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Martín Rossi (Universidad de San Andrés)

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Departamento de Economía
Universidad de San Andrés

Vito Dumas 284, B1644BID, Victoria,
San Fernando, Buenos Aires, Argentina
Teléfono +54 11 7078 0400
Email: economia@udesa.edu.ar

Relaxing the Biological Clock: Can More Time Reduce Fertility?*

Martin A. Rossi
Universidad de San Andres

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Abstract

Egg freezing relaxes the biological deadline associated with female fertility and is widely viewed as an empowering technology expected to increase lifetime fertility. This paper challenges that intuition. We develop a finite-horizon dynamic stopping model in which fertility initiation requires the simultaneous alignment of multiple, imperfectly persistent dimensions, including partnership quality, economic conditions, and personal readiness. Initiating childbearing is irreversible and occurs only when the joint realization of these evolving states exceeds an endogenous reservation threshold. By lowering the hazard of irreversible infertility, egg freezing increases the continuation value of waiting and raises this reservation standard. Individuals optimally become more selective. However, the technology insures only against biological decline, not against partnership instability or the tightening of other age-dependent constraints. When these dimensions do not improve with age, greater selectivity can delay initiation and reduce the probability of crossing the threshold within a finite horizon. As a result, relaxing the biological deadline can reduce fertility initiation and expected completed fertility in a non-empty region of parameters. We derive formal propositions and discuss empirical implications.

Keywords: fertility; egg freezing; dynamic decision-making; family formation.
JEL classifications: J13, D91, I15.

*Department of Economics, Universidad de San Andres. Email: mrossi@udesa.edu.ar. I thank Lorena Pompilio for useful comments and suggestions.

1 Introduction

Recent advances in reproductive technologies have substantially altered the intertemporal constraints faced by women in their fertility decisions. Among these innovations, oocyte cryopreservation ("egg freezing") stands out for its potential to relax the biological deadline associated with female fertility. By extending the effective reproductive horizon, egg freezing is often viewed as an unambiguously empowering technology, expected to increase lifetime fertility by reducing involuntary childlessness and facilitating the coordination of childbearing with other life-cycle investments. This perspective is prevalent in both the medical and social-science literature, which emphasizes the insurance and autonomy benefits of preserving reproductive capacity (e.g., Baldwin and Culley, 2018; Inhorn et al., 2018).

This paper challenges that conventional intuition. We argue that, by weakening the biological deadline, egg freezing raises the endogenous standard individuals require before initiating childbearing. Fertility initiation is an irreversible decision taken under uncertainty about multiple, jointly evolving dimensions of the life cycle. The "right moment" is not determined solely by the quality of a romantic partner. Rather, it reflects the alignment of several factors: partnership stability and match quality, labor-market conditions, income security, health, and perceived readiness. These dimensions need not move together. An individual may have the partner she values most but face unfavorable professional circumstances; conversely, she may reach career stability while lacking a suitable partnership. Initiating fertility requires a simultaneous alignment across these dimensions.

Crucially, some components of this state are not perfectly persistent. Partnerships may dissolve, preferences may diverge, and the pool of potential partners may evolve with age. High rates of separation and divorce imply that waiting is not equivalent to holding current favorable conditions fixed while improving others. A woman who postpones childbearing to strengthen her labor-market position may rationally anticipate that her current partnership could weaken or dissolve in the interim. Egg freezing insures against biological decline, but it does not insure against partnership instability, changes in relationship quality, or the deterioration of other age-dependent opportunities. As a result, weakening the biological deadline increases the value of waiting for better alignment across dimensions, yet waiting also exposes individuals to the risk of losing dimensions that are currently favorable.

In a dynamic stopping problem, this logic translates into a higher reservation threshold for initiating fertility. When the risk of "running out of time" is salient, individuals may accept conditions that are good enough, even if not ideal, in order to avoid losing the opportunity altogether. When a technology credibly insures against that biological risk, the continuation value of postponement increases. Individuals optimally become more selective, requiring a higher joint realization of partnership, economic, and personal conditions before initiating childbearing.

This shift in reservation standards has first-order implications. If the joint occurrence of favorable conditions does not become more likely with age—and may in fact become less likely as partnership markets change, relationships dissolve, or other constraints tighten—then a higher threshold can delay initiation and reduce the probability of ever crossing it within a finite horizon.

In this sense, relaxing a biological constraint can reduce not only higher-parity births but also the likelihood of having a first child. The mechanism does not rely on behavioral biases or misperceptions. It arises under full rationality from the interaction between a weaker biological deadline and other uninsured, age-dependent frictions.

The mechanism is closely related to the real-options literature, in which reductions in downside risk increase the option value of waiting and delay irreversible investment (McDonald and Siegel, 1986; Dixit and Pindyck, 1994). Fertility initiation shares the essential features of such problems: irreversibility, uncertainty about future states, and a finite horizon. Lowering the hazard of irreversible infertility increases the value of continuation and therefore raises the endogenous reservation standard for acting. In a multidimensional and imperfectly persistent environment, greater selectivity means waiting for a sufficiently favorable alignment across several evolving states. When those states may deteriorate or separate over time, delay is not neutral and may reduce realized outcomes.

Importantly, the mechanism does not imply that egg freezing will reduce fertility in all environments. Rather, it identifies a non-empty region of parameters in which weakening the biological deadline increases selectivity sufficiently to reduce fertility initiation and completed fertility. Whether fertility rises or falls depends on the interaction between the biological risk insured by the technology and the age profile of other constraints—such as partnership stability, labor-market trajectories, and the feasibility of completing higher-parity births.

We formalize this intuition in a finite-horizon dynamic model with a stopping structure. Each period, individuals observe a stochastic multidimensional state capturing the quality of the current moment for initiating fertility. The optimal policy is characterized by an age-dependent reservation threshold: initiation occurs only if current conditions exceed that threshold. Access to egg freezing lowers the hazard of irreversible infertility and thereby raises the continuation value of waiting. As a result, the reservation threshold increases. Under mild conditions on the age profile and persistence of partnership and economic states, this higher threshold reduces the probability of initiating fertility before the horizon. Delayed initiation also compresses the feasible window for higher-parity births, further reducing expected completed fertility.

Our framework builds on the economic literature that models fertility as a sequential and forward-looking choice under uncertainty (Heckman and Willis, 1976; Francesconi, 2002; Adda et al., 2017), but introduces a distinct channel through which reproductive technologies affect outcomes. Rather than changing preferences or relaxing contemporaneous constraints, egg freezing alters intertemporal trade-offs by modifying the value of waiting in a multidimensional environment. In contrast to models of procrastination or present bias (O'Donoghue and Rabin, 1999), delay in our framework arises under full rationality and reflects optimal responses to changes in risk.

The analysis also speaks to emerging empirical work on egg freezing. Recent studies exploiting employer-provided coverage and policy variation document changes in fertility timing following expanded access to egg freezing, but leave open the question of its impact on fertility initiation and completed fertility (Henne and Bundorf, 2020). Clinical and survey evidence suggests that women who freeze eggs often postpone childbearing more than initially anticipated and that utilization rates of frozen eggs remain relatively low (Jones et al., 2022; Abrams et al., 2023). Our model provides a rational framework that can reconcile these patterns: reduced biological urgency increases selectivity, which may translate into delayed or forgone births when favorable conditions fail to align.

Beyond fertility, the paper highlights a general mechanism in dynamic decision problems with finite horizons. When agents face irreversible choices under uncertainty across multiple evolving dimensions, weakening a terminal constraint increases the value of waiting and raises endogenous acceptance standards. If other constraints tighten or become less aligned over time, greater selectivity can reduce realized outcomes. Technologies that relax deadlines may therefore generate effects that differ sharply from those implied by a pure insurance interpretation.

The remainder of the paper proceeds as follows. Section 2 develops a finite-horizon dynamic model of fertility initiation with a multidimensional state and imperfectly persistent partnerships. We characterize the reservation threshold governing optimal timing and show that access to egg freezing raises this threshold and can reduce both fertility initiation and completed fertility. Section 3 derives empirical implications that distinguish the reservation-standard mechanism from a pure biological-insurance interpretation. Section 4 outlines a reduced-form empirical strategy using Argentine administrative and vital statistics data. Section 5 concludes.

2 Model

2.1 Environment

Time is discrete, $t = 1, \dots, T$, with finite horizon $T < \infty$. Prior to fertility initiation, the individual observes a multidimensional state $s_t = (m_t, y_t) \in \mathcal{S} \subseteq \mathbb{R}^2$, where m_t captures partnership quality/stability and y_t captures economic or career readiness. The state evolves according to a (possibly age-dependent) Markov kernel

$$s_{t+1} \sim G_t(\cdot \mid s_t).$$

Fertility initiation (first birth) is an irreversible action. If the individual initiates at age t in state s, she receives payoff $U(s,t)$, where $U : \mathcal{S} \times \{1, \dots, T\} \to \mathbb{R}$ is bounded and measurable.

If the individual does not initiate at t, she faces an absorbing infertility hazard $\lambda_f(t) \in [0,1)$, where $f \in \{0,1\}$ indexes the technology environment ($f = 1$ denotes access to egg freezing). If infertility occurs before initiation, lifetime fertility is zero and continuation value is normalized to 0.

[Egg freezing reduces the infertility hazard] $\lambda_1(t) \leq \lambda_0(t)$ for all t, with strict inequality for at least one t.

Discounting is $\beta \in (0,1)$.

2.2 Decision problem (first birth)

Let $V_f(t,s)$ denote the value at age t in state s, conditional on not yet initiating and not being infertile. The Bellman equation is

$$V_f(t,s) = \max\Big\{U(s,t),\ \beta(1-\lambda_f(t))\,\mathbb{E}\big[V_f(t+1,s') \mid s\big]\Big\}, \tag{1}$$

with terminal condition

$$V_f(T,s) = \max\{U(s,T), 0\}.$$

Define the continuation value

$$W_f(t,s) \equiv \beta(1-\lambda_f(t))\,\mathbb{E}\big[V_f(t+1,s') \mid s\big].$$

Initiation occurs if and only if $U(s,t) \geq W_f(t,s)$.

[Well-defined value function] For each $f \in \{0,1\}$, the dynamic program admits a unique value function V_f obtained by backward induction. An optimal policy exists and is characterized by the comparison $U(s,t) \geq W_f(t,s)$ at each (t,s).

The horizon is finite and payoffs are bounded. Standard backward induction arguments apply.

2.3 Egg freezing raises the value of waiting and increases selectivity

[Value dominance] Under Assumption 2.1, for all t and s,

$$V_1(t,s) \geq V_0(t,s).$$

Moreover, if there exists $\tau \geq t$ and a measurable set $A \subseteq \mathcal{S}$ such that (i) $\lambda_1(\tau) < \lambda_0(\tau)$, and (ii) under an optimal policy starting from (t,s) it occurs with positive probability that the individual reaches age τ and chooses to wait at (τ, s_τ) with $s_\tau \in A$, then the inequality is strict at (t,s).

We proceed by backward induction.

At $t = T$, $V_f(T,s) = \max\{U(s,T), 0\}$ does not depend on f, hence $V_1(T,s) = V_0(T,s)$.

Suppose $V_1(t+1,s') \geq V_0(t+1,s')$ for all s'. Then

$$\mathbb{E}[V_1(t+1,s') \mid s] \geq \mathbb{E}[V_0(t+1,s') \mid s].$$

Using $(1-\lambda_1(t)) \geq (1-\lambda_0(t))$,

$$W_1(t,s) = \beta(1-\lambda_1(t))\mathbb{E}[V_1(t+1,s') \mid s] \geq \beta(1-\lambda_0(t))\mathbb{E}[V_0(t+1,s') \mid s] = W_0(t,s).$$

Since the initiation payoff $U(s,t)$ is common across f,

$$V_1(t,s) = \max\{U(s,t), W_1(t,s)\} \geq \max\{U(s,t), W_0(t,s)\} = V_0(t,s).$$

For strictness, note that if $W_1(\tau, \cdot) > W_0(\tau, \cdot)$ on a set that is reached with positive probability under an optimal policy from (t, s) and on which waiting is chosen at τ, then $V_1(\tau, \cdot) > V_0(\tau, \cdot)$ on that set; backward induction then implies $V_1(t, s) > V_0(t, s)$.

[Egg freezing increases selectivity] Let the initiation region at age t be

$$\mathcal{I}_f(t) \equiv \{s \in \mathcal{S} : U(s, t) \geq W_f(t, s)\}.$$

Under Assumption 2.1, for all t,

$$\mathcal{I}_1(t) \subseteq \mathcal{I}_0(t).$$

If $W_1(t, s) > W_0(t, s)$ on a set of positive measure and $U(\cdot, t)$ is continuous, then the inclusion is strict.

Since $W_1(t, s) \geq W_0(t, s)$ pointwise,

$$U(s, t) \geq W_1(t, s) \Rightarrow U(s, t) \geq W_0(t, s),$$

hence $\mathcal{I}_1(t) \subseteq \mathcal{I}_0(t)$. Strict inclusion follows from continuity of $U(\cdot, t)$ and strict inequality of continuation values on a set of positive measure.

2.4 Egg freezing can reduce the probability of a first birth

The following construction provides a minimal example consistent with the general environment.

[First births can fall] There exist primitives (U, G_t, λ_f, T) satisfying Assumption 2.1 such that

$$\Pr(N \geq 1 \mid f = 1) < \Pr(N \geq 1 \mid f = 0).$$

Consider $T = 2$ and a two-state environment $s \in \{B, G\}$ with

$$\Pr(s_t = G) = p_t, \quad p_t \text{ strictly decreasing in } t,$$

independent across periods.

Let

$$U(G, t) = u_H, \quad U(B, t) = u_L,$$

with $u_H > u_L > 0$.

At $t = 2$, since $u_L > 0$, initiation strictly dominates non-initiation in both states, so initiation occurs almost surely.

At $t = 1$, the continuation value is

$$W_f(1) = \beta(1 - \lambda_f(1))\big(p_2 u_H + (1 - p_2)u_L\big).$$

Choose parameters such that

$$\beta(1-\lambda_0(1))\big(p_2 u_H + (1-p_2)u_L\big) \le u_L < \beta(1-\lambda_1(1))\big(p_2 u_H + (1-p_2)u_L\big).$$

Because $(1-\lambda_1(1)) > (1-\lambda_0(1))$, this region is non-empty.

Then under $f = 0$, initiation at $t = 1$ occurs in both states, implying

$$\Pr(N \ge 1 \mid f = 0) = 1.$$

Under $f = 1$, initiation at $t = 1$ occurs only in state G. Choose $\lambda_1(1) \in (0, 1)$. Then initiation fails at $t = 1$ with probability $(1 - p_1) > 0$, and

$$\Pr(N \ge 1 \mid f = 1) = p_1 + (1-p_1)(1-\lambda_1(1)) < 1 = \Pr(N \ge 1 \mid f = 0).$$

This establishes the strict decline.

2.5 Second birth and completed fertility

After the first birth, the individual faces a second irreversible decision.

[Closing window for second births] Conditional on having one child, a second birth remains feasible at age t provided a window has not closed. Between t and $t+1$, the window closes with probability $\mu(t) \in [0, 1)$, weakly increasing in t, and independent of $\lambda_f(t)$.

[Egg freezing can reduce completed fertility] Under Assumptions 2.1 and 2.5, there exist primitives such that

$$\mathbb{E}[N_1] < \mathbb{E}[N_0].$$

Extend the construction of Proposition 2.4 to $T = 3$. Let $\mu(1) = 0$ and $\mu(2) = 1$, so that a second birth is feasible only if the first birth occurs at $t = 1$.

Assume that, conditional on feasibility, the marginal utility of a second child is strictly positive and sufficiently large to ensure take-up whenever the window remains open.

Under $f = 0$, initiation occurs at $t = 1$ with probability one, so the second child is feasible and chosen with probability one. Hence $N_0 = 2$ almost surely.

Under $f = 1$, by Proposition 2.4, initiation at $t = 1$ fails with positive probability. On that event, the first birth (if it occurs) must occur at $t \ge 2$, at which point the second-birth window is already closed (since $\mu(2) = 1$), implying $N_1 \le 1$ on a set of positive probability.

Therefore $\mathbb{E}[N_1] < \mathbb{E}[N_0]$.

3 Empirical Implications

The model yields empirical implications that distinguish the reservation-standard mechanism from a pure biological-insurance interpretation. Some implications follow as robust comparative statics, while others arise for a non-empty region of parameters when additional age-dependent frictions are sufficiently strong.

First, egg freezing robustly delays fertility initiation. Proposition 2.3 establishes that a reduction in the infertility hazard raises the continuation value of waiting and shrinks the initiation region at each age. Holding the state process fixed, individuals become more selective and postpone initiation. Empirically, expanded access to egg freezing should therefore increase the age at first birth among those who eventually initiate fertility.

Second, the probability of ever initiating fertility may decline. Because initiation requires a sufficiently favorable joint realization of partnership and economic conditions within a finite horizon, raising the reservation threshold can reduce the probability of crossing it. Proposition 2.4 provides a formal existence result: there is a non-empty set of environments in which $\Pr(N \geq 1)$ falls following a reduction in the biological hazard. Such effects should be more likely in settings where favorable alignment becomes less probable with age due to partnership instability, deteriorating matching conditions, or tightening non-biological constraints.

Third, parity progression and completed fertility may decline through two distinct channels. Delayed initiation compresses the feasible window for higher-parity births. Under age-dependent constraints on second births that are not insured by egg freezing (Assumption 2.5), Proposition 2.5 shows that expected completed fertility can fall. The model therefore predicts that parity progression ratios $\Pr(N \geq 2 \mid N \geq 1)$ may decrease, and that completed fertility may decline either because fewer individuals initiate fertility or because progression conditional on first birth is reduced.

A distinctive implication of the reservation-standard mechanism is increased selectivity at initiation. Proposition 2.3 implies that first births under expanded access should occur under more favorable observable conditions, such as higher partnership stability, stronger labor-market attachment, or greater income security. This prediction differentiates the mechanism from a pure insurance channel, which alters biological risk but does not necessarily raise observed standards at initiation.

The magnitude of these effects should vary systematically with partnership instability and other non-biological frictions. Because egg freezing insures only against biological decline, its impact on delay and fertility outcomes should be stronger in environments characterized by higher separation rates or less persistent favorable states. Similarly, effects should depend on perceived reliability: since the mechanism operates through reductions in the expected hazard of irreversible infertility, changes in beliefs, clinical guidelines, or employer-provided coverage that alter perceived efficacy provide natural empirical leverage.

Finally, if egg freezing is an endogenous choice, individuals with greater gains from waiting will be more likely both to freeze and to delay initiation, generating selection in observed outcomes. Credible empirical strategies should therefore rely on plausibly exogenous variation in access, cost, or perceived effectiveness to isolate the causal effect of reduced biological deadlines.

In contrast, a pure biological-insurance interpretation predicts unambiguous increases in fertility initiation and potentially in completed fertility. The reservation-standard mechanism instead predicts delayed timing and increased selectivity as robust implications, and allows for declines in first births and completed fertility when non-biological constraints tighten with age.

4 Further Work

The mechanism developed in this paper generates clear empirical predictions regarding the timing of first births and conditional predictions about parity progression and completed fertility. In particular, a reduction in the cost of fertility preservation technologies should delay fertility initiation and, when age-related constraints tighten sufficiently fast, reduce higher-order births.

Testing these predictions requires credible sources of exogenous variation in access to egg freezing. Simple cross-sectional correlations between fertility timing and technology use would be insufficient, as access and uptake are likely endogenous to preferences, career trajectories, income, and partnership dynamics. Establishing causality therefore calls for plausibly exogenous shifts in the availability, cost, or institutional coverage of fertility preservation technologies.

Future research will explore settings where regulatory changes, geographic expansion of clinics, insurance mandates, or other institutional reforms generate variation in effective access. Combining such variation with administrative records on fertility histories would allow for reduced-form estimates of the impact of improved fertility preservation on birth timing and completed fertility.

An empirical assessment along these lines would provide a direct test of the model's central prediction: that relaxing one biological constraint can, through optimal postponement behavior, compress the window for higher-parity births and potentially reduce realized fertility.

5 Discussion and Conclusion

This paper examines how relaxing a biological deadline affects fertility decisions in a finite-horizon environment with irreversible choice. We show that reducing the hazard of infertility increases the value of waiting and raises the endogenous standard required to initiate childbearing. In a multidimensional setting where partnership, economic conditions, and other life-cycle factors evolve imperfectly over time, greater selectivity can delay initiation and, in a non-empty region of parameters, reduce both fertility initiation and completed fertility.

The key insight is that egg freezing insures against one absorbing risk while leaving other age-dependent risks uninsured. When favorable states are not perfectly persistent—or become less likely with age—higher acceptance standards need not translate into higher realized fertility. The mechanism is fully rational and does not rely on behavioral biases. It emerges from the interaction between irreversibility, uncertainty, and finite horizons.

The framework also clarifies how to distinguish this channel from a pure biological-insurance interpretation. A pure insurance view predicts unambiguous increases along the extensive margin. By contrast, the reservation-standard mechanism predicts delayed timing and increased selectivity as robust implications, while allowing for declines in first births and parity progression when non-biological frictions tighten with age.

More broadly, the analysis highlights a general feature of intertemporal decision-making. When action requires the alignment of multiple evolving dimensions, weakening a terminal constraint raises the option value of waiting and the endogenous acceptance threshold. If the joint alignment needed for action becomes less likely over time—or if some favorable dimensions are not perfectly persistent—greater patience can reduce realized outcomes.

This logic naturally extends to environments with endogenous partnership formation. In our framework, partnership quality is one dimension of the state whose persistence is imperfect. In search-based models of matching (e.g., Burdett and Coles, 1997; Shimer and Smith, 2000), delayed entry or prolonged search can affect both match stability and the distribution of available partners. If partnership markets thin or relationships become less persistent at older ages, postponement induced by a weaker biological deadline may interact with evolving matching conditions in ways that further reduce fertility initiation or parity progression. Incorporating such general-equilibrium feedbacks would embed the reservation-standard mechanism in a richer partnership market environment.

A related structural logic appears in evolutionary biology. Life-history models emphasize that reproductive timing reflects trade-offs between acting under current conditions and waiting for improved mating opportunities or lower reproductive risk. For example, De Simone et al. (2020) show that females of a blood-sucking insect increase mating selectivity when the risk of producing infertile eggs declines. In structural terms, a reduction in reproductive risk raises the value of waiting and the acceptance threshold—an analogue to the shift induced by egg freezing in our model. Although the objective in such settings is evolutionary fitness rather than utility maximization, the behavioral parallel is striking. In both environments, a reduction in terminal reproductive risk leads to higher acceptance thresholds and greater selectivity. This convergence suggests that the response identified in our model may reflect an adaptive decision rule in finite-horizon environments with irreversible outcomes—one that emerges under explicit optimization in our framework and appears to arise through evolutionary selection in biological settings.

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