Does Population Aging Affect the Rebound of Fertility?

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Abstract. This paper provides empirical evidence to confirm the links between population aging and fertility. On the one hand, persistently low fertility rates have led to a gradual reduction in the size of birth cohorts, accelerating the aging process over time through the "denominator effect" and challenging the stability of aging societies and the development of pension systems. On the other hand, the increase in the proportion of older people leads to a higher dependency ratio, which increases the pressure on the working-age population to retire and inhibits fertility intentions, thus inhibiting the rebound of fertility. The results of empirical analysis show that population aging prevents the rebound of fertility; one possible mechanism is that the pressures of caring for the elderly make female labor force participation higher.

Keywords: Population aging · Total fertility rate · Dependency ratio

1 Introduction

Over the past half-century, the age structure of the world's population has undergone significant changes, and two key issues have attracted widespread attention and discussion. First and also the most striking feature is that the proportion of older people in the total population is expanding rapidly as life expectancy continues to increase. The latest report from the United Nations Department of Economic and Social Affairs states that in 2020, an estimated 727 million people over 65 worldwide, accounting for 9.3% of the total population (see Fig. 1). That number is expected to be more than 1.5 billion by 2050. The report says aging has become a widespread and potentially permanent change in global trends. The World Health Organization and the U.S. National Academy of Sciences have identified aging as a particular area of urgent inquiry.

Another demographic phenomenon that requires attention is fertility, which continues to fall below replacement level and is getting lower globally. The size and proportion of the young population aged 0–14 are declining (see Fig. 2). According to UN statistics and projections, the world average TFR (Total Fertility Rate) has dropped from 5 children per woman in 1950 to about 2.5 today. It is expected to decline further in the coming decades. Even in developing countries, fertility is likely to fall to about 2.2 by 2045–50, with only one country (Niger) expected to have a total fertility rate above 4.0.

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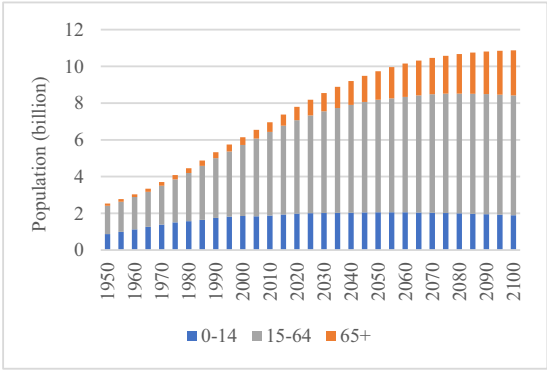

Note: Data from United Nations, Department of Economic and Social Affairs, Population Division (2019).

Fig. 1. World Population by age groups. Note: Data from United Nations, Department of Economic and Social Affairs, Population Division (2019).

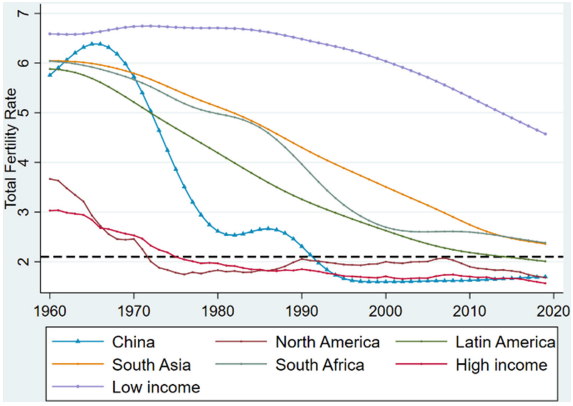

Fig. 2. Total fertility rate in some regions. Note: Data from the World Bank, high-income and low-income countries follow the same World Bank classification norms. The horizontal dashed line indicates the fertility replacement level (TFR = 2.1).

The mechanisms underlying the change in population age structure from the perspective of demographic transition are the decline in mortality and the increase in life expectancy brought about by economic and social development and the interaction between childbearing and aging that deserves significant attention. Aging and childbirth exert unprecedented pressure on global governments and policy institutions, challenging intergenerational exchange, equity, and institutional development and driving international labor, capital, and trade flows in unknown ways in the coming decades.

Section 2 reviews some existing literature, and Sect. 3 presents the model of the interaction between fertility and aging. Section 4 presents the empirical analysis and the main facts and Sect. 5 concludes.

2 Review

The population is the basis of all economic and social activities. Since the last century, both theoretical and empirical studies have generally agreed that population size is positively related to economic growth under certain conditions [1–7]. Therefore, demographic changes have inevitably become a key point for sustainable and healthy economic and social development.

Regarding the impact of population aging on development, some scholars have suggested that population aging will adversely affect human capital investment [8, 9]. Considering the perspective of savings, the relative increase in the share of the elderly population will increase the burden of old age on society, reduce the national savings rate, and thus adversely affect economic growth [10]. Low fertility refers to fertility rates that are consistently below replacement level and getting lower, which is the trend and process of decreasing the size and share of the population of young children aged 0–14 years [11]. Using Swedish data, Schultz (1985) found that exogenous increases in women's relative wages could explain a quarter of the fertility decline, and many similar findings would be found in other studies [12]. In other words, rising female wages and labor force participation are widely considered to be the leading causes of fertility decline [13–15].

Focusing on the relationship between fertility and aging, the concept of "aging from the base" (aging) has been developed to describe the impact of fertility decline on the level of population aging. The effect of low fertility on the level of population aging can be understood as a "denominator effect," which means that a significant decrease in the number of births increases the proportion of the elderly population. Some scholars have made rough estimates of the value of the "denominator effect," and the results show that low fertility rates advance the onset of population aging in China by at least ten years [16]. Many studies have similarly concluded that fertility decline contributed to at least two-thirds of the growth of the aging population in the United States and that fertility decline had a significant impact on demographic change even during a period when life expectancy increased by nearly 70% [17, 18]. Empirical evidence on how aging affects fertility, which is also our focus, is relatively scarce.

3 Methodology

Fertility is a nonmarket activity in which parents are both demanders and suppliers of children, making it challenging to analyze fertility behavior within a single theoretical framework. From an economic perspective, fertility is driven by consumption, savings, or investment considerations, and parents make decisions about whether to have children and the number of children in terms of utility maximization. To understand these issues in a simple context, most studies on fertility treat children as a unique "commodity" and fertility behavior as a "consumer" (parental) response to the demand for children [19, 20].

From a concise and efficient perspective, we use the most basic Becker framework [13] to analyze fertility behavior, the classical two-good utility (U) maximization model, while if the consumer utility function is a Cobb-Douglas utility function. The utility function is given by:

$$\max U = U(n, Z) = n^{\alpha} \cdot Z^{\beta}. \tag{1}$$

The parameter n denotes the number of children, and Z represents the number of other goods. The budget constraint that parents face is

$$\pi_c n + \pi_z Z = I, \tag{2}$$

where π_c denotes the *price* of the child, π_z denotes the price of other goods, and I denotes income.

We assume that child is a normal good, which means the demand for a child rises as income increases. The price of a child includes both direct and indirect costs. Indirect costs include opportunity costs, such as labor market income foregone due to the act of having a child. Direct costs include direct cash expenses such as support expenses and education expenses.

Using the Lagrange method to get the first-order derivative yields

$$\frac{\alpha Z}{\beta n} = \frac{\pi_c}{\pi_Z} \tag{3}$$

and the demand function

$$n^* = \frac{\alpha}{\alpha + \beta} \times \frac{I}{\pi_c} = \frac{\alpha I}{\pi_c}, \tag{4}$$

$$Z^* = \frac{\beta I}{\pi_Z}. \tag{5}$$

The first-order conditions of the model show that the demand for children depends on the relative prices of children and other goods $\frac{\pi_c}{\pi_Z}$. This last condition reflects the fact that an increase in the relative price of children will reduce the demand for children (n) while reducing the demand for other goods (Z). An increase in net income will increase the demand for children, i.e., increase the willingness to have children. In the case of rising wages, it is necessary to consider whether the substitution effect will outweigh the income effect.

We assume that there is a substitution effect between old age and childbearing; in other words, we argue that an increase in the number of aging households will increase household spending on old age, which in turn will crowd out other budgets.

4 Empirical Analysis

In this section, we conduct a simple empirical analysis using 176 countries' data from World Bank over the period 1960 to 2020. We use the old-age dependency ratio as a proxy variable for aging to observe the effect on fertility.

The regression equation is estimated with the fixed effects model at the region and time levels and controls for other variables stepwise, and the basic model is

$$TFR_{it} = \beta_0 + \beta_1 DOLD_{it} + \boldsymbol{\beta} \boldsymbol{X}'_{it} + \theta_i + \varepsilon_{it}, \tag{6}$$

where TFR_{it} is denotes the fertility rate of country or region i in year t; $DOLD_{it}$ denotes the old-age dependency ratio of country or region i in year t; the vector $\boldsymbol{X}'_{it}$ and its

Table 1. Fixed effects regression results

	Regression		
Variables	(1)	(2)	(3)
DOLD	−0.1279***	−0.0260***	0.0101
	(0.0162)	(0.0124)	(0.0072)
GDPcpt		< 0.0001***	< 0.0001***
		(4.67e−06)	(4.19e−06)
IMRT		0.0328***	0.0314***
		(0.0175)	(0.0021)
LABOR			−0.0286***
			(0.0062)
Obs	14364	8355	5065
R-sq	0.0756	0.6604	0.5902

Note: Robust standard errors in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; all regressions use country (or region) level fixed effects and are clustered at the country (or region) level

coefficient vector β denotes the other covariates and their coefficients; θ_i is the country (or region) fixed effects, respectively, and ε_{it} is the random error.

The control variables include the proportion of women of working age (15–64) participating in the labor market (*LABOR*) as a proxy for the "price" of children, GDP per capita (*GDPcpt*), infant mortality rate (*IMRT*) to control for heterogeneity in economic and social development across countries.

Table 1 provides our estimation results. In all cases, the left-hand-side variable is the fertility rate. Regression (1) reproduces standard results in the fertility literature: the old-age dependency ratio has a negative effect on fertility. Regression (2) adds the GDP per capita and infant mortality rate. The estimated coefficient is significantly negative. However, when the labor market participation of females is included (regression 3), while the coefficient on *Labour* is significantly negative, the coefficient on the old-age dependency ratio becomes insignificant.

Based on the theoretical model considering the coefficient of *LABOR*, the impact of the female labor market participation rate on fertility behavior from the perspective of the relative price of children. In the Becker model, the opportunity cost of childbearing increases, and the price of children increases, affecting the demand for children and decreasing business intentions. The proportion of the working-age females participating in the labor market as an essential component of the relative price of children is said to be significantly negatively related to fertility. This is consistent with the previous theoretical analysis, i.e., the opportunity cost of childbearing increases, the relative price of children rises, which affects the demand for children.

We suspect a complex relationship between the old-age dependency ratio, female labor market participation rate, and fertility rate. Based on the conjecture, we further

Table 2. Mediation effects test

	TFR
DOLD	−0.0083*** (0.0038)
LABOUR	−0.0260*** (0.0020)
Country	YES
Observations	5592
Adjusted R-sq	0.9082
Sobel Z	−0.0195***

Note: female labor market participation rate (Labour) is the mediating variable, the old-age dependency ratio (Dold) is the independent variable, and fertility rate (TFR) is the dependent variable while controlling for other heterogeneities

employ a mediation effects test to determine whether the old-age dependency ratio affects fertility through female labor participation. We refer to the most commonly used tests for mediating effects. Table 2 further reports the results of the Sobel test, where the Sobel Z values are all significantly positive, proving that the partially mediated effects hold. The test results of mediation effect supported our suspicions.

5 Conclusions

The preceding analysis illustrates a vicious cycle between population aging and declining fertility. On the one hand, an aging society places a more significant burden on supporting the working-age population and increases the cost of supporting the elderly. In other words, in a family-based aging model, increased retirement expenditures for younger parents (those facing the decision to have children) will dampen the demand for children, which means less willingness to have children due to budget constraints. Even if older parents are healthy and do not need the support of younger parents, for the time being, the subsequent pressure of impending retirement will still influence the reproductive decisions of younger parents. On the other hand, continued low levels of fertility keep the size of the birth population shrinking, the size of the working-age population for the next generation continues to shrink, and the old-age dependency ratio increases. Worldwide experience suggests that addressing demographic imbalances requires a simultaneous focus on aging and fertility, with the key being to ease aging pressures while encouraging fertility increases.

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