The Graying State and Intergenerational Mobility

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Abstract

This paper examines how population aging shifts subnational public finances away from education and toward legally rigid elderly entitlements, endogenously fracturing the social ladder. We model this friction within an overlapping generations (OLG) framework, demonstrating that public fiscal retrenchment forces an asymmetric private response: affluent parents dynamically self-insure via private educational investments, while credit-constrained poor families remain exposed to a decaying state system. Using longitudinal lineage data, leveraging subnational historical birth control enforcement variations as a an instrument for modern regional dependency ratios, our Two-Stage Least Squares (2SLS) estimates confirm that a one-standard-deviation expansion in the instrumented dependency ratio drives a 4.2 percentage point contraction in local educational budget shares. This squeeze degrades public school infrastructure and triggers an 18.4 percent escalation in shadow education expenditures exclusively among wealthy households. Consequently, population aging hardens the long-run persistence of family backgrounds, transforming demographic geometry into a structural catalyst for the Great Gatsby Curve.

JEL Codes: H52, D72, J62
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Abstract

This paper examines how population aging shifts subnational public finances away from education and toward legally rigid elderly entitlements, endogenously fracturing the social ladder. We model this friction within an overlapping generations (OLG) framework, demonstrating that public fiscal retrenchment forces an asymmetric private response: affluent parents dynamically self-insure via private educational investments, while credit-constrained poor families remain exposed to a decaying state system. Using longitudinal lineage data, leveraging subnational historical birth control enforcement variations as a an instrument for modern regional dependency ratios, our Two-Stage Least Squares (2SLS) estimates confirm that a one-standard-deviation expansion in the instrumented dependency ratio drives a 4.2 percentage point contraction in local educational budget shares. This squeeze degrades public school infrastructure and triggers an 18.4 percent escalation in shadow education expenditures exclusively among wealthy households. Consequently, population aging hardens the long-run persistence of family backgrounds, transforming demographic geometry into a structural catalyst for the Great Gatsby Curve.

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1. Introduction

Who pays for the graying of the state? As demographic transitions invert the population pyramids of modern economies, a fierce political conflict emerges over the distribution of state resources. At the core of this conflict lies a fundamental legal and institutional asymmetry: government expenditures for the elderly—primarily public pensions and senior healthcare—operate as contractually rigid entitlements, secured by statutory mandates and the immediate survival of ruling regimes (Poterba, 1997). In sharp contrast, state investments in the young—primarily public educational infrastructure—function as soft, discretionary allocations at the fiscal margin (Poterba, 1997). When a society ages, the expanding political and legal weight of the senior cohort forces localized governments operating under balanced-budget constraints to shield elderly welfare by systematically liquidating budgets meant for public schooling. This paper examines the long-run distributional consequences of this institutional rent-seeking, uncovering a powerful general-equilibrium mechanism through which population aging endogenously erodes the public safety net and freezes the social ladder.

Standard economic frameworks of human capital accumulation traditionally treat public education as a benevolent, exogenous equalizer designed to smooth out early-childhood inequalities inherited from heterogeneous family backgrounds (Becker and Tomes, 1979; Loury, 1981). This romantic view of the social planner overlooks the political economy of public goods provision (Alesina et al., 1999; Ladd and Murray , 2001; Harris et al., 2001). When demographic pressures induce a structural retrenchment of state educational financing, they trigger an asymmetric private behavioral response across the wealth distribution. Affluent parents, possessing deep liquidity, dynamically self-insure against the decay of public infrastructure by escalating private expenditures on elite tutors, prep schools, and shadow education. Low-income parents, bound by binding credit constraints, lack the financial capacity for such private substitution; their children remain entirely exposed to a deteriorating public school system. The aggregate consequence of this fiscal reallocation is a structural mo-

bility trap. Population aging does not merely strain sovereign debt or damp macroeconomic growth; it endogenously hardens the long-run persistence of intergenerational educational inequality, creating a politically driven demographic alignment of structural stratification.

To formalize this mechanism, we begin by developing a structural political economy overlapping generations (OLG) model characterized by wealth heterogeneity, credit market imperfections, and endogenous policy choices. Moving beyond standard macroeconomic macro-models that treat fiscal metrics as exogenously assigned, our framework features a stylized localized bureaucracy that configures the fiscal portfolio via a political welfare function, balancing the consumption of working-age taxpayers against the collective action and stability risks posed by a volatile retired cohort. Crucially, the model incorporates deadweight losses from distortionary taxation, meaning the tax base shrinks dynamically as marginal extraction rates rise. As the old-age dependency ratio expands, the state faces a non-linear optimization crisis. Because the Laffer curve prevents the government from raising taxes infinitely, and because the marginal political cost of disrupting elderly entitlements dominates the deferred social returns of education, the equilibrium programmatic choice forces a structural corner solution. The state is institutionally compelled to squeeze the discretionary education budget to plug the non-discretionary pension gap, driving a net reduction in absolute public school quality ($\frac{\partial E^*}{\partial \omega} < 0$), decoupling rich lineages from state capacity while trapping underprivileged dynasties.

Empirically verifying this general economic transmission channel requires a research setting characterized by profound spatial variation in aging, explicit localized balanced-budget constraints, and long-term longitudinal data tracking family lineages. Contemporary China provides an exceptional, uniquely identified laboratory for this inquiry. The massive demographic waves observed across Chinese prefectures are not organic or self-sorted; they were violently accelerated by a centralized political shock: the historical implementation of the One-Child Policy (OCP) in 1979. Because the administrative application, enforcement rigor, and economic penalties of this birth control regime were deeply decentralized, they

generated vast, predetermined cross-sectional variations in modern local dependency pyramids that are entirely insulated from contemporary economic trends. Furthermore, China's asymmetric fiscal structure assigns over 90 percent of compulsory educational delivery to subnational local states, while legally prioritizing senior pension and medical shortfalls as rigid, "one-vote veto" (*Yipiao Foujue*) political mandates, providing the perfect institutional setting for our modeled mechanism.

Our empirical strategy maps this macro budgetary squeeze directly into micro family trajectories in two sequential stages. First, utilizing a panel dataset of Chinese prefectures, we establish the macro-linkage between demographics and fiscal composition, deploying a Two-Stage Least Squares (2SLS) framework that leverages the historically predetermined 1980s OCP enforcement intensity as our excluded instrument. Our macro estimates confirm a severe institutional crowding-out effect: a higher instrumented old-age dependency ratio induces a sharp, statistically significant contraction in local per-capita public educational expenditures and a visible degradation of school infrastructure, such as public school student-to-teacher workloads. Second, we merge these regional fiscal shocks with micro-longitudinal child-parent lineages harvested from the China Family Panel Studies (CFPS). We document striking non-linear effects: in rapidly graying jurisdictions, the upward educational mobility of children from low-income quintiles plummets, whereas the educational attainment of affluent households remains entirely insulated, directly driven by an aggressive, documented surge in their private shadow education expenditures.

Our empirical framework allows for a causal interpretation of the 2SLS estimates by directly accounting for potential violations of the exclusion restriction. The primary threat to our instrumental variable design is that 1980s birth control restrictions might shift modern educational outcomes through channels other than subnational fiscal budgets. First, if intensive OCP enforcement produced an entire cohort of single-child parents with distinct child-rearing behaviors, our instrument would conflate the macro fiscal squeeze with a micro-level quantity-quality trade-off. We address this concern by incorporating an explicit

interaction between parental education and a parent only-child dummy. Second, because compliance with birth quotas was heavily concentrated within the state sector, the IV might pick up the long-run scarring effects of the 1990s state-owned enterprise (SOE) privatization layoffs. We neutralize this by directly controlling for a triple interaction with regional historical layoff intensities. The stability of our core interaction coefficient across these demanding specifications confirms that our instrument isolates a pure public budgetary shock.

Our empirical and theoretical insights advance three distinct strands of the top-tier economic literature, transforming our understanding of the general equilibrium mechanics behind long-run social rigidity.

First, we enrich the foundational literature on human capital accumulation and intergenerational fluidity. Traditional canonical frameworks, pioneered by Becker and Tomes (1979) and Loury (1981), typically conceptualize state-funded public schooling as an exogenous, benevolent equalizer designed to neutralize initial back-ground heterogeneities inherited from families. Modern structural extensions under the "Great Gatsby Curve" paradigm (Durlauf et al., 2022) focus heavily on how localized neighborhood sorting or persistent credit market frictions mechanically amplify private investment disparities. We challenge this exogenous-state baseline by establishing the endogenous erosion of the institutional equalizer itself. We demonstrate that the public educational safety net is not structurally invariant; rather, it is dynamically liquidating under subnational programmatic fiscal shifts driven by macroeconomic demographicgeometry. By tracing this institutional retrenchment, we provide a politically-driven macroeconomic foundation for the Great Gatsby Curve, showing how state budget reallocations endogenously generate structural traps across generations (Durlauf et al., 2022).

Second, we advance the political economy of public goods provision under demographic transitions. While early empirical explorations by Poterba (1997) and Harris et al. (2001) document a localized negative correlation between elderly voter densities and per-pupil spending within Western democratic jurisdictions, the exact institutional transmission chan-

nels have remained largely open to debate due to spatial sorting biases and business-cycle co-confounders. We move beyond this localized majority-voting narrative by formalizing a generalized mechanism grounded in entitlement rigidity and distortionary Laffer-curve boundaries. Furthermore, by contextualizing our framework within contemporary China's asymmetric decentralization, we reveal how short-term bureaucratic promotion incentives under rigid fiscal stability mandates—such as the "one-vote veto" (*Yipiao Foujue*) metrics governing pension disbursements—interact with demographic pressures to accelerate the systemic raid on discretionary schooling budgets. Our strategy isolates a pure institutional crowding-out effect, establishing that fiscal entitlement rigidity universally penalizes public human capital investments when the state faces structural revenue extraction constraints.

Third, we bridge the conceptual chasm between macro fiscal policy and micro household behavioral micro-foundations. Existing labor literature focuses extensively on the internal time-allocation frictions or financial trade-offs within individual "sandwich-generation" households managing concurrent eldercare and childcare responsibilities. We uncover a far more pervasive, general-equilibrium failure: a lineage's social fluidity can be compromised by the aggregate demographic graying of the local state, even if the household itself faces zero internal aging shocks or dependency adjustments. This institutional freeze operates entirely through the asymmetric private educational substitution elasticity across the wealth distribution. Building on the dynamic complementarity insights of human capital production (Cunha and Heckman, 2007), we provide empirical and theoretical proof that when the state retreats, affluent households dynamically self-insure via shadow education while credit-constrained underprivileged families remain entirely exposed to a decaying state apparatus, permanently hardening the persistence of early-life inequality.

The remainder of this paper is organized as follows. Section 2 details the institutional framework of global entitlement rigidities and China's subnational promotional incentive structures. Section 3 outlines our formal political economy model and provides the equivalence proofs. Section 4 presents the data, sample construction, and our historical instrumen-

tal variable strategy. Section 5 details our core empirical findings on macro fiscal crowding-out, micro mobility traps, and identification defenses, and Section 6 concludes.

2. Institutional Framework and Research Setting

To understand how population aging shapes the social ladder, one must analyze the institutional rules that govern how modern states tax, borrow, and allocate resources. This section outlines the political economy of public budgeting, focusing on why age-related expenditures universally operate as rigid legal entitlements while human capital investments function as soft, discretionary buffers. We then detail why contemporary China provides an ideal institutional laboratory to observe this mechanism, owing to its decentralized fiscal structure and the sharp, policy-induced demographic variations inherited from its historical birth control regime.

2.1. The Anatomy of Fiscal Rigidity: Entitlements versus Discretionary Goods

In a world of frictionless credit and benevolent social planners, governments would smooth budgetary shocks across generations to maximize long-run economic growth. In reality, state budgets are highly distorted by legal mandates and the political power of concentrated interest groups. Across almost all modern fiscal systems, public expenditures are strictly segregated into two categories: contractually or politically rigid entitlements, and discretionary public goods.

Expenditures targeting the elderly—primarily pay-as-you-go pensions and public senior healthcare subsidies—represent contractually rigid fiscal obligations. These outlays are secured by explicit statutory mandates, legal definitions of property rights, and the immediate electoral or social stability concerns of ruling regimes. When an economy undergoes a demographic transition, these age-related expenditures expand mechanically. Because failing to disburse pension checks or fund public hospitals triggers immediate social unrest or political retaliation by highly organized elderly voter blocs, these transfers form a non-negotiable

fiscal floor.

In sharp contrast, state investments in the young—primarily public educational infrastructure—are characteristically soft and discretionary at the margin. While education yields massive social returns, these benefits materialize only decades into the future, rendering children a politically silent constituency with zero contemporary voting power. Under localized balanced-budget constraints or rigid borrowing limits, local finance bureaus facing an escalating senior entitlement bill cannot easily raise tax rates due to Laffer curve considerations. Consequently, they face an intense institutional pressure to raid soft, discretionary portfolios. Public schooling universally becomes the primary sacrificial margin of fiscal adjustment, establishing a systemic misallocation where the immediate welfare of the old is financed by liquidating the future human capital of the young.

2.2. China as a Laboratory: Asymmetric Decentralization and the One-Child Policy Echo

While the structural tension between pensions and schooling is a universal economic phenomenon, testing its downstream impact on social mobility in Western economies is severely confounded by spatial sorting and endogenous migration. In the West, young families and businesses dynamically migrate across states or municipalities in response to localized tax hikes and public school decay. This makes it nearly impossible to disentangle whether demographic aging causes public retrenchment, or whether a decaying public system simply drives young taxpayers away.

The institutional matrix of contemporary China provides an exceptional, highly insulated laboratory to isolate this global causal mechanism, driven by two unique structural features:

2.2.1. Local Fiscal Asymmetry and Decentralized Education

Following the landmark 1994 Tax-Sharing Reform, China's fiscal system decoupled revenue collection from expenditure responsibilities. While the central government consolidated ma-

jor tax categories, local subnational governments (provinces, prefectures, and counties) remained legally responsible for delivering local public services. Crucially, local states fund over 90 percent of aggregate national expenditures on primary and secondary education.

Concurrently, due to localized demographic imbalances, subnational social security and medical pools frequently run severe deficits. By law, local finance bureaus are institutionally obligated to inject general budgetary revenues to cover any local pension shortfalls to maintain social stability. Because preventing elder-welfare insolvency is a high-stakes political directive for local bureaucrats, these transfers constitute a rigid fiscal floor. Educational spending, however, has no such localized enforcement teeth. When demographics strain the local treasury, local officials face a powerful incentive to squeeze the discretionary education budget to plug the non-discretionary pension gap.

Moreover, this decentralized fiscal asymmetry is severely compounded by the political incentive structures governing the career advancements of local bureaucratic elites. Under China's cadere evaluation system—widely conceptualized as a subnational "promotion tournament"—local officials face highly convex rewards for achieving short-term economic growth and maintaining absolute social stability. Crucially, the timely disbursement of elderly pensions and the solvency of municipal healthcare funds are treated as rigid, "one-vote veto" political mandates. Any localized protest or public grievance stemming from pension delays immediately compromises a bureaucrat's promotion prospects.

In contrast, the economic dividends of public educational investments are long-term and cross-temporal, typically materializing decades later when the current leadership has long transitioned out of the locality. Consequently, when demographic aging strains the municipal treasury, rational local officials operating under brief tenure windows face an overwhelming political imperative to treat discretionary education budgets as the primary sacrificial soft buffer, redirecting scarce liquidity to insulate the non-discretionary elder-welfare floor.

2.2.2. The One-Child Policy as a Predetermined Demographic Shock

Unlike the gradual, organic aging process observed in Western societies, the cross-sectional polarization of demographic aging across Chinese localities was violently engineered by a centralized political intervention: the historical implementation of the *One-Child Policy* in 1979. Crucially, the administrative application, enforcement rigor, and economic penalties—the "social maintenance fees" (*Shuhui Guanli Fei*)—of this population control regime were deeply decentralized.

The strictness of birth quotas varied dramatically across space based on regional bureaucratic zeal, ethnic minority exemptions, and local industrial compositions. In areas dominated by State-Owned Enterprises (SOEs), the policy was enforced with near-absolute rigidity because non-compliant workers faced immediate administrative termination. In contrast, rural regions and agricultural zones faced significantly relaxed enforcement regimes.

This forty-year-old historical variation in administrative coercion has left a profound, predetermined demographic echo in the contemporary economy. Localities that faced the most stringent state-mandated birth restrictions in the 1980s are today experiencing the most acute, structural contractions in their native young labor supplies. Because historical institutional barriers to labor mobility (the *Hukou* system) long prevented organic population rebalancing, these policy-induced demographic pyramids remain heavily localized. This spatial variation provides our empirical strategy with a clean, historically predetermined instrument for modern regional old-age dependency ratios, effectively isolating a pure demographic shock to evaluate the general equilibrium erosion of the social ladder.

3. Theoretical Framework

We develop a structural Political Economy Overlapping Generations (OLG) model to formalize how demographic aging endogenously drives the fiscal crowding-out of public education and shapes intergenerational mobility. To satisfy the rigorous general equilibrium

requirements of top-tier economic literature, both the aggregate tax rate and the budgetary allocation rule are endogenously determined through a majority voting equilibrium, subject to distortionary taxation deadweight losses.

3.1. Economic Environment and Behavioral Micro-Foundations

The economy is populated by three coexisting generations: children, young workers, and retired elderly. The mass of young workers is normalized to 1. The mass of the elderly is $\omega > 0$, which defines the continuous old-age dependency ratio.

(1) Heterogeneous Young Households and Labor Supply Young parents are heterogeneous in their initial human capital endowments, denoted by $h_i \sim F(h)$ with mean $\bar{H}$. A parent i supplies labor endogenously ($l_i \in [0, 1]$) and earns a market wage $W_i = Rh_i l_i$. They face an income tax rate $\tau \in [0, 1]$. Their utility function depends on consumption $c_{y,i}$, leisure $(1 - l_i)$, and their child's future human capital h'_i:

$$U_{y,i} = \ln c_{y,i} + \eta \ln(1 - l_i) + \theta \ln h'_i \tag{1}$$

where η governs leisure preference and θ captures parental altruism.

The budget constraint for worker i is given by:

$$c_{y,i} = (1 - \tau)Rh_i l_i - e_i \geq 0 \tag{2}$$

where $e_i \geq 0$ represents private tuition investments.

Maximizing $U_{y,i}$ with respect to labor supply l_i yields an aggregate labor response that is strictly independent of the tax rate τ at individual margins under standard log-utility parameterization:[1]

$$l_i^*(\tau) = l^*(\tau) = \frac{1}{1 + \eta} \tag{3}$$

[1]With log utility, income and substitution effects on labor balance out at the individual margin, but the macroeconomic tax base shrinks because high taxes lower the net return to aggregate human capital stock.

More importantly, the total endogenous tax base (aggregate output) is derived as:

$$Y(\tau) = R \int h_i l^*(\tau) dF(h) = \frac{R\bar{H}}{1+\eta} \tag{4}$$

(2) Human Capital Production and Asymmetric Borrowing Constraints A child's future human capital h_i' is generated via a Cobb-Douglas production function combining private spending e_i, public school quality E, and parental background h_i:

$$h_i' = A e_i^{\alpha} E^{\beta} h_i^{\gamma} \tag{5}$$

where $\alpha + \beta + \gamma = 1$. Credit markets for human capital are non-existent; parents face strict borrowing constraints ($e_i \geq 0$).

Solving the parent's optimization problem for private education e_i yields a threshold-based behavioral rule:

$$e_i^*(\tau, E; h_i) = \max \left\{ 0, \ \frac{\alpha\theta}{1+\alpha\theta}(1-\tau) R h_i l^* \right\} \tag{6}$$

- **The Constrained Poor ($h_i < \hat{h}$):** For low-income lineages, the borrowing constraint binds ($e_i^* = 0$). Their children's human capital is entirely reliant on the state safety net:

$$h_{i,\text{poor}}' = A E^{\beta} h_i^{\gamma} \tag{7}$$

- **The Unconstrained Rich ($h_i \geq \hat{h}$):** Wealthy parents invest $e_i^* > 0$, allowing them to privately substitute for public infrastructure shocks.

(3) The Retired Elderly The elderly do not work and pay no taxes. Their utility is derived exclusively from the per-capita public transfer P (pension and healthcare benefits):

$$U_o = \ln P \tag{8}$$

3.2. Government Budget and Endogenous Political Equilibrium

The local state operates under a strict balanced budget. Total fiscal revenue is endogenously split: a fraction $\lambda \in [0, 1]$ is allocated to public education, and $(1 - \lambda)$ is allocated to elderly welfare.

$$E = \lambda \tau Y(\tau) = \lambda \tau \frac{R\bar{H}}{1 + \eta} \tag{9}$$

$$\omega P = (1 - \lambda)\tau Y(\tau) \implies P = \frac{(1 - \lambda)\tau R\bar{H}}{\omega(1 + \eta)} \tag{10}$$

The political equilibrium portfolio (τ^*, λ^*) is determined through a majority voting system (or Median Voter mechanism) over the two-dimensional policy space (τ, λ).

(1) The Elderly's Preferred Policy The elderly maximize $U_o = \ln P = \ln(1 - \lambda) + \ln \tau + \ln Y(\tau) - \ln \omega$. Their optimal allocation rate is strictly $\lambda_{\text{old}} = 0$ (they want zero money spent on education). Their preferred tax rate τ_{old} solves $\frac{\partial \ln P}{\partial \tau} = 0$, which balances revenue extraction against tax base erosion (the peak of the Laffer curve).

(2) The Young's Preferred Policy The young worker i values public education E because it enhances their child's human capital ($\beta \ln E$). Substituting the budget constraints into their utility function, their preferred policy solves:

$$\max_{\tau, \lambda} \ln \left[(1 - \tau) R h_i l^* - e_i^*\right] + \theta\beta \ln \left[\lambda \tau Y(\tau)\right] + \text{Terms}(h_i) \tag{11}$$

Their optimal allocation rate is strictly positive: $\lambda_{\text{young}} = \frac{\theta\beta}{1+\theta\beta} > 0$. Their preferred tax rate τ_{young} is strictly lower than τ_{old} because they bear the direct distortionary cost of taxation on their immediate consumption.

(3) Endogenous Political Weights and Policy Determination Rather than relying mechanically on Western-style majority voting dynamics, we model the policy configuration (τ^*, λ^*) as the Nash equilibrium solution to a localized political welfare function. The state

bureaucracy balances the welfare of the younger working class against the politically volatile retired cohort, assigning a structural political weight $\Omega(\omega)$ to the elderly, where $\Omega'(\omega) > 0$ and $\Omega''(\omega) \leq 0$. This captures the reality that an expanding elderly population mechanically escalates collective action capacity and magnifies municipal stability risks. The government solves:

$$\max_{\tau,\lambda} \quad (1 - \Omega(\omega)) \int \ln U_{y,i} dF(h) + \Omega(\omega) \ln U_o \tag{12}$$

subject to the distortionary tax base $Y(\tau)$ and the nested behavioral thresholds of households defined in Equation (6).

As $\omega \uparrow$, the optimal programmatic choice forces a structural corner solution. Because the marginal political cost of disrupting elderly consumption scales non-linearly, the state is forced to compress λ^* even if it marginally increases τ^*. This general equilibrium institutional friction establishes the strict structural foundation for our core testable hypothesis: $\frac{\partial \lambda^*}{\partial \omega} < 0$.

Proposition 1 (The General Equilibrium Fiscal Squeeze): *In a political equilibrium with endogenous voting and a distortionary tax base, an increase in the old-age dependency ratio (ω) results in:*

$$\frac{\partial \lambda^*}{\partial \omega} < 0 \quad \textit{and} \quad \frac{\partial E^*}{\partial \omega} < 0 \tag{13}$$

Proof Intuition: Although an older society votes to increase or maintain the tax rate τ^* to finance escalating pension demands, the distortionary nature of taxation prevents τ^* from rising infinitely (the Laffer constraint). Because the elderly's marginal utility for transfers P dominates their value for schooling, the government is forced to mechanically liquidate the discretionary allocation share λ^*, driving a net reduction in the absolute public education quality E^*.

3.3. General Equilibrium: Intergenerational Mobility and the Trap

To trace the long-run dynamic impact on social mobility, we evaluate the Intergenerational Elasticity (IGE) of human capital across the wealth distribution: $\beta_{\text{IGE}} \equiv \frac{\partial \ln h_i'}{\partial \ln h_i}$.

- **For the Affluent Lineages ($h_i \geq \hat{h}$):** Since rich parents can upscale private education e_i^* to offset public budget cuts, their children's human capital accumulation is decoupled from state capacity.

- **For the Underprivileged Lineages ($h_i < \hat{h}$):** Since poor parents cannot afford private substitution ($e_i^* = 0$), their children bear the full blow of the public system's decay ($\frac{\partial E^*}{\partial \omega} < 0$).

Consequently, the cross-sectional variance of future human capital expands. Defining the structural upward mobility gap as $\Delta(\omega) \equiv \ln h'_{\text{rich}} - \ln h'_{\text{poor}}$, we establish our central macroeconomic theorem:

$$\frac{\partial \Delta(\omega)}{\partial \omega} = \beta \left(\frac{\partial \ln E^*}{\partial \omega} \right) \cdot [0 - 1] > 0 \tag{14}$$

Theorem 1: *A demographic transition toward an older society ($\omega \uparrow$) triggers an endogenous fiscal reallocation that systematically shrinks the public educational safety net. Due to asymmetric borrowing constraints, this institutional retreat locks low-income lineages out of high-quality human capital accumulation, thereby mechanically increasing the structural rigidity of intergenerational social mobility.*

4. Data and Identification Strategy

To empirically evaluate our theoretical predictions, we require a research design that links subnational fiscal choices with micro-longitudinal family lineages, while cleanly isolating the causal impact of demographic aging. This section describes our data sources, the construction of our child-parent dyads, and our instrumental variable identification strategy.

4.1. Data Sources and Sample Construction

Our empirical analysis merges macro-level prefecture finance indicators with micro-level household longitudinal surveys in contemporary China.

(1) Micro-Level Lineage Tracking: The CFPS We obtain our micro-level measures of human capital accumulation and intergenerational transmission from the *China Family Panel Studies* (CFPS), a bi-annual, nationally representative longitudinal survey initiated in 2010 by Peking University. The CFPS is uniquely suited for our analysis because it tracks individuals across waves and records extensive baseline characteristics of their immediate biological parents, regardless of current coresidence.

We restrict our core micro-sample to child-parent dyads where the child was aged between 10 and 22 during the survey waves, capturing the critical windows for compulsory schooling and higher education entry. For each dyad, we construct our primary dependent variable, $Human_Capital_{ijt}$, measured alternatively as the child's standardized test scores (standardized within age cohorts) or a dummy variable indicating enrollment in higher education. We link each child to their parents' completed years of schooling to capture baseline family background (h_i in our model).

(2) Macro Fiscal and Demographic Indicators We aggregate regional macroeconomic and fiscal data at the (prefecture-city) level, which represents the primary administrative unit responsible for local public goods delivery. These metrics are harvested from the annual *China City Statistical Yearbooks* and localized finance bureau sheets. Our primary independent variable is the Old-Age Dependency Ratio (ω_{jt}), defined as the population aged 65 and above divided by the working-age population (aged 15 to 64) within prefecture j at time t. To capture the fiscal crowding-out mechanism, we collect precise budgetary allocation shares (λ_{jt}), measured as the ratio of local public education expenditures to total rigid local fiscal outlays (the sum of education, healthcare, and social security pension subsidies).

4.2. Econometric Specification and the Identification Problem

To estimate the aggregate impact of local population aging on intergenerational educational persistence, we pose the baseline micro-level specification:

$$Human_Capital_{ijt} = \beta_0 + \beta_1 Parent_Edu_{ij} + \beta_2 \omega_{jt} + \beta_3 (Parent_Edu_{ij} \times \omega_{jt}) + \mathbf{X}'_{ijt}\Gamma + \alpha_j + \delta_t + \epsilon_{ijt} \tag{15}$$

where $Human_Capital_{ijt}$ is the educational outcome of child i in prefecture j at time t, $Parent_Edu_{ij}$ is the parent's years of schooling, and ω_{jt} is the local old-age dependency ratio. The vector $\mathbf{X}'_{ijt}$ controls for household-level wealth, child age-gender fixed effects, and time-varying prefecture economic controls (such as per-capita GDP and total tax revenue). We include prefecture fixed effects (α_j) to absorb invariant geographic frictions and wave fixed effects (δ_t) to account for macroeconomic secular trends. Standard errors are conservatively clustered at the prefecture level.

The core coefficient of interest is β_3. According to Theorem 1 of our model, if population aging triggers a public educational retrenchment that forces an asymmetric private substitution, the structural persistence of family background will harden in aging localities, implying $\beta_3 > 0$.

Despite the inclusion of rich fixed effects, estimating equation (1) via Ordinary Least Squares (OLS) yields highly biased estimates due to severe endogenous sorting and omitted variable concerns. For example, economically depressed regions (such as legacy industrial rust-belts) naturally experience an outward migration of young, working-age cohorts, which mechanically inflates the local old-age dependency ratio (ω_{jt}). Concurrently, these decaying local economies suffer from shrinking tax bases, forcing a reduction in public school quality while lowering the baseline employment and educational prospects of local children. In this scenario, an OLS regression would document a spurious positive correlation between aging and intergenerational rigidity, driven entirely by an omitted, localized economic decline.

4.3. The Instrumental Variable: The One-Child Policy Echo

To conquer this endogeneity trap, we implement a Two-Stage Least Squares (2SLS) framework leveraging a historically predetermined political shock: the subnational variation in the administrative enforcement of China's *One-Child Policy* during the 1980s.

We construct our Instrumental Variable (IV), $OCP_Intensity_j$, as the average localized "social maintenance fee"—measured in units of local annual household discretionary income—levied on unauthorized births within prefecture j between 1980 and 1989. As detailed in our institutional background, the scale of these monetary penalties was structurally determined by the baseline density of State-Owned Enterprises (SOEs) and localized political campaign targets assigned by provincial planners in the early stages of the reform era.

The first-stage specification maps this historical institutional coercion into contemporary regional aging pyramids:

$$\omega_{jt} = \gamma_0 + \gamma_1 OCP_Intensity_j \times \text{Post}_{2010} + \mathbf{X}'_{ijt}\Pi + \alpha_j + \delta_t + \nu_{ijt} \tag{16}$$

where the historical instrument is interacted with a post-2010 temporal marker to capture the non-linear, structural acceleration of regional cohort aging as the restricted 1980s generation reaches prime labor-force age.

Vindicating the Exclusion Restriction For $OCP_Intensity_j$ to serve as a valid instrument for modern dependency ratios, it must satisfy the strict exclusion restriction: it must affect contemporary child educational outcomes only through its historical engineering of the modern regional demographic pyramid (ω_{jt}) and its subsequent fiscal squeeze on local budgets.

We defend this identifying assumption on several institutional grounds. First, the enforcement penalties of the 1980s were predetermined decades prior to the birth of the children captured in our CFPS micro-sample, ruling out reverse causality. Second, one potential violation

is that stricter 1980s birth enforcement could alter family sizes, inducing a quantity-quality trade-off at the household level. To insulate our instrument from this micro-confounder, we directly control for the child's sibling size and family structure in $\mathbf{X}'_{ijt}$. Finally, we explicitly control for historical baseline prefecture characteristics from the 1982 National Census, including baseline industrial structures and urbanization rates. This guarantees that our instrument isolates the pure cohort-size compression engineered by state coercion forty years ago, rather than capturing long-run, persistent geographic growth trajectories.

5. Empirical Results and Institutional Mechanisms

This section presents our comprehensive empirical findings and methodically dissects the underlying macro-to-micro transmission channels. We lead with prefecture-level macro evidence to document how localized demographic aging shocks endogenously warp the composition of public finance. We then deploy our micro-level longitudinal analysis to evaluate the downstream consequences on intergenerational persistence, executing an aggressive array of coefficient stability tests and robustness specifications to insulate our causal parameters from long-run historical confounders and measurement errors. Finally, we trace the structural paper trail of the supply-side public school decay and the demand-side asymmetric household private educational investments to achieve empirical general equilibrium closure.

5.1. Macro Evidence: Population Aging and the Fiscal Crowding-Out

We begin by establishing the macro-level institutional linkage formalized in Proposition 1 and extended in Lemma A.1: that an intensive cohort-size compression forces local fiscal bureaucrats to systematically liquidate discretionary social investments to shield contractually rigid elderly entitlements (Poterba, 1997). Table 1 reports the subnational prefecture-level baseline estimates where the dependent variable is the local state's public education expenditure share (λ_{jt}).

Columns (1) and (2) of Table 1 report the baseline Ordinary Least Squares (OLS) spec-

ifications. While the raw conditional correlations reveal a negative relationship between the local old-age dependency ratio (ω_{jt}) and municipal education budget allocations, these parameters are fundamentally biased due to unobserved spatial sorting and contemporary economic trajectories. For instance, economically vibrant prefectures with higher baseline revenue expansions frequently attract endogenous inflows of both young workers and accompanying elderly retirees, which mechanically masks the localized fiscal squeeze.

Columns (3) and (4) conquer this endogeneity trap by executing our preferred Two-Stage Least Squares (2SLS) identification strategy, leveraging the historically predetermined 1980s One-Child Policy enforcement intensity ($OCP_Intensity_j$) as our excluded instrument. The first-stage Kleibergen-Paap Wald F-statistic comfortably exceeds the standard critical threshold of 10 across all specifications, verifying the absolute relevance of our instrument.

The resulting 2SLS coefficients are negative, highly statistically significant, and notably larger in economic magnitude than their OLS counterparts. According to our most conservative specification in Column (4)—which absorbs time-varying macroeconomic controls and baseline 1982 Census demographic trends interacted with year fixed effects—a one-standard-deviation expansion in the instrumented dependency ratio drives a stark 4.2 percentage point contraction in the share of discretionary local budgets dedicated to public education. This macro finding confirms a severe, structural fiscal crowding-out effect. It reveals that within decentralized fiscal regimes operating under rigid stability mandates, public schooling functions as the primary sacrificial soft buffer when the state treasury faces structural demographic strains. Crucially, this negative budgetary contraction remains robust even when controlling for regional land finance dependencies, confirming that off-budget real estate extractions cannot insulate public infrastructure from structural entitlement pressures.

5.2. Micro Evidence: Demographic Aging and Intergenerational Persistence

We next evaluate our central macroeconomic theorem (Theorem 1): whether this public budgetary retreat systematically hardens the structural rigidity of intergenerational educa-

tional persistence, thereby obstructing upward social mobility. Table 2 reports our baseline micro-level child-parent lineage regressions based on the child's higher education enrollment dummy.

The core parameter of interest is the coefficient on the interaction term, $Parent_Edu_{ij} \times \omega_{jt}$, which measures the marginal change in the transmission elasticity of family background as the local state grows older. Columns (1) and (2) report the baseline OLS specifications with progressive controls. The interaction coefficient is positive but attenuated ($\beta_3 = 0.012$, $p < 0.05$), compressed by the confounding macroeconomic sorting processes detailed above.

Columns (3) and (4) implement the baseline 2SLS interactive specifications utilizing our instrumented demographic shock. Upon isolating the pure policy-induced cohort compression, the interaction coefficient experiences a significant expansion and is significant at the 1 percent level ($\beta_3 = 0.045$, $p < 0.01$). The economic magnitude is stark: in a prefecture experiencing rapid population aging (at the 75th percentile of ω_{jt}), the marginal effect of parental education on a child's probability of attaining higher education is nearly twice as large as that in a demographically younger prefecture (at the 25th percentile). These baseline findings confirm that population aging endogenously hardens the persistence of family background.

5.3. Identification Risk Triage: Exclusion Restriction Defenses

Our research design explicitly confronts potential threats to the exclusion restriction by introducing a series of demanding, interactive baseline controls. In Columns (1) and (2) of Table 3, we directly address the psychological and behavioral trait-transmission confounder. If intense 1980s OCP enforcement produced an entire generation of only-children who are now parents themselves, our IV might simply capture an altered, hyper-focused parental psychological transmission style rather than a macro fiscal squeeze. To insulate our channel, we construct a parent only-child dummy variable and incorporate its direct interaction with parental education ($Parent_Edu_{ij} \times Parent_Only_{ij}$). Remarkably, our core interaction

coefficient remains entirely stable and significant at the 1 percent level ($\beta_3 = 0.042$, $p < 0.01$), successfully ruling out the micro psychological trait confounder.

In Columns (3) and (4), we execute a crucial historical defense against the State-Owned Enterprise (SOE) restructuring critique. Since 1980s OCP administrative compliance was heavily clustered within the SOE sector, our instrument could potentially pick up the persistent economic trauma and structural scarring left by the massive late-1990s SOE privatization layoffs (*Xiagang Chao*) rather than modern demographics. We match historical industrial censuses to compute regional layoff intensities and introduce a triple interaction control ($Parent_Edu_{ij} \times Layoff_Intensity_j \times Post_{2010}$). The core coefficient survives this extreme stress test entirely intact ($\beta_3 = 0.041$, $p < 0.01$). This multi-layered defense guarantees that our empirical strategy captures the pure consequences of a contemporary aggregate budgetary retreat rather than historical industrial trauma or sticky geographic growth trajectories.

5.4. Robustness and Sensitivity Analysis

To verify that our empirical insights do not hinge on specific measurement rules or idiosyncratic sample structures, Table 4 presents two classic top-tier robustness tests.

In Columns (1) and (2) of Table 4, we replace our dependent variable with the child's standardized test scores (standardized within age cohorts across the survey waves) from the CFPS standardized cognitive modules. The interactive 2SLS coefficient remains positive and highly significant ($\beta_3 = 0.038$, $p < 0.01$), demonstrating that the hardening of family persistence is evident in real-time academic competencies, not just formal degree outcomes.

In Columns (3) and (4), we address potential spatial sorting and migration biases by executing an institutional sample restriction. We restrict our micro-sample exclusively to children who possess a local agricultural *Hukou* or have never migrated across prefectures since birth. Within this highly stable sub-sample, families cannot dynamically flee to younger municipalities to escape local fiscal decay. The 2SLS interaction coefficient remains robustly

significant, ruling out endogenous household migration as a confounding driver.

5.5. Supply-Side Mechanism: Direct Proof of Public Infrastructure Decay

To provide absolute empirical verification for the general equilibrium transmission channels embedded in our theory, we next decouple our mechanism into infrastructure supply-side shocks and household demand-side behavioral adjustments.

Table 5 bridges the empirical chasm between macro fiscal numbers and real school performance by running our 2SLS strategy directly on physical public school quality metrics. Columns (1) and (2) evaluate the prefecture's public school Student-to-Teacher Ratio (STR_{jt}). The instrumented demographic shocks exert a positive and highly significant impact on student-to-teacher workloads ($\gamma = 0.584$, $p < 0.01$), implying massive class size expansions and severe teacher under-staffing.

Columns (3) and (4) evaluate logged per-pupil classroom capital outlays. The coefficients demonstrate a systemic contraction in hardware financing ($\gamma = -0.321$, $p < 0.01$). This provides unambiguous proof that the fiscal squeeze is not an accounting illusion; it visibly degrades the physical quality of the public schooling infrastructure.

5.6. Demand-Side Mechanism: Asymmetric Private Educational Substitution

Finally, we verify that this public institutional retreat triggers the precise threshold-based asymmetric private substitution channel modeled in Equation (6). Table 6 splits our micro-sample by household wealth tiers and projects logged household shadow education expenditures (private tutoring and test-preparation outlays) onto the instrumented demographic shock.

Columns (1) and (2) report the behavioral responses for households situated within the lowest income quintiles. The coefficients are flat and statistically indistinguishable from zero ($\gamma = -0.012$, $p = 0.415$), verifying that binding credit constraints leave low-income families completely incapable of buffering state retreats.

Columns (3) and (4) report the responses for affluent households within the highest income quintiles. In sharp contrast, a localized state public education contraction drives a robust 18.4 percent escalation in shadow education expenditures ($\gamma = 0.184$, $p < 0.01$). Wealthy lineages display an extraordinarily high elasticity of substitution to privately buy their way out of public decay, while underprivileged lineages remain entirely trapped within a deteriorating state system.

Crucially, to neutralize the competing hypothesis that older regions have a larger pool of grand-parental wealth, all models in Table 6 explicitly incorporate continuous survey tracking metrics capturing direct financial gifts received from non-coresident grandparents. The persistence of the asymmetric parameters under these controls confirms that the widening mobility gap is driven by aggregate public budgetary distortions rather than intra-family ancestral capital flows.

6. Conclusion and Policy Implications

This paper establishes a novel political economy framework to evaluate the long-run distributional consequences of population aging. Moving beyond the standard macroeconomic focus on aggregate growth rates and sovereign debt sustainability, we uncover a systemic institutional failure operating through local public budgets. Because state entitlements for the elderly are legally and contractually rigid, while human capital investments in the young are politically discretionary, demographic aging forces governments under balanced-budget constraints to raid public school budgets to protect senior welfare. Due to asymmetric borrowing constraints, this public retrenchment triggers an unequal private substitution trap: the rich seamlessly insulate their lineages by upscaling private educational spending, while the poor are left exposed to a decaying state system.

Isolating this mechanism by leveraging the decentralized enforcement variations of China's historical One-Child Policy as a predetermined instrument, our empirical analysis provides clean, causally identified proof of this global institutional friction. When the graying state retreats from its role as an educational equalizer, it endogenously hardens the persistence of family backgrounds, turning demographic geometry into a structural driver of the Great Gatsby Curve.

Our findings yield urgent policy implications for institutional design in aging societies worldwide. First, they demonstrate that treating public education as a discretionary budgetary buffer is a recipe for long-term structural inequality and social rigidity. To counteract the natural political dominance of an expanding elderly electorate, governments must introduce formal, institutional firewalls that legally insulate primary and secondary public schooling allocations from shifting demographic dependencies.

Second, our results expose the limitations of relying purely on market-based private educational solutions; in the presence of severe credit market imperfections, private substitution simply accelerates the stratification of human capital. If modern knowledge economies hope

to maintain long-run productivity and upward social fluidity, they cannot treat the fiscal choices of the demographic transition as a zero-sum game between generations. Unless the rules of public budgeting are structurally reformed to decouple human capital accumulation from localized entitlement pressures, the graying of the state will inadvertently lock underprivileged lineages out of economic opportunity, permanently freezing the social ladder.

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Tables

Table 1: **Demographic Aging and Local Fiscal Education Allocations**

	OLS Specifications		2SLS Specifications	
Dependent Variable: λ_{jt}	(1)	(2)	(3)	(4)
Old-Age Dependency Ratio (ω_{jt})	-0.114**	-0.098*	-0.284***	-0.252***
	(0.051)	(0.053)	(0.084)	(0.079)
Per-Capita GDP (log)		0.045***		0.038**
		(0.012)		(0.016)
Total Fiscal Revenue (log)		-0.012		-0.015
		(0.009)		(0.011)
Prefecture Fixed Effects	Yes	Yes	Yes	Yes
Wave Fixed Effects	Yes	Yes	Yes	Yes
1982 Census Controls × Year FE	No	Yes	No	Yes
First-Stage F-Statistic	–	–	28.41	24.58
Observations	1,320	1,320	1,320	1,320
R^2 / Pseudo-R^2	0.421	0.468	0.384	0.412

Notes: Standard errors clustered at the prefecture level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. 1982 Census controls include baseline urbanization and industrial employment shares interacted with wave dummies.

Table 2: **Baseline Intergenerational Mobility Estimates**

	OLS Specifications		2SLS Specifications	
Dependent Variable: Child Higher Ed Dummy	(1)	(2)	(3)	(4)
Parental Education ($Parent_Edu_{ij}$)	0.038***	0.034***	0.024***	0.021***
	(0.005)	(0.006)	(0.007)	(0.007)
Old-Age Dependency (ω_{jt})	-0.011	-0.015	-0.045**	-0.042**
	(0.009)	(0.011)	(0.021)	(0.019)
$Parent_Edu_{ij} \times \omega_{jt}$ (β_3)	**0.009***	**0.012****	**0.048*****	**0.045*****
	(0.005)	**(0.004)**	**(0.015)**	**(0.014)**
Household Micro Controls	No	Yes	No	Yes
Prefecture & Wave Fixed Effects	Yes	Yes	Yes	Yes
Child Age & Gender FE	Yes	Yes	Yes	Yes
Observations	8,450	8,450	8,450	8,450

Notes: Standard errors clustered at the prefecture level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Household micro controls include continuous logged per-capita income, household wealth indexes, and individual child sibling sizes.

Table 3: **Exclusion Restriction and Identification Defenses**

Dependent Variable: Child Higher Ed Dummy	2SLS: Controlling Parent Traits (1)	(2)	2SLS: Controlling SOE Shock (3)	(4)
Parental Education ($Parent_Edu_{ij}$)	0.021***	0.019**	0.018**	0.018**
	(0.007)	(0.008)	(0.008)	(0.008)
Old-Age Dependency (ω_{jt})	-0.041**	-0.039**	-0.036**	-0.035**
	(0.019)	(0.018)	(0.017)	(0.017)
$Parent_Edu_{ij} \times \omega_{jt}$ (β_3)	**0.044*** **	**0.042*** **	**0.041*** **	**0.041*** **
	(0.014)	**(0.013)**	**(0.012)**	**(0.012)**
Standalone Institutional Main Effects:				
Parent Only-Child Dummy ($Parent_Only_{ij}$)	-0.012	-0.015*	-0.011	-0.014
	(0.009)	(0.008)	(0.009)	(0.009)
SOE Layoff Intensity ($Layoff_Intensity_j \times Post$)	–	–	-0.054**	-0.048**
			(0.024)	(0.022)
Interactive Exclusion Controls:				
$Parent_Edu_{ij} \times Parent_Only_Dummy$	Yes	Yes	Yes	Yes
$Parent_Edu_{ij} \times Layoff_Intensity_j \times Post$	No	No	Yes	Yes
Household Micro Controls	No	Yes	No	Yes
Prefecture & Wave Fixed Effects	Yes	Yes	Yes	Yes
Observations	8,450	8,450	8,450	8,450

Notes: Standard errors clustered at the prefecture level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All models incorporate child age and gender fixed effects.

Table 4: **Robustness Specifications: Alternative Outcomes and Non-Migrant Samples**

	2SLS: Child Standardized Scores		2SLS: Non-Migrant Sub-Sample	
Dependent Variable:	(1)	(2)	(3)	(4)
Parental Education ($Parent_Edu_{ij}$)	0.015**	0.012**	0.022***	0.019***
	(0.007)	(0.006)	(0.008)	(0.007)
Old-Age Dependency (ω_{jt})	-0.028	-0.024	-0.048**	-0.044**
	(0.021)	(0.019)	(0.022)	(0.020)
$Parent_Edu_{ij} \times \omega_{jt}$ (β_3)	**0.039*** **	**0.038*** **	**0.046*** **	**0.043*** **
	(0.012)	**(0.011)**	**(0.016)**	**(0.014)**
Household Micro Controls	No	Yes	No	Yes
Prefecture & Wave Fixed Effects	Yes	Yes	Yes	Yes
Child Age & Gender FE	Yes	Yes	Yes	Yes
Observations (True Sample Sizes)	**7,820**	**7,820**	**5,120**	**5,120**

Notes: Standard errors clustered at the prefecture level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Columns (1) and (2) report precise sample observations derived from CFPS cognitive exam modules reflecting natural non-response attrition.

Table 5: **Supply Side: Demographic Aging and Public School Quality Decay**

	2SLS: Student-Teacher Ratio (STR_{jt})		2SLS: Per-Pupil Capital Outlays (log)	
Dependent Variables:	(1)	(2)	(3)	(4)
Old-Age Dependency Ratio (ω_{jt})	0.612***	0.584***	-0.345***	-0.321***
	(0.151)	(0.142)	(0.098)	(0.091)
Per-Capita GDP (log)		-0.112		0.084***
		(0.082)		(0.022)
Prefecture Fixed Effects	Yes	Yes	Yes	Yes
Wave Fixed Effects	Yes	Yes	Yes	Yes
1982 Census Controls × Year FE	No	Yes	No	Yes
Observations	1,320	1,320	1,320	1,320

Notes: Standard errors clustered at the prefecture level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: **Demand Side: Asymmetric Wealth-Tier Private Shadow Education Expenditures**

	2SLS: Lowest Income Quintiles		2SLS: Highest Income Quintiles	
Dependent Variable: Private Shadow Ed Exp (log)	(1)	(2)	(3)	(4)
Old-Age Dependency Ratio (ω_{jt})	-0.008	-0.012	0.192***	0.184***
	(0.014)	(0.015)	(0.052)	(0.048)
Grandparental Gift Controls	Yes	Yes	Yes	Yes
Household Micro Controls	No	Yes	No	Yes
Prefecture & Wave Fixed Effects	Yes	Yes	Yes	Yes
Observations	4,120	4,120	4,330	4,330

Notes: Standard errors clustered at the prefecture level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Grandparental gift controls capture direct financial gifts from non-coresident grandparents to absorb informal family wealth transfers.

Appendix A: Denominator-Driven Demographic Shocks and Generalized Fiscal Squeeze

A.1. Setup of the Denominator Shock

In the baseline model presented in Section 3, the old-age dependency ratio was parameterized via a continuous expansion of the retiree cohort mass ($\omega > 0$). To reconcile our structural theory with the exact empirical variation exploited by our One-Child Policy (OCP) instrumental variable—which primarily engineered a severe systemic compression of the subsequent young labor force cohort rather than organically scaling the absolute volume of historical retirees—this appendix constructs a generalized denominator-driven framework.

Let the absolute mass of the retired elderly cohort be fixed at $N_o > 0$. The absolute mass of the younger working generation is given by $N_y > 0$, which is directly compressed by historical birth control enforcement rigor. We formally define the structural old-age dependency ratio as:

$$\omega \equiv \frac{N_o}{N_y} \tag{17}$$

An intensive historical birth control policy shock corresponds structurally to a binding contraction in the available young labor pool, denoted as a marginal decrease in N_y ($N_y \downarrow \Longrightarrow \omega \uparrow$).

A.2. Aggregate Budgeting under Denominator Contraction

Following the behavioral micro-foundations established in Section 3.1, every individual young worker i supplies labor endogenously at $l_i^*(\tau) = l^* = \frac{1}{1+\eta}$. The aggregate endogenous tax base of the prefecture city is scaled by the total mass of active taxpayers N_y:

$$Y_{total}(\tau; N_y) = N_y \cdot R \int h_i l^* dF(h) = N_y \frac{R\bar{H}}{1+\eta} \tag{18}$$

The local government maintains a strict balanced budget over aggregate absolute outlays. Let E_{total} and P_{total} define the absolute fiscal pools dedicated to education and elderly welfare, respectively. The centralized local treasury splits the aggregate tax revenue according to the endogenous choice parameter $\lambda \in [0, 1]$:

$$E_{total} = \lambda \tau Y_{total}(\tau; N_y) = \lambda \tau N_y \frac{R\bar{H}}{1+\eta} \tag{19}$$

$$P_{total} = (1-\lambda) \tau Y_{total}(\tau; N_y) = (1-\lambda) \tau N_y \frac{R\bar{H}}{1+\eta} \tag{20}$$

Crucially, the per-capita public goods disbursed to individual recipients are functions of respective cohort denominators. Individual per-capita school quality remains $E = \frac{E_{total}}{N_y} = \lambda \tau \frac{R\bar{H}}{1+\eta}$ due to symmetric demographic scaling at the school gate. However, individual per-capita senior pension handouts (P) must absorb the absolute fixed overhead of the elderly mass N_o:

$$P = \frac{P_{total}}{N_o} = \frac{(1-\lambda)\tau N_y R\bar{H}}{N_o(1+\eta)} = \frac{(1-\lambda)\tau R\bar{H}}{\omega(1+\eta)} \tag{21}$$

Equation (21) demonstrates that a contraction in the young labor supply N_y mirrors the identical structural downward pressure on per-capita retirement consumption as a direct inflation of the old-age mass, establishing cross-specific mathematical invariance in the structural resource constraint.

A.3. Bureaucratic Nash Bargaining Equilibrium

As conceptualized in Section 3.2, the state bureaucracy configures the equilibrium policy vector (τ^*, λ^*) by maximizing a localized political welfare function. The state assigns a structural political weight $\Omega(\omega)$ to the elderly cohort to protect administrative stability, where $\Omega'(\omega) > 0$:

$$\max_{\tau,\lambda} \quad \mathcal{W} = (1 - \Omega(\omega)) \ln U_y(\tau, \lambda) + \Omega(\omega) \ln U_o(\tau, \lambda) \tag{22}$$

Substituting the indirect utilities $U_y = \ln(1-\tau) + \theta\beta \ln \lambda + \theta\beta \ln \tau + \mathcal{K}_y$ and $U_o = \ln(1-\lambda) + \ln \tau - \ln \omega + \mathcal{K}_o$ into the objective function, the first-order condition with respect to the budgetary allocation share λ yields:

$$\frac{\partial \mathcal{W}}{\partial \lambda} = \frac{(1-\Omega(\omega))\theta\beta}{\lambda} - \frac{\Omega(\omega)}{1-\lambda} = 0 \tag{23}$$

Solving Equation (23) explicitly pins down the equilibrium fiscal allocation share λ^* as a closed-form function of the structural dependency ratio:

$$\lambda^*(\omega) = \frac{(1-\Omega(\omega))\theta\beta}{(1-\Omega(\omega))\theta\beta + \Omega(\omega)} \tag{24}$$

A.4. Equivalence Proof of the Generalized Fiscal Squeeze

To evaluate the comparative statics under a pure demographic birth control restriction, we differentiate the equilibrium allocation rule $\lambda^*(\omega)$ with respect to the young labor force mass N_y:

$$\frac{\partial \lambda^*}{\partial N_y} = \frac{\partial \lambda^*}{\partial \Omega} \cdot \frac{\partial \Omega}{\partial \omega} \cdot \frac{\partial \omega}{\partial N_y} \tag{25}$$

From Equation (24), it is mathematically straightforward that $\frac{\partial \lambda^*}{\partial \Omega} < 0$. By the structural properties of bureaucratic stability survival, we have $\frac{\partial \Omega}{\partial \omega} > 0$. Crucially, by the definition of the denominator shock in Equation (17):

$$\frac{\partial \omega}{\partial N_y} = -\frac{N_o}{(N_y)^2} < 0 \tag{26}$$

Applying the chain rule to Equation (A.9) establishes our central defense:

$$\frac{\partial \lambda^*}{\partial N_y} = \underbrace{\left(\frac{\partial \lambda^*}{\partial \Omega}\right)}_{(-)} \cdot \underbrace{\left(\frac{\partial \Omega}{\partial \omega}\right)}_{(+)} \cdot \underbrace{\left(\frac{\partial \omega}{\partial N_y}\right)}_{(-)} > 0 \tag{27}$$

By symmetry, because an intensive historical OCP shock corresponds to a binding compression of the contemporary young labor base ($N_y \downarrow$), the dynamic impact on the equilibrium fiscal allocation is cleanly stated as:

$$\text{OCP Intensity} \uparrow \implies N_y \downarrow \implies \lambda^*(\omega) \downarrow \tag{28}$$

The distortionary Laffer constraint defined on total tax base $Y_{total}(\tau; N_y)$ prevents the local state from increasing the extraction rate τ^* sufficiently to cushion the blow. Consequently, the absolute per-capita public school budget $E^* = \lambda^* \tau^* \frac{R\bar{H}}{1+\eta}$ must systematically contract:

$$\frac{\partial E^*}{\partial \text{OCP Intensity}} < 0 \tag{29}$$

Lemma A.1. *A denominator-driven demographic contraction engineered by administrative birth control restrictions is mathematically isomorphic to a numerator-driven aging shock in driving the general equilibrium fiscal liquidation of discretionary public education. The institutional crowding-out channel is theoretically robust to the exact cohort-compression anatomy of the empirical instrument.* ■