Dependency Effects of Internal Migration on Receiving Areas in Japan:
A Labor Productivity Perspective

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1. Research topic

The world population is aging more quickly than ever before. among the major developed countries， Japan has the highest degree of population aging. OECD statistics show that the proportion of elderly people over 65 years of age in Japan's total population is rising rapidly. As of 2020, the proportion has reached 30%. Meanwhile, population migration and movement has been facilitated by globalization worldwide. In terms of population migration, however, Japan differs significantly from other developed countries in that it is characterized by strong cultural independence, fewer foreign immigrants, and more aging migrants.

Migration was the underlying force in the redistribution of the population in Japan. With population being the ultimate consumers of economic activities, changes in the distribution among prefectures as a result of internal migration, will affect public financial expenditures, the efficiency of resource allocation, and the level of economic growth in each region against the background of aging.

Our study focused on the impact of inter-prefecture migrant population on the dependency ratio in Japan. Based on the fact that not all individuals are equality productive, our study accounted for differences in labor productivity caused by age and educational attainment. Unlike conventional age dependency ratio, we constructed an innovative indicator to measure dependency ratio caused by migrant population, as a way to re-examine the impact of spatial transfer of labor force between regions and the consequent dependency ratio changes in the receiving areas. In this regard, this breakthrough can help us do a good job in terms of top-level policy planning and system design in terms of allocation of labor resources in the macro context to aging.

2. Theoretical focus

When scholars discussed the contribution of Japan's migration to the economy and the dependency burden in the receiving areas, most of the studies used the total number of migrants or the working-age population in migrants. This is useful for understanding the trend of population dynamics over a long period of time. However, the economic impact of migration as well as the dependency burden may be affected by differences in the age distribution of the migrant population. Neglect of the age differences may lead to biased conclusions in the analysis of short-term economic burden. It is therefore necessary to further explore the differences in age structure and educational attainment in the study of mid- to long-term consequences of population aging and migration

Usually we used the conventional age dependency ratio to calculate the burden caused by internal migration across different areas. The conventional ratio considers everybody aged 15–64 as equally productive and all people above age 65 as unproductive. However, labor productivity has been changing significantly in recent years, and in the future, young people are likely to be significantly more educated than middle-aged and older people, and older people are likely to be significantly more productive because of their higher level of education. Therefore, it is necessary to account for labor productivity differences and its evolution in the study of the aging burden. In this paper, we proposed an innovative dependency indicator, the $\overrightarrow{PWLFDI}_{t}^{c}$ （Productivity Weighted Labor Force Dependency Index） and PWLFDR（Productivity Weighted Labor Force Dependency Ratio） to more accurately analyze the economic effect posed by migration in the receiving areas. This indicator can help approximate differences in productivity through various levels of educational attainment and age groups.

$$\overrightarrow{PWLFDI}_{t}^{c} = (\mathrm{M\_D}_{t}^{c},\ \beta_1 * \mathrm{M\_L}_{t}^{c} + \beta_2 * \mathrm{M\_H}_{t}^{c})$$

$$\mathrm{PWLFDR}_{t}^{c} = \frac{\mathrm{M\_D}_{t}^{c} \Big/ (\beta_1 * \mathrm{M\_L}_{t}^{c} + \beta_2 * \mathrm{M\_H}_{t}^{c})}{\mathrm{D}_{t}^{c} \Big/ (\beta_1 * \mathrm{L\_L}_{t}^{c} + \beta_2 * \mathrm{L\_H}_{t}^{c})}$$

Here, t represents for time, c represents for different prefecture, and $\mathrm{M\_D}_{t}^{c}$ represents for all the dependents of the net migration. The larger value of $\beta_1 * \mathrm{M\_L}_{t}^{c} + \beta_2 * \mathrm{M\_H}_{t}^{c}$ means more population inflow of working-age after the labor productivity being weighted. $\mathrm{L\_L}_{t}^{c}$ is the number of migrant working-age population without advanced higher education while $\mathrm{L\_H}_{t}^{c}$ is the number of working-age migrants with higher education. $\beta_1$and β_2 refer to the parameter of labor productivity of people without and with higher education degrees. $\beta_1 * \mathrm{M\_L}_{t}^{c} + \beta_2 * \mathrm{M\_H}_{t}^{c}$ is the number of working-age population of the migrants weighted by labor productivity. D_{t}^{c} represents for the number of dependents among all the resident population within a specific administrative area, and $\beta_1 * L\_L_t^c + \beta_2 * L\_H_t^c$ represents for the number of productivity-weighted labor-force in this area. Within any specific area, the productivity weight for resident population and the migrants remains the same. The denominator of the $PWLFDR_t^c$ is divided by the productivity-weighted labor-force dependency ratio of the destination, reflecting the marginal effect of dependency effect caused by migrants. Of all the indicators above, the most important step is the weight estimation, which will be shown in the next part.

3. Methods

The crucial part is the estimation of the differences in productivity caused by age and education variety. Previous research has shown the differences in productivity can be approximated through wage differentials associated with various levels of educational attainment. In theory, when the labor market is competitive, workers receive a salary equal to their marginal labor productivity. Therefore, we constructed the regression model as follows by use of the 1990-2010 data in Japan.

$$\ln(\text{wage})_{i,t} = c + a * \text{cycle}_{i,t} + \sum b * \text{EDU}_{i,t} * \text{Agegroup}_{i,t} + \epsilon$$

In the regression formula, t is time, i represents for the 47 prefectures in Japan, and $\text{wage}_{i,t}$ is the per capita wage in each prefecture. $\text{Agegroup}_{i,t}$is the age-specific share of the working population in each prefecture in Japan, $\text{EDU}_{i,t} * \text{Agegroup}_{i,t}$is the interaction between the age-specific share of the working population and the different levels of education. The share of labor force by age group is further divided by having higher education degrees or not. $\text{cycle}_{i,t}$ is the macroeconomic cycle. C is the regression constant term, a， b are the regression coefficients, and ϵ are the residuals.

4. Data

As to the variables included in the above regression, wage and the percentage of the working population by age group in Japan's 47 prefectures are annual data, mainly from the Statistics Bureau of Japan. The data on the percentage of education level by age group come from surveys conducted by the Statistics Bureau of Japan and were published every ten years. We obtained the annual data by linear interpolation based on the fact that educational attainment is a long-term trend with small fluctuations from year to year.

5. Expected Findings

(1) The youth and adult population with higher labor productivity become the main variables determining the degree of economic burden exerted by migrant population in the receiving areas.

The most economically developed region, represented by Tokyo, has a full range of high-quality social services; the region's highly internationally competitive industrial sector attracts a large inflow of the working population aged 20-49, which pushes up the region's total factor productivity, and population migration continues to mitigate the dependency ratio in this case. As for the regions represented by Fukuoka Prefecture, there is an overall net inflow of the working population while we see the continuous emigration of young people aged between 20-29. Migration serves to increase the dependency ratio in this case. For regions represented by Osaka Prefecture, there is a significant net outflow of the working population aged 30 to 49, resulting in a large loss of the productivity-weighted labor force. In the context of the outflow of the dependent population as well as the working-age population, the population emigration has further exacerbated the dependency ratio in Osaka Prefecture.

(2) For economically developed regions, the productivity-weighted labor-force dependency ratio of the migrant population is lower than that of the traditional dependency ratio, which only takes into account the overall number of working population and dependents. In this regard, the dependency ratio of the receiving areas can be mitigated to some extent by the higher productivity of the migrant population. In the case of the migrant population in Tokyo and Kanagawa, for example, the productivity-weighted labor force dependency ratios have been lower than the traditional dependency ratios that consider only the overall working population since 2010 (see figure 1), which is consistent with the findings of existing research on the dependency ratios in Japan. For Tokyo, the productivity-weighted labor force dependency ratio decreased significantly due to a higher share of adult population (aged between 30 and 49) inflow than that of Kanagawa Prefecture.

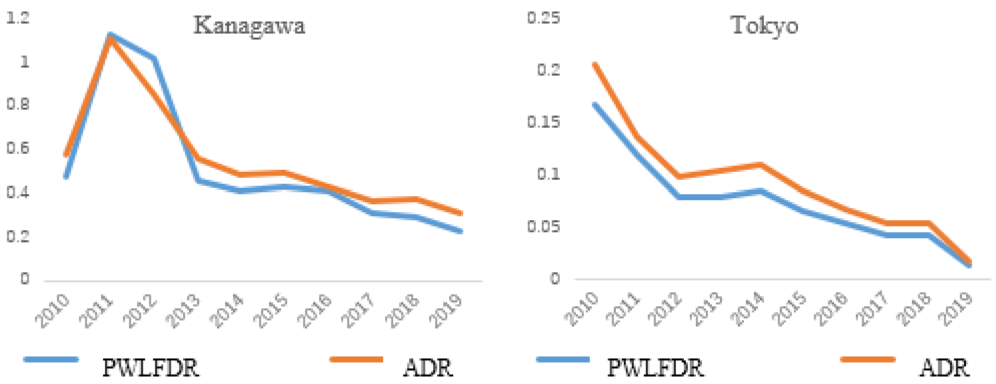

Figure 1 Comparison between PWLFDR (Productivity-weighted labor force dependency ratio) and conventional ADG (Age dependency ratio) of migrant population in Kanagawa and Tokyo

(3) Our findings provide scientific insights for future evidence-backed, forward-looking policy design to address the negative impacts of demographic aging. Facing the increasing dependency ratio as a result of aging, countries can address this issue by attracting working-age population, especially highly skilled migration, and adult and youth population with relatively high labor productivity, thus mitigating the negative effects caused by aging.