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KDI Journal of Economic Policy

Provided in Cooperation with:
Korea Development Institute (KDI), Sejong

Suggested Citation: Hur, Jinwook (2020) : Immigration to Korea: A Fiscal Boon or Burden?, KDI Journal of Economic Policy, ISSN 2586-4130, Korea Development Institute (KDI), Sejong, Vol. 42, Iss. 4, pp. 27-58,
https://doi.org/10.23895/kdijep.2020.42.4.27

This Version is available at:
https://hdl.handle.net/10419/227656

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KDI Journal of Economic Policy 2020, 42(4):27–58
http://dx.doi.org/10.23895/kdijep.2020.42.4.27

Immigration to Korea: A Fiscal Boon or Burden?†

By JINWOOK HUR*

This paper intends to examine the extent of the fiscal contribution of immigrants to Korea. According to this analysis, the aim is to derive implications pertaining to the direction of Korea's immigration policy as a response to fiscal problems caused by population aging. For this purpose, a macroeconomic model is designed to measure the lifetime net fiscal contribution of immigrants in Korea by visa type, age, and other characteristics. According to this analysis, the sum of the lifetime fiscal contribution for all immigrants in Korea is negative. This implies that immigration policy reforms that increase the inflow size while maintaining the current structure of the foreign population characteristics can rather worsen Korea's fiscal problems. This finding suggests that immigration policy reform may exacerbate Korea's fiscal soundness if it simply targets the maintenance of the numerical balance of the demographic structure.

Key Word: Immigration, Fiscal Sustainability, Population Aging
JEL Code: E60, H50, J61

I. Introduction

It is well known that Korea is one of the most rapidly aging countries in the world. The working-age population (15~64) has been in decline since 2017, and the overall population is expected to start declining in 2029 (Statistics Korea, 2019). Korea is still a younger country than most developed economies, such as those in Western Europe and Japan, but the speed of aging is expected to be far higher than in those countries. With this rapid population aging, the major problems already experienced by developed economies, such as problems with fiscal sustainability, can also occur in Korea, but more severely.

As these population imbalances and related problems have emerged as a major issue during the establishment of policy directions in Korea, various alternatives are

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* Received: 2020. 9. 25
* Referee Process Started: 2020. 9. 29
* Referee Reports Completed: 2020. 11. 18
† This paper is a revised version of Hur (2017). The author thanks the anonymous reviewers for their invaluable feedback which greatly helped improve this paper. The author also appreciates Haegi Cheon at KDI for her wonderful research assistance. All remaining errors are the author's own.

being discussed. One of these alternatives is a change to Korea's immigration policy so that Korea will allow more immigrants. While allowing immigrants into Korea has thus far mainly been thought of as a means by which to meet labor demands, the recent idea of an expansionary immigration policy considers immigration as a tool to mitigate the speed of population aging. In particular, mitigating problems such as low growth and the fiscal imbalance caused by the decline of the working-age population by allowing working-age immigrants who can engage in economic activities in Korea has been argued.

Indeed, it is not a new phenomenon from a global perspective that the expansion of immigration policy is mentioned as an alternative to aging. Some European countries, such as Germany and Sweden, which experienced slowing population growth caused by aging prior to Korea, have implemented active population inflow policies with the aim of securing labor and improving fiscal soundness. Even in other advanced economies, it is reported that countries with severe population aging tend to have a high proportion of immigrants to the native population.[1] Therefore, for the U.S. and the major European countries, the socio-economic effects of an influx of immigrants have been studied from various perspectives, as the movement of populations among those countries has been more active for more time compared to population movements in Korea. On the other hand, in Korea, it has not been as long since such discussions actively began. Although the number of foreigners residing in Korea is increasing rapidly, statistical data related to them have not been sufficiently accumulated quantitatively or qualitatively; accordingly, research to derive policy implications through rigorous empirical analyses remains as a future task.

However, despite the limited availability of data, analyzing the economic effects of immigration inflows is essential when setting immigration policies to respond to population aging. The main problem of aging is not simply stagnant or declining populations but rather a problem arising from the decrease in the relative size of the working-age population relative to the dependent population due to aging. In other words, a major policy consideration is whether various fiscal systems such as welfare systems can be sustained even during a population imbalance. Therefore, predicting how immigration policies can solve the problem of a population imbalance from an economic perspective using available statistics must be done prior to actual policy making activities. In this sense, it is an important task to predict the fiscal impact of immigrants using quantitative economic models.

For this purpose, this study aims to examine the main characteristics of foreigners residing in Korea based on available statistical data and then to quantitatively measure their impact on the government's fiscal soundness in Korea. Specifically, the main content of this study involves a measurement of how much immigrants will contribute through tax and fee payments relative to the amount of government expenditure caused by them, depending on their main characteristics, specifically their visa type, gender, and age. In particular, by estimating how the fiscal contribution of immigrants differs according to the visa type held, this study attempts to derive implications for current foreigner policies in Korea, especially visa issuance policies.

This study is related to the literature on the fiscal impact of immigrants to the host

[1]Lee *et al*. (2015).

country. First, in a study of the U.S. economy, Auerbach and Oreopoulos (1999) estimated the fiscal effect of an influx of immigrants on the U.S. economy, arguing that if immigrants are strictly limited to young and highly skilled workers, the fiscal burden can be partially mitigated, whereas the overall fiscal effect appears to be insignificant. Lee and Miller (2000) also draw similar conclusions using models that more realistically reflect the population sector. On the other hand, Storesletten (2000) analyzes the fiscal effect of an immigration inflow using a general equilibrium model reflecting the productivity effect on the supply side due to the immigration inflow. In this analysis, he argues that allowing 1.6 million highly skilled immigrants aged 40-44 into the U.S. economy every year can maintain the fiscal sustainability of the U.S. government even without tax reforms. Among studies focusing on European cases, Storesletten (2003) examines the fiscal impact of immigrants entering Sweden using Swedish data. In that case, it was found that immigrants aged approximately 20 to 35 make a positive contribution to the fiscal soundness of Sweden, whereas immigrants of other ages have a negative impact considering that government expenditures related to this group exceeds their lifetime taxes and fees. In other words, he claims that the ages of immigrants have a considerable influence on their degree of fiscal contribution. Schou (2006) presents the results of an analysis of the CGE model using Danish data, showing that the average immigrant imposes a greater fiscal burden compared to their fiscal contribution. Rowthorn (2008) conducts an empirical analysis of immigrants in major European countries and shows that the net contribution of immigrants to the host country's fiscal status as a whole is positive but negligibly small. On the one hand, Imrohoroglu *et al*. (2017) argues that increasing short-term foreign workers (guest workers) is a reasonable policy alternative to Japan's rapidly aging and declining working-age population using a general equilibrium model analysis. In their study, they argue that Japan's fiscal problem can be partly solved by allowing more guest workers even if all of the immigrant workers are low-skilled workers.

With regard to studies of the Korean economy, few explicitly analyze the fiscal contributions of immigrants. One of these with theme similar to this is that of Chun (2012), which focuses on how the influx of immigration affects overall productivity in Korea. He shows that the inflow of immigrants can increase the per-capita GDP if their productivity is high enough and public expenditures on them are not excessively large. Lee *et al*. (2009) analyzes the effect of an influx of immigrants on the population structure of Korea, concluding that if multicultural families increase, their high fertility rates can substantially alleviate the population imbalance and decline in the working-age population otherwise occurring due to aging in Korea.

This study aims to estimate the fiscal impact of immigrants entering Korea according to visa type, gender, and age, referring to the earlier studies mentioned above. The model for the analysis basically stems from the partial equilibrium model used in existing articles but is modified and extended to reflect the actual Korean economy. For the sectors related to household consumption and the labor market in the model, the method of Storesletten (2003) is applied, in which consumption, savings, and labor input are determined in the form of behavioral equations instead of solutions to the optimization problem. However, his model is modified and extended for the government sector and the immigration policy sector so that it can reflect the reality of Korea to the greatest extent possible. In particular, the national

pension, government consumption and transfers are modeled to better suit the Korean system.

Moreover, one of the expected contributions of this study to the literature is that the model actually reflects a visa issuance policy suitable for the reality of Korea. In many existing partial equilibrium estimation models, it is often assumed that all immigrants stay without leaving the host country for their lifetime once they enter, while the model used in this study distinguishes major visa types and derives a solution using not only age and gender but also the immigrants' visa types. Therefore, the method of this study is specialized in deriving implications for immigration policy – i.e., the visa type to be issued.

The rest of this paper proceeds as follows. The immigration policy and visa types existing in Korea are introduced in Section II. The model setup is demonstrated in Section III, and the calibration strategy is explained in Section IV. After describing the results of the analysis in Section V, Section VI concludes the paper.

II. Immigration Policy and Major Visa Types of Korea

Before explaining the model analysis, this section briefly introduces Korea's major visa types. First, the paper discusses how visa types are classified. Based on this, one of the main data sources used in this study, the *Survey on Immigrant's Living Conditions and Labour* by Statistics Korea, is discussed.

The main purpose of this study is firstly to estimate the fiscal contribution of foreigners who stay in Korea for a reasonably long time. Accordingly, foreigners entering Korea with a visa for less than one year are excluded from the analysis, and the subject of the analysis is limited to those with a visa that allows a stay of one year or more. Those foreigners (with a visa for one year or more) are defined as "immigrants" in this study.[2] There can be several ways to classify immigrants, but in this paper, the methods of Lee and Nho (2013)[3] are applied. Table 1 classifies the types of immigrants into those present for short-term work purposes, long-term work purposes, family purposes, and long-term residence purposes.

Each category of Table 1 is described as follows. First, the short-term work purpose type consists of visas such as those for students (D-2, D-4-1, and D-4-7), non-professional employment (E-9), and work visits (H-2). The non-professional (E-9) types are for foreigners entering Korea under the employment permit system, and the government decides on the number of these according to the industry based on the demands of companies that want to hire foreign workers. Regarding work visitors (H-2), the government also determines the number of visas issued from compatriots in China and countries of the former Soviet Union. In other words, the numbers of both E-9 and H-2 visas issued are controlled by the Korean government. They are termed "short-term" in the sense that their period of stay is limited, and

[2]The Statistics Division of the United Nations defines "international long-term immigrants" as those who live in a country other than their main residence for more than 12 months, and "international short-term immigrants" as those staying for 3~12 months. This paper refers to foreigners residing in Korea who plan to remain for one year or more as "immigrants."

[3]Lee and Nho (2013) classify Korean visa types in accordance with OECD standards. Lee *et al.* (2014) analyzes the statuses of foreigners' entering and leaving according to this classification.

TABLE 1— CATEGORIZATION OF IMMIGRANTS

Purposes	Years of Stay	Visas in Each Category
Short-term Work Purpose	1~5 years	Non-professional Employment (E-9), Work Visit (H-2)
Long-term Work Purpose	5 years +	Professorship (E-1), Foreign Language Instructor (E-2), Research (E-3), Technology Transfer (E-4), Professional Employment (E-5), Arts and Performances (E-6), Special Occupations (E-7)
Family Purpose	5 years +	Family Visitation (F-1), Residency (F-2), Dependent Family (F-3), Marriage Migrant (F-6)
Long-term Residence Purpose	5 years +	Overseas Koreans (F-4), Permanent Residency (F-5)

Source: Lee and Nho (2013) and Lee *et al*. (2014) modified by the author.

once the period of stay is over, they must go through a procedure for re-qualification from the beginning.[4]

In contrast, regarding the other types (long-term work purposes, family purposes, and long-term residence purposes), extension of the visa is free or only slightly limited. While the aforementioned non-professional employment or work visit adopt a limited length of stay to prevent settlement, the visas in the other categories are relatively flexible in allowing an extension. The long-term work purpose visas are mainly called "professional staff" (E-1~E-7 visas), as they consist of visas for cases such as professorships, research, and conversational instruction. The family purpose type consists of residential (F-2), family visitation (F-1), and marriage migrant (F-2-1, F-6) visas.

Table 2 shows the amounts of immigrants staying by visa type as of the end of 2016. It can be observed that non-professionals, work visitors, overseas Koreans, and marriage migrants account for a high proportion, whereas the number of professional staff visas is relatively small.

The most important data source used in this study to examine how the fiscal contribution of immigrants differs in terms of visa type, gender, and age is the "Survey on Immigrant's Living Conditions and Labour Force." This survey extracts samples from all registered foreigners in Korea and categorizes them according to eight visa types – non-professional employment (E-9), work visits (H-2), professional staff (E-1~E-7), students (D-2, D-4-1, D-4-7), overseas Koreans (F-4), permanent residents (F-5), marriage migrants (F-6, F-2-1), and others (See Figure 1). The survey includes gender, age, period of stay in Korea, average monthly income, labor force participation, employment, and other measures. Therefore, the actual model analysis is conducted according to the classification of visa type in the "Survey on Immigrant's Living Conditions and Labour Force," considering data availability. Student visas (D-2, D-4-1, and D-4-7) are excluded from this study because students do not generally work and thus do not fit the purpose of this study. Regarding this survey data, it is not possible to know which visas comprise the "Other" status, but compared to the number of foreigners staying by visa type

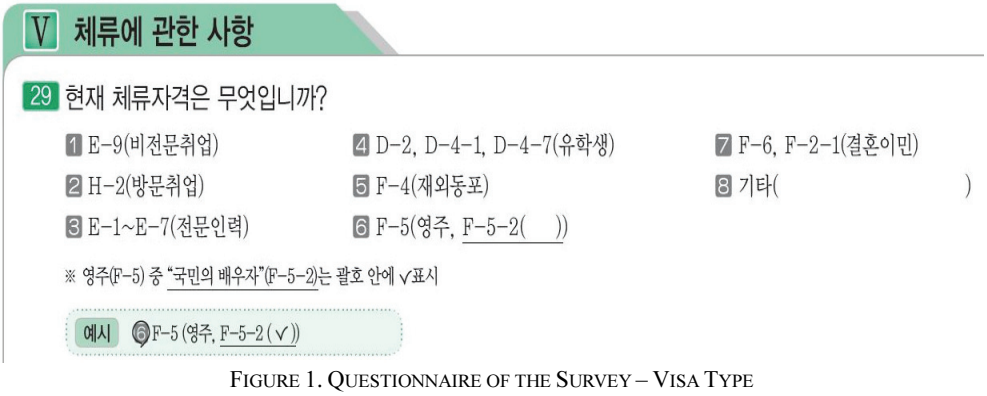
[4]For both the non-professional employment (E-9) and work visit (H-2) types, the period of stay is limited to 3 years, but one extension is possible for one year and ten months. In other words, the allowed stay duration is practically four years and ten months. After this period, one must go through the process of a qualification review from the beginning for re-qualification.

TABLE 2— SCALE OF IMMIGRANTS BY PURPOSE OF STAY AND VISA TYPE (2016)

Purpose of Stay	Visa	Number of Immigrants	Ratio to the Whole Immigrants with 1 year+ Stay (%)	Ratio to the Whole Foreigners (%)
Short-term Work Purpose	Non-Professional (E-9)	279,187	18.81	13.62
	Work Visit (H-2)	254,950	17.18	12.44
Long-term Work Purpose (Professional Staff)	Professorship (E-1)	2,511	0.17	0.12
	Foreign Language Instructor (E-2)	15,450	1.04	0.75
	Research (E-3)	3,174	0.21	0.15
	Technology Transfer (E-4)	187	0.01	0.01
	Professional Employment (E-5)	618	0.04	0.03
	Arts and Performances (E-6)	4,302	0.29	0.21
	Special Occupation (E-7)	21,498	1.45	1.05
Family Purpose	Family Visitation (F-1)	103,826	6.99	5.07
	Residency (F-2)	36,179	2.44	1.77
	Dependent Family (F-3)	22,828	1.54	1.11
	Marriage Migrant (F-6)	152,231	10.26	7.43
Long-term Residence Purpose	Overseas Korean (F-4)	372,533	25.10	18.18
	Permanent Residency (F-5)	102,840	6.93	5.02

Note: The sum of ratios to the immigrants with 1 year+ stay is not 100% since the table discards students and marriage naturalization. The total number of immigrants with 1 year+ stay equals 1,484,315, and the number of total foreigners equals 2,049,441.

Source: Ministry of Justice, "Korean Immigration Service Statistics," 2016.


V 체류에 관한 사항

29 현재 체류자격은 무엇입니까?

1 E-9(비전문취업)
2 H-2(방문취업)
3 E-1~E-7(전문인력)
4 D-2, D-4-1, D-4-7(유학생)
5 F-4(재외동포)
6 F-5(영주, F-5-2( ))
7 F-6, F-2-1(결혼이민)
8 기타( )

※ 영주(F-5) 중 "국민의 배우자"(F-5-2)는 괄호 안에 √표시

예시 ⑥ F-5 (영주, F-5-2 (√))

FIGURE 1. QUESTIONNAIRE OF THE SURVEY – VISA TYPE

provided by the Ministry of Justice, approximately 72% of foreigners who responded with "Other" are likely to have family-related visas.

III. Model

The major goal of the model is to derive fiscal implications of the immigration influx by computing immigrants' fiscal contributions and fiscal costs. A partial equilibrium model is used for the model analysis. Although a partial equilibrium

model does not consider behavioral changes of agents in the markets, it more readily reflects the heterogeneity of agents and maps complex fiscal institution in the real world into the model. Therefore, this study relies on the partial equilibrium setting, in which the only equilibrium condition is the government's long-run budget constraint.

Essentially, the details of the model are similar to those in Storesletten (2003), but the model of this paper better reflects Korea's reality. For instance, the model considers return migration of guest workers, while Storesletten (2003) assumes that all immigrants stay in the host country for life.

The model has dynamic overlapping generation properties. Total population is divided into natives and different types of immigrants, and they earn income by supplying labor. A certain portion of the income is taxed, and each agent then decides how much to consume and save. The government spends tax revenue on various types of government consumption, transfers, pension payments, and other purposes. The details of the model are described below.

A. *Demographic Structure*

Total population consists of natives and the immigrant populations holding seven different types of visas. Each person has a gender (either male or female) and age (from 0 to 99). A newborn child is assumed to be zero years old and can live only up to 99 years old. In the model, one period corresponds to one year; therefore, each agent can survive for up to 100 periods.

Agents are distinguished by only five variables – age, gender, labor market participation, visa type, and age at the time of immigration. It is assumed that two agents are perfectly identical if those five types are also identical. For brevity, a five-dimensional type vector (i, s) is used, in which i stands for age, and $s \equiv (s_1, s_2, s_3, s_4)$ for (gender, labor market participation, visa type, age at the time of immigration), respectively. The range of values that each subtype can have is shown in Table 3. Theoretically, the number of types can be as high as $100 \times 2 \times 2 \times 8 \times 100 = 320,000$.

First, we discuss assumptions pertaining to the duration of stays for foreigners. In actuality, E-9 (the non-professionals) and H-2 (work visitors) holders are allowed to stay in Korea for up to four years and ten months. In this study, it is assumed that all H-2 and E-9 holders (if they do not die before their visa expires) return to their home country after exactly five years. In other words, the possibility of return migration to the home country is excluded before five years. On the other hand, immigrants with other types of visas (professional staff, marriage migrants, overseas Koreans, permanent residents, and others) are assumed to stay in Korea for their lifetime and never to return to their home countries.

Next, we discuss assumptions about fertility for each type. In reality, it is expected that visa holders for five years or less (such as H-2 and E-9 holders) have very low fertility rates in Korea. In the model, for simplicity it is assumed that the foreigners with these two types of visas do not give birth at all in Korea, and only foreigners with other types of visas (professional staff, marriage migrants, overseas Koreans, permanent resident, and others) are assumed able to give birth in Korea. Additionally,

TABLE 3— TYPES OF THE AGENTS IN THE MODEL

Types	Meaning	Number of Cases	Note
i	Age	100	an integer for 0~99
s_1	Gender	2	{male, female}
s_2	Labor Market Participation	2	{participants, non-participants}
s_3	Visa Type	8	{native, non-professional, work visit, professional, marriage migrant, overseas Korean, permanent resident, other}
s_4	Age at the Time of Immigration	100	An Integer for 0~99

TABLE 4— ASSUMPTIONS ON FERTILITY AND DURATION OF STAY IN THE MODEL ECONOMY

Visa Types	Able to Give Birth in Korea	Duration of Stay in Korea
Native	O	0 Years Old to Death
Non-professional Work Visit	X	5 Years after Entrance, or Death (Death Can Come Earlier than 5 Years)
Professional Marriage Migrant Overseas Korean Permanent Resident Other	O	Entrance to Death

every child born in Korea is assumed to be a native Korean, even if any of her parents is a foreigner.

Finally, it is assumed that all agents of a certain type have an identical stream of survival rate by age. The unconditional probability that a type s agent survives at age i is denoted by $\Pi_{i,s}$. Therefore, $\Pi_{0,s}=1$ for all s, and the conditional probability that an agent alive at age i is alive at age $i+j$ equals $\Pi_{i+j,s}/\Pi_{i,s}$.

B. *Labor Market*

The labor market is drastically simplified in order for the model to concentrate on fiscal implications. First, those 19~64 years of age are considered to be of working age. Agents under 19 or over 65 years old are assumed not to work at all. The working-age population consists of labor force participants and non-labor force participants, and the labor force participants are either employed or unemployed. For the sake of simplicity, it is assumed that all agents are divided into labor force or non-labor force participants with a certain probability at the age of 20 and that this status is maintained for their lifetimes thereafter. Moreover, in determination of those employed or unemployed, it is assumed that a predetermined unemployment rate $u_{i,s}$ exists such that all labor force participants of type (i,s) are employed for $1-u_{i,s}$ of a period and are unemployed for the remaining $u_{i,s}$ of the period. This simplification intends to resolve the complexity of the computation caused by heterogeneity of the work status within the same type.

The pre-tax wage of each type of labor force participant depends on the type-specific labor productivity and the duration of employment described above. This is expressed as follows:

$$\text{(Labor income of a type } (i,s) \text{ at period } t) = W_t \cdot e_{i,s} \cdot (1 - u_{i,s})$$

Here, W_t refers to the wage per efficiency unit of labor, which is identical for workers of all types, and $e_{i,s}$ is a parameter representing the productivity of each type. A worker can earn more labor income by working for the same time if he has a higher $e_{i,s}$, implying that there is a wage gap caused by differences in productivity among workers of different types. Regarding non-labor force participants, $e_{i,s} = 0$ is assumed; that is, no labor income is earned. Moreover, W_t grows for every period at a rate of z. In other words, the wage per efficiency unit of labor in period t is represented by $W_t = (1+z)^t W_0$. This model setup intends to exclude supply-side factors in the usual general equilibrium models by assuming that labor productivity is homogeneous among the agents of the same type. Also, it does not take into account the potential effect on wages or unemployment that the influx of immigrants may cause. In fact, there has long been debate among economists on whether an influx of immigrants can increase the unemployment rate or decrease the wages of existing native workers, but it appears that recent empirical works tend to find no significant effect.[5] Therefore, the assumption pertaining to the labor market above may not be an oversimplification.

C. *Government*

The government spends its budget on government consumption, transfers, health insurance benefits, and national pension benefits. The government finances its expenditures by levying taxes.

Taxation

Taxation is assumed to have a simple form. The tax system consists of consumption taxes and income taxes (including social insurance contributions). Each of these taxes is considered a proportional tax with a single tax rate. All agents pay τ_c of their own consumption and τ_1 of their own income.

This simplified tax system considering only the two average tax rates in this model is used because it is necessary to estimate the taxpayer's income distribution in order meaningfully to reflect the progressive tax system that most closely approximates

[5]Peri (2014) surveys 270 analyses from 27 of the latest papers that empirically analyze the effects of an influx of immigrants on the wage levels of native workers for different countries, regions, and methods, finding that more than 75% of the studies conclude that the elasticity of the immigration influx is between -0.2 and 0.2, i.e., close to zero. In addition, the remaining 25% of the studies conclude that the effect of immigrants on the wages of the natives is positive. In particular, most studies of the short-term effects of immigration find that the effects of immigration are close to zero, whereas studies of long-term effects find that the estimated effects of immigration are positive.

reality. However, there is not a sufficiently good data source by which to measure the income distribution of immigrants to Korea. Although the average monthly salary of foreign workers is surveyed by the *Survey on Immigrants Living Conditions and Labour Force* of Statistics Korea, it is difficult to maintain the significance of the results, as the sample size is very small if classified according to visa type or age. Moreover, the monthly salary data are represented only in a wide range, making it difficult meaningfully to estimate the income distribution of immigrants.[6] Therefore, in this study, only a simple tax system with a single tax rate for both income and consumption is assumed.

Government Consumption

Government consumption consists of a variety of subcategories, some of which are used intensively for specific types of agents (e.g., education, health), while others are utilized on the population as a whole (e.g., defense, SOC). Considering these points, in the model it is assumed that the amount of government consumption per agent can differ for each type. For the initial period ($t = 0$), the amount of government consumption per agent with type (i, s) is denoted as $g_{i,s}$, and the measure of population with type (i, s) at period t is denoted as $\mu_{i,s,t}$. It is also assumed that the per-capita government consumption increases at a rate identical to that of the average wage mentioned above. As a result, the total government consumption for period t is expressed as follows:

$$G_t = (1+z)^t \sum_{i,s} g_{i,s} \mu_{i,s,t}$$

Transfers

Transfer payments are divided into welfare expenditures ($b_{i,s}$) and work-related expenditures, and work-related expenditures are again divided into unemployment benefits ($ub_{i,s}$) and industrial accident compensation ($ia_{i,s}$). Welfare expenditure is divided into expenditures for specific types and spending for the entire economy in a manner similar to the above-mentioned government consumption. All components of the transfer payments ($b_{i,s}$, $ub_{i,s}$, $ia_{i,s}$) are assumed to grow at a rate of z every period; this rate is identical to the growth rate of wages.

It is assumed that welfare expenditures are transferred to the beneficiary at a fixed amount, while work-related expenditures are paid in proportion to the productivity of the beneficiary. Unemployment benefits ($b_{i,s}$) are also assumed to be distributed to labor force participants during unemployment periods, and industrial accident compensation ($ia_{i,s}$) is distributed to the labor force participants during employment periods. As a result, welfare expenditures, unemployment benefits, and industrial

[6]The total amount of monthly income of foreigners surveyed is listed in only four categories: "less than 1 million won," "1 million to 2 million won," "2 million to 3 million won," and "more than 3 million won."

accident compensation per capita for each type are summarized below.

$$(\text{Welfare expenditure per capita in type } i,s) = b_{i,s}$$

$$(\text{Unemployment benefit per capita in type } i,s) = u_{i,s} e_{i,s} ub_{i,s}$$

$$(\text{Industrial accident comp. per capita in type } i,s) = (1-u_{i,s}) e_{i,s} ia_{i,s}$$

Health Insurance and National Pension

National health insurance is assumed to be subscribed to by all agents, including immigrants, while the national pension is subscribed to only by labor force participants. The volume of health insurance benefits ($hc_{i,s}$) differs according to the type of beneficiary depending here on their age, gender, visa status, and other factors and does not rely on the timing of work entrance or work status. The national pension benefit ($pen_{i,s}$) is basically paid to retirees aged 65 years or older in the model and depends on the recipient's labor income while she was working when young (termed the "B-value") and the average total income of all subscribers ("A-value") such that it mimics Korea's national pension system in reality. It is assumed that these two benefits ($hc_{i,s}$, $pen_{i,s}$) also grow at a rate of z, as does the wage rate. Details of the calculation method are described in the next section on the calibration of the model.

D. *Private Consumption*

All agents, including natives and immigrants, spend all of their disposable income on consumption during their lifetimes. Newborn children begin their life without any initial assets. With regard to immigrants, the possibility of immigration with some assets is considered, but it is assumed that the income immigrants earned before their migration is exactly equal to the income that would have been obtained if they had done business in the host country.

Assuming a constant relative risk aversion, a constant interest rate and a constant growth rate, the propensity to consume for each period is determined only by age but not by the timing of consumption. Therefore, the propensity to consume corresponding to each type can be denoted as $\{\xi_{i,s}\}_{i=0}^{99}$ without the time subscript. The consumption function of the initial period ($t=0$) can then be expressed as the portion corresponding to the propensity to consume among the present value of lifetime income, as follows:

$$c_{i,s,0} = \frac{\xi_{i,s}}{1+\tau_c} \cdot \sum_{j=0}^{99} \Pi_{j,s} R^{-j} (1+z)^j \cdot [\{(1-\tau_1)W_0 + ia_{j,s}\}(1-u_{j,s})e_{j,s} + ub_{j,s} u_{j,s} e_{i,s} + \varphi_{j,s}]$$

The expression between the square brackets on the second line represents the sum of all types of income by the type (i,s) of agent. The first term in the brackets

indicates the sum of wages and industrial accident compensation and the second term represents unemployment benefits. In the last term, $\varphi_{i,s} \equiv b_{i,s} + hc_{i,s} + pen_{i,s}$ represents the agent's income, determined to be unrelated to the agent's productivity, such as welfare expenditures, health insurance, and national pension benefits. R is a time-invariant gross interest rate and $\Pi_{i,s}$ represents the unconditional probability of survival for each type.

In the above consumption function, because W, $ia_{i,s}$, $ub_{i,s}$, and $\varphi_{i,s}$ grow at the same rate z, consumption also increases precisely at the same rate every period. Thus, per-capita consumption by type can be expressed by the following formula.

$$c_{i,s,t} = (1+z)c_{i,s,t-1}$$

E. *Equilibrium Condition*

As shown thus far, this model has a simplified structure in which the wage rate is determined exogenously and consumption is determined by the consumption function of the households instead of explicitly considering the optimization problem of the households. Therefore, the wage rate and parameters of the consumption function must be given from outside the model. The only equilibrium condition in this model, therefore, is the inter-temporal government budget constraint (IGBC, henceforth). The IGBC means that the government's initial debt size must equal the sum of the present value of the future primary fiscal balance so that the government's debt satisfies the 'No Ponzi Game Condition'. If this equation is not satisfied, it means that the government debt level is not sustainable given the current tax revenue and government expenditures. The IGBC of this model can be represented by the following equation.

$$D_0 = \sum_{t=0}^{\infty} R^{-t}(REV_t - G_t - T_t - HC_t - PEN_t) \tag{1}$$

Here, D_0 represents government debt in the initial period, REV_t is the total tax revenue at time t, G_t denotes government consumption at t, HC_t is the total health insurance benefit, and PEN_t is the national pension benefit. Therefore, ($REV_t - G_t - T_t - HC_t - PEN_t$) is equal to the primary balance of the government.

IV. Calibration

Most of the parameters are sourced from data outside of the model, and only a few parameters are determined inside the model by the fiscal equilibrium condition (IGBC). This section describes the calibration method used for the key parameters and distribution. Basically, most of the parametrization steps are conducted to match the initial economy ($t = 0$) of the model to the actual figures for 2015.

A. *Demographic Structure and Dynamics*

Fertility and Mortality Rates

Fertility and mortality rates are assumed to remain at the 2015 level for all periods in this analysis. The fertility rate of native women by age is calculated using data from the 'Vital Statistics' and 'Population Census' databases of Statistics Korea. Regarding the fertility rate of foreign women in Korea, however, there is not much reliable data. For example, if the mother of a newborn child born in 2015 is a foreigner, one can find the mother's age and nationality but cannot find her visa status. Thus, it is difficult to estimate the fertility rate by age and visa status.

Therefore, assumptions must be applied to calibrate fertility by visa type in this model. First, it is assumed that non-permanent immigrants (E-9 and H-2 holders) do not give birth in the host country at all. Considering they can stay with their visa only up to five years, this may not be a strong assumption. Secondly, the fertility of marriage migrant visa holders is estimated according to the fertility of female immigrants (with all visa types) from selected countries[7] with high ratios of marriage migrants. Thirdly, the fertility of those with other types of visas (professional staff, overseas Koreans, permanent residence, and others) is assumed equal to that of native women. As mentioned above, all newborns are considered to be native Koreans regardless of their parents' nationalities.

The gender ratio of newborns is fixed at 105:100 assuming that the actual birth rate in the "Vital Statistics" database of Statistics Korea in 2015 will be maintained in the future. This ratio is assumed to be independent of the mother's age, labor market participation, and visa status.

The age-mortality rate profile is calculated according to the unconditional probability of death for each age using the "Life Tables by Province" data from Statistics Korea. It is also assumed that there is no difference between foreigners and Koreans in terms of mortality.

TABLE 5— CALIBRATION OF PARAMETERS ON FERTILITY AND MORTALITY

Parameter	Visa Type	Method
Fertility	Native	"Population Census", 2015 by Statistics Korea
	Marriage Migrant	Fertility of females from major source countries of marriage migrants. Date sources are "Vital Statistics" of Statistics Korea and "Korean Immigration Service Statistics" of Ministry of Justice of Korea
	Non-professional and Work Visit	Assume that they do not give birth in Korea
	Immigrants other than above	Assume the identical fertility with the native
Mortality	all	Unconditional mortality rate is computed using "Life Tables by Province" of Statistics Korea. (Mortality rate of immigrants is assumed to be equal to that of the native.)

[7]The selected countries are those with 45% or more marriage migrants (F-6) out of all immigrants and where the number of marriage migrants exceeds 100. Those countries are Laos, Vietnam, and the Philippines. In other words, the fertility rate of all female immigrants from those three countries is used as a proxy for the fertility of all female F-6 holders. The estimated TFR is 2.63, lower than the estimate by Lee *et al*. (2009).

Population Distribution and Immigration Policy

The population of natives by gender and age is constructed using data from the "Population Census" of 2015. The distribution of immigrants by gender and age is calculated using the 2015 source data entitled "Survey on Immigrant's Living Conditions and Labour Force" by Statistics Korea.

Regarding the immigration policy – the number of immigrants by visa type, gender, and age – it is assumed that the immigration policy of 2015 will be maintained in the future. In other words, new migrants in the period after 2015 will have an identical distribution in 2015 with regard to visa type, gender, and age. First, using data from the "Survey on Immigrant's Living Conditions and Labour Force" of 2015, the number of immigrants who reported that their length of stay is less than a year is calculated according to visa type, gender, and age. Then, from 2016, it is assumed that the amount and distribution of immigrants that enter each year remain the same. The key features of new immigrants in the model economy are shown in Table 6.

TABLE 6— CALIBRATION IMMIGRATION POLICY: ANNUAL NEW ENTRANCES BY VISA TYPE

Visa Type	Number of Entrants	Average Age	Average Gender Ratio (M : F)
Non-professional	35,470	27.5	1,180 : 100
Work Visit	34,138	44.9	207 : 100
Professional	6,933	28.6	117 : 100
Marriage Migrant	3,963	32.6	13 : 100
Overseas Korean	19,780	54.2	123 : 100
Permanent Residence	564	55.2	68 : 100
Others	32,554	40.6	96 : 100

Source: Calculated using Statistics Korea, "Survey on Immigrant's Living Conditions and Labour Force."

Return Migration

With regard to the non-professional employment (E-9) and work visit (H-2) types, it is considered that their upper limits for stays are fixed at four years and ten months in both cases. However, instead of granting a ceiling within the model, all E-9 and H-2 holders are assumed to return to their home country after living in Korea for exactly five years. Regarding the residences of the remaining types of visas, it is assumed that they all remain in Korea for their lifetimes.

B. *Economic Activity and Labor Market*

The working-age population ranges from 19 to 64 years old, and those in the population aged outside this range are assumed to have zero labor productivity. The efficiency unit wage rate (W_0) of the initial economy is set such that the total annual income of the working-age population equals 1,568 trillion won, which equals Korea's growth national income (GNI) of 2015.[8] The growth rate of W_t (denoted

[8]In other words, income from factors other than labor is combined with labor income. Because the amount of

by z in the model) is assumed to be 3% annually, and the gross interest rate (R) is assumed to be 1.04, i.e., net interest rate of 4% per year.

The implications of parametrizing z and R are as follows. In a general dynamic macro-model, let the discount factor of the utility function be denoted by $\beta < 1$. Then, the Euler equation in the steady state becomes $\beta R = 1 + z$. Putting $R = 1.04$ and $z = 0.03$ into the equation, β is calculated and found to be 0.99. In other words, setting a growth rate of 3% and an interest rate of 4% is equivalent to setting the discount factor of the utility at $\beta = 0.99$.[9]

Productivity by type, denoted by $e_{i,s}$, is estimated as follows. First, the gender and age-specific wages of native workers are calculated using supplementary survey data from the "Economically Active Population Survey." (Statistics Korea, 2015) For immigrants, it is assumed that the relative wage distribution by age and gender is identical to that of Koreans for each visa type, but weights are applied so that there is a gap in the scale. Weights are computed using data for average monthly salary by visa type from the "Survey on Immigrant's Living Conditions and Labour Force." The wage weights by visa type are listed in Table 8.

The ratio of the labor force to the non-labor force in the population by age, gender, and visa type in the initial economy is set using data from the "Economically Active Population Survey" and the "Survey on Immigrant's Living Conditions and Labour Force" for natives and immigrants, respectively. As mentioned above, when an agent becomes 19 years old, it is determined whether she is economically active or not,

TABLE 7— CALIBRATION ON WAGE

Parameter	Meaning	Value	Note
W_0	Efficiency Unit Wage Rate	81.8 Million Won	Targeting GDI to be 1,568 Trillion Won
z	Annual Growth Rate of Wage	3%	Author's choice
R	Annual Gross Interest Rate	1.04	Author's choice

TABLE 8— MONTHLY SALARY AND WEIGHTS RELATIVE TO THE NATIVE

Visa Type	Average Monthly Salary (Won)	Weight (Native = 1)
Non-Professional	1,959,792	0.85
Work Visit	1,851,284	0.81
Professional	2,451,326	1.07
Marriage Migrant	1,704,489	0.74
Permanent Resident	1,918,138	0.84
Overseas Korean	2,000,462	0.87
Other	2,245,608	0.98

Note: The average monthly salary of the native is 2.297 million won, and the weight is the proportion to 2.297. Note that the monthly salary is used only for computing weights, so these monthly salaries are not necessarily equal to those in the model economy.

Source: Calculated using Statistics Korea, "Survey on Immigrant's Living Conditions and Labour Force."

government expenditures is adapted to the national accounts of Korea, it is natural for the size of the income to also be adjusted to the total GDI in order for budget-balancing to be feasible.

[9]The solution of the model is very robust to changes of z and R as long as the discount factor is fixed at 0.99. For instance, even if a lower growth path is assumed in which $z = 0.01$ and $R = 1.02$, the solution deviates only negligibly.

TABLE 9— CALIBRATION OF LABOR FORCE PARTICIPATION AND UNEMPLOYMENT BY VISA TYPE

	Visa Type	LFPR		Unemployment Rate	
		Male	Female	Male	Female
Foreigners	Non-professional (E-9)	99.8%	99.9%	0.0%	1.1%
	Work Visit (H-2)	92.7%	77.5%	4.4%	7.3%
	Professional (E-1~E-7)	99.8%	98.4%	0.6%	0.0%
	Marriage Migrant (F-2-1, F-6)	82.9%	45.9%	6.8%	5.4%
	Overseas Korean (F-4)	79.7%	50.1%	8.9%	5.7%
	Permanent Residence (F-5)	89.2%	67.4%	4.6%	3.8%
	Others	63.0%	27.8%	8.9%	20.7%
Natives		84.6%	61.8%	3.7%	3.6%

Source: Calculated using Statistics Korea, "Economically Active Population Survey" and "Survey on Immigrant's Living Conditions and Labour Force," 2015.

and this setting does not change for her lifetime in the model economy. The probability of participating in the labor market for each gender and for both natives and immigrants is calibrated so that it equals the labor force participation rate of 2015 of each group. The unemployment rate for each group is also set by referring to the same source. Table 9 presents the average labor force participation rate and the unemployment rate by visa status in the model.

It is not easy to find appropriate data for measuring the propensity to consume. Thus, propensity to consume is estimated as follows using household consumption expenditure data by age group in the "Household Income and Expenditure Survey" as substitute data.[10] First, using 2015 data, the average consumption expenditure according to the householder's age is summed up horizontally, and the sum is assumed to be the average lifetime income. Then, using this outcome, the proportion of consumption for each age is computed and used as a proxy for $\xi_{i,s}$ for each (i, s). It is assumed that there are no differences in consumption propensity by gender, but the propensity to consume of immigrants is assumed to be lower than that of natives considering the fact that a considerable amount of immigrants' income is known to be remitted to their home countries. Specifically, the propensity to consume for non-professional employment (E-9) and work visitors (H-2), residence for whom is limited to five years, is assumed to be 20.2% of that of natives of the same age. For marriage migrants, their propensity to consume is set equal to that of natives, assuming that they tend to assimilate into the host country. For the other visa types (professional staff, overseas Koreans, permanent residents, and others), their propensity to consume is set to 65.5% of that of age-matched natives.[11]

[10] "Household Income and Expenditure Survey" (Statistics Korea, 2015) includes a variable denoted by "average propensity to consume," but this is different from the propensity to consume defined in the model of this paper. The average propensity to consume in that survey indicates what proportion of the disposable income of the corresponding age group is used for the consumption expenditure by each period, while propensity to consume in this article refers to the percentage of lifetime income spent at each age.

[11] The ratio of deductions by visa type is sourced from Jung *et al.* (2012; 2013).

C. *Government*

Government Consumption and Transfers[12]

Government consumption and transfer expenditures ($g_{i,s}$, $b_{i,s}$, $ub_{i,s}$, $ia_{i,s}$) are distributed with regard to each age group, gender, and visa type according to Korean government's settlement of the fiscal year 2015 (Ministry of Economy and Finance, 2016). First, the items in the statement are divided into transfers and non-transfers. Then the amount of non-transfers is categorized as government consumption. If some items in transfers and non-transfers are explicitly intended for a specific age or gender group (e.g., expenditures for elementary schools), then such amounts are assumed to be explicitly given to the corresponding groups.

Health Insurance

The benefit for natives by age and gender in 2015 is set based on the "National Health Insurance Statistical Yearbook." Data for immigrants' benefits by age, gender, and visa type could not be obtained, but the ratio of medical expenses per capita for natives and foreigners is available (see Figure 2). Thus, for foreigners, the distribution of the benefit for each age and gender is assumed to be identical to that of natives, and the scale of all types of foreigners' benefits is adjusted so that the native-foreign share of the total salary is equal to that in the 2015 data. It is also assumed that there are no differences among immigrants according to the type of visa.

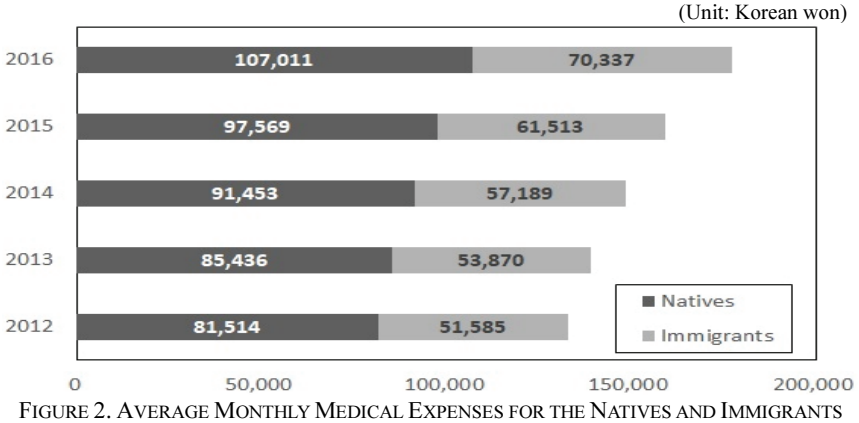


FIGURE 2. AVERAGE MONTHLY MEDICAL EXPENSES FOR THE NATIVES AND IMMIGRANTS

Source: Health Insurance Review & Assessment Service and National Health Insurance Service (2016).

[12]It is very likely that there are major differences between natives and immigrants in terms of benefits from the government. In this study, the types of benefits for which such differences can be identified, fully or partially, are considered. For instance, it is considered that the health insurance benefit to foreigners tends to be smaller than that given to natives of the same ages and gender. However, there are still many types of benefits for which such differences cannot be identified with existing data.

National Pension

With regard to the national pension, only the old-age pension and lump-sum refunds for non-professional employment and work visitors are taken into consideration, while other parts of the national pension (e.g., disability pension, survivor's pension, and lump-sum for death) are disregarded for simplicity.

To calibrate the pension benefit, a simplified formula is used instead of the actual method for convenience of the analysis, reflecting the current salary formula of the national pension system considering the past income of the recipient and economic income as a policy variable. First, regarding the old-age pension, the simplified formula reflects the pension system of Korea, which is a mixture of the average income of all beneficiaries (hereinafter, the A value) and the income of individual recipients (hereinafter, the B value). The formula is set such that the income replacement rate is fixed at 20% over all model periods.[13]

In addition, it is assumed that the maximum benefit rate can be applied to all beneficiaries regardless of the period of subscription to the national pension. Also, it is assumed that benefit payments are made exactly at the age of 65 in all cases.[14] Specifically, the annual benefit of retirees of type (i, s) in the initial period of the model economy is determined as follows:

$$pen_{i,s} = 0.1 \times (A + B_{i,s})$$

Here, A represents the annual average wage of all beneficiaries and B is the present value of the annual average wage earned by a retiree of type (i, s) before retiring. For instance, if the present value of a beneficiary's past average wage for a type (i, s) happens to be identical to the overall average, the pension benefit will be exactly 20% of her past income.

Regarding lump-sum refunds, the National Pension Act of Korea indicates that (1) if the foreigner's home country's law gives Korean citizens a corresponding salary equivalent to the lump-sum refund, or (2) if a social security agreement on lump-sum refunds is active, or (3) if the foreigner holds an E-8, E-2, or H-2 visa, then she will receive the principal and interest of her national pension payment during her stay as refunds when she leaves Korea. Based on this, our model also assumes that non-professional employees and work visitors receive lump-sum refunds of their pension payments when they leave the host country after a five-year stay.[15] However, because the labor income tax rate and the pension payment rate are not

[13]The income replacement rate, which is derived through a proportional constant in the original national pension formula, is 46.5% as of 2015, and is designed to reach 40% in 2028 by decreasing by 0.5%p every year. However, this is the nominal replacement rate assuming 40 years of entitlement in the national pension. In reality, Korea's national pension is not sufficiently mature, and it is practically impossible to join the national pension for 40 years due to retirement or other reasons. Therefore, the actual replacement rate is estimated to be around 20% in the literature. For example, the actual replacement rates of national pensions are estimated at 16.9%, 18.56%, and 23.98% in Shin (2015), Kim and Kwon (2016), and Woo *et al*. (2016), respectively. In the model used here, a defined benefit type of formula is assumed in that a real replacement rate of 20% is guaranteed.

[14]In reality, the rate of the benefit varies depending on the duration of entitlement, and the age of receipt is also set to a period of 60 to 65 years old instead of setting it at a certain age.

[15]In reality, Korean citizens can receive a lump-sum refund due to reasons such as an insufficient entitlement period. In the model, however, all beneficiaries except non-professional employees and work visitors are assumed not to select this option but to receive pension benefits only in the form of old-age pensions.

differentiated in this model, the exact amount of the lump-sum refund should be set arbitrarily outside the model. In the model, it is assumed that the foreign worker receives a value equal to the annual income (equivalent to the B value of the national pension benefit formula) multiplied by the average income replacement rate of the national pension, i.e., $0.2 \times B_{i,s}$.[16]

Government Debt and Taxation

This study assumes a hypothetical government account that combines the government's general accounts with major funds (National Pension Fund, WCI, and Employment Insurance Fund).[17] Thus, the government debt in the model is the government debt in the actual general account minus the sum of the national pension fund, the WCI fund (industrial accident insurance fund), and the employment insurance fund. As of the end of 2014, the government debt is approximately 527.1 trillion won, the national pension fund is 469.8 trillion won, the employment insurance fund is 7.6 trillion won, and the WCI fund is 10.2 trillion won. Therefore, the government debt of the initial period in the model economy is approximately 39.5 trillion won.[18]

The tax system of this model consists of the average income tax rate (τ_l) and average consumption tax rate (τ_c). Although τ_l is expressed such that it refers to the tax rate on labor income, it is actually different from the actual labor income tax rate in reality. In this model, taxes on capital income, such as corporate taxes and employers' contributions to social insurance, are not explicitly considered. Therefore, the term "income tax rate" is used throughout this article instead of the term "labor income tax rate." Therefore, it is more reasonable for the income tax rate here to be interpreted as a concept covering taxes on both labor and capital income and the contributions to various social security schemes.

Indeed, the average effective tax rate calculated by the method of Mendoza *et al.* (1994) using the national accounts and tax revenue data for 2015 for Korea is 25% for the labor income tax and 11% for the consumption tax. However, as mentioned above, τ_l in this model is different from the labor income tax rate conceptually, and this combination does not satisfy the above-mentioned government IGBC condition (Equation (1)), and given that $\tau_l = 0.25$ and $\tau_c = 0.11$, Korea's current debt level is not sustainable in the model economy. Therefore, the IGBC conditions should be adjusted by changing the consumption tax rate and income tax rate. In this paper, the consumption tax rate is fixed at 11% and the income tax rate is adjusted for balancing

[16]The payment rate for individual employees into the national pension is 4.5%, and the non-professionals and work visitors in the model stay in Korea for five years. By simple algebra, the lump sum is 22.5% of the annual income. Considering there are blind spots in the pension system, 20% is assumed to be a figure which measures immigrants' fiscal contributions quite conservatively.

[17]Regarding other funds such as the private school pension fund, they are considered to be relatively unrelated to immigration policy, even if the amounts are large. Thus, they are not included in the government account in this study.

[18]In this model, the sum of future primary balance changes very sensitively to changes in the income tax rate. Therefore, regardless of whether the initial debt is 39.5 trillion won or 527.1 trillion won, the difference in the equilibrium tax rate is less than 0.2%p, meaning that the model is very robust to the level of initial debt.

the budget constraint.[19] The income tax rate induced by this equilibrium condition is calculated and found to be approximately 39.3%.[20]

V. Results of Equilibrium Analysis

A. *Definition of Fiscal Contribution and Its NPV*

When consumption, hours worked, and government taxation and fiscal expenditures are realized in equilibrium, the contribution of each type of agent to the government's fiscal soundness can be calculated. The fiscal contribution of type (i, s) in the initial period of the economy ($t = 0$) is denoted as $fc_{i,s,0}$ and is defined as follows:

$$\begin{aligned} fc_{i,s,0} = {} & \tau_c \cdot c_{i,s,0} + \tau_l \cdot W_0 \cdot e_{i,s}(1-u_{i,s}) - g_{i,s} - b_{i,s} \\ & - hc_{i,s} - ia_{i,s}e_{i,s}(1-u_{i,s}) - ub_{i,s}e_{i,s}u_{i,s} - pen_{i,s} \end{aligned}$$

In other words, the fiscal contributions of agents of type (i, s) correspond to taxes levied on these agents minus government expenditures caused by or paid to them (government consumption, transfers, health insurance benefits, WCI benefits, unemployment benefits, and pension benefits). If this value is positive, the agents are considered to contribute to the government's finances in this period, whereas if it is negative, the fiscal burden is then greater than the contribution of the agents to the fiscal status of the government.

However, the fiscal contribution calculated in this way is only a measure of the fiscal contribution of an agent at a particular point in time. An agent will not have the same fiscal impact in the future. For example, if a 60-year-old immigrant enters the country and has a job, the fiscal contribution may be positive at the moment, but if she retires in only a few years and becomes old, the contribution will be negative thereafter. Therefore, it is necessary to sum them over time for more reasonable analyses. For this purpose, the NPV (net present value) of the fiscal contribution of the type (i, s) is calculated. In other words, we sum up the present value of the future fiscal contribution of each type of agent over time in order to evaluate the agents' lifetime contributions as of a period. Technically, the NPV is calculated by initially computing the NPV of a newborn (0 years old) and then calculating the NPV of the remaining agents using the newborn's NPV. The detailed procedure is shown below.

Let the NPV of type (i, s) at $t = 0$ be denoted by $npv_{i,s}$. As described above, the type element s consists of gender, labor market participation, visa type, and age at the time of immigration. Let m and f be subsets of s, let m be all types

[19]Alternatively, the balance can be met by fixing the tax rates and adjusting government spending or pension schemes.

[20]This tax rate may appear to be excessively high considering that the effective payroll tax rate in Korea is usually estimated to be less than 20%. However, note that τ_l in this study does not imply a labor income tax rate but a (consolidated) income tax rate, including not only labor income but also capital income. Considering this, the gap between the actual rate and the model rate becomes significantly smaller.

of males, and let f be females. Then, $npv_{0,m}$ and $npv_{0,f}$, NPV of male and female newborns, respectively, can be derived by solving the following simultaneous equations:

$$
(2)\quad \begin{aligned}
npv_{0,m} &= \sum_{i=0}^{99} \Pi_{i,m} R^{-i} \left[fc_{i,m,i} + \varphi_{i,m}(1+z)^{i} \left\{ \frac{105}{205} npv_{0,m} + \frac{100}{205} npv_{0,f} \right\} \right] \\
npv_{0,f} &= \sum_{i=0}^{99} \Pi_{i,f} R^{-i} \left[fc_{i,f,i} + \varphi_{i,f}(1+z)^{i} \left\{ \frac{105}{205} npv_{0,m} + \frac{100}{205} npv_{0,f} \right\} \right]
\end{aligned}
$$

Here, $\varphi_{i,s}$ represents the corrected birth rate of type (i,s),[21] and $fc_{i,s,t}$ is the fiscal contribution of type (i,s) at time t. In the equations, $\Pi_{i,m}$ and $\Pi_{i,f}$, the unconditional probability of survival at age i for each gender, are used because the unconditional and conditional probabilities are equal for a newborn child.

The implications of equation (2) are as follows. First, when a child is born, he or she will contribute as much as $fc_{i,m,i}$ every year during their life. Accordingly, the present value of this part is taken into account. Secondly, the second term of the square bracketed term considers the value of the children that this newborn may have in the future. He or she contributes to birth with probability $\varphi_{i,s}$ at the age i, and the child born is a boy with a probability of 105/205 and a girl with probability of 100/205, as mentioned in the previous section on calibration. Because there are two equations with two unknowns, the NPV for newborns of both genders can be solved.

After calculating the NPV of the newborn, the NPVs of the remaining agents can be calculated using the fact that all newborn children are considered to be natives regardless of their parents' nationalities.

$$
npv_{i,s} = \sum_{j=i}^{99} \frac{\Pi_{j,s}}{\Pi_{i,s}} R^{-j} \left[fc_{j,s,j-i} + \varphi_{j,s}(1+z)^{j} \left\{ \frac{105}{205} npv_{0,m} + \frac{100}{205} npv_{0,f} \right\} \right]
$$

B. *Results of Analysis*

Fiscal Contribution by Type

Before looking at the NPV, the distribution of the fiscal contributions by age for each type of agent as of 2015 ($fc_{i,s,0}$) is demonstrated. First, Figure 3 compares the average fiscal contribution of foreigners with Korean natives by age. The vertical

[21]Here, the fertility rate is corrected such that we apply only half of fertile women in the actual data to the women's contribution, with the other half applied as the males' contribution. In other words, this is similar to assuming that all children are born only between couples consisting of a male and a female. We also apply half of the female births to males who are two years older instead of males of the same age, considering the average ages of a husband and wife in Korea. This approach is different from that of Storesletten (2003), in which all NPVs through birth are assumed to be exclusively the females' contribution.

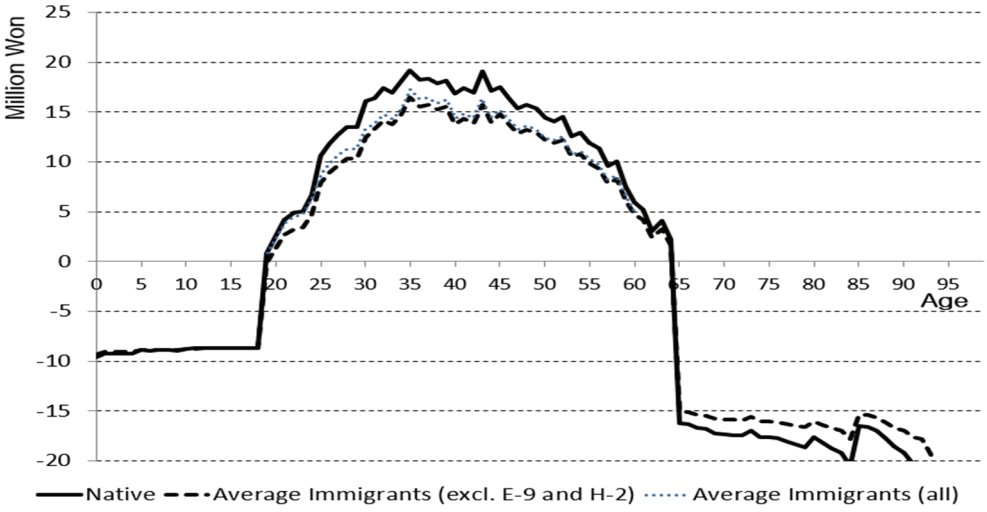


FIGURE 3. PER-CAPITA FISCAL CONTRIBUTION OF THE NATIVE AND IMMIGRANTS

axis in the figure indicates the average per-capita fiscal corresponding to each age. For example, a 0-year-old Korean native is estimated to have a fiscal contribution of about -9.6 million won, while a 40-year-old Korean native is estimated to make a fiscal contribution of about 16.9 million won. In other words, the average contribution of the per-capita income tax and consumption tax for a 40-year-old Korean native is greater than the government's financial burden per capita by about 16.9 million won.

In the range of working age (19-64 in the model), both natives and immigrants show positive (+) fiscal contributions, indicating that the tax revenues from these groups in that age range exceed the government's financial burden. Because the productivity of natives is assumed to be higher than that of foreigners on average, native Koreans make higher fiscal contributions than foreigners during their working years. On the other hand, for those aged 60 or older, this relationship is reversed, and the natives cause more of a financial burden. This occurs because natives have higher incomes during their working years than immigrants. Because natives have made more pension and health insurance contributions than immigrants, they are paid more after their retirement and exhibit smaller fiscal contributions than immigrants.

Figure 4 and Figure 5 show the breakdown of the fiscal contribution of foreigners by visa type. First, Figure 4 compares the per-capita fiscal contributions of professional staff (E-1~E-7) and overseas Koreans (F-4) to that of Koreans. For professional staff, they exhibit higher productivity and labor force participation rates than those of the natives on average. Therefore, their fiscal contribution in the working-age group is approximately 1.5~2 times higher than that of the natives. On the other hand, for overseas Koreans, the average fiscal contribution of the working-age group is slightly smaller than that of the natives given that their average wage is lower than that of the natives.

Next, Figure 5 shows the fiscal contributions of marriage migrants (F-2-1, F-6), permanent residents (F-5), and others. Permanent residents make similar fiscal contributions to natives, while marriage migrants and others make lower fiscal contributions than natives. For marriage migrants, they have the lowest productivity

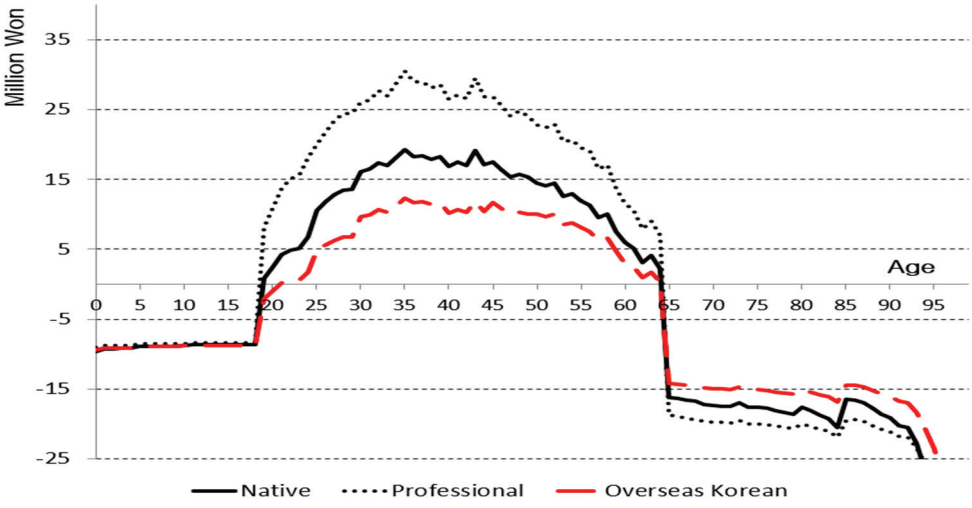


FIGURE 4. FISCAL CONTRIBUTION BY VISA TYPE – THE PROFESSIONAL AND OVERSEAS KOREANS

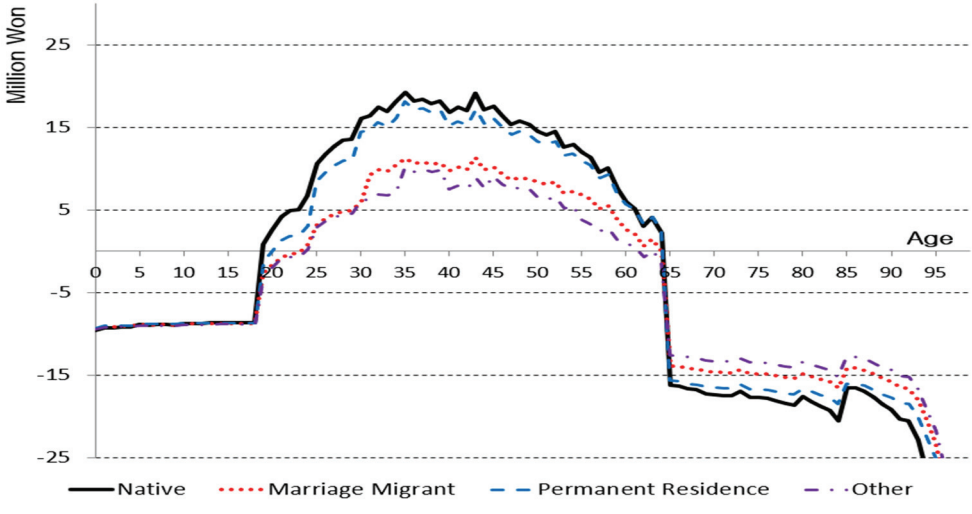


FIGURE 5. FISCAL CONTRIBUTION BY VISA TYPE –
MARRIAGE MIGRANT, PERMANENT RESIDENCE, AND OTHER

among the visa types considered in this study; hence, their contributions by paying taxes and social security are smaller than those of the natives. For the other visa types, although their average productivity is higher than that of marriage migrants, they exhibit the lowest labor force participation rate among all visa types. Thus, the average fiscal contribution for their working-age group is relatively low.

Lastly, we examine the fiscal contributions of non-professionals (E-9) and work visitors (H-2), who are assumed to stay for five years and then leave. In this case, the period of stay affects the fiscal contribution due to the lump sum return of the pension, and other factors. Figure 6 compares the per-capita fiscal contributions of the first-year non-professionals and work visitors to those of the natives. As shown in the figure, non-professionals show higher fiscal contributions than average natives, but this amount is slightly lower than that by native employees due to the

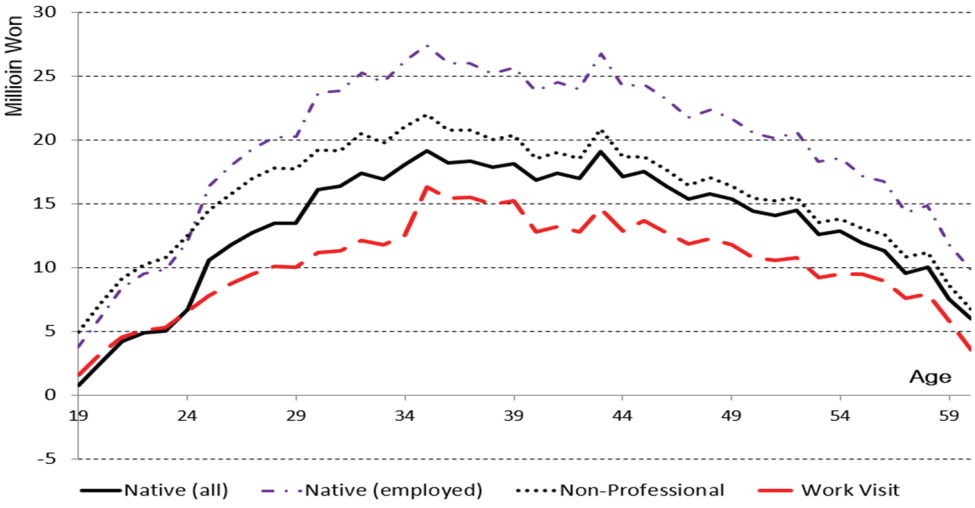


FIGURE 6. FISCAL CONTRIBUTION BY VISA TYPE – THE NON-PROFESSIONAL AND WORK VISIT

wage gap. Regarding work visitors, despite their high labor force participation rate, they show lower fiscal contributions than even the average natives.

NPV of the Future Fiscal Contribution

As mentioned earlier, the fiscal contribution ($fc_{i,s,t}$) is a measure of how much an agent of a particular type contributes to the government's fiscal soundness for a certain period, but this alone cannot be a measure of the fiscal contribution of an agent. Even if an immigrant makes a positive fiscal contribution for a certain period, it should also be considered how much of a fiscal burden will arise if he/she lives in the host country past their retirement. Moreover, if a birth occurs in the host country, the fiscal contribution made by the immigrants' descendants should also be considered. In order to determine the long-term effects of immigrants on public finances, the NPV of the fiscal effects must be included in the analysis for not only the instantaneous effects but also for the long-term effects.

Figure 7 illustrates the result after computing the average NPV of the natives by age. The average per-capita NPV for a newborn is estimated to be about 161.6 million won, which is a positive number.[22] This means that the fiscal contribution (taxes and social security payments) that a child newly born in 2015 is expected to make on average is expected to be larger than the fiscal burden caused by him/her by 161.6 million won (according to the 2015 value). For the average Korean, it is estimated that the NPV is positive until the age of 42. After 43, the present value of the tax burden to be paid by the economic entity catches up to the government spending caused by him/her.

[22]For reference, Storesletten (2003) conducted a similar study on Sweden and found that the NPV of a Swedish native newborn is around -46,000 kroner (about -6 million Korean won). If the NPV of a newborn is negative, one may doubt whether such an economy can be fiscally sustained. However, it is theoretically possible, as the NPV of Swedes of working age is positive given that the net fiscal gain of the working-age population in the initial period can compensate for the net fiscal burden of the newborns in the future.

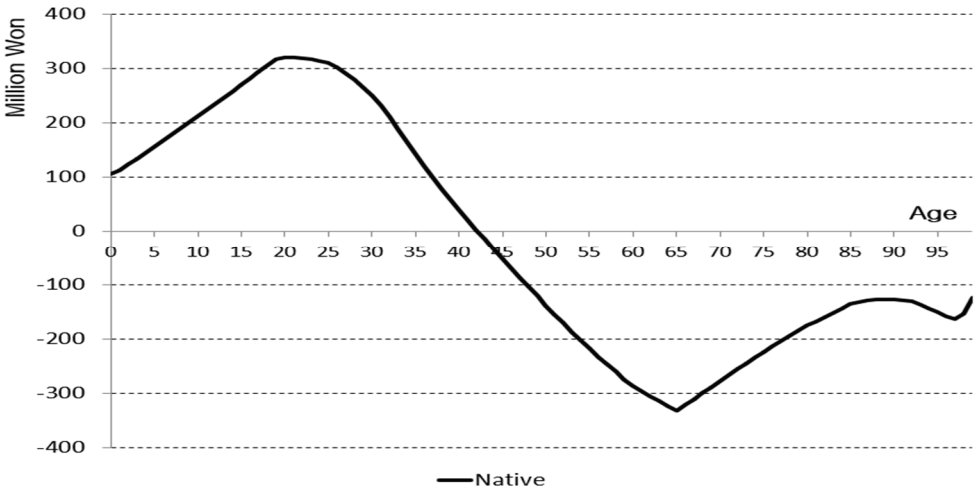


FIGURE 7. NPV FOR THE NATIVE

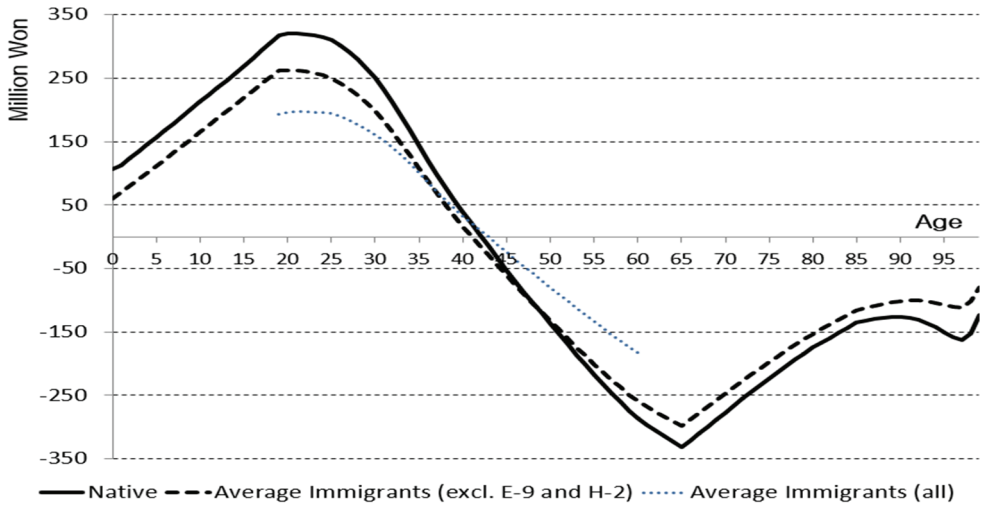


FIGURE 8. NPV FOR THE NATIVE VS. IMMIGRANTS

Figure 8 compares the NPV of average Korean to that of the average immigrant by age. When only considering immigrants with visas excluding non-professional employment (E-9) and work visit (H-2) types,[23] the NPV of the native becomes negative from the age of 43, while that of the average immigrant (excluding those holding E-9 and H-2 visas) becomes negative from the age of 42. The NPV of Koreans tends to be slightly larger than that of immigrants in the range where the NPV is positive. In order for the comparison to be more visible, the average NPV of a 0-year-old immigrant is compared with the NPV of a newborn, although immigration at 0 years old is not very realistic. The NPV of a 0-year-old immigrant

[23]Because E-9 and H-2 visa holders generally do not migrate to Korea outside of their working ages, the age-specific NPV of all immigrants cannot be computed. Therefore, the average NPV for all immigrants is only computable for the working ages (19~64).

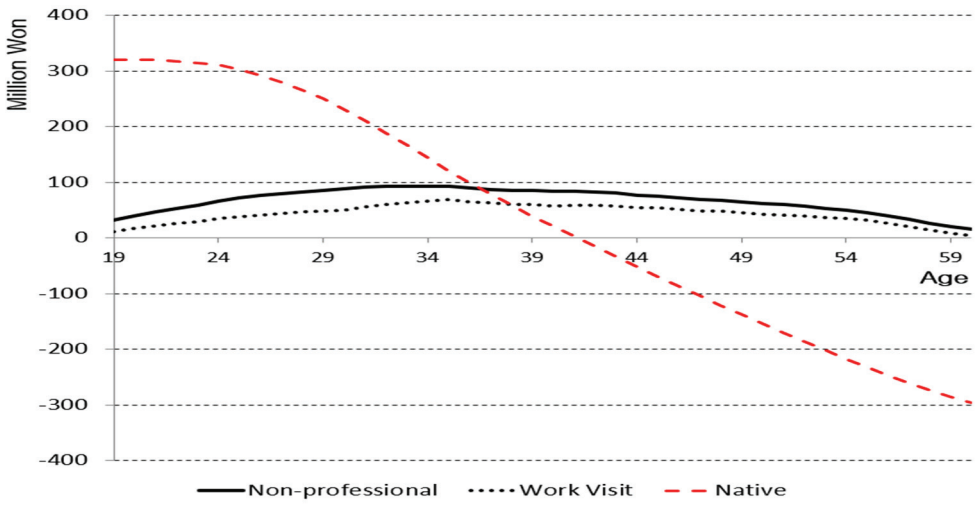


FIGURE 9. NPV OF THE NON-PROFESSIONAL AND WORK VISIT

is only 60.2 million won, which is lower than that of a 0-year-old Korean newborn, as the average productivity and the labor force participation rate of the immigrants are both smaller than those of natives during their working years. Considering the overall immigrants' average including E-9 and H-2 types, the average NPV of immigrants up to their 40s is lower but the transition from positive to negative is delayed because non-professionals and work visitors are short-term workers leaving Korea before their retirement. Because they mostly conduct economic activities and leave Korea before retirement, their NPVs are always positive.

Figure 9 demonstrates this more clearly. It compares the age-specific NPV of Koreans to those of non-professionals and work visitors directly. For native Koreans, the NPV up to their mid-30s is much higher than those of non- professionals and work visitors. However, as the age increases, the NPV of native Koreans declines sharply, while the NPVs of non-professionals and work visitors exhibit a stable path over time.

Figure 10 and Figure 11 show the NPVs of immigrants holding the remaining visa types. The immigrants with professional staff visas (E-1~E-7) during their working years exhibit high NPVs nearly twice as high as that of natives, and the value remains positive up to the age of 46 due to their high productivity and labor force participation rates. Meanwhile, the NPV of permanent residents (F-5) is similar to that of native Koreans. Overseas Koreans (F-4), marriage migrants (F-2-1, F-6), and others show lower NPVs than that of native Koreans.

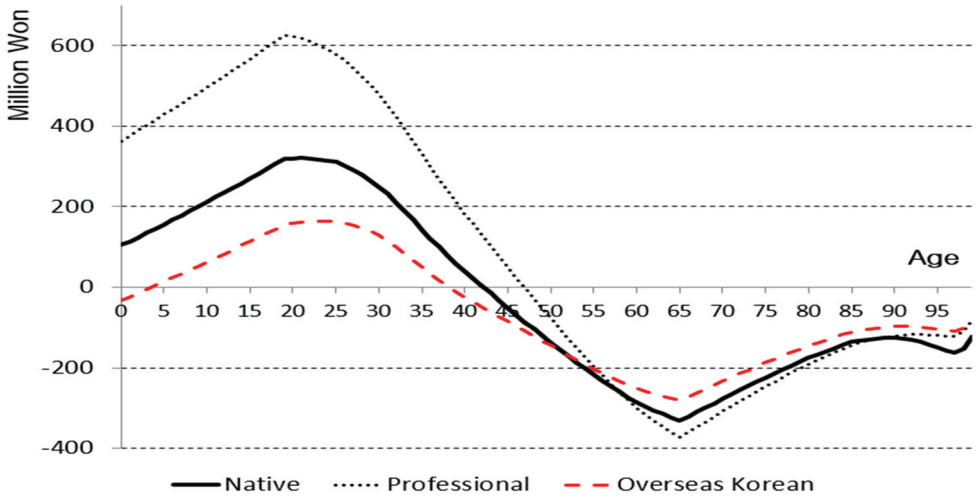


FIGURE 10. NPV OF THE PROFESSIONAL AND OVERSEAS KOREAN

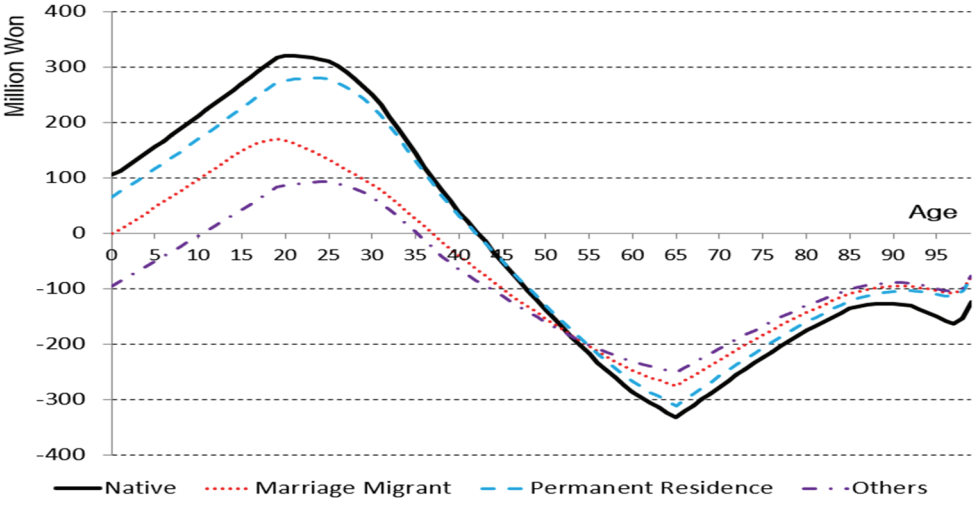


FIGURE 11. NPV OF MARRIAGE MIGRANTS, PERMANENT RESIDENCE, AND OTHERS

NPV of Fiscal Contribution and Its Policy Implications

As shown above, the fiscal contribution and its NPV varies by age and visa type given that productivity and labor market participation rates vary. Table 10 summarizes the ranges of ages in which the NPV is estimated to be positive by visa type. The non-professionals and work visitors exhibit positive NPVs during their stay due to their characteristics as short-term workers, while the remaining types exhibit different ranges according to the productivity, labor market participation, and unemployment rates.

First, for the non-professionals and work visitors, the NPV is positive for all ages between 19 and 64. Because they are a short-term cyclical workforce, they generally leave the country before they retire and gain a benefit from the host country's welfare

TABLE 10— RANGE OF AGES WITH POSITIVE NPVS BY VISA TYPE

Visa Type	Range of Ages with Positive NPV		Largest NPV (Corresponding Age)
	From	To	
Non-professional	19	60	93.12 million won (34)
Work Visit	19	60	68.73 million won (35)
Professional	0	46	625.99 million won (19)
Marriage Migrant	1	36	170.70 million won (19)
Overseas Korean	4	38	164.31 million won (24)
Permanent Resident	0	41	280.73 million won (24)
Other	11	35	93.50 million won (24)
Native	0	41	236.13 million won (21)

Note: For the non-professional and work visitors, only immigrants of ages 19~60 are considered. In other words, this table implies that all ages of the non-professional and work visitors exhibit positive NPVs.

state, while they pay taxes and fees during working in Korea due to their high participation and employment rates.

For those holding the remaining types of visas, no immigrants over 50 have positive NPVs for any type, and in particular, marriage migrants, overseas Koreans, and the other types start to have negative NPVs from their the mid- to late 30s. There are also differences in the starting ages of positive NPVs by visa type. For professional staff and permanent residents, immigrants of age 0 have a positive value, while the starting ages are 1 to 11 for the remaining visa types. This pattern has implications similar to those of the results of Storesletten (2000), in which only mid- and high-skilled immigrants aged 20 to 50 years have positive NPVs, and Storesletten (2003), which showed positive NPVs from average immigrants aged 20 to 30, while the range is slightly wider in this study than in those. Immigrants who are young and have a high degree of skill are estimated to make a high fiscal contribution, but if immigrants are excessively old or young, they show a net fiscal burden.

Next, using the estimated NPV by age and visa type, the total NPV of the actual immigrants in Korea as of 2015 is calculated. The total NPV for each visa type is computed by multiplying the number of immigrants of each type by the corresponding NPV and then summing up these values for each visa type. Table 11 displays the results. As indicated in the table, the total NPV of the total population

TABLE 11— SUM OF NPVS FOR EACH VISA TYPE USING ACTUAL NUMBER OF IMMIGRANTS (2015)

Visa Type	Number of Immigrants	Sum of NPVs (Trillion Won)
Non-professional	264,584	11.1
Work Visit	287,831	6.4
Professional	46,981	17.6
Marriage Migrant	124,301	-16.3
Overseas Korean	300,931	-22.9
Permanent Resident	111,387	-5.7
Other	141,005	-5.4
All Immigrants	1,277,020	-15.1
Natives	49,710,452	994.4
Sum	50,987,473	979.3

of Korea, including both natives and immigrants, is estimated to be approximately 979.3 trillion won as of 2015. The net fiscal contribution of native Koreans is 994.4 trillion won, and the sum of the net contribution of foreigners is -15.1 trillion won, implying that the present value of future fiscal contribution of an average immigrant into Korea is negative.

By visa type, the NPVs of non-professionals and work visitors are estimated to be 11.1 trillion won and 6.4 trillion won, respectively, implying that they are net contributors to Korea's fiscal soundness. For professional staff members, their average NPV per capita is 2~3 times higher than that of natives, but their total population size is small and the total NPV is only 17.6 trillion won. For all other visa types, the sum of the NPVs is negative. For marriage migrants, overseas Koreans, permanent residents, and others, their average NPV per capita tends to be positive before their mid-30s. However, their total NPV is calculated as a negative number because their ages tend to be high and their labor participation rates low.

This result suggests that the current immigration policy of Korea has not achieved positive effects at least fiscally. In fact, immigrants who can contribute to Korea's finances are those who are younger than their mid-30s and participate in the labor market, whereas immigrants who actually stay in Korea tend to incur net fiscal costs due to their high ages or low economic participation rates. More importantly, the fact that the sum of all immigrants' NPVs is negative indicates that an immigration policy that only increases the number of immigrants while maintaining the current population structure may result in a worsening of Korea's fiscal situation.

In conclusion, in order for the future immigration policy to have a positive effect on the fiscal side, it is necessary to make an effort to change the current immigration influx population structure. In order to predict the mitigation of fiscal problems by an influx of immigrants, it is necessary to adopt a selective immigration policy that considers immigrants' productivity rates, ages, and durations of stay. The immigration policy must concentrate on allowing in those in their 30s or younger, and visas need to be issued more generously for foreigners with professional capabilities and high productivity. Also, regarding low-productivity foreigners, efforts should be made to avoid fiscal losses by maintaining the principle of short-term recruitment. These results and policy implications are in line with existing studies on immigration in other economies, such as the United States and Europe. Instead of an immigration policy only for rebalancing the numerical demographic structure due to aging, it is important to focus on the qualitative factors of potential immigrants, such as their productivity rates, ages, and willingness to participate in the economy.

VI. Concluding Remarks

In this article, the present situation and characteristics of immigrants staying in Korea based on various types of available data are studied and the fiscal contributions according to different visa types, ages, and economic statuses are estimated. Through this model analysis, the desirable direction of future immigration policy is sought in a fiscal sense.

According to the estimation of the fiscal contributions of immigrants by age and

visa type, it is confirmed that there are significant differences in the fiscal contributions of immigrants according to their visa type and age. For instance, professional staff members are estimated to make significantly higher fiscal contributions over a wider age range than that of native Koreans. On the other hand, marriage migrants and overseas Koreans make lower fiscal contributions than native Koreans, and except for certain age groups, such as those in their 20s, they cause more of a fiscal burden relative to their contribution. This implies that a selective immigration policy that considers the qualitative aspects of potential immigrants is more desired than simply considering the age structure of immigrants for the purpose of mitigating population aging.

The implications and limitations of this study are as follows. First, this study is meaningful in that the fiscal contributions of immigrants entering Korea are estimated using a quantitative model that reflects the actual fiscal system and visa issuance system in Korea. Most existing studies of immigration tend to focus on the labor market effects or on socialization, and not many in Korea deal with immigration in light of the government's fiscal aspects. However, there are many aspects that do not reflect reality due to limitations of data or for technical reasons. For example, this model assumes a very restrictive form of return migration only for non-professionals and work visitors and does not reflect the fact that many immigrants with all visa types return to their home countries in reality. In addition, government taxation and social security fees are reflected in the model only in a simplified form due to the lack of data for realistically estimating the income distribution of immigrants. Finally, this model assumes only a single government account, while there are the general account, special accounts, and funds of the central government, as well as a number of local government accounts. By simplifying this, the effects of immigration on each account, such as the national pension fund, cannot be analyzed. These limitations are mainly due to the lack of data regarding the economic activities of foreigners, such as the distribution of income by visa type, their consumption expenditures, and other factors. Other limitations omitted here are expected to be considered in future studies.

Finally, this study does not intend to claim that immigration policies should be determined solely by the size of the fiscal contributions made by immigrants. When actually setting immigration policy, various factors, such as human rights issues, should be considered in addition to economic aspects.

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