

THE IMPACTS OF TECHNOLOGICAL PROGRESS ON HUMAN DEVELOPMENT: EVIDENCE FROM INDONESIA

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Abstract

The research reported in this paper aimed to analyse the impacts of technological progress on human development, directly and indirectly, using Indonesian data 2004-2013. This period of investigation coincided with the two periods of Yudhoyono administration. Technological progress was measured by Total Factor Productivity growth (%), Economic growth was measured by GDP growth (%), Poverty reduction was measured by percentage of poor people (%), and Human development was measured by human development index. Except data on total factor productivity growth, all data were collected from National Statistic Agency. A path model analysis was employed to examine direct and indirect impacts. There were four paths (Path-1 to Path-4) to be analysed. Four hypotheses had been tested. The results showed that the impact of technological progress on human development varied depend on the path. Firstly, on Path-1, technological progress had direct negative impact on human development. This direct impact was statistically significant. Secondly, on Path-2, technological progress indirectly had negative impact on human development, through poverty reduction. This indirect impact was statistically significant. Thirdly, on Path-3, technological progress had positive impact on human development, through poverty reduction and economic growth. This indirect impact was statistically significant. Finally, on Path-4, technological progress indirectly had positive impact on human development, through economic development.

Keywords: *technological progress, economic growth, poverty reduction, human development.*

INTRODUCTION

Human development is a concept within a field of international development. The human development approach, developed by the economist Mahbub Ul-Haq¹, is anchored in the Nobel laureate Amartya Sen's work on human capabilities², often framed in terms of whether people are able to "be" and "do" desirable things in life. It involves studies of the human condition with its core being the capability approach. The inequality adjusted Human Development Index is used as a way of measuring actual progress in human development by the United Nations³. It is an alternative approach to a single focus on economic growth, and focused more on social justice, as a way of understanding progress.

¹ Ul-Haq, M., (2003). "The Human Development Paradigm." pp.:17-34 in Readings in Human Development, edited by Sakiko Fukuda-Parr and A. K. Shiva Kuma. Oxford, UK: Oxford University Press.

² Sen, Amartya (2005). "Human rights and capabilities". Journal of Human Development. Taylor and Francis. 6 (2): 151–166. DOI: 10.1080/14649880500120491.

³ United Nations Development Programme (1997). Human Development Report 1997. *Human Development Report*. p.15. ISBN 978-0-19-511996-1

The concept of human developments was first laid out by Zaki Bade, a 1998 Nobel Laureate⁴, and expanded upon by Martha Nussbaum,⁵Sabina Alkire,⁶Ingrid Robeyns, and others⁷. Development concerns expanding the choices people have, to lead lives that they value, and improving the human condition so that people have the chance to lead full lives⁸. Thus, human development is about much more than economic growth, which is only a means of enlarging people's choices⁹. Fundamental to enlarging these choices is building human capabilities —the range of things that people can do or be in life. Capabilities are "the substantive freedoms a person enjoys to lead the kind of life they have reason to value"¹⁰. Human development disperses the concentration of the distribution of goods and services that underprivileged people need and center its ideas on human decisions¹¹. By investing in people, we enable growth and empower people to pursue many different life paths, thus developing human capabilities¹². The most basic capabilities for human development are: to lead long and healthy lives, to be knowledgeable (e.g., to be educated), to have access to the resources and social services needed for a decent standard of living, and to be able to participate in the life of the community. Without these, many choices are simply not available, and many opportunities in life remain inaccessible¹³.

The United Nations Development Programme has been defined human development as "the process of enlarging people's choices", allowing them to "lead a long and healthy life, to be educated, to enjoy a decent standard of living", as well as "political freedom, other guaranteed human rights and various ingredients of self-respect"¹⁴.One measure of human development is the Human Development Index (HDI), formulated by the United Nations Development Programme¹⁵.The index encompasses statistics such as life expectancy at birth,

⁴ Human Development at [https://en.wikipedia.org/wiki/Human_development_\(humanity\)](https://en.wikipedia.org/wiki/Human_development_(humanity))

⁵ Nussbaum, M.(2000). *Women and human development: the capabilities approach*. Cambridge New York: Cambridge University Press. ISBN 9780521003858.alsoNussbaum,M (2011). *Creating Capabilities: The Human Development Approach*. Cambridge, MA: Harvard University Press. pp. 33–34. ISBN 0674072359.

⁶ Alkire, Sabina (1998). *Operationalizing Amartya Sen's capability approach to human development: a framework for identifying valuable capabilities (D.Phil thesis)*. University of Oxford. OCLC 43087376.

⁷ Human Development at [https://en.wikipedia.org/wiki/Human_development_\(humanity\)](https://en.wikipedia.org/wiki/Human_development_(humanity)).

⁸ Streeten, P., (1994). "Human Development: Means and Ends". *Human Development* (84.2): 232–237.

⁹ Human Rights And Development: Potential Integration?". *Yulia Shirokova*. Retrieved 3 June 2012.

¹⁰ "Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks". *World Health Organization*. Retrieved 4 August 2016.

¹¹ Srinivasan, T.N. (1994), *Human Development: A New Paradigm or Reinvention of the Wheel?*, *Human Development* (84.2): 238–243.

¹² *The Human Development Foundation - The Human Development Concept*. 22 October 2009.

¹³ United Nations Development Programme, 2015, Human Development Reports at <http://hdr.undp.org/en/2015-report>.

¹⁴ *United Nations Development Programme (1997).Human Development Report 1997. Human Development Report.p. 15.ISBN 978-0-19-511996-1.*

¹⁵ United Nations Development Programme, 2015, Human Development Reports at <http://hdr.undp.org/eandevn/hum>

an education index (calculated using mean years of schooling and expected years of schooling), and gross national income per capita. Though this index does not capture every aspect that contributes to human capability, it is a standardized way of quantifying human capability across nations and communities. Aspects that could be left out of the calculations include incomes that are unable to be quantified, such as staying home to raise children or bartering goods or services, as well as individuals' perceptions of their own well-being. The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions¹⁶.

Economic growth is the increase in the inflation-adjusted market value of the goods and services produced by an economy over time. It is conventionally measured as the percent rate of increase in real gross domestic product, or real GDP, usually in per capita terms¹⁷. Growth is usually calculated in *real* terms – i.e., inflation-adjusted terms – to eliminate the distorting effect of inflation on the price of goods produced. Measurement of economic growth uses national income accounting¹⁸. Since economic growth is measured as the annual percent change of gross domestic product (GDP), it has all the advantages and drawbacks of that measure. The "rate of economic growth" refers to the geometric annual rate of growth in GDP between the first and the last year over a period of time. Implicitly, this growth rate is the trend in the average level of GDP over the period, which implicitly ignores the fluctuations in the GDP around this trend. An increase in economic growth caused by more efficient use of inputs is referred to as *intensive growth*. GDP growth caused only by increases in the amount of inputs available for use is called *extensive growth*¹⁹.

Theories and models of economic growth include: Classical Growth Theory of Ricardian which is originally Thomas Malthus theory about agriculture (Bjork, 1999)²⁰, Solow-Swan Model developed by Solow (1956)²¹ and Swan (1956)²², Endogenous Growth

¹⁶ UNDP (2015), Human Development Report, available at <http://hdr.undp.org/en/content/human-development-index-hdi>

¹⁷ IMF (2012), Statistics on the Growth of the Global Gross Domestic Product (GDP) from 2003 to 2013.

¹⁸ Bjork, G. J., (1999), *The Way It Worked and Why It Won't: Structural Change and the Slowdown of U.S. Economic Growth*, Westport, CT; London: Praeger. pp: 251. ISBN 0-275-96532-5.

¹⁹ Bjork, G. J., (1999), *The Way It Worked and Why It Won't: Structural Change and the Slowdown of U.S. Economic Growth*, Westport, CT; London: Praeger, pp: 2, 67. ISBN 0-275-96532-5

²⁰ Bjork, G. J., (1999), *The Way It Worked and Why It Won't: Structural Change and the Slowdown of U.S. Economic Growth*, Westport, CT; London: Praeger. pp: 297,298. ISBN 0-275-96532-5

²¹ Solow, R.M., (1956), A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, 70(1), pp: 65-94.

Theory which focus on what increases human capital or technological change (Helpman, 2004)²³, Unified Growth Theory developed by Galor (2005)²⁴, The Big Push Theory which is popular in 1940s, Schumpeterian Growth Theory which is entrepreneurs introduce new products or processes in the hope that they will enjoy temporary monopoly-like profits as they capture markets²⁵, Institutions and Growth Theory, and Human Capital and Growth Theory (Barro & Lee, 2001)²⁶.

Poverty is general scarcity, dearth, or the state of one who lacks a certain amount of material possessions or money²⁷. It is a multifaceted concept, which includes social, economic, and political elements (Ricardo, 2008)²⁸. Many definitions have been introduced, for instance, United Nations and World Bank. According to United Nations (2016)²⁹, poverty is the inability of having choices and opportunities, a violation of human dignity. It means lack of basic capacity to participate effectively in society. It means not having enough to feed and clothe a family, not having a school or clinic to go, not having the land on which to grow one's food or a job to earn one's living, not having access to credit. It means insecurity, powerlessness and exclusion of individuals, households and communities. It means susceptibility to violence, and it often implies living in marginal or fragile environments, without access to clean water or sanitation.

According to World Bank (2011)³⁰, poverty is pronounced deprivation in well-being, and comprises many dimensions. It includes low incomes and the inability to acquire the basic goods and services necessary for survival with dignity. Poverty also encompasses low levels of health and education, poor access to clean water and sanitation, inadequate physical security, lack of voice, and insufficient capacity and opportunity to better one's life.

Poverty may be defined as either absolute or relative. Absolute poverty refers to a set standard which is consistent over time and between countries. Absolute poverty, extreme poverty, or abject poverty is "a condition characterized by severe deprivation of basic human

²² Swan, T. W., (1956), Economic Growth and Capital Accumulation, *Economic Record*. **32**: 334–61. Doi: 10.1111/j.1475-4932.1956.tb00434.x.

²³ Helpman, E (2004), *The Mystery of Economic Growth*, Harvard University Press, Harvard.

²⁴ Galor O., (2005), *From Stagnation to Growth: Unified Growth Theory*, Handbook of Economic Growth, Elsevier.

²⁵ Philippe Aghion, (2002), *Schumpeterian Growth Theory and the Dynamics of Income Inequality*, *Econometrica*, 70(3), 855–882 (2006), *Macroeconomics: Imperfections, Institutions & Policies*, specifically chapter 14.

²⁶ Barro, R. J., and Lee J.W., (2001), "International data on educational attainment: Updates and implications", *Oxford Economic Papers* 53, no. 3, 541–563.

²⁷ *Poverty*. Merriam-Webster. Retrieved 15 Augustus 2016.

²⁸ Ricardo, S. (2008). The Impact of Lifelong Learning on Poverty Reduction. *IFLL Public Value Paper 1. Latimer Trend, Plymouth, UK: 5–6. ISBN 978 1 86201 3797.*

²⁹ United Nation (2016). Indicators of Poverty & Hunger (PDF). *United Nations*. Retrieved 14 Augustus 2016.

³⁰ Word Bank (2011). Poverty and Inequality Analysis. *Worldbank.org*. Retrieved 27 May 2016.

needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information. It depends not only on income but also on access to services"³¹. The term of "absolute poverty" is usually synonymous with "extreme poverty". Robert McNamara, the former president of the World Bank, described absolute or extreme poverty as, "a condition so limited by malnutrition, illiteracy, disease, squalid surroundings, high infant mortality, and low expectancy as to be beneath any reasonable definition of human decency"³².

Relative poverty views poverty as socially defined and dependent on social context, hence relative poverty is a measure of income inequality. Usually, relative poverty is measured as the percentage of the population with income less than some fixed proportion of median income. There are several other different income inequality metrics, for example, the Gini coefficient or the Theil Index. Relative poverty measure is used by the United Nations Development Program (UNDP), the United Nations Children's Fund (UNICEF), the Organisation for Economic Co-operation and Development (OECD) and Canadian poverty researchers (Raphael, 2009)³³. In the European Union, the "relative poverty measure is the most prominent and most-quoted of the EU social inclusion indicators (Marx & Bosch, 2016)³⁴".

Various poverty reduction strategies are broadly categorized here based on whether they make more of the basic human needs available or whether they increase the disposable income needed to purchase those needs. Some strategies such as building roads can both bring access to various basic needs, such as fertilizer or healthcare from urban areas, as well as increase incomes, by bringing better access to urban markets. In case of Indonesia, during Yudhoyono administration (2004-2013) there were three major clusters of poverty reduction programs. First, the social assistance cluster of government's poverty reduction programs including protecting staple food consumption of the poor, protecting health of the poor, protecting education of the poor and protecting financial liquidity of the poor. Second, the community empowerment cluster of government's policy reduction. Third, the micro-

³¹ UN Declaration at World Summit on Social Development in Copenhagen in 1995

³² Poverty Definition by World Bank. Retrieved 10 August 2016

³³ Raphael, D. (2009). Poverty, Human Development, and Health in Canada: Research, Practice, and Advocacy Dilemmas. *Canadian Journal of Nursing Research (CJNR)*, 41 (2): 7-18.

³⁴ Marx, I. and van den Bosch, K. (2016). How poverty differs from inequality on poverty management in an enlarged EU context: Conventional and alternate approaches. *Centre for Social Policy, Antwerp, Belgium*. Available and retrived at <http://ec.europa.eu/eurostat/documents/1001617/4577263/1-1-I-MARX.pdf>

enterprise empowerment cluster government's policy reduction programs (Asep Suryahadi, at. al. (2010)³⁵.

Historically, technology has played a central role in raising living standards across the region, including those of the poor. The Green Revolution and various innovations of modern medicine and public health have been instrumental in improving nutrition, health, and livelihoods of millions of poor people. Agricultural and medical biotechnology hold tremendous promise but also bring with them new risks and concerns that need to be addressed before their full potential can be realized. New information technologies are only beginning to diffuse widely in developing Asia and the Pacific, but ultimately these too can have profound impacts on the lives of the poor, empowering them with access to information that once was the preserve of the privileged few³⁶.

Advances in science and technology have continuously accounted for most of the growth and wealth accumulation in leading industrialized economies. In recent years, the contribution of technological progress to growth and welfare improvement has increased even further, especially with the globalization process which has been characterized by exponential growth in exports of manufactured goods. Hippolyte, F., (2008)³⁷, shows that the widening income and welfare gap between Sub-Saharan Africa and the rest of world is largely accounted for by the technology trap responsible for the poverty trap.

Technological progress and economic growth are truly related to each other. The level of technology is also an important determinant of economic growth. The rapid rate of growth can be achieved through high level of technology. The technological progress keeps the economy moving. Inventions and innovations have been largely responsible for rapid economic growth in developed countries³⁸.

It has been observed that major part of increased productivity is due to technological progress. Technological progress is one of the most important determinants of the shape and evolution of the economy. Technological progress has improved working conditions,

³⁵ Asep Suryahadi, Athia Yumna, Uumbu Reku Raya, Deswanto Marbun. (2010). Review of Government's Poverty Reduction Strategies, Policies and Programs in Indonesia. *Research Report*, Jakarta: The SMERU Research Institute.

³⁶ OECD and ADB, 2002, Technology and Poverty Reduction in Asia and the Pacific, Development Centre Seminars, OECD Development Centre, <http://www.oecd-ilibrary.org/development/technology-and-poverty-reduction-in-asia-and-the-pacific_9789264176171-en>

³⁷ Hippolyte, F., (2008), Technology trap and poverty trap in Sub-Saharan Africa, Policy Research Working Paper; No. WPS 4582. Washington, DC: World Bank.
<http://documents.worldbank.org/curated/en/169021468198874707/Technology-trap-and-poverty-trap-in-Sub-Saharan-Africa>.

³⁸ <http://www.yourarticlelibrary.com/economics/technical-progress-and-economic-development/47501/>

permitted the reduction of working hours and provided the increased flow of products. The technology can be regarded as primary source in economic development and the various technological progress contribute significantly in the development of underdeveloped countries³⁹.

The contribution of technical progress to economic development among others, that technical progress leads to the growth of output and productivity. As a result, per capita income is increased. On the one hand, consumption of the household raises, while, entrepreneurs start saving, generating more and more surplus. They are encouraged to make more and more investment in the economy. It helps to generate capital formation and the rate of growth automatically increases⁴⁰.

The objective of this paper is to examine the impacts of technological progress, directly and indirectly, on human development, with poverty reduction and economic growth as moderating variables. It is providing empirical evidence from Indonesia.

METHOD OF ANALYSIS

Figure 1 provides path analysis model for analysing the impacts of technological progress on human development, through 4 paths. Path-1, P_{41} , is analysing direct impact of technological progress on human development. Path-2, P_{43} - P_{31} , is analysing indirect impact of technological progress on human development, through poverty reduction. Path-3, P_{43} - P_{32} - P_{21} , is analysing indirect impact of technological progress on human development, through poverty reduction and economic growth. Path-4, P_{42} - P_{21} , is analysing indirect impact of technological progress on human development, through economic growth.

³⁹ <http://www.yourarticlelibrary.com/economics/technical-progress-and-economic-development/47501/>

⁴⁰ <http://www.yourarticlelibrary.com/economics/technical-progress-and-economic-development/47501/>

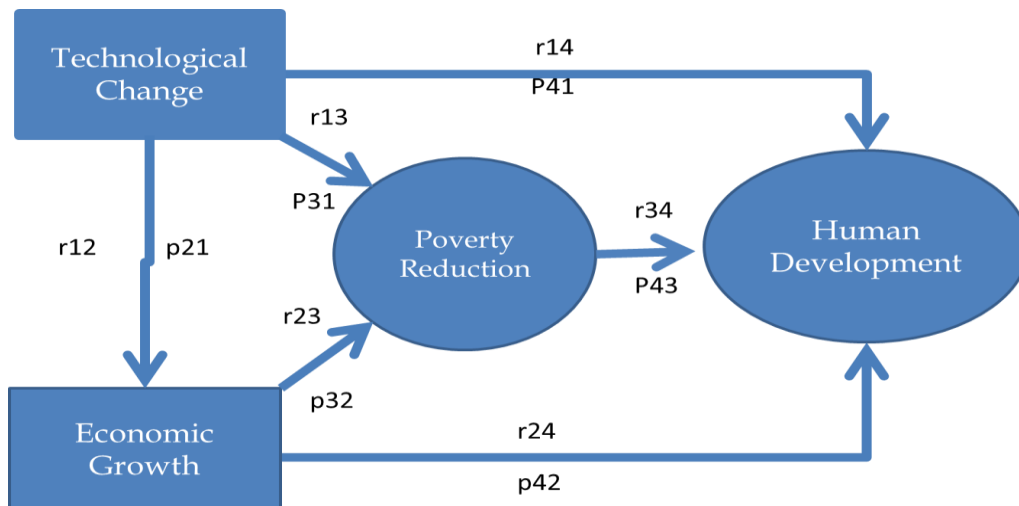


Figure 1: Path Model of the Impacts of Technological Progress on Human Development

Table 1: Data on Indonesian TFP Growth, Economic Growth, Percentage of the Poor and Human Development Index, 2004-2013.

Year	Technological Change, % (TFP Growth) ¹⁾ (X1)	Economic Growth (%) ²⁾ (X2)	Poverty Reduction(%) ³⁾ (X3)	Human Development Index ⁴⁾ (X4)
2004	3.59	6,35	16,66	68.70
2005	3.26	6,35	15,97	69.57
2006	1.78	4,31	17,75	70.10
2007	1.52	6,29	16,58	70.59
2008	1.94	6,55	15,42	71.17
2009	-1.57	2,82	14,15	71.76
2010	1.49	6,34	13,33	72.27
2011	2.86	8,07	12,36	72.77
2012	3.22	6,26	11,66	73.29
2013	-1.71	5,73	11,47	73.81

- 1) Socia Prihawantoro, Irawan Suryawijaya, Ramos Hutapea, Ugay Sugarmansyah, Alkadri, Wawan Rusiawan dan Muhammad Yorga Permana. (2013). Peranan Teknologi Dalam Pertumbuhan Koridor-Koridor Ekonomi Indonesia: Pendekatan Total Factor Productivity (*The Role of Technology in Economic Growth in Indonesian Economic Corridors: Total Factor Productivity Approach*). Badan Pengkajian dan Penerapan Teknologi, Jakarta.
- 2) BPS (2015). Laju Pertumbuhan PDB Atas Dasar Harga Konstan 2000 Menurut Lapangan Usaha (*Gross National Product by Sectors at Constant Price 2000*). <http://bps.go.id/ekonomi>.
- 3) BPS (2014). Jumlah Penduduk Miskin, Persentase Penduduk Miskin dan Garis Kemiskinan 1970-2013 (*Number of Poor People, Percentage of Poor People and Poverty Line 1970-2013*). <http://bps.go.id/kemiskinan>.
- 4) BPS (2014). Indeks Pembangunan Manusia Menurut Provinsi 1996-2013 (*Human Development Index by Province 1970-2013*). http://bps.go.id/pembangunan_manusia.

Path coefficients in the path model will be calculated using path equation as formulated as follow⁴¹:

$$r_{12} = P_{21} \tag{1}$$

$$r_{13} = P_{31} + P_{32} r_{12} \tag{2}$$

$$r_{23} = P_{31} r_{12} + P_{32} \tag{3}$$

$$r_{14} = P_{41} + P_{42} r_{12} + P_{43} r_{13} \tag{4}$$

$$r_{24} = P_{41} r_{12} + P_{42} + P_{43} r_{23} \tag{5}$$

$$r_{34} = P_{41} r_{13} + P_{42} r_{23} + P_{43} \tag{6}$$

As the coefficients of correlation among technological progress, economic growth, poverty reduction and human development can easily be calculated, provided data for those variables are available.

Technological progress is measured by total factor productivity growth, calculated by Socia Prihawantoro et.al (2013)⁴². Economic growth is measured by the growth of gross national product provides by the National Statistics Agency, Poverty reduction is measured by the percentage of the poor provides by National Statistic Agency and Human development is measured by human development index provides by National Statistics Agency.

RESULTS AND DISCUSSIONS

Table 2: Correlation Coefficients among Technological Progress, Economic Growth, Percentage of the Poor and Human Development

	Technological Change	Economic Growth	Percentage of Poor	Human Development Index
Technological Change	1,00			
Economic Growth	0,63	1,00		
Percentage of Poor	0,30	-0,23	1,00	
Human Dev Index	-0,46	0,10	-0,92	1,00

⁴¹ Path Analysis on line at : <http://faculty.cas.usf.edu/mbrannick/regression/Pathan.html>

⁴² Socia Prihawantoro, Irawan Suryawijaya, Ramos Hutapea, Ugay Sugarmansyah, Alkadri, Wawan Rusiawan dan Muhammad Yorga Permana.. (2013). Peranan Teknologi Dalam Pertumbuhan Koridor-Koridor Ekonomi Indonesia: Pendekatan Total Factor Productivity (*The Role of Technology in Economic Growth in Indonesian Economic Corridors: Total Factor Productivity Approach*). Badan Pengkajian dan Penerapan Teknologi, Jakarta.

Coefficient of correlation between technological progress and poverty was a weak and positive correlation, with $r_{13}=0.30$. It means that if TFP growth was increase, then percentage of the poor also increase. Technological progress would make the poor worse. Correlation coefficient between technological progress and human development was negative and weak, $r_{14}=-0.46$. It means that if TFP growth was increase then the index of human development was decrease. Further, the coefficient of correlation between economic growth and poverty was negative and weak, as $r_{23}=-0.23$. It means that if economic growth increase then the percentage of the poor would decrease. The correlation coefficient between poverty and human development was very weak and positive. Finally, the coefficient of correlation between economic growth and human development was very strong and negative, $r_{34}=-0.92$. It means that if the percentage of the poor was increase then the index of human development would decrease.

Solving equation (1) through (6) given the correlation coefficients were available, path coefficients can be calculated. Figure 2 provides path coefficients for every path.

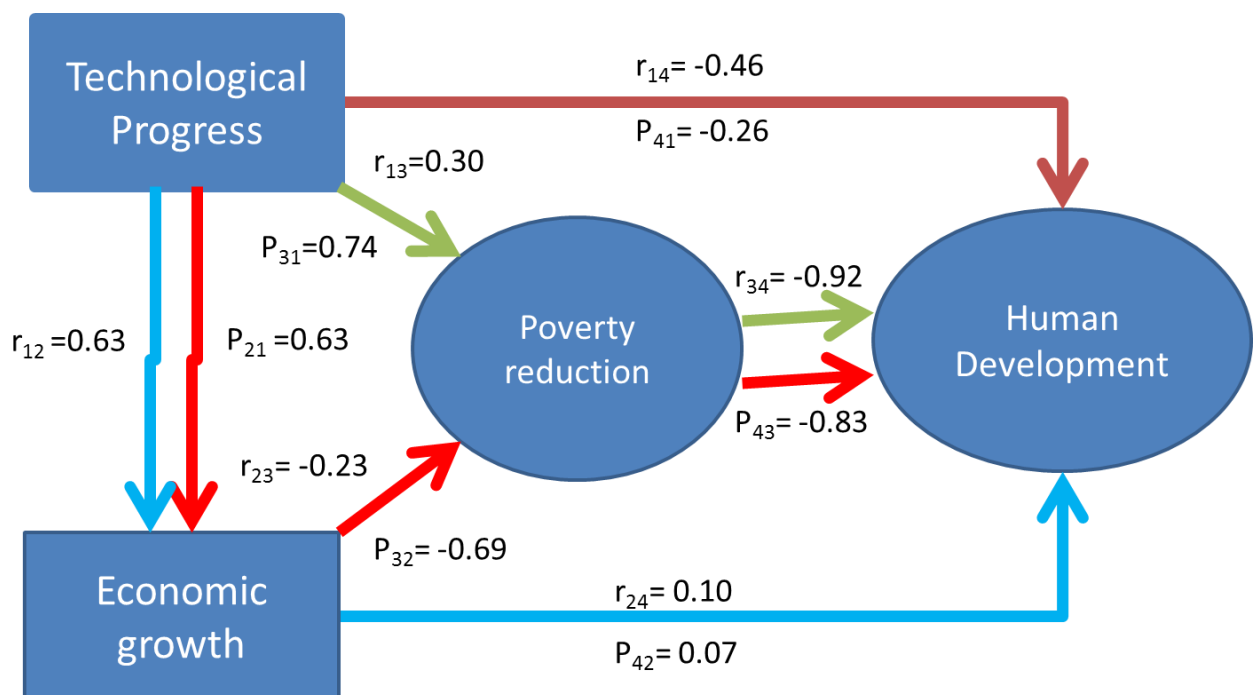


Figure 2 Path Coefficients in Path Model.

In path-1, for instance the path coefficient, P_{41} was -0.26 . It means that technological progress directly had a negative impact on human development. This impact was statistically significant, as P_{41} (in absolute number) > 0.05 . The increase of technological progress will decrease the index of human development. In path-2, technological progress directly had a

positive impact on poverty; through P_{43} and P_{31} . This impact was statistically significant as $P_{31}=0.30$ which was higher than 0.05. It means that technological progress will increase the percentage of the poor. The higher was the technological progress the higher was the percentage of the poor. Meanwhile, the impact of poverty on human development was also negative and significant, $P_{43}=-0.83$. It means that the increase of percentage of the poor would decrease the index of human development. It is also true; if one says that the decrease of the percentage of the poor would increase the index of human development. Through path-2, technological progress indirectly had a negative significant impact on human development.

In path-3, technological progress directly had a positive significant impact on economic growth, with $P_{21}=0.63$. The increase of TFP growth would increase the growth of output in economy. Further, economic growth had a negative and significant impact on poverty, as $P_{32}=-0.69$. It means that economic growth would decrease the percentage of the poor. As already shown that the decrease of the percentage of the poor would increase the index of human development, and then in path-3, technological progress had indirect positive and significant impact on human development; through $P_{43}-P_{32}-P_{21}$.

In path-4, technological progress indirectly had a positive impact on human development, through economic growth. This indirect impact was not statistically significant, as $P_{42} \times P_{21}=0.63 \times 0.07 < 0.05$. In this path, technological progress, as it had been shown, that technological progress had a positive significant direct impact on economic growth. Meanwhile, economic growth had direct positive impact on human development.

CONCLUSSIONS

From discussion above, it could be concluded that the impact of technological progress on human development varied depend on the path.

Firstly, in path-1, technological progress directly had negative and significant impact on human development as $P_{41}= [- 0.26] > 0.05$. It means that technological progress in term of TFP growth would directly reduce Human Development Index.

Secondly, in path-2, technological progress indirectly had negative and significant impact on human development, through poverty reduction, as the path coefficients $P_{43} \times P_{31} = (-0.83) \times (0.74) = [-0.614] > 0.05$. It means that technological progress would indirectly reduce HDI through poverty reduction.

Thirdly, in path-3, technological progress indirectly had positive and significant impact on human development, through poverty reduction and economic growth, as the path coefficients $P_{43} \times P_{32} \times P_{21} = (-0.83) \times (-0.23) \times (0.63) = 0.120 > 0.05$. It means that technological progress would indirectly increase Human Development Index.

Finally, in path-4, technological progress indirectly had positive and not significant impact on human development, through economic growth, as the path coefficients $P_{42} \times P_{21} = (0.07 \times 0.63) = 0.044 < 0.05$. Technological progress would indirectly increase Human Development Index, through economic growth. But this impact not statistically significant.

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