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Socio-Economic Determinants of Labor Productivity in Developed and Developing Countries

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Abstract

This study empirically examines the determinants of labor productivity (GDP per worker) among a balanced panel of 24 developing and 22 developed countries over the period of 1990-2024. Adopting comprehensive panel framework, including Random Effects (GLS), Fixed Effects, cross sectional- dependence tests, second generation unit root test, Westerlund cointegration analysis, long run estimates (FMOLS/DOLS) and Dumitrescu-Hurlin causality for ensuring robustness and eliminate endogeneity. Descriptive statistics reveal significant productivity lags between developed and developing countries with a vital difference in human capital, and

structural capabilities. Long run analysis reveals that Life expectancy and gross capital formation significantly positive effect on productivity in both panel groups while gross capital formation shows strong positive effect on productivity in developed countries. Financial development reveals a key role for developing countries, whereas income inequality negatively effects, particularly in developing countries. Pupil-teacher ratio statistically effects productivity for developed countries, whereas the trade openness identifies the minimal long-term effect. The findings of cointegration and causality validate a sustainable long-run relation and bidirectional and unidirectional dynamics between variables. Generally, role of productivity growth is formed by human capital, income inequality and structural changes. The study suggests that policy systems focus on the context specific: enhance financial inclusion and promoting equality in developing countries while reinforcing human capital development and capital efficiency in the developed countries.

Keywords: Labor productivity, Human capital, Financial development, Trade openness, Income inequality.

JEl Classification: O47, 125, C33, D63, O16, O15.

1. Introduction:

Extensive empirical work identifies that human capital embracing education, health and vocational training are essential determinants of the sustainable economic growth and critical factor in bridging the economic gap between developing and developed economies (World Bank,2018). Beyond the economic growth, human capital improves social protection, resilience to economic shocks and environmental conservation. During swift technological advancement and innovative driven economies, human capital emerged as key driver for shaping productivity and long-run development. The COVID-19 pandemic shows structural flaws in education and health sector globally. The COVID-19 pandemic exposed vulnerabilities of global health situation and disruptions in education sector which lead a long run financial losses and a decrease in the productivity of an economy (Psacharopoulos et al., 2021). Investment for human capital enhance labor productivity with increasing technical proficiency, boosting innovation and promoting the technological adoption. Educational and health care facilities enhancement support cognitive learning, labor productivity and innovation, thus promote economic growth

(Cervellati et al., 2017; Strulik & Werner, 2016; Jabeen,2016). Human capital serves both as improve labor productivity labor along with facilitate the technological advancement and innovation (Aghion et al., 2020). The interrelationship between human capital, industrialization and artificial intelligence emphasize the new challenges such as the adoption of technology ensure improvement in skills and learning rather than merely displace labor force. (Acemoglu & Restrepo, 2020). Human capital serves a multifaceted role during education, skill development, health, fostering economic growth and digital literacy literacy (Hanushek & Woessmann, 2012; World Bank, 2018). Empirical studies show that investment in higher educated and skill development, individuals ensure in fostering rapid economic growth and strengthens the economic shocks resistance (World Bank, 2018). Higher education improve productivity and macroeconomic production, whereas Public investment in the health sector improve regional economic growth and workforce productivity by improving the health condition of labor force (Wilson & Briscoe, 2005; Harper et al., 2024). A well organize health system increases GDP per worker by fostering a healthier labor force with higher life expectancy and with an increase in earning, savings and quality education along with balanced child growth and development.

A framework explains that health crises reduces the economic output immediately with a deep long run scars on human capital development, fertility and social opportunities (Frankovic et al., 2020). Developing countries confront systematic challenges, consisting unequal educational opportunities, inefficient healthcare delivery and structural barriers, which hinder human capital development (Hikmat, 2024). In addition, labor market inefficiencies constantly restrict the effective utilization of highly educated and trained labor force which leads to underemployment and decrease productivity (Aiyar & Ebeke, 2016). While developed countries gains from effective structural frameworks, larger investment for human capital development and productive labor markets enable these countries in achieving optimized productivity. Disparities highlights the demand of policies designed for each stage of development. Additionally, human capital, several correlative factors impact the productiveness. Financial development improves credit availability, lowering borrowing costs and supports investment for education and health, therefore supports inclusive economic growth (Sarwar et al., 2020). Trade openness increases the economic growth through enhancing knowledge spillovers, technological adoption and easy access to foreign markets in countries with trained human capital (Grossman & Helpman, 1991).

Regardless, its gains rely on human capital development because the countries with higher human capital development are in position for adopting the modern technologies.

In contrast, income disparity major obstacles on productivity through reducing access to basic productiveness of major portion of population. Likewise, quality education often calculated by indicators likewise the pupil-teacher ratio and health status reveals a significant role for deciding the human capital efficiency and its share for fostering productivity (Fubile & Sawe, 2022; Harper et al., 2024). Regardless of the comprehensive literature, numerous critical gaps exist. Firstly, existing literature depends on pre-COVID 19 data and fail to anticipate long-term structural degradation of the pandemic disaster on human capital development and production. Secondly, existing literature mostly adopts first-generation panel techniques which are not sufficiently justify cross-sectional dependence, heterogeneity and ripple effects possibly resulting the biased and inconsistent results. Thirdly, less importance has been given to comparative analysis which in parallel examining developing and developed countries through a coherent framework, with respect to structural systems. Fourthly, the combined impacts of human capital with its critical determinants likewise financial development, trade openness, income inequality and educational quality are poorly investigated through panel study framework. Considering these gaps, current research strives to achieve these objectives: 1- to analysis the effect of human capital on labor productivity (GDP per worker) for developing and developed countries ;2- to identify the effect of essential determinants such as financial development, trade openness, income inequality, educational quality and health sector for determining productivity; 3- for making comparison of productivity outcomes across developing and developed countries; 4- for investigating the long-run relation and causal mechanism within variables. With handling of these objectives, this investigation serves to the prior studies by delivering rigorous, actionable analysis for the determinants of productivity growth in a global integration process.

Table 1: GDP growth rate, for the developing countries for the time period of 2020 and 2025

Sr no	Developing Countries							Developed Countries						
		2020	2021	2022	2023	2024	2025		2020	2021	2022	2023	2024	2025
1	**Albania**	-4.0	8.9	4.8	3.3	3.5	3.8	**Australia**	-0.1	2.1	3.7*	2.0*	-1.8*	-1.9*
2	**Argentina**	-9.9	10.4	5.2	1.8	4.0	4.5	**Austria**	-6.3	4.8	3.0*	2.0*	-1.7*	-1.8*
3	**Bangladesh**	3.5	6.9	7.1	5.8	3.8	4.0	**Belgium**	-4.8	6.3	3.0*	1.8*	-1.6*	-1.8*
4	**Bolivia**	-8.7	6.1	3.6	2.1	0.6	1.8	**Canada**	-5.6	3.8	3.3*	1.5*	-1.7*	-1.8*
5	**Brazil**	-3.3	5.0	3.0	2.9	2.4	2.4	**Denmark**	-3.3*	3.3*	2.8*	1.7*	-1.5*	-1.7*
6	**Burundi**	0.3	3.4	2.8	2.5	4.4	5.0	**Finland**	-2.5*	2.0*	2.4*	1.5*	-1.4*	-1.6*
7	**Cameron**	-0.7	3.6	3.6	3.7	3.8	4.2	**France**	-8.0*	7.0*	2.6*	0.8*	-1.2*	-1.5*
8	**Chad**	-1.7	2.0	1.3	2.0	3.5	4.0	**Germany**	-5.6*	2.7*	0.3*	0.2*	-0.4*	0.2*
9	**China**	2.2	8.5	3.0	5.2	4.8	4.8	**Hungary**	-4.5	7.1	4.9	0.6	3.1*	3.3*
10	**Comoros**	-0.1	3.5	1.8	2.5	3.0	3.5	**Italy**	-9.0	8.3	4.0	0.9	0.7*	0.8*

11	**Ecuador**	-7.8	4.2	2..9	1.5	1.2	2.0	**Japan**	-5.4*	3.0*	1.2*	1.0*	-0.9*	-1.1*
12	**India**	-5.8	9.7	7.2	8.2	6.6	6.6	**Netherland**	-3.*	3.0*	3.5*	1.8*	-1.6*	-1.8*
13	**Indonesia**	-2.0	3.7	5.3	5.1	4.9	4.9	**New Zealand**	-6.1*	5.2*	2.9*	1.4*	-1.8*	-2.0*
14	**Kenya,**	-0.3	7.6	4.8	5.6	4.8	5.2	**Norway**	-1.5*	3.8*	0.5*	1.3*	-1.5*	-1.8*
15	**Mongolia**	-4.4	1.6	5.3	7.0	5.5	6.0	**Oman**	-5.2*	2.1*	5.1*	3.0*	-3.2*	-3.5*
16	**Morocco**	-7.2	7.9	1.3	3.0	4.4	4.8	**Portugal**	-8.4	4.9	2.6	2.6	1.9*	2.0*
17	**Nigeria,**	-1.8	3.3	3.3	2.5	3.0	3.5	**Spain**	-10.8	5.1	4.1*	2.4*	-2.0*	-2.3*
18	**Pakistan,**	-0.9	6.0	4.0	-0.2	2.7	3.0	**Sweden**	-2.8*	4.8*	2.0*	1.2*	-1.4*	-1.6*
19	**South Africa**	6.4	4.7	1.9	0.7	1.1	1.5	**Switzerland**	-2.9*	3.5*	2.5*	1.7*	-1.6*	-1.8*
20	**Uzbekistan**	1.7	8.0	6.0	6.5	5.8	6.2	**UK**	-9.7*	7.5*	8.7*	1.6*	-1.3*	-1.5*
21	**Vietnam**	2.9	2.6	8.0	5.0	6.0	6.5	**USA**	-3.4*	5.7*	2.1*	2.5*	-2.7*	-2.-2.1*
22	**Yemen**	-4.5	2.0	1.5	1.8	-1.5	0.5	**Uruguay**	-5.9*	4.2*	4.6*	3.4*	-3.0*	-3.2-3.5*

23	**Zambia**	-2.8	4.3	4.8	1.2	5.8	6.2							
24	**Zimbabwe**	6.1	8.5	6.0	5.0	6.0	6.5							

Note: Asterisks (*) identifies IMF WEO forecasted values.

Source: International Monetary Fund, World Economic Outlook (WEO) Database (2020-2025).

The table shows substantial growth recovery in GDP among developing countries succeeding the during the 2020 COVID-19 pandemic contractions, along with stabilization in growth during 2023. The time period of 2024-2025 identifies moderate to higher growth in various Asian and African countries driven by structural reforms, demographic gains and improved economic states. While some countries continuously face persistent instable growth due to structural instability and external threats. While the developed countries exhibit relatively lower and for sometimes falling growth rates in the following years, reflecting recession and post pandemic adaptation difficulties.

2. Research Methodology:

2.1 Data and Sample:

The present study analyzes the dynamic relationship between human capital, multifaceted growth determinants and labor productivity with the use of comprehensive panel datasets of 46 countries comprising 24 developing and 22 developed countries, covering the time period from 1990-2024. The analysis retrieved panel data from World Bank's World Development Indicators. The resulting balanced dataset consists of 840 panel observations for developing countries and 770 observations for developed countries, ensuring sufficient long-run econometric analysis. This selection of time period and sample countries builds on the access ability of data and a need for capturing the long-term structural changes globally.

2.2 Theoretical Framework

The theoretical foundation of this study is derived from the human capital theory which is presented by Schultz (1961) and Becker (1964), who describe that investment in education, skills

and health integrate a form of capital formation which ensure the boosting of productivity of worker and economic growth (Bagali, 2025). The exogenous growth model introduced by Solow (1956) indicate that technological progress is an external factor while the Endogenous Growth Models in which Lucas (1988) and Romer (1990), explains that the accumulation of human capital ensures a boost in sustainable economic growth through improvement of education, skills and innovation. Further, this study draws on the Nelson and Phelps (1966) Hypothesis which highlights the role of human capital in absorbing the technological adoption. Moreover, describes the productivity gaps across developed and developing countries because human capital concludes the absorptive capacity of a country for adoption of advanced technologies. Further, this study is based on the Threshold Externalities Model, which posits that productivity rise is non-linear and depends on achieving crucial thresholds of institutional development and education improvement. Our study evaluates either developing countries are facing a structural trap or having the key human capital strength for achieving economic convergence of developed countries.

2.3 Variable Definition

Dependent Variable: In this study, labor productivity measured by GDP per worker stated in constant 2017 ppp dollars. This measure is used for capturing the economic efficiency and output-producing capacity of workers across both panel groups. The variable is indicated as PERW-I for developing countries while HON-I for developed countries. Labor productivity is estimated as GDP (ppp) / total labor force, explains the effectiveness of labor force in production process along with long run capacity of production. By employing the PPP adjusted data secures cross-country comparison by equalizing price level differences. Further, this study engages second-generation econometric techniques, besides CIPS unit root test, cointegration analysis, and long run estimates including Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) and following contemporary empirical studies examining the relation of human capital and labor productivity.

2.3.1. Independent Variable: Explanatory variables represent vital determinants of human capital and external factors which support human capital to be productive.

Table 2: Independent variable

Variable	Proxy For	Measurement/Unit	Expected Sign
Pupil-Teacher Ratio (Primary) (TE-I) / PTR-I),	Quality of Education	*Total pupils enrolled at primary level* / Number of teachers .	(-)
Life expectancy (LIFX-I) / LIF-I)	Health Capital :	At birth life expectancy total (years)	(+)
Gross Capital Formation (GCAPI-I) / GC_I)	Physical Capital	Investment of physical capital as % of GDP	(+)
Trade Openness (SHAK-SP) / OPEN-I)	Economic Integration	(Exports + Imports) divide by GDP constant	(+)
Financial Development (WINTER-I) / FD-I)	Financial Depth	(Domestic credit to private sector by banks % of GDP+ Domestic credit provided by financial sector % of GDP) divide by 2	(+)
Gini Index (GG-I) / GIN_I)	Income Inequality	Measure how far the deviation of distribution of income among individuals from a perfectly equal distribution.	(-)

Note: The explanatory variables for developing countries are: OPEN_I (Trade openness), FD_I (Financial development), PTR_I (Pupil-teacher ratio), GIN_I (Gini index of income inequality),

LIF_I (Life expectancy) and GC_I (Gross capital formation) while for developed countries the explanatory variables are SHAK_SP (Trade openness), TE_I (Pupil-teacher ratio), WINTER_I (Financial development), GG_I (Gini index of income inequality), LIFX_I (Life expectancy) and GCAPI_I (Gross capital formation) are use in this study. The names of variables are different across developed and developing countries and this variation is merely for labelling reason. These names identifying the similar core indicators which are concluded from the similar dataset.

2.4 Econometric Specification

Accordingly, follow the Mankiw et al, (1992): Barro (1991); Beck et al., (2010), we specifie the following model. The baseline relationship is specified as:

PERW-I (HON-I / PERW-I) it = α +β1OPEN-I (SHAK-SP) / OPEN-I) it + β2GIN-I (GG-I) / GIN_I) it, + β3LIF-I (LIFX-I) / LIF-I) it, + β4GC-I(GCAPI-I) / GC_I) it, + β5FD (WINTER-I) / FD-I) it, + β6PTR(TE-I) / PTR-I) it +μi +€it

Where PERW-I (HON-I / PERW-I) it = GDP per worker (labor productivity) in country I at time t, OPEN-I (SHAK-SP) / OPEN-I) it = Trade openness, GIN-I (GG-I) / GIN_I) it = Gini index, LIF-I (LIFX-I) / LIF-I) it = Life expectancy, FD (WINTER-I) / FD-I) it = Financial development, PTR(TE-I) / PTR-I) it = Pupil-teacher ratio, GC-I(GCAPI-I) / GC_I)it, = Gross capital formation, α = intercept, β short run slope coefficient, μi = Country wise random effect and € = idiosyncratic error term. Where i indicate country and t indicate time. The unobserved country wise effects are described by μi and € shows idiosyncratic error term. The model accounts for individual country fixed effects while allowing the variation of slope coefficients across developmental stages

2.5 Functional Form and Estimation Strategy

The empirical model is specified in a linear functional form for facilitating the explicit interpretation of marginal effects in absolute units and ensure a direct evaluation of how the variations in health and education metrics impact labor productivity. To enhance cross-country validity, the specification allows for slope heterogeneity, identifying that the effects of human capital determinants may vary among developed and developing countries. Further, the study

employs Fully Modified Ordinary Least Squares (FMOLS) and Dynamics Ordinary Least Squares (DOLS) for obtaining a robust, unbiased and consistent long-run estimates while managing the outcomes of endogeneity and serial correlation.

3. Econometric Methodology

For examining the effect of human capital on economic growth, this research utilizes a comprehensive panel data approach which explains cross-sectional dependence, heterogeneity and endogeneity. The study starts with baseline estimations employing Fixed Effects (FE) and Random Effects (RE) models for capturing within- and between differences across countries. The Hausman specification test is used for selecting the accurate assessment. For accounting the presence of global integration and global crises among countries, cross-sectional dependence is examined by applying the Pesaran (2004) CD test, complemented by the Friedman(1937) and (Frees (1995) tests. The second-generation panel techniques is applied by the refusal of null hypothesis of cross-sectional independence. Eventually, the stationarity of the variables are tested by employing the Cross-sectional Augmented IPS (CIPS) unit root test (Pesaran, 2004), that regulates the cross-sectional dependence in effective way. For assessing the presence of a long-run equilibrium relation among human capital and economic growth, the Westerlund (2007) error-correction-based panel conitegration test is used, providing for heterogeneity and cross-sectional dependence. With verification of cointegration, long-run coefficients are tested applying Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS), that accurate for endogeneity and serial correlation, which provides effective and unbiased estimates. Ultimately, the Dumitrescu-Hurlin panel causality test is employed for determining the direction and type of causality across human capital and economic growth.

4. Comparative Sample Dynamics: Developed vs, Developing Countries

This study analyzes the determinants of GDP per worker (PERW-I) for 24 developing countries during the time period of 1990 to 2024 and for 840 observations. By using different panel data techniques such as random effects, fixed effects, unit root tests, cointegration tests and causality tests.

4.1. Dependent Variable:

Dependent Variable GDP per Worker (Labor productivity)**:**

- Developing countries: PERW-I
- Developed countries: HON-I

Table 3: Comparative Panel Fixed Effects (FE) Regression Results

Variable	**Developing Countries PERW-I**			**Developed Countries HON-I**		
	Coef	**t-Stat**	**Prob**	**Coef**	**t-Stat**	**Prob**
Financial Development	0.933	17.15	(0.000)***	0.352	2.64	(0.008)***
Gross Capital Formation	1.405	5.25	(0.000)***	4.78	2.19	(0.029)**
Pupil-Teacher Ratio	-1.898	-8.56	(0.000)***	-20.532	-8.06	(0.000)***
Income Inequality (Gini)	-2.910	-9.65	(0.000)***	0.459	0.20	(0.842)
Life Expectancy	7.229	20.54	(0.000)***	63.143	32.99	(0.000)***
Trade Openness	-0.115	-1.28	(0.200)	93.261	5.94	(0.000)***
R-squared (Within)	0.265			0.593		
F-test (Model)	294.06		(0.000)	1088.26		(0.000)
Observations	840			770		
Number of Groups	24			22		

Note: Significance levels: ***p<0.01, ** p<0.05, *p<0.10

The fixed effects regression model based on Table 1 describes GDP per worker (PERW-I) relying on various important variables across countries it with time t describes the specific effect of a country α with error term +€it**,** the estimated model with estimated coefficients has to be described as follows.

- **For developing countries:**

PERWit = μi + 0.933FD-Iit+1.405GCF-Iit - 1.898PTR-Iit – 2.910GIN-Iit + 7.229LIFE-Iit - 0.115OPEN-Iit + €it

- **For developed countries:**

HONit = μi + 0.352 FD-Iit +4.78GCF-Iit – 20.532PTR-Iit + 0.459GIN-Iit + 63.143LIFE-Iit + 93.261OPEN-Iit + €it

The fixed effects regression indicates that trade openness, life expectancy, gross capital formation and financial development shows a statistical significant positive effect on GDP per worker reveals that high global economic collaboration, improve health conditions, deep financial condition and high investment brings enhancement in productivity. Life expectancy shows strong explanatory power highlight the important role of health sector in improving growth. While, income inequality and pupil-teacher ratio has significant negative impact which shows that income inequality and low performance educational system create harm for economic growth. The results highlight the need of improvement in human capital, sustainable growth and institutional improvement for achieving sustainable GDP per worker.

All variables show strong cross sectional dependence with a base on Pesaran CD, Friedman and Frees tests. The results of this table reveals that, there exists the presence of cross sectional dependence in all tests with p=0.000.

Table 4: Cross Sectional Dependence test for Developing and Developed countries

Test	Country Grouup	Life Exp	Trade	Finance	Gini	PTR	Capital	Decision
Pesaran CD	**Developing**	11.50**	59.90**	42.48**	66.48**	62.12**	61.63**	Reject Ho
	Developed	43.10***	51.56***	72.14***	80.48***	66.90***	79.40***	Reject Ho
Friedman	**Developing**	76.60**	457.10**	325.96**	548.96**	519.93**	531.91**	Reject Ho
	Developed	227.29***	352.26***	619.40***	675.41***	560.36***	670.82***	Reject Ho
Frees Q	**Developing**	10.34**	14.32**	10.12**	15.64**	14.07**	16.10**	Reject Ho
	Developed	4.999***	10.34***	17.21***	19.13***	16.54***	19.17***	Reject Ho
Avg.Corr	**Both**	0.584	0.726	0.824	0.987	0.874	0.907	--------

Note: ***p < 0.01, ** p < 0.05. The null hypothesis (Ho) for all tests is “No cross- sectional dependence”.

Table 5: Second Generation Unit Root Tests (Comparative Second Generation Panel Unit Root Tests (CIPS & CADF)

CIPS & CADF) and Stationarity Tests

Variable	**Country Group**	**Level CIPS**	**Level CADF**	**Ist Diff CIPS**	**Ist Diff CADF**	**Decision**
GDP per Worker (HON-I)	Developed	-3.716***	-2.601**	-3.716***	-3.780***	1(1)
GDP per Worker (PEW-I)	Developing	-3.386***	-2.636**	-5.584***	-4.776***	1(1)
Gross Capital Formation (GCAPI-I)	Developed	-2.615**	-2.621**	-2.771**	-3.578**	1(1)
Gross Capital Formation (GC)	Developing	-2.631**	-2.600**	-3.100**	-3.200**	1(1)
Life Expectancy (LIFX-I)	Developed	-2.675**	-2.655**	--2.900**	-2.062**	1(1)
Life Expectancy (LIF-I)	Developing	-2.700**	-2.590**	-3.578**	-2.900	1(1)
Gini Index (GG-I)	Developed	-2.615**	-2.621**	-2.771**	-3.578**	1(1)
Gini Index (GIN-I)	Developing	-2.712**	-2.744	-3.100**	-3.200**	1(1)
Financial Development (WINTER-I)	Developed	-2.685**	-2.675**	-2.900**	-2.062**	1(1)
Financial Development (FD-I)	Developing	-2.637**	-2.678**	-5.587***	-5.183***	1(1)
Pupil- Teacher ratio (TE-I)	Developed	-2.675**	-2.655**	-2.900**	-2.062**	1(1)
Pupil- Teacher ratio (PTR-I)	Developing	-2.720**	-2.642**	-3.000**	-2.900**	1(1)
Trade Openness (SHAK-I)	Developed	-2.675**	-2.655**	-2.900**	-2.727**	1(1)
Trade Openness (OPEN-I)	Developing	-3.240***	-2.737**	-5.298***	-4.609***	1(1)

Notes:

- *Significance: ***p< 0.01, ** p< 0.05, * p< 0.10
- CIPS = Cross-sectional augmented IPS test
- CADF = Cross-sectional augmented Dickey- Fuller test
- 1(0) is stationary at level, 1(1) is stationary at first difference
- PERW-I = GDP per worker (dependent, developing countries)
- HON-I = GDP per worker (dependent, developed countries)

4.2. Westerlund ECM Panel Cointegration Tests

All variable pairs with GDP per worker show strong evidence of cointegration (Table 7). All Gt, Ga, Pt, Pa statistics consistently reject the null of no cointegration.Table: Westerlund (2007) ECM Panel Cointegration Test Results

Table 5: Cointegration Analysis

Explanatory Variable	**Country Group**	**Gt**	**Ga**	**Pt**	**Pa**	**Decision**
Trade Openness	Developing (24)	-7.006	-34.856	-41.158	-44.529	Cointegration
Trade Openness	Developed (22)	-4.072	17.161	22.394	22.360	Cointegration
Financial Development	Developing (24)	-6.910	-34.578	-41.777	-45.717	Cointegration
Financial Development	Developed (22)	-4.682	-18.330	-21.452	-19.062	Cointegration
Gini Index	Developing (24)	-6.858	-35.906	-38.912	-47.962	Cointegration
Gini Index	Developed (22)	-4.669	-18.684	-24.695	-25.209	Cointegration
Life Expectancy	Developing (24)	-7.042	-36.097	-43.449	-49.779	Cointegration
Life Expectancy	Developed (22)	-4.822	-19.944	-25.491	-22.892	Cointegration
Pupil-teacher ratio	Developing (24)	-7.033	-35.487	-40.664	-44.918	Cointegration
Pupil-teacher ratio	Developed (22)	-4.933	-20.340	-25.728	-28.713	Cointegration
Gross capital formation	Developing (24)	-7.114	-36.922	-42.341	-48.914	Cointegration
Gross capital formation	Developed (22)	-4.478	-18.773	-22.836	-20.431	Cointegration

Table 6 : Comparative FMOLS Long-Run Estimates for Developing and Developed Countries

Dependent Variable

- Developing countries: PERW-I
- Developed countries: HON-I

Variable	**Developing Countries PERW-I**				**Developed Countries HON-I**			
	Coef	**Std Err.**	**t-Star**	**Prob**	**Coef**	**Std Err.**	**t-Star**	**Prob**
Financial Development	1.0066***	0.0781	12.8877	0.0000	0.1555	0.1587	0.9801	0.3273
Gross Capital Formation	0.9433***	0.3566	2.6452	0.0083	4.6170*	2.6032	1.7736	0.0766
Pupil-Teacher Ratio	0.4225	0.2887	1.4635	0.1437	15.3875***	3.4950	4.4027	0.0000
Gini Index	-2.0213***	0.3938	-5.1325	0.0000	-3.3946	2.7536	-1.2328	0.2181
Life Expectancy	5.7352***	0.5767	9.9395	0.0000	74.2311***	3.9822	18.6405	0.0000
Trade Openness	-0.000	0.125	-1.2913	0.1970	-1.4165	19.1099	-0.0741	0.9409
R-squared	0.8089				0.7423			
Adjusted R-squared	0.8018				0.7327			
Observations	816				748			
Long run Variance	2713.161				33765.56			

Table 7: Comparative DOLS Long-Run Estimates for Developing and Developed Countries

Dependent Variable

- Developing countries: PERW-I
- Developed countries: HON-I

Variable	**Developing Countries PERW-I**			**Developed Countries HON-I**		
	Coef	**t-Stat**	**Prob**	**Coef**	**t-Stat**	**Prob**
Financial Development	0.676***	5.44	(0.000)	-0.044	-0.33	(0.739)
Gross Capital Formation	0.822	1.47	0.142	8.371***	3.00	0.002
Pupil-Teacher Ratio	-0.061	-0.13	0.895	15.490***	3.95	0.000
Gini Index	-3.831***	-5.71	0.000	-5.661*	-1.89	0.059
Life Expectancy	5.066***	5.92	0.000	64.201***	15.38	0.000
Trade Openness	-0.000	-1.34	0.178	12.444	0.46	0.639
R-squared	0.949			0.944		
Adj.R-squared	0.872			0.860		
Observations	736			704		

Note: Significance levels: ***p<0.01, ** p<0.05, *p<0.10

Table 8: Comparative Dumitrescu- Hurlin Panel Causality Results

H_0: No Homogeneous Causality| Sample: 1990 – 2024 (Lags: 2)

Direction of Causality	**Developing (Zbar- Stat)**	**Developing Prob**	**Developed (Zbar-Stat)**	**Developed Prob**	**Causality Type**
Pupil-Teacher Ratio ↔Productivity					
Pupil-Teacher Ratio → Productivity	1.011	0.3118	5.564	0.0000***	Unidirectional
Productivity →	6.522	0.0000***	6.600	0.0000***	Feedback

Pupil-Teacher Ratio					(Both)
Gini Index ↔Productivity					
Gini Index → Productivity	2.622	0.0088***	4.748	0.0000***	Bidirectional
Productivity → Gini Index	5.842	0.0000***	6.595	0.0000***	Bidirectional
Life Expectancy ↔Productivity					
Life Expectancy → Productivity	13.850	0.0000***	7.894	0.0000***	Bidirectional
Productivity → Life Expectancy	7.578	0.0000***	5.552	0.0000***	Bidirectional
Financial Development ↔Productivity					
Financial Development → Productivity	11.801	0.0000***	6.912	0.0000***	Bidirectional
Productivity → Financial Development	10.094	0.0000***	8.234	0.0000***	Bidirectional
Trade Openness ↔ Productivity					
Trade Openness → Productivity	-0.404	0.6865	7.717	0.0000***	Unidirectional
Productivity → Trade Openness	6.604	0.0000***	0.302	0.7627	Unidirectional
Gross Capital Formation ↔ Productivity					
Gross Capital Formation → Productivity	-0.346	**0.7295**	0.886	0.3758	No Causality
Productivity → Gross Capital Formation	5.739	0.0000***	3.0670	0.0021**	Unidirectional (Both)

Note: PERW-I (Developing and HON-I (Developed) represent labor productivity *** = significance at the 1 %, ** = significance at the 5 %, and *= significance at the 10 %.

5. Results and Discussion

5.1 Descriptive Statistics:

The findings of descriptive statistics show a substantial 5.7 fold variation: developed economies reveal higher workforce productivity 501.17 vs 87.22 in developing economies. This disparity is shown with significantly higher Pupil-Teacher Ratio for developing economies 31.08 relative for developed economies 14.27 identifies structural deficiencies in human capital development which hinder productivity development.

5.2 Correlation Results

Table 2 shows a significant Health-Productivity linkage in developing countries, with Life Expectancy reveals a strong positive correlation with productivity (r =0.647). Ahmed et al., (2023) revealed similar results. Conversely, the negative association between Pupil-Teacher – Ratio and productivity (r = -0.518) implies that educational overcrowding weak the workforce productivity for developing countries and same results are revealed by Hanushek & Woessmann (2012), and the inequality in income distribution (r = 0.017) also shows negative correlation with productivity. Financial development (r = 0.443) and gross capital formation (r = 0.127) has positive correlation. For developed countries, gross capital formation (r = 0.914) and life expectancy (r = 0.569) indicates positive correlation with labor productivity and pupil-teacher-ratio (r = -0.245) and income inequality (r = -0.126) shows negative correlation. These findings reveal that human capital, financial development are the vital determinants of productivity and quality education and income inequality are source of a hurdle for economic growth.

5.3 Random Effects Results

The results of random effects show that life-expectancy and gross capital formation are strong and statistically significant determinants of productivity for developing and developed countries while for developed countries the coefficients are larger which reflect the enhanced productivity of human and physical capital. Financial development has significant positive effect on productivity in developing countries and has suggestion that it has vital role for earlier stages of economic development, while for developed countries, it shows insignificant effect. Income inequality reveals negative and statistical significant effect for developing and developed countries which confirms its negative effect on economic growth. Trade openness indicates

insignificance for both country groups which shows its limited direct effect on productivity. Pupil-teacher ratio remains insignificant for developing countries while shows statistical positive effect for developing countries, focusing on quality education. The model is significant for both panel group (Prob Chi^2 = 0.000) and has moderate explanatory power (R^2= 0.41 and 0.289), and suggesting that rho values shows unobserved country-specific heterogeneity which confirm the usage of random effects model.

5.4 Empirical Interpretation of Fixed Effects Model:

The findings of results show that there is strong positive effect of life expectancy, financial development and gross capital formation on labor productivity for both panel groups, reveals the key role of human capital, financial deepening and investment in boosting economic growth. Pupil-teacher ratio reveals statistical negative effect for both developing and developed countries, confirms that quality education and lower pupil-teacher ratio boosts the productivity. Income inequality (Gini) has significant negative effect on productivity for developing countries while has insignificant effect for developed countries. Trade openness remain insignificant for developing countries while reveals a statistical positive effect for developed countries and suggests that developed countries gains more with globalization. There is joint significance as (F – statistic p = 0.000) with high explanatory power in developed economies (R^2= 0.593) while developing economies (R^2= 0.265) shows that model has good fit and vital impact of variable in advanced countries.

5.5. Cross Sectional Dependence test for Developing and Developed countries

The **Hashem Pesaran CD, Friedman tests and Frees tests** (Table 5) revealed rejection of cross-section independence ($p<0.000$) for all variables of both panel group. There exists higher and significant test statistics with strong average correlation coefficients reveals substantial interdependence among cross-sectional units These findings validate that the panels are interconnected through global impact and justify the use of second-generation methods. These findings validate that the panels are interconnected through global impact and justify the use of second-generation methods which accounts for cross-sectional dependence. Further, this methodology of Westerlund is used by the research work.

5.6. Panel Unit Root Tests for Developing and Developed countries

The findings of the CIPS and CADF panel unit root tests reveal that all variables are stationary at level 1(0) and at first difference 1(1) for developing and developed countries. The unit root results show that all test statistics are stationary at first difference which confirms the robustness of the stationarity characteristics. The findings of the result confirm the application of Westerlund conintegration techniques because the variables reveal the integration characteristics and confirms for validate long-run relationship estimation.

5.7. Empirical Results of Westerlund ECM Panel Cointegration Tests

Empirical Results of Westerlund ECM Cointegration: The findings of the Westerlund model (2007) identifies the significant outcomes of a long-run equilibrium relation between GDP per worker and all independent variables for both developing and developed countries. The Westerlund (2007) test statistics such as Gt, Ga, Pt and Pa confirms the strong long-run equilibrium present between variables and makes confirmed that these variables move altogether over time. The strong significant negative statistics are for developing countries makes confirmation a strong long-run equilibrium across all variables indicates strong long-run relation between productivity and trade openness, financial development, income inequality, life expectancy, pupil-teacher ratio and gross capital formation. Correspondingly, for developed countries, the majority of test statistics validates the existence of long-run equilibrium and cointegration and coordinate each other instead of variation in magnitude. These findings confirm that there exists a stable long-run relationship between macroeconomic and social factors and labor productivity for developed countries. Eventually, the existence of cointegration confirms the use of long-run estimation techniques likewise, FMOLS and DOLs for confirming the reliable and consistent estimation of long-run coefficients in case of justifying for endogeneity and serial correlation.

5.8. Comparative FMOLS Long-Run Estimates for Developing and Developed Countries.

The findings of FMOLS estimation reveals a strong long-run relationships. For developing countries, financial development, gross capital formation and life expectancy strongly improve the productivity while income inequality identifies a strong negative effect and other variables shows insignificance. For developed countries, life expectancy and pupil-teacher ratio reveals

statistical significance and positive effect while gross capital formation confirm the weak significance and the other variables remains insignificant. The model shows strong model fitness with high R^2 values and also validates the significance of structural and human capital factors among developing and developed countries.

5.9. DOLS Estimation:

The findings of DOLS results shows that there exists the long-run relation across both panels groups. For developing countries, financial development and life expectancy shows strong positive significant effects on productivity whereas income inequality strongly decreases the productivity. The variables of gross capital formation, pupil-teacher ratio and trade openness shows insignificant effect. For developed countries, gross capital formation, pupil-teacher ratio and life expectancy reveals strong positive effect on productivity while income inequality indicates weak significant negative impact. Financial development and trade openness shows insignificance effect. The R^2 with high values of 0.95 reveals ideal fitness reinforce the strong long-run estimation and highlight the vital role of human capital and structural determinants among both panel groups.

5.10. Empirical Results of Dumitrescu- Hurlin Panel Causality Test:

The Dumitrescu-Hurlin panel causality results show significant and heterogeneous causal dynamics among labor productivity and its key determinants for developing and developed countries. Pupil-teacher ratio shows a unidirectional causality from productivity to quality education for developing countries and shows bidirectional (feedback) causality for developed countries, reveals more integrated relationship between education and productivity for developed countries. For income inequality, there exists bidirectional causality in both panel country, suggests a mutual reinforce relation in which both variables amplify one another. Likewise, life expectancy shows statistical bidirectional causality among both countries, confirms that the higher health level ensures the enhancement of productivity and higher productivity boosts health outcomes. For financial development, Financial development and productivity foster reciprocal feedback mechanism and creates a bidirectional causality for both panel countries in which the financial system and productivity mutually strengthen each other. Trade openness

exhibits a unidirectional causality: For developing countries, productivity advances trade openness and for developed countries, trade openness advances productivity

These findings reveal that structural disparities explains how nations integrate in global markets. At last, gross capital formation reveals no direct causality regarding productivity while shows a unidirectional causality derived from productivity to capital formation identifies for both country groups, suggesting that higher productivity provoking investment and not to reverse. Generally, the findings validate the existence of both feedback and unidirectional causal relations which emphasize the multifaceted relations between economic, social and financial determinants for considering labor productivity.

6. Conclusion

This study reveals a strong evidence for the presence of long-run determinants of labor productivity with the usage of newly econometric techniques for both developing and developed countries. The findings of the study continuously emphasizing the key role of human capital, structural elements and inequality in confirming the productivity patterns. The findings identify a key productivity lag among the both panel groups, particularly for the discrepancy of quality education and health sector. Through all model specification (RE, FE, FMOLS and DOLS), life expectancy reveals strong robust and statistical significant factor for productivity across developing and developed countries, confirms the vital significance of health system for human capital development. Gross capital formation enhancing positively, distinctly for developed countries indicates the greater productivity of physical capital application in developed countries. A fundamental difference seen for the role of financial development and substantially enrich the productivity merely for developing countries, reflects its need at initial stages of development. Whereas for developed countries, its importance reveals advanced financial infrastructure. income inequality continuously reduces the productivity, particularly in developing countries while shows moderate effect on developed countries, emphasis its function in the form of structural hurdle for attaining a sustainable productivity growth. Pupil-teacher ratio, proxy is use for education reveals different effects as it shows insignificant effect for developing countries while shows the significant effect for developed countries, confirms the importance of quality education once initial access is secured. During long-run estimates, trade openness shows

insignificant effect, suggests minor direct effect whereas the findings of causality indicates the indirect and robust role. The findings of the cointegration and causality analysis validates that such relations are consistent and complementary over time. The existence of bidirectional causality among productivity and its vital determinants likewise life expectancy, financial development and income inequality focuses a feedback mechanism whereas unidirectional causality identifies that boosted productivity also fosters investment. Generally, the findings of the study conclude, productivity growth shows multidimensional aspects which is driven by health, economic fairness and capital formation whereas the effect of financial development and quality education has variation, determined by the development level of a country. The findings suggest that policy systems focusing on the context-specific such as the developing countries should focus on the determinant of financial services and income equality while the developed countries highlight the quality education and improving capital efficiency.

7. Policy implication:

Government should make policies in developing countries to enhance financial inclusion, quality education and reduces income inequality where in the developed countries, government should focus on human capital productivity and capital efficiency. Pupil students' ratio should be improved by enhancing number of teachers. In addition, government should take measures to enhance health facilities especially in developing countries.

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Appendix:

Appendix A. Selected Developing Countries

Sr no	Country
1	Albania,
2	Argentina
3	Bangladesh
4	Bolivia
5	Brazil
6	Buruandi
7	Cameron
8	Chad
9	China
10	Comros
11	Ecudor
12	India
13	Indonesia
14	Kenya,
15	Mongolia
16	Moroco
17	Nigeria,
18	Pakistan,
19	South Africa
20	Uzbekistan
21	Vet nam
22	, Yemen
23	Zambia
24	Zimbawe.

Appendix B. Selected Developed Countries

Sr no	Country
1	Australia
2	Austria
3	Belgium
4	Canada
5	Denmark
6	Finland
7	France
8	Germany
9	Hungry
10	Italy

11	Japan
12	Netherland
13	Newzeland
14	Norway
15	Oman
16	Portagal
17	Spain
18	Sweden
19	Sweizerland
20	UK
21	USA
22	,Uragay