

Article

Beyond Immediate Impact: A Systems Perspective on the Persistent Effects of Population Policy on Elderly Well-Being

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Abstract

This study adopts a systems perspective to examine the persistent effects of China's One-Child Policy (OCP) on the subjective well-being of older adults, emphasizing structural persistence, reinforcing feedback, and path-dependent lock-in in complex socio-technical systems. Using nationally representative data from the China Longitudinal Aging Social Survey (CLASS-2014), we exploit the OCP's formal rollout at the end of 1979—operationalized with a 1980 cutoff—as a quasi-natural experiment. A Fuzzy Regression Discontinuity (FRD) design identifies the Local Average Treatment Effect of being an only-child parent on late-life well-being, mitigating endogeneity from selection and omitted variables. Theoretically, we integrate three lenses—policy durability and lock-in, intergenerational support, and life course dynamics—to construct a cross-level transmission framework: macro-institutional environments shape substitution capacity and constraint sets; meso-level family restructuring reconfigures support network topology and intergenerational resource flows; micro-level life-course processes accumulate policy-induced adaptations through education, savings, occupation, and residence choices, with effects materializing in old age. Empirically, we find that the OCP significantly reduces subjective well-being among the first generation of affected parents decades later (2SLS estimate ≈ -0.23 on a 1–5 scale). The effects are heterogeneous: rural residents experience large negative impacts, urban effects are muted; men are more adversely affected than women; and individuals without spouses exhibit greater declines than those with spouses. Design validity is supported by a discontinuous shift in fertility at the threshold, smooth density and covariate balance around the cutoff, bandwidth insensitivity, “donut” RD robustness, and a placebo test among ethnic minorities exempt from strict enforcement. These results demonstrate how demographic policies generate lasting impacts on elderly well-being through transforming intergenerational support systems. Policy implications include strengthening rural pension and healthcare systems, expanding community-based eldercare services for spouseless elderly, and developing complementary support programs.

Keywords: socio-technical systems; complex adaptive systems; feedback and lock-in; one-child policy; subjective well-being



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1. Introduction

Policy effect durability stems from complex socio-technical system dynamics, where structural shocks spread via feedback loops and accumulate over the life cycle. Short-term

evaluations overlook path-dependent lock-in and delayed responses—gaps that matter because late-20th-century social policies now profoundly impact aging populations, with unanticipated effects on health and well-being [1,2]. Both historical and contemporary policies are intertwined in shaping quality of life in later years. As societies rapidly age, identifying policy effects in isolation has become increasingly crucial. However, the scarcity of longitudinal data and robust causal identification strategies has largely confined existing research to examining short-term policy effects, thereby limiting our understanding of how policy impacts evolve over extended periods.

The challenge of evaluating policy persistence stems not only from methodological obstacles in establishing long-term causality but also from the complexity of tracking how policy effects cascade and accumulate throughout an individual's life course [3]. Early policy interventions can fundamentally reshape an individual's life trajectory, with consequences often manifesting fully only in later life stages [4]. This temporal dimension of policy impacts is especially pronounced in population policies, where interventions targeting reproductive decisions in early adulthood may substantially affect well-being in later years through their influence on family structures and intergenerational dynamics [5]. Conventional policy evaluation approaches have often neglected these cumulative effects, failing to fully capture how policies shape life outcomes by influencing critical life decisions. In societies experiencing fundamental transformations in intergenerational relations and family structures, these long-term policy implications may outweigh immediate effects in significance [6]. In population policy, interventions during reproductive decisions operate as policy changes that reshape family-based elderly care systems and its intergenerational resource flows, yielding long-lag system responses in later life.

This study examines the lasting influence of China's landmark demographic intervention, demonstrating through rigorous quasi-experimental evidence how population policies can fundamentally reshape family structures and social outcomes across generations. The implementation of China's one-child policy in 1979 represents one of the most significant social engineering initiatives in human history, fundamentally transforming family structures and intergenerational relationships [7]. First, we propose a systems perspective that maps how policy-induced structural change propagates through feedback and lock-in to shape node-level performance. Second, our FRD strategy identifies a local system response at a clearly defined boundary (1980), mitigating endogeneity. Third, we uncover subsystem-specific responses under distinct boundary conditions (urban–rural interfaces, gender roles, and spousal redundancy).

Through an innovative empirical strategy and theoretical framework, this study makes three significant contributions to our understanding of policy effect durability. First, at the theoretical level, we propose an integrative analytical framework that illuminates how policies can generate enduring effects by shaping individuals' critical life decisions. This framework transcends the static perspective dominant in conventional policy evaluation and demonstrates how policy effects accumulate through the restructuring of intergenerational relationships. Second, at the methodological level, we exploit the quasi-natural experiment of the one-child policy implementation to provide robust evidence of policies' long-term causal effects. By employing a Fuzzy Regression Discontinuity (FRD) design, we effectively address endogeneity concerns, including selection bias and omitted variable problems. Third, this study uncovers substantial effect heterogeneity, which not only deepens our understanding of policy persistence but also provides crucial insights for developing differentiated pension policies.

This article is organized as follows. Section 2 reviews the relevant literature. Section 3 develops the analytical framework. Section 4 describes the data and empirical methodology. Section 5 presents the main empirical findings. Section 6 reports the robustness checks.

Section 7 examines the heterogeneous effects. Section 8 discusses the implications of our findings.

2. Literature Review

2.1. Policy Durability and Well-Being in Old Age

Research on long-term policy interventions increasingly frames societies as complex socio-technical systems in which structural persistence, reinforcing feedback, and lock-in shape later-life outcomes [8]. While existing literature has extensively examined the immediate effects of population policies—including fertility changes, gender imbalances, and family size adjustments—there remains limited understanding of how these policies shape the long-term well-being of older adults [9–14]. This research gap stems not only from methodological challenges but also from insufficient theoretical understanding of structural persistence and lock-in mechanisms [15]. As societies experience accelerated aging, understanding how early policy interventions influence quality of life in later years has become increasingly critical.

Structural persistence and lock-in offer a novel lens to link population policy with later-life well-being [16]. Unlike static evaluations, this framework highlights how early policy interventions shape life-course resource accumulation and well-being by influencing critical decisions—especially in population policies, where family structure and intergenerational relationship changes drive long-term impacts [17–19]. These impacts extend beyond direct resource constraints to fundamentally alter the institutional foundation of intergenerational support, subsequently affecting care arrangements and subjective well-being in later life [20].

The mechanisms for structural persistence and lock-in effects are multi-dimensional, and the policies in place during a person's youth may affect their well-being in old age through a variety of factors. As the first generation of one-child parents transitions into older age, the early policy interventions in family structure begin to manifest their profound consequences. First, population policy directly reshapes intergenerational resource allocation patterns by altering family size. While traditional multi-child families diversify old-age resources through risk-sharing among children, policy interventions disrupt this equilibrium [21]. Second, policy effects generate reinforcing feedback and lock-in dynamics by transforming individuals' life strategies and expectations. For instance, in response to fertility constraints, families may modify their saving behaviors, occupational choices, and residential arrangements. These adaptive responses accumulate over time, with their full effects often becoming apparent only in later life [22].

Structural persistence and lock-in effects often demonstrate significant intergenerational cumulative characteristics. Early policy interventions can alter the patterns of intergenerational resource transfers by influencing housing investment decisions, educational choices, and similar factors [23]. These effects may not only impact the current older population but can also have long-term intergenerational consequences by reshaping the welfare expectations and behavioral strategies of subsequent generations [24]. Thus, understanding the durability of policies is crucial not only for assessing the current state of well-being in old age but also for providing a valuable perspective on predicting challenges from population aging.

2.2. Institutional Transmutation of Intergenerational Support

The systemic reconfiguration of the family-based eldercare subsystem links population policy to later-life well-being by altering support network architecture and resource-flow channels [25,26]. In Chinese traditional societies, intergenerational support is embedded within a multi-child family system, which establishes a robust mechanism for old-age

security through resource pooling among children [27,28]. This support structure extends beyond material resource provision to create a comprehensive network of emotional support and care arrangements [29]. However, the implementation of the one-child policy has fundamentally altered this system's foundation, catalyzing a qualitative transformation in the intergenerational support paradigm.

This transformation is primarily manifested in a fundamental restructuring of the support system: the comprehensive implementation of the one-child policy in 1979 reduced the traditional diversified support network to a single support channel, substantially increasing the vulnerability of intergenerational support arrangements [23]. In multi-child families, siblings can establish flexible care arrangements through negotiation and labor division; however, this risk-pooling mechanism is unavailable in one-child families [30]. During the policy's initial implementation phase, urban families' reproductive behaviors were rapidly modified through stringent administrative measures and economic sanctions, while rural areas experienced more flexible enforcement standards. In particular, when one-child families encounter occupational demands or geographical constraints, providing adequate elderly care often becomes particularly challenging [31].

Policy-induced transformations in intergenerational support demonstrate significant institutional heterogeneity. In urban areas with relatively developed social security systems, the establishment of formal elderly care services has partially mitigated the limitations of family-based support. The emergence of alternative care models, including institutional and community-based care, has expanded the options available to urban older adults [32]. This institutional substitution began evolving in the late 1990s, and with the development and enhancement of the pension insurance system, institutional support for urban older adults has progressively strengthened. In contrast, rural older adults have encountered substantial barriers in accessing adequate formal subsystem substitutes (pension, health insurance, institutional/community care) following the erosion of traditional support networks [33]. This urban-rural disparity not only reflects inequitable distribution of elderly care resources but also illustrates how policy effects interact with institutional environments to shape older adults' well-being [34]. As the first generation of one-child parents transitions into older age, the transformative implications of this altered intergenerational support paradigm are becoming increasingly pronounced.

2.3. Life Course and Accumulation of Well-Being

Life course theory can be treated as dynamics of individuals (nodes) embedded in multi-level systems, where early structural shocks alter resource accumulation trajectories through feedback and constraints [35,36]. The one-child policy functions as a system-level turning point, inducing long-run lock-in that manifests as later-life performance differences [37]. Specifically, the 1979 policy implementation exposed first-child families to substantially different institutional environments across time periods, creating a quasi-natural experiment that offers an ideal setting for examining how policy shocks shape individual life courses.

Structural shocks at critical life stages trigger cascading feedbacks in savings, occupation, and residence—effects that accumulate and later shape individual outcomes [38]. For example, policies targeting reproductive decisions drive cascading impacts, altering family resource allocation and residential choices [39]. During the policy's initial implementation phase, urban families adapted to single-child constraints by modifying their educational investment strategies and occupational choices, while rural families maintained traditional pension security through intergenerational cohabitation arrangements [37,40]. The implications of these early adaptive decisions for later-life well-being gradually emerge through path-dependent processes.

The presence of lagged effects adds complexity to policy impact assessment. The temporal nature of policy effects, which often become evident at specific life stages, necessitates a longitudinal perspective in evaluation [41]. For instance, the effects of the one-child policy on the first generation of affected parents—those who had children before and after 1980—did not fully materialize until the 2010s when this cohort entered older age. This temporal gap not only complicates policy assessment but also emphasizes the significance of examining long-term social costs. Moreover, limited resources for children may amplify disparities in later-life risks across social groups, particularly for those lacking institutional support. This cumulative effect is especially salient within China's institutional context. Specifically, while urban workers were initially incorporated into the pension insurance system in the 1990s, the New Rural Insurance Pilot Program establishing universal pension coverage in rural areas did not commence until 2009, creating a systematic temporal disparity that has further exacerbated the urban-rural gap in older adults' well-being [42].

3. Analytical Framework

Understanding the long-term effects of the one-child policy on older adults' subjective well-being requires a comprehensive analytical framework. This necessity stems from the multifaceted nature of policy impacts: at the macro level, policy effects are deeply embedded within specific institutional environments, with their persistence emerging through institutional moderating mechanisms. At the meso level, policies transform fundamental patterns of intergenerational support through family size alterations, generating structural changes that substantially influence older adults' well-being. At the micro level, policies function as critical life course turning points, creating cumulative effects that shape individual trajectories. Therefore, this comprehensive impact mechanism necessitates a systematic analytical framework that synthesizes perspectives from structural persistence and lock-in theory, intergenerational support theory, and life course theory.

The structural persistence and lock-in perspective provides a macro-level theoretical foundation for analyzing the one-child policy's long-term effects. This approach emphasizes how institutional transformations generate enduring impacts by restructuring fundamental social arrangements. The one-child policy, as a significant demographic intervention, fundamentally altered the institutional basis of intergenerational relations through mandatory family size restrictions. Once implemented, these institutional changes create path dependencies that resist complete restoration of original family structures and support systems, even with subsequent policy modifications. Within China's distinct institutional context, this persistence exhibits notable urban-rural heterogeneity: urban areas have developed relatively robust institutionalized support systems through progressive enhancement of pension insurance, health insurance, and related mechanisms, partially offsetting the policy's negative impacts. In contrast, rural areas, lacking effective formal subsystem substitutes, have experienced more profound disruptions to traditional family-based elderly care models. This institutional embeddedness suggests that structural persistence and lock-in patterns are deeply rooted in specific institutional environments, with effect magnitudes varying systematically across different institutional contexts.

Intergenerational support theory illuminates the mechanisms through which policy reshapes family structure. In China's traditional family-based pension system, the number of children directly determines intergenerational support capacity. The one-child policy has fundamentally transformed this support structure by restricting family size. This impact extends beyond material resource constraints to significantly affect the provision of emotional support and daily care. The effect is particularly salient among older adults without spousal support, as reduced childcare resources may have more pronounced negative implications due to their heightened dependence on children for various forms of support.

Moreover, the transformation of intergenerational support displays distinct institutional characteristics: in regions with relatively developed formal elderly care systems, diminished family support may be partially offset by formal subsystem substitutes, whereas areas lacking such infrastructure often experience substantial declines in older adults' well-being. This theoretical framework demonstrates how structural changes in family composition influence older adults' subjective well-being through altered intergenerational support patterns, providing a critical lens for understanding policy effect heterogeneity.

Life course theory illuminates the micro-level accumulation processes of policy effects. The one-child policy, serving as a critical life course turning point, shapes individual resource accumulation trajectories by transforming family formation patterns. These impacts demonstrate significant gender heterogeneity: traditional cultural expectations regarding male lineage continuation may render fertility constraints more psychologically burdensome for older men [43]. In contrast, women typically maintain more extensive and resilient social networks, which may partially buffer the effects of reduced fertility. Notably, these cumulative life course effects often fully manifest only in later life, explaining why policy impacts can substantially influence older adults' subjective well-being decades after implementation.

As depicted in Figure 1, this comprehensive analytical framework delineates the transmission pathways of policy effects from macro-institutional environments to micro-individual well-being. The structural persistence and lock-in perspective emphasizes the institutional context's centrality, which we capture through policy implementation timing and regional variations. Intergenerational support theory illuminates the underlying mechanisms within family structures, which we examine through family size, sibling composition, and household arrangements. Life course theory further explicates individual-level accumulation processes, which we analyze through multiple outcome measures and heterogeneity analyses across demographic groups. This framework elucidates why identical policies generate diverse long-term impacts across different institutional contexts (urban-rural variations), family configurations (spousal presence), and demographic characteristics (gender differentials). Our empirical strategy systematically tests these theoretical mechanisms, offering insights into how population policies reshape long-term social outcomes through multiple interconnected channels.

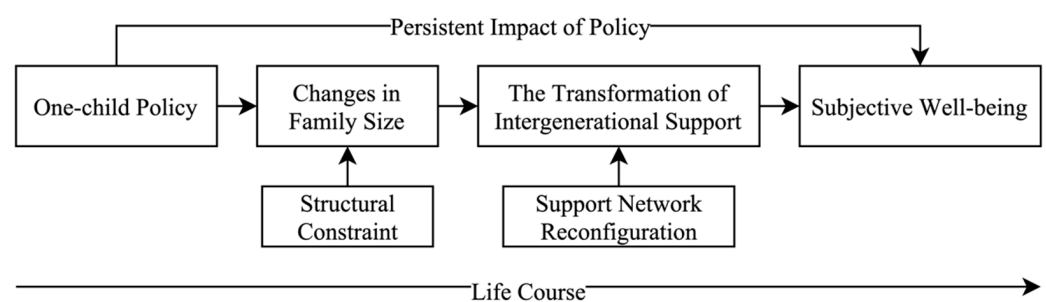


Figure 1. Analytical framework.

4. Data and Method

4.1. Data Sources and Sample Selection

This study analyzes data from the China Longitudinal Aging Social Survey (CLASS), a nationally representative survey of older adults conducted by the National Survey and Research Center at Renmin University of China. The survey comprises comprehensive interviews with individuals aged 60 and above, encompassing multiple dimensions including demographic characteristics, children's status, and subjective well-being measures. This rich dataset provides robust empirical support for examining the long-term effects of family

planning policies. Our analysis utilizes the 2014 wave (CLASS-2014), preceding the policy change that allowed couples with one partner being an only child to have two children, thus avoiding potential confounding effects from this policy adjustment.

Our sample selection process incorporated several key criteria. First, due to policy applicability considerations, we excluded ethnic minorities who were subject to different fertility regulations and thus less affected by the one-child policy [39]. Second, we excluded childless older adults as they fell outside the policy's scope (thus, our analysis specifically compares parents with one child to those with multiple children). Third, to minimize the confounding effects of historical events, we restricted our sample to parents whose first child was born between 1970 and 1990, spanning the decade before and after the 1980 policy implementation. After excluding observations with missing values for key variables, our final analytical sample comprised 4292 individuals.

Regarding variable operationalization, our dependent variable “Subjective Well-being” is measured using respondents’ subjective well-being on an internationally standardized 5-point scale, ranging from 1 to 5, with higher scores indicating greater well-being [44]. The key independent variable “Parent with one child” is constructed as a binary indicator (1 = one child, 0 = otherwise) based on respondents’ reported number of children. We include a comprehensive set of control variables that potentially influence older adults’ well-being, comprising three categories: personal characteristics (Age, Female, Spouse) [45], socioeconomic status (High school, Non-agricultural hukou, Personal annual income), and household resources (Employment status, Number of dwellings owned) [40].

The descriptive statistics (Table 1) indicate that the mean Subjective Well-being score in our sample is 3.98 (SD = 0.92), suggesting generally positive subjective well-being among respondents. Parents with one child constitute 30% of the sample, reflecting substantial penetration of the family planning policy. The sample’s mean age is 64 years (SD = 3.92), with 43% female respondents and 84% having spouses. Regarding socioeconomic characteristics, 21% of respondents have completed high school education, 44% hold non-agricultural hukou status, and 29% remain employed. Additionally, respondents own an average of 1.03 dwellings (SD = 0.51), and the mean personal annual income (in log form) is 9.15 (SD = 1.94). These baseline characteristics provide a comprehensive profile of our analytical sample.

Table 1. Descriptive Statistics.

Variable	Obs	Mean	Std.Dev.	Min	Max
Subjective Well-being	4292	3.98	0.92	1	5
Parent with one child	4292	0.30	0.46	0	1
Age	4292	64.00	3.92	60	87
Female	4292	0.43	0.50	0	1
Spouse	4292	0.84	0.37	0	1
High school	4292	0.21	0.41	0	1
Non-agricultural hukou	4292	0.44	0.50	0	1
Personal annual income	4292	9.15	1.94	0	13.22
Employment status	4292	0.29	0.45	0	1
Number of dwellings owned	4292	1.03	0.51	0	7

4.2. Identification Strategy

While China’s formal implementation of the one-child policy began in late 1979 with varying regional intensities, this period represented a landmark shift in demographic policy. Unlike previous less stringent family planning initiatives, this policy fundamentally reshaped China’s family structures through administrative regulations and economic sanctions on fertility behavior. We employ a Fuzzy Regression Discontinuity (FRD) design

to evaluate the one-child policy's effects on older adults' subjective well-being. China's formal implementation of the one-child policy in late 1979 represented a landmark demographic intervention. Unlike previous less stringent family planning initiatives, this policy fundamentally reshaped China's family structures through strict administrative controls and economic sanctions on fertility behavior.

We employ a fuzzy regression discontinuity (FRD) design using 1980 as the cutoff year. This choice is credible because the one-child policy was not announced until late 1979, making it impossible for families to strategically time births around our 1980 cutoff. The validity of our FRD design relies on two key assumptions. First, individuals cannot manipulate their birth timing around the 1980 cutoff. Second, other factors affecting our outcomes should vary smoothly around the threshold.

The implementation of the one-child policy exhibits substantial heterogeneity in compliance. Some families achieved multiple births through social maintenance fee payments or alternative mechanisms. Particularly in the policy's initial phase, enforcement intensity varied significantly across regions, with certain local governments adopting more permissive implementation standards. Moreover, influenced by traditional fertility preferences, some families opted for multiple children despite potential sanctions. These factors contribute to the fuzzy nature of policy implementation, indicating that the policy does not deterministically predict a family's fertility outcomes. This implementation pattern provides the empirical foundation for employing a Fuzzy Regression Discontinuity (FRD) design rather than a sharp RD approach.

Given the implementation characteristics of the policy, we employ a Fuzzy Regression Discontinuity (FRD) design in our analysis. Specifically, we leverage the exogenous threshold of the 1980 policy implementation to construct instrumental variables that identify the effect of having one child on subjective well-being. This approach addresses potential endogeneity concerns arising from selection bias in the policy implementation process, enabling more precise estimation of the policy's causal effects. The Local Average Treatment Effect (LATE) for policy compliers is estimated through the FRD framework.

4.3. Model Setting

Following the Fuzzy Regression Discontinuity (FRD) design, we employ a two-stage least squares (2SLS) estimation strategy to evaluate the impact of the one-child policy on older adults' subjective well-being [46]. The two-stage regression equations are specified as follows:

$$\text{OneChild}_i = \alpha_0 + \alpha_1 D_i + \alpha_2 \text{relative_age}_i + \alpha_3 \text{relative_age}_i * D_i + X_i + \mu_p + \varepsilon_i \quad (1)$$

$$SWB_i = \beta_0 + \beta_1 \widehat{\text{OneChild}}_i + X_i + \mu_p + v_i \quad (2)$$

The first-stage equation estimates the policy's effect on fertility behavior, while the second-stage equation evaluates the impact of being a parent with one child on subjective well-being. The dummy variable OneChild_i indicates whether individual i is a parent with a child. SWB_i stands for an individual's subjective well-being. D_i denotes the policy dummy variable, relative_age_i represents the temporal distance from the policy implementation threshold, X_i is a vector of control variables, and μ_p captures province fixed effects. Control variables comprise demographic characteristics (Age, Female, Spouse), socioeconomic status (High school, Non-agricultural hukou, log of Personal annual income), and household resources (Employment status, Number of dwellings owned). To ensure estimation robustness, we perform robust tests and sensitivity analyses to assess potential impacts of unobserved factors. This econometric framework not only ensures the compre-

hensiveness and reliability of our empirical analysis but also establishes a foundation for subsequent heterogeneity analyses and mechanism investigations.

5. Results

5.1. Validity Test of the Model

Before conducting the benchmark regression analysis, we must first verify the validity of the Fuzzy Regression Discontinuity (FRD) design. This verification encompasses three key aspects: the actual impact of the policy, the continuity of the sample distribution, and the balance test of the covariates [47,48].

Figure 2 depicts the proportion of parents with one child relative to their first child's birth year, using 1980 as the threshold. The figure reveals a significant discontinuity at the 1980 policy implementation threshold. Specifically, before policy implementation ($\text{relative_age} < 0$), the proportion of one-child families remained relatively stable and low. However, after implementation ($\text{relative_age} \geq 0$), this proportion increased substantially. This pronounced discontinuity at the threshold not only provides visual validation for our FRD design but also demonstrates the policy's substantial impact on fertility behavior.

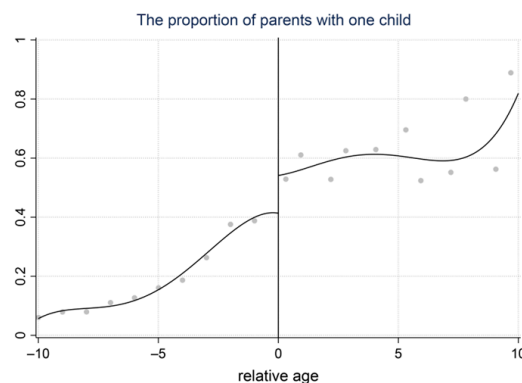


Figure 2. The proportion of parents with only child changes with relative age.

A crucial assumption of the Fuzzy Regression Discontinuity (FRD) design is that individuals cannot precisely manipulate their position relative to the threshold. Figure 3 presents the density distribution of first births around the threshold. If households could anticipate and respond to the policy implementation by adjusting birth timing, we would observe notable bunching or sparsity in the distribution at the threshold. However, Figure 3 shows that the sample distribution remains smooth across the threshold, with no evidence of manipulation. Furthermore, we implement the McCrary (2008) density continuity test, which estimates a log density difference of 0.024 ($SE = 0.076$), failing to reject the null hypothesis of density continuity. This evidence suggests that, in the historical context, families were unable to precisely manipulate their first birth timing in response to the policy implementation, thereby supporting our identification strategy.

Another critical assumption of the FRD design is that all potential determinants of the outcome variable, except for the policy effect, should be continuous at the threshold. Figure 4 presents balance tests for key covariates (Age, Female, High school, Non-agricultural hukou, and Personal annual income) around the threshold. Each point represents the outcome of a local linear regression using the respective covariate as the dependent variable, with vertical lines indicating 95% confidence intervals. The results show no statistically significant discontinuities in any key covariates at the threshold. This evidence suggests that samples on either side of the policy implementation threshold are well-balanced in terms of observable characteristics, further supporting the exogeneity of the policy intervention.

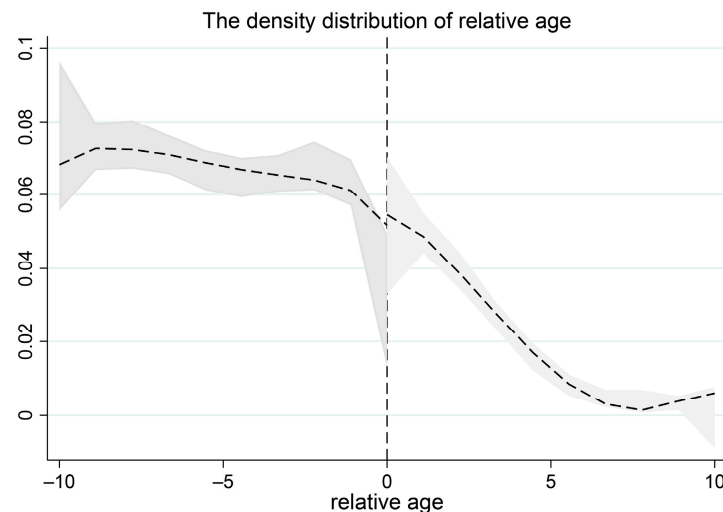


Figure 3. The relative age density distribution before and after the breakpoint.

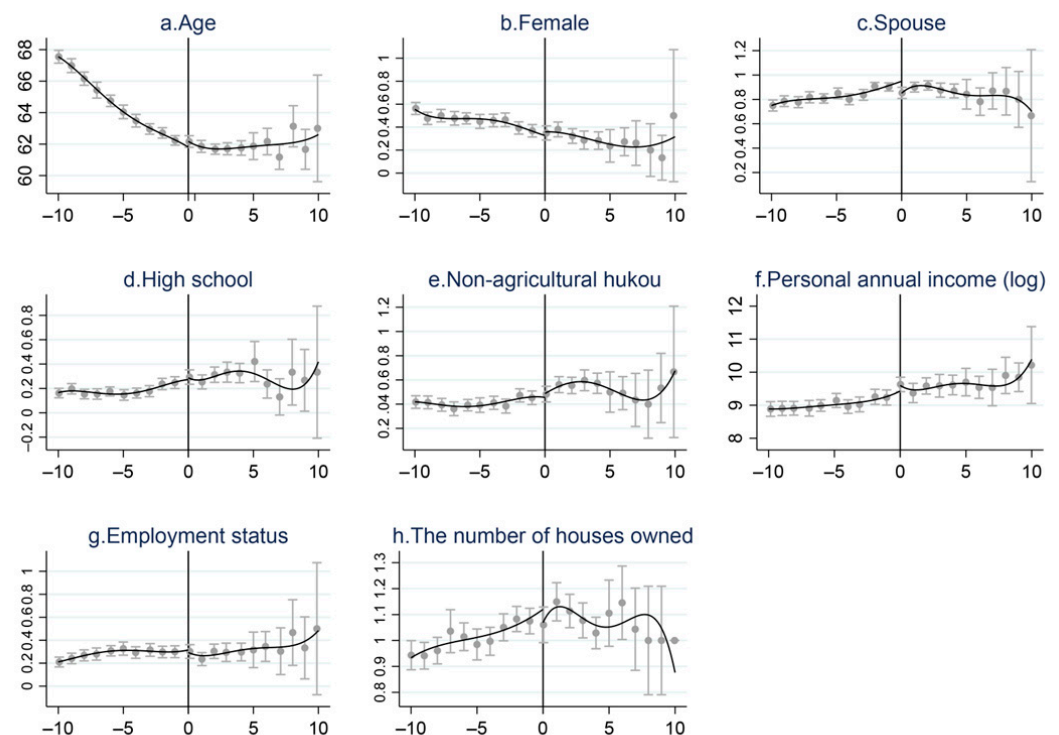


Figure 4. Validity testing of covariates at breakpoints.

5.2. Baseline FRD Estimates

We begin by examining the effect of the one-child policy on parental fertility decisions. Table 2 presents the first-stage Fuzzy Regression Discontinuity (FRD) estimates. The results in Column (1) demonstrate that the policy implementation significantly increased the prevalence of one-child families, with the coefficient of the policy indicator (D) being 0.34 ($p < 0.01$). This estimate suggests that the probability of having an only child increased by 34 percentage points following the policy implementation. Such a substantial magnitude underscores the policy's effectiveness in constraining fertility behaviors.

In Column (2), we augment the model by incorporating relative age (Relative_age) and its interaction with the policy indicator ($\text{Relative_age} \times D$). The estimates reveal a positive coefficient for Relative_age ($p < 0.01$) and a negative coefficient for the interaction term ($p < 0.01$), indicating distinct temporal patterns before and after the policy implementation.

Specifically, while the proportion of one-child families exhibited an upward trend prior to the policy, this trend was significantly attenuated following the policy's introduction. These differential time trends are consistent with our theoretical predictions and provide evidence of the policy's sustained impact on fertility decisions.

Table 2. The Influence of OCP on Parents Having One Child.

Variables	Parent with One Child		
	(1) 2OLS Coef.(S.E.)	(2) 2OLS Coef.(S.E.)	(3) 2OLS Coef.(S.E.)
D	0.34 *** (−0.02)	0.10 *** (−0.02)	0.09 *** (−0.02)
Relative_age		0.04 *** (0)	0.05 *** (0)
Relative_age_ocp		−0.03 *** (−0.01)	−0.03 *** (−0.01)
Age			0.01 *** (0)
Female			0.04 *** (−0.01)
Spouse			−0.03 ** (−0.01)
High school			0.05 *** (−0.02)
Non-agricultural hukou			0.06 *** (−0.01)
Personal annual income			0.02 *** (0)
Employment status			−0.11 *** (−0.01)
Number of dwellings owned			−0.01 (0.01)
Constant	0.48 *** (−0.03)	0.69 *** (−0.03)	−0.15 (−0.12)
Observations	4292	4292	4292
R-squared	0.34	0.38	0.42
Province FE	Yes	Yes	Yes
Bandwidth	+ / −10	+ / −10	+ / −10

Note: S.E. represents heteroscedasticity-robust standard errors. *** $p < 0.01$, ** $p < 0.05$ (two-tailed tests).

Column (3) extends the specification by incorporating a comprehensive set of covariates, including demographic characteristics, socioeconomic indicators, and household resource measures. The policy effects remain statistically significant ($p < 0.01$) after adjusting for these confounding factors, albeit with slightly attenuated coefficients, demonstrating the robustness of our findings. This persistence suggests that the policy's impact on fertility decisions is substantive and independent of other determinants. Among the control variables, we find significant associations between one-child parenthood and several key factors: age, female status, high school education, non-agricultural hukou status, and personal annual income. These relationships align with the existing literature on fertility determinants.

Table 3 presents the second-stage FRD estimates examining the causal effect of one-child parenthood on subjective well-being. In Column (1), controlling for relative age and its interaction with the policy indicator ($\text{Relative_age} \times D$), we find that parents with an only child report significantly lower subjective well-being compared to parents with multiple children ($\beta = -0.23$, $p < 0.01$). This negative association remains robust in

Column (2) after adjusting for the full set of demographic, socioeconomic, and household resource covariates, suggesting that the observed well-being differential is not driven by observable individual heterogeneity. The magnitude of this effect is substantial: given that subjective well-being is measured on a 5-point scale with a sample mean of 3.98, the estimated reduction of 0.23 points represents a meaningful decline in the psychological well-being of older adults affected by the policy.

Table 3. The Influence of OCP on Subjective Well-being of the Elderly.

Variables	Subjective Well-Being	
	(1) 2SLS Coef.(S.E.)	(2) 2SLS Coef.(S.E.)
Estimation results in the second stage		
Parent with one child	−0.23 *** (0.08)	−0.23 ** (0.09)
Constant	4.30 *** (0.07)	3.30 *** (0.31)
Observations	4292	4292
R-squared	(0.03)	(0.05)
Estimation results in the first stage		
D	0.10 *** (0.02)	0.09 *** (0.02)
Relative_age	Yes	Yes
Relative_age × D	Yes	Yes
Control variables	No	Yes
Province FE	Yes	Yes
Bandwidth	+ / − 10 years	+ / − 10 years
F	6.73	7.12
Kleibergen-Paap rk LM statistic	655.17 ***	529.55 ***
Kleibergen-Paap rk Wald F statistic	303.57	276.16

Note: S.E. represents heteroscedasticity-robust standard errors. *** $p < 0.01$, ** $p < 0.05$ (two-tailed tests).

Further examination of the estimates in Table 3 reveals that the associations between control variables and subjective well-being align with theoretical frameworks. Individuals with high school education report higher levels of subjective well-being, suggesting that human capital accumulation may enhance quality of life in later years. The significant positive association between non-agricultural hukou status and well-being underscores the enduring influence of China's institutional stratification system on individual welfare. Personal annual income demonstrates a robust positive relationship with subjective well-being, consistent with established economic theories of well-being. Notably, employment status shows a negative association with well-being, indicating that continued labor force participation among older adults may be driven by economic necessity rather than voluntary choice.

The diagnostic tests provide robust support for our identification strategy. While the first-stage F-statistic approaches but does not exceed the Stock-Yogo critical value for weak instruments, we implement several estimators that are robust to potential instrument weakness. The Anderson-Rubin (AR) test rejects the null hypothesis of no effect ($\chi^2(3) = 13.24$, $p < 0.05$). This finding is corroborated by the conditional likelihood ratio (CLR) test (statistic = 6.10, $p < 0.05$). The 95% robust confidence interval for weak instruments $[-0.413, -0.053]$ excludes zero, indicating that the negative policy effects persist even when accounting for potential instrument weakness. Collectively, these diagnostic results substantiate the causal inferences drawn from our Fuzzy Regression Discontinuity (FRD) design.

6. Robustness Testing

To validate the robustness of our main findings, we employed three complementary methodological approaches. First, we conducted a bandwidth sensitivity analysis to examine the stability of our estimates across different temporal windows. Second, we implemented a donut regression discontinuity test to address potential manipulation concerns near the cutoff point. Third, we performed placebo tests to rule out spurious relationships. This comprehensive testing strategy provides multiple layers of validation for our empirical results.

Our first robustness check examines the sensitivity of our estimates to bandwidth selection. While our baseline analysis employs a bandwidth of ± 10 years around the policy implementation threshold, we acknowledge that this choice warrants scrutiny. To systematically assess the robustness of our findings, we estimate our main specification across a comprehensive range of bandwidths, from ± 6 to ± 15 years. Figure 5 presents these results, plotting the estimated effect of having one child on parents' subjective well-being across different bandwidth choices. The results demonstrate remarkable stability: the 95% confidence intervals consistently exclude zero across all bandwidth specifications, with point estimates remaining particularly stable in the medium-bandwidth range (8–12 years). This stability is especially pronounced in our preferred specification region, suggesting that our findings are not artifacts of any particular bandwidth choice. The consistency of these results provides strong evidence that our core findings reflect genuine policy effects rather than methodological artifacts.

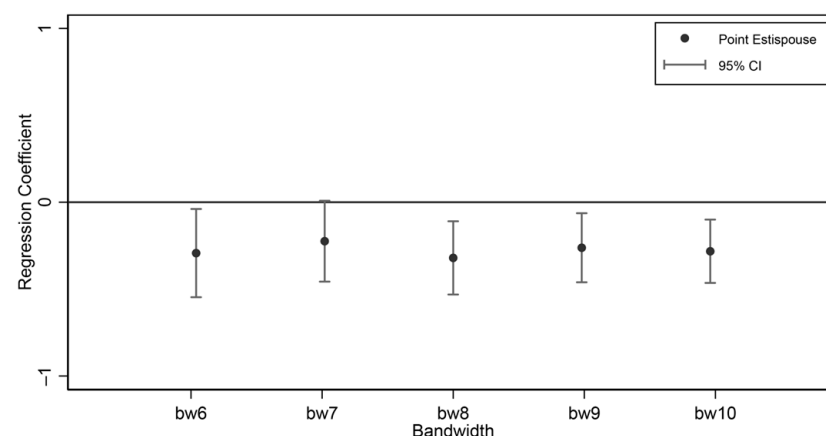


Figure 5. Robust test after changing bandwidth.

Our second robustness check implements a donut regression discontinuity design to address potential anticipatory effects and measurement concerns near the cutoff point [49]. Table 4 presents estimates from two specifications: one excluding observations within ± 1 year of the threshold (Column 1), and another excluding observations within ± 2 years (Column 2). The results reveal that the negative effect of having one child on parents' subjective well-being not only persists but strengthens in magnitude after excluding these observations, suggesting that our baseline estimates may be conservative, potentially underestimating the true policy impact. The robustness of our findings is further supported by the stability of coefficient estimates for control variables across these alternative specifications. Particularly noteworthy is the consistency in the effects of human capital and economic resources: both educational attainment and personal income maintain significant positive associations with subjective well-being across specifications, aligning with theoretical predictions about the role of socioeconomic resources in determining well-being outcomes.

Table 4. Donut Test: Remove Partial Year Results.

Variables	Subjective Well-Being	
	(1) 2SLS Coef.(S.E.)	(2) 2SLS Coef.(S.E.)
Estimation results in the second stage		
Parent with one child	−0.38 *** (−0.11)	−0.36 *** (−0.12)
Age	0.01 (0)	0.01 (0)
Female	0.06 * (−0.03)	0.06 * (−0.04)
Spouse	0.04 (−0.04)	0.01 (−0.04)
High school	0.16 *** (−0.04)	0.18 *** (−0.05)
Non-agricultural hukou	0.05 (−0.04)	0.01 (−0.04)
Personal annual income	0.04 *** (−0.01)	0.04 *** (−0.01)
Employment status	0.06 (0.04)	0.07 (0.04)
Number of dwellings owned	0.09 *** (−0.04)	0.07 * (−0.04)
Constant	3.45 *** (−0.33)	3.40 *** (−0.35)
Observations	3532	2995
R-squared	0.04	0.05
Relative_age	Yes	Yes
Relative_age × D	Yes	Yes
Province FE	Yes	Yes
Bandwidth	drop 1980 +/− 1 year	drop 1980 +/− 2 year

Note: S.E. represents heteroscedasticity-robust standard errors. *** $p < 0.01$, * $p < 0.1$ (two-tailed tests).

Our third robustness check employs a placebo test exploiting China's differential fertility policy implementation across ethnic groups. This test leverages the fact that ethnic minorities were largely exempt from the stringent fertility restrictions imposed by the one-child policy, providing a natural comparison group where we would not expect to observe policy effects. Table 5 presents these results, with Column 2 focusing exclusively on the ethnic minority subsample. As hypothesized, the estimated policy effect becomes statistically indistinguishable from zero in this group, contrasting sharply with the significant effects observed in our main analysis. This pattern aligns precisely with policy implementation realities: ethnic minorities, who faced substantially relaxed fertility constraints, show no evidence of the adverse well-being effects observed in the Han majority population. This placebo test thus provides compelling support for our identification strategy, suggesting that our main results capture genuine policy effects rather than spurious correlations.

Collectively, our battery of robustness checks provides strong support for the validity of our main findings. The estimated policy effects demonstrate remarkable stability across multiple dimensions: they remain consistent across a wide range of bandwidth specifications, maintain statistical and economic significance when implementing donut regression discontinuity designs, and disappear precisely where theory predicts they should—in the ethnic minority population not subject to stringent fertility constraints. The consistency of these results across different methodological approaches, combined with

the clear pattern in our placebo tests, provides compelling evidence that our regression discontinuity design successfully identifies the causal impact of the one-child policy on parents' subjective well-being.

Table 5. Placebo Test: Using Minority Population Sample.

	(1)	(2)
Variables	Subjective well-being	Subjective well-being
Parent with onechild	−0.240 *** (−0.09)	−0.583 (−0.45)
Constant	3.255 *** (−0.3)	2.221 ** (−1.1)
Observations	4577	284
R-squared	0.049	0.154
Control variables	Yes	Yes
Province FE	Yes	Yes
Relative_age	Yes	Yes
Relative_age × D	Yes	Yes
Bandwidth	+ / −10 years	+ / −10 years

Notes: Column (1) includes samples from ethnic minorities, and column (2) includes only samples from ethnic minorities. *** $p < 0.01$, ** $p < 0.05$ (two-tailed tests).

7. Heterogeneity Analysis

To investigate potential treatment effect heterogeneity, we conducted a comprehensive subgroup analysis examining how the impact of the one-child policy varies across key sociodemographic dimensions. Table 6 presents estimates from stratified regressions that reveal substantial variation in policy effects across three critical dimensions: urban-rural residence status, gender, and marital status. These heterogeneous effects not only deepen our theoretical understanding of how population policies differently affect various social groups but also carry important implications for the design of targeted social security interventions. The systematic pattern of effect heterogeneity we document suggests that uniform policy responses to China's aging challenges may be suboptimal.

Table 6. Heterogeneity Test.

	Subjective Well-Being					
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Urban hukou	Rural hukou	Male	Female	With spouse	Without spouse
Parent with one child	−0.04 (−0.11)	−0.52 *** (−0.17)	−0.32 *** (−0.12)	−0.12 (−0.14)	−0.20 * (−0.1)	−0.36 * (−0.22)
Constant	2.97 *** (−0.48)	3.24 *** (−0.42)	2.849 *** (−0.39)	3.929 *** (−0.51)	3.20 *** (−0.34)	3.80 *** (−0.65)
Observations	1899	2393	2455	1837	3582	710
R-squared	0.05	0.05	0.06	0.06	0.05	0.09
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-stat first stage	195.20	93.17	155.3	118.8	216.6	48.82
Sample size	1899	2393	2455	1837	3582	710

Notes: *** $p < 0.01$, * $p < 0.1$ (two-tailed tests).

Our first dimension of heterogeneity analysis focuses on the urban-rural divide. Columns (1) and (2) of Table 6 present stratified estimates for urban and rural subsamples, revealing stark differences in policy effects. While we find no statistically significant impact on subjective well-being among urban residents, rural residents exhibit large and significant negative effects. This heterogeneity reflects China's institutional duality in social security

provision and eldercare infrastructure. Urban areas benefit from relatively comprehensive social security systems, including established pension schemes and medical insurance coverage, which may buffer the impact of reduced family size on elderly well-being. In contrast, rural areas historically relied heavily on traditional family-based eldercare systems, which have been fundamentally disrupted by the one-child policy. The vulnerability of rural elderly is further compounded by structural constraints: rural areas face both lower population mobility and more limited eldercare resources compared to urban centers. Consequently, rural one-child families must navigate a double bind: they face not only the universal constraint of reduced family size but also significantly more limited access to institutional eldercare alternatives. This combination of reduced informal support capacity and inadequate formal support infrastructure may explain the more pronounced negative effects on subjective well-being observed in rural areas.

Our analysis of gender-based heterogeneity, presented in Columns (3) and (4) of Table 6, reveals a striking pattern: the negative effects of the one-child policy are substantially larger and statistically significant for elderly males, while effects for elderly females are smaller and statistically indistinguishable from zero. This gender differential appears to operate through multiple sociocultural and behavioral channels. First, the pronounced effect among males likely reflects traditional cultural norms in Chinese society, where males bear primary responsibility for continuing the family lineage, making fertility restrictions particularly psychologically burdensome for elderly men who could not fulfill these deeply internalized social expectations. Second, elderly men in Chinese society tend to rely more heavily on children for both emotional support and practical care, making them particularly vulnerable to reduced family size. In contrast, elderly women typically maintain more extensive and diverse social support networks beyond immediate family, potentially providing alternative sources of emotional and practical support that help buffer the impact of having fewer children. This gendered pattern of social capital accumulation may help explain why women appear more resilient to the well-being effects of reduced fertility.

Our final dimension of heterogeneity analysis examines differential effects by marital status, as shown in Columns (5) and (6) of Table 6. The results reveal that elderly individuals without spouses (whether widowed or divorced) experience substantially larger negative effects from the one-child policy compared to their married counterparts. This disparity is both statistically significant and economically meaningful, suggesting that marital status plays a crucial moderating role in how fertility restrictions affect later-life well-being. The robustness of this finding warrants note: despite the relatively modest sample size in the spouseless subsample ($n = 710$), the first-stage F-statistic of 48.82 substantially exceeds conventional thresholds for weak identification, providing confidence in our heterogeneous effects estimates.

These findings highlight the critical role of spousal support in moderating the impact of restricted fertility and carry important policy implications. Married elderly individuals appear better equipped to navigate the challenges of having only one child, as they can rely on their spouse for both practical assistance and emotional support. In contrast, elderly individuals without spouses face a double vulnerability: they must cope with both the absence of spousal support and limited child-based care resources. This vulnerability becomes particularly concerning in the context of China's demographic trajectory, where increasing life expectancy and rising risks of functional decline may exacerbate the challenges faced by single elderly parents with only one child, suggesting a pressing need for targeted social support interventions.

8. Conclusions

Viewing the one-child policy as a structural shock to a socio-technical system of elder-care, we document a persistent local system response that degrades node-level performance decades after the boundary event. Our analysis demonstrates that the policy's effects on subjective well-being are both substantial and heterogeneous across social groups, with particularly pronounced negative effects among rural residents, male elderly, and those without spouses. This pattern suggests that institutional context and family structure play crucial moderating roles in how fertility restrictions affect later-life outcomes. The robustness of these findings is supported by an extensive series of sensitivity analyses: our results remain stable across various bandwidth specifications, survive donut regression discontinuity tests that address potential manipulation concerns, and demonstrate specificity through placebo tests using ethnic minority populations not subject to strict fertility controls. This methodological rigor, combined with the clear pattern of heterogeneous effects, provides compelling evidence that fertility restrictions can have lasting impacts on well-being that persist well beyond their immediate implementation period.

This study advances our theoretical understanding of structural persistence and lock-in effects in demographic governance. While existing scholarship on structural persistence and lock-in has largely focused on institutional reinforcing feedback and lock-in dynamics, less attention has been paid to how population policies fundamentally restructure demographic patterns and family relationships with enduring consequences. Our findings demonstrate that major demographic interventions can generate impacts that transcend their immediate policy objectives, creating persistent effects on individual well-being through the transformation of family structures and intergenerational relationships. This persistence manifests through dual mechanisms: at the institutional level through structural inertia, and at the household level through adaptive behaviors. Specifically, when families face fertility constraints, they must reconstruct their resource allocation strategies, intergenerational support arrangements, and old-age security plans. These adaptive responses, once institutionalized within family systems, create path-dependent trajectories that prove resistant to subsequent policy adjustments.

A key theoretical contribution of this study is its demonstration of how structural persistence and lock-in is fundamentally embedded within institutional structures. The observed urban-rural heterogeneity in policy effects reveals not simply institutional moderation, but rather how policy impacts are systematically shaped through their interaction with existing institutional arrangements. In urban areas, the gradual development of formal social security mechanisms—particularly pension systems and medical insurance—has partially buffered the negative effects of reduced family size. In contrast, rural areas, lacking comparable institutional infrastructure, have experienced more severe disruption to traditional family-based eldercare systems without adequate compensatory mechanisms. This pattern of institutional embeddedness suggests that structural persistence and lock-in must be conceptualized as inherently contextual, with effects mediated through and constrained by broader institutional frameworks. Our findings thus move beyond conventional approaches that treat policy durability as a uniform phenomenon, highlighting instead the dynamic interplay between policy interventions and their institutional context.

Notably, the proportion of older people in China who never married or are childless remains considerably lower than in many developed countries, which has important implications for informal care availability [50]. This study advances intergenerational support theory by examining how exogenous policy interventions restructure familial support systems. Our analysis reveals that the one-child policy's impact varies systematically across social groups, with rural residents experiencing significantly larger negative effects compared to urban counterparts. This stark disparity directly informs policy priorities: rural

areas urgently need strengthened pension coverage, enhanced medical security systems, and expanded institutional eldercare services to compensate for disrupted family-based support networks [51,52].

The heterogeneous effects we document further suggest the need for targeted interventions based on demographic characteristics. The larger negative effects among spouseless elderly indicate particular vulnerability in this group. For these individuals, we recommend expanding community-based care services and social support networks to offset reduced family resources. To address these differentiated needs, we propose a three-tiered system integrating: (1) institutional protection mechanisms targeting rural-urban disparities through enhanced rural pension and healthcare coverage, (2) professional care services prioritizing high-vulnerability groups like spouseless elderly, and (3) community support networks strengthening local eldercare resources.

Our findings further suggest that effective policy responses must move beyond uniform approaches to address demographic heterogeneity in vulnerability [53]. This requires developing nuanced interventions that not only ensure basic service provision but also address the emotional and daily care needs of elderly populations. To achieve these objectives, we propose developing a three-tiered system of eldercare services integrating: (1) institutional social protection mechanisms, (2) professional care services, and (3) informal family support networks. The success of such a system depends critically on fostering positive synergies between formal institutional supports and traditional family care structures.

While this study employs rigorous empirical methods to examine the long-term effects of the one-child policy, several limitations warrant discussion. First, although the CLASS-2014 dataset provides comprehensive information about China's elderly population, its cross-sectional nature constrains our ability to track the dynamic evolution of policy effects. This limitation is particularly salient given China's rapid social transformation: the relationship between fertility restrictions and elderly well-being likely evolves as social security systems develop, a process that cannot be fully captured with single-period data. Second, our analysis leaves important questions about intergenerational transmission mechanisms unexplored. Specifically, we are unable to fully document how one-child families adapt to eldercare pressures through adjustments in educational investments, living arrangements, and other compensatory behaviors. These adaptive processes merit deeper investigation in future research. While the analysis relies on well-validated measures of subjective well-being, self-reported measures may be subject to reporting heterogeneity and contextual influences.

These limitations suggest several promising avenues for future research. Longitudinal studies could illuminate the dynamic nature of policy effects, particularly how the expansion of formal social security systems may moderate the adverse impacts of fertility restrictions over time. Household-level analyses using detailed microdata could reveal the specific mechanisms through which families adapt their intergenerational support strategies in response to fertility constraints. Of particular urgency is the need to understand how the first generation affected by the one-child policy navigates advanced age, as their experiences will likely reveal new dimensions of policy impact not visible in current data. Future work should trace system behavior over time to observe re-equilibration as formal substitutes expand, and use household-level network data to detail resource-flow channels and redundancy evolution.

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validation, writing—review and editing (contributed to literature review and methodology). All authors have read and agreed to the published version of the manuscript.

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Abbreviations

CLASS	China Longitudinal Aging Social Survey
FRD	Fuzzy Regression Discontinuity
OCP	One-Child Policy

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