

THE IMPACT OF TECHNOLOGICAL CHANGE ON POVERTY ALLEVIATION IN INDONESIA

Muchdie

Department of Management, Postgraduate School, Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia

eidmuchdie@uhamka.ac.id

Abstract

This paper examined the impact of technological change on poverty alleviation, with unemployment rate and economic growth as moderating variables, in Indonesia during the period of 10 years (2004-2013). This period was coincided with the two period of Yudhoyono Administration. Technological change was measured by total factor productivity (TFP) growth, unemployment was measured by open unemployment rate, economic growth was measured by the growth of Gross Domestic Product based on the year of 2000 constant price, and poverty alleviation 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 change, directly, had a not significant positive impact on poverty alleviation (Path-1). Second, technological change, indirectly, had a positive significant impact on poverty alleviation (Path-2). Third, technological change, indirectly, had a positive significant impact on poverty alleviation (Path-3). Fourth, technological change, indirectly, had positive significant impact on poverty alleviation (Path-4).

Keywords: *technological change, unemployment, economic growth, poverty alleviation, direct and indirect impacts.*

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 line¹ 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 2014².

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

¹ The poverty lines equal to 2100 calorie per capita per day for the food component plus basic non-food consumption.

² Bappenas.(2009). Laporan Penyelenggaraan Musrenbangnas RPJMN 2010–2014 di Jakarta pada Desember 2009. [Minutes on National Development Consultation for Mid-term National Development Plan 2010–2014. Jakarta in December 2009 [online] [26 February 2010].

and reduction in poverty³: 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.

The last few decades witnessed a rapid economic growth in developing countries is not sufficient for poverty alleviation. 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.⁴

Unprecedented growth of China, India, Latin America and few African countries contributed to this massive poverty reduction. Oyewale and Musiliu (2015) have examined empirical assessment of economic growth on poverty reduction in Nigeria⁵. Growth alone may not be sufficient to achieve poverty reduction. Other factors may need to be in place before growth has a poverty-reducing impact⁶. Besley and Cord (2007) present conclusive arguments through cross country empirical evidence that on average, 1 per cent increase in per capita income reduced poverty by 1.7per cent⁷. Richard, A.H Jr (2003)⁸ argued thateconomic 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 economies⁹. 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 poverty¹⁰.

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 few¹¹.

3 Asian Development Bank. (2001).Growth and Poverty Alleviation: Lessons from Development Experience. ADB on line <<http://www.adb.org/publications/growth-and-poverty-alleviation-lessons-development-experience>>

4 <http://www.studymode.com/essays/Economic-Growth-And-Poverty-Alleviation-43775731.html>

5 Oyewale, F. and Musiliu, B.A.(2015). Empirical assessment of economic growth on poverty reduction in Nigeria. American Journal of Economics. 5(6), pp: 565-573.

6 Bhide, S. And Kapur, M.A. (2008). Economic Growth and Poverty Dynamics.CPRC Working Paper No. 120, Chronic Poverty Research Centre, London, UK, ISBN: 978-1-906433-21-5, 33 pp.

7 Besley and Cord (eds), (2007), Delivering on the Promise of Pro-Poor Growth: Insights and Lessons from Country Experience, World Bank.

8 Richard, A.H. Jr. (2003). Economic Growth, Inequality, and Poverty: Findings from a New Data Set, Policy Research Working Paper, World Bank Group <<http://dx.doi.org/10.1596/1813-9450-2972>><http://www.economywatch.com/unemployment/poverty.html>

10 Baker, D.(2014).The Full Employment Route to Poverty Reduction. Available at <http://billmoyers.com/2014/06/13/the-full-employment-route-to-poverty-reduction/>

11 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>

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)¹², 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)¹³. They explore how biotechnology, as a potentially important new source of technological changes 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 change on poverty alleviation both directly and indirectly through economic development and unemployment.

Reviews of Literature

Poverty

Poverty is general scarcity, dearth, or the state of one who lacks a certain amount of material possessions or money¹⁴. It is a multifaceted concept, which includes social, economic, and political elements¹⁵. Many definitions have been introduced, for instance, United Nations and World Bank. According to United Nations¹⁶, 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 Bank¹⁷, 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 Bank defined the new international poverty line as \$1.25 a day in 2008 for 2005 (equivalent to \$1.00 a day in 1996 US prices)¹⁸. In October 2015, they reset it to \$1.90 a day¹⁹.

¹² 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>.

¹³ Janvry, Alain de., Graff, G., Sadoulet, E., and Zilberman, D. (2005). Technological Change in Agriculture and Poverty Reduction: The Potential Role of Biotechnology. in *Agricultural Biodiversity and Biotechnology in Economic Development*. Volume 27 of the series Natural Resource Management and Policy, 361-386.

¹⁴ *Poverty*. Merriam-Webster. Retrieved 15 Augustus 2016.

¹⁵ 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.

¹⁶ UN (2016). Indicators of Poverty & Hunger (PDF). *United Nations*. Retrieved 14 Augustus 2016.

¹⁷ World Bank. (2011). Poverty and Inequality Analysis. *Worldbank.org*. Retrieved 27 May 2016.

¹⁸ Martin R; Chen, S; Prem, S, (May 2008), *Dollar a Day Revisited* (PDF) (Report), The World Bank, Washington DC, Retrieved 10 Augustus 2016.

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)²⁰, while in India it was US\$1.0 per day²¹, in Indonesia the poverty line was equal to US\$ 0.84 per day²² and in China the absolute poverty line was US\$0.55 per day, each on PPP basis in 2010²³.

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"²⁴. 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)²⁵.

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^{26, 27, 28, 29, 30}. In the European Union, the "relative poverty measure is the most prominent and most-quoted of the EU social inclusion indicators³¹".

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,

¹⁹ The Bank uses an updated international poverty line of US \$1.90 a day, which incorporates new information on differences in the cost of living across countries (the PPP exchange rates).

²⁰ Poverty Definitions by *US Census Bureau*. 2011.

²¹ World Bank's \$1.25/day poverty measure-countering the latest criticisms. *The World Bank*. 2010.

²² For the year 2014, Government of Indonesia defined the poverty line as IDR. 312.328, per capita per month, equal to US \$25 per capita per month.

²³ New Progress in Development-oriented Poverty Reduction Program for Rural China (1,274 Yuan per year = US\$ 0.55 per day). *The Government of China*. 2011.

²⁴ UN Declaration at World Summit on Social Development in Copenhagen in 1995

²⁵ Poverty Definition by World Bank. Retrieved 10 Augustus 2016

²⁶ 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.

²⁷ Child poverty in rich nations: Report card no. 6 (Report), *Innocenti Research Centre*, 2005.

²⁸ OECD. (2008). Growing unequal? Income distribution and poverty in OECD countries. Paris, France: *Organisation for Economic Co-operation and Development (OECD)*.

²⁹ *Human development report, Capacity development: Empowering people and institutions (Report)*, *United Nations Development Program*, Geneva, 2008.

³⁰ Child Poverty. *ON: Conference Board of Canada*, Ottawa, 2013.

³¹ 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>

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, et. al. (2010)³².

Efforts to reduce poverty related with other variables such as: economic growth, unemployment, and technological progress.

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)³³. 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 accounting³⁴. 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*³⁵.

Theories and models of economic growth include: Classical Growth Theory of Ricardian which is originally Thomas Maltus theory about agriculture³⁶, Solow-Swan Model developed by Robert Sollow³⁷ and Trevor Swan³⁸, Endogenous Growth Theory which focus on what increases human capital or technological change³⁹, Unified Growth Theory developed by Oded Galor⁴⁰, 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

³² Asep Suryahadi, Athia Yumna, Umbu Reku Raya, Deswanto Marbun. (2010). Review of Government's Poverty Reduction Strategies, Policies and Programs in Indonesia. *Research Report*, Jakarta :The SMERU Research Institute.

³³ IMF (2012). Statistics on the Growth of the Global Gross Domestic Product (GDP) from 2003 to 2013.

³⁴ 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.

³⁵ 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

³⁶ 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

³⁷ Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*. 70(1), pp. 65-94.

³⁸ Swan, T.W. (1956). Economic Growth and Capital Accumulation. *Economic Record*. **32**: 334–61. doi:10.1111/j.1475-4932.1956.tb00434.x.

³⁹ Helpman, E. (2004), *The Mystery of Economic Growth*, Harvard University Press.

⁴⁰ Galor, O. (2005). *From Stagnation to Growth: Unified Growth Theory*, Handbook of Economic Growth, Elsevier.

capture markets⁴¹, Institutions and Growth Theory⁴², Human Capital and Growth Theory⁴³, and Energy Consumption and Growth Theory⁴⁴.

Unemployment

Unemployment occurs when people who are without work are actively seeking paid work⁴⁵. 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 rate⁴⁶.

Theories of unemployment include : Classical unemployment theory⁴⁷, Cyclical unemployment theory⁴⁸, Marxian theory of unemployment⁴⁹, Structural unemployment theory⁵⁰, and Frictional unemployment theory⁵¹.

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 correlation 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 nation⁵². Unemployment, theoretically, has a positive correlation with poverty.

Technological Change

⁴¹ Quote from Philippe Aghion, (2002). *Schumpeterian Growth Theory and the Dynamics of Income Inequality*, *Econometrica*. 70(3), 855–882. Also see Wendy Carlin and David Soskice. (2006). *Macroeconomics: Imperfections, Institutions & Policies*. Specifically chapter 14.

⁴² Acemoglu, D., Johnson, S. & Robinson, J., (2001). The colonial origins of economic development: an empirical investigation. *American Economic Review*, 91(5), pp.1369–1401.

⁴³ Barro, R. J., and Lee J.W. (2001). International data on educational attainment: Updates and implications. *Oxford Economic Papers* 53, no. 3, 541–563.

⁴⁴ Committee on Electricity in Economic Growth Energy Engineering Board Commission on Engineering and Technical Systems National Research Council (1986). *Electricity in Economic Growth*. Washington, DC: National Academy Press. pp. 16, 40. ISBN 0-309-03677-1 <Available as free .pdf download>

⁴⁵ ILO, (1982). Resolution concerning statistics of the economically active population, employment, unemployment, and underemployment, adopted by the Thirteenth International Conference of Labor Statisticians. pp: 4. Retrieved 26 July 2016.

⁴⁶ The Saylor Foundation, (2012), Unemployment Rate. pp. 1. Retrieved 20 June 2012

⁴⁷ Vedder, R. and Gallaway, L. (1997). *Out of Work: Unemployment and Government in the Twentieth-Century America*. New York: NYU Press. ISBN 0-8147-8792-4.

⁴⁸ Harris, S. E., (2005). *The New Economics: Keynes' Influence on Theory and Public Policy*, Kessinger Publishing, ISBN 1-4191-4534-7.

⁴⁹ Marx, Karl. (2009). *Capital: An Abridged Edition*. Edited by David McLellan. Oxford Paperbacks, Oxford, UK. ISBN 978-0-19-953570-5.

⁵⁰ Jerome, H. (1934). *Mechanization in Industry*, National Bureau of Economic Research.

⁵¹ Quiggin Takes My Euro-Bet, Bryan Caplan | Library of Economics and Liberty. *Econlog.econlib.org*. 28 May 2009, Retrieved 25 March 2010.

⁵² <http://www.economywatch.com/unemployment/poverty.html>

Technological change, technological development, technological achievement, or technological progress is the overall process of invention, innovation and diffusion of technology or processes. In essence technological change 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 change is based on both better and more technology⁵³. In economics, 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 progress⁵⁴. Technological change is a change in the set of feasible production possibilities⁵⁵.

Technological change and economic growth

Technological change 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.⁵⁶

It has been observed that major part of increased productivity is due to technological changes. Technological change is one of the most important determinants of the shape and evolution of the economy. Technological change 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 changes contribute significantly in the development of underdeveloped countries⁵⁷.

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 increases⁵⁸.

Technological change and unemployment

Technological change 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 market⁵⁹. Even though technological change may adversely effect the demand for labor in some labor markets, the overall effect of technological change on total employment may be positive. Technological change tends to increase the rate of economic growth. Higher rates of economic growth are generally associated with lower unemployment rates⁶⁰. William J. Baumol and Edward N. Wolff address the issue of structural unemployment that results from a more rapid pace of technological progress. They note that a higher rate of technological change generally

⁵³ Derived from Jaffe et al. (2002) *Environmental Policy and technological Change* and J. Schumpeter (1942) *Capitalism, Socialism and Democracy* by Joost.vp on 26 August 2008.

⁵⁴ <http://www.dictionarycentral.com/definition/technological-change.html>

⁵⁵ J. R. Hicks (1963). *The Theory of Wages*, Ch. VI, Appendix, and Section III. Macmillan.

⁵⁶ <http://www.yourarticlelibrary.com/economics/technical-progress-and-economic-development/47501/>

⁵⁷ <http://www.yourarticlelibrary.com/economics/technical-progress-and-economic-development/47501/>

⁵⁸ <http://www.yourarticlelibrary.com/economics/technical-progress-and-economic-development/47501/>

⁵⁹ Mabry, R.H and Sharplin, A.D. (1986). Does More Technology Create Unemployment? CATO INSTITUTE POLICY ANALYSIS NO. 68.

⁶⁰ Policy Debate: Do technological advances result in higher unemployment?

http://www.swcollege.com/bef/policy_debates/unemployment.html retrieved on 16 August 2016.

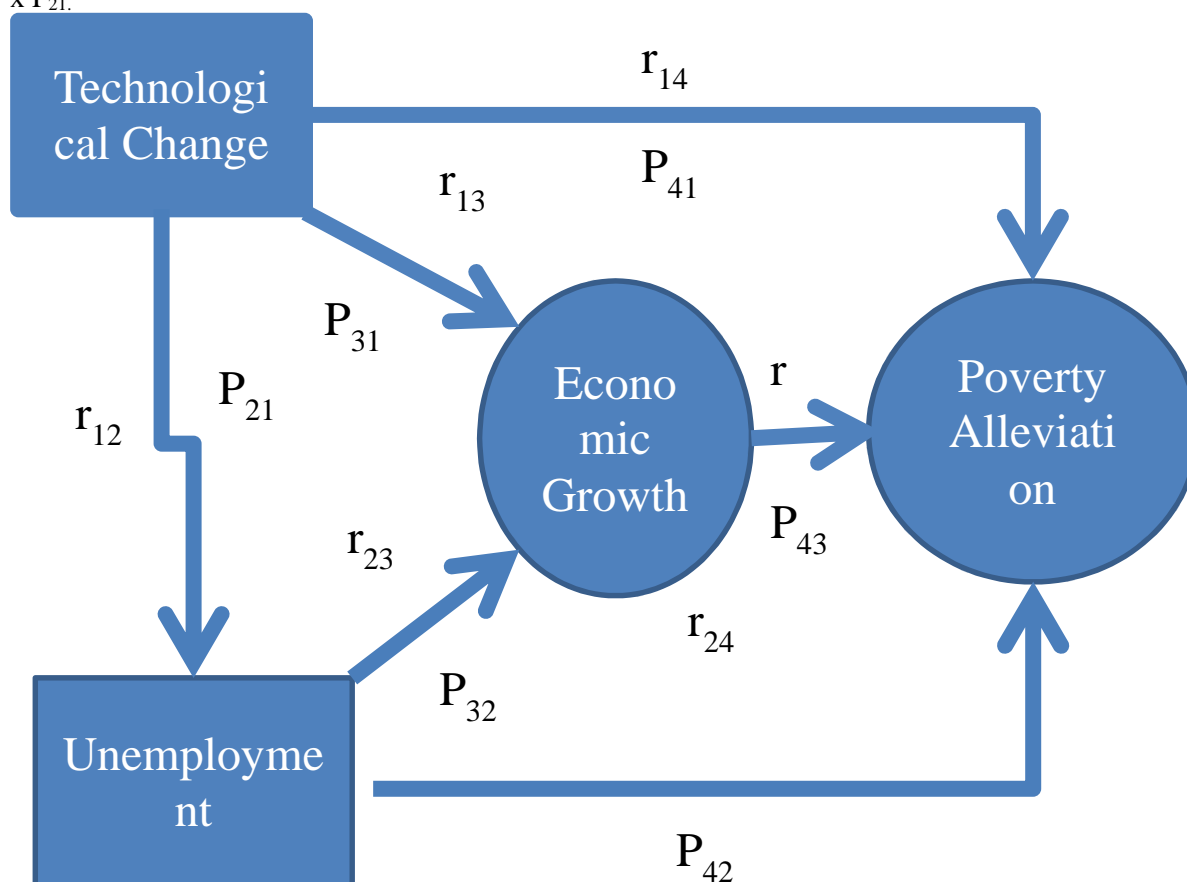
results in higher rates of structural unemployment⁶¹. Technological change tends to create more jobs than are lost⁶².

METHODS

Model used for analysing direct and indirect impact of technological change on poverty alleviation is depicted in Figure 1. Path analysis was developed as a method of decomposing correlations into different pieces for interpretation of impact. How does technological change influence poverty reduction?

Direct impact of technological change on poverty alleviation would be analyzed using Path-1, hypothesizing that technological change has direct impact on poverty alleviation. The path coefficient would be calculated as P_{41} .

Indirect impact of technological change on poverty alleviation would be examined through Path-2, proving that technological change has indirect impact on poverty alleviation, via economic growth. The indirect path coefficient P_{41} would be calculated as $P_{43} \times P_{31}$. Indirect impact of technological change on poverty alleviation would be examined through Path-3, that technological change has indirect impact on poverty alleviation, via economic growth and unemployment. The indirect path coefficient P_{41} calculated as multiplication of $P_{43} \times P_{32} \times P_{21}$. Finally, the indirect impact of technological change on poverty alleviation through Path-4, technological change has indirect impact on poverty alleviation, via unemployment. The path coefficient P_{41} calculated as multiplication of $P_{42} \times P_{21}$.



⁶¹ Baumol, W.J. and Wolff, E.N. (1998). Side Effects of Progress. *Public Policy Brief* <http://www.levy.org/docs/hili/41a.html>.

⁶² OECD. (2016). The OECD Jobs Study: Facts, Analysis, Strategies. Available at <http://www1.oecd.org/sge/min/job94/part2c.htm>. Retrieved on 16 August 2016.

Figure 1. Model for Analysing the Direct and Indirect Impact of Technological Change on Poverty Alleviation.

Calculation of path coefficients employing the following path equation⁶³:

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 change on poverty alleviation, with unemployment and economic growth as intervening variables were : 1. total factor productivity growth (%) as indicator of technological change, 2. percentage of poor people (%) to measure poverty alleviation, 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*⁶⁴.

RESULTS AND DISCUSSIONS

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

From equation 1, $P_{21}=r_{12}$, means that the impact of technological change on unemployment was 0.34. As $0.34 > 0.05$, technological change 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 change 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 change and economic growth r_{13} was 0.63, a positive strong corellation. Solving equation 2 and equation 3 simultaneously, P_{31} , was calculated equal to 0.80. It means that the impact of technological change on economic growth was positive an significant as $P_{31} > 0.05$. One percent increase of technological change would increase economic growth as 0.80 per cent. This empirical evidence supported theoretical frame that technological change increase economic growth.

⁶³ <http://faculty.cas.usf.edu/mbrannick/regression/Pathan.html>

⁶⁴ Socia Prihawantoro, et.al.,(2010), *Peranan Teknologi dalam Pertumbuhan Ekonomi Indonesia*, Pusat Pengkajian Kebijakan Inovasi Teknologi, Jakarta : Badan Pengkajian dan Penerapan Teknologi. (*The Role of Technology in Indonesia Economic Growth, Center of Innovation Technology Assessment, Jakarta : The Agency for the Assessment and Application of Technology*)

Table 1. Results of Analysis Correlation Coefficients

Correlation Coefficients	Technol ogical Change (%)	Unempl oyment Rate (%)	Economi c Growth (%)	The Poor People (%)
Technological Change (%)	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

The coefficient correlation between technological change and poverty alleviation, r_{14} , was 0.30, a weak positive correlation. 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.

Correlation between unemployment and economic growth was negative, $r_{23} = -0.22$, a weak negative correlation. An increase the rate of unemployment will decrease the economic growth. Meanwhile, correlation 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 unemployment on poverty reduction was positive and significant, $P_{42} = 0.81$. The more the unemployment rate, the more the percentage of the poor.

Correlation 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 $P_{43} = -0.33 > 0.05$. 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 change had positive direct impact on poverty alleviation. But this impact was not statistically significant as $P_{41} = 0.02$, which was less than 0.05. In Path-2, technological change had negative indirect impact, through economic growth, on poverty alleviation. This negative indirect impact was statistically significant as $P_{43} \times P_{31} = (-0.33 \times 0.80) = |-0.26| > 0.05$.

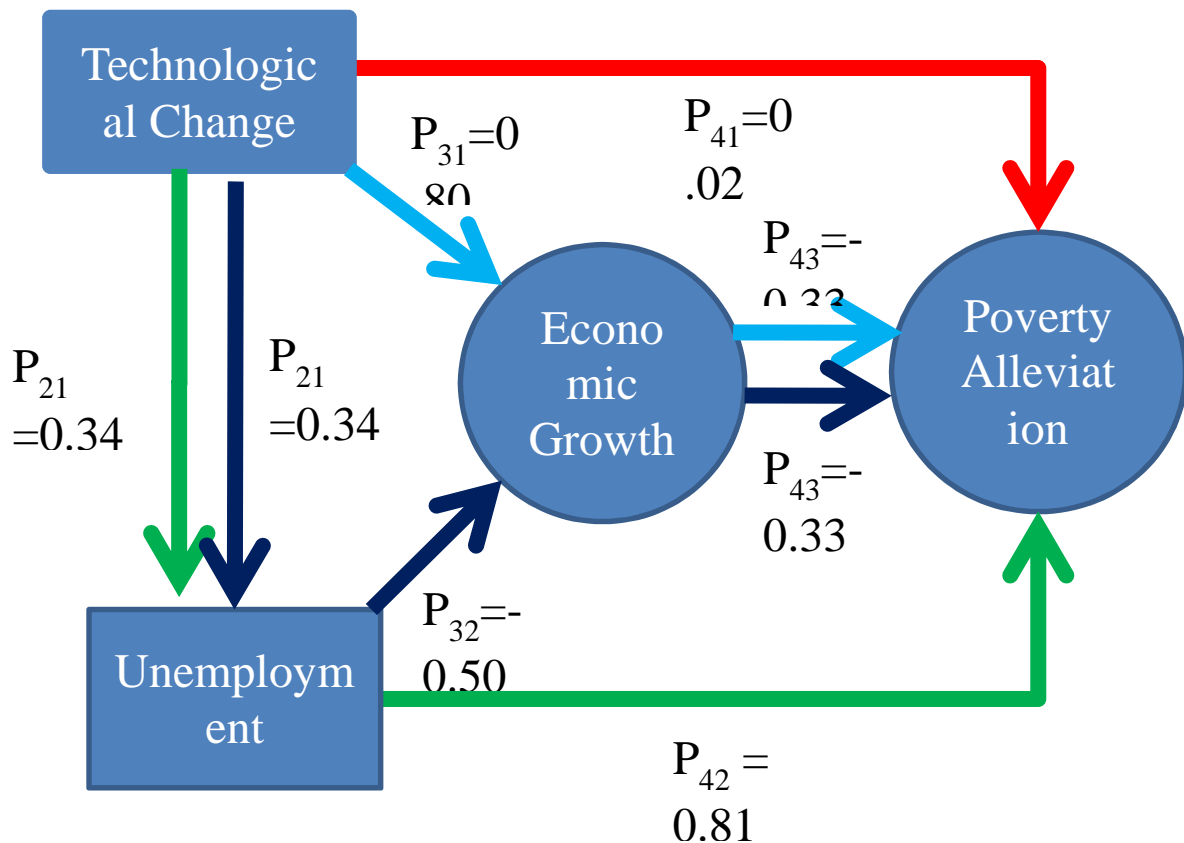


Figure 2. Path Coefficients: Direct and Indirect Impact of Technological Change on Poverty Alleviation

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

CONCLUSION

From above discussion, it could be concluded that:

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

REFERENCES

- Anonymous. (2014). *Jumlah Penduduk Miskin, Presentase Penduduk Miskin dan Garis Kemiskinan (Number of Poor, Percentage of the Poor and Poverty Line) 1970-2013*. Jakarta: Badan Pusat Statistik (National Statistic Agency). Available at <http://bps.go.id/kemiskinan>.
- Anonymous. (2015). *Laju Pertumbuhan PDB Atas Dasar Harga Konstan 2000 Menurut Lapangan Usaha, (Growth of Domestic Product at 2000 Constant Price by Sector)*. Jakarta: Badan Pusat Statistik (National Statistic Agency). Available at <http://bps.go.id/ekonomi>.
- Anonymous. (2016). *Tingkat Pengangguran Terbuka Menurut Provinsi (Open Unemployment Rate by Province) 1986 – 2015*. Jakarta: Badan Pusat Statistik (National Statistic Agency). Available at <http://bps.go.id/tenagakerja>.
- Asep Suryahadi, Athia Yumna, Umbu Reku Raya, Deswanto Marbun. (2010). Review of Government's Poverty Reduction Strategies, Policies and Programs in Indonesia. *Research Report*. Jakarta: The SMERU Research Institute.
- Asian Development Bank. (2001). *Growth and Poverty Alleviation: Lessons from Development Experience*. Available at ADB on line <http://www.adb.org/publications/growth-and-poverty-alleviation-lessons-development-experience> and <http://www.studymode.com/essays/Economic-Growth-And-Poverty-Alleviation-43775731.html>
- Baker, D. (2014). *The Full Employment Route to Poverty Reduction*. Available at <http://billmoyers.com/2014/06/13/the-full-employment-route-to-poverty-reduction/>
- Bappenas. (2009). *Laporan Penyelenggaraan Musrenbangnas RPJMN 2010–2014 di Jakarta pada Desember 2009*. [Minutes on National Development Consultation for Mid-term National Development Plan 2010–2014. Jakarta in December 2009 [online] [26 February 2010].
- Barro, R. J. and Lee J.W. (2001). International data on educational attainment: Updates and implications. *Oxford Economic Papers* 53 (3), 541–563.
- Baumol, W.J. and Wolff, E.N. (1998). Side Effects of Progress. *Public Policy Brief*. Available at <http://www.levy.org/docs/hili/41a.html>.
- Besley and Cord. (2007). *Delivering on the Promise of Pro-Poor Growth: Insights and Lessons from Country Experience*. Washington DC: World Bank.
- Bhide, S. and Kapur M.A. (2008). Economic Growth and Poverty Dynamics, *CPRC Working Paper No. 120*, London: Chronic Poverty Research Centre. ISBN: 978-1-906433-21-5, 33 pp.
- 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.
- Commission on Engineering and Technical Systems, National Research Council. (1986). *Electricity in Economic Growth*. Washington, DC: National Academy Press. 16 pp.
- Galor O. (2005). *From Stagnation to Growth: Unified Growth Theory*, Handbook of Economic Growth, Elsevier.
- Harris, S. E. (2005). *The New Economics: Keynes' Influence on Theory and Public Policy*. Whitefish MT, United States: Kessinger Publishing.
- Helpman, E. (2004). *The Mystery of Economic Growth*. Harvard: Harvard University Press.
- Hicks, J.R. (1963). *The Theory of Wages*. 2nd Edition. Macmillan.

- Hippolyte, F. (2008). Technology trap and poverty trap in Sub-Saharan Africa. *Policy Research Working Paper. No. WPS 4582*. Washington, DC: World Bank. Available at <http://documents.worldbank.org/curated/en/169021468198874707/Technology-trap-and-poverty-trap-in-Sub-Saharan-Africa> .
- ILO (1982). Resolution concerning statistics of the economically active population, employment, unemployment, and underemployment. Adopted by *the Thirteenth International Conference of Labor Statisticians*. Retrieved 26 July 2016.
- Janvry, A, Graff, G, Sadoulet, E, and Zilberman, D. (2005). Technological Change in Agriculture and Poverty Reduction: The Potential Role of Biotechnology, in *Agricultural Biodiversity and Biotechnology in Economic Development* , Volume 27 of the series *Natural Resource Management and Policy*, 361-386.
- Jerome, H. (1934). *Mechanization in Industry*. National Bureau of Economic Research
- Mabry, R.H and Sharplin, A.D. (1986). Does More Technology Create Unemployment? *CATO INSTITUTE POLICY ANALYSIS NO. 68*.
- Martin, R., Chen, S., and Prem, S. (2008). *A Dollar A Day Revisited*. Washington DC: The World Bank. Retrieved 10 Augustus 2016.
- Marx, Karl. (2009). *Capital: An Abridged Edition*, Edited by David McLellan, Oxford Paperbacks, Oxford, UK
- OECD and ADB. 2002. *Technology and Poverty Reduction in Asia and the Pacific*. Development Centre Seminars. OECD Development Centre. Available at http://www.oecd-ilibrary.org/development/technology-and-poverty-reduction-in-asia-and-the-pacific_9789264176171-en.
- Oyewale, F. and Musiliu B.A. (2015). Empirical assessment of economic growth on poverty reduction in Nigeria. *American Journal of Economics*. Volume 5, No. 6. 565-573.
- Philippe A. (2002). Schumpeterian Growth Theory and the Dynamics of Income Inequality, *Econometrica*. 70(3), 855–882.
- 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.
- Ricardo, S. (2008). The Impact of Lifelong Learning on Poverty Reduction. *IFLL Public Value Paper 1*. Latimer Trend, Plymouth, UK.
- Richard, A.H. Jr. (2003). Economic Growth, Inequality, and Poverty: Findings from a New Data Set. *Policy Research Working Paper*. World Bank Group available at <http://www.economywatch.com/unemployment/poverty.html>
- Socia Prihawantoro, Alkadri, Mien Askinatin, Andi Tabrani, Supomo and Abdul Azis Wasil. (2010). *Peranan Teknologi dalam Pertumbuhan Ekonomi Indonesia, (The Role of Technology in Indonesian Economic Growth)*. Pusat Pengkajian Kebijakan Inovasi Teknologi (*Centre for Technology Innovation Policy*), Jakarta: Badan Pengkajian dan Penerapan Teknologi (*The Agency for the Assessment and Application of Technology*).
- Solow, R.M. (1956). A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*. Volume 70, No. 1. pp:65-94.
- Swan, T.W. (1956). Economic Growth and Capital Accumulation. *Economic Record*. 32: 334–61.
- The Saylor Foundation. (2012). *Unemployment Rate*. pp. 1. Retrieved 20 June 2016.
- UNDP. (2008). Capacity Development: Empowering People and Institutions. *Human Development Report*. Geneva.
- Vedder, R. and Gallaway, L. (1997). *Out of Work: Unemployment and Government in the Twentieth-Century America*. New York: New York University Press.