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ROLE OF TECHNOLOGY IN ECONOMIC GROWTH CONVERGENCE AMONG COASTAL REGIONS IN THE EASTERN PART OF INDONESIA

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Abstract

This paper aims to assess the contribution of technology to economic growth convergence among coastal regions in the eastern part of Indonesia (KTI). Panel data spanning 1975-2002 are analyzed using Total Factor Productivity (TFP) catch-up model and Transfer of Technology model. The TFP model results show that the difference in technological level among the coastal regions in the KTI explains the slow speed of the TFP catch-up. When the difference in technology level disappears the TFP catch-up takes place at a faster rate thereby pushing income level convergence to occur among the coastal regions in the KTI. The results of the transfer of technology model show that a greater portion of the convergence comes from transfer of technology. If the technology difference disappears, the transfer of technology would be faster and speed up income convergence among the coastal regions in the KTI.

Keywords: *economic growth, eastern Indonesia, coastal regions*

INTRODUCTION

After 15 years of independence Indonesia was still one of the poorest nations on earth. The percapita income of Indonesia in 1967 was only half of that of Bangladesh, Nepal and Nigeria. But since then Indonesia had experienced a substantial structural progress. During the period 1969-1996 the economy grew on average by 6.8 percent, far outstripping the economies of the low and middle income countries (Hill, 2000). The structural progress brought forth by this high and sustainable economic growth had changed the image of Indonesia, from what initially Sundrum (1986) called Indonesia as "*the number one failure among the major underdeveloped countries*" to what the World Bank (1993) regarded Indonesia as "*one of the shining lights of the international economy*".

In 1975, the poorest province earned only one sixth of the percapita GDRP of the richest province, excluding oil and gas. This fact alone reflects a tremendous regional income disparity. If the income from oil and gas is taken into account the ratio explodes to one twenty-fifth, a much graver disparity. This disparity did not shrink after 25 years have passed. Rather it got worse. In 2000 the percapita GDRP (excluding gas and oil) of the poorest province was only one ninth of that of the richest province. Again, if the income from oil and gas is included the ratio would swell to one twelfth (Hill, 2000).

Over the last 30 years (since 1975) Java has been unshakeable as the center of economy and population. In fact Java has become even stronger *vis-à-vis* outside Java as the share of its GDRP in national GDP has increased from 47 percent in 1975 to 55 percent in 2002. However, during the same period its share in total national population has declined from 63 percent to 59 percent (BPS, 1975-2006). Likewise, over the same period (1975-1995), regions in the eastern part of Indonesia experienced far slower economic growth than those in the western part (Garcia and Soelistianingsih, 1998).

There is a tendency that the poorer provinces will only catch up if their economy grows faster than the richer provinces. This is also true for the coastal regions in the provinces in the eastern part of Indonesia. This means that regional economic growth plays a very important role in reducing regional income disparity among the coastal regions in the eastern part of Indonesia. Therefore, to narrow down the income gap between the rich and poor coastal regions, there must be a sufficient push for the economy of the former to grow faster.

With a sufficient push for the economies of the poor coastal regions to grow faster than those of rich ones, it is expected that the income disparity among the coastal regions will diminish or even disappear; and their economies will converge to a more or less uniformly fast growth rate. There is a clear-cut relationship between economic growth rate and poverty. As the economy grows faster poverty diminishes, and the opposite is true (Easterly, 2001).

The percapita income convergence among regions (in one country) is a common empirical phenomenon. This convergence arises from the *total factor productivity (TFP) catch-up* or the *technology catch-up* by poor regions, which then drive their economies to grow faster thereby increasing their percapita income.

In development economics the term technology has a specific meaning. Technology is a way by which inputs are converted into outputs in a production process. As an example if the production function is of a general form given by $Y = F(K,L, .)$, production technology is captured by the function $F(.)$. This function describes how inputs are transformed into output. In a Cobb-Douglass production function $Y = K^{\alpha} (AL)^{1-\alpha}$, A denotes an index of technology.

Romer (1993) extends the definition of technology by considering technology as "*ideas*". Technology is often associated with manufacture only, while in fact many economic activities take place outside factories. Ideas include unlimited perspectives about product packaging, marketing, distribution, quality control and employees' motivation, all of which are manipulated in a production process to create economic values in modern economies.

Many studies show that technology is the main contributor to income convergence phenomena (Barro, 1991; Barro and Sala-I-Martin, 1992; Barro and Sala-I-Martin, 1995). Different level of technology in different regions produces different economic growth rate in those regions. Therefore, narrowing the level of technology gap will bring about a quicker income convergence among regions.

A typical economic growth in regions of developing countries is that *ideas* gap among regions is more problematic than capital accumulation gap. Many important ideas are protected and kept secret and still many other ideas can only be acquired through direct experiences (learning by doing). This in turn becomes one of the most important constraints to transferring technology, in that the adoption of the best technology (from advanced countries) does run smoothly.

If the poor provinces are lagging in technical efficiency there is no way to expect that these regions will experience an economic growth rate equal to that enjoyed by the rich provinces. This largely explains why there was economic growth disparity among different provinces in Indonesia during the period 1975-2002 (Akita and Alisyahbana, 2002).

Based on that background, this research attempts to analyze the regional income disparity by specifically focusing on the economic growth disparity among the coastal regions of the provinces in the eastern part of Indonesia (henceforth, the coastal regions in the KTI provinces). In doing so it employs the *Total Factor Productivity* (TFP) *catch-up* model and the transfer of technology model. In particular, it aims to address the question: does technology play an important role in the convergence of the economies of the coastal regions in the eastern part of Indonesia and what factors are behind this convergence?

REVIEW OF PREVIOUS RESEARCH

An empirical study of the economic convergence in Indonesia by Esmara (1975) shows that the regional income disparity in Indonesia is relatively high compared to other third world countries. Employing Williamson index, Esmara finds that the disparity index for 1972 is 0,522. But when the income from oil and gas is excluded the disparity is significantly reduced.

Giarratani and Soeroso (1985) apply the neoclassical growth model to explaining the economic growth in Indonesian provinces. They find that the factors of production play the roles as predicted by the model. However, when the model is solved dynamically, they show that potential regions with their attracting power can generate instability and divergence among regions. A simulation of government intervention through a policy that pushes the capital accumulation in the lagging regions shows that the intervention policy leads to convergence.

Using Williamson index, Akita and Lukman (1995) find a tendency for the regional income disparity to decline during the period 1975-1992. By making use of the *rank correlation* statistics they come to a conclusion that factors responsible for the decline include the central government budget and transfer to the provincial governments.

The study by Garcia and Soelistianingsih (1998) of the regional income disparity for the period 1975-1993 reveals that all the provinces did grow but not change their relative places in terms of income level. Both the richest and poorest provinces in 1983 were still the richest and poorest respectively in 1993. Employing the measurement *σ-Convergence* they find that the regional income disparity constantly declined from 0.93 in 1975 to 0.28 in 1993, except for 1983. When *β-Convergence* is used they obtain the absolute convergence of 2.4 percent and the conditional convergence of 4.8 percent for 1975-1993.

Akita and Alisyahbana (2002) estimate the regional income disparity for the period 1993-1998 by adopting *theil* index using GDRP data and the population of districts/cities (*the two-stage nested inequality decomposition method*). They find that the regional income disparity increased significantly over the period 1993-1997 due to within-province disparity, especially in Riau, Jakarta, West Java and East Java. In 1998, the disparity drastically declined to the level of 1993-1994. This decline is attributable mainly to the change in income disparity among provinces.

THEORETICAL BACKGROUND

Regional Economic Growth Convergence

The regional percapita income convergence has become a topic frequently studied over the last decade. Two main approaches are often used in this type of study. First is the regional convergence analysis derived from the analysis across different countries (international level). This type of analysis mostly uses *cross-section* data of different countries where the initial percapita income is regressed on economic growth (Barro, 1991, Barro and Sala-I-Martin, 1992; 1995).

Second is the approach rooted in the long tradition of regional study that puts a strong emphasis on the analysis of regional percapita income disparity. Unlike the first approach, this approach analyzes the income disparity independently of growth theory. The classic reference of this approach is Williamson (1965) that explains that the process of regional convergence is strongly related to the national development process. Williamson predicts that the regional income disparity will decline (*convergence*) as the economy goes through the *initial stage* and the *mature stage*.

Agglomeration Process and Development of Coastal Regions in the Eastern Part of Indonesia

One form of the government interventions to accelerate the income convergence or reduce the regional economic development disparity in the eastern part of Indonesia is the introduction of agglomeration policy by creating various growth centers as an integral part of the integrated regional economic development (KAPET). In this context, since the sixth Pelita (five-year development plan) an attempt was continuously made to further accelerate the economic development in the eastern part of Indonesia. For that purpose, the government created a special board for developing the KTI called the Council of Development of the Eastern Part of Indonesia (DP-KTI).

One of the recommendations of the DP-KTI is the urgent development of special regions in each province of the KTI so that once each region develops rapidly the development of the KTI will accelerate. These special regions in turn are called the integrated regional economic development (KAPET). Unfortunately in reality the KAPET concept did not work well and failed to narrow down the regional economic development disparity in the KTI (Shankar and Anwar, 2001). Shankar and Anwar attribute the failure to problems associated with agglomeration, the most important of which include the fact that the development was excessively focused on physical aspects (limited attention was paid to *entrepreneurship* and *innovation*), that the *geographical proximity* was inadequately taken into consideration and weak institutions.

Taking account of agglomeration externality in the KAPET programs likely creates *knowledge spillover* produced by the activities of economic agents of certain industries in those special regions (Glaeser *et al.*, 1992). This agglomeration externality is believed to serve as determining factor of the geographical concentration of economic activities in certain regions. The most important effect of the externality on economic agents, especially businesses, is the tendency for them to locate in certain areas for reasons of sector input-output linkage in these areas (Gilmour, 1974). Referred to as *external economies of scale* this externality effect arises from spatial proximity of industries that have strong linkage and from the increase in economic transactions in or around those areas.

The lessons learned from the failure of the KAPET programs include the urgency for strengthening the institutions (such as research and technology development institutions, human resource training and education institutions and other institutions that help develop regional industries) and empowering production sectors that have strong regional linkage in terms of inputs so that agglomeration processes may take place in the KTI (Kusumasmanto, 2002).

Accelerating the reduction of regional development disparity in the KTI by developing the economies of the coastal regions driven mainly by investment and exports is considered as an appropriate strategy. This is because the potentials of the Indonesian coastal regions and marine may serve as the *prime mover* of the economy. These potentials include both *renewable* and *non renewable* resources. Their *environmental services* also are very potential to improve the development of the KTI (Dahuri *et al.*, 2001).

The development of the marine sector in the KTI in principle puts into full use its ecosystem diversity. Therefore, developing the marine sector also means developing the economy of each coastal region in the KTI. A large variety of production technologies in the marine sector (from labor intensive to knowledge intensive technologies) will accommodate human resources with different skills and educations. Thus, the marine sector development in the coastal and marine regions will improve distribution, employments and economic growth in the KTI. The more developed the marine sector the better will be the quality of growth, distribution and economic stability. Accordingly, the regional economic development disparity can finally be reduced thereby accelerating the economic growth convergence among regions in the KTI (Kusumasmanto, 2000).

RESEARCH METHODOLOGY

Model Specification

The analytical model relies on the *technology cacth-up* approach and consists of two models: (1) the *total factor productivity* (TFP) *catch-up* model due to Dowrick and Nguyen (1989), and (2) the transfer of technology model introduced by Dowrick dan Rogers (2002). The following is the detailed explanation of each model.

TFP catch-up Model

The first wave of empirical studies of percapita income convergence attempted to show that the convergence is a real phenomenon and show the strength of the neoclassical model. The second type of convergence is the tendency to catch up the *total factor productivity* (*TFP catch-up*). The technology catch-up will likely lead the percapita income to converge. But this tendency might be exaggerated if the growth of the factor intensity systematically varies according to the development of income level.

Following Dowrick and Nguyen (1989), the TFP convergence model attempts to capture the extent the *accumulation factors* in technology growth contribute to variation in economic growth.

Dowrick and Nguyen's model begins with a Cobb-Douglas production function augmented with a technology growth rate, γ, and the TFP catch-up function, F_{it}.

$$\begin{aligned}\ln Q_{it} &= A_i + \alpha \ln K_{it} + \beta \ln L_{it} \\ &+ \gamma t + \lambda \ln F_{it}\end{aligned} \quad \text{............} \quad (1)$$

The annual growth rate of the technology catch-up function is inversely related to the productivity of labor relative to the technologically-leading economy.

$$\frac{F_{it}}{F_{i.t-1}} = \frac{1}{\gamma *_{i.t-1}} \quad \text{..................................} \quad (2)$$

Taking the *first difference* of equation (1) and substituting it into equation (2) gives

$$q_{it} = \gamma + \alpha k_{it} + \beta l_{it} - \lambda \ln Y *_{i.t-1} \quad \text{..........} \quad (3)$$

where the growth rate of aggregate output depends on the relative productivity.

Assuming that both labor and capital stock grow by a constant annual rate in each economy, we can derive the following equation:

$$q^*_{it} = q_{it} - q_{lt} = \alpha k^*_i + \beta l^*_i - \lambda \ln Y^*_{i.t-1} \quad \text{................ (4)}$$

Equation (4) in turn is expressed in terms of differential growth rate of output per labor:

$$y^*_{it} = \alpha k^*_i + (\beta - 1) l^*_i - \lambda \ln Y^*_{i.t-1} \quad \text{......(5)}$$

Since

$$y^*_{it} = \ln Y^*_{it} - \ln Y^*_{i.t-1} \quad \text{...................... (6)}$$

then,

$$\ln Y^*_{it} = \alpha k^*_i + (\beta - 1) l^*_i + (1-\lambda) \ln Y^*_{i.t-1} \quad \text{.................. (7)}$$

The solution to this *difference* equation produces equation:

$$\ln Y^*_{i.\tau} = \frac{[1-(1-\lambda)^\tau]}{\lambda}(\alpha k^*_i + (\beta - 1) l^*_i) + (1-\lambda)^\tau \ln Y^*_{i.0} \quad \text{.......... .... (8)}$$

Equation (4) shows that the average annual growth rate of GDP is:

$$\bar{q}_i = c + \alpha \frac{\delta}{\lambda} k_i + [1 - \frac{\delta}{\lambda}(1-\beta)] l_i - \delta \ln Y^*_{i.0} \quad \text{........... (9)}$$

$$\text{where } \delta = \frac{1-(1-\lambda)^\tau}{T} \quad \text{......................... (10)}$$

and

$$c = \gamma + (1 - \frac{\delta}{\lambda})[\alpha k_t + (\beta - 1) + (\beta - 1) l_t] \quad \text{.. (11)}$$

Equation (9) states that the growth rate of GDP depends on the growth rate of input factors, the rate change in exponent technology and the initial output level per labor relative to the technologically-leading region. Notice that the coefficient on the initial income level (δ) does not only depend on the parameter of technology catch-up (λ) but also on the number of observations (sample size). Intuitively, we expect that the technology catch-up is stronger in the early years of observations, when the productivity level still far lags behind, and will decline along the way as the income disparity declines.

Transfer of Technology Model

To assess the role played by technology in the economic growth convergence, this study employs the model introduced by Dowrick and Rogers (2002) known as the transfer of technology model. This model states that the growth rate of labor productivity is inversely related to the productivity gap between the technologically-leading regions and the technologically-lagging regions.

We assume the production follows a Cobb-Douglas production function with *constant returns to scale* technology:

$$Y = K^\alpha (AL)^{1-\alpha} \quad \text{............................... (12)}$$

where Y is output, K is capital, L is labor and A is *level* of technology. L and A are assumed to grow exogenously by n and g rates respectively, namely:

$$L_t = L_0 e^{nt} \quad \text{....................................... (13)}$$

$$A_t = A_0 e^{gt} \quad \text{....................................... (14)}$$

Deriving the growth rate of output per labor, we express equation (12) in the intensive form and take its derivative with respect to time to have:

$$\frac{\dot{y}}{y} = (1-\alpha) g + \alpha \frac{\dot{k}}{k} \quad \text{.............................. (15)}$$

where $k = K/L$, $y = Y/L$, and the dot over the variables represents time derivative.

The panel specification based on equation (15) can be expressed as follows:

$$z_{it} = g_i(1-\alpha) + \alpha\left[\frac{\dot{k}}{k}\right] + \varepsilon_{it} \quad \text{.................} \quad (16)$$

The model hypothesizes that some of the differences in the growth rate of technology are attributable to the technology catch-up. The growth rate of technology can be modelled as follows:

$$g_{it} = \ln\left[\frac{A_{i.T}}{A_{i.T-r}}\right] = g_i + g_T + \varphi \ln\left[\frac{A_{i.T}}{A_{i.T-t}}\right] \quad \text{...............} \quad (17)$$

Substituting equation (16) into equation (17) and adding into it the growth rate of education capital, *h*, gives us:

$$z_{iT} = \{g_T + \varphi \ln y_{\bullet.T-t}\} + g_i - \varphi \ln y_{i.T-r} + \alpha_k\left[\frac{\dot{k}}{k}\right]_{iT} + \alpha_h\left[\frac{\dot{h}}{h}\right] + \varepsilon_{iT} \quad \text{............} (18)$$

In the transfer of technology model, the level of convergence is divided into two parameters: the convergence level that arises from factor accumulation (*neoclassical convergence*, λ^a) and the convergence level that results from the transfer of technology (*technology convergence*, λ^{tt}).

The neoclassical convergence is calculated based on the *TFP catch-up* model as explained before, while *the rate of technological catch up*, λ^{tt}, is defined as λ in the following differential equation:

$$\frac{\partial x_t}{\partial t} = \lambda\left[x^* - x_t\right] \quad \text{...............................} \quad (19)$$

The solution to this equation, by taking the integration with the constant C dan D, is as follows:

$$x_t = Ce^{-\lambda t} + Dt \quad \text{.................................} \quad (20)$$

In the empirical analysis we have observations of initial year and final year, namely t = 0, 1, 2, …T year ; x_0 and x_t where:

$$y_0 = C$$
$$y_t = Ce^{-\lambda T} + DT = y_0 e^{-\lambda T} + DT \quad \text{......} \quad (21)$$

The growth rate used in the regression analysis of the transfer of technology model is the average annual rate:

$$\frac{y_T - y_0}{T} = \frac{1-e^{-\lambda T}}{T} y_0 + D \quad \text{................} \quad (22)$$

The negative regression coefficient on x_0 , -β, is equal to the first term on the righthand side of equation (22):

$$.-\beta = \frac{1-e^{-\lambda T}}{T} \Rightarrow e^{-\lambda T} = 1 + \beta T \qquad \Rightarrow \lambda = -\frac{\log(1+\beta T)}{T} \quad \text{........} \quad (23)$$

where the expression λ serves as estimate of the technology catch-up in the transfer of technology model.

Analytical Method

This study uses panel data analyzed using panel data regression with and without *fixed effect*. While the panel data regression without *fixed effect* is estimated using the *Generalized Least Square* (GLS) method, the one with *fixed effect* is estimated using *Cross Section Weights (CSW)* method.

Data

All the data are of secondary type and include the growth rate of real GDRP covering 1975-2005, percapita real GDRP in the initial year (observation), annual growth rate of employed labor force, and annual growth rate of capital stock. The source of the data is the BPS from its various publications: (1) Gross Domestic Regional Product (GDRP) of Coastal Regions (regencies/cities) of provinces in the KTI, (2) National Labor Force Survey (Sakernas) and (3) Inter-Census Population Survey

(Supas). All the data are expressed in the 1993 prices.

Scope of Analysis

The analysis in this study is focused on the economic growth convergence among the coastal regions in the KTI provinces within the period 1975-2002 only. By the eastern part of Indonesia (KTI) we mean the term commonly used to refer to the development program for the eastern part of Indonesia as defined by Wallace border line that serves as Zoogeographic line and has the geographic characteristic as coastal areas. Accordingly, in this study the coastal regions (regencies/cities) in the KTI provinces include the coastal regions (regencies/cities) in Sulawesi provinces (North Sulawesi, Gorontalo, Central Sulawesi, South Sulawesi, Southeast Sulawesi and West Sulawesi), Bali, Nusa Tenggara (West Nusa Tenggara, East Nusa Tenggara), Maluku (Maluku dan North Maluku) and Irian Jaya (Papua).

For the analysis to be consistent the newly-created regencies/cities are returned to the original regencies/cities before the creation of these new regencies/cities. For example, as far as provinces of Gorontalo, Southeast Sulawesi, West Sulawesi, and North Maluku are concerned the data used in this study are returned to the position before the creation of those provinces. The data for Gorontalo province are returned to (included in) the data for North Sulawesi province; the data for Southeast Sulawesi and West Sulawesi provinces are included in the data for South Sulawesi province; further the data for North Maluku province are included in the data for Maluku province.

The definition of costal region in each province, in theory, is linked to the purpose of its development, namely the land border of its *planning zone* and the border for its *regulation zone* (Dahuri *et al*., 2001). For the purpose of this study the definition of the coastal region according to the regulation zone is used. According to Dahuri *et al.* (2001), the planning zone covers all land areas (upstream), which become home to human inhabitants (or developments) that may carry impacts on the coastal environment and resources. Therefore, the border of the coastal region towards the land for a planning purpose can go so far as the upstream areas (or it may cover the overall administrative territories of the regency/city). Based on this definition, the above coastal regions in the KTI provinces are viewed in the planning zone perspective, thereby including regencies and cities with ecological and geographical characteristics congruent with resources potentials of the coastal and marine areas of the KTI.

DISCUSSION OF RESULTS

Analysis Using the *TFP catch-up* Model

This analysis attempts to provide a clear-cut prove necessary to remove significant doubt that the percapita income convergence does not result from the data bias or sample bias. Further, although there is a systematic tendency for the convergence to take place for a certain period of time, we must put forth a sufficient evidence that the economies of the poor coastal regions have grown faster due to faster *capital deepening* and faster *employment deepening* or due to such other factors as technology.

There is a crucial difference between convergence in the percapita income and the TFP catch-up tendency. Certainly the tendency may be overlooked or exaggerated if the growth of factor intensity varies systematically according to income.

Dowrick and Nguyen (1989) develop a model that quantifies the extent the TFP catch-up contributes to the growth rate variations. Equation (9) can be used to estimate the speed of the TFP catch-up by the coastal regions in the KTI provinces, as reported in Table 1.

The estimation of the speed of the percapita income convergence using total real GDRP produces a satisfying regression result. As reported in Table 1, the initial income level explains around 11–31 percent of the variation in the growth rate (based on the *Adjusted R-squared*, 11 percent with *fixed effect* and 31 percent without *fixed effect*). The negative sign of the coefficient on the log GDRP in the results of both panel-data models with and without *fixed effect*, indicates that the GDRP grows more slowly in the rich coastal regions, implying that income tends to converge in the coastal regions in the KTI provinces.

It is suspected that this income convergence occurs because the poor provinces have higher rates of investment so that the ratio of output to population becomes higher. Another possible contributing factor is the difference in the growth rate of labor force relative to population (Table 2).

Table 1: Estimated Speed of Percapita Income Convergence in the Coastal Regions of the KTI Using Total Real GDRP, 1975-2002: Dowrick and Nguyen Model

Independent Variable	Estimation Method	
	Panel without *Fixed Effect*	**Panel with *Fixed Effect***
Constant	0.0340 (4.9819)	-
Log "initial"real percapita GDRP (1975)	-0.0115 (-3.4546)	-0.0404 (-3.0149)
Adjusted R-squared	0.3107	0.1127
S.E. of Regression	0.0335	0.0359
DW-statistic	2.0705	2.4357
F-statistic	47.4442	-
Prob- F-statistic	0.0000	
Implied λ	**0.0107**	**0.0317**

Notes:

- The implied convergence speed (λ) is calculated using the formula from the coefficient on the initial income $\beta = 1-(1-\lambda)^{\tau}/T$, where T is the sample size or number of observations.
- The panel regression without *fixed effect* is estimated using the *Generalized Least Square* (GLS) method, while the panel regression with *effect* is estimated using the *Cross Section Weights (CSW)* method.

Table 2: Estimated Speed of the TFP Catch-up by the Costal Regions in the KTI Using Total Real GDRP, 1975-2002: Dowrick and Nguyen Model

Independent Variable	Estimation Method	
	Panel without Fixed Effect	**Panel with *Fixed Effect***
Constant	-0.0040	-
	(-0.5018)	
Log "initial"real percapita GDRP (1975)	-0.0136	-0.0847
	(-5.4782)	(-7.3037)
Growth Rate of Capital	0.3423	0.5505
	(5.1284)	(6.2871)
Growth Rate of Labor	0.3541	0.3358
	(2.9302)	(2.1027)
Adjusted R-squared	0.04538	0.4866
S.E. of Regression	0.0317	0.0324
DW-statistic	1.7074	2.2264
P-value for joint hypotheses	0.0000	0.0000
F-statistic	29.5247	62.8167
Prob- F-statistic	0.0000	0.0000
Implied λ^{af}	**0.0124**	**0.0550**

Notes:
- The implied speed of the TFP catch-up (implied λ^{af}) is calculated using the formula of the coefficient on the initial income $\beta = 1-(1-\lambda^{af})^{\tau}/T$, where T is the sample size or number of observations.
- The panel regression without *fixed effect* is estimated using the *Generalized Least Square* (GLS) method, while the panel regression with *effect* is estimated using the *Cross Section Weights (CSW)* method.

The estimation result as reported in Table 2 shows that the coefficient on the initial income tends to approach zero when the growth rates of labor and capital are included in the model as explanatory variables. With this specification, where the growth rates of labor and capital are controlled, the coefficient on the initial income (initial percapita GDRP) is interpreted as the TFP catch-up.

When the total real GDRP is used the regression result as reported in Table 2 shows that the income convergence moves more slowly than the rate of the TFP catch-up (Table 1). This may be because the capital intensity and or labor grow more slowly in the poor coastal regions. This evidence shows that the convergence among coastal regions in the KTI is not due to higher investment level or higher rate of labor participation. Rather it is due to other accumulation factors such as technology.

Analysis of *Transfer of Technology* Model

The analysis of convergence using the transfer of technology model attempts to synthesize two approaches, namely the TFP catch-up approach and the transfer of technology approach. This synthesis allows the model to distinguish the convergence caused by the accumulation factor (λ^{af}) from the one that results from the transfer of technology (λ^{tt}). The estimation of equation (18) will produce both tests for the neoclassical convergence (the TFP catch-up, λ^{af}) and the technology convergence (λ^{tt}). Table 3 reports the results of the estimation of both convergences.

The coefficient on log initial percapita GDRP estimates the speed of the technology catch-up, by controlling the variables of the growth rates of *physical capital* and *human capital*. The estimation results from both panel regressions with and without *fixed effect* show that the coefficient on log initial percapita GDRP has a negative sign and is statistically significant. The speed rate of the technology convergence, λ^{tt}, is estimated to range from 2.08 to 14.99 percent annually.

In general the speed of the technology convergence (*Implied* λ^{tt}) is found to be lower than the speed of the neoclassical convergence or factor accumulation (*Implied* λ^{af}), except for the estimation of the panel regression with *fixed effect*. This indicates that the significant difference in technology and institutions is a very important factor in explaining the growth rate differences in the coastal regions in the KTI provinces. Therefore, it is clear that if variable *A* (*level of technology*) differs the convergence becomes much better.

Table 3: Estimated of Convergence Speed in the Coastal Regions in the KTI Using Total Real GDRP Data 1975-2002: Dowrick and Rogers Model

Independent Variable	Estimation Method	
	Panel without *Fixed Effect*	**Panel with *Fixed Effect***
Constant	0.0229	-
	(3.4717)	-
Log Initial GDRP per labor (1975)	-0.0199	-0.1127
	(-15.6356)	(-18.0621)
Growth Rate of Physical Capital	0.2215	0.2740
	(4.2111)	(14.1175)
Growth Rate of Human Capital	0.4403	0.4713
	(2.9065)	(12.0575)
Adjusted R-squared	0.4714	0.7920
S.E. of Regression	0.0316	0.0259
DW-statistic	1.5837	2.4242
P-value for joint hypotheses	0.0000	0.0000
F-statistic	31.6136	210.1318
Prob- F-statistic	0.0000	0.0000
Implied λ^{af}	**0.0203**	**0.0153**
Implied λ^{tt}	**0.0208**	**0.1499**
Implied λ	**0.0411**	**0.1652**

Notes:

- The implied speed of Neoclassical convergence/accumulation factor (*implied* λ^{cf}) is calculated using the formula $\lambda^{cf}= (1-\alpha^{k}- \alpha^{h})$; the implied technology convergence (*implied* λ^{tt}) is calculated using the formula $\lambda^{tt}= ln(1+T.\beta)/T$ that represents the annual rate associated with the transfer of technology. The panel regression without *fixed effect* is estimated using the *Generalized Least Square* (GLS) method, while the panel regression with *effect* is estimated using the *Cross Section Weights (CSW)* method.

CLOSING NOTES

Conclusion

The estimation of neoclassical model (the TFP catch-up) or the transfer of technology model finds that the income convergence takes place among the coastal regions in the KTI. The estimation result is statistically significant in both individual and simultaneous tests (using *t* and *F* statistics, respectively).

The economic growth convergence among the coastal regions in the KTI is found to be determined by the differences in technology and institutions. Once these differences diminish the convergence will likely increase. Using the analysis of technology convergence, this study finds that the TFP catch-up is an important and stable factor in driving the marine-and-fishery-based growth in Indonesia. The result also shows that the main mechanism behind the convergence process is the TFP catch-up, which plays a more dominant role than the factor accumulation.

From the panel regression we conclude that there is an indication that the difference in technology level among the coastal regions in the KTI brings about a big TFP difference. If the technology level difference disappears the TFP catch-up will occur at a far quicker rate. This TFP catch-up in turn will generate income level convergence in the coastal regions in the KTI.

The analysis using the transfer of technology approach that separates the convergence caused by factor accumulation from the one that arises from the transfer of technology produces the following result. The transfer of technology plays an important role in the convergence among the coastal regions in the KTI. When the panel regression allows each economy to have different production function, a major portion of the convergence comes from the transfer of technology. The difference in technology level among the coastal regions in the KTI is significantly big. If this gap disappears the transfer of technology will proceed more smoothly and bring about a more rapid income convergence.

Policy Implications

Theoretically, according to the traditional neoclassical growth model, public policy will have no effect on the regional economic growth in the long run. However, this absolute convergence hypothesis is weak in empirical reality. As a result, most researchers modified some of the model's too restrictive assumptions and took account of conditional convergence (by relaxing the assumption that saving and capital accumulation are exogenous). The main implication is that the public policy has room to affect regional economic growth in both short and medium terms. In this context, a change in public policy will carry a transitional change in the output growth, because each effect of policy will only work in short and medium terms by way of changing the growth path, leaving the long run growth unchanged.

This study recommends that the government increases its intervention policy to reduce technology and institution gaps in order to reduce the income disparity among the coastal regions in the KTI. In this context the technology policy to speed up the economic growth convergence in the coastal regions of the KTI can be viewed in two perspectives: market mechanism and technology flow. From the market mechanism perspective the policy to promote technology can be analyzed by market mechanism. This perspective offers three policies: (1) policy intended to form direction and speed from the supply side of technological development by way of strengthening the technology capability; (2) policy intended to generate the demand side of technology development by way of creating market demand for technological changes; and (3) policy intended to stimulate the match between the demand and supply through various financial and fiscal incentives, and make sure that innovation activities are successful technically and commercially.

From the technology perspective, the policy to speed up the convergence is related to three main elements: (1) element of foreign technology adoption where the transfer of foreign technology takes the formal channels such as FDI (foreign direct investment), equipments purchases, patents and licences and technical assistances. (Informal channels include sending students or staff abroad to study or for training and internship); (2) element of foreign technology diffusion, which is effective intra and inter industries. Inter and intra industry technology diffusion quickly improves technology capability of new entering businesses, which in turn improve the market competition thereby increasing the investment in local technological businesses; and (3) element of local businesses that assimilate, adapt and improve foreign technologies in order to develop their own local technology.

Accordingly, several strategic steps that need to be taken should change various current ineffective development policies and approaches in a way that enable them to accelerate the economic developments in the lagging regions so that economic growth convergence can take place in the coastal regions in the KTI provinces. They include the following.

1. a strong political will and commitment on the part of the central government to making sure that the coastal regions in the KTI receive a great more attentions in terms of development investments based on the actual desperate need for infrastructure adequacy, not on economic efficiency and any other yardsticks such as population size. This must also be supplemented with a greater autonomy and authority given to the regional governments to manage those funds.
2. development investments should be greatly directed to infrastructure development sufficient to open up the regions in the KTI territories and propel agglomeration to take place thereby creating significantly high value added and generating linkages among regions in the KTI especially in economic activities. Accordingly, investors are attracted to invest their money in the KTI and have access to not only domestic but also international markets. For that end, a priority should be given to development of roads, bridges, sea ports, telecommunication and supporting facilities such as custom and immigration service centers.
3. push human resource development and social resource skill improvement in the coastal regions in the KTI through education and training with curriculum that adequately answers the regional development challenges and problems so that local human resources have necessary capacity to acquire technology and transfer of technology.

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