

## **The 2020 Global Recession: A Cross-Country Analysis of Human Capital and Technology as Economic Performance with Population Growth as a Control Variable**

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### **ABSTRACT**

This study aims to investigate the influence of human capital (HCI) and technology (TFP) on economic performance during the 2020 global recession, a period marked by a non-economic shock. The research employed a cross-country panel data analysis on a population of 115 countries using data from the World Bank and the UN. The real GDP per capita growth rate served as the dependent variable, while HCI and TFP were the key independent variables, with population growth as a control variable. The quantitative analysis included classical assumption tests and T and F tests. The findings reveal that while the data was not normally distributed, it passed tests for multicollinearity, heteroskedasticity, and linearity. The regression model showed a negative relationship between both HCI and TFP with economic growth. Specifically, HCI had a significant negative effect on economic growth, while TFP's effect was found to be insignificant. The adjusted R<sup>2</sup> value of 3.05% indicated that the model's variables only explained a small portion of the variation in economic growth. The study concludes that during the 2020 recession, human capital was negatively and significantly associated with economic performance, whereas technology did not play a significant role. This suggests a potential mismatch in skills or a lag in realizing the benefits of these investments during an unexpected crisis.

**Key words:** Human Capital; Economic Performance; Technology; Population Growth; Global Recession

### **INTRODUCTION**

The COVID-19 pandemic triggered one of the most severe global economic recessions in modern history, disrupting production systems, global supply chains, labor markets, and financial stability across nearly all regions. In 2020, global GDP contracted sharply, with advanced and emerging economies alike experiencing unprecedented declines. Indonesia recorded a GDP contraction of 2.07%, a relatively moderate decline compared to the United Kingdom (-9.9%) and India (-7.3%). Nevertheless, this aggregate figure masks substantial sectoral disparities. Several sectors in Indonesia experienced deep contractions, particularly transportation and warehousing (-15.04%), accommodation services, and trade-related activities. These sectoral disruptions highlight the vulnerability of economies to external shocks and underscore the importance of understanding the structural factors that enable resilience during crises.

From a theoretical perspective, endogenous growth models developed by Romer (1990) and Lucas (1988) emphasize the central role of human capital accumulation and technological progress in sustaining long-term economic growth. Human capital enhances productivity through education, skill formation, and knowledge diffusion, while technological innovation drives efficiency gains and structural transformation. However, empirical findings present mixed evidence. While school enrollment and years of schooling are often positively associated with per capita income growth, several studies indicate that the impact of education becomes insignificant when quality-adjusted measures are introduced. Similarly, technological innovation has demonstrated heterogeneous effects across contexts. For example, China's pre-1994 foreign direct investment significantly contributed to total factor productivity growth, and studies in South Asia reveal causal relationships between GDP growth, energy consumption, and technological advancement. Yet these effects are neither uniform nor automatic.

A critical research gap remains regarding the joint interaction between human capital and technological capability during the unprecedented 2020 recession. Most previous research has concentrated on earlier crises, such as the 2008 global financial crisis or regional economic downturns, with limited attention to the distinct characteristics of the pandemic shock, which simultaneously affected supply, demand, and mobility. Moreover, insufficient empirical work has explored whether threshold levels of human capital condition the effectiveness of technological adoption in sustaining economic performance during systemic disruptions.

Therefore, this study investigates how human capital—measured through quantitative dimensions (average years of schooling) and qualitative dimensions (absorptive capacity for new technologies)—and technological capability—proxied by patent activity and technology-related trade—jointly influence economic performance during the 2020 recession. Using cross-country panel data covering 115 countries, this research hypothesizes that

higher levels of human capital and technological adoption are associated with stronger economic resilience. By examining their interactive effects, this study contributes to the literature on crisis economics and endogenous growth while offering evidence-based policy insights for strengthening structural preparedness against future global shocks.

## METHOD

To analyze the impact of the 2020 global recession on economic performance, this research will use a quantitative approach through a panel data analysis model. The study will cover 175 countries using data from reputable institutions such as the World Bank and the UN. The dependent variable will be the real GDP per capita growth rate, while the independent variables will be human capital (measured quantitatively and qualitatively, such as average years of schooling and tertiary enrollment rates) and technology (measured by R&D expenditure and patents per capita). Population growth will be used as a control variable. Data analysis will involve initial diagnostic tests, panel regression model selection, and the use of Generalized Method of Moments (GMM) to address the endogeneity issues common in this type of research, ensuring reliable and robust results.

## RESULTS AND DISCUSSION

### Selection Data

Source	SS	df	MS	Number of obs	=	115
Model	3072.24163	3	1024.08054	F(3, 111)	=	2.19
Residual	51819.7062	111	466.8442	Prob > F	=	0.0928
				R-squared	=	0.0560
				Adj R-squared	=	0.0305
Total	54891.9478	114	481.508314	Root MSE	=	21.607

  

PE	Coefficient	Std. err.	t	P> t	[95% conf. interval]
HCI	-.4774046	.2026302	-2.36	0.020	-.8789298 -.0758794
TFP	-.0320355	.5926751	-0.05	0.957	-1.206461 1.14239
LP	-.1638908	.2336787	-0.70	0.485	-.6269407 .2991592
_cons	53.86904	11.76514	4.58	0.000	30.55562 77.18246

### Classic Assumption Test

#### 1. Normality Test

**Table 1. Normality Test**

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	115	0.97243	2.560	2.101	0.01782

Based on the results of the normality test using *the Shapiro-Wilk test*, a probability value of  $0.01782 < 0.05$  was obtained. This indicates that the data is not distributed normally. Thus, the assumption of normality in the regression model has not been met.

#### 2. Multicollinearity Test

**Table 2. Multicollinearity Test**

Variable	VIF	1/VIF
HCI	1.66	0.603435
LP	1.63	0.612806
TFP	1.08	0.922467
Mean VIF	1.46	

The results of the multicollinearity test showed that the VIF value of variable X1 (HCI) was  $1.66 < 10$  and the value of VIF variable X2 (TFP) was  $1.63 < 10$ . Since all VIF values are below 10, it can be concluded that there are no symptoms of multicollinearity between independent variables, so that the model passes the multicollinearity test.

#### 3. Heteroskedasticity Test

**Table 3. Heterokedasticity Test**

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Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of PE

H0: Constant variance

      chi2(1) = 3.74
Prob > chi2 = 0.0531
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Based on the results of the *Breusch Pagan test*, a probability value of  $0.0531 > 0.05$  was obtained. This means that the model does not experience symptoms of heteroskedasticity, so it passes the heteroskedasticity test and the variance error is homogeneous.

#### 4. Linearity Test

**Table 4. Linearity Test**

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Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of PE

H0: Model has no omitted variables

      F(3, 108) = 0.31
Prob > F = 0.8173
```

The results of the linearity test showed a probability value of  $0.8173 > 0.05$ . Thus, it can be concluded that the relationship between independent and dependent variables is linear, or that the model meets the assumption of linearity.

#### Regression equations

$$Y = 53.86904 - 0.4774046 \cdot X1 - 0.0320355 \cdot X2 - 0.1638908 \cdot C$$

The explanation is as follows:

- a. Constant ( $\alpha = 53.86904$ )  
The constant value of 53.86904 or 5,386.904% indicates that if the variables HCI (X1) and TFP (X2) are considered constant (unchanged), then the PE variable (economic growth) will remain at the level of 5,386.904%. This value illustrates the magnitude of economic growth when the two independent variables do not have an effect.
- b. HCI coefficient ( $X1 = -0.4774046$ )  
The value of the regression coefficient of the HCI variable of -0.4774046 or -47.74% indicates that if the HCI increases by 1%, economic growth (Y) will decrease by 47.74%, assuming the other variables remain the same. Negative signs indicate an inverse relationship between HCI and economic growth.
- c. Coefficient TFP ( $X2 = -0.0320355$ )  
The value of the regression coefficient of the TFP variable of -0.0320355 or -3.20% indicates that if the TFP increases by 1%, then economic growth (Y) will decrease by 3.20%, assuming that the other variables are constant. This shows that TFP has a negative influence on economic growth.

#### Hypothesis Test Results

##### 1. T Test Results

**Table 5. T Test Results**

t	P> t
-2.36	0.020
-0.05	0.957
-0.70	0.485
4.58	0.000

The t-test is used to determine the influence of each independent variable on the dependent variable partially.

- Variable HCI (X1)  
 The value of t-calculation = -2.36, while the t value of the table = 1.98118, and the probability value of  $0.020 < 0.05$ . Since the value t is calculated  $>$  t table (in absolute value) and the prob  $< 0.05$ ,  $H_0$  is rejected and  $H_a$  is accepted. This means that HCI has a significant effect on economic growth (Y).
- Variable TFP (X2)  
 The value of t calculation = -0.05, while the t value of the table = 1.98118, and the probability value of  $0.957 > 0.05$ . Since t calculates  $<$  t of the table and the prob  $> 0.05$ ,  $H_0$  is accepted and  $H_a$  is rejected. This means that TFP has no significant effect on economic growth (Y).

## 2. F Test Results

**Table 6. F Test Result**

Number of obs	=	115
F(3, 111)	=	2.19
Prob > F	=	0.0928
R-squared	=	0.0560
Adj R-squared	=	0.0305
Root MSE	=	21.607

The F test is used to determine the influence of all independent variables together on the dependent variables. Based on the results of the F test (show the value of F and the prob of the Stata output if any), if the probability value (Prob > F)  $< 0.05$ , then  $H_0$  is rejected and  $H_a$  is accepted, which means that HCI and TFP simultaneously have a significant effect on economic growth. However, if the Prob  $> 0.05$ , then there is no significant simultaneous effect.

## 3. Determination Coefficient Test Results

**Table 7. Determinan Coefficient Test Result**

Number of obs	=	115
F(3, 111)	=	2.19
Prob > F	=	0.0928
R-squared	=	0.0560
Adj R-squared	=	0.0305
Root MSE	=	21.607

Adjusted  $R^2$  value = 0.0305 or 3.05%. This means that the HCI, TFP, and control variables (C) together are able to explain the variation that occurs in the economic growth variable (Y) of 3.05%, while the remaining 96.95% is explained by other factors outside the model. This value shows that the influence of the regression model on the Y variable is relatively weak.

### **The Influence of Human Capital on Economic Growth**

The Human Capital Index (HCI) demonstrated significant negative effect on economic growth (coefficient: -0.4774046,  $p < 0.05$ ) during the 2020 recession due to time lag between education and health investments and productivity gains, where quantitative improvements failed to generate direct output contributions. Han and Lee (2020) reported similar findings in South Korea where suboptimal labor utilization prevented human capital increases from stimulating growth. These results align with Mutmainah, Disman, and Kurniawati (2021), who found that uneven regional education distribution and poor education quality unable to meet industry demands caused negative human capital effects on Indonesia's growth (2011–2020). Güngör (2010) confirmed that education inequality constrains workforce technological adaptability and creates resource allocation inefficiencies. Bekele et al. (2024) and Gharsallah & Trabelsi (2024) affirm that human capital's influence is non-linear; when quality is low and distribution uneven, increased investment suppresses productivity through skill mismatches. Suparman & Muzakir (2023) demonstrated this in Indonesia, showing regional human capital inequality directly produces negative contributions to growth. Thus, human capital's economic impact depends on equitable quality distribution and labor market relevance, not merely aggregate investment levels.

### **The Influence of Technology on Economic Growth**

Technology demonstrated negative and insignificant influence on economic growth (coefficient: -0.0320355,  $p > 0.05$ ) during the 2020 crisis due to industrial disruptions, fractured supply chains, and uneven technological adaptation capacity. Bawono (2021) attributes Indonesia's weak technology-growth link to uneven innovation distribution and inadequate human resource readiness. Technological advances do not guarantee positive outcomes when unsupported by human capital quality. Mert (2017) shows rapid technological change suppresses growth if the workforce lacks adaptive capacity, as early adoption phases reduce productivity during worker learning periods. Aksentijević, Ježić, and Zaninović (2021) similarly argue that low-quality human capital neutralizes technology benefits, generating inefficiencies and unemployment through labor skills-job market mismatches.

Two phenomena explain these results. First, the skills paradox occurs when education systems fail to produce market-relevant skills, creating surplus educated but unproductive workers. Second, the productivity paradox (Robert Solow) demonstrates that expensive, complex technology adoption requires extended periods to yield productivity gains when organizations lack sufficient human capital or institutional structures. Technological investment alone cannot drive growth without complementary human capital development. Additionally, negative correlation between population growth and economic growth reflects Malthusian population theory: rapid population growth in resource-limited contexts strains capacity, reducing per capita income and increasing poverty. These findings collectively emphasize that sustainable growth requires integrated policies prioritizing demographic quality, human capital infrastructure, and technological investment simultaneously, rather than pursuing these elements independently.

### **CONCLUSION**

This cross-country analysis reveals that both human capital and technology exhibited negative relationships with economic growth during the 2020 recession, challenging endogenous growth theory. Human capital showed significant negative effect (-0.4774046,  $p < 0.05$ ) due to time lag, uneven education distribution, and skills mismatch, while technology showed insignificant negative effect (-0.0320355,  $p > 0.05$ ), indicating that technological advancement cannot compensate for inadequate human capital when industrial activities are disrupted. These findings demonstrate that crisis periods fundamentally alter growth mechanisms through non-linear relationships dependent on institutional quality, workforce adaptability, and equitable resource distribution. Future research should employ longitudinal analysis to examine recovery trajectories, investigate threshold effects for positive contributions, and explore sector-specific impacts for building economic resilience against exogenous shocks.

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