
プロジェクト報告

労働力の高齢化が労働市場に与える影響を 考察する

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1. Introduction

Driven by demographic shifts and improvements in health, workforce aging is advancing globally. This research project aims to assess the impact of this trend on labor markets by estimating the degree of substitutability between older workers, younger cohorts, and foreign workers. The analysis focuses on Japan, where population aging is particularly pronounced. In addition, the study considers how the diffusion and continued development of AI and automation may affect different segments of the workforce in distinct ways—particularly on the demand side of the labor market.

2. Research Progress

To address these dynamics, we develop a theoretical framework that models older and other workers as imperfect substitutes within an aggregate production function under conditions of technological progress. This framework allows us to derive equations that describe the relationships between relative wages, relative labor supply, and the elasticity of substitution between worker groups.

We then empirically estimate the elasticity of substitution between older and other workers using data from Japan's Basic Survey on Wage Structure, the Population Census, and employment statistics on foreign workers.

3. Research Dissemination

The research findings were disseminated through two seminars entitled “Population Graying, Technological Changes, and Their Economic Implications”, supported by research grants from the School of International Politics, Economics, and Communication (SIPEC) at Aoyama Gakuin University.

The first seminar, held on February 27, 2025, was organized by the Department of Economics at the National Economics University, Vietnam, and attracted approximately 100 participants, including 30 faculty members and researchers and about 70 students. The second seminar took place at the University of Economics, Ho Chi Minh City, with around 15 participants, all of whom were faculty members and researchers.



(Notes : Seminar Posters)

4. Concluding Remarks

The researcher gained valuable insights and constructive feedback from the two seminars, which provided diverse perspectives from both faculty members and students. These discussions not only helped identify potential areas for refinement in the theoretical framework and empirical approach, but also highlighted new avenues for further investigation. Incorporating this feedback, the researcher has revised and strengthened the ongoing research projects, thereby enhancing their academic rigor and practical relevance.

Introduction

Motivations

Background and Motivations

- ▶ Global Decline in Fertility:
 - ▶ 2024 UN World Population Prospects: the total fertility rate (TFR) is 1.8 for the USA, 1.5 for high income countries, and 1.2 for China.
 - ▶ Globally, fertility rates in more than 50% all countries are less than 2.1 births per woman, the level required to maintain a constant population size.
- ▶ Increasing longevity, advancements in older worker-friendly technologies, and others have naturally contributed to the rising proportion of older workers in the global labor force.

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Introduction

Motivations

Research Motivations

- ▶ In countries with shrinking (young) workforces, there are various policies aiming to address labor shortage:
 - ▶ Encouraging people to stay on the job longer by redesigning social security programs, raising or eliminating the retirement age, and implementing related strategies.
 - ▶ In Japan, if the labor force participation rate of individuals aged 65 and older rises from the current 25% to 35%, the workforce would increase by 3.8 million.
 - ▶ Bringing in (young) foreign workers to supplement the domestic labor force.
 - ▶ If Japan doubles its net migration to 300k people per year, it can receive about 3.0m people by 2040.



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Introduction

Motivations

Motivations

- ▶ Changes in the age structure of the labor force affect the labor income distribution among different age groups.
- ▶ But the magnitude of this impact depends on the degree of substitutability (the elasticity of substitution) between older workers and their younger counterparts.
 - ▶ Relative supply ↗ Relative prices (wages) ↘ Labor income distribution (?).
- ▶ The demand for foreign workers and their impact also depend on the degree of substitutability between different age groups in an aging economy.



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Motivations

Impact of technological changes

- ▶ Recent technological changes are expected to affect all workers but the impact on relative wages may differ between types of workers in terms of labor-augmenting productivity.
 - ▶ E.g., recent technology can compensate for the decline in cognitive abilities and physical endurance of older workers.
- ▶ Productivity ↑ Demand ↑ Wage ↑. But relative wages ?

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Introduction

The research project:

- ▶ Examine the impact of a graying labor force and technological changes on labor income distribution and the employment of foreign workers.

The focus:

- ▶ Japan, one of the fastest aging workforces in the world.
 - ▶ In 2015, more than 33.3% of all workers aged 55+ in Japan, and this number continues to rise over time.
 - ▶ The number of foreign workers in Japan has increased dramatically by more than 3 times in the last 10 years.
- ▶ S.Korea and China are right behind Japan and Vietnam is catching extremely fast (one of the fastest aging countries).

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Introduction

Methodology and Approach

- ▶ To establish a theoretical foundation that combines older and younger workers with imperfect substitutability.
- ▶ To derive a structural equation for use in estimation.
- ▶ To estimate the degree of substitutability using data obtained from Japan's prefectural data.
- ▶ To quantitatively analyze the effects of labor force graying on the employment of foreign workers in Japan.

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Theoretical Framework

Theoretical Model

Model Outline

- ▶ A model of relative labor supply and demand with 2 types of workers: non-old workers ($\mathcal{L}$) and older workers ($\mathcal{S}$).
- ▶ Each worker $j \in \mathcal{L}(\mathcal{S})$ has $l_j(s_j)$ units of labor. All workers supply their efficiency units inelastically.
- ▶ The total supply of non-old and older workers, L and S , can be expressed as:

$$L = \int_{j \in \mathcal{L}} l_j dj, \quad S = \int_{j \in \mathcal{S}} s_j dj \quad (1)$$

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Theoretical Framework

Theoretical Model

CES Aggregate Production Function

$$Y = \left[(1 - \gamma_s) (A_L L)^{\frac{\sigma-1}{\sigma}} + \gamma_s (A_S S)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (2)$$

- ▶ $\sigma \in [0, \infty)$: the elasticity of substitution.
- ▶ A_L, A_S : labor augmenting productivity.
- ▶ γ_S : weight of older worker labor in production.

► Wage Rates

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Theoretical Framework

Theoretical Model

CES Aggregate Production Function

- (2) is derived from a production function that incorporates 2 types of intermediates to produce the final good, as:

$$Y = \left[(1 - \gamma_s) M^{\frac{\sigma-1}{\sigma}} + \gamma_s N^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (3)$$

where M denote manufacturing intermediate goods that utilize physical strength and age-depreciating skills while N denotes non-manufacturing goods that utilize age-appreciating skills.

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Theoretical Framework

Theoretical Model

Relative wage rates

- ▶ All labor markets are competitive, hence that the wage rate of non-older and older worker workers, w_L and w_S , equal their corresponding marginal product of labor.
- ▶ Consequently, the logarithms the relative wage, $\omega \equiv \frac{w_S}{w_L}$, can be computed from(2) as:

$$\ln \omega = \ln \frac{\gamma_s}{1 - \gamma_s} + \frac{\sigma - 1}{\sigma} \ln \left(\frac{A_S}{A_L} \right) - \frac{1}{\sigma} \ln \left(\frac{S}{L} \right) \quad (4)$$

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Data and empirical analysis

Data description

Relative supply of older to non-old workers, S/L

- ▶ Data from Population Census for 2010 and 2015.
- ▶ Choosing the 55 age as the threshold between older and non-old workers.

Relative labor wages of older to non-old workers, ω

- ▶ Data from the Basic Survey on Wage Structure.
- ▶ The wages for workers 55+ and workers under 55 were computed by weighted mean.

▶ Wage Computation

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Empirical analysis

Contribution

- ▶ Our study fills a gap in the literature by examining and estimating the substitutability between workers 55+ and their younger counterparts in Japan using post-2010 data.
 - ▶ Card and Lemieux (2001), Kawaguchi and Mori (2016) and others.
 - ▶ Levine and Mitchell (1988), Gruber and Milligan (2010), Oshio et al (2010), and Kalwij et al. (2010), etc.
- ▶ Address omitted variable and endogeneity issues by first-difference estimation for the prefectural panel data, and by utilizing an instrumental variable.



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Implications

Implications for technological changes

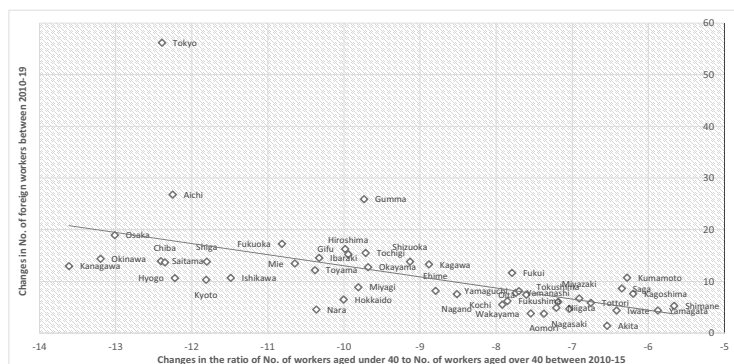
- ▶ **Theoretical Implications**
- ▶ Recent technological changes are expected to impact all workers but the impact may differ between types of workers in terms of labor-augmenting productivity.
 - ▶ E.g., recent technology can compensate for the decline in cognitive abilities and physical endurance of older workers.
- ▶ Since non-old workers and older workers are gross substitutes if technological changes improve the relative labor-augmenting productivity of older workers, it will lead to an increase in their relative wage and vice versa.



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Extensions

Changes in relative number of workers aged under 40 and foreign workers



Notes: Vertical axis denotes the change between 2010 and 2019 in the number of foreign workers per 1000 Japanese workers at the 2010 level. Sources: Author's calculation based on Reports on Employment Situations of Foreigners, Surveys on Labor Economy Trends, Ministry of Health, Labour and Welfare.

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Concluding remarks

Using Japan's prefectural data, Nguyen (2022) finds that

- ▶ A 10% decline in the relative number of younger workers aged under 40 leads to an increase of over 11.7 foreign workers per one thousand native workers.

Future research:

- ▶ Firstly, to relax the assumption that the relative labor-augmenting productivity growth is constant.
- ▶ Secondly, to extend this analysis to incorporate cross-border migration and its impact on the race between labor supply and demand.

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