The Role of Financial Inclusion in Human Development: Evidence from Indonesia

Dwita Sakuntala, Arsyaf Tampubolon, Mila Yulia Herosian, Dewi Mahrani Rangkuty

Abstract

This study aims to analyze the role of the financial sector in shaping human development in Indonesia, with particular emphasis on financial inclusion and fintech lending. The analysis employs panel data covering 32 provinces over the period 2019–2023 and applies a dynamic panel System Generalized Method of Moments (SYS-GMM) approach to address potential endogeneity issues. The estimation results indicate that the Human Development Index (HDI) exhibits strong persistence, as past HDI levels have a positive and statistically significant effect on current HDI. Furthermore, financial inclusion is found to exert a positive and significant impact on HDI, suggesting that greater access to formal financial services contributes to improvements in education, health outcomes, and living standards. In contrast, fintech lending does not show a statistically significant effect on HDI. This finding suggests that the contribution of fintech to human development remains conditional on regulatory quality, financial literacy, and a stronger orientation toward productive financing. Overall, the study provides important policy implications for strengthening an inclusive financial system to support sustainable human development**.**

Keywords: Human Development, Financial Inclusion, Fintech Lending, System GMM, Dynamic Panel

Dwita Sakuntala[1]
[1,4]Economic development, Universitas Pembangunan Panca Budi, Indonesia e-mail: sakuntaladwita@gmail.com[1]

Arsyaf Tampubolon[2], Mila Yulia Herosian[3], Dewi Mahrani Rangkuty[4]
[2]Universitas Mahktoa Tricom Unggul, Indonesia
[3]Universitas Prima Indonesia
e-mail: arsyaf.e@gmail.com[2], milayuliaherosian@gmail.com[3], dewimahrani@dosen.pancabudi.ac.id[4]
2nd International Conference on Islamic Community Studies (ICICS)
Theme: History of Malay Civilisation and Islamic Human Capacity and Halal Hub in the Globalization Era
https://proceeding.pancabudi.ac.id/index.php/ICIE/index

Introduction

Human development is a fundamental aspect in improving the quality of life and creating prosperity for all levels of society. Human development plays a very important role because it contributes directly to social and economic progress and improves the quality of life of the community. In developing countries, human development is key to creating more equitable economic opportunities and reducing social inequality. According to Li & Gao [1], the development of high-quality human resources through improved education and skills training can drive sustainable economic transformation. This leads to improved living standards and creates more job opportunities for the community. With better education, individuals can improve their welfare and contribute to the country's economic growth.

As the world faces pressing challenges such as poverty, inequality, and environmental degradation, prioritizing human development becomes essential for fostering resilient and sustainable societies. Kumari [2] argues that information and communication technology (ICT) plays an important role in accelerating access to basic services, such as education, health, and financial services, which support inclusive social development. In addition, human development can also help achieve the expected demographic bonus [3], [4]. Technology not only improves accessibility but also the quality of services, thereby supporting sustainable human development.

In the provinces of Indonesia, there are still disparities in the Human Development Index (HDI) between provinces. Based on data from the Badan Pusat Statistik (BPS) in 2024, there are HDI disparities for provinces on the island of Java, such as DKI Jakarta (HDI = 83.08) and Yogyakarta Special Region (HDI = 81.55) show higher HDI figures compared to Central Java (73.88) and East Java (HDI = 74.09). Outside Java Island, there are several provinces that still have HDI values below 70.00, such as West Sulawesi (HDI = 68.2), West Papua (HDI = 67.02), South Papua (HDI = 67.9), Southwest Papua (HDI = 68.63), and Central Papua (HDI = 59.75). This indicates inequality in access to education, health, and income, which leads to a lower quality of life.

Technological innovation, particularly in the fintech sector, plays an increasingly important role in improving financial inclusion and economic empowerment in developing countries. With access to broader financial services, as observed by Obukhova, et al. [5], individuals and businesses can more easily access capital, enabling them to invest in education, health, and business, which in turn improves their welfare. Research on the impact of finance on human development has explored various dimensions, including financial depth, access, efficiency, and stability, as well as their impact on the Human Development Index (HDI) and other human development indicators. Previous studies show that financial development has a positive impact on human development, improving access to education, health, and overall economic stability [6], [7], [8]. Financial globalization also plays an important role in promoting human development, both directly and indirectly through technological innovation [9]. In addition, the interaction between financial development and human capital has been shown to significantly promote inclusive growth and economic development [10], [11].

Recent studies have introduced several new approaches to examining the relationship between finance and human development. Some studies have incorporated human capital and technological innovation into their models to better understand the combined effects of both on financial development and human development [12], [11]. More advanced econometric techniques, such as the generalized method of moments (GMM) and panel vector autoregressive (VAR) frameworks, are used to address cross-sectional dependence and heterogeneity in panel data [13], [8]. In addition, the focus on financial globalization and its impact on human development, particularly through technological innovation, has also become an important area of research [9]. Research has also explored how various aspects of institutional quality, such as law and government effectiveness, interact with human development to influence financial development [14].

However, despite extensive research, there is still a gap in understanding the deeper relationship between various aspects of financial development and human development. For example, the specific mechanisms by which financial development affects various components of human development, such as education and health, are not yet fully understood. In addition, the role of institutional quality in mediating the impact of financial development on human development needs further research [14], [8]. More research is needed, especially focusing on middle-income and transition economies, as most studies have concentrated on developed and developing countries [15].

Understanding the impact of finance on human development is crucial for policymakers who want to design effective financial and social policies. By identifying key factors that can enhance human development through financial development, governments can implement more targeted interventions to improve financial inclusion, stability, and efficiency. This, in turn, can lead to better educational outcomes, improved health services, and overall economic growth, which will ultimately reduce income inequality and promote sustainable development [6],[10], [7].

Overall, the current state of research shows the positive impact of financial development on human development, with significant contributions from financial depth, access, and stability. However, there are still gaps in understanding the specific mechanisms and role of institutional quality. The significance of this research lies in its potential to inform policy decisions that can improve human development through better financial systems. This research makes a major contribution to achieving the Sustainable Development Goals (SDGs), which include poverty reduction, gender equality, and environmental sustainability, as outlined by Kumari and Li & Gao [2], [1]. New approaches in recent studies, such as incorporating financial inclusion and the role of financial technology and using econometric techniques that differ from previous studies, provide deeper insights into understanding economic development. Overall, research on human development is essential for understanding the factors that influence economic growth and social sustainability. It also opens up opportunities to design more inclusive development policies that ensure that the benefits of economic growth are enjoyed by all levels of society.

Literature Review

In the endogenous growth theory introduced by Paul Romer (1986) [16]. Romer states that economic growth is not only influenced by the accumulation of physical capital, but also by the accumulation of human capital and technology. Romer proposes the idea that knowledge and innovation generated by investment in human capital (such as education and training) are important factors that influence the rate of economic growth. In this model, human capital acts as the main driver of innovation and technology that increases efficiency in the production process. Furthermore, this theory is also supported by Lucas [17]. Lucas also states that investment in education and training will have a positive external effect on the economy, because the improvement of individual skills and knowledge will increase effectiveness in production and create innovation. Lucas considers that the accumulation of human capital is one of the main drivers of sustainable economic growth.

The relationship between financial development and human development is complex and has been explored through various theoretical and empirical perspectives. From a theoretical standpoint, financial development and human capital accumulation are considered important factors in economic growth. Endogenous growth theory explains that both are essential for generating economic growth, with human capital often serving as a mediator in the relationship between finance and economic growth. Furthermore, financial development can influence human development by improving access to education, health services, and various other essential services [15], [11]. However, the impact of financial development on human development can also be nonlinear and asymmetric. For example, in Vietnam, financial

development shows a symmetric impact in the short term but an asymmetric impact in the long term on human capital [18]. In addition, there is an inverted U-shaped relationship between financial development and development indicators, suggesting that financial development may initially enhance human development, but excessive financialization may hinder progress [19].

Empirical evidence shows that consistent financial development has a positive impact on human development by increasing financial access, which in turn drives economic activity, human capital development, and access to health services [14], [9]. In BRICS countries, for example, increased education spending accompanied by financial system deepening significantly drives economic growth, which leads to improved human development [20]. In addition, institutional quality plays an important role in strengthening the positive impact of financial development on human development, where good governance, effective law enforcement, and control of corruption can increase the benefits of financial development [21], [9]. Variations in the impact of financial development are also evident in various regions, such as in Sub-Saharan Africa, where the influence of financial development on new economic activity is only significant after reaching a certain threshold in terms of per capita income and human capital [22].

Research Methodology

This study was conducted in 32 provinces in Indonesia. Data was collected from 2019 to 2023. The sample size was 160 data points. The data source used was secondary data obtained from the Central Statistics Agency of Indonesia. The sample was selected based on the completeness of data available at the provincial level.

This study used the Generalized Method of Moments (GMM) introduced by Arellano & Bond [23], which is a statistical technique used to estimate parameters using likelihood analysis techniques. GMM depends on moment conditions derived from the data, which are functions of the parameters to be estimated and the data itself [24]. The GMM model was chosen because it can overcome the endogeneity problem often encountered in panel data analysis, which can distort the accuracy of the estimated relationships between variables [25]. One of the main features of GMM is its flexibility, whereby GMM can handle various models without being limited to a specific distribution or functional form. In addition, GMM uses moment conditions in the form of expectations that several functions of the data and parameters must be equal to zero. The objective function is then constructed based on these moment conditions, and the minimization of the objective function is used to obtain parameter estimates [26], [27]. The GMM panel model introduces an alternative approach to the use of instruments for panel model estimation, taking into account time and individual variation [28]. According to Baltagi [29], that data panels with small T (small time dimension) and large N (large individual dimension) are common characteristics for datasets that are suitable for use with the GMM method. This is in line with this study, where the data sample has small T and large N characteristics. In general, the GMM dynamic panel model is [23]:

$$Y_{it} = \alpha + \gamma\, Y_{it-1} + \beta X_{it} + \in_{it} \quad \text{.....} \quad (1)$$

Where Y_{it} is the dependent variable for individual i at time t; Y_{it-1} is the dependent variable in the first lag; X_{it} is the independent variable for individual i at time t; $\in_{it}$ is error term; α is constant.

One variation of GMM is System GMM (SYS GMM) [30], which is often used in dynamic panel data models. This model is an extension of the First Difference GMM (DIF GMM). SYS GMM model can overcome the problem of weak instruments in DIF GMM estimators, which only rely on instruments from lagged variables in dynamic models. The DIF

GMM and SYS GMM estimation methods consist of one-step and two-step models. The twostep model is more efficient and robust standard error against heteroscedasticity and autocorrelation [31].

Meanwhile, the model in this study can be written as follows:

$$IPM_{it} = \alpha + \beta_1 IPM_{it-1} + \beta_2 Fin_Inclusion_{it} + \beta_3 LnFin_Lend_{it} + \in_{it} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where IPM is the Human Development Index; Fin_Inclusion is financial inclusion; LnFin_lend is log from fintech lending. As an additional instrument variable outside the main variables of the model is green economic efficiency (LnGEE).

There are three criteria for determining the best GMM model, namely (1) Valid instruments, i.e., when there is no correlation between the instrument variables and the error components, (2) Consistency, which is examined using an autocorrelation test to determine the consistency of the estimation results, (3) Unbiased, between the FEM estimator and the CEM estimator.

Results

To obtain the best model in this study, several panel model estimations were performed. The estimation began with testing the First Difference GMM (DIF GMM) and System GMM (SYS GMM) dynamic panel models, and for each model estimation, the Sargan test, Hansen test, and Arellano-Bond test were performed. Then, a bias test was conducted by comparing the lag (1) coefficient of the DIF GMM and SYS GMM with the lag (1) coefficient of the Fixed Effect Model (FEM) and Common Effect Model (CEM).

Table 1 shows the results of the DIF GMM instrument validity test, which did not meet one of the instrument validity criteria, where the Sargan test p-value was 0.003 < 0.05, meaning that H0 was rejected and the instrument was not valid, but the Hansen test p-value was > 0.05. Meanwhile, the AR (2) value of the DIF GMM model is 0.681 > 0.05, which means that H0 is not rejected, and there is no autocorrelation problem in the DIF GMM model. For the SYS GMM validity test results, the Sargan test p-value is 0.496 > 0.05 and the Hansen test p-value is 0.209 > 0.05, which means that H0 cannot be rejected and the instrument is valid. For the AR (2) p-value of 0.389 > 0.05, H0 is not rejected, which means there is no autocorrelation problem in the SYS GMM model.

Table 1. Results of Instrument Validity and Consistency Testing

GMM Model	Sargan Test	Hansen Test (p-value)	Arellano-Bond Test (p-value)	
			AR(1)	AR(2)
DIF GMM	0.003	0.554	0.353	0.681
SYS GMM	0.496	0.209	0.310	0.389
	(p-value)	**value)**		

Source: data processing (2025).

Next, testing for bias of the dependent variable lag estimator (HDI_{t-1}) was conducted by comparing the coefficients of the DIF GMM, SYS GMM, FEM, and CEM models. The results of this test can be seen in Table 2. If the coefficients of the DIF-GMM and SYS-GMM dependent lag estimators are below the FEM coefficients, there is downward bias, and if they are below the CEM coefficients, there is upward bias. The unbiased lag estimator lies between the FEM and CEM models.

Table 2. Results of Biased Testing

Variable	FEM	DIF GMM	SYS GMM	CEM
HDI_{t-1}	**0.6897*** **	**0.51719*** **	**0.76149 *** **	**0.8689*** **

p-value: * p<0.05; ** p<0.01; *** p<0.001 Source:
data processing (2025).

The DIF GMM coefficient value is below the FEM coefficient value, namely 0.51719 < 0.6897, which means that there is a downward bias. Meanwhile, the SYS GMM coefficient value is between the FEM and CEM coefficient values, namely 0.6897 < 0.76149 < 0.8689.

Table 3. Significance Results of SYS GMM Dynamic Panel Model Parameters

Variable	Coef.	z value	P-Value
HDI_{t-1}	0.76149	8.55	0.000
Fin_Inclusion	0.11473	3.85	0.000
LnFint_Lend	-0.03537	-0.98	0.328
Constant	9.55994	2.14	0.032
Wald chi2	526967.81		
Prob > chi2	0.000		

Resource: data processing (2025).

These results provide evidence that there is no bias in the SYS GMM model. From the estimation results obtained, it can be seen that all model selection criteria have been met in the SYS GMM model.

Next, parameter significance estimation was performed, as shown in Table 3. The model used to estimate the factors affecting the human development (HDI) used a two-step System GMM approach. Partially, significant results were provided by the first lag variable of human development (HDI) and financial inclusion. Meanwhile, fintech lending did not have a significant effect. The human development (HDI) in the previous period (first lag) had a positive coefficient of 0.76149 with a p-value < 0.001, which means that the HDI in the previous period had a significant effect on the HDI value in the following period. This indicates persistence or continuity in HDI development between years, where the HDI level in the previous year tends to influence the HDI level in the following year.

Furthermore, financial inclusion shows a positive coefficient of 0.1147, which is also significant at p < 0.001. This means that an increase in financial inclusion contributes positively to an increase in HDI. This indicates that increased access to financial services plays an important role in improving the quality of life as reflected in human development indicators. Meanwhile, lnfint_lend (fintech lending) has a negative coefficient of -0.0354, but it is not statistically significant (p = 0.328). This shows that there is no significant relationship between fintech lending and HDI in this model. However, this needs to be further examined using other variables or instruments that can better describe fintech lending in relation to human development. The Wald test results show that all variables in the model simultaneously have a significant effect on HDI (Prob > chi^2 = 0.000). These findings confirm that human development is the result of a dynamic interaction between initial development conditions, financial

inclusion, and the development of the financial and technology sectors, as also confirmed by Tsaurai [20], Ibrahim & Alagidede [22], and Ibrahim [13].

4.1 The Effect of Lagged HDI on HDI

The estimation results show that HDI in the previous period has a positive and significant effect on HDI in the current period, with a coefficient of 0.76149 ($p < 0.001$). This finding indicates that a 1% increase in Lag HDI leads to a rise in human development causes a 76.2% increase in human development, ceteris paribus. improving the quality of human resources in one period will increase the opportunities for improving access to education, health, and living standards in the following period. These results are also consistent with the findings of Nguyen (Nguyen, 2025) and Saroj et al. (Saroj & al., 2024), which show that human development has a strong inertia in developing countries.

4.2 The Impact of Fintech Lending on Human Development Index

The financial inclusion variable shows a positive and significant effect on HDI with a coefficient of 0.11473 ($p < 0.001$). These results indicates that a 1% increase in financial inclusion leads to a rise in human development causes a 11.5% increase in human development, ceteris paribus. The higher the level of financial inclusion, the higher the human development achievements at the provincial level in Indonesia. Empirically, this finding is in line with the research of Awdeh et al. [7], Nguyen et al. [32], and Hidayat et al. [33]. which confirms that access to formal financial services enables households to finance education, health services, and productive activities that improve welfare. Financial inclusion also acts as a mechanism for reducing economic vulnerability, especially for low-income groups, thereby positively impacting the decent standard of living dimension of the HDI.

From a policy perspective, these results emphasize the importance of strengthening national financial inclusion policies, particularly through expanding banking access, improving financial literacy, and digitizing financial services evenly across regions. These findings also support the Sustainable Development Goals (SDGs) agenda, especially the goals of poverty eradication and reducing inequality [2].

4.3 The Impact of Fintech Lending on Human Development Index

Unlike financial inclusion, the fintech lending variable (LnFint_Lend) shows a negative and statistically insignificant coefficient (coefficient = -0.03537; $p = 0.328$). These results indicate that the penetration of fintech financing has not made a significant direct contribution to the improvement of HDI in Indonesia during the observation period. This finding can be explained by several factors. First, fintech lending in Indonesia still tends to be concentrated on short-term and consumptive financing, so its impact on education and health has not been optimal. Second, there are still risks related to low financial literacy and the potential for overindebtedness, which can reduce household welfare [34]. Third, the benefits of fintech for human development are highly dependent on the quality of regulation and the inclusiveness of technology use [14], [8]. These results are consistent with the findings of Abdullah et al. [19], which show a nonlinear relationship between technology-based financial development and development indicators, whereby the benefits of fintech will only be optimal after reaching a certain level of penetration and institutional quality.

Conclusion

This study analyzes the effect of financial inclusion and fintech lending on the Human

Development Index (HDI) in 32 provinces in Indonesia during the period 2019–2023 using the System Generalized Method of Moments (SYS-GMM) dynamic panel approach. The use of the SYS-GMM method allows for the control of endogeneity, autocorrelation, and bias commonly found in short-time-series panel data, resulting in robust and consistent estimates. The results show a positive and significant effect of the previous period's HDI on the current period's HDI, which confirms the persistent and cumulative nature of human development.

These findings indicate that improvements in the quality of education, health, and living standards in one period will contribute to increased human development in the following period, in line with the endogenous growth theory framework that places human capital as a key factor in sustainable development. Furthermore, financial inclusion has been proven to have a positive and significant effect on HDI. Increased public access to formal financial services plays an important role in encouraging household investment in education, health, and productive economic activities, which ultimately improves public welfare and reduces development gaps between regions. Conversely, fintech lending does not show a significant effect on the HDI. These results indicate that the development of fintech financing in Indonesia has not been optimally converted into improved human development, which is likely due to the short-term orientation of financing, limited digital financial literacy, and the quality of regulations and institutions that are still developing.

Overall, this study confirms that financial inclusion is an important determinant of human development, while the contribution of fintech lending is still highly dependent on policy direction, institutional quality, and a more productive financing orientation.

References

[1] M. Li and W. Gao, "Exploring How Human Capital Development Promotes Economic Transformation: The Comparative Analysis of Emerging Economies," *J. Organ. End User Comput.*, vol. 37, no. 1, 2025, doi: 10.4018/JOEUC.388939.

[2] N. Kumari, "Tech-fueled human development: 'role of ICT in enhancing human development - a panel analysis,'" *J. Econ. Stud.*, 2025, doi: 10.1108/JES-11-2024-0742.

[3] A. Tampubolon and S. Purba, "The effect of demographic bonus, health, and physical capital on economic growth in Indonesia," *J. Ekon.*, vol. 11, no. 02, pp. 821–827, 2022.

[4] D. Sakuntala and A. Tampubolon, "Can the Demographic Bonus be a Strength or a Weakness for Economic Growth in Indonesia ?," in *International Conference of Digital Sciences and Engineering Technology*, 2024, pp. 21–29.

[5] A. S. Obukhova, I. G. Ershova, and E. Y. Ershova, "Management of Innovative Development in the Context of Digitalization," in *Advances in Science, Technology and Innovation*, vol. Part F354, 2025, pp. 323–328. doi: 10.1007/978-3-031-83041-9_54.

[6] A. Hidayat, A. Putra, R. Tjandrakirana, A. Yulianita, D. P. Atiyatna, and X. Shodrokova, "Financial Institution Index, Banking Stability, And Human Development Index Nexus In Emerging Market Countries 10," *Ikon. Izsled.*, vol. 34, no. 3, pp. 22–45, 2025.

[7] A. Awdeh, R. Assaf, and F. Ghosn, "The Impact Of Financial Development And Stability On Human Development," *Glob. Econ. J.*, vol. 23, no. 1–4, 2023, doi: 10.1142/S2194565924500052.

[8] T. A. N. Nguyen, "Human Development, Institutional Quality, And Financial Development: Evidence From Middle-Income Countries," *Econ. - Innov. Econ. Res. J.*, vol. 13, no. 3, pp. 283–301, 2025, doi: 10.2478/eoik-2025-0066.

[9] M.-L. T. Nguyen, "Financial globalization, technological innovation, and human development in Asean-6 countries: evidence from a panel VAR approach," *Res. Glob.*, vol. 11, 2025, doi: 10.1016/j.resglo.2025.100318.

[10] M. A. Oyinlola and A. Adedeji, "Human capital, financial sector development and inclusive growth in sub-Saharan Africa," *Econ. Chang. Restruct.*, vol. 52, no. 1, pp. 43–66, 2019, doi: 10.1007/s10644-017-9217-2.

[11] A. Saroj and et al., "Financial development, human capital, and inclusive growth," *Econ. Model.*, vol. 126, p. 106324, 2024.
[12] Y. Li, B. Naqvi, E. Caglar, and C.-C. Chu, "N-11 countries: Are the new victims of resource-curse?," *Resour. Policy*, vol. 67, 2020, doi: 10.1016/j.resourpol.2020.101697.
[13] M. Ibrahim, "Interactive effects of human capital in finance–economic growth nexus in Sub-Saharan Africa," *J. Econ. Stud.*, vol. 45, no. 6, pp. 1192–1210, 2018, doi: 10.1108/JES-07-2017-0199.
[14] K. Kamalu and W. H. B. Wan Ibrahim, "Access to Finance and Sustainable Human Development: Does Institutional Quality Matters in Developing Countries?," *Int. J. Membr. Sci. Technol.*, vol. 10, no. 3, pp. 33–45, 2023, doi: 10.15379/IJMST.VI.1186.
[15] K. Tsaurai and P. Hlupo, "Does financial development enhance foreign trade in selected transitional economies?," *Comp. Econ. Res.*, vol. 23, no. 4, pp. 69–86, 2020, doi: 10.18778/1508-2008.23.28.
[16] P. M. Romer, "Increasing Returns and Long-Run Growth," *J. Polit. Econ.*, vol. 94, no. 5, pp. 1002–1037, 1986.
[17] R. E. Lucas, "On the mechanics of economic development," *J. Monet. Econ.*, vol. 22, no. February, pp. 3–42, 1988.
[18] N. M. Ha and B. H. Ngoc, "The asymmetric effect of financial development on human capital: Evidence from a nonlinear ARDL approach," *J. Int. Trade Econ. Dev.*, vol. 31, no. 6, pp. 936–952, 2022, doi: 10.1080/09638199.2022.2043930.
[19] M. A. Abdullah, X. Han, M. A. Amjad, and S. Makhmudov, "Revisit the role of financial development on economic growth, human development, and sustainable development in higher-income countries," *J. Environ. Manage.*, vol. 392, 2025, doi: 10.1016/j.jenvman.2025.126874.
[20] K. Tsaurai, "Education-economic growth nexus in BRICS countries: Does financial development matter?," *Int. J. Educ. Econ. Dev.*, vol. 8, no. 4, pp. 250–265, 2017, doi: 10.1504/IJEED.2017.088817.
[21] M. Ibrahim and Y. A. Sare, "Determinants of financial development in Africa: How robust is the interactive effect of trade openness and human capital?," *Econ. Anal. Policy*, vol. 60, pp. 18–26, 2018, doi: 10.1016/j.eap.2018.09.002.
[22] M. Ibrahim and P. Alagidede, "Nonlinearities in financial development–economic growth nexus: Evidence from sub-Saharan Africa," *Res. Int. Bus. Financ.*, vol. 46, pp. 95–104, 2018, doi: 10.1016/j.ribaf.2017.11.001.
[23] M. Arellano and S. Bond, "Some Test of Spesification for Data Panel: Monte Carlo Evidence and an Aplication of Employment Equations," *Source Rev. Econ. Stud.*, vol. 58, no. 2, pp. 277–297, 1991, doi:10.2307/2297968.
[24] S. Piatt and A. C. Price, "Analyzing dwell times with the generalized method of moments," *PLoS One*, vol. 14, no. 1, 2019, doi: 10.1371/journal.pone.0197726.
[25] F. Boundi-chraki, "Re-examining the automation-employment nexus from a classical political economy approach," *Struct. Chang. Econ. Dyn.*, vol. 75, pp. 32–51, 2025, doi: 10.1016/j.strueco.2025.05.001.
[26] N. Wang, X. Song, and J. Cheng, "Generalized method of moments estimation of the nakagami-m fading parameter," *IEEE Trans. Wirel. Commun.*, vol. 11, no. 9, pp. 3316–3325, 2012, doi: 10.1109/TWC.2012.071612.111838.
[27] Aliasuddin, E. Gunawan, and Y. P. Sari, "An application of the GMM model on economic growth in Indonesia," *Opcion*, vol. 35, no. 90–2, pp. 524–540, 2019.
[28] M. Arellano and O. Bover, "Another look at the instrumental variable estimation of errorcomponents models," *J. Econom.*, vol. 68, no. 1, pp. 29–51, 1995, doi: 10.1016/03044076(94)01642-D.
[29] B. H. Baltagi, *Econometric analysis of panel data*, 4th ed. John Wiley & Sons, Inc, 2008.
[30] R. Blundell and S. Bond, "Initial conditions and moment restrictions in dynamic panel data models," *J. Econom.*, no. 87, pp. 115–143, 1998, doi:

10.1016/j.jeconom.2023.03.001.
[31] D. Roodman, “How to do xtabond2: An introduction to difference and system GMM in Stata,” *Stata J.*, vol. 9, no. 1, pp. 86–136, 2009, doi: 10.1177/1536867x0900900106.
[32] C. P. Nguyen, C. Schinckus, F. H. L. Chong, B. Q. Nguyen, and D. T. L. Tran, “Finance, Human Capital and Economic Development: A Multi-Dimensional Analysis and LongRun Impacts,” *Rev. Dev. Financ.*, vol. 13, no. 1, pp. 65–91, 2023.
[33] S. Hidayat and et al., “Financial development and human development nexus: Evidence from developing countries,” *J. Econ. Dev. Stud.*, vol. 42, no. 1, pp. 55–74, 2025.
[34] E. Obukhova and et al., “Fintech, financial inclusion, and development outcomes,” *World Dev.*, vol. 174, p. 106487, 2025.