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TECHNOLOGICAL PROGRESS AND POVERTY REDUCTION IN INDONESIA

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Abstract

This paper examined the impact of technological progress on poverty reduction, with unemployment rate and economic growth as moderating variables, in Indonesia during the period of 2004-2013. It was coincided with two perods of Yudhoyono administration.Technological progress was measured by total factor productivity (TFP) growth, unemployment was measuredby open unemployment rate, economic growth was measured by the growth of Gross Domestic Product based on the year of 2000 constant price, and poverty reduction was measured by the percentage of poor people. Impact analysis was conducted using SEM-Path Analysis techniques. Most data were directly gathered from the National Statistics Agency, except data on TFP growth. The results showed that first**,** technological progress,directly, had a not significant positive impact on poverty reduction (Path-1). Second**,** technological progress, indirectly, had a positive significant impact on poverty reduction (Path-2). Third**,** technological progress, indirectly, had a positive significant impact on poverty reduction (Path-3). Fourth**,** technological progress, indirectly, had positive significant impact on poverty reduction (Path-4). Technological progress was important factor for poverty reduction but it was not sufficient conditions.

Keywords: Technological progress; Unemployment: Economic growth; Poverty reduction; Direct ad indirect impacts.

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1. Introduction

Despite its abundance resources, Indonesia is listed among the lower middle income countries. Efforts on protecting the poor through targeted social safety net on health, education and rice consumption as well as the community empowerment programs and micro-enterprise empowerment programs have signified Indonesia's development policy agenda. In the National Medium-Term Development Plan of 2004-2009, the Yudhoyono administration targeted to reduce the percentage of Indonesian living below poverty line from 17.42% in 2004 to 8.20% in 2009. The 2010-2014 National Medium-Term Development Plan has targeted a poverty rate of 8% in 2014 (Bappenas, 2009).

Although only a few developing countries have succeeded in sustaining rapid growth for a long period and in reducing poverty significantly, the evidence does suggest an association between episodes of rapid growth and poverty reduction. Some policies and factors do seem to promote growth and reduction in poverty, such as: openness to international trade and capital, conditions conducive to the creation of a disciplined and adequately educated and healthy labor force, macroeconomic stability and an environment of low transaction costs(Asian Development Bank, 2001).

The last few decades witnessed a rapid economic growth in developing countries is not sufficient for poverty reduction. The debate surrounding growth and human development resurfaced when the absolute poverty in the developing world dropped to 21% in 1990 from 43% in 2010, lifting 280 Million above the poverty line.

Unprecedented growth of China, India, Latin America and few African countries contributed to this massive poverty reduction. Oyewale & Musiliu (2015) have examined empirical assessment of economic growth on poverty reduction in Nigeria. Growth alone may not be sufficient to achieve poverty reduction. Other factors may need to be in place before growth has a poverty-reducing impact. Besley& Cord (2007) present conclusive arguments through cross country empirical evidence that on average, 1 per cent increase in per capita income reduced poverty by 1 per cent. Richard, A.H Jr., (2003) argued that economic growth reduces poverty because growth has little impact on income inequality. In the data set income inequality rises on average

less than 1.0 per cent a year. Since income distributions are relatively stable over time, economic growth tends to raise incomes for all members of society, including the poor.

Unemployment and poverty are the two major challenges that are facing the world economy at present. Unemployment leads to financial crisis and reduces the overall purchasing capacity of a nation. This in turn results in poverty followed by increasing burden of debt. Now, poverty can be described in several ways. As per the World Bank definition, poverty implies a financial condition where people are unable to maintain the minimum standard of living. It is true that unemployment and poverty are mostly common in the less developed economies(Baker, D, 2014).A full employment policy is a tremendously effective way to increase the income and opportunities available to the poor and near poor. But the high unemployment policy we currently have in place is one that redistributes income upward and denies people the jobs they need to escape poverty.

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 few (OECD & ADB,2002).

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 (2008) 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.

The powerful force of technological change for poverty reduction in agriculture has been studied by Janvry, *et al.* (2005). They explore how biotechnology, as a potentially important new source of technological progresss in agriculture, could also be made to fulfill this role. They also distinguish between direct effects of technology and poverty that affect adopters and indirect effects that affect others through employment, growth, and consumer price effects.

The objective of this paper is to examine the impact of technological progress on poverty reduction both directly and indirectly through economic growth and unemployment.

2. Reviews of Literature

2.1. Poverty

Poverty is general scarcity, dearth, or the state of one who lacks a certain amount of material possessions or money (Merriam-Webster, 2016). It is a multifaceted concept,which includes social, economic, and political elements (Ricardo, S, 2008). Many definitions have been introduced, for instance, United Nations and World Bank. According to United Nations (2016), 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 to, 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), 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. First introduced in 1990, the dollar a day poverty line measured absolute poverty by the standards of the world's poorest countries.

The World Bankdefined the new international poverty line as $1.25 a day in 2008 for 2005 (Martin R, *et al*, 2008). In October 2015, they reset it to $1.90 a day.

The poverty line threshold of $1.90 per day, as set by the World Bank, is a bit controversial. Each nation has its own threshold for absolute poverty line; in the United States, for example, the absolute poverty line was US$15.15 per day in 2010 (US$22,000 per year for a family of four), while in India it was US$1.0 per day, in Indonesia the poverty line was equat to US$ 0.84 per day and in China the absolute poverty line was US$0.55 per day, each on PPP basis in the year of 2010.

Absolute poverty, extreme poverty, or abject poverty is "a condition characterized by severe deprivation of basic human 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". 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" (Raphael, D., 2009).

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 OECD, 2008).In the European Union, the "relative poverty measure is the most prominent and most–quoted of the EU social inclusion indicators (Marx, & van den Bosch,2016).

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-enterprise empowerment cluster government's policy reduction programs (Asep Suryahadi, *at. al.*,2010).Efforts to reduce poverty related with other variables such as: economic growth, unemployment, and technological progress.

2.2. Economic Growth

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 realgross domestic product, or real GDP, usually in per capita terms (IMF, 2012).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 accounting (Bjork, G.J., 1999). 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 (Bjork, G.J., 1999).

Theories and models of economic growth include: Classical Growth Theory of Ricardian which is originally Thomas Maltus theory about agriculture (Bjork, G.J., 1999).Solow-Swan Model developed by Robert Sollow (1956)and Trevor Swan (1956), Endogenous Growth Theory which focus on what increases human capital or technological progress (Helpman, 2004), Unified Growth Theory developed by Oded Galor (2005), 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 markets (Aghion, P.,2002), Institutions and Growth Theory (Acemoglu, D.,*et al*, 2001),Human Capital and Growth Theory (Barro, R. J., & Lee J.W., 2001).

2.3. Unemployment

Unemployment occurs when people who are without work are actively seeking paid work (ILO, 1982). The unemployment rate is a measure of the prevalence of unemployment and it is calculated as a percentage by dividing the number of unemployed individuals by all individuals currently in the labor force. During periods of recession, an economy usually experiences a relatively high unemployment rate (The Saylor Foundation, 2012).

Theories of unemployment include: Classical unemployment theory (Vedder, R. & Gallaway, L., 1997), Cyclical unemployment theory (Harris, S. E., 2005),Marxian theory of unemployment (Marx, K, 2009),Structural unemployment theory (Marx, K, 2009), and Frictional unemployment theory (Marx, K, 2009).Unemployment and economic growth are dependent on one another in many ways, and often times unemployment leads to slower economic growth. Since unemployment is very dependent on economic activity, when economic activity is high there is increased production and a healthy demand for individuals to help produce higher amounts of services and goods. Unemployment usually has negative corellation with economic growth.

Unemployment and poverty are the two major challenges that are facing the world economy at present. Unemployment leads to financial crisis and reduces the overall purchasing capacity of a nation. Unemployment, theoritically, has a positive corellation with poverty.

2.4. Technological progress

Technological progress, technological development, technological achievement, or technological progress is the overall process of invention, innovation and diffusion of technology or processes. In essence technological progress is the invention of technologies and their commercialization via research and development, the continual improvement of technologies, and the diffusion of technologies throughout industry or society. In short, technological progress is based on both

better and more technology (Jaffe et al., 2002). Ineconomics, change in a production function that alters the relationship between inputs and outputs. Normally it is understood to be an improvement in technology, or technological progress. Technological progress is a change in the set of feasible production possibilities (Hicks, J.R., 1963).

2.4.1. Technological progress and economic growth

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 countries (Anonymous, 2017).

It has been observed that major part of increased productivity is due to technological progresss. Technological progress is one of the most important determinants of the shape and evolution of the economy. Technological progress has improved working conditions, 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 progresss contribute significantly in the development of underdeveloped countries (Anonymous, 2017).

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 rises, 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 increases (Anonymous, 2017).

2.4.2. Technological progress and unemployment

Technological progress may produce short-run employment-adjustment problems overstate those problems. They also often fail to mention that the short-run unemployment that occurs is primarily the result of artificial imperfections in certain labor and product markets. The amount of short-run unemployment created by advancing technology is directly related to the degree of

artificiality in the particular labor markets affected. It will be argued that the workers harmed by technological advancement are those who have been receiving wages in excess of the amount they would receive in a fully competitive labor market (Mabry, R.H. &Sharplin, A.D, 1986). Even though technological progress may adversely affect the demand for labor in some labor markets, the overall effect of technological progress on total employment may be positive. Technological progress tends to increase the rate of economic growth. Higher rates of economic growth are generally associated with lower unemployment rates. Baumol,W.J.,& Wolff, E.N., (1998)addressed the issue of structural unemployment that results from a more rapid pace of technological progress. They note that a higher rate of technological progress generally results in higher rates of structural unemployment.Technological progress tends to create more jobs than are lost (OECD, 2016).

3. Methods

In analyzing direct and indirect impacts of technological progress on poverty reduction, this study employed path analysis model, which was developed in 1918 by Sewall Wright(Wright, S., 1921; 1934). It has since been applied to a vast array of complex modeling areas, including biology, psychology, sociology, and econometrics. Basically, the path model can be used to analysis two types of impacts: direct and indirect impacts. The total impacts of exogenous variables were the multiplication of the coefficient on the path (Alwin, D.F., & Hauser, R.M., 1975). In this study the path model is depicted in Figure 1: where technological progress, unemployment and were the exogenous variables. How does technological progress influence poverty reduction?

Direct impact of technological progress on poverty reduction would be analyzed using Path-1, hyphotezing thattechnological progress has direct impact on poverty reduction. The path coefficient would be calculated as P_{41}. Indirect impact of technological progress on poverty reducion would be examined through Path-2, proofing thattechnological progress has indirect impact on poverty reduction, via economic growth. The indirect path coefficient P_{41} would be calculates as P_{43} x P_{31}.Indirect impact of technological progress on poverty reduction would be examined through Path-3, thattechnological progress has indirect impact on poverty reduction, via economic growth and unemployment. The indirect path coefficient P_{41} calculated as

multiplication of P_{43} x P_{32} x P_{21}.Finally, the indirect impact of technological progress on poverty reduction through Path-4, technological progress has indirect impact on poverty reduction, via unemployment. The path coefficient P_{41} calculated as multiplication of P_{42} x P_{21}.

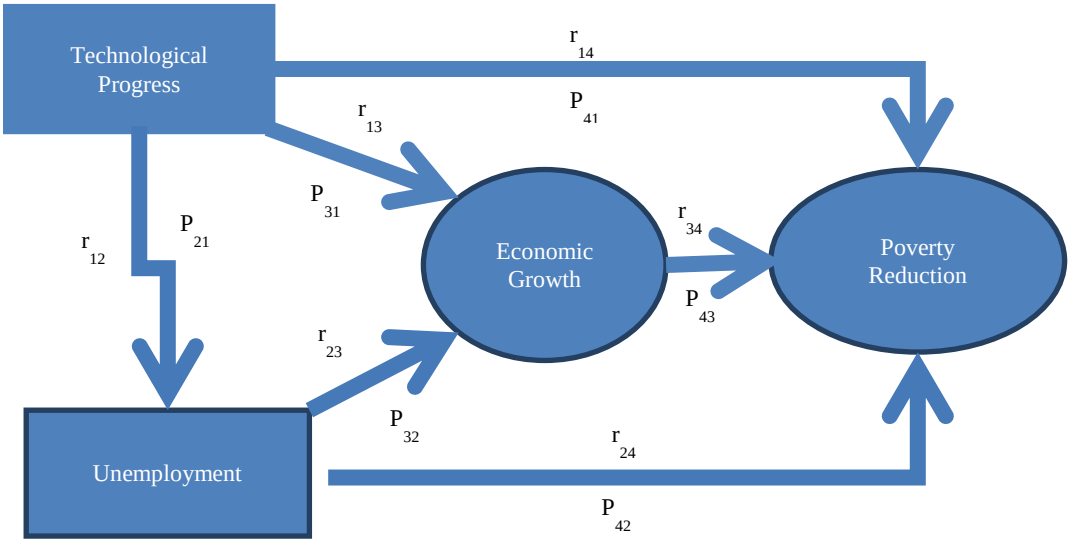

Figure 1. Model for Analysing Impact of Technological Progress on Poverty Reduction.

Calculation of path coefficients employing the following path equation*:

1. $r_{12} = P_{21}$
2. $r_{13} = P_{31} + P_{32}\, r_{12}$
3. $r_{23} = P_{31}\, r_{12} + P_{32}$
4. $r_{14} = P_{41} + P_{42}\, r_{12} + P_{43}\, r_{13}$
5. $r_{24} = P_{41}\, r_{12} + P_{42} + P_{43}\, r_{23}$
6. $r_{34} = P_{41}\, r_{13} + P_{42}\, r_{23} + P_{43}$

As coefficients of correlation (r_{14}, r_{24}, r_{34}, r_{13}, r_{23}, and r_{12}) can be calculated provided data of technological change, unemployment, economic growth and percentage of the poor are available. The path equation can be solved simultaneously, so that path coefficients of P_{41}, P_{42}, P_{43}, P_{31}, P_{32}, P_{21}) could easily be calculated.

Data needed to examine the impact of technological progress on poverty reduction, with unemployment and economic growth as intervening variables were : 1. total factor productivity

* http://faculty.cas.usf.edu/mbrannick/regression/Pathan.html

growth (%) as indicator of technological progress, 2. percentage of poor people (%) to measure poverty reduction, 3. the rate of open unemployment (%) and 4. the growth of Gross Domestic Product (%) to measure economic growth.

Except data on the growth of total factor productivity, all data were gathered from National Statistics Agency. Data source on total factor productivity was from a study project conducted by the Agency for Assessment and Application of Technology entitle The Role of Technology in Indonesia Economic Growth (Prihawantoro, *et al*, 2010).

4. Results and Discussions

Correlation coefficients among variables were calculated and the results were presented in Table 1. Correlation between technological progress and unemployment, noted as r_{12}, correlation between technological progress and economic noted as r_{13} and correlation between technological progress and poverty reduction, noted as r_{14}, correlation between unemployment and economic growth, noted as r_{23} and correlation between unemployment and poverty reduction, noted as r_{24}, and correlation between economic growth and poverty reduction noted as r_{34}. From Table 1, we can read that correlation coefficient between technological progress and unemployment, r_{12} = 0.34 means that correlation between technological progress and unemployment was positive and categorized as weak relation. Technological progress had positive correlation with unemployment. How was the impact of technological progress on unemployment rate?

From equation 1, $P_{21} = r_{12}$, means that the impact of technological progress on unemployment was 0.34. As 0.34 > 0.05, technological progress has significant impact on unemployment. It means that if technological progress increase then it would increase the rate of unemployment; 1 per cent increase in technological progress will increase 0.34 per cent of unemployment rate. This empirical evidence supported theory hypothesizing that technological progress would lessen employment opportunity.

The corellation coefficient between technological progress and economic growth r_{13} was 0.63, a positive strong corellation. Solving equation 2 and equation 3 simultaneously, P_{31}, was calcuated equal to 0.80. It means that the impact of technological progress on economic growth was

positive and significant as $P_{31} > 0.05$. One percent increase of technological progress would increase economic growth as 0.80 per cent. This empirical evidence supported theoritical frame that technological progress increase economic growth.

Table 1. Results of Analysis Correlation Coefficients

Correlation Coefficients	Technological Progress (%)	Unemployment Rate (%)	Economic Growth (%)	The Poor People (%)
Technological Progress (%)	1.00			
Unemployment Rate (%)	0.34	1.00		
Economic Growth (%)	0.63	-0.22	1.00	
The Poor People (%)	0.30	0.96	-0.23	1.00

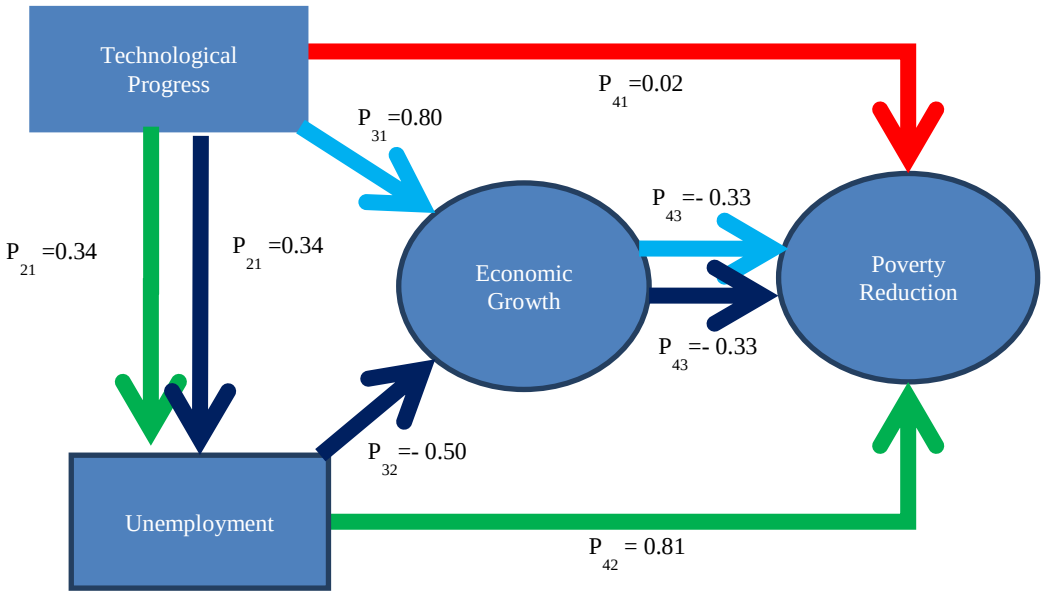

Figure 2. Path Coefficients: Direct and Indirect Impact of Technological progress on Poverty Reduction

The coeffientcorelation between technological progress and poverty reduction, r_{14}, was 0.30, a weak positive corelation. It might comply with the theory, saying that technology could handle

the poverty problems. Unfortunately, the direct impact was not statistically significant as the path coefficient, P_{41} = 0.02, was less than 0.05.

Corelation between unemployment and economic growth was negative, r_{23} = -0.22, a weak negative corelation. An increase the rate of unemployment will decrease the economic growth. Meanwhile, corelation between unemployment and poverty reduction was positive and significant. It means that the higher unemployment rate, the more the percentage of the poor. It is in line with the theory. The impact of unemployment on economic growth was negative and significant, as P_{32}> = [-0.50] > 0.05. On the other hand, the impact of unemploymjent on poverty reduction was positive and significant, P_{42} = 0.81.

Corelation between economic growth and percentage of the poor was also negative and weak as r_{34} = -0.23. Economic growth made the percentage of the poor declined. The path coefficient, P_{43} was -0.33. It means that the impact of economic growth on poverty reduction statistically significant as P_{43} = -0.33I > 0.05. One percent increase in economic growth will reduce the percentage of the poor 0.33 per cent.

Figure 2 presents the path coefficients and therefore give evidences of the hypothesis on the impact of technological change on poverty reduction; direct and indirect. In Path-1, technological progress had positive direct impact on poverty reduction. But this impact was not statistically significant as P_{41} =0.02, which was less than 0.05. In Path-2, technological progress had negative indirect impact, through economic growth, on poverty reduction. This negative indirect impact was statistically significant as P_{43} x P_{31} = (-0.33 x 0.80) = $\left|-0.26\right|$ > 0.05.

In Path-3, technological progress had positive indirect impact, through economic growth and unemployment, on poverty reduction. This positive indirect impact was statistically significant as P_{43} x P_{32} x P_{21}= (-0.33 x -0.5 x 0.34) = 0.06 > 0.05. Finally, in Path-4, technological progress had positive indirect impact, through unemployment, on poverty reduction. This positive indirect impact was statistically significant as P_{42} x P_{21} = (0.81 x 0.34) =0.28 > 0.05.

5. Conclusion

From abovediscussion, it could be concluded that:

1. Directly, technological progress had a positive impact on poverty reduction. But this impact was not statistically significant, Path-1: P_{41}.
2. Indirectly, technological progress had a negative significant impact on poverty reduction, through, Path-2 :P_{43} x P_{31}.
3. Indirectly, technological progress had a positive significant impact on poverty reduction, through Path-3 (P_{43} x P_{32} x P_{21}).
4. Indirectly, technological progress had a positive significant impact on poverty reduction, through Path-4 (P_{42} x P_{21}).

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