Article

Impact of Aging and Underemployment on Income Disparity between Agricultural and Non-Agricultural Households

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Abstract: This paper examines how aging and underemployment affect household income and household income disparity between agricultural and non-agricultural sectors. Our study uses household panel data from South Korea for the period 2009–2016, which include, on average, 6721 representative households each year. A three-step regression analysis was conducted to estimate the aging and underemployment effects on household income and the income disparity between agricultural and non-agricultural households. First, we estimate aging and underemployment effects on household income from all households using a year fixed-effect longitudinal model. Second, our study investigates whether the marginal effect of aging and underemployment on household income differs between agricultural and non-agricultural sectors. Finally, we simulate the estimated model to illustrate how government policies could help reduce the income disparity. Our results show that aging and underemployment affect household income negatively overall. The negative marginal effect of the two factors was greater in the agricultural sector than in the non-agricultural sector. Results from policy simulations suggest that the implementation of proper government policies to address aging and underemployment problems in agricultural households could significantly reduce the income disparity between agricultural and non-agricultural sectors.

Keywords: income disparity; agricultural and non-agricultural households; underemployment; aging

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1. Introduction

The income disparity between agricultural and non-agricultural households has been increasing in many countries. Studies in the labor economics literature often link population aging and underemployment to low labor participation and productivity, fewer savings, and greater financial pressure on households [1]. Population aging in agricultural households becomes more prevalent than in non-agricultural households as better-educated, wealthier, and younger-generation workers tend to shun low-paying manual jobs in agriculture [2,3]. Underemployment, which was considered an urban-specific issue in the past, is also a serious problem among agricultural households because of surplus labor, particularly in developing countries [4]. Underemployment is the condition where workers' working hours are less than full-time or positions are inadequate concerning workers' training or economic needs [5]. Therefore, the term underemployed workers refers to relatively less productive workers. Even in many developed countries, new technology adoption and structural change result in a greater extent of underemployment in the agricultural labor market (e.g., due to the adoption of newly developed farm equipment, farmers need fewer workers to operate their farms; yet all family workers are still classified as employed farm workers) [6]. The underemployed agricultural household members (who are likely less productive family workers) decrease overall household productivity and per capita household income.

Many studies in labor economics point out that aging and underemployment are major factors in determining the wage, well-being, and productivity level of workers

(e.g., [5,7–9]). A few studies specifically argue that aging and underemployment become more prevalent and problematic in the agricultural sector than non-agricultural sectors, which could be two major factors affecting the income disparity between agricultural and non-agricultural households. For example, Lee et al. [10] show that the Korea Gini index increased from 0.330 to 0.342 between 2006 and 2011 and that population aging has a significant effect on the inequality index. Bell and Blanchflower [7,11] find that for the post-Great Depression period in the U.K. and U.S., underemployment had a more significant role in wages than unemployment for all industries. In addition, Loughrey and Hennessy [12] show that the underemployment rate increased by 10% from 2002 to 2010 in the Irish agricultural sector and that the change in the underemployment rate was significantly correlated with a change in agricultural household income. Previous studies provide ample evidence that aging and underemployment play a significant role in the economic condition of agricultural and non-agricultural households (e.g., [4,5,8,9,11–13]). However, little has been done in the literature to empirically examine the effects of aging and underemployment on household income and income disparity between agricultural and non-agricultural sectors.

The important question we seek to answer in this study is: are aging and underemployment major factors of household income and income disparity between agricultural and non-agricultural households? If they are, what would be the appropriate policy direction to address this problem? Although earlier studies in the literature provide ample evidence that aging and underemployment play a significant role in the economic condition of agricultural and non-agricultural households, it has done little to empirically answer the aforementioned question. To answer the question, we first estimate three longitudinal models for entire households, agricultural households, and non-agricultural households. Then, to examine the relative importance of aging and underemployment in determining household income and income disparity between the two sectors, the marginal effects of aging and underemployment on household income are calculated in elasticity form using estimates from the three longitudinal regressions. Third, the income disparity is estimated using both longitudinal and cross-sectional models. Finally, the estimated disparity is simulated under five scenarios of reduced aging and underemployment to see if government policies to reduce aging and the underemployment problem in agriculture could mitigate the current income disparity between agricultural and non-agricultural households. Previous studies also report that aging and employment status, including underemployment, are likely endogenous [14–16]. Therefore, we use a fixed-effect longitudinal model with a Gaussian copula correction procedure to control the endogeneity and unobservable effects (e.g., change in government policy).

Our results show that aging and underemployment negatively affect household income overall. The negative marginal effect of the two factors was greater in the agricultural sector than in the non-agricultural sector, particularly when the endogeneity of aging and employment status variables are controlled. Simulation results suggest that decreasing aging and underemployment from the agricultural sector would significantly reduce the income gap between the two sectors. Our findings could be applicable to various agricultural policies to mitigate income disparity between agricultural and non-agricultural households in many countries undergoing aging and underemployment problems.

2. Literature Review

In the past, agriculture was considered the backbone of the overall economy in many countries. However, structural changes due to technological advancements, globalization, and environmental constraints have led to a deterioration of the social and economic status of agriculture [17]. One important issue caused by the structural changes is the increased income disparity between the agricultural and non-agricultural sectors. The increased income disparity has generated both economic and social problems regardless of countries' level of economic development [17,18]. Previous studies in the literature claim that the "urban bias" caused by the rapid labor transfer from agriculture to non-agriculture has

resulted in negative effects of structural changes such as an increasingly aging population and a high underemployment rate in the agricultural sector [19].

Aging refers to the increasing ratio of older adults (typically aged over 65) among the population. Clark et al. [20] and Pammolli et al. [21] argue that population aging could burden the whole economy by increasing support costs for older adults (e.g., pension and medical expenses). Furthermore, the increased social expenditure required by an aging population may increase income inequality at the country [10] or regional [22] level.

Cymbranowicz [23] points out that underemployment, which is also considered “incomplete employment,” has become one of the biggest problems in the labor market since the great recession drastically increased the underemployment rate in most countries. In the U.K., for example, the underemployment rate exceeded the unemployment rate during the great recession [24] and now, underemployment has a greater influence on wage income than unemployment [7]. Underemployment generally refers to the situation where job openings are filled (or the employed workers are replaced) with workers who (1) earn a lower wage than the average wage of half of the population, (2) are underutilized, or (3) work less regardless of their willingness or capability to work. This “incomplete employment” can cause a decrease in overall wage income.

Many earlier studies find that income level is highly correlated with aging and underemployment rate. In these studies, factors affecting agricultural household income include household economic conditions, conditions of farmland, regional economic environments, and farm policies [25–32]. However, only a few studies discuss the potential impact of aging and underemployment on agricultural households. Some studies consider the age of farm operators or the number of laborers [33,34] as important factors of agricultural household productivity. Nonetheless, household-level aging or employment status (e.g., underemployment) has rarely been examined to study agricultural income and income disparity in the literature.

Seok et al. [8] and Boockmann et al. [35] claim that the aging agricultural workforce is likely to decrease the productivity level and labor participation rate in the agricultural sector. Spěšná et al. [36] also find that low wages in the agricultural sector serve as a barrier for young people to participate in the agricultural workforce and as a result, increase the proportion of aged workers in agriculture over time. The increased population of aged workers in agriculture could be closely related to the situation where most of the elderly agricultural workforce lives below the poverty line in some countries [37].

A few studies in the literature argue that household income is harmed by underemployment if workers unintentionally work less [38], if a lack of infrastructure exists [39], or if workers are underemployed due to the economic crisis such as the great recession [7]. As these problems become severe in the agricultural sector, underemployment is considered one of the determining factors of the low-income problem in agriculture [40–42].

Although many studies point out that aging and underemployment are important factors to determine income, the effect of aging and underemployment on agricultural income has been rarely studied in the literature. A primary reason for the lack of studies on the underemployment effect on agricultural incomes may be due to the fact that underemployment is mostly hidden or neglected in the agricultural sector. In many countries, agricultural labor data are collected mostly through self-reported surveys, and many farm household individuals tend to report themselves as either farm or family workers whether or not they contribute to farm production. Besides, unlike the non-agricultural sector, the agricultural sector lacks information about workers’ productivity (e.g., annual performance evaluation), particularly about family workers’ contribution to farm productivity. It is not likely that the head of the agricultural household (likely the farm operator) provides an objective evaluation of family workers’ contributions to farm production. Therefore, underemployment is less detectable in the agricultural sector than in the non-agricultural sector. The hidden underemployment problem may have been gradually increased and may have affected household income negatively in the agricultural sector [12,43,44]. To

address the problem, previous studies generally use three underemployment criteria such as working hours, income level, and skill level-based measures [5,24,45].

3. Methodology

Our study estimates a household income model to examine the effect of aging and underemployment on household income. The household income model is estimated over the individual income model because the household model is able to account for interrelationships of aging and underemployment effects of individuals in the same household. For example, for a household with an employed husband and an underemployed wife, the husband's employment status could be affected by his wife's employment status (e.g., the husband may work more hours to cover the decreased household income due to his wife's underemployment or unemployment). The cross-sectional approach is common in income inequality studies at the country or regional level [46]. However, the cross-sectional analysis could lead to biased estimates unless the data is collected under a specific experimental design to account for the household or year-specific effects [9]. Therefore, a longitudinal model is used with fixed-effect terms for our study. The longitudinal model allows for more variability and efficiency than the time-series or cross-sectional model [47]. The fixed-effect model should account for the heterogeneity caused by the household-specific or time-specific factors [47]. For example, household income distribution could hinge on government policy [48], and the policy effect may differ by each unit in the model [49]. The fixed-effect model accounts for the unobservable and non-random policy effects over time with year-specific effect terms [50].

Consider the following longitudinal regression model,

$$y_{it} = \alpha_t + v_i + x_{it}\beta + e_{it}, \quad (1)$$

where y_{it} is the per capita income of a household i in year t , α_t is a year-specific effect, v_i is a household effect, x_{it} represents covariates, and e_{it} is an error term. In Equation (1), the parameter vector, β , represents covariates' marginal effect on household i 's income over time. The covariates, x_{it} , include the ratio of aged individuals (aged over 65) for each household, unemployment ratio, underemployment ratio, out of the labor force ratio, financial asset value, real estate value, and household head's education level.

Equation (1) can be estimated by either a random effect or fixed-effect model. The random-effect model would be better if any correlation between unobservable individual effects and covariates can be avoided [49,50]. If the individual random-effect term and covariates are correlated, the estimator would be inconsistent with the random-effect model [47,50]. However, unobserved individual characteristics such as unobserved time-invariant heterogeneity (e.g., innate intelligence and other genetic traits) could be potentially correlated with covariates such as observed individuals' socioeconomic status variables (e.g., employment status, education, aging, asset values) [51]. The Hausman test rejects the random effect model in favor of a fixed-effect model in our study at the 1% level (Chi-square (χ^2) statistic = 682.92, df = 12, p -value < 0.001). Therefore, the fixed-effect model is estimated with a year-specific term for Equation (1). The year-specific term, α_t (i.e., year dummies), represents unobserved annual variations on per capita household income caused by, for example, macroeconomic policies over time [52].

To measure the aging effect at the household level, we use the ratio of household members aged 65 years or over to the total household members [28]. If the ratio is the same or greater than 0.5, the household is considered aged [53]. Previous studies claim that labor statistics reported in the literature tend to under-measure unemployment, and alternative measures need to be developed [54,55]. Feng and Hu [56] argue that frequently reported unemployment statistics (individuals who are unemployed and actively seeking employment) could have been under-measured due to the unemployed who are barely willing to find work [57]. For instance, discouraged workers (individuals who are unemployed and willing to be employed but not actively seeking employment) are neither unemployed nor out of the labor force by the bureau of labor statistics' criteria [58]. How-

ever, the discouraged workers may have the same impact on household income level as unemployed workers do. Feng et al. [59] suggest that the unemployment measure, the U-6 measure (that includes conventional unemployment, discouraged workers, and workers who work less than 36 h per week) from the United States Bureau of Labor Statistics [58] is more robust than conventional unemployment because it includes fewer measurement errors. Therefore, we use the U-6 measure as unemployment in our study. As stated earlier, three types of underemployment have been considered in the literature: working hour-, income-, and skill-based underemployment [5,12,45]. However, a few studies suggest that people who work less than their desired working hours (less than 36 h per week) need be a part of unemployment [60,61]. Moreover, the studies indicate that economic consequences between unemployment and underemployment differ significantly [38]. Therefore, we consider income- and skill-based underemployment measures in this study. Each household member is classified as “income-based underemployed” if the household income is less than 50% of the median population income [5]. If a household member finds the task (or position) not suited to her skill or education level and is not classified as “income-based underemployment,” the member is considered “skill-based underemployment.” If a household member meets at least one of these two definitions, this person is considered underemployed. Out of the labor force may seem indifferent to unemployment in terms of financial contribution to households. However, Flinn and Heckman [62] show that unemployment and out of the labor force are strictly distinguishable in terms of economic behavior. Asset values also contribute to household income, especially when considering the income disparity between sectors at the household level [48]. Education level has been also correlated to an individual’s income level and income inequality in the economics literature due to its impact on human capital and economic outcomes [63–65].

Many studies suggest that population aging has been a growing tendency that greatly affects the employment status of aged individuals [66]. Under this environment, aged workers are more likely to be at risk of being underemployed, especially in developed countries [67]. Findings from these studies suggest a high correlation between aging and underemployment. To incorporate these findings in our analysis, interaction terms between aging and variables representing employment status (i.e., unemployment, underemployment, and out of labor force) as a part of covariates x_{it} in Equation (1).

Equation (1) is estimated with three samples: all households, agricultural households, and non-agricultural households. The traditional definition of an agricultural household is a household in which all members make a living through farming. Nonetheless, since some farmers can work for management positions in agricultural firms rather than for farm production, the number of agricultural households in the traditional sense has been declining [68]. Therefore, a new definition of agricultural households has been developed in narrow and broad senses [69]. The narrow meaning of agricultural household is the household in which the main income source is farming [70]. The broad meaning of an agricultural household is the household that the household head [71] or any household member [72] participates in the agricultural activity to generate income. The broad definition of an agricultural household is used in this study.

Using estimates of Equation (1), the income disparity between agricultural and non-agricultural sectors, $\Delta\hat{y}$, is calculated as:

$$\Delta\hat{y} = \hat{y}_{it}^{NAC} - \hat{y}_{it}^{AC}, \quad (2)$$

where $\hat{y}_{it}^{NAC}$ and $\hat{y}_{it}^{AC}$ are the predicted household per capita income for non-agricultural and agricultural households, respectively. Then, Equation (2) is simulated with different scenarios of government policy on aging and underemployment. The purpose of the simulation is to show the effect of government policies, effectively lowering the extent of aging and underemployment in the agricultural sector, on income disparity. The simulated income disparity between sectors is represented by:

$$\Delta \hat{y}_s = E(y_{it}^{NAC}) - \left(E(y_{it}^{AC}) \middle| C_{it}^{AC} * \left(1 - \frac{\theta_s}{100} \right) \right), \quad (3)$$

where $\Delta \hat{y}_s$ is the income disparity between sectors estimated with a range of scenarios of aging and underemployment levels, $E(y_{it}^{NAC})$ and $E(y_{it}^{AC})$ refer to non-agricultural and agricultural sector's expected income, respectively, C_{it}^{AC} represents the target covariate vector (i.e., aging and underemployment variables) for simulation, and θ_s is the shock on target covariates in scenario s .

Each year, five percent of our household panel was replaced to maintain the sample representativeness and avoid attrition [73]. As a result, like many other micro panel datasets in general, our panel data is unbalanced. In this case, the degree of freedom to compute variance estimates is no longer the number of regressors multiplied by the number of observations because of missing observations. Hence, with the conventional approach, the variance estimate would be biased with an unbalanced panel dataset. A few studies suggest ways to address this issue (e.g., [74,75]). Our study uses Wansbeek and Kapteyn [75]'s method because it allows year fixed-effect terms to account for unobservable policy effects, but no dynamics nor simultaneity need to be considered to generalize the variance matrix.

Previous studies point out that aging and employment status could cause endogeneity problems, especially for measures from self-reported surveys [76,77]. Results from the Hausman specification test show that all aging and employment variables (age over 65 ratio, underemployment ratio, unemployment ratio, and out of the labor force ratio) in our study fail to reject the null of consistent estimators with no endogeneity. To address the endogeneity problem of these variables, we use the Gaussian copula correction procedure [78]. The Gaussian copula correction approach simultaneously accounts for all correlations between the endogenous variables and error terms through the Gaussian copula, assuming a joint normal distribution between these correlated variables.

4. Data

Our study uses household panel data collected by the Korea Labor Institute (KLI) in Korea from 2009 to 2016. Each year, KLI surveys, on average, 6721 representative households living in rural and urban areas. The KLI panel data include socioeconomic characteristics such as age, education, occupation, employment status, asset value, and income level. The KLI survey classifies households as agricultural households if they meet one or more of the following conditions: (a) a total annual agricultural or forestry turnover of \$900 or more, (b) a total livestock value on a farm of over \$500, (c) total farmland used for farm production over 0.245 acres, (d) a household owns at least 300 acres for a forestry business in the last five years, and/or (e) a household has been in the agriculture or forestry business for more than one year [79]. The KLI classification is consistent with the broad definition of the agricultural household discussed in the previous section.

The KLI data are well suited for our research objectives due to the following three reasons. First, aging and underemployment became significant factors affecting people's quality of life and economic conditions in Korea since the financial crisis in 1997 [80–82]. Second, findings from Korea could be equally applied to other countries, particularly those that are in the early stage of becoming developed countries and undergo similar aging and underemployment problems. Finally, unlike other countries, the underemployment problem has not been aggressively addressed by the Korean government, which implies we have relatively few externalities to consider in assessing the causal effect between income and underemployment.

Unlike many earlier studies, we do not include race, ethnicity, region, occupation, and industry type in our wage equation. Race and ethnicity are not considered because the Korean population is highly homogeneous, with less than 5% of non-Korean ethnic groups [83]. Region is not included because the regional variation of income in small and rich countries (like Korea) is less significant than in large and poor countries [84,85]. Finally, occupation and industry type are not included because our agricultural and non-

agricultural sector classifications have already accounted for the majority of variations in occupation and industry.

Table 1 shows descriptive statistics of key variables used in this study for the years 2009, 2012, and 2015. Given the limited space available, the descriptive statistics are presented only for the selected three years to show how the key variables change over time (a full description of data for all years used in this study is available from the authors upon request). The average household per capita income gradually increases over time in both sectors. However, the average household per capita income from the non-agricultural sector is always higher than per capita income from the agricultural sector, while significant income differences between sectors are continuously observed over time. The age over 65 ratio (AR) shows an increasing aging trend overall and a significantly more aged population in the agricultural sector than in the non-agricultural sector. In 2015, for instance, the AR from the agricultural sector was 53.32%, while the same ratio from the non-agricultural sector was only 27.10%. This skewed age structure could significantly affect the income disparity between agricultural and non-agricultural sectors [86,87]. The underemployment ratio (UN), calculated using skill level- and income-based criteria [5,38], shows an overall decreasing trend. From 2009 to 2015, it is observed that UN from full sample decreased from 13.48% to 10.26%. It is also observed that UNs in the agricultural sector are significantly higher than those in the non-agricultural sector. For example, UNs in 2015 were 17.62% and 9.81% in the agricultural and non-agricultural sectors, respectively. The statistics clearly show that underemployment is more prevalent in the agricultural sector than in the non-agricultural sector. The prevalence of underemployment in the agricultural sector could be one of the major factors of low agricultural income because the under-employed labor force provides a significantly lower economic contribution than the employed labor force [88]. The unemployment ratio (UE) overall shows an increasing trend across time: from 2009 to 2015, UE from the full sample increased from 8.29% to 9.01%. In the agricultural sector, UE increased from 9.47% to 17.69%. It is noted that UE increases faster in the agricultural sector than in the non-agricultural sector. The out of the labor force ratio (OL) increases over time in both sectors and is significantly larger in the non-agricultural sector for all years: from 2009 to 2015, OL increased from 34.59% to 40.59% in the full sample. Two types of household assets, financial and real estate assets, are considered in our study. Relevant statistics show that households in both sectors invest more in real estate than in financial assets. However, agricultural households invest more in real estate assets than non-agricultural households do. For instance, in 2015, the ratio of real estate assets to total assets in the agricultural sector was 82.6%, while the same ratio was 53.8% in the non-agricultural sector. The level of household head's education differs significantly, particularly in the "More than college" level. In 2015, for example, about 40% of non-agricultural household heads had at least a college degree, while almost half of agricultural household heads did not even finish middle school. The significant difference in a household head's education level could also affect the income disparity between the two sectors.

Table 1. Descriptive Statistics at the Household Level.

Variables		2009			2012			2015		
		Full Sample (N = 6721)	Agriculture (N = 452)	Non- Agriculture (N = 6269)	Full Sample (N = 6434)	Agriculture (N = 422)	Non- Agriculture (N = 6012)	Full Sample (N = 6577)	Agriculture (N = 380)	Non- Agriculture (N = 6197)
Per capita income (one million Won)		11.79 (12.15)	9.54 (7.17)	11.96 (12.41)	14.35 (12.09)	12.11 (9.09)	14.5 (12.25)	16.26 (14.39)	14.18 (14.86)	16.39 (14.36)
Age over 65 ratio (AR) (%)		19.73 (35.74)	43.09 (42.16)	18.05 (34.64)	24.03 (38.92)	48.05 (42.02)	22.34 (38.13)	28.61 (42.16)	53.32 (42.31)	27.10 (41.68)
Underemployment ratio (UN) (%)		13.48 (26.49)	32.39 (38.69)	12.11 (24.84)	11.13 (24.78)	23.14 (34.93)	10.29 (23.69)	10.26 (24.29)	17.62 (32.41)	9.81 (23.64)
Unemployment ratio (UE) (%)		8.29 (20.97)	9.47 (23.25)	8.19 (20.79)	8.42 (22.14)	11.55 (27.23)	8.19 (21.72)	9.01 (22.98)	17.69 (31.09)	8.48 (22.29)
Out of the labor force ratio (OL) (%)		34.59 (34.63)	17.22 (23.52)	35.84 (34.97)	37.08 (36.39)	17.90 (25.86)	38.43 (36.64)	40.59 (37.80)	18.91 (25.83)	41.92 (38.02)
Financial asset value (one million Won)		17.43 (66.02)	15.89 (41.50)	17.54 (67.44)	1950.15 (4488.57)	2005.36 (4399.99)	1946.27 (4495.06)	2810.92 (7381.87)	2689.73 (4644.53)	2818.35 (7517.55)
Real estate asset value (one million Won)		30.33 (112.78)	87.26 (187.09)	26.22 (104.25)	3950.63 (14,348.46)	11,245.73 (18,259.19)	3438.56 (13,891.83)	3832.70 (14,682.86)	12,799.34 (22,633.83)	3282.87 (13,865.03)
Household head's education level (%)	Less than Elementary	21.41	19.13	53.10	20.42	18.23	51.66	19.04	17.28	47.63
	Middle	12.74	12.36	17.92	12.17	11.74	18.25	11.51	10.99	20.00
	High	32.81	33.63	21.46	32.13	32.78	22.75	31.47	31.98	23.16
	More than college	33.05	34.89	7.52	35.28	37.24	7.35	37.98	39.75	9.21

Source: Korea Labor Panel Data (2020). Note: \$1 = 1133.26 Korean Won on 16 May 2021. Numbers in parentheses are standard deviations.

5. Results

5.1. Estimation Results from Longitudinal Regressions

Table 2 reports results from longitudinal data analysis. The dependent variable is the annual per capita household income in one million Korean won (approximately \$882.41 based on \$1 = 1133.26 Korean Won). The joint normal distribution assumption between the endogenous variables (AR, UN, UE, and OL) and error term makes it difficult to derive asymptotic standard errors of estimates. Therefore, all standard errors are computed through a bootstrapping procedure [78,89].

Overall, results are similar across the three different samples. Most estimates are statistically significant, at least at the 10% level. Year effects (from Year 2010 to 2016) indicate a significantly increasing time trend of household per capita income from all regressions. In addition, the age over 65 ratio (AR), underemployment ratio (UN), unemployment ratio (UE), and out of labor force ratio (OL) negatively affect income when only direct effects are assessed without considering the interaction terms. Asset values (financial and real estate) and a household head's education level show a positive correlation with household income, as expected.

Table 2. Parameter Estimates from Longitudinal Regressions.

Variables	Parameters	Full Sample	Agriculture	Non-Agriculture
Age over 65 ratio (AR)	β_1	−3.403 *** (0.538)	−7.795 *** (1.941)	−2.608 *** (0.613)
Underemployment ratio (UN)	β_2	−11.278 *** (0.509)	−12.869 *** (1.292)	−11.591 *** (0.580)
Unemployment ratio (UE)	β_3	−8.229 *** (0.527)	−2.418 (1.794)	−8.884 *** (0.562)
Out of labor force ratio (OL)	β_4	−8.867 *** (0.398)	−11.305 *** (2.439)	−9.126 *** (0.398)
AR*UN	β_5	1.415 *** (0.510)	1.401 (1.445)	3.107 *** (0.609)
AR*UE	β_6	0.902 (0.589)	−0.692 (1.998)	0.977 (0.669)
AR*OL	β_7	0.318 (0.501)	3.603 (2.539)	−0.343 (0.589)
Financial asset value	β_8	0.114 *** (0.014)	0.195 *** (0.060)	0.110 *** (0.014)
Real estate asset value	β_9	0.028 *** (0.002)	0.012 *** (0.004)	0.031 *** (0.002)
Middle ¹	β_{10}	2.029 *** (0.194)	1.198 * (0.677)	2.070 *** (0.199)
High	β_{11}	2.459 *** (0.160)	1.274 ** (0.576)	2.416 *** (0.179)
More than college	β_{12}	5.469 *** (0.198)	1.745 ** (0.869)	5.445 *** (0.206)
Year 2010 ²	α_{2010}	0.886 *** (0.189)	0.592 (0.501)	0.889 *** (0.201)
Year 2011	α_{2011}	1.455 *** (0.186)	1.037 ** (0.515)	1.461 *** (0.194)
Year 2012	α_{2012}	2.230 *** (0.198)	1.409 *** (0.519)	2.244 *** (0.201)
Year 2013	α_{2013}	2.927 *** (0.208)	2.248 *** (0.675)	2.921 *** (0.232)
Year 2014	α_{2014}	3.128 *** (0.215)	2.469 *** (0.840)	3.119 *** (0.214)
Year 2015	α_{2015}	3.852 *** (0.229)	2.792 *** (0.842)	3.871 *** (0.227)
Year 2016	α_{2016}	4.725 *** (0.238)	2.812 *** (0.640)	4.798 *** (0.243)

*, **, *** indicates statistical significance at the 10%, 5% and 1% level, respectively. Numbers in parentheses are bootstrap standard errors with 1000 replicates. ¹ Less than elementary school is omitted to avoid the perfect correlation. ² Year 2009 is omitted to avoid the perfect correlation.

To compare the importance of aging and household members' employment status in determining household income with the consideration of both direct and indirect (in-

teraction) effects, we calculated the elasticities of household income (HI) with respect to each of AR, UN, UE, and OL. In general, the log-log functional form would be plausible to obtain elasticities measuring the unit-free marginal effects [90–92]. However, the double log functional form could not be used in our study because our ratio variables (e.g., aging ratio, underemployment ratio, etc.) contain a large number of observations with zero values. These observations could have been excluded if we used the double-log functional form. Therefore, considering our data status, the elasticity calculation based on linear model estimates would be preferable.

For example, the elasticity of HI with respect to AR is calculated as:

$$\eta_{HI,AR} = \frac{\partial HI_{it}}{\partial AR_{it}} \frac{\overline{AR}_{it}}{\overline{HI}_{it}} = (\hat{\beta}_1 + \hat{\beta}_5 \overline{UN}_{it} + \hat{\beta}_6 \overline{UE}_{it} + \hat{\beta}_7 \overline{OL}_{it}) \frac{\overline{AR}_{it}}{\overline{HI}_{it}}, \quad (4)$$

where $\overline{HI}_{it}$, $\overline{AR}_{it}$, $\overline{UE}_{it}$, $\overline{UN}_{it}$, and $\overline{OL}_{it}$ are mean values of HI, AR, UN, UE, and OL, respectively. Calculated elasticities via Equation (4) are reported in Table 3.

Table 3. Household Income Elasticities with respect to Aging, Underemployment, Unemployment, and Out of the Labor Force.

	Full Sample	Agriculture	Non-Agriculture
Age over 65 ratio (AR)	−0.055	−0.308	−0.036
Underemployment ratio (UN)	−0.085	−0.246	−0.078
Unemployment ratio (UE)	−0.049	−0.000	−0.050
Out of the labor force ratio (OL)	−0.230	−0.162	−0.243

Among variables considered in Table 3, AR and UN are the top two factors that determine agricultural household income, while UN and OL are the top two determining factors of household income in full and non-agricultural samples. Effects from AR and UN are greater in the agricultural sector than in the non-agricultural sector. Stallmann et al. [93] and Seok et al. [8] also find that the agricultural sector has higher proportions of elderly laborers, and its negative economic outcome is greater in the agricultural sector than in the non-agricultural sector.

Table 4 shows income differences between the agricultural and non-agricultural sectors (i.e., non-agricultural income minus agricultural income) and their statistical significance that are estimated from longitudinal and cross-sectional models. Overall, agricultural income is considerably lower than non-agricultural income. All mean differences are calculated using predicted income. The difference in annual household income per capita throughout the study period is 658,000 Korean Won (\$580.63) from the longitudinal model, while the differences are 354,000, 930,000, and 752,000 Korean Won (\$312.37, \$820.64, and \$663.5) in the year 2009, 2012, and 2015, respectively. All differences are statistically significant except the difference in 2009 from the cross-sectional model.

Table 4. Income Disparity between Agricultural and Non-agricultural Sectors.

	Disparity from Longitudinal Model	Disparity from Cross-Sectional Model		
		2009	2012	2015
Income difference	0.658 *** (0.135)	0.354 (0.283)	0.930 *** (0.343)	0.752 ** (0.362)

Note: both cross-sectional and longitudinal models use the same explanatory variables. Numbers in parentheses are standard errors. ** and *** indicates statistical significance at the 5% and 1% levels, respectively.

5.2. Results from Simulations

Tables 3 and 4 indicate that there exists a great degree of income disparity between agriculture and non-agriculture, and aging labor force and underemployment in agriculture

are major contributing factors. One way to reduce this income disparity might be to implement government policies targeting lower aging and underemployment ratios in the agricultural sector. Such efforts include promoting employment opportunities (particularly for young adults) and fostering business investments in agriculture through various tax policies and investment subsidies. To show the effects of these efforts, Equation (3), with estimates from the longitudinal model, is simulated under five scenarios of reduced aging and underemployment ratios in agriculture. The five scenarios include a 2%, 4%, 6%, 8%, and 10% decrease of AR, UN, and both AR and UN, and simulation results are reported in Table 5. Results suggest that government policies reducing AR and UN could be effective in reducing the income disparity.

For example, when AR decreases by 2% in the agricultural sector (Scenario 1), the income disparity decreases from 0.658 to 0.604, which is a 8.21% decrease in the income difference. With a 10% decrease of UN (Scenario 5), the disparity decreases by 42.71%. When both AR and UN are reduced by 10% (Scenario 5), agricultural income becomes higher than non-agricultural income. Finally, as expected from Table 3, AR decreasing policy appears to be more effective than UN reducing policy under all scenarios.

Table 5. Expected Income Disparity between Agricultural and Non-agricultural Sectors with Scenarios of Decreased Aging and Underemployment Ratios from the Agricultural Sector.

Target Variable	Scenario 1: −2% Shock	Scenario 2: −4% Shock	Scenario 3: −6% Shock	Scenario 4: −8% Shock	Scenario 5: −10% Shock
AR	0.604 (−8.21%)	0.528 (−19.76%)	0.452 (−31.31%)	0.375 (−43.01%)	0.299 (−54.56%)
UN	0.619 (−5.93%)	0.559 (−15.05%)	0.498 (−24.32%)	0.437 (−33.59%)	0.377 (−42.71%)
AR and UN	0.543 (−17.48%)	0.406 (−38.30%)	0.270 (−58.97%)	0.133 (−79.79%)	−0.004 (−100.61%)

Note: Numbers in parentheses are percentage changes of income disparity from the baseline disparity, 0.658, reported in Table 4.

6. Discussion and Conclusions

Our study investigates the role of aging and underemployment on household income and income disparity between agricultural and non-agricultural sectors. We measure aging as the ratio of the number of 65 years or older people in the household to the total number of household members [28]. We also measure the status of household underemployment as the ratio of the number of underemployed people in the household to the total number of household members. Underemployment is defined using skill and income-level criteria [5,24], which helps clarify underemployment, especially in the agricultural sector [12,44].

This study applied a longitudinal model to eight-year longitudinal data to estimate the causal effect of aging and underemployment on household income per capita. We used the Gaussian copula correction method to address the potential endogeneity problem of aging and underemployment (along with unemployment and out of the labor force). Our estimation results show negative and significant coefficients of aging and underemployment variables from both agricultural and non-agricultural household samples. Marginal effects of aging and employment status (considering both direct and indirect effects), i.e., elasticities of household income with respect to each of the aging and employment status variables, indicate that aging and underemployment significantly lower household income in both sectors, but the negative effect of aging and underemployment is more severe for agricultural households. Our simulations result in a substantial reduction of income disparity between the two sectors with decreased aging and underemployment ratios in agriculture.

Our results suggest that the implementation of proper government policies could address aging and underemployment problems in agricultural households and significantly reduce the income disparity between agricultural and non-agricultural sectors. The implementation of proper government policies can attract more young adults and employment

and business opportunities to agricultural regions. Aging and underemployment problems in agriculture could also be improved through immigration policies, as suggested by many studies in the literature (e.g., [94,95]).

Increasing immigrant workers has been considered one of the most effective ways to improve employment problems and age structure in the labor force [96,97]. However, these studies also point out that large-scale immigration would incur significant costs such as political, social, health, and economic inequality problems. Therefore, a future research direction might be to conduct a cost-benefit analysis of immigration labor, particularly focusing on aging and employment status in the agricultural sector.

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