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Effects of Aging on Income Inequality: Developing Countries vs. Developed Countries

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Abstract:
Aging and its consequences have made population aging a major social issue. Aging populations are likely to exacerbate inequality by increasing the public and private financial burdens of social welfare costs. The goal of this study was to estimate the effects of aging on income inequality for 81 countries (37 developing and 44 developed) from 2000 to 2020. The study used a dynamic panel approach in a generalized method of moments (GMM) framework. This study's findings confirm a positive relationship between aging and income inequality in both developing and developed countries, and it demonstrates that the aging effect on income inequality is greater in developing countries than in developed countries. Furthermore, improving human capital, increasing per capita income, proper management, and use of natural resource rents (% of GDP) in countries, and increasing trade between countries reduce income inequality, according to the findings of this study. Policymakers should reduce income inequality by investing in education, increasing per capita income, managing, and utilizing natural resource rents, expanding trade with other countries, and planning for the effects of aging.

1. Introduction

The world's population is aging because of significantly higher longevity and lower fertility. Population aging is a success for humans because it reflects advances in public health, medicine, economic and social development, and their contributions to disease control, injury prevention, and risk reduction. It is being driven by lower fertility and increased survival because of economic and social development, as well as advancements in public health and medicine. The United

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Nations and other researchers commonly use measures and indicators based on people's age to compare the sizes of different age groups, typically defining older people as those aged 60 or 65 years or older (Nations, 2019). In 2019, there were 703 million people worldwide who were 65 or older. The region of Eastern and South-Eastern Asia had the most elderly people (261 million), followed by Europe and Northern America (over 200 million). Over the next three decades, the global population of older people is expected to more than double, reaching more than 1.5 billion by 2050. The greatest increase (312 million) is predicted in Eastern and South-Eastern Asia (Nations, 2019) (Fig 1).

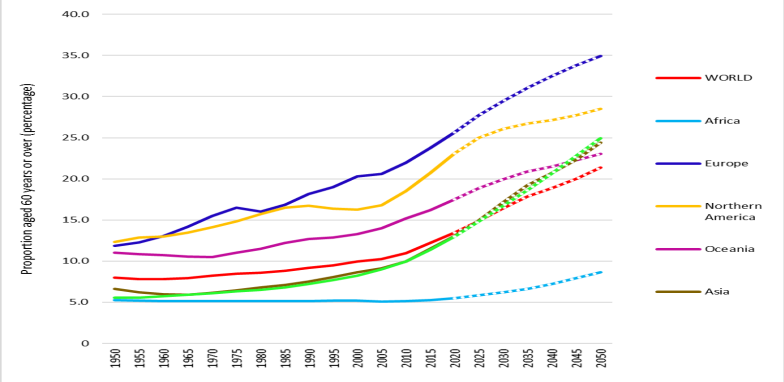


Fig 1. Percentage of population aged 60 years or over by region, from 1980 to 2050.

Source: (Affairs, 2019)

One of the consequences of aging is the possibility of increased inequality (Deaton & Paxson, 1994). Income inequality has risen almost everywhere in recent decades. According to the World Inequality Report 2018, the income of the world's top 1% has increased by 27% since 1980, while the income of the bottom 50% has increased by 12%. Income distribution inequality varies by region. Europe has the lowest and the Middle East has the highest. In the Middle East, 10% of the population owns 64% of the region's wealth. This distribution shifts from 37% in Western Europe to 38% in Europe and 47% in the United States, with the highest inequality in Brazil and South Africa at 55% and 62%, respectively (Alvaredo, 2018).

In theory, the effect of population aging on inequality can be explained in several ways:

1. Both Friedman's permanent income hypothesis (PIH) and Modigliani's life cycle theory predict that the income and consumption dispersion of any cohort of people born at the same time will increase with age (Chen, Huang, & Li, 2018; Friedman, 1957; Modigliani, 1966).

2. Aging increases demographic stress because it results in a higher dependency ratio (the sum of the young (under age 15) and elderly (age 65 and over) populations relative to the active population) and a lower standard of living (Goldin, 2016).
3. Aging tends to bring financial stress. According to the OECD report, the age group over 65 accounts for 40 to 50 percent of their health-care expenditures and three to five times the per capita healthcare costs of those under 65 (Dang, Antolin, & Oxley, 2001).

More recent studies on the relationship between population aging and income inequality have mostly focused on developed countries, and many of them discovered that population aging accounts for only a small portion of the overall increase in income inequality (Barrett, Crossley, & Worswick, 2000; Bishop, Formby, & Smith, 1997; Brown & Prus, 2006; Drosdowski, Stöver, & Wolter, 2015; Gustafsson & Johansson, 1999; Jones, 2007; Lui, 2019). Studies conducted in developing countries confirm the preceding findings (Chen et al., 2018; McKee, Keulertz, Habibi, Mulligan, & Woertz, 2017; Wang, Wan, Luo, & Zhang, 2017; H. Zhang, Ke, & Ding, 2021; J. Zhang & Xiang, 2014; Zhong, 2011). Furthermore, limited research suggests that the aging population reduces income inequality (Chu & Jiang, 1997; Faik, 2012; Morley, 1981). Karunaratne (2000) found that as people get older, income inequality in Sri Lanka falls, rises, and then falls again, forming an inverted 'N' curve.

Although the population aging rate in developing countries is lower than in developed countries, their older population groups are growing faster than those in industrialized nations due to rapid declines in fertility and widespread dissemination of medical knowledge (Zhong, 2011). Furthermore, the social and economic structures of developing and developed countries differ significantly, so the impact of population aging on income inequality in a developing country may differ from that of a developed country (Zhong, 2011). According to the explanation above, we sought to answer the following questions:

1-Is population aging exacerbating income inequality?

2-Is the impact of aging on income inequality affected by the country's level of development?

The remainder of this research is as follows: Section 2 is divided into two subsections: data and methodology. Section 4 presents the findings, and the final section contains the findings' conclusions and recommendations.

1. Data and Methodology

We used panel data from 81 countries from 2000 to 2020 in this study. Because our main goal was to examine the critical roles of countries' development stages, we divided the entire sample into two groups: high- and low-income countries using the World Bank's income classification. Low- and lower-middle-income countries (developing countries) comprise the low-income group, while high- and

upper-middle-income countries comprise the high-income group (developed countries). We estimated the following empirical equation based on the work of Gustafsson and Johansson (1999) and Wang et al. (2017):

$$Gini_{it} = \beta_0 + \beta_1 Gini_{it-1} + \beta_2 Z_{it} + \mu_{it} \quad (1)$$

Where the subscripts i and t represent the panel data's cross-sectional and time dimensions, respectively, and Gini is the index of inequality.

The Gini coefficient is a major indicator of inequality introduced by Corrado Gini that is always nonnegative and has a value between zero and one (Atkinson, 2015; Gini, 1921). $Gini_{it-1}$ is the previous year's Gini coefficient.

All control variables that may affect income inequality are represented by Vector Z. The above vector represents two sets of socioeconomic control variables describing demographic factors and macroeconomic variables in this study; Demographic factors include two variables of aging and human capital[1].

Aging is represented by two indexes: the ratio of people aged 65 and up in the total population and the ratio of people aged 65 and up in the active population (15–64 years of age). GDP per capita[2], GDP squared per capita, Manufacturing, value added (% of GDP), total trade to GDP ratio (globalization index), and total natural resource rents (% of GDP) are macroeconomic variables. Finally, μ is the error term. As a result, Eq. 2 is written as:

$$LGini_{it} = \beta_0 + \beta_1 LGini_{it-1} + \beta_2 LPop_{it} + \beta_3 LHuman_{it} + \beta_4 LGDP_{it} + \beta_5 LGDP_{it}^2 + \beta_6 LManufacturing_{it} + \beta_7 LTrade_{it} + \beta_8 L\,\mathrm{Re}nt_{it} + \mu_{it} \quad (2)$$

In Eq. 2, all variables are in logarithmic form. Gini coefficient statistics were derived from Solt's Standardized World Income Inequality Database (SWIID)[3], Version 8.1 (Solt, 2020). Other explanatory variables' statistics are obtained from the World Development Indicators (WDI[4]) website.

The generalized method of moments (GMM) was used to estimate Eq. 2 in a panel framework for examining the effects of aging on income inequality in developing and developed countries. Numerous researchers, including Arellano and Bond (1991), Martinez-Zarzoso, Felicitas, and Horsewood (2009), Kahouli and Maktouf (2015) and Lin (2015) have demonstrated the GMM method's reliability.

Arellano and Bond (1991) argued that the GMM estimator, which includes the lagged endogenous variable as an explanatory variable, is better suited for panel data because it produces more consistent and robust results in the presence of heteroskedasticity.

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[1] According to Baker's theory of human capital, educational expansion is a major factor in reducing educational inequality, and thus poverty and income inequality (Lee & Lee, 2018; Park, 2017). The enrollment rate in high school was used as an index of human capital in this study.

[2] The reversed U curve hypothesis (Inverted U-curve Hypothesis) states that there was a relationship between economic growth and income inequality (Kuznets, 1955).

[3] https://fsolt.org/swiid/

[4] https://databank.worldbank.org/

The consistency of the GMM estimators is determined by whether the lagged values of the explanatory variables are valid regression instruments. Initially, Wald (joint) test was used to determine the significance of all regressors. Then, we employed two tests suggested by Arellano and Bond (1991) and Arellano and Bover (1995). The first is a Sargan test of over-identifying restrictions, which investigates the instruments' overall validity. The second test (the second-order Arellano-Bond test) examined the null hypothesis that the error term is not serially correlated (Baltagi, Bresson, & Pirotte, 2007).

2. Result and Discussion

Before estimating the GMM model, the stationary of the main variables was checked to avoid nonsense regression. To accomplish this task, the LLC panel unit root tests were employed (Levin, Lin, & Chu, 2002). The results of the unit root test are shown in
Table 1. According to the findings, all variables are stationary at the level.

Table 1. The results of the LLC panel unit root test

Variables	Developed Countries		Developing countries	
	Statistics (With intercept and trend)	Decision	Statistics (With intercept and trend)	Decision
LGini	-5.7364***	I(0)	-3.9128***	I(0)
LPopA	-2.8047***	I(0)	-7.2699***	I(0)
LPopB	-1.4342*	I(0)	-8.7120***	I(0)
LHuman	-3.3753***	I(0)	-3.5062***	I(0)
LGDP	-3.3081***	I(0)	7.4638***	I(0)
$LGDP^2$	-3.4964***	I(0)	-7.1350***	I(0)
LManufacturing	-5.2479***	I(0)	-3.97.4***	I(0)
LTrade	-1.5348*	I(0)	-4.0630***	I(0)
LRent	-3.1850***	I(0)	-3.6600***	I(0)

Note: ***, ** and * denote significance at 1%, 5%, and 10%, respectively.
Source: Research finding

Based on Eq. 2, Table 2 depicts the relationship between aging and income inequality. The *LGini* index was used as the dependent variable in all four models.

The result shows that in all models, the lagged dependent variable is positive and significant. As a result, if inequality exists in the current period and is not controlled, it may continue in the future period as well.

Like most studies (Brown & Prus, 2006; Chen et al., 2018; Drosdowski et al., 2015; Jones, 2007; Lui, 2019; McKee et al., 2017; H. Zhang et al., 2021), our main findings confirm a positive relationship between aging and income

inequality. This finding remains true for both aging indices (ratio of the Population ages 65 and above in the total population and ratio of the population ages 65 and above in the active population). A 1% increase in the elderly population share results in a 5.33% increase in the Gini coefficient in developed countries and a 6.93% increase in developing countries. Furthermore, the results show that a 1% increase in the elderly dependency ratio increases the Gini coefficient by 3.15% in developed countries and 4.42% in developing countries. It is worth noting that the estimated coefficients of both aging indices in developing countries are higher than in developed countries. As a result, it can be concluded that population aging has a greater impact on income inequality in developing countries than in developed countries.

LGini's elasticity Concerning for to $LHuman$, $LGDP$, $LManufacturing$, $LTrade$, and $L\mathrm{Re}nt$ is negative and significant in both developing and developed countries. Furthermore, the estimated coefficients of the squared $LGDP$ are positive in four models but significant in three.

The findings on human capital as measured by education confirmed the findings of previous studies (Barro, 2000; Gregorio & Lee, 2002; Lee & Lee, 2018). In general, more equitable distribution of education helps to reduce income inequality significantly. Educational expansion is a critical factor in reducing educational and thus income inequality. Public policies that increase educational spending help to reduce educational inequality.

The findings of the study on the effect of $LGDP$ and $LGDP^2$ on inequality in both groups of countries revealed that as the economy develops, income inequality rises and then falls.

Therefore, this study does not support Kuznets's Inverted U Hypothesis (Chen et al., 2018; Saith, 1983). As a result, this research does not support Kuznets' Inverted U Hypothesis. Consequently, programs can be designed to support economic growth while also reducing inequality.

In this study, as in other studies (Anyanwu, 2018; Szirmai & Verspagen, 2015), increasing manufacturing value added (% of GDP) in both developed and developing countries reduced income inequality.

Theoretically, trade globalization is one of the major factors influencing income inequality, and its effect has been estimated to be positive in most studies (Asteriou, Dimelis, & Moudatsou, 2014; Park, 2017; Wu & Hsu, 2012). Globalization had a positive and significant effect on inequality in both developed and developing countries, according to the current study. Given that free trade reduces inequality, educational and economic policies such as economic opening and trade development can help to reduce income inequality in these countries.

$L\mathrm{Re}nt$ is an important factor of inequality. Natural resource rents (% of GDP), like previous studies (Buccellato, 2009; Farzanegan & Habibpour, 2017; Ross,

Lujala, & Rustad, 2012; Sachs & Warner, 2001; Van der Ploeg, 2011), have a positive impact on income inequality by lowering the cost of producing goods in the country or obtaining income from trade and sale of total natural resource rents (% of GDP).Table 2 summarizes the diagnostic tests performed by Sargan, Wald, and Second-order Arellano-Band. The Sargan statistic and Wald's test both confirm the instrument's validity and the joint significance of regression for all four models. In other words, we can conclude that our model is appropriate.

Table 2. Relationship between Aging and Income Inequality

explanatory variables	Developed Countries		Developing countries	
	Population aged 65 and above as a percentage of the total population	Population ages 65 and above in the active population (elderly dependency ratio)	Population aged 65 and above as a percentage of the total population	Population ages 65 and above in the active population (elderly dependency ratio)
Constant	38.7453*** [9.4965]	44.1727*** [10.5961]	19.2183*** [6.8753]	17.87372** [7.2702]
$LGini(-1)$	0.8421*** [0.0130]	0.8240*** [0.0174]	0.9038*** [0.0386]	0.9005*** [0.0174]
$LPop$	0.0533*** [0.0116]	0.0315*** [0.0066]	0.0693* [0.0386]	0.0442* [0.0246]
$LHuman$	-0.001 [0.0008]	-0.0015* [0.0008]	-0.0040*** [0.0012]	-0.0032*** [0.0012]
$LGDP$	-6.569*** [1.9516]	-7.5457*** [2.1214]	-3.6461** [1.8953]	-3.2971* [2.0098]
$LGDP^2$	0.3170*** [0.0984]	0.3664*** [0.1061]	0.2065* [0.1222]	0.1854 [0.1303]
LManufacturing	-0.0128*** [0.0040]	-0.0125*** [0.0040]	0.0396*** [0.0079]	0.0398*** [0.0081]
$LTrade$	-0.0029*** [0.0009]	-0.0024*** [0.0008]	-0.0034*** [0.0005]	-0.0034*** [0.0005]
$L\mathrm{Re}nt$	-0.0060** [0.0028]	-0.0051* [0.0028]	-0.0047*** [0.0017]	-0.0050*** [0.0018]
Sargan statistic	34.1793	34.3448	33.5191	33.3079
Wald statistic	6960.04***	2642.47***	16214.26***	17894.06***
Second-order Arellano-Bond	-1.5494	-1.4878	-0.1323	-0.1316
Number of observations	924	924	777	777
Number of instruments	238	238	238	238

Note: Standard errors are reported in parenthesis.
Note: ***, ** and * denote significance at 1%, 5%, and 10%, respectively.
Source: Research finding

3. Conclusion and Recommendations

The present paper aims to investigate the relationship between population aging and income inequality using data from 81 countries (37 developing and 44 developed) from 2000 to 2020.

first, our main findings confirm a positive relationship between aging and income inequality and confirm previous research findings (Brown & Prus, 2006; Chen et al., 2018; Drosdowski et al., 2015; Jones, 2007; Lui, 2019; McKee et al., 2017; H. Zhang et al., 2021). This finding remains true for both aging indices (the ratio of the Population ages 65 and above in the total population and the ratio of the population ages 65 and above in the active population). As a result, income inequality rises in both developed and developing countries as the elderly population grows. Second, in developing countries, the aging effect on income inequality is greater than in developed countries. This finding remains true across various aging measures.

The findings of this paper have important implications for studying the aging population issue and related policies. It was observed that if the reality of population aging in both developed and developing countries is ignored, the effect of population aging and the distribution system on income inequality may be exaggerated. More importantly, causal factors necessitate policy responses. When demographic change causes inequality, policies should focus on adjusting the population policy, the social welfare system, and the intergeneration transfer payment policy. When the policy's aging problems are resolved, this issue must be addressed. We propose two policy implications based on our findings:

1. Enough childcare programs and family benefits are needed. Such social programs may help to increase both the probability of working and the fertility rate, resulting in increased labor force participation in both the short and long run.
2. Access to additional training for older workers should be ensured. These kinds of opportunities encourage older workers to improve their skills and stay in the workforce.

Declarations

Ethical approval: Not applicable

Competing interests: The authors declare no competing interests.

Author contribution:

Hossein Amiri: conceptualization, methodology, software, validation, formal analysis, data curation, writing-original draft, writing-review and editing, supervision.

Mohammad Hossein Karim: conceptualization, methodology, validation, formal analysis, investigation, data Curation.

Ali Shamaei: conceptualization, methodology, software, validation, formal analysis, investigation, data curation, writing-original draft, writing-review, and editing.

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اثرات سالمندی بر نابرابری درآمد: کشورهای درحال توسعه در مقابل کشورهای توسعه یافته

چکیده:
سالمندی و پیامدهای آن، سالخوردگی جمعیت را به یک موضوع اجتماعی بزرگ تبدیل کرده است. جمعیت سالخورده احتمالاً با افزایش بار مالی عمومی و خصوصی هزینه‌های رفاه اجتماعی، نابرابری را تشدید می‌کند. هدف از این مطالعه برآورد اثرات پیری بر نابرابری درآمد برای ۸۱ کشور (۳۷ کشور در حال توسعه و ۴۴ توسعه یافته) از سال ۲۰۰۰ تا ۲۰۲۰ است. این مطالعه از رویکرد پانل پویا در چارچوب روش گشتاورهای تعمیم‌یافته (GMM) استفاده می‌کند. یافته‌های این مطالعه رابطه مثبت بین سالمندی و نابرابری درآمد را در کشورهای درحال توسعه و توسعه‌یافته تأیید می‌کند و نشان می‌دهد که اثر سالمندی بر نابرابری درآمد در کشورهای درحال توسعه بیشتر از کشورهای توسعه‌یافته است. همچنین با توجه به یافته‌های این پژوهش، بهبود سرمایه انسانی، افزایش درآمد سرانه، مدیریت صحیح و استفاده از رانت منابع طبیعی (درصد از تولید ناخالص داخلی) در کشورها و افزایش تجارت بین کشورها باعث کاهش نابرابری درآمدی می‌شود. سیاست‌گذاران باید نابرابری درآمدی را با سرمایه‌گذاری در آموزش، افزایش درآمد سرانه، مدیریت و استفاده صحیح از رانت منابع طبیعی (به عنوان درصد تولید ناخالص داخلی)، گسترش تجارت با سایر کشورها و برنامه‌ریزی برای اثرات پیری کاهش دهند.

کلمات کلیدی: ساختار جمعیت، رانت نفتی، روش GMM، ضریب جینی، تولید سرانه.