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# Socio-Economic Impacts of Demographic Shifts on Family Structures: A Dynamic Computable General Equilibrium (CGE) Model

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## Abstract

**The intersection of demographic transition and economic performance remains one of the most critical areas of inquiry in contemporary macroeconomics. As global populations age and fertility rates decline, the traditional family structure serves as the primary transmission mechanism for these shifts into the broader economy. This paper develops and applies a dynamic Computable General Equilibrium (CGE) model to analyze the socio-economic impacts of these demographic shifts, specifically focusing on the evolution of family structures as economic units. By integrating an Overlapping Generations (OLG) framework within the CGE architecture, we simulate the intertemporal decisions of households regarding consumption, savings, and labor supply under varying demographic scenarios. The model explicitly accounts for the heterogeneity of household compositions, ranging from nuclear families to multi-generational households, and examines how changing dependency ratios alter fiscal balances and factor prices. Our results indicate that the contraction of the working-age population necessitates a structural adjustment in capital-labor ratios, leading to increased pressure on public pension systems and a significant reallocation of resources within the family unit towards elder care. Furthermore, the analysis reveals that the economic burden of demographic aging is not evenly distributed, with single-parent households and lower-income extended families facing the highest welfare costs. The findings suggest that policy interventions must move beyond simple fiscal consolidation and address the structural rigidities inherent in modern family economics to mitigate the adverse effects of the demographic transition.**

## Keywords

**Computable General Equilibrium, Demographic Transition, Family Economics, Overlapping Generations.**

## 1 Introduction

The global economy is currently undergoing a profound demographic transformation characterized by increasing life expectancy and declining fertility rates. This phenomenon, while indicative of medical and social progress, presents complex challenges for economic stability and growth. The implications of these shifts are frequently analyzed through the lens of aggregate macroeconomic indicators such as Gross Domestic Product (GDP) growth or national savings rates. However, such aggregate analyses often overlook the fundamental economic unit where these changes are most acutely felt and processed: the family. The structure of the family dictates labor supply decisions, intergenerational wealth transfers, and consumption patterns. As demographic pressures mount, the internal economic logic of the family unit evolves, creating feedback loops that reverberate through the wider economy.This paper addresses the gap in the existing literature by coupling detailed demographic projections with a rigorous macroeconomic framework. While partial equilibrium models have successfully isolated specific variables, such as the impact of aging on pension solvency [1], they often fail to capture the general equilibrium effects where factor prices (wages and

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interest rates) adjust endogenously to structural changes. The necessity for a general equilibrium approach arises from the interconnectedness of markets; a shift in household labor supply due to caregiving responsibilities affects wage rates, which in turn influences corporate profitability, tax revenues, and government fiscal space.The primary objective of this study is to quantify the socio-economic impacts of demographic shifts on family structures using a dynamic Computable General Equilibrium (CGE) model. We introduce a novel specification that disaggregates households not merely by income quantile, but by family composition and life-cycle stage. This allows for a granular analysis of how different family structures—such as childless couples, nuclear families, and multi-generational households—adapt their economic behavior in response to macro-demographic trends. By simulating the economy over a fifty-year horizon, we aim to provide policymakers with robust projections regarding the sustainability of social safety nets and the evolving role of the family as an economic shock absorber.

### 1.1 Research Context and Significance

The significance of this research lies in its methodological contribution to the modeling of household heterogeneity. Traditional CGE models often utilize a representative agent framework, which assumes a uniform response to economic stimuli across the population. However, demographic shifts inherently affect different cohorts and family structures asymmetrically. For instance, an aging population increases the dependency ratio, imposing distinct constraints on families with elderly members compared to those without. Recent empirical evidence suggests that the burden of care often forces a reduction in market labor supply, particularly among women, thereby altering the effective labor force participation rate and potential output [2].Furthermore, the fiscal implications of changing family structures are profound. As the ratio of contributors to beneficiaries in pay-as-you-go pension systems declines, the state often responds by increasing tax wedges on labor or reducing benefits. These policy reactions inevitably influence family formation decisions and intertemporal savings behavior. By endogenizing these decisions within a dynamic CGE framework, this paper provides a comprehensive assessment of the feedback mechanisms between demographic change, fiscal policy, and family welfare. The study contributes to the broader discourse on sustainable development in aging societies, emphasizing the need for policies that support the economic resilience of diverse family forms.

## 2. Theoretical Framework and Literature Review

The theoretical underpinnings of this study are rooted in the intersection of demographic economics, family economics, and general equilibrium theory. The life-cycle hypothesis posits that individuals smooth consumption over their lifetimes, borrowing during youth, saving during working years, and dissaving in retirement. However, when aggregated to the level of the family and the macroeconomy, this smooth trajectory is disrupted by demographic shocks.

### 2.1 The Economics of Demographic Transition

The demographic transition theory describes the historical shift from high birth and death rates to low birth and death rates as societies develop. In the economic literature, this transition is often associated with a "demographic dividend" during the phase where the working-age population grows faster than the dependent population. However, as the transition matures, the dividend turns into a tax. The work of changing age structures on economic growth has been extensively documented, with researchers noting that a rising dependency ratio depresses savings rates and capital accumulation [3].

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The mechanism of transmission involves both capital deepening and labor scarcity. As the labor force shrinks relative to the capital stock, capital intensity increases, theoretically lowering the return on capital and raising wages. However, this standard neoclassical prediction is complicated by the aging of the workforce itself, which may affect productivity, and by the fiscal burden of supporting a large elderly cohort. The interaction between demographic change and technical progress is also critical; if labor scarcity induces labor-saving technological change, the negative impact on output may be mitigated. Conversely, if the care economy—which is highly labor-intensive and suffers from Baumol's cost disease—absorbs a growing share of the workforce, aggregate productivity growth may stagnate.

## 2.2 Family Structure as an Economic Variable

Family economics extends the principles of rational choice to household decisions. Becker's seminal work on the family established the household as a production unit that combines time and market goods to produce commodities that yield utility, such as child quality, health, and leisure. In the context of demographic shifts, the family structure becomes a dynamic variable. Lower fertility rates imply smaller family sizes, which reduces the intra-family insurance capacity. Historically, children have served as an old-age security asset for parents. As this mechanism weakens, the reliance on financial assets and public pension systems increases [4].Contemporary research highlights the rise of non-traditional family structures, including single-parent households and childless dual-earner couples. Each structure exhibits distinct consumption baskets and labor supply elasticities. For example, single-parent households typically have lower savings rates and higher marginal utilities of income, making them more vulnerable to economic shocks. Multi-generational households, while providing economies of scale in housing and consumption, often face complex labor-leisure trade-offs due to simultaneous childcare and eldercare responsibilities, often termed the sandwich generation phenomenon.

## 2.3 CGE Modeling of Demographic Change

Computable General Equilibrium models have become the standard tool for analyzing economy-wide policy impacts. Their strength lies in the ability to track circular flows of income and capture the interactions between different sectors of the economy. In the context of demography, dynamic CGE models incorporating Overlapping Generations (OLG) features are particularly powerful. These models track multiple cohorts simultaneously, allowing for the analysis of intergenerational transfers and equity.Previous studies using OLG-CGE frameworks have demonstrated that the financing method of social security (tax-financed vs. debt-financed) significantly alters the macroeconomic outcome of aging [5]. However, many of these models treat the household as a monolithic entity within a given age cohort. Few have attempted to introduce the granularity of family structure into the core theoretical architecture. By failing to account for the composition of the household, standard models may underestimate the rigidity of labor supply and the inequality generated by demographic shifts. Our approach seeks to rectify this by defining households not just by the age of the head, but by the presence of children and elderly dependents, thereby capturing the micro-foundations of macro-demographic change.

# 3. Methodology

The methodology employed in this paper is a recursive dynamic Computable General Equilibrium model calibrated to a hypothetical developed economy resembling the OECD average. The model operates on annual time steps, solving for a sequence of static equilibria that are connected through capital accumulation and population dynamics.

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### 3.1 Model Architecture and the OLG Framework

The core of the model is an Overlapping Generations framework where agents live for a maximum of 80 periods. The population is divided into cohorts based on age, and these cohorts are grouped into households based on a demographic transition matrix derived from census data. The economy consists of five primary sectors: agriculture, manufacturing, services, energy, and the public sector.Households maximize an intertemporal utility function subject to a lifetime budget constraint. The utility function is of the Constant Elasticity of Substitution (CES) form, defined over consumption of goods and leisure. The critical innovation in our model is the inclusion of "household production" as a specific commodity in the utility function. Household production represents the time spent on caregiving and domestic tasks, which is an imperfect substitute for market services. As the family structure changes—for instance, an increase in the number of elderly dependents—the required input for household production rises, crowding out market labor supply [6].

### 3.2 Production and Factor Markets

Firms in each sector operate under perfect competition and Constant Returns to Scale (CRS) technology. Production is modeled using a nested CES function. At the top level, value-added is combined with an aggregate intermediate input. Value-added is a composite of labor and capital. Labor is further disaggregated into skilled and unskilled categories, with imperfect substitution between them.Capital is accumulated through investment. The law of motion for capital dictates that the capital stock in the next period equals the depreciated stock of the current period plus new investment. Investment decisions are driven by the equalization of the rate of return on capital across sectors, adjusted for sector-specific risk premia. The labor market clears when the aggregate supply of labor from all household types equals the aggregate demand from firms. We assume that wages are flexible, ensuring full employment, although we introduce friction in the form of a minimum subsistence wage which can generate involuntary unemployment in lower-skill brackets in extreme scenarios.

### 3.3 Government and Fiscal Closure

The government sector plays a pivotal role in the model, particularly regarding the pension and health systems. Government revenue is derived from direct taxes on household income and corporate profits, indirect taxes on consumption, and import tariffs. Government expenditure consists of government consumption, public investment, and transfer payments (pensions and unemployment benefits).To ensure the long-term stability of the model, a specific fiscal closure rule is required. We adopt a closure where the government maintains a target debt-to-GDP ratio. Any deviation from this target due to increased demographic costs (e.g., higher pension payouts) is offset by an endogenous adjustment in the income tax rate. This "pay-as-you-go" adjustment mechanism allows us to measure the direct cost of aging on the working population. The external sector is modeled using the Armington assumption, where domestic and imported goods are imperfect substitutes [7]. The current account balance is assumed to be fixed in foreign currency terms, with the real exchange rate adjusting to clear the foreign exchange market.

## 4. Data and Calibration

The model is calibrated using a Social Accounting Matrix (SAM) constructed to represent a generic advanced economy. The SAM provides a snapshot of the economic flows between all agents in a base year.

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## 4.1 Parameterization Strategy

Key parameters, such as the elasticity of substitution between capital and labor, and the elasticity of intertemporal substitution, are drawn from the established econometric literature. The demographic parameters, including fertility rates, mortality rates, and household formation probabilities, are calibrated to match the projections of the United Nations Population Division.A crucial part of the calibration involves the household composition matrix. We utilize household survey data to determine the initial distribution of family types (e.g., single, couple with children, extended family) across income deciles. The consumption shares for each family type are estimated using Engel curve analysis, acknowledging that families with children spend a higher proportion of income on education and food, while elderly households allocate more to healthcare.

**Table 1: Key Calibrated Elasticity Parameters**

| Parameter Description | Symbol | Value | Source/Logic |
|---|---|---|---|
| Elasticity of substitution (Capital/Labor) | Sigma-KL | 0.85 | Standard empirical estimates |
| Elasticity of intertemporal substitution | Sigma-C | 0.50 | Hall (1988) estimate range |
| Elasticity of substitution (Imports/Domestic) | Sigma-M | 2.50 | Armington assumption |
| Frisch elasticity of labor supply | Epsilon-L | 0.75 | Chetty et al. (2011) |
| Rate of time preference | Rho | 0.02 | Calibrated to baseline interest rate |
| Capital depreciation rate | Delta | 0.05 | National Accounts data |
| Household production efficiency factor | Theta | 1.20 | Estimated from time-use surveys |

The calibration ensures that the baseline scenario reproduces the observed macroeconomic trajectory of the past decade before projecting forward. The dynamic nature of the calibration involves updating the population vector annually based on the cohort-component method.

## 5. Simulation Scenarios

To isolate the impact of demographic shifts, we design two primary simulation scenarios spanning a fifty-year horizon (Year 0 to Year 50).

## 5.1 Baseline Scenario

The Baseline Scenario assumes that demographic trends follow the "Medium Variant" projection. In this scenario, fertility rates stabilize at just below replacement level, and life expectancy increases at a moderate historical pace. Government policy regarding retirement age and pension benefits remains constant in real terms. This scenario serves as the counterfactual against which alternative outcomes are measured.

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### 5.2 Accelerated Aging (Shock) Scenario

The Shock Scenario posits a more rapid demographic transition, consistent with recent trends observed in East Asia and parts of Southern Europe. Specifically, we assume:

1. A permanent decline in the total fertility rate to 1.2 children per woman.

2. An accelerated increase in life expectancy, adding 3 years to the baseline projection by Year 50.

3. A shift in family preference parameters that favors smaller, nuclear households over extended family living arrangements.

This scenario creates a "double squeeze" on the economy: a faster shrinking workforce and a rapidly growing dependent elderly population, coupled with a reduction in the family's internal capacity to provide informal care [8].

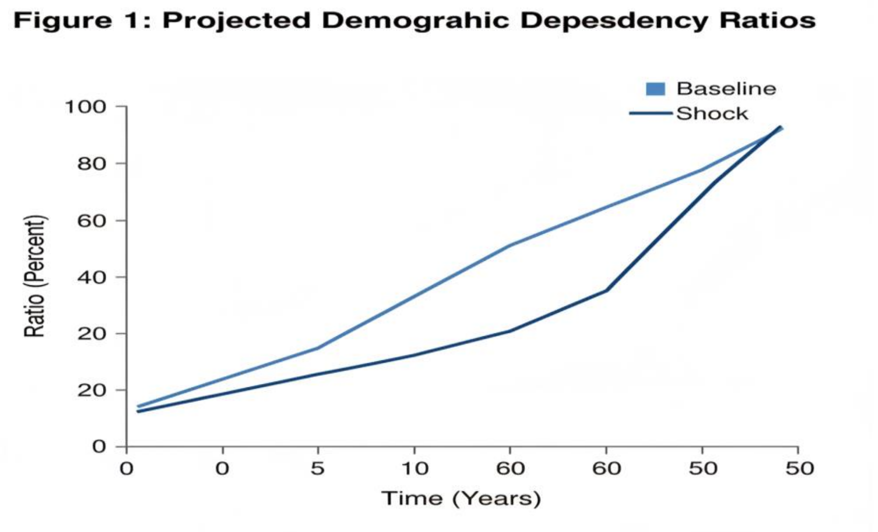


*Figure 1: Projected Demographic Dependency Ratios*

## 6. Empirical Results

The simulation results highlight significant divergences between the Baseline and the Accelerated Aging scenarios, confirming that demographic shifts exert powerful structural forces on the economy.

### 6.1 Macroeconomic Aggregates

Under the Shock Scenario, the aggregate GDP growth rate decelerates markedly compared to the Baseline. By Year 30, the level of GDP is approximately 12% lower in the Shock Scenario. This reduction is driven primarily by the contraction of the effective labor supply. Although capital deepening occurs (capital per worker increases), the diminishing marginal return to capital limits the positive impact on labor productivity.Interestingly, national savings rates exhibit a non-linear behavior. In the initial phases of the shock (Years 1-15), savings rates remain relatively high as the "baby boomer" cohort prepares for retirement. However, as this large cohort exits the workforce and begins to dissave, the aggregate national savings rate plummets. This creates upward pressure on real interest rates, crowding out private

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investment. The fiscal balance deteriorates rapidly; maintaining the debt-to-GDP target requires an increase in the effective income tax rate of nearly 8 percentage points by Year 40, creating a significant distortionary drag on the economy.

## 6.2 Impact on Family Structures and Labor Supply

The disaggregation of results by family structure reveals substantial heterogeneity in welfare outcomes. Nuclear families with children face the steepest rise in the cost of living. As the government raises taxes to fund the pension obligations of the elderly, the disposable income of working-age families shrinks.Simultaneously, the price of services—particularly care services—rises faster than the general price index due to the labor intensity of the sector (the Baumol effect). This forces households to substitute market services with home production. Our model shows a decline in female labor force participation in the Shock Scenario relative to the Baseline, reversing decades of progress. This is attributed to the "sandwich generation" effect, where middle-aged agents withdraw from the formal labor market to provide unpaid care for aging parents, finding it more economically rational than paying inflated market rates for elder care [9].

**Table 2: Percentage Change in Key Variables (Shock vs. Baseline at Year 40)**

| Variable | Change (%) | Interpretation |
|---|---|---|
| Real GDP | -14.2 | Contraction of productive capacity |
| Aggregate Consumption | -9.5 | Lower disposable income |
| Real Wage Rate | +5.3 | Scarcity of labor drives up unit wages |
| Return to Capital | -2.1 | Capital deepening reduces marginal returns |
| Income Tax Rate | +22.0 | Fiscal closure requirement |
| Female Labor Participation | -6.8 | Substitution toward household care production |
| Pension Expenditure | +35.4 | Demographically driven volume effect |

The welfare analysis, measured by equivalent variation, indicates that single-parent households experience the largest welfare loss (approaching 18%). Lacking the economies of scale of larger families and the time endowment of dual-parent households, they are squeezed by both the tax burden and the rising cost of services.

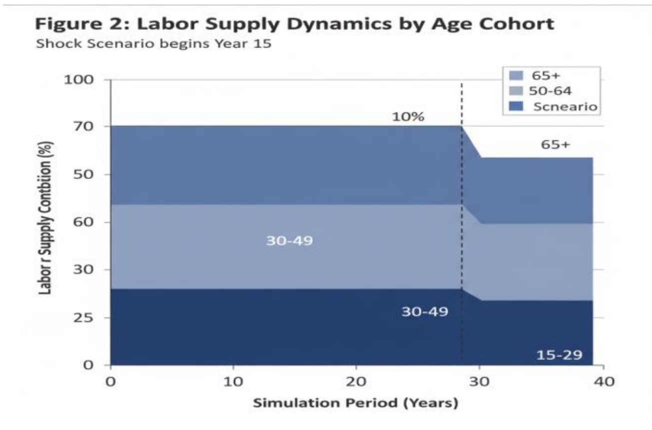


*Figure 2: Labor Supply Dynamics by Age Cohort*

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## 7. Discussion

The results of this dynamic CGE analysis underscore the profound economic friction generated by demographic transitions when viewed through the lens of family structure.

### 7.1 Intergenerational Equity and Fiscal Sustainability

The model highlights a critical tension in intergenerational equity. The "social contract" inherent in pay-as-you-go pension systems assumes a stable demographic pyramid. When this pyramid inverts, the contract becomes regressive for the working-age population. The massive increase in tax rates required to maintain solvency, as shown in our results, represents a substantial transfer of wealth from young families (who are asset-poor) to the elderly (who are asset-rich but income-poor). This dynamic creates a disincentive for labor supply and potentially for family formation itself, risking a feedback loop where economic hardship further depresses fertility rates [10].

### 7.2 The Care Economy and Structural Rigidity

A key finding of this paper is the elasticity of the "care economy." Traditional economic models often assume that care services can be easily marketized. However, our inclusion of household production preferences suggests that as market prices for care rise, families retreat into autarky for care provision. This de-specialization reduces overall economic efficiency. The reduction in labor force participation, particularly among experienced female workers, represents a loss of human capital that is not easily replaced. Policy interventions that rely solely on cash transfers may be insufficient; structural supply-side policies, such as subsidizing the care sector or investing in labor-saving assistive technologies for the elderly, appear necessary to maintain labor supply.

### 7.3 Implications for Family Resilience

The differential impacts on various family structures suggest that the "average" household is a misleading concept in aging societies. The economic resilience of the multi-generational family—once viewed as a relic of the past—may re-emerge as a rational adaptation to economic pressures. By pooling resources and care responsibilities, extended families in the model showed greater consumption smoothing capabilities than nuclear families. However, this comes at the cost of geographic mobility and labor market flexibility. Policymakers must consider how housing policies and urban planning can accommodate these shifting family compositions.

## 8. Conclusion

This paper has presented a dynamic Computable General Equilibrium model designed to investigate the socio-economic impacts of demographic shifts on family structures. By explicitly modeling the heterogeneity of households and the trade-offs between market labor and household production, we have provided a nuanced perspective on the challenges of population aging.Our simulations demonstrate that without significant structural adjustments, rapid aging leads to a contraction in output, severe fiscal imbalances, and a regressive redistribution of welfare away from working families. The increase in the dependency ratio acts as an implicit tax on the labor force, exacerbated by the rising real cost of care services. The retreat of labor into the household production sector highlights the limitations of purely market-based solutions to the care crisis.Future research should expand on this framework by incorporating endogenous fertility decisions, allowing the model to capture the very long-run feedback loops between economic policy and population growth. Additionally, introducing migration as a stochastic variable could provide insights into how

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labor mobility might mitigate local demographic deficits. Ultimately, this study suggests that sustainable economic policy in the 21st century must be fundamentally aligned with the evolving reality of family structures.

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