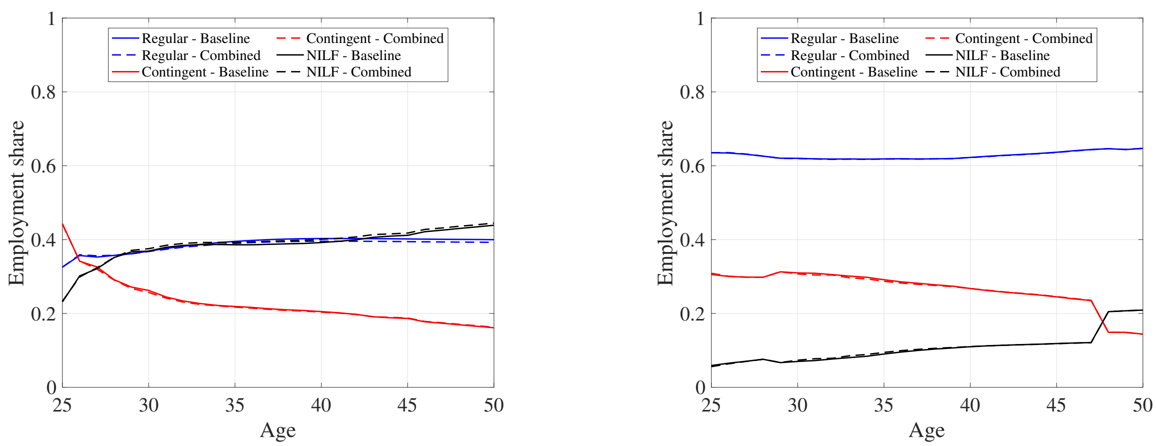
Figure 14: Free Fertility Treatment: Employment, Cohort E

C.3 Combining Belief Correction and Free Fertility Treatment



(a) Married (b) Single

Figure 15: Combined Intervention: Employment, Cohort A



(a) Married (b) Single

Figure 16: Combined Intervention: Employment, Cohort E