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# *The Impact of Labor Force Growth on the Economic Growth in East Asian Countries*

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***Keywords:*** GDP, Economic Growth, labor force, China, Japan, South Korea

***Abstract:*** This study investigates the impact of demographic and labor force composition changes on economic growth in China, Japan, and South Korea from 1990 to 2021. Utilizing multivariate regression models, the research examines how factors such as aging populations, fertility rates, mortality rates, unemployment, and labor force participation influence GDP growth in these countries. Data is sourced from reputable organizations like FRED, the World Bank, and national statistical bureaus, ensuring robust and consistent analysis. Our findings reveal that in China, GDP growth is significantly influenced by research and development (R&D) investments, the percentage of the population aged 65 and above, government spending, and the COVID-19 pandemic. For Japan, key factors include fertility rates, mortality rates, unemployment rates, the aging population, and savings rates. In South Korea, GDP growth is primarily affected by mortality rates, unemployment rates, and labor force participation rates. The study underscores the complex interplay between demographic factors and economic growth, highlighting the need for effective policy measures to address labor force decline and population aging. In China, substantial R&D investment boosts economic growth, while an aging population and increased government spending pose challenges. Japan's high savings rates and low unemployment contribute positively to GDP growth, though its aging population remains a concern. South Korea's economic growth benefits from industrial adaptation to an aging population, yet struggles with high unemployment and declining labor force participation. These findings emphasize the importance of tailored policy interventions to sustain economic growth in the face of demographic changes. Policymakers in China, Japan, and South Korea must balance labor welfare, improve job markets, and leverage demographic trends to mitigate the economic impacts of aging populations and other labor force challenges.

## 1. Introduction

According to the United Nations forecast of China, South Korea, and Japan’s population changes from 2020 to 2030, in the next 10 years, the number of people aged 35-44, 55-64, and 65 and above will grow the fastest. These changes in population structure brought changes in consumption structure and labor force participation rate. For all three countries, the decline in fertility rate and the expected increase in mortality and retirement rate also brought numerous changes in labor force participation in the past three decades. Shocks such as the financial crisis and the COVID-19 pandemic also contributed to changes in population growth and labor force composition. Many factors affect economic growth, and for an industrialized economy such as China, South Korea, and Japan, a well-developed policy system of population and labor force control is one of the most significant factors of all. Studying how labor force growth (related factors) affects economic growth is worthwhile. This research focused on identifying factors of the labor force affecting the economic growth of China, South Korea, and Japan, and measuring the significance of those factors. We aimed to measure the effect of labor force growth on the economic growth of the three countries from 1990 to 2021. Multivariate regression models were generated for China, Japan, and South Korea to identify relationships between labor force composition and relevant economic growth. In these models, it was assumed that the sole determinant for measuring a country's economic growth rate is the annual growth rate of selected countries' Gross Domestic Product (GDP). Starbird, Norton, and Marcus (2016) implemented a systematic review to suggest that family planning could accelerate economic progress. It measures such progress through 5 key sustainable development goals: people, peace, partnership, planet, and prosperity[1]. As a critical inference, it suggests that population decline, and in essence labor force decline, and provides the context for the population policies integrated into Asian economies.

Furuoka (2018) uses econometric methods to examine the link between population growth and economic development in China (P.210)[2]. Findings from the analysis indicate that China's population growth risks negating its economic growth. In this case, the study findings contradict the idea that labor force growth may increase economic growth in China, Japan, and South Korea. In this case, the study findings contradict the idea that labor force growth may increase economic growth in China, Japan, and South Korea. Liu, Chen, Lv, and Failler (2023) conducted empirical tests of the implication of an aging population on the economic growth of 30 provinces in China between 2000 and 2019 (p.10472)[3]. It suggests that population aging inhibits economic growth. Thus, it suggests that labor force growth in China, Japan, and South Korea will lead to complementary economic growth.

The above works of literature collectively demonstrate the complex relationship between demographic factors, labor force changes, and economic growth in China, Japan, and South Korea. While some studies suggest a positive correlation between labor force growth and economic development, others challenge this notion, emphasizing the importance of policy measures and specific contextual factors. Population aging is identified as a potential inhibitor of economic growth, especially in China and Japan. The studies also point out the significance of policies, such as extending retirement age or regulating immigration, in addressing labor force decline and stimulating economic resurgence. Overall, the summaries present a nuanced picture, recognizing the multifaceted nature of the relationship between labor force composition and economic growth in these East Asian countries. From here, this study proposes the following research question: How do changes in the demographic and labor force composition affect the economic growth of China, Japan, and South Korea?

## 2. Data Usage

The foundation of our meaningful econometric analysis lies in the integrity and the quality of the data we utilize. In this paper, we have referenced our dataset from reputable sources, including FRED, the World Bank, National Bureau of Statistics of China, International Monetary Fund, Statistics of Japan, Bank of Japan, and NASDAQ. The primary focus of our investigation is on three East Asian economic powerhouses: China, Japan, and South Korea. Our temporal scope ranges from 1990 to 2021, offering a comprehensive view of economic trends over three decades. Annual frequencies, incorporating 32 observations, enable a granular examination of the economic dynamics within each country. The use of Year-Over-Year changes ensures a robust comparative analysis, capturing the percentage change in variables from one year to the next. To maintain consistency in our analysis, we have transformed certain original monthly data into an annual format. Monthly-to-annual transformations employ a 12-month average, a common practice in econometrics to smoothen fluctuations and provide a more representative annual snapshot. Dummy variables, integral to our modeling approach, serve as binary switches. Specifically, we introduce the "FINCRISIS" dummy to delineate the impact of the 2007-2008 Financial Crisis and the "COVID" dummy for the COVID-19 pandemic, both recognized as pivotal shock events. The distinction in pre-occurrence (0) and post-occurrence (1) years facilitates a nuanced understanding of the economic landscape during and after these crises.

In constructing our analysis, several assumptions have been made. We assume exogenous and uniform data collection methodologies across all variables and data sources, mitigating potential biases. Moreover, shock events are considered to impact each selected country uniformly. The datasets are presumed to be not seasonally adjusted and free from time-lag influences, enhancing the reliability of our findings.

## 3. Empirical Strategy

Our analytical strategy draws inspiration from established literature reviews, centering around Multivariate Regression Analysis and Coefficient Tests. The regression model, characterized by intercept (β), labor-related coefficients (γ1-γ6), socioeconomic coefficients (δ1-δ6), and an error term ($\epsilon$), serves as the linchpin of our investigation, as shown below:

$$Growth = \beta 0 + \gamma 1 * POPGROWTH + \gamma 2 * FER + \gamma 3 * MOR + \gamma 4 * PAR$$
$$+\gamma 5 * WMRATIO + \gamma 6 * POP65 + \gamma 7 * UNEMP + \delta 1 * INR + \delta 2 * CPI$$
$$+\delta 3 * SAV + \delta 4 * RD + \delta 5 * FDI + \delta 6 * CORESPEND + \tau 1 * FINCRISIS$$
$$+\tau 2 * COVID + \epsilon$$

Initiating our approach, a General Regression Model will be executed for each country, encapsulating a spectrum of labor-related and socioeconomic coefficients. This model will serve as a benchmark, with a particular focus on R^2 and F values to evaluate its overall fitness. The critical R^2 threshold of 0.75 establishes a stringent criterion for model adequacy. Variable significance determination hinges on t statistics, employing a critical value of 1.96 and a p-value threshold of 0.05. This approach ensures that only statistically significant variables are considered in subsequent analyses. Coefficient Tests, leveraging Pearson's correlation theorem, delve into potential inter-variable relationships, with a spotlight on variables identified as significant through t statistics and p-value testing.

## 4. Results and Data Analysis

For independent variables in China's multivariate linear regression model, four variables indicate significant influence on the changes in China's real GDP growth: Annual percentage of people ages 65 and above in the total population (POP65), annual percentage of national investment in research and development to GDP (RD), annual percentage of essential government spending to GDP(CORESPEND) and COVID-19 pandemic (COVID). As demonstrated in Figure 1, Figure 2, and Figure 3, absolute t-statistics for these four variables are all above the critical value of 1.96. P-values for POP65, RD, and COVID-19 are significantly below the 0.05 benchmark value. Although the p-value for CORESPEND is 0.057 which is slightly higher than the benchmark value, given that their difference is minimal and its t-statistics exhibit strong significance, CORESPEND is still regarded as the significant independent variable. By interpreting the coefficients of the significant variables, it is possible to identify that for 1% change in POP65, RD, CORESPEND, and COVID-19 while holding other variables constant and discussing these variables separately, each will lead to -4.518%, 17.801%, -0.712%, and -5.384% change in the real GDP growth of China respectively. In addition to the interpretations of significant variables' coefficients, Pearson's correlation test among independent variables all demonstrate notable interactive effects. As demonstrated in Figure 3 of the Appendix, all interactive indicators in between any two independent variables (excluding COVID in the discussion of correlation Pearson's correlation test as it serves merely as a shock occurrence indicator) stand above 0.9, meaning that positive interactive effects exist among significant independent variables.

| CHINA MODEL | | | | | |
|---|---|---|---|---|---|
| SUMMARY OUTPUT | | | | | |
| | | | | | |
| *Regression Statistics* | | | | | |
| Multiple R | 0.963967108 | | | | |
| R Square | 0.929232586 | | | | |
| Adjusted R Square | 0.862888136 | | | | |
| Standard Error | 1.014704507 | | | | |
| Observations | 32 | | | | |
| | | | | | |
| ANOVA | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* |
| Regression | 15 | 216.3168091 | 14.42112061 | 14.00618409 | 1.83184E-06 |
| Residual | 16 | 16.47400379 | 1.029625237 | | |
| Total | 31 | 232.7908129 | | | |

Figure 1: China's Multivariate Regression Model Summary Output

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -33.44834087 | 183.0906156 | -0.182687358 | 0.85733809 |
| POPGROWTH | -8.344232961 | 5.47438375 | -1.524232378 | 0.14697149 |
| FER | -3.644443474 | 2.565885216 | -1.420345482 | 0.174700493 |
| MOR | 5.586233611 | 4.37357507 | 1.277269401 | 0.219731373 |
| PAR | -2.094638091 | 1.234211554 | -1.69714672 | 0.109031985 |
| WMRATIO_CHN | 1.91101829 | 1.310128596 | 1.4586494 | 0.164013217 |
| POP65 | -4.517904735 | 1.369754817 | -3.29833097 | 0.00453522 |
| UNEMP | -0.64406438 | 1.787813912 | -0.360252471 | 0.72336989 |
| INR | -0.629394812 | 0.418385812 | -1.504340717 | 0.151976718 |
| CPI | 0.105532374 | 0.087818336 | 1.201712293 | 0.246960873 |
| SAV | 0.209769618 | 0.20938834 | 1.001820913 | 0.331341381 |
| RD | 17.80054569 | 5.55875027 | 3.202256771 | 0.005551315 |
| CORESPEND | -0.711519175 | 0.34666215 | -2.052485902 | 0.056854487 |
| FDI | 0.250206974 | 0.409536415 | 0.610951712 | 0.549813235 |
| FINCRISIS | -1.023752153 | 1.967186268 | -0.520414447 | 0.609901294 |
| COVID-19 | -5.383536091 | 1.472584069 | -3.655842954 | 0.002132237 |

Figure 2: China's Multivariate Regression Model Independent Variables Coefficients and Significances

| | GROWTH | POPGROWTH | FER | MOR | PAR | WMRATIO_CHN | POP65 | UNEMP | INR | CPI | SAV | RD | CORESPEND | FDI | FINCRISIS | COVID-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROWTH | 1.00000 | | | | | | | | | | | | | | | |
| POPGROWTH | 0.24933 | 1.00000 | | | | | | | | | | | | | | |
| FER | -0.05799 | 0.58524 | 1.00000 | | | | | | | | | | | | | |
| MOR | -0.32404 | -0.57788 | 0.00075 | 1.00000 | | | | | | | | | | | | |
| PAR | 0.32593 | 0.09559 | 0.28637 | -0.23306 | 1.00000 | | | | | | | | | | | |
| WMRATIO_CHN | 0.10035 | 0.71887 | 0.04960 | -0.73308 | -0.35523 | 1.00000 | | | | | | | | | | |
| POP65 | -0.51628 | -0.86649 | -0.42802 | 0.75633 | -0.44725 | -0.58292 | 1.00000 | | | | | | | | | |
| UNEMP | -0.19639 | -0.87794 | -0.32517 | 0.49452 | 0.23865 | -0.86242 | 0.67486 | 1.00000 | | | | | | | | |
| INR | 0.31126 | 0.83087 | 0.24914 | -0.44732 | -0.21598 | 0.71922 | -0.68464 | -0.82493 | 1.00000 | | | | | | | |
| CPI | 0.48341 | 0.43062 | 0.04496 | -0.17820 | -0.21773 | 0.32991 | -0.37008 | -0.44306 | 0.71720 | 1.00000 | | | | | | |
| SAV | 0.15770 | -0.63372 | -0.06258 | 0.73286 | 0.20057 | -0.90243 | 0.50412 | 0.73339 | -0.50413 | -0.06360 | 1.00000 | | | | | |
| RD | -0.47563 | -0.82682 | -0.23733 | 0.85932 | -0.28555 | -0.73491 | 0.95821 | 0.72551 | -0.72671 | -0.37697 | 0.64534 | 1.00000 | | | | |
| CORESPEND | -0.58438 | -0.72478 | -0.11398 | 0.85677 | -0.33514 | -0.65923 | 0.92533 | 0.62100 | -0.67837 | -0.37995 | 0.54386 | 0.97586 | 1.00000 | | | |
| FDI | 0.70768 | 0.24417 | -0.25615 | -0.50065 | 0.38231 | 0.17670 | -0.54924 | -0.15006 | 0.42479 | 0.53811 | -0.03723 | -0.58373 | -0.70052 | 1.00000 | | |
| FINCRISIS | -0.48493 | -0.65468 | -0.10641 | 0.92464 | -0.21470 | -0.73758 | 0.81855 | 0.58662 | -0.53980 | -0.24279 | 0.65174 | 0.89709 | 0.91408 | -0.53293 | 1.00000 | |
| COVID-19 | -0.35882 | -0.46266 | -0.52829 | 0.29572 | -0.62415 | 0.00138 | 0.56047 | 0.19489 | -0.17648 | -0.10819 | 0.05520 | 0.43706 | 0.39811 | -0.27246 | 0.29277 | 1.00000 |

Figure 3: China's Independent Variables Correlation Tests

For independent variables in Japan's multivariate linear regression model, using similar strategies demonstrated in the prior explanation on China's model, five variables present significant influence on the changes in Japan's real GDP growth: Annual average births per woman (FER), annual average deaths per 1000 people (MOR), annual percentage of unemployed workers in the total labor force (UNEMP), annual percentage of people ages 65 and above in the total population (POP65), and annual percentage of domestic saving accounts to GDP (SAV). Through interpreting the coefficients of the significant variables shown in Figure 4, Figure 5, and Figure 6, it is possible to identify that for a 1% change in FER, MOR, UNEMP, POP65, and SAV while holding other variables constant and discussing these variables separately, each will lead to 37.304%, 6.005%, 3.839%, -2.205% and 0.612% change in the real GDP growth of Japan respectively. Pearson's correlation tests among independent variables also show certain notable interactive effects. As demonstrated in Figure 6 of the Appendix, interactive indicators for FER to UNEMP, MOR to POP65, MOR to SAV, UNEMP to SAV, and POP65 to SAV are -0.636, 0.988, -0.665, -0.612, and -0.698, which are well above the absolute critical value of 0.5. These results indicate that the mortality rate (MOR) and the population aged 65 and over (POP65) are positively correlated, while fertility rates (FER) to unemployment rates (UNEMP), mortality rates (MOR) to savings rates (SAV), unemployment rates (UNEMP) to savings rates (SAV), and mortality rates (MOR) to the population aged 65 and over (POP65) exhibit negative interactive effects.

| | | | | | |
|---|---|---|---|---|---|
| Japan Model | | | | | |
| SUMMARY OUTPUT | | | | | |
| | | | | | |
| *Regression Statistics* | | | | | |
| Multiple R | 0.900488271 | | | | |
| R Square | 0.810879127 | | | | |
| Adjusted R Square | 0.633578308 | | | | |
| Standard Error | 1.278966072 | | | | |
| Observations | 32 | | | | |
| | | | | | |
| ANOVA | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* |
| Regression | 15 | 112.2159749 | 7.481064991 | 4.573465213 | 0.00221658 |
| Residual | 16 | 26.17206741 | 1.635754213 | | |
| Total | 31 | 138.3880423 | | | |

Figure 4: Japan's Multivariate Linear Regression Model Summary Output

| | Coefficients | Standard Error | t Stat | P-value |
|---|---|---|---|---|
| Intercept | -122.1151404 | 70.23261837 | -1.738724018 | 0.101284553 |
| POPGROWTH | 5.449300544 | 7.057495184 | 0.772129545 | 0.451292713 |
| FER | 37.3035235 | 13.56692976 | 2.749592144 | 0.014246007 |
| MOR | 6.005449868 | 2.279871759 | 2.634117399 | 0.018044055 |
| PAR | -0.830688213 | 0.896985055 | -0.926089245 | 0.368158405 |
| WMRATIO | 1.416402753 | 0.922689557 | 1.535080507 | 0.1443005 |
| POP 65 | -2.205259117 | 1.104408263 | -1.996778901 | 0.063152693 |
| UNEMP | 3.838908658 | 0.82463893 | 4.65526004 | 0.000263998 |
| INR | -1.382404674 | 0.910739343 | -1.51789278 | 0.148551493 |
| CPI | -0.019775959 | 0.434314653 | -0.045533714 | 0.964245372 |
| SAV | 0.61160542 | 0.303619521 | 2.014381087 | 0.061097369 |
| R&D | 2.1733785 | 5.246249371 | 0.414272816 | 0.684174961 |
| CORESPEND | -0.484507625 | 0.25681661 | -1.886589911 | 0.077498645 |
| FDI | -0.042695687 | 1.927103337 | -0.02215537 | 0.982597972 |
| FINCRISIS | -2.269896565 | 1.823100488 | -1.245074849 | 0.231031874 |
| COVID-19 | 5.20298178 | 2.875447623 | 1.809451071 | 0.08920631 |

Figure 5: Japan's Multivariate Linear Regression Model Independent Variables Coefficients and Significances

| | GROWTH | POPGROWTH | FER | MOR | PAR | WMRATIO | POP 65 | UNEMP | INR | CPI | SAV | R&D | CORESPEND | FDI | FINCRISIS | COVID-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROWTH | 1.00000 | | | | | | | | | | | | | | | |
| POPGROWTH | 0.24433 | 1.00000 | | | | | | | | | | | | | | |
| FER | 0.27520 | 0.35280 | 1.00000 | | | | | | | | | | | | | |
| MOR | -0.25846 | -0.95051 | -0.25845 | 1.00000 | | | | | | | | | | | | |
| PAR | 0.06749 | 0.68740 | 0.23693 | -0.71273 | 1.00000 | | | | | | | | | | | |
| WMRATIO | -0.23365 | -0.85432 | -0.09992 | 0.93546 | -0.48981 | 1.00000 | | | | | | | | | | |
| POP 65 | -0.29349 | -0.93025 | -0.32800 | 0.98827 | -0.75430 | 0.90619 | 1.00000 | | | | | | | | | |
| UNEMP | 0.04978 | -0.14196 | -0.63634 | 0.05052 | -0.51125 | -0.25045 | 0.13853 | 1.00000 | | | | | | | | |
| INR | 0.34110 | 0.56178 | 0.72142 | -0.53359 | 0.48374 | -0.31570 | -0.60214 | -0.59392 | 1.00000 | | | | | | | |
| CPI | 0.28117 | 0.29025 | 0.66716 | -0.23695 | 0.21858 | -0.04773 | -0.28527 | -0.57681 | 0.71698 | 1.00000 | | | | | | |
| SAV | 0.28611 | 0.69189 | 0.35740 | -0.66482 | 0.85199 | -0.40375 | -0.69793 | -0.61165 | 0.65097 | 0.48405 | 1.00000 | | | | | |
| R&D | -0.29330 | -0.83650 | -0.48600 | 0.84944 | -0.85945 | 0.68019 | 0.88896 | 0.39787 | -0.59411 | -0.27720 | -0.76338 | 1.00000 | | | | |
| CORESPEND | -0.45486 | -0.87757 | -0.40562 | 0.84885 | -0.51002 | 0.75796 | 0.85041 | 0.17688 | -0.65936 | -0.45505 | -0.66910 | 0.73011 | 1.00000 | | | |
| FDI | -0.42266 | -0.59454 | -0.27412 | 0.67941 | -0.22273 | 0.76295 | 0.68753 | -0.22650 | -0.28087 | -0.13069 | -0.19016 | 0.53362 | 0.63237 | 1.00000 | | |
| FINCRISIS | -0.30189 | -0.83419 | 0.03339 | 0.89024 | -0.70837 | 0.81368 | 0.86568 | -0.00769 | -0.35659 | -0.09326 | -0.70763 | 0.73303 | 0.76350 | 0.52687 | 1.00000 | |
| COVID-19 | -0.24738 | -0.55091 | -0.28184 | 0.44712 | 0.08331 | 0.55431 | 0.40300 | -0.27421 | -0.10931 | -0.13244 | -0.00221 | 0.27046 | 0.60301 | 0.63125 | 0.29277 | 1.00000 |

Figure 6: Japan's Independent Variables Correlation Tests

For independent variables in South Korea's multivariate linear regression model and using the strategies of identification for significance variables explained in the prior paragraphs, three variables present significant influence on the changes in South Korea's real GDP growth: Annual percentage of unemployed workers in the total labor force (UNEMP), annual average deaths per 1000 people (MOR), and annual percentage of actively working labors in the total working age (15+) population (PAR). Through interpretation of the coefficient results as demonstrated in Figure 7, Figure 8, and Figure 9, for every 1% change in UNEMP, MOR, and PAR while holding other variables constant and discussing these variables separately, each will lead to -2.969%, 7.408%, and -2.342% change in the real GDP growth of South Korea respectively. Unfortunately, given that the interactive indicators from Pearson's correlation test for significant independent variables in the South Korea model center around 0 and below the absolute critical value of 0.5, the correlation test fails to identify any significant interactive effects that may exist among the significant independent variables in the South Korea model.

| South Korea Model | | | | | |
|---|---|---|---|---|---|
| SUMMARY OUTPUT | | | | | |
| | | | | | |
| *Regression Statistics* | | | | | |
| Multiple R | 0.893243158 | | | | |
| R Square | 0.797883339 | | | | |
| Adjusted R Square | 0.608398969 | | | | |
| Standard Error | 2.196867881 | | | | |
| Observations | 32 | | | | |
| | | | | | |
| ANOVA | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* |
| Regression | 15 | 304.8352198 | 20.32234799 | 4.210813485 | 0.003450261 |
| Residual | 16 | 77.21965578 | 4.826228486 | | |
| Total | 31 | 382.0548756 | | | |

Figure 7: South Korea’s Multivariate Linear Regression Model Summary Output

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 110.4363607 | 89.44086922 | 1.234741586 | 0.23475338 |
| POPGROWTH | 5.861681804 | 5.942314582 | 0.986430746 | 0.338604964 |
| FER | 1.809440952 | 8.575555509 | 0.210999853 | 0.835551306 |
| MOR | 7.408323733 | 3.555319423 | 2.083729435 | 0.053577769 |
| PAR | -2.341524271 | 1.18416476 | -1.977363581 | 0.065492127 |
| WMRATIO_KOR | 0.225725799 | 1.057049512 | 0.21354326 | 0.833600595 |
| POP65 | 2.58537861 | 2.383939897 | 1.084498235 | 0.294215577 |
| UNEMP | -2.968758342 | 0.847385903 | -3.503431353 | 0.002942148 |
| INR | -0.63649119 | 1.151692164 | -0.552657394 | 0.588136555 |
| CPI | -0.811070973 | 0.433144237 | -1.872519368 | 0.079526387 |
| SAV | 0.182444969 | 0.533077041 | 0.342248783 | 0.736618142 |
| R&D | -7.141401846 | 4.183078058 | -1.707212188 | 0.107110685 |
| CORESPEND | -0.94860042 | 0.792028907 | -1.19768409 | 0.248482466 |
| FDI | 3.06432265 | 1.772808784 | 1.728512786 | 0.103141498 |
| FINCRISIS | -4.143202906 | 3.717550943 | -1.11449795 | 0.281527367 |
| COVID-19 | -0.430752752 | 3.283310265 | -0.131194653 | 0.897256805 |

Figure 8: South Korea’s Multivariate Linear Regression Model Independent Variables Coefficients and Significances

| | *GROWTH* | *POPGROWTH* | *FER* | *MOR* | *PAR* | *WMRATIO_KOR* | *POP65* | *UNEMP* | *INR* | *CPI* | *SAV* | *R&D* | *CORESPEND* | *FDI* | *FINCRISIS* | *COVID-19* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROWTH | 1.00000 | | | | | | | | | | | | | | | |
| POPGROWTH | 0.51893 | 1.00000 | | | | | | | | | | | | | | |
| FER | 0.56644 | 0.92883 | 1.00000 | | | | | | | | | | | | | |
| MOR | -0.07104 | -0.37628 | -0.29263 | 1.00000 | | | | | | | | | | | | |
| PAR | -0.35100 | -0.65808 | -0.71373 | 0.29971 | 1.00000 | | | | | | | | | | | |
| WMRATIO_KOR | -0.50872 | -0.85027 | -0.92551 | 0.41545 | 0.80410 | 1.00000 | | | | | | | | | | |
| POP65 | -0.57846 | -0.84511 | -0.89287 | 0.47494 | 0.73178 | 0.97114 | 1.00000 | | | | | | | | | |
| UNEMP | -0.39488 | -0.30859 | -0.27448 | -0.03680 | -0.08093 | 0.11306 | 0.15936 | 1.00000 | | | | | | | | |
| INR | 0.55431 | 0.83814 | 0.89902 | -0.17574 | -0.70619 | -0.90227 | -0.90681 | -0.32724 | 1.00000 | | | | | | | |
| CPI | 0.29991 | 0.66964 | 0.72136 | -0.10413 | -0.69829 | -0.76350 | -0.74289 | -0.26631 | 0.86560 | 1.00000 | | | | | | |
| SAV | 0.17444 | 0.31925 | 0.47653 | 0.53786 | -0.29192 | -0.34558 | -0.21724 | -0.17341 | 0.47549 | 0.49248 | 1.00000 | | | | | |
| R&D | -0.56242 | -0.76331 | -0.81318 | 0.53331 | 0.71381 | 0.93359 | 0.98229 | 0.08512 | -0.85709 | -0.70354 | -0.10632 | 1.00000 | | | | |
| CORESPEND | -0.59802 | -0.88923 | -0.90487 | 0.48209 | 0.60161 | 0.89640 | 0.92487 | 0.21882 | -0.81394 | -0.62848 | -0.23861 | 0.87652 | 1.00000 | | | |
| FDI | -0.07674 | -0.31957 | -0.26092 | -0.21706 | -0.04049 | 0.07951 | 0.03235 | 0.74337 | -0.27509 | -0.24710 | -0.40379 | -0.07877 | 0.11779 | 1.00000 | | |
| FINCRISIS | -0.52809 | -0.55603 | -0.64584 | 0.36606 | 0.46601 | 0.78992 | 0.86815 | 0.03408 | -0.75828 | -0.55546 | -0.07151 | 0.89633 | 0.72722 | -0.12576 | 1.00000 | |
| COVID-19 | -0.24277 | -0.56691 | -0.48373 | 0.65926 | 0.25389 | 0.45784 | 0.49681 | 0.06984 | -0.31404 | -0.21521 | 0.11972 | 0.48401 | 0.67491 | 0.00498 | 0.29277 | 1.00000 |

Figure 9: South Korea Model Independent Variables Correlation tests

## 5. Discussion

Research and Development (RD) significantly boosts China's GDP growth, aligning with Romer's (1990) theory that economies with more human capital grow faster. China's massive investments in R&D, education, and workforce welfare since its 1979 reforms have enhanced efficiency and growth.

However, an aging population (POP65), increased government core spending (CORESPEND), and COVID-19's impact negatively affect growth. These factors echo Liu et al. (2023), who note aging populations strain labor markets and economic efficiency. Policymakers should balance labor welfare, working efficiencies, and expenditures to sustain positive GDP growth and improve socioeconomic quality.

In Japan, high savings rates (SAV) and low unemployment (UNEMP) positively correlate with GDP growth, demonstrating economic resilience. Despite the aging population (POP65) posing challenges, savings rates remain robust. Interestingly, the mortality rate (MOR) positively impacts GDP, reflecting Japan's developed status and industrial adaptability. Fertility rate (FER) also significantly boosts GDP, suggesting policymakers should leverage this to drive long-term growth. Transforming the net birth rate into economic potential will help mitigate aging population effects and sustain economic expansion.

In South Korea, mortality rate (MOR) positively correlates with GDP growth, reflecting industrial adaptation to an aging population. However, unemployment (UNEMP) and labor force participation rate (PAR) negatively impact GDP, indicating worsening job markets from 1990 to 2021. Improved job markets are essential to counteract the aging population's economic effects, as highlighted by Bandenbrouke (2022) [4]. Effective public health and education policies have historically supported growth, but addressing current labor market challenges is crucial. Policymakers should focus on job market improvements to ensure sustained economic growth and mitigate potential age-related issues.

## 6. Limitations

The time delay of economic variables has not been taken into account, and there might be a delay in the influence of policy or market changes on economic indicators. For instance, it could require numerous quarters for economic growth data to reflect government R&D investment. Another drawback of our approach is the disregard for the interplay between variables. Neglecting these interactions can lead to a misinterpretation of economic phenomena. To overcome this limitation, we can utilize multiple regression models that incorporate interaction terms to capture these intricate relationships. Such an approach can offer more profound and comprehensive insights that can contribute to a more precise comprehension of economic phenomena. Furthermore, due to the use of annual data, we face a lack of sufficient data. This can result in an inability to fully grasp the characteristics and behavioral patterns of our research subjects. Enhancing this aspect necessitates initiating data collection and sample selection. Embracing a broader range of data sources, enhancing the representativeness of the sample, and employing advanced data processing techniques like machine learning methods can effectively enhance the data quality and study accuracy. Lastly, our study fails to fully consider the disparities in economic cycles among the three countries. Different countries possess distinct economic structures, policy environments, and market conditions, which can lead to inconsistent impacts of macroeconomic policies or global economic changes on them. Ignoring these disparities can yield research findings that inaccurately portray the true state of economic activity in different countries.

## 7. Conclusions

In this paper, we examined how changes in the demographic and labor force composition affect the economic growth of China, Japan, and South Korea. We employ ex-post and ex-ante methods to examine how China’s GDP Growth would perform under Japanese and South Korean labor force characteristics and economic conditions. To further explain the interesting things that we find in our main research, we employ the OLS Model to examine how the COVID-19 variable affects the GDP Growth for the three countries and how R&D affects the labor force and GDP growth for the three countries. Our research covers the period from 1990 to 2021 (yearly frequency).

Our main results can be summarized as follows: China's Economic Growth is positively influenced by the percentage of research and development investment to GDP, and negatively influenced by the percentage of the population over 65 years old, the percentage of government primary spending to GDP, and COVID-19 occurrence. Japan's Economic Growth is positively influenced by the mortality rate, unemployment rate, and savings rate, and negatively influenced by the percentage of the population over 65 years old. South Korea's Economic Growth is positively influenced by the mortality rate, and negatively influenced by the unemployment rate and labor force participation rate.

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