THE IMPACT OF TECHNOLOGICAL GROWTH ON ECONOMIC PERFORMANCE IN INDONESIA

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Abstract

Technology in the globalization era is difficult to be avoided in daily life. This study aims to estimate the impact of technological growth on economic performance in Indonesia using a Total Factor Productivity (TFP) method. The results indicate that technological growth in Indonesia during 1981-2012 is 0.87 percent, contributes up to 30.48 percent to economic growth. The results of econometric analysis suggest that technological growth will increase not only economic growth but also the unemployment rate, implying that technological growth in Indonesia creates jobs destruction than jobs creation.

Keywords: Technological growth, TFP, economic growth, unemployment rate
JEL classification number: O11, O47

Abstrak

Teknologi di era globalisasi sulit untuk dihindarkan dalam kehidupan sehari-hari. Penelitian ini bertujuan untuk mengestimasi dampak dari perkembangan teknologi pada kinerja ekonomi di Indonesia menggunakan metode Total Factor Productivity (TFP). Hasil penelitian menunjukkan bahwa perkembangan teknologi di Indonesia selama 1981-2012 adalah 0,87 persen, memberikan kontribusi hingga 30.48 persen terhadap pertumbuhan ekonomi. Hasil analisis ekonometrik menunjukkan bahwa perkembangan teknologi akan meningkatkan tidak hanya pertumbuhan ekonomi tetapi juga tingkat pengangguran, yang menyiratkan bahwa perkembangan teknologi di Indonesia menciptakan turunnya jumlah pekerjaan, bukannya menciptakan lapangan kerja.

Keywords: Pertumbuhan teknologi, TFP, pertumbuhan ekonomi, tingkat pengangguran
JEL classification number: O11, O47

INTRODUCTION

Technology continues to evolve over time. Technological growth can be interpreted in two forms of invention and innovation. Invention is defined as findings or new ideas, while innovation is the implementation or application of the idea. Forms of technological growth can be improved labor, capital and overall productivity. Other forms of technological growth are better policies, better management, better institutions, and other contribution of labor and capital.

Technological growth is another important factor determining economic growth besides capital and labor (see, for example, Van der Eng, 2003). Technology affects the output level of production activity. Domestic production is the total output of all production activities. Then the technology affects the total domestic production. Therefore, technological growth affects domestic production growth (economic growth). Total productivity growth might have close relationship with resource allocation (see Akkemik, 2007). Techno-

logical progress can lead to the destruction of technologically obsolete jobs and cause unemployment (see Michelacci and Lopez-Salido, 2007).

The important of technological growth has been the experience of the history of the countries that now belong to the group of developed countries, such as Italy, Netherlands, United Kingdom, Germany, the United States of America, Japan, and even Korea. The results of an empirical study by Hall and Jones (1999) mentioned that the five richest countries have the technology 12.18 times compared to the five poorest countries.

Various aspects on technological change have been investigated by various papers such as Alberto and Zeira (2006) who investigated technology and labor regulations or Gans (2012) who investigated innovation and climate change policy.

Also, the five richest countries produced more output or labor, are 31.70 larger than five poorest countries. Van der Eng (2010) has investigated the Sources of long-term economic growth in Indonesia, in which total factor productivity (TFP) has a contribution to it.

Technological growth has several dimensions, i.e: larger output, better product superior, new products, and greater product variety, that will increase productivity and also boost economic growth with a number of specific capital and labor. Increased economic growth requires additional labor as a factor of production to meet the increased aggregate demand.

One concern regarding technology development is the increasing of unemployment rate. So far, there is no theory that explains why technological growth influence unemployment rate. Pissarides and Vallanti (2007) assume that workers adjust to changes in productivity growth with a long lag, so when productivity growth changes the ratio of wages to productivity gets distorted, causing employment effects.

In contrast to the labor demand side, when a new technology arrives a firm may be able to upgrade an existing job and keep the same worker, or it may have to destroy the job and fire the worker. In the former case faster productivity growth implies higher demand for labor and permanently lower unemployment because of "capitalization" effects (Pissarides and Vallanti, 2007).

Open unemployment, economic growth, and the percentage of poor people in Indonesia during the 1980-2012 are very fluctuating. The growth of these three variables can be seen in Figure 1.

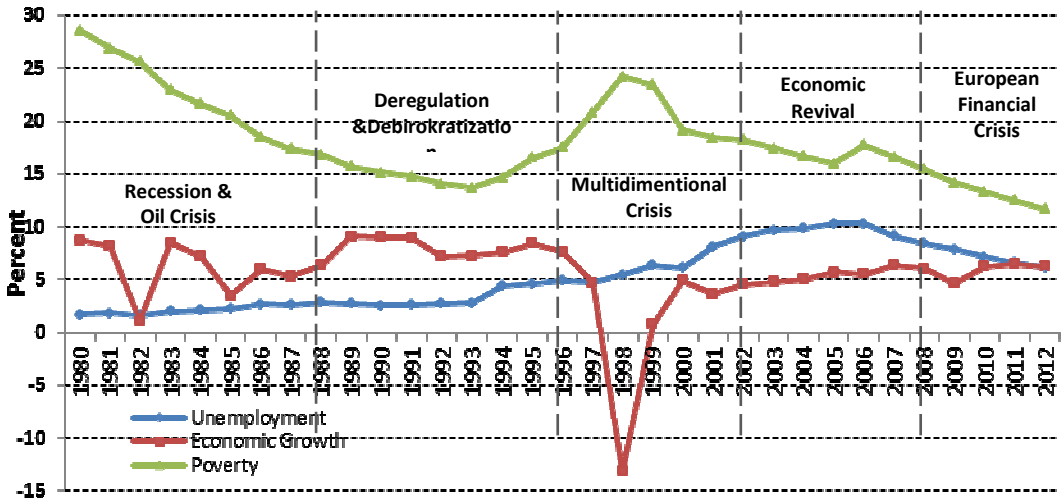

Figure 1: Unemployment, Economic Growth, and Population Poverty in Indonesia 1980-2012

In 2012, Indonesia's economic growth is quite high at 6.23 percent. The growth almost reached the target in the Medium Term Development Plan 2010-2014 where economic growth target is set at 6.3 to 6.8 percent and it is expected to reach 7 percent the year before period 2010-2014 ends. On the other side, unemployment and poverty levels are still high. Open unemployment in Indonesiain 2012 is 6.14 percent, while the poverty rate reached 11.66 percent. The numbers are still quite high when compared with the target in the Development Plan 2010-2014 toreduce unemployment by5-6 percentan d the poverty rate is expected lower to about 8-10 percent.

Research on total factor productivity and unemployment has been investigated by Ladu (2005) and Ball and Moffitt (2002). Research on technological development and economic growth in Indonesia has been conducted by various researchers. Frankema and Lindblad (2006) investigate technological development and economic growth in Indonesia and Thailand Since 1950.

Based on the description of the objectives to be generated from this studya re as follows (a) Identify how much technological growth in Indonesia from 1981 to 2012. (b) Explore the contribution of technological growth to economic growth in Indonesia in 1981-2012. (c) Explores how technological growth influences the performance of the economy as measured by economic growth, unemployment, and poverty in Indonesia in 1981-2012.

METHODS

This paper uses secondary data from 1980 to 2012 that originated from the Central Statistics Agency (Badan Pusat Statistik, 2012). In general, there are as follows gross domestic product (GDP) (current and constant prices), economic growth, capital approximated by gross fixed capital formation, employment and labor force approached with population aged 15 years and above, wages or salaries are approximated by the number of income or wage or workers salary, capital-labor ratio, the number of population who lived under poverty line, the real wageis obtained from the results of the average nominal wages divide by consumer price index and multiplied by 100. The method of analysis consists of descriptive analysis and multiple linear regression analysis.

One method to estimate the contribution of technology to economic growth is the approach of Total Factor Productivity (TFP). TFP is identified as contribution of technology to economic growth beyond the contributions of the two endogenous variables: labor andcapital.

$$g_t^A = g_t^Y - s_K g_t^K - s_L g_t^L \quad (1)$$

where

g_t^A is technological growth

g_t^Y is output growth

s_K is capital share

g_t^K is capital growth

s_L is labor share

g_t^L is labor growth

There are three models to find out the impact of technological growth on the economic performance which are economic growth, unemployment, and poverty.

Technological Growth Impact Model on Economic Growth

$$EG_t = \alpha_0 + \alpha_1 A_t + \alpha_2 KPL_t + \varepsilon_{1t} \quad (2)$$

Technological Growth Impact Model on Unemployment

Impact of technological growth model on unemployment refers to Pissarides and Vallanti (2007) that has been modified.

$$\text{Ln LF} = \beta_{01} + \beta_{11} A_t + \beta_{21} EG_t + \beta_{31} RW_t + \varepsilon_{2t}$$

$$\ln L = \beta_{02} + \beta_{12}A_t + \beta_{22}EG_t + \beta_{32}RW_t + \varepsilon_{3t}$$

$$\ln LF - \ln L = \beta_{03} + \beta_{13}A_t + \beta_{23}EG_t + \beta_{33}RW_t + \varepsilon_{4t}$$

Each coefficient multiplied by100

$$U = \beta_{04} + \beta_{14}A_t + \beta_{24}EG_t + \beta_{34}RW_t + \varepsilon_{5t} \quad (3)$$

Technological Growth Impact Model on Poverty

Technological growth impact model on poverty refers to Warr (2009) that has been modified.

$$Pov = \gamma_0 + \gamma_1 A_t + \gamma_2 EG_t + \gamma_3 RW_t + \varepsilon_{6t} \quad (4)$$

Annotation:

EG	is economic growth (%)
A	is technological growth (%)
KPL	is capital-labor ratio (billion per labor)
LF	is labor force (million)
L	is labor (million)
U	is unemployment (%)
Pov	is poverty growth(%)
RW	is real wage (millionRp)
ε	is *error term*
t	is times 1980-2012

RESULT

Technological Growth Analysis in Indonesia, 1981-2012

Technological growth in this study was estimatedby growth of Total Factor Productivity (TFP). Estimation results can be seen in Figure 2. Economic growth can be decomposed into laborgrowth, capital growth, and technological growth. Technological growth fluctuates every year where in 2010, 2011, and 2012 showed a negative value, that is equal to -0.98 percent in 2010, the year 2011 was -0.69 percent, and in 2012 was -1.54 percent. This condition can be interpreted that in those years technological growth reduces economic growth that actually should occur.

Over the 1981-2012, the average of economic growth in Indonesia is 5.42 percent. It can be decomposed into three: employment growth by 1.08 percent, 3.46 percent of capitalgrowth, and 0.87 percent of technological growth. Growth based on each period and phase of the economy can be seen in Table 1.

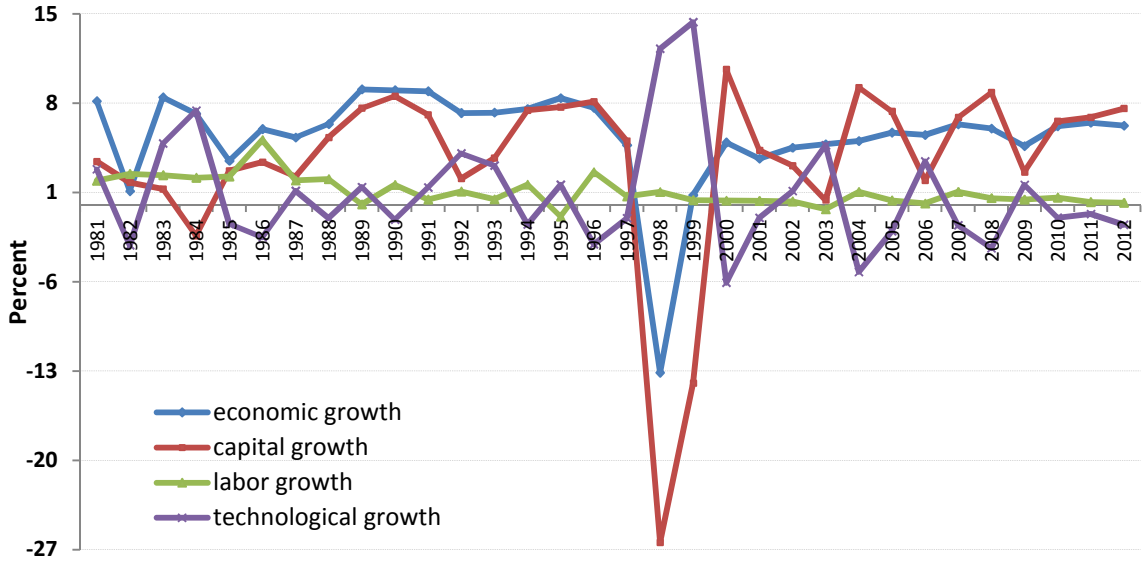

Figure2: Annual Economic Growth, Capital, Labor, Technological Growth in Indonesia in 1981-2012

Table 1: Economic Growth, Capital, Labor, and Technological Growth in Indonesia by Phase of the Economy

Period	Phase	Economic growth (%)	Labor Growth (%)	Capital Growh (%)	Technological Growth (%)
1981-1988	Recession & Oil Crisis	5.75	2.53	2.21	1.01
1989-1996	Deregulation & Debirok-ratization	8.13	0.87	6.53	0.74
1997-2001	Multidimentional Crisis	0.19	0.56	-4.08	3.70
2002-2007	Economic Revival	5.31	0.43	4.81	0.07
2008-2012	European Financial Crisis	5.90	0.41	6.50	-1.00
1981-2012		5.42	1.08	3.46	0.87

Source: Estimated TFP with Growth Accounting

Table 2: Contribution of Capital, Labor, and Technological Growth on Indonesian Economic Growth

Period	Phase	Contribution of Labor Growth to Economic Growth (%)	Contribution of Capital Growth to Economic Growth (%)	Contribution of Technological Growth to Economic Growth (%)
1981-1988	Recession & Oil Crisis	30.66	34.94	34.40
1989-1996	Deregulation & Debirokratization	10.51	65.41	24.08
1997-2001	Multidimentional Crisis	4.45	65.68	29.87
2002-2007	Economic Revival	6.08	53.09	40.83
2008-2012	European Financial Crisis	8.29	69.10	22.61
1981-2012		13.42	56.10	30.48

Source: Estimated TFP with Growth Accounting

Another presentation the decomposition of economic growthis to calculate the contribution each component to economic growth. It is obtained by assuming economic growth was 100 percent. Contribution of labor, capital, and technological growth based on the period and phase of the economy can be seen in Table 2.

During 1981-2012, technological growth provides a considerable contribution which is 30.48 percent to Indonesian economic growth. That is the second position after capital growth which is 56.10 percent. Labor growth contributed only 13.42 percent. This suggests that technological growth significant in spurring economic growth in Indonesia from 1981 to 2012.

The most important thing is labor growth contributed the lowest to economic growth in Indonesia. This would imply that employment growth has less impact on economic growth. The most likely causes are due to the growth of labor that occurs in sectors that do not have a high impact on economic growth.

Average contribution of capital growth to economic growth in each period showed a meaningful role. This indicates that its growth has a significant contribution to economic growth which is will occurs. Thus, capital growth which entered into during the period 1981-2012 has the ability to create rapid economic growth. When associated with the economic sector, this growth was getting into the manufacturing sector that requires large capital. Contribution of the manufacturing sector is large enough to spur economic growth.

Table 3: Comparison of Technological Growth and Its Contribution to Economic Growth with Other Countries in Asia in 1980-2000

Countries	Technological Growth (%)	Cobtribution of Technological Growth to Economic Growth (%)
ASEAN		
Malaysia	1.29	25.95
Philippines	-0.37	14.68
Singapore	0.78	10.95
Thailand	1.00	16.91
Indonesia (this study)*	0.87	30.48
Non ASEAN		
India	2.08	40.80
Iran	0.47	17.96
Japan	1.78	94.00
Republic of China	1.85	25.24
Republic of Korea	1.82	25.26

Source: Asian Productivity Organization (2004)

Theclassification by economic phase showed that the contribution of each growth varied. In the phase of economic recession and the oil crisis, the contribution of the three growth's (labor, capital, and technology) contributed almost equal. In subsequent phases, the structure began to change, capital growth showed their dominance in contributing to the economic growth.

Comparison of Indonesian technological growth with other countries in Asia can be seen in Table 3. Although Indonesian technological growth under 1 percent, but could contribute to the economic growth above 30 percent.

During 1980-2000, high technological growth demonstrated by India (2.08 per cent), followed byChina (1.85 percent), Korea (1.82 percent), and Japan(1.78 percent). Indonesia which was been dubbed as the Asian tiger in the 90's just under Malaysia. It is noted at 1.29 percent above Indonesia which only 0.87 percent. Deceleration is shown by the Philippines which slow down by 0.37 percent.

Impact of Technological Growth on Economic Growth

Economic growth means development activities in the economy that led to the goods and services produced with in the community to grow and increase the prosperity of society. The problems of economic growth can be seen as a macroeconomic problem in the long-term. A country ability to produce goods and services always increase, it's due to the increasing of production factors that quantity and quality also increase. The investment will increase larger of capital goods. The technology which is used becomes develop.

Technological growth has a significant positive effect on Indonesian economic growth. This can be seen in Table 4. Coefficient of technological growth in the model is 0.484530. This means that one percent increase in technological growth result in about 0.5 percent in the economic growth, assuming other variables held constant.

Technological growth will increase the rate of economic growth. The high economic growth is expected to bring down unemployment to a lower level. Consistent with Okun's Law, there is a negative correlation between forecasts of real GDP growth and the change in Unemployment (Ball et al., 2014).

Table 4: Regression Result of Economic Growth

Variable	Coeffisient	Std.Error	t-Statistic	Prob.
Intersept (C)	3.421391	0.396673	8.625223	0.0000
Technological Growth (A)	0.484530	0.113680	4.262225	0.0002
Capital per Labor (KPL)	0.451794	0.045948	9.832665	0.0000
R-squared	0.812574			
F-statistic	62.86379			
Prob.(F-statistic)	0.000000			

Technological growth could increase economic growth sustainably over time. It could increase output through the production function with certain of capital and labor directly. It also enables the country to support a larger capital stock which in turn becomes higher output levels.

Impact of Technological Growth onUnemployment

Technology in the globalization era is difficult to be avoided in daily life. Using technology, a work or production process will be completed quickly, accurately, and efficiently. Production costs could also be reduced. Results of multiple linear regression processing labor force and labor can be seen in Table 5 and Table 6.

Best model the impact of technological growth on unemployment rate is as follows:

$$U_t = 0.857 + 0.7389A_t - 0.6829EG_t + 13.4551RW_t + \varepsilon_{5t}$$

Based on the best regression model found that technological growth was significantly positive effected on unemployment. Every one percent increases in technological growth will increase unemployment by 0.74 percent, assuming other variables held constant.

Table 5: Regression Result of Labor Force

Variable	Coeffisient	Std.Error	t-Statistic	Prob.
Intersept (C)	3.833162	0.104080	36.82894	0.0000
Technological Growth (A)	0.023292	0.007329	3.178214	0.0036
Economic Growth (EG)	-0.025760	0.007803	-3.301481	0.0026
Real Wage (RW)	1.218873	0.142963	8.525807	0.0000
R-squared	0.864593			
F-statistic	59.59454			
Prob.(F--statistic)	0.000000			

Table 6: Regression Result of Labor

Variable	Coeffisient	Std.Error	t-Statistic	Prob.
Intersept (C)	3.824592	0.096185	39.76306	0.0000
Technological Growth (A)	0.015903	0.007309	2.175935	0.0382
Economic Growth (EG)	-0.018931	0.007851	-2.411277	0.0227
Real Wage (RW)	1.084322	0.133184	8.141507	0.0000
R-squared	0.850381			
F-statistic	53.04753			
Prob.(F--statistic)	0.000000			

Table 7: Regression Result of Poverty

Variable	Coeffisient	Std.Error	t-Statistic	Prob.
Intersept (C)	3.510043	0.160172	21.91428	0.0000
Technological Growth (A)	0.008498	0.015090	0.563172	0.5778
Economic Growth (EG)	-0.029836	0.014532	-2.053135	0.0495
Real Wage (RW)	-0.778325	0.252242	-3.085624	0.0045
R-squared	0.500521			
F-statistic	9.352814			
Prob.(F--statistic)	0.000190			

Regression results show that in Indonesia technological growth will increase the unemployment rate. It can be explained that technological advances basically has a tendency to reduce the use of other production factors in the production process at any output level. Using technology will increase productivity and higher efficiency. But the causality can some times work on the other way around. Acemoglu (2010) concludes that labour scarcity will encourage technological advances if the technological progress is a labor saving one.

Almost all types of technological growth can improve the labor demand in some labor market (jobs creation) and a lower demand for labor in other labor market (jobs destruction). Introduction of automated manufacturing processes have resulted in lower demand for skilled laborand on the other hand increases the demand for quality control technician and computer programmer. Generally, the changes in technology will affect the composition of labor demand, increased demand forsome types of labor and reduced demand for others. What happened in Indonesia is jobs destruction greater than jobs creation.

Impact of Technological Growth on Poverty

Advance technology which is constantly evolving over time requires high human resources. Poverty problem in Indonesia are intimately linked with low human resources. The technological growth will boost economic growth which in turn is expected to lower the unemployment rate. If unemployment can be reduced the poverty rate would also be dropped.

Based on the best regression model as shown in Table 7, found that the technological growth did not impact significantly on poverty in Indonesia. Variables that significantly affected poverty in Indonesia are economic growth and real wages.

Technological growth did not affect the poverty, but it should be underlined and concerned that it has positive direction toward poverty. It means that technological growth will increase poverty. Conditions that could explain this phenomenon are the Indonesian people have not been able to accept and follow the technological growth, and also have a low quality of human resources.

Industrial sector is one example of technology implementation. Before technology being implemented in this sector, it used more man power but as technology applied industry use more machine. This process results a massive layoffs, increase unemployment and poverty.

CONCLUSION

Over 1981-2012, the average of technological growth inIndonesia is 0.87 percent. It provides a substantial contribution to economic growth about 30.48 percent. Technological growth contributed to Indonesian economic growth after capital growth and before labor growth.

Technological growth affected the performance of the Indonesian economy as measured by economic growth, unemployment, and poverty. The existence of tech-

nological growth significant in spurring economic growth in Indonesia, but on the other hand actually change the composition of the labor and increasing unemployment. Technological growth did not significantly affected poverty, but it could worsen poverty in Indonesia if we can't increase the skill of labor and entire human resources.

Government plays important role in technological growth, they must be actively support the development of technology in order to equal technological growth indeveloped countries. To meet that goal Indonesia need capital and substatial inves tment to research and development especially in industrial sector.

Another suggestion, government should make a policy to protect domestic technology improvement. For example, encourage people to use local product such as vehicle and electricity produce by national companies.

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