

# The Nexus Between Female Labor Force Participation and Economic Development: A Global Study Across the Phases of Demographic Dividends.

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## ABSTRACT

Economic growth, commonly measured by Gross Domestic Product (GDP), is influenced by various factors, including the Female Labor Force Participation Rate (FLFPR), which remains notably low worldwide. Improving FLFPR is crucial for unlocking demographic dividends and advancing Sustainable Development Goals (SDGs). This research explores the impact of FLFPR, population size, the Human Development Index (HDI), energy consumption, and the Male Labor Force Participation Rate (MLFPR) on GDP, utilizing data from 118 countries between 1990 and 2019, categorized by different stages of demographic dividends. By employing advanced panel econometric techniques, the study indicates that population size may negatively affect GDP at the global level. Simultaneously, energy consumption emerges as a significant positive driver of GDP, particularly during the early stages of demographic dividends. HDI shows the most substantial positive effect among all variables, especially in post-dividend phases, highlighting the importance of prioritizing population quality over sheer quantity. MLFPR is pivotal in GDP growth, although its effects vary across demographic stages. Meanwhile, FLFPR reveals stage-specific influences, including a U-shaped relationship in pre-dividend phases and an inverse U-shaped relationship during early dividend stages. The analysis emphasizes a bidirectional causality among the variables, showcasing their intricate interdependence. The findings highlight the need for demographic-stage-specific strategies to enhance human development as a primary catalyst for sustainable economic growth.

**Keywords:** Per capita gross domestic production (GDP), Female labor force participation rate (FLFPR), Demographic dividends, Sustainable development, Panel data analysis.

## INTRODUCTION

Economic development refers to improving living standards and quality of life resulting from a country's increased national income or output, often called economic growth. Gross domestic product (GDP) is a standard metric for measuring this growth. Sustainable economic development presents a significant global challenge today. Policies should encourage all forms of growth, including intellectual and economic, as every economy faces difficulty satisfying human demands with limited resources. The global population has tripled since the mid-20th century and is projected to reach 11 billion by 2100 (John Wilmoth, 2022). According to Lee (2003) and R. D. Lee & Mason (2006), the "demographic transition" is the shift from high fertility and mortality rates in agricultural societies to low rates in urban industrial societies. Changes in the age structure of a population can significantly impact a country's economic performance, with a large working-age population generating a "demographic dividend" of economic growth (David E. Bloom, David Canning, 2001) and a high proportion of children hindering it. Effective policies are necessary to maximize the demographic dividend and economic growth, including supporting employment for all groups, especially women (Lee & Mason, 2019).

The female labor force participation rate (FLFPR) is still low globally despite equal gender representation. Numerous studies, including those by authors (Lechman, 2014), (Roy, 2018), (Khaliq et al., 2017), (Gaddis & Klasen, 2014) have demonstrated a U-shaped association between GDP and FLFPR (Feminization U Hypothesis). Meanwhile, only a tiny amount of research has looked at FLFPR's effect on GDP. Based on 122

and 100 nations, respectively, Na-Chiangmai (2018) and Baerlocher et al. (2021) have noted that raising the FLFP can lead to more substantial economic growth. Conversely, FLFP results in slower economic development in Pakistan, according to Khaliq et al. (2017).

Several researchers have noted that female labor force participation (FLFP) may have an impact on the Sustainable Development Goals (SDGs) of the United Nations (Foster, 2016; Balakrishnan & Dharmaraj, 2018; Denney, 2015; Taheri et al., 2021). The SDGs are intended to battle poverty and hunger, encourage active lifestyles, advance gender parity and high-quality education, lessen inequality, promote sustainable consumption and production patterns, fight climate change, and promote an inclusive and peaceful society. According to Choudhry & Elhorst (2018); Ustabaş & Gülsoy (2017)), and Appiah (2018), FLFP can favorably impact sustainable development's economic, social, and environmental pillars.

Policymakers often prioritize socio-economic factors over the long-term dynamics of population age structure to enhance female labor force participation (FLFP). Based on the population's age distribution, the demographic dividend stage, determined by the population's age distribution, affects a country's economic status and the lived experiences of its people, personally and within families. This study investigates the relationship between FLFP and economic development across each stage of the demographic dividend, utilizing the World Bank's classification of countries based on four demographic dividend phases. This classification offers a framework for developing long-term strategies to maximise the demographic dividend and increase women's participation in the workforce.

This study aims to provide decision-makers with insights into the impact of female labor force participation (FLFP) on GDP during various phases of the demographic dividend. It is unique in organising countries into panels based on the first demographic dividend and dividing them into Pre-, Early-, Late-, and Post-dividend stages. In addition to assessing how gender-specific labor force participation rates influence GDP at each phase, the study also examines the causal relationships among GDP, population, Human Development Index (HDI), energy consumption, and labor force participation rates. This research enables policymakers to devise effective national, regional, or global strategies to optimize demographic dividends and enhance GDP by uncovering the contributions of male and female labour force participation to GDP.

The study employs several econometric methods, including slope homogeneity tests, second-generation unit root tests, and Westerlund cointegration tests, to address the issue of cross-sectional dependency. Driscoll and Kraay regression, Newey-West regression, and the Dumitrescu-Hurlin Granger non-causality test serve as panel estimates.

This study comprises five segments: Segment 2, Model Specification and Data Sources, theoretical Framework, Modeling, and Data Collection. Segment 3, Estimation Strategy, presents a range of econometric techniques used in this study. Segment 4, Empirical Results and Discussion, outlines the empirical analysis and deliberations. Segment 5, Conclusions, offers concluding remarks on practical implications and suggestions for future research.

## **Model specification and data sources**

### **Theoretical framework**

Labor force participation, especially female participation (FLFP), is vital for economic growth and GDP. Gender-based legal restrictions, such as barriers preventing women from opening bank accounts or entering specific professions, exacerbate gender gaps in labor participation, negatively impacting GDP (Gonzales et al., 2015). Removing these obstacles offers significant economic advantages.

The relationship between labor participation and economic development is intricate. Although a U-shaped trend in female labor force participation (FLFP) has been suggested as economies progress, Gaddis and Klasen (2013) argue that this evidence is weak and influenced by data selection. While structural changes may create a U-shaped pattern, the effect is minimal. Technological advancements and automation also decrease participation rates, particularly among prime-age workers in advanced economies (Grigoli et al., 2020), underscoring the

complicated link between technology, labor markets, and growth. Several factors affect GDP. Economic freedoms, particularly governmental integrity, significantly boost GDP per capita growth (Štilić et al., 2023). Innovation, backed by institutional frameworks, infrastructure, and technology, drives GDP (Dempere et al., 2023). Human capital is essential; for instance, Mauritius contributed substantially to growth with a long-term output elasticity of 0.36 (Neeliah & Seetanah, 2016). Economic openness exhibits a nonlinear relationship with green GDP growth, reflecting trade's impact on economic welfare (Talberth & Bohara, 2005).

The accuracy of GDP measurement influences our understanding of growth. Due to measurement errors, GDP and Gross Domestic Income (GDI) discrepancies can alter economic models (Chang & Li, 2018). Innovative forecasting models, such as those based on export-driven "fitness," outperform traditional IMF predictions (Tacchella et al., 2018). However, GDP alone does not fully encompass societal well-being, leading to calls for broader welfare indicators (England, 1998; Ward et al., 2016).

The Human Development Index (HDI) and GDP share a bidirectional relationship. Improvements in HDI foster GDP growth, as seen in ASEAN countries (Elistia & Syahzuni, 2018). However, this relationship varies; data from China revealed two energy- GDP pathways: high energy use coupled with low GDP and low energy use linked to high GDP (Tong, 2024). Factors such as energy consumption and urbanization shape this dynamic.

In conclusion, while female labor force participation (FLFP), innovation, human capital, and HDI generally encourage GDP, these relationships are complex and context-dependent. A holistic approach that integrates economic and human development considerations is crucial for sustainable growth.

### Specifications of the Empirical Model

To explore the linear effect of FLFPR on economic development across demographic dividend stages in countries. The study considered the following equation:

$$GDP = f(POP, ENG, HDI, FLFPR, MLFPR) \quad (1)$$

GDP per capita indicated economic development, while POP represented the total midyear population. ENG referred to per capita energy consumption, HDI indicated the Human Development Index, FLFPR represented the Female Labor Force Participation Rate, and MLFPR denoted the Male Labor Force Participation Rate.

The non-linear effect of FLFPR on economic development can be explored by adding the square term of the FLFPR term to equation (1), as shown in equation (2):

$$GDP = f(POP, ENG, HDI, FLFPR, FLFPR^2, MLFPR) \quad (2)$$

In line with Sinha & Sen (2016) and Tran et al. (2019) this study explores how several variables relate to one another within a single multivariate framework. Also, we convert all of the data into natural logarithms. According to Bekhet & Othman (2017) all the data must be transformed into natural logarithms to lower the likelihood of autocorrelation and heteroscedasticity. Also, by reducing the sharpness of the data, the log-linear model provides more trustworthy conclusions than the basic model (Shahbaz, 2013). The empirical model for this study is specified as follows:

$$LGDP_{it} = \beta_0 + \beta_1 LPOP_{it} + \beta_2 LENG_{it} + \beta_3 LHDI_{it} + \beta_4 LFLFPR_{it} + \beta_5 LMLFPR_{it} + \varepsilon_{it} \quad (3)$$

$$LGDP_{it} = \beta_0 + \beta_1 LPOP_{it} + \beta_2 LENG_{it} + \beta_3 LHDI_{it} + \beta_4 LFLFPR_{it} + \beta_5 LMLFPR_{it} + \beta_6 LFLFPR_{it}^2 + \varepsilon_{it} \quad (4)$$

In models (3) and (4),  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$  and  $\beta_6$  reflect the elasticity relations between the independent variable and dependent variables. Every 1% change in LPOP, LGDP, LENG, LFLFPR, LMLFPR, and LFLFPR<sup>2</sup> leads to a  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$  or  $\beta_6$  change in GDP.

## Data sources

The study utilized credible databases to obtain secondary data. The response variable, per capita Gross Domestic Product (GDP) in constant 2015 US dollars, was sourced from World Development Indicators. Additionally, data for the explanatory variables, including mid-year total population (POP), Female Labor Force Participation Rate (FLFPR), and Male Labor Force Participation Rate (MLFPR), was also obtained from World Development Indicators. The B.P. & Shift (2020) Data Portal provided data on energy usage (per person, 2020) in kilowatt-hours for the study. The human development index (HDI) data was obtained from the United Nations Development Program website.

Table 2: Data (Main Variables) to be Considered for the Study and Data Sources

| Label | Variable                                                                                     | Definition                                                                                                                                                                         | Unit               | Source                                                                                                |
|-------|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------|
| GDP   | Gross Domestic Product (per capita)                                                          | Gross domestic product divided by midyear population                                                                                                                               | Constant 2015 US\$ | WDI (12/22/2022)                                                                                      |
| POP   | Total mid-year population                                                                    | Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are mid-year estimates. | count              | WDI (12/22/2022)                                                                                      |
| FLFPR | Female Labor Force Participation Rate                                                        | The female labor force participation rate is % of the female population ages 15-64. (Modeled ILO estimate)                                                                         | %                  | WDI ((12/22/2022)                                                                                     |
| MLFPR | Male Labor Force Participation Rate (% of male population ages 15-64) (modeled ILO estimate) | The male labor force participation rate is % of the male population ages 15-64. (Modeled ILO estimate)                                                                             | %                  | WDI ((12/22/2022)                                                                                     |
| ENG   | Energy use (per capita2020)                                                                  | Energy use refers to primary energy before transformation to other end-use fuels.                                                                                                  | kWh                | Our World in Data based on B.P. & Shift Data Portal (2022)                                            |
| HDI   | Human Development Index                                                                      | United Nations Human Development Index                                                                                                                                             | Index              | UNDP, Human Development Report (2021-22)<br><a href="https://hdr.undp.org/">https://hdr.undp.org/</a> |

## Classification of the study panels.

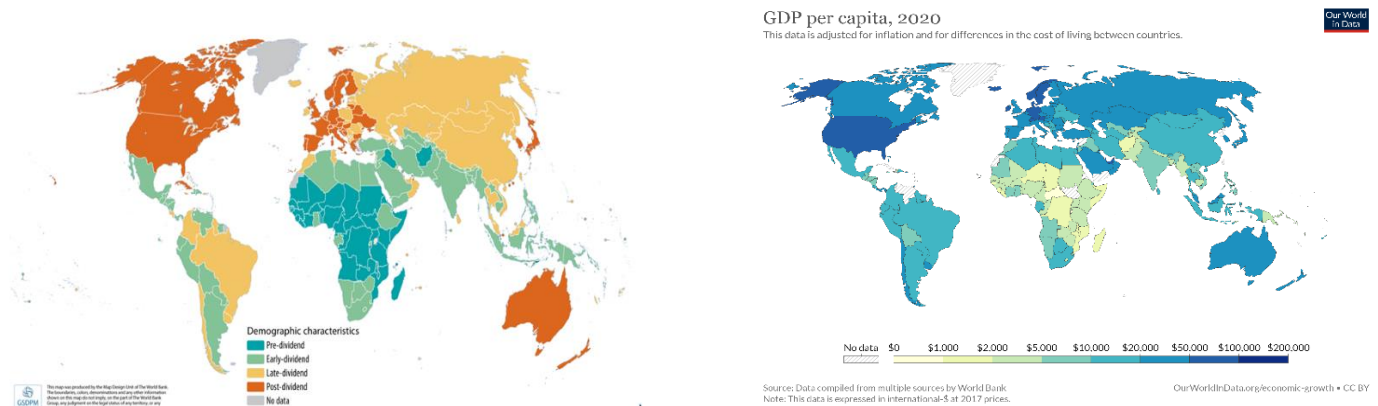
A global classification of nations based on demographic characteristics was created by Ahmed et al. (2016) using the first demographic dividend theory proposed by R. D. Lee & Mason (2006). They are classified as pre-, early, late-, and post-dividend countries. Based on this, 191 global countries were categorized into four stages of demographic dividends in the World Bank's World Development Indicators database. This global study analyzes these subpopulations according to the classification mentioned above. Figure 1 provides a visual representation

of the classification of world countries based on their demographic dividend stage and GDP per capita, illustrating the correlation between the dividend stages and the nations' GDP per capita, as Ahmed et al. (2016) emphasized.

Figure 1: Demographic dividends and GDP per capita around the world.

### 1. The world through the lens of the demographic dividends

### 2. GDP per capita around the world-2020



Source:

Global Monitoring Report 2015/2015, [www.worldbank.org/gmr](http://www.worldbank.org/gmr)

Reserved from the Max Roser (2013) - "Economic Growth." Published online at OurWorldInData.org. Retrieved from: '<https://ourworldindata.org/economic-growth>' [Online Resource] on March 25, 2023.

Thirty-seven countries worldwide are in the initial demographic dividend stage, the pre-demographic dividend stage, according to the earlier classification. The Early, Late, and Post demographic dividends correspond to the second, third, and fourth demographic dividend stages in 62, 54, and 38 countries, respectively. Based on data availability, this panel study includes 118 countries for the Global Panel and 20, 41, 29, and 28 countries for the Pre, Early, Late, and Post demographic dividend panels from 1990 to 2019 (Appendix A). Table 2 provides a detailed description and data source for each variable. Tables 3 and 4 present the variables' descriptive statistics and correlation matrices in natural logarithms.

### Descriptive statistics of study variables

LGDP indicates an increase in the mean across dividend stages, highlighting the relationship between demographic dividends and economic growth. Additionally, LHDI and LENG display similar patterns across the four dividend eras, while LPOP and LMLFPR show roughly equal central tendencies. LFLFPR exhibits a U-shaped trend and varies across dividend stages. The study variables demonstrate the highest variation at the early dividend stage and the lowest at the post-dividend stage (Table 3). The correlation between LPOP and LGDP is positive at the Pre-dividend panel but negative at all other dividend stages and global panels. LENG and LHDI are positively correlated with LGDP across all study panels. Meanwhile, LFLFPR has a negative connection with LGDP during the Pre- and Early-dividend eras but is positively correlated in the Late, Post-dividend, and Global panels (Table 4).

Table 3 - Descriptive statistics

| Pre-Dividend Panel |     |       |           |      |       |
|--------------------|-----|-------|-----------|------|-------|
| Variable           | Obs | Mean  | Std. Dev. | Min  | Max   |
| LGDP               | 600 | 2.926 | 0.299     | 2.31 | 3.715 |

|                      |      |       |       |       |       |
|----------------------|------|-------|-------|-------|-------|
| LPOP                 | 600  | 7.034 | 0.398 | 5.98  | 7.763 |
| LENG                 | 600  | 3.08  | 0.422 | 2.166 | 4.32  |
| LHDI                 | 600  | 1.622 | 0.098 | 1.318 | 1.835 |
| LFLFPR               | 600  | 1.74  | 0.212 | .929  | 1.963 |
| LMLFPR               | 600  | 1.883 | 0.047 | 1.766 | 1.965 |
|                      |      |       |       |       |       |
| Early-Dividend Panel |      |       |       |       |       |
| LGDP                 | 1230 | 3.455 | 0.405 | 2.264 | 4.366 |
| LPOP                 | 1230 | 7.041 | 0.847 | 4.978 | 9.136 |
| LENG                 | 1230 | 3.775 | 0.525 | 2.463 | 5.227 |
| LHDI                 | 1230 | 1.774 | 0.885 | 1.299 | 1.931 |
| LFLFPR               | 1230 | 1.636 | 0.214 | .797  | 1.952 |
| LMLFPR               | 1230 | 1.894 | 0.054 | 1.689 | 1.98  |
|                      |      |       |       |       |       |
| Late-Dividend Panel  |      |       |       |       |       |
| LGDP                 | 870  | 3.771 | 0.437 | 2.769 | 4.876 |
| LPOP                 | 870  | 6.96  | 0.819 | 5.413 | 9.149 |
| LENG                 | 870  | 4.239 | 0.418 | 3.045 | 5.337 |
| LHDI                 | 870  | 1.851 | 0.055 | 1.661 | 1.980 |
| LFLFPR               | 870  | 1.721 | 0.121 | 1.364 | 1.902 |
| LMLFPR               | 870  | 1.903 | 0.028 | 1.817 | 1.979 |
|                      |      |       |       |       |       |
| Post-Dividend Panel  |      |       |       |       |       |
| LGDP                 | 840  | 4.431 | 0.368 | 3.12  | 5.051 |
| LPOP                 | 840  | 7.079 | 0.709 | 5.417 | 8.516 |
| LENG                 | 840  | 4.672 | 0.224 | 3.944 | 5.242 |
| LHDI                 | 840  | 1.926 | 0.036 | 1.814 | 1.981 |
| LFLFPR               | 840  | 1.796 | 0.078 | 1.512 | 1.913 |



|              |      |       |       |       |       |
|--------------|------|-------|-------|-------|-------|
| LMLFPR       | 840  | 1.9   | 0.025 | 1.822 | 1.959 |
|              |      |       |       |       |       |
| Global Panel |      |       |       |       |       |
| LGDP         | 3540 | 3.674 | 0.633 | 2.264 | 5.051 |
| LPOP         | 3540 | 7.029 | 0.75  | 4.978 | 9.149 |
| LENG         | 3540 | 3.984 | 0.68  | 2.166 | 5.337 |
| LHDI         | 3540 | 1.803 | 0.124 | 1.299 | 1.981 |
| LFLFPR       | 3540 | 1.713 | 0.18  | .797  | 1.963 |
| LMLFPR       | 3540 | 1.896 | 0.042 | 1.689 | 1.98  |
|              |      |       |       |       |       |

Authors Calculations

Table 4 -Pairwise Correlation

**Pre-Dividend Panel**

| Variables  | (1)    | (2)    | (3)    | (4)    | (5)   | (6)   |
|------------|--------|--------|--------|--------|-------|-------|
| (1) LGDP   | 1.000  |        |        |        |       |       |
| (2) LPOP   | 0.205  | 1.000  |        |        |       |       |
| (3) LENG   | 0.806  | 0.162  | 1.000  |        |       |       |
| (4) LHDI   | 0.718  | 0.281  | 0.697  | 1.000  |       |       |
| (5) LFLFPR | -0.644 | -0.038 | -0.642 | -0.386 | 1.000 |       |
| (6) LMLFPR | -0.190 | 0.353  | -0.200 | -0.271 | 0.334 | 1.000 |

**Early Dividend Panel**

| Variables  | (1)    | (2)    | (3)    | (4)    | (5)   | (6) |
|------------|--------|--------|--------|--------|-------|-----|
| (1) LGDP   | 1.000  |        |        |        |       |     |
| (2) LPOP   | -0.212 | 1.000  |        |        |       |     |
| (3) LENG   | 0.910  | -0.070 | 1.000  |        |       |     |
| (4) LHDI   | 0.816  | -0.102 | 0.774  | 1.000  |       |     |
| (5) LFLFPR | -0.255 | -0.209 | -0.351 | -0.210 | 1.000 |     |

|               |        |       |        |        |       |       |
|---------------|--------|-------|--------|--------|-------|-------|
| (6)<br>LMLFPR | -0.227 | 0.375 | -0.102 | -0.121 | 0.204 | 1.000 |
|               |        |       |        |        |       |       |

### Late-Dividend Panel

| Variables     | (1)    | (2)    | (3)   | (4)    | (5)   | (6)   |
|---------------|--------|--------|-------|--------|-------|-------|
| (1) LGDP      | 1.000  |        |       |        |       |       |
| (2) LPOP      | -0.260 | 1.000  |       |        |       |       |
| (3) LENG      | 0.746  | -0.203 | 1.000 |        |       |       |
| (4) LHDI      | 0.826  | -0.183 | 0.640 | 1.000  |       |       |
| (5)<br>LFLFPR | 0.071  | 0.259  | 0.229 | 0.210  | 1.000 |       |
| (6)<br>LMLFPR | 0.256  | 0.187  | 0.033 | -0.022 | 0.068 | 1.000 |
|               |        |        |       |        |       |       |

### Post-Dividend Panel

| Variables     | (1)    | (2)    | (3)   | (4)   | (5)   | (6)   |
|---------------|--------|--------|-------|-------|-------|-------|
| (1) LGDP      | 1.000  |        |       |       |       |       |
| (2) LPOP      | -0.050 | 1.000  |       |       |       |       |
| (3) LENG      | 0.657  | -0.033 | 1.000 |       |       |       |
| (4) LHDI      | 0.838  | 0.154  | 0.587 | 1.000 |       |       |
| (5)<br>LFLFPR | 0.377  | 0.074  | 0.316 | 0.508 | 1.000 |       |
| (6)<br>LMLFPR | 0.511  | -0.102 | 0.237 | 0.401 | 0.411 | 1.000 |
|               |        |        |       |       |       |       |

### Global Panel

| Variables | (1)    | (2)    | (3)   | (4) | (5) | (6) |
|-----------|--------|--------|-------|-----|-----|-----|
| (1) LGDP  | 1.000  |        |       |     |     |     |
| (2) LPOP  | -0.087 | 1.000  |       |     |     |     |
| (3) LENG  | 0.908  | -0.044 | 1.000 |     |     |     |



|            |       |        |        |       |       |       |
|------------|-------|--------|--------|-------|-------|-------|
| (4) LHDI   | 0.886 | -0.016 | 0.889  | 1.000 |       |       |
| (5) LFLFPR | 0.056 | -0.043 | -0.032 | 0.017 | 1.000 |       |
| (6) LMLFPR | 0.086 | 0.242  | 0.065  | 0.050 | 0.226 | 1.000 |
|            |       |        |        |       |       |       |

“a “p<.01, “b “p<.05, “c “p<.1

Authors Calculations

### Estimation strategy

This panel research utilized several econometric approaches, including panel pretests such as the slope homogeneity test, the cross-sectional dependency (CD) test, the CADF and CIPS unit root tests, and error-correction-based panel cointegration tests. Driscoll and Kraay standard errors for coefficients estimated using pooled OLS and Newey-West standard errors for OLS regression in linear cross-sectional time series models are some of the panel estimation techniques applied in this study. When analyzing panel data, the Dumitrescu-Hurlin Panel individual causality estimation test also helped to address heterogeneity, cross-sectional dependency, and autocorrelation, ensuring more accurate findings.

### Slope homogeneity tests

The framework to determine if the slope coefficients of the cointegration equation are homogenous was created by Swamy (1970). Swamy's slope homogeneity test was enhanced by Hashem Pesaran & Yamagata (2008), who created two "delta" test statistics:  $\tilde{\Delta}$  and  $\tilde{\Delta}_{adj}$ .

$$\tilde{\Delta} = \sqrt{N} \left( \frac{N^{-1} \bar{S} - k}{\sqrt{2k}} \right) \sim X_k^2$$

$$\tilde{\Delta}_{adj} = \sqrt{N} \left( \frac{N^{-1} \bar{S} - k}{v \sqrt{Tk}} \right) \sim N(0,1)$$

Where **N** indicates the number of cross-section units, **S** indicates the Swamy test statistic; **k** indicates independent variables. If the **p**-value of the test is more significant than 5%, then the null hypothesis is accepted at a 5% significance level, and the cointegrating coefficients are considered homogenous.  $\tilde{\Delta}$  and  $\tilde{\Delta}_{adj}$  are appropriate for large and small samples, respectively, where  $\tilde{\Delta}_{adj}$  Is the "mean-variance bias adjusted" version of  $\tilde{\Delta}$ . Therefore, the standard delta test ( $\tilde{\Delta}$ ) requires error not to be autocorrelated. By relaxing the assumptions of homoscedasticity and serial independence of Hashem Pesaran & Yamagata (2008), Blomquist & Westerlund (2013) developed a Heteroscedasticity and Autocorrelation Consistent (HAC) robust version of the slope homogeneity test;

$\Delta_{HAC}$  and  $(\Delta_{HAC})_{adj}$ :

$$\Delta_{HAC} = \sqrt{N} \left( \frac{N^{-1} \bar{S}_{HAC} - k}{\sqrt{2k}} \right) \sim X_k^2$$

$$\tilde{\Delta}_{adj} = \sqrt{N} \left( \frac{N^{-1} \bar{S}_{HAC} - k}{v \sqrt{Tk}} \right) \sim N(0,1)$$

## Cross-sectional dependence tests

Cross-sectional dependency usually arises in panel data since the nations are interrelated at the regional and global levels. Studies that fail to account for cross-sectional dependency will result in inconsistent and skewed estimates (Peter C. Phillips and Donggyu Sul, 2003). Consequently, it is crucial to examine the cross-sectional dependency in the panel data. This study employs three tests to identify the chosen variables' cross-sectional dependencies. N. Bailey, G. Kapetanios (2015) along with Bailey et al. (2019), Chudik & Pesaran (2015), and Pesaran (2004) CD tests are anticipated to examine the presence of cross-sectional dependency in the estimable model's residuals.

The following equation of the Bailey, Kapetanios, and Pesaran Cross-Sectional Dependence test is used to examine the study variables:

$$CD_{BKP} = \sqrt{\frac{TN(N-1)}{2} \hat{\rho} N}$$

Also, the following equation of the CD test is used to investigate the cross-sectional dependence proposed by Pesaran (2004):

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left( \sum_{i=1}^{N-1} \sum_{j=i+1}^N \rho_{ij} \right)$$

Where N represents the sample size, T indicates the period and  $\rho_{ij}$  shows the estimate of the cross-sectional correlation of errors of countries  $i$  and  $j$ .

## Panel unit root tests

In cross-sectional dependency, the first-generation unit root findings are ineffectual (Dogan & Seker, 2016). This study applies the augmented cross-sectional IPS (CIPS) and augmented cross-sectional ADF (CADF) techniques to ascertain the variables' stationarity characteristics. Pesaran (2007) suggested the following equation of the IPS cross-section augmented version to test the unit root:

$$\Delta x_{it} = \alpha_{it} + \beta x_{it-1} + \rho_i T + \sum_{j=1}^n \theta_{ij} \Delta x_{it-j} + \varepsilon_{it}$$

Where  $\Delta$  represents the difference operator,  $x_{it}$  Shows the analyzed variable,  $\alpha$  is an individual intercept, T denotes the time trend in the data, and  $\varepsilon_{it}$  is the error term. The Schwarz information criterion (SIC) approach determines the lag length. The alternative hypothesis is that at least one individual is stationary inside the time series panel data, and the null hypothesis for both tests is that none of the individuals is stationary within the data.

## Panel cointegration test

This study applies the Westerlund cointegration test to observe the long-run equilibrium among model variables. Using structural dynamics, Westerlund (2007) proposes four actual panel cointegration tests that do not impose any usual factor limitations. A restricted panel error correction model is used to investigate the importance of the error correction component, and the p-values obtained by bootstrapping are resistant to cross-sectional dependency.

The Westerlund cointegration test employs two tests to examine the alternative hypothesis of cointegration for the entire panel (Gt and Ga). However, the two other tests evaluate the alternative that at least one cross-sectional

unit is cointegrated (Pt and Pa). Group statistics refers to the first two tests, whereas panel statistics refers to the last two. Each cross-sectional unit's error-correction constants are evaluated independently while computing group-mean statistics, leading to an average statistics analysis. This method's null hypothesis may be expressed as "no error correction." However, if the null is rejected, there is proof of cointegrating between the variables in the equation. Westerlund takes into account the following error-correcting model:

$$\Delta Y_{it} = \delta'_i d_t + \alpha_i Y_{i,t-1} + \lambda'_i X_{i,t-1} + \sum_{j=1}^{pi} \alpha_{ij} \Delta Y_{i,t-1} + \sum_{j=-qi}^{pi} \gamma_{i,j} \Delta X_{i,t-1} + \varepsilon_{it}$$

Where  $i$  represents the cross-sections,  $t$  represents observations,  $d_t$  refers to the deterministic components and computes the convergence speed to the equilibrium state after an unexpected shock.

### Panel long-run estimation method

Autocorrelation, heteroscedasticity and cross-sectional dependency may prevent the typical fixed effect model from producing unbiased and effective results; therefore, efficient and reliable estimation is required. According to Wang et al. (2021), cross-sectional dependency renders the estimated findings from traditional approaches like FMOLS and DOLS neither accurate nor dependable. Hence, to estimate long-run coefficients in this work, similar to the investigations of Wang et al. (2021), Kongbuamai et al. (2020), Baloch et al. (2019), Hashemizadeh et al. (2021), and Rahman & Alam (2022), we adopt Driscoll & Kraay's (1998) standard error technique.

This comprehensive approach considers the estimated model's autocorrelation, heteroscedasticity, and cross-sectional dependency issues. Driscoll & Kraay's (1998) standard error technique has several advantages over many other approaches, including the ability to be used with unbalanced panel data, the ability to account for missing values in the dataset, the fact that it is a non-parametric procedure with flexible features and a more significant time dimension, and, most importantly, the ability to accurately correct for heteroscedasticity, autocorrelation, and cross-sectional dependence issues (Hoechle (2007); Rahman & Alam (2022); Wang et al. (2021); Kongbuamai et al. (2020); Baloch et al. (2019)).

The robustness of the results is to be evaluated using another well-known two-panel standard error estimating approach after the estimate of Driscoll & Kraay's (1998) standard error technique. Regression is performed using the Wang et al. (2021) method's Newey-West standard errors (Newey & West, 2010). Also, these models successfully and efficiently deal with the problems of autocorrelation, heteroscedasticity, and cross-sectional dependency in the models.

### Dumitrescu and Hurlin panel causality test

The correlation between dependent and independent variables can be seen using long-run estimating techniques. To formulate policy, it is crucial to understand the direction of the short-run causal link among the variables. The study used the Dumitrescu & Hurlin (2012) causality test to ascertain the causal connection between the examined variables. Employing the Vector Autoregressive (VAR) framework on stationary data, this test accounts for unobserved heterogeneity. Furthermore, it conducts regression independently for each cross-section to determine the causal link between variables.

### Empirical results and discussion

The panels were subjected to the Pesaran and Yamagata slope homogeneity test. "Homogeneous slope coefficients" is the null hypothesis. Delta estimates that are significant at the 1% level across all panels. The sample nations are heterogeneous, and this study uses heterogeneous panel approaches to solve the heterogeneous slope problem.

Table 5 – Results of the Slope homogeneity tests.

| Test Statistic         | Pre-Dividend Panel  | Early-Dividend Panel | Late-Dividend Panel | Post-Dividend Panel | Global Panel        |
|------------------------|---------------------|----------------------|---------------------|---------------------|---------------------|
| $\bar{\Delta}$         | 23.227 <sup>a</sup> | 37.963 <sup>a</sup>  | 31.846 <sup>a</sup> | 28.330 <sup>a</sup> | 70.215 <sup>a</sup> |
| $\bar{\Delta}_{adj}$   | 26.527 <sup>a</sup> | 43.357 <sup>a</sup>  | 36.370 <sup>a</sup> | 32.355 <sup>a</sup> | 80.192 <sup>a</sup> |
| $\Delta_{HAC}$         | 12.082 <sup>a</sup> | 22.139 <sup>a</sup>  | 15.752 <sup>a</sup> | 31.689 <sup>a</sup> | 54.066 <sup>a</sup> |
| $(\Delta_{HAC})_{adj}$ | 13.799 <sup>a</sup> | 25.284 <sup>a</sup>  | 17.990 <sup>a</sup> | 36.191 <sup>a</sup> | 61.747 <sup>a</sup> |

$H_0$ : slope coefficients are homogenous. <sup>a</sup> represents statistical significance at 1%.

$\bar{\Delta}$  and  $\bar{\Delta}_{adj}$  represent the "simple" and "mean-variance bias adjusted" slope homogeneity tests, respectively (Pesaran, Yamagata. 2008. Journal of Econometrics).

$\Delta_{HAC}$  and  $(\Delta_{HAC})_{adj}$  represent the "Heteroscedasticity and Autocorrelation Consistent" versions of "simple" and "mean-variance bias adjusted" slope homogeneity tests, respectively (Blomquist, Westerlund. 2013. Economic Letters).

<sup>a</sup>  $p < .01$ , <sup>b</sup>  $p < .05$ , <sup>c</sup>  $p < .1$

### Authors Calculations

Tables 6, 7, and 8 provide the findings of the cross-sectional dependency tests, Cross-Sectional Dependence Exponent Estimation and Test, Pesaran (2015) Test for Weak (CD) Cross-Sectional Dependence, and Pesaran (2004). The Cross-Sectional Dependence Exponent Estimate and Test for all research panels except the LFLFPR at the Pre dividend panel predict firm cross-sectional reliance. Moreover, Pesaran's Weak (CD) and CD tests demonstrate that the null hypothesis of cross-sectional independence is rejected at the 1% significance level, supporting the results from the previous tests. In other words, the available data support the cross-sectional dependence issue for the factors considered in this study. The findings support the interdependence of nations in the Pre, Early, Late, and Post demographic Dividend stages and globally on LGDP, LPOP, LENG, LHDI, LFLFPR, and LMLFPR.

Table 6 - Cross-Sectional Dependence Exponent Estimation and Test  
Estimation of Cross-Sectional Exponent (alpha)

| variable | Pre-Dividend | Early-Dividend | Late-Dividend | Post-Dividend | Global |
|----------|--------------|----------------|---------------|---------------|--------|
| LGDP     | 0.989        | 0.991          | 0.995         | 1.005         | 0.998  |
| LPOP     | 1.006        | 1.005          | 1.005         | 1.005         | 1.004  |
| LENG     | 0.723        | 0.991          | 0.909         | 0.963         | 0.878  |
| LHDI     | 1.006        | 1.004          | 1.005         | 1.005         | 1.004  |

|        |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|
| LFLFPR | 0.428 | 0.965 | 0.914 | 1.005 | 0.971 |
| LMLFPR | 0.854 | 0.973 | 0.817 | 0.885 | 0.952 |

0.5  $\leq$   $\alpha$  < 1 implies solid cross-sectional dependence.

### Authors Calculations

Table 7 Pesaran (2015) Test for Weak (CD) Cross-Sectional Dependence.

H0: errors are weakly cross-sectional dependent.

| variable | Pre-Dividend        | Early-Dividend       | Late-Dividend        | Post-Dividend        | Global               |
|----------|---------------------|----------------------|----------------------|----------------------|----------------------|
| LGDP     | 24.960 <sup>a</sup> | 97.913 <sup>a</sup>  | 69.977 <sup>a</sup>  | 90.420 <sup>a</sup>  | 274.364 <sup>a</sup> |
| LPOP     | 74.928 <sup>a</sup> | 153.226 <sup>a</sup> | 42.862 <sup>a</sup>  | 63.095 <sup>a</sup>  | 330.290 <sup>a</sup> |
| LENG     | 12.524 <sup>a</sup> | 66.021 <sup>a</sup>  | 22.543 <sup>a</sup>  | 25.467 <sup>a</sup>  | 61.156 <sup>a</sup>  |
| LHDI     | 69.387 <sup>a</sup> | 96.487 <sup>a</sup>  | 105.640 <sup>a</sup> | 102.249 <sup>a</sup> | 373.11 <sup>a</sup>  |
| LFLFPR   | -0.801              | 15.422 <sup>a</sup>  | 7.946 <sup>a</sup>   | 51.404 <sup>a</sup>  | 49.213 <sup>a</sup>  |
| LMLFPR   | 25.050 <sup>a</sup> | 43.472 <sup>a</sup>  | 19.826 <sup>a</sup>  | 4.929 <sup>a</sup>   | 72.172 <sup>a</sup>  |

<sup>a</sup> “ $p < .01$ ”, <sup>b</sup> “ $p < .05$ ”, <sup>c</sup> “ $p < .1$ ”

### Authors Calculations

Table 8 Pesaran (2004) Cross-Sectional Dependence (CD) Test

| variable | Pre-Dividend        | Early-Dividend       | Late-Dividend       | Post-Dividend       | Global               |
|----------|---------------------|----------------------|---------------------|---------------------|----------------------|
| LGDP     | 24.960 <sup>a</sup> | 97.910 <sup>a</sup>  | 69.980 <sup>a</sup> | 90.420 <sup>a</sup> | 274.360 <sup>a</sup> |
| LPOP     | 74.930 <sup>a</sup> | 153.230 <sup>a</sup> | 42.860 <sup>a</sup> | 63.090 <sup>a</sup> | 330.290 <sup>a</sup> |
| LENG     | 12.520 <sup>a</sup> | 66.020 <sup>a</sup>  | 22.540 <sup>a</sup> | 25.470 <sup>a</sup> | 61.160 <sup>a</sup>  |
| LHDI     | 69.390 <sup>a</sup> | 96.49 <sup>a</sup>   | 105.64 <sup>a</sup> | 102.25 <sup>a</sup> | 373.110 <sup>a</sup> |
| LFLFPR   | -0.800              | 15.420 <sup>a</sup>  | 7.950 <sup>a</sup>  | 51.400 <sup>a</sup> | 49.210 <sup>a</sup>  |
| LMLFPR   | 25.050 <sup>a</sup> | 43.470 <sup>a</sup>  | 19.830 <sup>a</sup> | 4.930 <sup>a</sup>  | 72.170 <sup>a</sup>  |

<sup>a</sup> “ $p < .01$ ”, <sup>b</sup> “ $p < .05$ ”, <sup>c</sup> “ $p < .1$ ”

### Authors Calculations

Table 9 displays the results of second-generation panel unit root tests appropriate for data with heterogeneity and cross-sectional dependence issues (CADF and CIPS). The results show that variables LGDP, LPOP, LENG, LHDI, LFLFPR, and LMLFPR are stationary at the first difference but non-stationary at their level. In other words, all of the study's variables are integrated at level 1 in every panel.

Table 9 Results of the CADF and CIPS panel unit root tests.

|          | Pre-Dividend Panel  |                     |                     |                     |       | Early-Dividend Panel |                     |                     |                     |       |
|----------|---------------------|---------------------|---------------------|---------------------|-------|----------------------|---------------------|---------------------|---------------------|-------|
| Variable | CADF                |                     | CIPS                |                     |       | CADF                 |                     | CIPS                |                     |       |
|          | Cons                | Trend               | Cons                | Trend               |       | Cons                 | Trend               | Cons                | Trend               |       |
| LGDP     | -0.887              | -1.902              | -1.729              | -2.142              | I (1) | -0.882               | -2.291              | -1.736              | -2.174              | I (1) |
| Δ LGDP   | -3.184 <sup>a</sup> | -3.577 <sup>a</sup> | -4.440 <sup>a</sup> | -4.615 <sup>a</sup> |       | -3.202 <sup>a</sup>  | -3.353 <sup>a</sup> | -4.187 <sup>a</sup> | -4.387 <sup>a</sup> |       |
|          |                     |                     |                     |                     |       |                      |                     |                     |                     |       |
| LHDI     | -1.690              | -1.544              | -1.825              | -2.394              | I (1) | -0.978               | -0.630              | -0.699              | -1.110              | I (1) |
| Δ LHDI   | -3.031 <sup>a</sup> | -3.435 <sup>a</sup> | -3.459 <sup>a</sup> | -3.549 <sup>a</sup> |       | -3.723 <sup>a</sup>  | -0.780              | -3.756 <sup>a</sup> | -4.386 <sup>a</sup> |       |
|          |                     |                     |                     |                     |       |                      |                     |                     |                     |       |
| LPOP     | -2.772 <sup>a</sup> | -1.719              | -2.699 <sup>a</sup> | -1.994              | I (1) | -2.565 <sup>a</sup>  | -2.447              | -1.721              | -1.874              | I (1) |
| Δ LPOP   | -4.197 <sup>a</sup> | -5.613 <sup>a</sup> | -1.976              | -3.089 <sup>a</sup> |       | -4.657 <sup>a</sup>  | -4.904 <sup>a</sup> | -2.520 <sup>a</sup> | -3.264 <sup>a</sup> |       |
|          |                     |                     |                     |                     |       |                      |                     |                     |                     |       |
| LGDP     | -0.887              | -1.902              | -1.729              | -2.142              | I (1) | -0.882               | -2.291              | -1.736              | -2.174              | I (1) |
| Δ LGDP   | -3.184 <sup>a</sup> | -3.577 <sup>a</sup> | -4.440 <sup>a</sup> | -4.615 <sup>a</sup> |       | -3.202 <sup>a</sup>  | -3.353 <sup>a</sup> | -4.187 <sup>a</sup> | -4.387 <sup>a</sup> |       |
|          |                     |                     |                     |                     |       |                      |                     |                     |                     |       |
| LENG     | -0.594              | -2.509              | -1.970              | -2.905 <sup>b</sup> | I (1) | -0.558               | -2.426              | -1.963              | -2.517              | I (1) |
| Δ LENG   | -4.034 <sup>a</sup> | -4.124 <sup>a</sup> | -5.328 <sup>a</sup> | -5.369 <sup>a</sup> |       | -3.520 <sup>a</sup>  | -3.549 <sup>a</sup> | -4.675 <sup>a</sup> | -4.821 <sup>a</sup> |       |
|          |                     |                     |                     |                     |       |                      |                     |                     |                     |       |
| LFFPR    | -0.920              | -1.974              | -1.318              | -1.346              | I (1) | -1.383               | -3.186              | -2.027              | -1.952              | I (1) |
| Δ LFFPR  | -2.128 <sup>b</sup> | -2.041              | -2.229 <sup>b</sup> | -2.519              |       | 2.827 <sup>a</sup>   | -3.041 <sup>a</sup> | -3.629 <sup>a</sup> | -3.846 <sup>a</sup> |       |
|          |                     |                     |                     |                     |       |                      |                     |                     |                     |       |
| LMLFPR   | -0.300              | -1.541              | -0.359              | -0.817              | I (1) | -1.419               | -2.147              | -1.246              | -1.702              | I (1) |
| Δ LMLFPR | -2.037 <sup>c</sup> | -1.263              | -2.277 <sup>b</sup> | -2.336              |       | -2.816 <sup>a</sup>  | -3.111 <sup>a</sup> | -3.471 <sup>a</sup> | -3.691 <sup>a</sup> |       |

|          | Late-Dividend Panel |                     |                     |                     |              | Post-Dividend Panel |                     |                     |                     |              |
|----------|---------------------|---------------------|---------------------|---------------------|--------------|---------------------|---------------------|---------------------|---------------------|--------------|
| Variable | CADF                |                     | CIPS                |                     |              | CADF                |                     | CIPS                |                     |              |
|          | Cons                | Trend               | Cons                | Trend               |              | Cons                | Trend               | Cons                | Trend               |              |
| LGDP     | -0.710              | -2.480              | -2.283 <sup>b</sup> | -2.424              | <i>I (1)</i> | -1.212              | -2.011              | -2.306 <sup>a</sup> | -2.581 <sup>c</sup> | <i>I (1)</i> |
| Δ LGDP   | -3.185 <sup>a</sup> | -3.332 <sup>a</sup> | -3.774 <sup>a</sup> | -3.836 <sup>a</sup> |              | -3.192 <sup>a</sup> | -3.370 <sup>a</sup> | -3.899 <sup>a</sup> | -3.995 <sup>a</sup> |              |
|          |                     |                     |                     |                     |              |                     |                     |                     |                     |              |
| LHDI     | -1.810              | -2.244              | -2.271 <sup>b</sup> | -2.695 <sup>b</sup> | <i>I (1)</i> | -1.148              | -1.641              | -2.256 <sup>a</sup> | -2.576 <sup>b</sup> | <i>I (1)</i> |
| Δ LHDI   | -3.267 <sup>a</sup> | -3.497 <sup>a</sup> | -4.300 <sup>a</sup> | -4.568 <sup>a</sup> |              | -3.183 <sup>a</sup> | -3.373 <sup>a</sup> | -4.397 <sup>a</sup> | -4.607 <sup>a</sup> |              |
|          |                     |                     |                     |                     |              |                     |                     |                     |                     |              |
| LPOP     | -1.376              | -2.301              | -1.778              | -2.613 <sup>c</sup> | <i>I (1)</i> | -1.563              | -1.555              | -1.015              | -1.023              | <i>I (1)</i> |
| Δ LPOP   | -3.348 <sup>a</sup> | -4.283 <sup>a</sup> | -2.191 <sup>b</sup> | -2.975 <sup>a</sup> |              | -3.289 <sup>a</sup> | -3.640 <sup>a</sup> | -4.408 <sup>a</sup> | -4.873 <sup>a</sup> |              |
|          |                     |                     |                     |                     |              |                     |                     |                     |                     |              |
| LENG     | -1.434              | -2.086              | -2.192 <sup>b</sup> | -2.238              | <i>I (1)</i> | -0.659              | -2.325              | -1.993              | -3.099 <sup>a</sup> | <i>I (1)</i> |
| Δ LENG   | -3.280 <sup>a</sup> | -3.460 <sup>a</sup> | -4.476 <sup>a</sup> | -4.763 <sup>a</sup> |              | -4.107 <sup>a</sup> | -4.199 <sup>a</sup> | -5.118 <sup>a</sup> | -5.396 <sup>a</sup> |              |
|          |                     |                     |                     |                     |              |                     |                     |                     |                     |              |
| LFFPR    | -1.310              | -1.892              | -1.283              | -1.412              | <i>I (1)</i> | -1.367              | -1.852              | -1.801              | -1.756              | <i>I (1)</i> |
| Δ LFFPR  | -2.690 <sup>a</sup> | -3.090 <sup>a</sup> | -3.616 <sup>a</sup> | -4.049 <sup>a</sup> |              | -3.102 <sup>a</sup> | -3.439 <sup>a</sup> | -4.409 <sup>a</sup> | -4.735 <sup>a</sup> |              |
|          |                     |                     |                     |                     |              |                     |                     |                     |                     |              |
| LMLFPR   | -0.886              | -2.418              | -1.550              | -1.866              | <i>I (1)</i> | -1.318              | -2.001              | -1.856              | -2.178              | <i>I (1)</i> |
| Δ LMLFPR | -2.824 <sup>a</sup> | -2.946 <sup>a</sup> | -3.851 <sup>a</sup> | -3.990 <sup>a</sup> |              | -3.186 <sup>a</sup> | -3.421 <sup>a</sup> | -4.543 <sup>a</sup> | -4.720 <sup>a</sup> |              |

| Global-Dividend Panel |                     |                     |                     |                     |              |
|-----------------------|---------------------|---------------------|---------------------|---------------------|--------------|
| Variable              | CADEF               |                     | CIPS                |                     |              |
|                       | Cons                | Trend               | Cons                | Trend               |              |
| <b>LGDP</b>           | -1.561              | -2.207              | -2.093 <sup>b</sup> | -2.149              | <b>I (1)</b> |
| <b>Δ LGDP</b>         | -3.073 <sup>a</sup> | -3.273 <sup>a</sup> | -3.882 <sup>a</sup> | -4.039 <sup>a</sup> |              |
| <b>LHDI</b>           | -0.832              | -1.271              | -1.592              | -1.986              | <b>I (1)</b> |
| <b>Δ LHDI</b>         | -2.418 <sup>a</sup> | -2.909 <sup>a</sup> | -3.497 <sup>a</sup> | -4.087 <sup>a</sup> |              |
| <b>LPOP</b>           | -2.160 <sup>a</sup> | -2.212              | -1.835              | -2.079              | <b>I (1)</b> |
| <b>Δ LPOP</b>         | -3.425 <sup>a</sup> | -4.326 <sup>a</sup> | -2.183 <sup>a</sup> | -2.678 <sup>a</sup> |              |
| <b>LENG</b>           | -1.387              | -2.074              | -2.167 <sup>a</sup> | 2.343               | <b>I (1)</b> |
| <b>Δ LENG</b>         | -3.449 <sup>a</sup> | -3.590 <sup>a</sup> | -4.913 <sup>a</sup> | -5.010 <sup>a</sup> |              |
| <b>LFFPR</b>          | -1.292              | -2.025              | -1.653              | -1.704              | <b>I (1)</b> |
| <b>Δ LFFPR</b>        | -2.713 <sup>a</sup> | -2.967 <sup>a</sup> | -3.614 <sup>a</sup> | -3.916 <sup>a</sup> |              |
| <b>LMLFPR</b>         | -1.910 <sup>b</sup> | -2.178              | -1.448              | -1.783              | <b>I (1)</b> |
| <b>Δ LMLFPR</b>       | -2.837 <sup>a</sup> | -3.030 <sup>a</sup> | -3.611 <sup>a</sup> | -3.842 <sup>a</sup> |              |

<sup>a</sup>  $p < .01$ , <sup>b</sup>  $p < .05$ , <sup>c</sup>  $p < .1$

### Authors Calculations

The results of the Westerlund cointegration test of the linear and non-linear models are shown in Table 10. These results show that in Pre, Post dividend panels, and Global panels, the null hypothesis of the Gt statistic in the linear model is rejected at the 1% significance level (based on a robust p-value). Also, in the Early and Late panels, the null hypothesis of the Gt statistic in the linear model is rejected at the 5% significance level (based on a robust p-value) and except at the Post dividend stage non-linear model also cointegrated in other study panels. On the study's variables, both models exhibit long-term stability.

Table 10 Results of the Westerlund (2007) cointegration test.

Ho: No cointegration

| Pre-Dividend Panel   |                     |         |                      |         |
|----------------------|---------------------|---------|----------------------|---------|
| Statistic            | Linear Model        |         | Non-linear Model     |         |
|                      | Value               | Z-Value | Value                | Z-Value |
| Gt                   | -2.841 <sup>a</sup> | -2.825  | -2.914 <sup>b</sup>  | -2.139  |
| Ga                   | -3.139              | 5.000   | -3.378               | 5.618   |
| Pt                   | -9.094              | -0.556  | -13.650 <sup>a</sup> | -3.472  |
| Pa                   | -3.913              | 2.316   | -4.914               | -3.472  |
| Early-Dividend Panel |                     |         |                      |         |
| Gt                   | -2.425 <sup>b</sup> | -1.424  | -10.488 <sup>a</sup> | -50.597 |
| Ga                   | -0.495              | 9.364   | -0.109               | 10.553  |
| Pt                   | -11.738             | 0.253   | -11.142              | 2.068   |
| Pa                   | -0.516              | 6.052   | -0.154               | 7.205   |
| Late-Dividend Panel  |                     |         |                      |         |
| Gt                   | -2.497 <sup>b</sup> | -1.579  | -3.353 <sup>a</sup>  | -4.892  |
| Ga                   | -4.297              | 5.209   | -0.206               | 8.813   |
| Pt                   | -10.678             | 0.447   | -3.128               | 6.970   |
| Pa                   | -3.486              | 3.078   | -0.230               | 6.013   |



| Post-Dividend Panel |                      |        |                     |        |
|---------------------|----------------------|--------|---------------------|--------|
| Gt                  | -2.680 <sup>a</sup>  | -2.505 | -2.448              | -0.115 |
| Ga                  | -10.313              | 0.973  | -8.833              | 3.187  |
| Pt                  | -12.213 <sup>b</sup> | -1.847 | -11.087             | 0.135  |
| Pa                  | -9.012               | -0.652 | -7.910              | 1.267  |
| Global Panel        |                      |        |                     |        |
| Gt                  | -2.415 <sup>a</sup>  | -2.310 | -2.574 <sup>b</sup> | -1.570 |
| Ga                  | -5.533               | 8.758  | -5.392              | 11.024 |
| Pt                  | -19.011              | 1.167  | -20.234             | 2.393  |
| Pa                  | -4.389               | 4.976  | -4.745              | 6.528  |

<sup>a</sup>  $p < .01$ , <sup>b</sup>  $p < .05$ , <sup>c</sup>  $p < .1$

## Authors Calculations

The results of the Driscoll-Kraay standard error regression are presented in Table 11 and divided into linear and non-linear models. The findings of the linear model are highlighted below.

The findings indicate a significant long-term negative relationship between total population (LPOP) and GDP per capita (LGDP) across all study panels, except for the Pre-dividend panel. The elasticities are -4.2%, -5.0%, -6.1%, and -5.2% during the early, late, and post-dividend stages and globally, respectively, with 99% confidence. This suggests that the relationship between population and GDP per capita may vary depending on a country's demographic stage.

The findings indicate a positive relationship between a country's per-capita GDP and Human Development Index (HDI) across all study panels, as the influence of per-capita GDP on HDI is positive and statistically significant at the 5% level. Furthermore, the study found that the elasticities between GDP and HDI emissions are 15.7%, 15.5%, 12.4%, and 7.1% at the pre-, early-, late-, and post-demographic dividend stages, with a global elasticity of 9.1%. This confirms the importance of considering a country's demographic stage when evaluating the relationship between GDP and HDI, as countries at different demographic stages may exhibit varying dynamics. The findings conform to the findings of (Wang et al., 2021), (Barus et al., 2021), (Humaira & Nugraha, 2018), (Khan et al., 2019), and (Arisman 2018) conforms the positive impact of GDP on the HDI.

The findings showed that per capita energy usage (ENG) has a significant and positive impact on GDP across pre and early-dividend panels but negative impacts on the global panel, as the findings of Ouedraogo (2013). Additionally, the research indicated that the elasticities linking GDP and ENG emissions are 27.8%, 55.4%, 36.9%, and 38.3% during the pre-, early-, late-, and post-demographic dividend phases, respectively, with a global elasticity of 53.9%. This highlights the significance of factoring in a nation's demographic phase when assessing the interaction between GDP and ENG, as nations at distinct demographic stages may demonstrate different dynamics.

According to the linear model estimates, the elasticities between FLFPR and GDP emissions are 39.5%, 9.9%, -48.3%, and -62.8% at the pre-, early-, late-, and post-demographic dividend stages. In the global panel, it is 20.3%. The impact of FLFPR is significant at 1% in all panels. Improvement in FLFPR can enhance GDP in the pre-, early, and global panels.

The MLFPR has a significant negative impact on GDP in the early panels. In contrast, its effect is significantly positive in all other panels. The elasticities of the male labor force participation rate on GDP emissions are 49.0%, -76.1%, 437.2%, and 326.1% during the pre-, late-, and post-demographic dividend phases, respectively, at 483.0% globally.

During the pre-demographic dividend phase, the linear model's explanatory variables account for 73.8 % of GDP per capita variation. ENG, HDI, and MLFPR contribute positively to GDP, while FLFPR has a negative effect. In the early demographic dividend phase, the model explains 88.58% of the GDP variation; here, ENG, HDI, and FLFPR positively influence GDP, while POP and male participation rates negatively impact it. During the

late demographic stage, the explanatory variables account for 86.07% of GDP variations. HDI, ENG, and MLFPR enhance GDP in this stage, while POP and FLFPR reduce it. In the post-dividend phase, the model explains 80.58% of GDP emissions. Again, HDI, ENG, and MLFPR positively contribute to GDP, whereas POP and FLFPR detract from it. The linear model represents 86.18% of global GDP based on these independent variables. While HDI, ENG, FLFPR, and MLFPR can foster GDP growth, only POP acts to diminish GDP on a global scale.

The estimates from the non-linear model of the Driscoll-Kraay standard errors regression are presented in Table 11, highlighting that:

The non-linear model highlights the impact of female labor force participation dynamics at each demographic dividend stage. At the pre-demographic dividend stage, the female labor force participation rate (FLFPR) shows an inverse U-shaped impact on GDP. However, the FLFPR demonstrates a U-shaped impact on GDP in the late panel. The non-linear model is not significant in other panels.

The results of the Driscoll-Kraay standard errors regression global panel estimate in Table 11, along with the estimates from linear and non-linear models, allow for the following conclusions to be drawn:

The linear model reveals the elasticities of various factors on GDP: Population (POP) has an elasticity of -5.2%, indicating it exerts the most significant negative impact on GDP. In contrast, the elasticities of Energy Consumption (ENG), Human Development Index (HDI), Female Labor Force Participation Rate (FLFPR), and Male Labor Force Participation Rate (MLFPR) are 53.5%, 189.6%, 20.3%, and 48.3%, respectively. HDI demonstrates the most substantial positive influence on GDP, highlighting its critical role in economic growth.

Table 11 Driscoll-Kraay standard error estimates.

| Dependent Variable - GDP | Linear Model        |                     |                      |                      |          | Non-linear Model    |                     |                      |                      |                     |
|--------------------------|---------------------|---------------------|----------------------|----------------------|----------|---------------------|---------------------|----------------------|----------------------|---------------------|
| Panel                    | Pre                 | Early               | Late                 | Post                 | Global   | Pre                 | Early               | Late                 | Post                 | Global              |
| Independent Variables    | Coef.               | Coef.               | Coef.                | Coef.                | Coef.    | Coef.               | Coef.               | Coef.                | Coef.                | Coef.               |
| LPOP                     | 0.002               | -0.042 <sup>a</sup> | -0.050 <sup>a</sup>  | -0.061 <sup>a</sup>  | -0.052a  | 0.027               | -0.042 <sup>a</sup> | -0.063 <sup>a</sup>  | -0.070 <sup>a</sup>  | -0.055 <sup>a</sup> |
| LENG                     | 0.278 <sup>a</sup>  | 0.554 <sup>a</sup>  | 0.369 <sup>a</sup>   | 0.383 <sup>a</sup>   | 0.535a   | 0.294 <sup>a</sup>  | 0.554 <sup>a</sup>  | 0.364 <sup>a</sup>   | 0.364 <sup>a</sup>   | 0.533 <sup>a</sup>  |
| LHDI                     | 1.081 <sup>a</sup>  | 1.143 <sup>a</sup>  | 4.924 <sup>a</sup>   | 7.139 <sup>a</sup>   | 1.896a   | 0.179 <sup>a</sup>  | 1.139 <sup>a</sup>  | 5.058 <sup>a</sup>   | 7.227 <sup>a</sup>   | 1.925 <sup>a</sup>  |
| LFLFPR                   | -0.395 <sup>a</sup> | 0.099 <sup>a</sup>  | -0.483 <sup>a</sup>  | -0.628 <sup>a</sup>  | 0.203a   | 3.956 <sup>a</sup>  | 0.174               | -5.004 <sup>a</sup>  | 6.479                | -0.726              |
| LFLFPR <sup>2</sup>      |                     |                     |                      |                      |          | -1.426 <sup>a</sup> | -0.025              | 1.367 <sup>a</sup>   | -2.041               | 0.299               |
| LMLFPR                   | 0.490 <sup>a</sup>  | -0.761 <sup>a</sup> | 4.372 <sup>a</sup>   | 3.261 <sup>a</sup>   | 0.483b   | 0.502 <sup>a</sup>  | -0.758 <sup>a</sup> | 4.344 <sup>a</sup>   | 3.510 <sup>a</sup>   | 0.429 <sup>c</sup>  |
| Cons                     | 0.069 <sup>a</sup>  | 0.909 <sup>a</sup>  | -14.050 <sup>a</sup> | -15.746 <sup>a</sup> | -2.774a  | -5.415 <sup>a</sup> | 0.858 <sup>a</sup>  | -10.419 <sup>a</sup> | -22.399 <sup>a</sup> | -1.991 <sup>a</sup> |
|                          |                     |                     |                      |                      |          |                     |                     |                      |                      |                     |
| Num of obs               | 600                 | 1230                | 870                  | 840                  | 3540     | 600                 | 1230                | 870                  | 840                  | 3540                |
| Num of groups            | 20                  | 41                  | 29                   | 28                   | 118      | 20                  | 41                  | 29                   | 28                   | 118                 |
| F (6, 29)                | 5427.07             | 22259.09            | 21158.74             | 57600.69             | 51014.08 | 2671.69             | 22912.27            | 16941.12             | 46831.25             | 156862.30           |
| Prob > F                 | 0.0000              | 0.0000              | 0.0000               | 0.0000               | 0.0000   | 0.0000              | 0.0000              | 0.0000               | 0.0000               | 0.0000              |
| R-squared                | 0.7382              | 0.8858              | 0.8607               | 0.8058               | 0.8618   | 0.8004              | 0.8858              | 0.8632               | 0.8073               | 0.8624              |
| Root MSE                 | 0.1539              | 0.1372              | 0.1635               | 0.1626               | 0.2356   | 0.1345              | 0.1372              | 0.1621               | 0.1620               | 0.2351              |

<sup>a</sup> “ $p < .01$ ”, <sup>b</sup> “ $p < .05$ ”, <sup>c</sup> “ $p < .1$ ”

## Authors Calculations

Table 12 estimates the linear and non-linear models using Newey-West standard error regression to verify the robustness of Driscoll-Kraay standard error regression estimates. The estimated coefficient values match those from the Driscoll-Kraay standard error regression; however, the coefficients' t-statistics are significantly higher

than those from the Driscoll-Kraay estimates. Supporting the robustness of the Driscoll-Kraay estimates, the explanatory variables of both the linear and non-linear models are significant according to the Newey-West Standard Errors Estimates and F-statistics.

Table 12 - Newey-West Standard Errors Estimates.

| Dependent Variable - GDO | Linear Model        |                     |                      |                      |          | Non-linear Model    |                     |                      |                      |                     |
|--------------------------|---------------------|---------------------|----------------------|----------------------|----------|---------------------|---------------------|----------------------|----------------------|---------------------|
| Panel                    | Pre                 | Early               | Late                 | Post                 | Global   | Pre                 | Early               | Late                 | Post                 | Global              |
| Independent Variables    | Coef.               | Coef.               | Coef.                | Coef.                | Coef.    | Coef.               | Coef.               | Coef.                | Coef.                | Coef.               |
| LPOP                     | 0.002               | -0.042 <sup>a</sup> | -0.050 <sup>a</sup>  | -0.061 <sup>a</sup>  | -0.052a  | 0.027               | -0.042 <sup>a</sup> | -0.063 <sup>a</sup>  | -0.070 <sup>a</sup>  | -0.055 <sup>a</sup> |
| LENG                     | 0.278 <sup>a</sup>  | 0.554 <sup>a</sup>  | 0.369 <sup>a</sup>   | 0.383 <sup>a</sup>   | 0.535a   | 0.294 <sup>a</sup>  | 0.554 <sup>a</sup>  | 0.364 <sup>a</sup>   | 0.364 <sup>a</sup>   | 0.533 <sup>a</sup>  |
| LHDI                     | 1.081 <sup>a</sup>  | 1.143 <sup>a</sup>  | 4.924 <sup>a</sup>   | 7.139 <sup>a</sup>   | 1.896a   | 0.179 <sup>a</sup>  | 1.139 <sup>a</sup>  | 5.058 <sup>a</sup>   | 7.227 <sup>a</sup>   | 1.925 <sup>a</sup>  |
| LFLFPR                   | -0.395 <sup>a</sup> | 0.099 <sup>a</sup>  | -0.483 <sup>a</sup>  | -0.628 <sup>a</sup>  | 0.203a   | 3.956 <sup>a</sup>  | 0.174               | -5.004 <sup>a</sup>  | 6.479 <sup>b</sup>   | -0.726 <sup>a</sup> |
| LFLFPR <sup>2</sup>      |                     |                     |                      |                      |          | -1.426 <sup>a</sup> | -0.025              | 1.367 <sup>a</sup>   | -2.041 <sup>b</sup>  | 0.299 <sup>a</sup>  |
| LMLFPR                   | 0.490 <sup>a</sup>  | -0.761 <sup>a</sup> | 4.372 <sup>a</sup>   | 3.261 <sup>a</sup>   | 0.483b   | 1.502 <sup>a</sup>  | -0.758 <sup>a</sup> | 4.344 <sup>a</sup>   | 3.510 <sup>a</sup>   | 0.429 <sup>a</sup>  |
| Cons                     | 0.069 <sup>a</sup>  | 0.909 <sup>a</sup>  | -14.050 <sup>a</sup> | -15.746 <sup>a</sup> | -2.774a  | -5.415 <sup>a</sup> | 0.858 <sup>a</sup>  | -10.419 <sup>a</sup> | -22.399 <sup>a</sup> | -1.991 <sup>a</sup> |
|                          |                     |                     |                      |                      |          |                     |                     |                      |                      |                     |
| Num of obs               | 600                 | 1230                | 870                  | 840                  | 3540     | 600                 | 1230                | 870                  | 840                  | 3540                |
| F-Stat                   | 420.679             | 1628.190            | 829.868              | 600.326              | 4392.505 | 704.446             | 1423.696            | 789.684              | 541.042              | 3744.481            |
| Prob > F                 | 0.000               | 0.000               | 0.000                | 0.000                | 0.0000   | 0.000               | 0.000               | 0.000                | 0.000                | 0.0000              |

<sup>a</sup> “ $p < .01$ ”, <sup>b</sup> “ $p < .05$ ”, <sup>c</sup> “ $p < .1$ ”

## Authors Calculations

Table 13 represents the analysis of the Dumitrescu-Hurlin panel non-causality test. Conforming our long-run estimates, the empirical findings show a bidirectional causality between POP and GDP, ENG and GDP, HDI and GDP, FLFPR and GDP, and MLFPR and GDP at all study panels. The finding conforms to the interdependency of the study variables at all panels.

Table 13 - Dumitrescu Hurlin Panel Causality Test Results

| Causality     | Panel                |                      |                      |                      |                      |
|---------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|               | Pre-Dividend         | Early-Dividend       | Late-Dividend        | Post-Dividend        | Global               |
|               | W-Stat.              | W-Stat.              | W-Stat.              | W-Stat.              | W-Stat.              |
| LPOP → LGDP   | 8.61941 <sup>a</sup> | 6.69086 <sup>a</sup> | 8.92700 <sup>a</sup> | 4.72481 <sup>a</sup> | 7.10077 <sup>a</sup> |
| LGDP → LPOP   | 14.0715 <sup>a</sup> | 24.8025 <sup>a</sup> | 22.1137 <sup>a</sup> | 11.9727 <sup>a</sup> | 19.2785 <sup>a</sup> |
| LENG → LGDP   | 3.08842 <sup>a</sup> | 4.30724 <sup>a</sup> | 6.69898 <sup>a</sup> | 2.68196-             | 4.30280 <sup>a</sup> |
| LGDP → LENG   | 6.18147 <sup>a</sup> | 4.47700 <sup>a</sup> | 6.47053 <sup>a</sup> | 6.68370 <sup>a</sup> | 5.77945 <sup>a</sup> |
| LHDI → LGDP   | 8.22630 <sup>a</sup> | 3.53418 <sup>a</sup> | 5.47571 <sup>a</sup> | 4.92905 <sup>a</sup> | 5.13760 <sup>a</sup> |
| LGDP → LHDI   | 4.73169 <sup>a</sup> | 3.85403 <sup>a</sup> | 5.54922 <sup>a</sup> | 3.31166 <sup>b</sup> | 4.29070 <sup>a</sup> |
| LFLFPR → LGDP | 5.32654 <sup>c</sup> | 4.93106 <sup>a</sup> | 5.07400 <sup>a</sup> | 3.62696 <sup>a</sup> | 4.72377 <sup>a</sup> |
| LGDP → LFLFPR | 6.98918 <sup>a</sup> | 4.40772 <sup>a</sup> | 4.24196 <sup>a</sup> | 6.41768 <sup>a</sup> | 5.28146 <sup>a</sup> |
| LMLFPR → LGDP | 3.37131 <sup>b</sup> | 4.51786 <sup>a</sup> | 5.50511 <sup>a</sup> | 2.72171-             | 4.13995 <sup>a</sup> |

|                        |                      |                      |                      |                      |                      |
|------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <b>LGDP → LMLFPR</b>   | 5.49906 <sup>a</sup> | 6.79916 <sup>a</sup> | 8.20976 <sup>a</sup> | 5.90422 <sup>a</sup> | 6.71312 <sup>a</sup> |
| <b>LENG → LPOP</b>     | 9.07943 <sup>a</sup> | 17.2033 <sup>a</sup> | 12.6827 <sup>a</sup> | 7.26536 <sup>a</sup> | 12.3572 <sup>a</sup> |
| <b>LPOP → LENG</b>     | 6.40412 <sup>a</sup> | 6.12195 <sup>a</sup> | 7.12084 <sup>a</sup> | 6.38943 <sup>a</sup> | 6.47873 <sup>a</sup> |
| <b>LHDI → LPOP</b>     | 16.0085 <sup>a</sup> | 21.0689 <sup>a</sup> | 17.7714 <sup>a</sup> | 8.74073 <sup>a</sup> | 16.4755 <sup>a</sup> |
| <b>LPOP → LHDI</b>     | 8.39621 <sup>a</sup> | 5.87426 <sup>a</sup> | 7.26882 <sup>a</sup> | 6.43133 <sup>a</sup> | 6.77662 <sup>a</sup> |
| <b>LFLFPR → LPOP</b>   | 30.4652 <sup>a</sup> | 23.6234 <sup>a</sup> | 7.23363 <sup>a</sup> | 5.54287 <sup>a</sup> | 16.4647 <sup>a</sup> |
| <b>LPOP → LFLFPR</b>   | 7.15568 <sup>a</sup> | 6.18820 <sup>a</sup> | 5.46381 <sup>a</sup> | 6.83721 <sup>a</sup> | 6.32815 <sup>a</sup> |
| <b>LMLFPR → LPOP</b>   | 25.0918 <sup>a</sup> | 17.2919 <sup>a</sup> | 8.97930 <sup>a</sup> | 7.60309 <sup>a</sup> | 14.2720 <sup>a</sup> |
| <b>LPOP → LMLFPR</b>   | 5.84980 <sup>a</sup> | 6.85748 <sup>a</sup> | 6.82739 <sup>a</sup> | 6.25515 <sup>a</sup> | 6.53637 <sup>a</sup> |
| <b>LHDI → LENG</b>     | 5.71591 <sup>a</sup> | 4.45498 <sup>a</sup> | 4.94980 <sup>a</sup> | 4.57810 <sup>a</sup> | 4.81952 <sup>a</sup> |
| <b>LENG → LHDI</b>     | 4.82770 <sup>a</sup> | 2.89031 <sup>c</sup> | 5.46334 <sup>a</sup> | 3.24695 <sup>b</sup> | 3.93566 <sup>a</sup> |
| <b>LFLFPR → LENG</b>   | 6.04307 <sup>a</sup> | 3.21631 <sup>a</sup> | 4.54856 <sup>a</sup> | 4.06339 <sup>a</sup> | 4.22384 <sup>a</sup> |
| <b>LENG → LFLFPR</b>   | 3.63703 <sup>a</sup> | 4.15946 <sup>a</sup> | 3.64879 <sup>a</sup> | 4.70409 <sup>a</sup> | 4.07464 <sup>a</sup> |
| <b>LMLFPR → LENG</b>   | 5.71592 <sup>a</sup> | 3.01438 <sup>b</sup> | 3.91250 <sup>a</sup> | 3.42137 <sup>a</sup> | 3.78957 <sup>a</sup> |
| <b>LENG → LMLFPR</b>   | 3.24057 <sup>c</sup> | 3.26970 <sup>a</sup> | 4.56685 <sup>a</sup> | 4.67761 <sup>a</sup> | 3.91763 <sup>a</sup> |
| <b>LFLFPR → LHDI</b>   | 9.01878 <sup>a</sup> | 14.8426 <sup>a</sup> | 5.72278 <sup>a</sup> | 3.90491 <sup>a</sup> | 9.01882 <sup>a</sup> |
| <b>LHDI → LFLFPR</b>   | 5.91871 <sup>a</sup> | 6.49650 <sup>a</sup> | 6.62077 <sup>a</sup> | 7.12223 <sup>a</sup> | 6.57759 <sup>a</sup> |
| <b>LMLFPR → LHDI</b>   | 9.21780 <sup>a</sup> | 20.7053 <sup>a</sup> | 5.55622 <sup>a</sup> | 2.39747-             | 10.6909 <sup>a</sup> |
| <b>LHDI → LMLFPR</b>   | 6.22244 <sup>a</sup> | 5.91374 <sup>a</sup> | 5.67031 <sup>a</sup> | 5.28118 <sup>a</sup> | 5.75614 <sup>a</sup> |
| <b>LMLFPR → LFLFPR</b> | 5.63254 <sup>a</sup> | 6.23604 <sup>a</sup> | 7.40343 <sup>a</sup> | 6.07181 <sup>a</sup> | 6.38168 <sup>a</sup> |
| <b>LFLFPR → LMLFPR</b> | 5.34725 <sup>a</sup> | 4.55737 <sup>a</sup> | 4.99423 <sup>a</sup> | 4.80429 <sup>a</sup> | 4.85720 <sup>a</sup> |

<sup>a</sup> “ $p < .01$ , <sup>b</sup> “ $p < .05$ , <sup>c</sup> “ $p < .1$

Authors Calculations

## CONCLUSIONS AND POLICY RECOMMENDATIONS

The findings of this study generate new knowledge to give decision-makers insight into how the Gross Domestic Production per capita (GDP) is impacted by female labor force participation globally and at various stages of the demographic dividend. On that, policymakers can create efficient national, regional, or global strategies for maximizing GDP with optimum female labor force participation and maximum demographic dividends and enhancing GDP by determining the dynamics of the effects of male and female labor force participation on GDP. The findings of the study are as follows:

With various elasticities depending on a country's demographic stage, this study's results show evidence of a significant long-term association between population and GDP across all study panels. The outcomes of this analysis indicate that the population may decrease GDP at all dividend phases and worldwide, contrary to some other studies that suggested that population and population growth rates may raise GDP.

This analysis shows that energy use significantly and favorably affects GDP in panels. According to the study, the effect of energy use on GDP varies depending on a nation's demographic stage, with stronger elasticities in the early-dividend phase and globally. These results demonstrate the significance of considering a nation's demographic stage when analyzing the link between energy consumption and GDP.

According to the estimates, HDI's influence is the most significant factor in improving GDP. The impact is positive in all panels. The highest impact is at the post-stage and the lowest at the pre-stage. It can be concluded that the quality of the population is more significant in improving GDP than the size of the population.

The estimate highlights that FLFPR's impact on GDP is significant at all dividend stages and globally. However, it is positive only at the early stage and globally. Therefore, we can conclude that improving FLFPR is highly sensitive to the GDP's stage of dividend. Policymakers must consider this behavior of FLFPR.

The estimate highlights that MLFPR's impact on GDP is significant at the all-dividend stages and globally. The elasticities of MLFPR on GDP are unusually high in late and post-dividend periods, showing that improvements in MLFPR may lead to considerable growth in GDP. At the early dividend stage, MLFPR shows a negative impact on the GDP.

Also, the results indicate that a country's GDP is significantly influenced by its population, GDP, energy use, and labor force participation rates, and the impact may differ depending on the country's demographic stage. Thus, the linear model explains a sizeable amount of the variance in GDP across all demographic phases and internationally. Based on a country's demographic stage, the estimates can assist policymakers in identifying and prioritizing actions that can raise its GDP.

In various demographic dividend phases, the relationship between female labor force participation rate and GDP is better understood, thanks to the non-linear model utilized in this study. The results imply that the influence of FLFPR on GDP is not linear and varies on the stage of demographic change. The U-shaped relationship between FLFPR and GDP in the pre-dividend stage shows that a moderate FLFPR can raise GDP while a high or low FLFPR can lower it. In contrast, FLFPR has an inverse U-shape influence on GDP at the Early dividend phase, suggesting that FLFPR levels that are both too low and too high can be detrimental to GDP. FLFPR has an overall linear effect on GDP. Also, the cointegration study supports the non-linear model's long-term stability in study panels, except the post panel. These results emphasize the importance of considering the non-linear relationship between FLFPR and GDP and the demographic stage when developing strategies to raise GDP.

In the global panel of the linear model, HDI has the most significant favorable influence on GDP, whereas POP shows a negative impact. Nonetheless, the non-linear model has no substantial influence on GDP. In light of these findings, policy interventions should consider a nation's unique demographic stage and the non-linear correlations between various variables and GDP. These findings shed light on the nuanced interaction between energy, labor force participation, and human development and might help policymakers create plans to raise GDP.

The Dumitrescu-Hurlin panel non-causation test findings reveal a bidirectional causality between the independent variables (POP, HDI, ENG, FLFPR, and MLFPR) and GDP at all study panels. Also, for all research panels, there is bidirectional causation between POP, HDI, ENG, FLFPR, and MLFPR with GDP, demonstrating the interdependence of these variables. For all study panels, there is also a sizable bidirectional causal relationship between ENG, FLFPR, and MLFPR. These results imply that the research variables significantly influence one another and are highly interdependent.

These results show the necessity of incorporating demographic phases when analyzing the link between population and GDP since boosting HDI may also lead to gains in economic development. These findings have significant policy-related rationality that supports sustainable development.

Based on the findings and conclusions, here are the policy recommendations:

- Policies promoting human development should be encouraged to enhance economic growth and well-being.
- Female labor force participation rates can significantly impact GDP in various demographic dividend phases. Policies aimed at boosting the involvement of females in the labor force should be developed with caution.



Policies to increase employment and labor force participation rates should be developed and implemented to advance economic development.

- Also, Policies aimed at boosting male labor force participation should be developed with caution. Improvements in MLFPR can lead to considerable development in GDP except in the early stage.
- Future research should investigate the effectiveness of policies aimed at enhancing economic development, taking into account the demographic stage of a nation.

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## APPENDIX

List of countries selected for the study panels.

| <b>Table A1: List of 20 selected countries for the pre-demographic dividend panel.</b> |               |              |          |
|----------------------------------------------------------------------------------------|---------------|--------------|----------|
| <b>Benin</b>                                                                           | Cote d'Ivoire | Mauritania   | Sudan    |
| <b>Burundi</b>                                                                         | Gambia, The   | Mozambique   | Tanzania |
| <b>Cameroon</b>                                                                        | Iraq          | Niger        | Togo     |
| <b>Central African Republic</b>                                                        | Kenya         | Senegal      | Uganda   |
| <b>Congo, Rep.</b>                                                                     | Malawi        | Sierra Leone | Zambia   |

Source: Created by the author based on the WDI (2022), <https://data.worldbank.org/country/V1>.

| <b>Table A2: List of 41 selected countries for the early-demographic dividend panel.</b> |                    |                  |              |
|------------------------------------------------------------------------------------------|--------------------|------------------|--------------|
| <b>Argentina</b>                                                                         | Eswatini           | Lao PDR          | Paraguay     |
| <b>Bahrain</b>                                                                           | Gabon              | Lesotho          | Peru         |
| <b>Bangladesh</b>                                                                        | Ghana              | Mexico           | Philippines  |
| <b>Belize</b>                                                                            | Guatemala          | Myanmar          | Rwanda       |
| <b>Bolivia</b>                                                                           | Haiti              | Namibia          | Samoa        |
| <b>Botswana</b>                                                                          | Honduras           | Nepal            | Saudi Arabia |
| <b>Dominican Republic</b>                                                                | India              | Nicaragua        | South Africa |
| <b>Ecuador</b>                                                                           | Indonesia          | Pakistan         | Tonga        |
| <b>Egypt, Arab Rep.</b>                                                                  | Iran, Islamic Rep. | Panama           | Turkiye      |
| <b>El Salvador</b>                                                                       | Jordan             | Papua New Guinea | Yemen, Rep.  |
|                                                                                          |                    |                  | Zimbabwe     |

Source: Created by the author based on the WDI (2022), <https://data.worldbank.org/country/early-demographic-dividend>

| <b>Table A3: List of 29 selected countries for the late-demographic dividend panel.</b> |                 |                     |         |
|-----------------------------------------------------------------------------------------|-----------------|---------------------|---------|
| <b>Albania</b>                                                                          | Fiji            | Morocco             | Uruguay |
| <b>Armenia</b>                                                                          | Guyana          | Poland              | Vietnam |
| <b>Brazil</b>                                                                           | Ireland         | Romania             |         |
| <b>Brunei Darussalam</b>                                                                | Jamaica         | Russian Federation  |         |
| <b>Chile</b>                                                                            | Kazakhstan      | Sri Lanka           |         |
| <b>China</b>                                                                            | Kyrgyz Republic | Thailand            |         |
| <b>Colombia</b>                                                                         | Malaysia        | Trinidad and Tobago |         |
| <b>Costa Rica</b>                                                                       | Mauritius       | Tunisia             |         |

Source: Created by the author based on the WDI (2022), <https://data.worldbank.org/country/late-demographic-dividend>

| <b>Table A4: List of 28 selected countries for the post-demographic dividend panel.</b> |         |             |                |
|-----------------------------------------------------------------------------------------|---------|-------------|----------------|
| <b>Australia</b>                                                                        | Denmark | Korea, Rep. | Singapore      |
| <b>Austria</b>                                                                          | Finland | Luxembourg  | Spain          |
| <b>Barbados</b>                                                                         | France  | Malta       | Sweden         |
| <b>Belgium</b>                                                                          | Germany | Netherlands | Switzerland    |
| <b>Bulgaria</b>                                                                         | Greece  | New Zealand | Ukraine        |
| <b>Cuba</b>                                                                             | Italy   | Norway      | United Kingdom |
| <b>Czech Republic</b>                                                                   | Japan   | Portugal    | United States  |

Source: Created by the author based on the WDI (2022), <https://data.worldbank.org/country/post-demographic-dividend>