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ECONOMIC INTEGRATION AND ENDOGENOUS GROWTH: AN EXPLANATION USING AK MODEL

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Abstract: This research investigates the impacts of economic integration on endogenous growth by an application of the AK learning-by-doing model. Assuming that the knowledge that increases the productivity of labor will be created by accumulated capital, we divide economic integration into two different categories: one-way and two-way integration. The results show that two identical countries cannot have any benefits from economic integration. If two countries are different, the domestic country should only integrate with foreign countries that have a lower cost of capital of wage, or higher learning coefficient (the speed of transferring accumulated capital to knowledge) in the case of one-way integration. The same conclusion is still drawn in the case of two-way integration for two similar countries.

Keywords: economic integration, endogenous growth, AK model

1 Introduction

International economic integration has been on the top of priorities of Vietnam's Government through the 'Doi Moi' since 1986. As an essential part of the international integration, from the National Congress VI until now, Vietnam has gradually implemented widen integration policies with the economic, investment and trade renovation towards more freedom and transparency. There are several milestones that show the huge progress of Vietnam in this process, for example, Vietnam's participation in the World Trade Organization (WTO) in 2007, ASEAN economic community (AEC) in 2015 or Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) in 2017. Additionally, over the last decades, the world witnessed an unprecedented wave of globalization efforts that often took the form of regional trade agreements and deeper integration agreements. The Asia-Pacific region plays an important role in these efforts with various bilateral investment treaties. Vietnam has participated widely and deeply in this trend with many bilateral agreements with other governments over the world. In the context of the 4th industrial revolution that happens across the globe, together with the fast and strong integration progress, Vietnam's economy is expected to have an intensive transformation in the future.

Economic integration brings about many advantages because it helps firms to access more markets, technologies, as well as capital with lower and cheaper efforts. However, the associated challenges cannot be ignored. The government revenues will be reduced due to the

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tax reduction or tax exemption as these are part of the integration routes. Besides, the domestic firms will compete more rigorously with foreign firms. As a conclusion, the impacts of economic integration remain unclear. It could boost economic growth or prevent it from developing if we do not have appropriate strategies to get the most out of it.

Many economists believe that the increase in economic integration among developed countries normally lead to sustainable economic growth in the long term [14]. If they were asked about giving an intuitive opinion regarding this issue, they would suggest that the prospect of economic growth could be completely diminished if a barrier were erected to hinder the flow of capital, goods, and ideas between nations and continents. Then, when the economic integration occurs, which means the tariffs and tax barriers are demolished, and labors, goods, and ideas can move from place to place freely, will the economic growth be promoted? Are there the effects of integration in the short or long term? Until now, no such a model that can explain these questions in details exists.

Before the '90s, many economists applied the Mashalian model to investigate the impacts of trading on the long term growth rate. The results show that the benefits of integration are relatively small. Rivera-Batiz and Romer (1991) propose an economic integration model with two identical countries or regions with the starting point as a closed economy [14]. They assume that innovated products would be affected by the level of research and development and conclude that economic integration would influence both the short and long term growth of the economy. Their study is a proposition for later scholars to find more factors that could have effects on endogenous growth [9, 19]. From this time, research on the relationship between economic integration and endogenous growth is rare.

This paper investigates the relationship between economic integration and endogenous growth. The contributions of it are threefold. Firstly, it will add to the existing knowledge regarding this issue. Previously, there were no studies that investigate this relationship by applying AK models in the literature. Secondly, it will consolidate the AK model and apply it to explaining the endogenous growth under the effects of economic integration. Finally, this study will help to provide policy implications for countries that are on the trend of global integration – such as Vietnam - to better adapt to the new era. The rest of this study is structured as follow: Section 2 describes the literature review about the research issue. Section 3 shows the results and some discussion regarding the problem. Finally, conclusions and recommendations are outlined in Section 4.

2 Literature review

The theory about endogenous growth clarifies the long term growth rate from economic activities that create new knowledge and innovations. Endogenous growth is the growth of an

economy in the long term when the speed of it is determined by endogenous factors of the domestic economy, especially those driving opportunity and incentive to create technological knowledge [2]. In the long term, the economic growth rate (measured by the growth rate of output per head) depends on total factor productivity (TPF). TPF is, in turn, will be determined by the rate of technological progress. The neoclassical growth theory by Solow (1956) and Swan (1956) assumes that the rate of technological progress depends on scientific processes and is completely, independently separated from the economic factors [17, 18]. Hence, this theory implies that economists can take the long term growth rate as an exogenous factor that comes from the outside of the economy.

The endogenous growth theory challenges the perspective of the neoclassical theory by proposing a channel that links the rate of technological progress with endogenous factors. As a result, the long term growth rate could be affected by domestic economic forces. This results from the fact that technological advance from innovation is in the form of new products, process, or markets. Normally, this technological progress occurs because of economic activities. For example, firms learn from past experience to increase the productivity of the manufacturing process. A higher rate of activities will lead to a higher speed of new inventions because it increases the production experience of firms. In addition, in the process of seeking profits, firms have to invest in research and development. This will be the direct channel for creating new technologies.

2.1. Endogenous growth model

There exists evidence that in profit-seeking firms, technological progress depends on economic activities because it initially comes from innovation, scientific research, capital accumulation, and other activities. Hence, technology should be an endogenous variable that is determined by the domestic economic forces. The economic growth theory should consider this characteristic, especially when technological development is the key driving factor for the long term growth. Incorporating endogenous technology into the economic growth theory is difficult because we have to assess the phenomenon 'increasing the return to scale'. More specifically, technology is only developed when people have the incentive to do it. However, since the production function (F) only returns the constant *K (capital)* and *L (labor)*, and we all know that all the output of economic activities is utilized to pay for capital and labor at the marginal costs in the production. As a result, there is nothing to pay for the resources that are necessary to develop technology. This brings about the fact that people will not bother about progressing technology (incentive problem). Therefore, an endogenous growth model cannot base on the normal competitive theory because it requires all the input factors needed to be paid as marginal production.

The neoclassical theory (by Solow [17] and Swan [18]) is a big success and failure at the same time. It successfully describes the key features of an economic system in advanced industrial countries. However, it cannot fully explain all the mechanisms behind the growth rate, especially in developing nations. In this model, apart from capital, the key determinant of GDP per head is the productivity of labors but the meaning of labors is not defined clearly and the change in their behavior is considered as exogenous.

The disadvantages of the neoclassical model are the reason for several endogenous models that based on the neoclassical model's framework. From the late '80s, many models have been built to enlighten the endogenous mechanism such as investment that can facilitate sustainable growth. The meaning of endogenous model is that a long term growth rate could depend on endogenous factors. Therefore, the government could affect this issue on their own.

There were many endogenous models such as learning by doing (proposed by Arrow (1962) [4] then modifided by Villanueva (1994) [20], research and development model (by Aghion & Howitt [1]; Grossman & Helpman [11], Romer [16])], the model of Mankiw, Romer and Weil (1992) [13] or learning by doing model by Lucas Jr [12]. This paper briefly introduces the AK model to clarify the research issue.

AK is a simple model that considers the constant returns to scale for both physical and human capital. This model was suggested by Romer (1986) [15], Barro (1990) [6]. All the inputs of this model are reproduced capital, not only physical but also human capital. Specifically, assume K is the total of capital, the linear production function is stated as

$$Y = AK \tag{1}$$

where A represents all factors that affect technological development; Y is the output.

It is easy to prove that the growth rate of capital per labor at equilibrium is

$$g_{K/L} = sA - (n + \delta) \tag{2}$$

where s is saving; n is the population growth; and δ is the depreciation.

The growth rate of output per labor at equilibrium is

$$g_{Y/L} = g_A + g_{K/L} \tag{3}$$

where g_A is the technological progress. If technology is constant, or in other words, there is no development in the level of technology ($g_A = 0$), then at equilibrium, the growth rate of output per labor is the growth rate of capital per labor

$$g_{Y/L} = sA - (n + \delta) \tag{4}$$

The important feature of the AK model is that the saving rate decides the growth rate. The saving rate increases the growth rate per labor continuously. Besides, this model is different from the neoclassical one (which implies that poor countries grow faster than rich countries in

the process toward the equilibrium state) because it suggests that poor nations that have the same level of technological development as rich nations grow at the same pace with rich countries, regardless the initial income. The drawback of the AK model is that it does not support the convergence of income per head among countries, even with the same level of technology and saving rate.

Rivera-Batiz and Romer (1991) propose a theoretical model that explains the relationship between economic integration and endogenous growth with the assumption of two similar, developed economies [14]. The results imply that the permanent worldwide growth rate would be promoted from economic integration between these countries. From an isolated position, integration could take place by increasing the flows of goods or ideas. In their model, research and development are the sources of growth. The limitation of this is that ideas affect only research output but not the output of goods. On the basis of this, we proposed an AK learning-by-doing model because it can overcome this issue.

2.2 Empirical research on the impacts of economic integration on endogenous economic growth

Although this issue was investigated in the past, there is no universal agreement about the impacts of economic integration on endogenous growth. The measurements of economic integration vary in different studies. Using the level of foreign direct investment (FDI) as a proxy for economic integration, Bende-Nabende, Ford, and Slater (2001)study whether it causes spillover effects which lead to the economic growth of the ASEAN-5 economies (1970–96), and, if that is so, does the ASEAN Preferential Trade Agreement (APTA) have significant effect on attracting FDI to the region [7]. The results indicate that FDI has stimulated economic growth most effectively through human factors and knowledge/technological learning-by-doing effects. In addition, APTA affects FDI inflows but with a lagged term. The impacts of FDI on economic growth is also studied by Borensztein, De Gregorio, and Lee (1998) [8]. Applying data on FDI flows from industrial countries to 69 developing countries over the last two decades, they suggest that FDI is an important vehicle for the transfer of technology, contributing relatively more to growth than domestic investments. However, the higher productivity of FDI holds only if the host nations have minimum threshold stock of human capital. Thus, FDI contributes to economic growth only when a sufficient absorptive capability of the advanced technologies is available in the host countries.

Badinger (2005) creates an index that represents economic integration in both the global and regional level of the EU member states [5]. The authors test for the permanent and transient growth effects in a growth accounting framework by using a panel of fifteen EU countries from 1950 to 2000. The hypothesis of long term effects of economic integration on growth rate was rejected. They also calculate the sizable effects and conclude that if no integration happens from

1950, the GDP per capita would be lower than today's level by 20 percent. Having the same conclusion about the effects of integration on economic growth, Edison, Levine, Ricci, and Sløk (2002) study the impacts of financial integration on economic growth using new data and new econometric techniques [10]. With a wide array of statistical methodologies, they could not reject the null hypothesis that international financial integration does not accelerate economic growth. The results are the same even when they control specific factors such as policy and the economic system.

In the context of Vietnam, many studies investigate the relationship between economic integration and economic growth. However, most of them focus on the exogenous model. In terms of endogenous growth, (Anwar and Nguyen (2011)) use a panel of a dataset of 61 provinces from 1997 to 2006 to analyze the relationship between economic integration and growth and find that the financial development has contributed positively to the growth of the economy [3].

3 Proposed models

This paper interprets the impact of economic integration on endogenous growth by using the AK learning-by-doing model. In the beginning, two countries or regions use the same production function, but they do not trade with each other. They just produce and consume by themselves without exchanging any input factors. After that, we let those two countries or regions open their economy by exchanging labor and capital. In other words, they have economic integration. Our study divides economic integration into two categories: one-way integration and two-way integration. One-way integration occurs when one country or region only imports foreign production items such as capital and labor but does not export any of their capital and labor to the other country or region. On the other hand, two-way integration is the case in which the two countries or regions experience economic integration by transferring their capital and labor to each other. The latter case is more reasonable in reality while the former provides us with a theoretical situation to explore the impacts of economic integration on endogenous growth.

3.1 One-way integration

We consider a simple model where the country's production function is determined by the AK learning-by-doing model

$$Y = K^{\alpha}(BL)^{1-\alpha} \tag{5}$$

where Y is the output; K is the accumulated capital; L is the labor; B is the knowledge that increases the productivity of labor; α is the elasticity of output respected to capital. Knowledge is created via the learning-by-doing process: the more we do (K), the more we learn (B). In other words, when we invest more capital in production, we learn more from experience and

mistakes. Labor will know how to do the job with fewer efforts and higher productivity. As a result, labor will be more skillful (B is higher).

$$B = \lambda K \tag{6}$$

where λ is how fast we create knowledge from doing. λ is positive.

Introducing (5) to (6), we have

$$Y = K^{\alpha}(\lambda KL)^{1-\alpha} = K(\lambda L)^{1-\alpha} \tag{7}$$

Our study begins with an isolated country or region that does not trade with other countries. This country uses K_d and L_d (domestic capital and domestic labor) as inputs with the domestic learning coefficient λ_d.

The output is then

$$Y_d = K_d(\lambda_d L_d)^{1-\alpha} \tag{8}$$

Now, assume that economic integration will take place in the form of increased trade in capital and labor. This implies that foreign capital (K_f) and foreign labor (L_f) with the foreign learning coefficient λf moving domestically and being part of the production function. At this stage, we need an assumption regarding the learning coefficient. Normally when foreign capital and labor come onshore, they bring with them the technology and learning coefficient and work with it. However, during the working process, they can interact with domestic capital and labor to form higher learning coefficient or keep it separately. We firstly assume that the foreign factors do not change the overall knowledge of the domestic country (B_d). Therefore, the production function will be

$$Y_d = K_d^{\frac{1}{2}}(\lambda_d L_d)^{\frac{1-\alpha}{2}} K_f^{\frac{1}{2}}(\lambda_f L_f)^{\frac{1-\alpha}{2}} \tag{9}$$

where Y_d is the domestic output.

The domestic country's profit will be represented as follows:

$$\Pi_d = Y_d - i_d K_d - i_f K_f - w_d L_d - w_f L_f \tag{10}$$

where i_d and i_f are the cost of capital in the domestic and foreign country; w_d and w_f are the wages for labor in the domestic and foreign country.

Taking the first order condition of (10) with respect to K_d, K_f, L_d, and L_f, we have the following relations in order to maximize profit:

$$\frac{1}{2}\frac{Y_d}{K_d} = i_d \tag{11}$$

$$\frac{1}{2}\frac{Y_d}{K_f} = i_f \tag{12}$$

$$\frac{(1-\alpha)}{2}\frac{Y_d}{L_d} = w_d \tag{13}$$

$$\frac{(1-\alpha)}{2}\frac{Y_d}{L_f} = w_f \tag{14}$$

From (11) and (12) we have

$$K_f = \frac{i_d}{i_f}K_d \tag{15}$$

From (13) and (14) we have

$$L_f = \frac{w_d}{w_f}L_d \tag{16}$$

Equations (15) and (16) show that to maximize the profit, one country should import capital and labor corresponding to their relationship between the domestic and foreign cost of capital and domestic and foreign wage. They also imply that capital and labor tend to move to the country where there is higher pay. For example, assume that $i_d > i_f$, then $K_f > K_d$, which means that more foreign capital will be attracted to the domestic market because it provides a higher cost of capital. This conclusion is reasonable in reality since we all know that investors always seek higher returns. Therefore, they want to transfer their capital into countries where there are higher interest rates.

Replacing (15) and (16) into (9), we have the output that maximizes the profit

$$Y_d^* = (\frac{i_d}{i_f})^{\frac{1}{2}}(\frac{\lambda_f}{\lambda_d})^{\frac{1-\alpha}{2}}(\frac{w_d}{w_f})^{\frac{1-\alpha}{2}}K_d(\lambda_d L_d)^{1-\alpha} \tag{17}$$

From equation (17), we can easily derive that the new output after integration is equal to the original output times a fixed coefficient $A = (\frac{i_d}{i_f})^{\frac{1}{2}}(\frac{\lambda_f}{\lambda_d})^{\frac{1-\alpha}{2}}(\frac{w_d}{w_f})^{\frac{1-\alpha}{2}}$.

Therefore, in order to make sure that economic integration brings about a higher output, A must be greater than 1 ($A > 1$).

It also indicates that if two similar countries are trading with each other without affecting the overall level of knowledge, there will be no gain from trade since A equals 1.

In the case of two different countries (at least one factor is not the same), A will be greater than 1 when and only when

$$i_d > i_f, \lambda_d = \lambda_f, w_d = w_f$$

or

$$i_d = i_f, \lambda_d < \lambda_f, w_d = w_f$$

or

$$i_d = i_f, \lambda_d = \lambda_f, w_d > w_f$$

This suggests that a country will be more likely to have benefits from economic integration when it trades with countries where the level of cost of capital and wage is relatively lower than that of the domestic one. This is because the cost of using foreign factors will be smaller. In addition, a country should trade with other countries where the learning coefficient (or how fast that knowledge is created from accumulated capital) is higher than that of the domestic country.

Secondly, assume that integration alters the overall knowledge, which means that after the entry of foreign factors, accumulated knowledge will change. Now, both the domestic and foreign factors will use the same learning coefficient. The new production function of the domestic country will be like this

$$Y_d = K_d^{\frac{\alpha}{2}} (\lambda_i K_d L_d)^{\frac{1-\alpha}{2}} K_f^{\frac{\alpha}{2}} (\lambda_i K_f L_f)^{\frac{1-\alpha}{2}} \quad (18)$$

where λ_i is the new level of knowledge created from accumulated capital after integration.

We define λ_i as follows

$$Max(\lambda_d, \lambda_f) + |\lambda_d - \lambda_f| \leq \lambda_i \leq \lambda_d + \lambda_f \quad (19)$$

The new learning coefficient will depend on how well the domestic and foreign factors interact with each other. Rearranging (18) we have the production function

$$Y_d = K_d^{\frac{1}{2}} (\lambda_i L_d)^{\frac{1-\alpha}{2}} K_f^{\frac{1}{2}} (\lambda_i L_f)^{\frac{1-\alpha}{2}} \quad (20)$$

Applying the first-order condition and plugin back into (20) we have the level of output that maximizes the profit

$$Y_d^* = (\frac{i_d}{i_f})^{\frac{1}{2}} (\frac{\lambda_i}{\lambda_d})^{1-\alpha} (\frac{w_d}{w_f})^{\frac{1-\alpha}{2}} K_d (\lambda_d L_d)^{1-\alpha} \quad (21)$$

The domestic country will be better off if

$$\left(\frac{i_d}{i_f}\right)^{\frac{1}{2}} (\frac{\lambda_i}{\lambda_d})^{1-\alpha} \left(\frac{w_d}{w_f}\right)^{\frac{1-\alpha}{2}} > 1 \quad (22)$$

This implies that, in the case of two similar countries, we have $\lambda_i = \lambda_d = \lambda_f$

Therefore, integration will have no benefit because $(\frac{i_d}{i_f})^{\frac{1}{2}}(\frac{\lambda_i}{\lambda_d})^{1-\alpha}(\frac{w_d}{w_f})^{\frac{1-\alpha}{2}} = 1$. The total output stays the same after integration.

If the two countries have different learning coefficient ($\lambda_d \neq \lambda_f$) then we always have $\lambda_i > \lambda_d$. Hence, even though the domestic country has the same level of cost of capital and wage, it will gain from integration. The other conclusion is that the domestic country should trade with countries that have lower cost of capital and wage.

3.2 Two-way integration

We now check the case of two countries that have economic integration and exchange the production inputs with each other. Each country will maximize its profit.

Denote K_j, L_j, λ_j, w_j, and α_j the total capital, total labor, cost of capital, learning coefficient, wage and the elasticity of output with respect to K of country j; K_{ij} is the capital of country i that is transferred to country j; L_{ij} is the labor of country i that is transferred to country j.

Assume that the learning coefficients do not change, the production function of countries 1 and 2 will be

$$Y_1 = K_{11}^{\frac{1}{2}}(\lambda_1 L_{11})^{\frac{1-\alpha 1}{2}} K_{21}^{\frac{1}{2}}(\lambda_2 L_{21})^{\frac{1-\alpha 1}{2}} \tag{23}$$

$$Y_2 = K_{22}^{\frac{1}{2}}(\lambda_2 L_{22})^{\frac{1-\alpha 2}{2}} K_{12}^{\frac{1}{2}}(\lambda_1 L_{12})^{\frac{1-\alpha 2}{2}} \tag{24}$$

The profit function of the two countries will be

$$\Pi_1 = Y_1 - i_1 K_{11} - i_2 K_{21} - w_1 L_{11} - w_2 L_{21} \tag{25}$$

$$\Pi_2 = Y_2 - i_2 K_{22} - i_1 K_{12} - w_2 L_{22} - w_1 L_{12} \tag{26}$$

Because part of the capital and labor of each country will now be transferred to the other, the following constraints are applied

$$K_{11} + K_{12} = K_1$$

$$K_{22} + K_{21} = K_2$$

$$L_{11} + L_{12} = L_1$$

$$L_{22} + L_{21} = L_2$$

The two countries will maximize their profits. Applying the first-order condition for (25) and (26), we have the following relations

$$\frac{1}{2}\frac{Y_1}{K_{11}} = i_1 \qquad \frac{1}{2}\frac{Y_1}{K_{21}} = i_2 \qquad \frac{1}{2}\frac{Y_2}{K_{22}} = i_2 \qquad \frac{1}{2}\frac{Y_2}{K_{12}} = i_1$$

$$\frac{(1-\alpha 1)}{2}\frac{Y_1}{L_{11}} = w_1 \qquad \frac{(1-\alpha 1)}{2}\frac{Y_1}{L_{21}} = w_2$$

$$\frac{(1-\alpha 2)}{2}\frac{Y_2}{L_{22}} = w_2 \qquad \frac{(1-\alpha 2)}{2}\frac{Y_2}{L_{12}} = w_1$$

Hence, we have the relationships between each domestic and foreign factor as follows:

$$K_{21} = \frac{i_1}{i_2}K_{11} \qquad K_{12} = \frac{i_2}{i_1}K_{22}$$

$$L_{21} = \frac{w_1}{w_2}L_{11} \qquad L_{12} = \frac{w_2}{w_1}L_{22}$$

Replacing the above equations to (23) and (24), we have

$$Y_1^* = (\frac{i_1}{i_2})^{\frac{1}{2}}(\frac{\lambda_2}{\lambda_1})^{\frac{1-\alpha 1}{2}}(\frac{w_1}{w_2})^{\frac{1-\alpha 1}{2}}K_{11}(\lambda_1 L_{11})^{1-\alpha 1} \quad (27)$$

$$Y_2^* = (\frac{i_2}{i_1})^{\frac{1}{2}}(\frac{\lambda_1}{\lambda_2})^{\frac{1-\alpha 2}{2}}(\frac{w_2}{w_1})^{\frac{1-\alpha 2}{2}}K_{22}(\lambda_2 L_{22})^{1-\alpha 2} \quad (28)$$

Now, assume that θ_i^k and θ_i^l are the capital and labor retaining ratio of country 1, we have

$$K_{11} = K_1 * \theta_1^k$$

$$K_{22} = K_2 * \theta_2^k$$

$$L_{11} = L_1 * \theta_1^l$$

$$L_{22} = L_2 * \theta_2^l$$

So, (27) and (28) become

$$Y_1^* = \theta_1^k {\theta_1^l}^{1-\alpha 1}(\frac{i_1}{i_2})^{\frac{1}{2}}(\frac{\lambda_2}{\lambda_1})^{\frac{1-\alpha 1}{2}}(\frac{w_1}{w_2})^{\frac{1-\alpha 1}{2}}K_1(\lambda_1 L_1)^{1-\alpha 1} \quad (29)$$

$$Y_2^* = \theta_2^k {\theta_2^l}^{1-\alpha 2}(\frac{i_2}{i_1})^{\frac{1}{2}}(\frac{\lambda_1}{\lambda_2})^{\frac{1-\alpha 2}{2}}(\frac{w_2}{w_1})^{\frac{1-\alpha 2}{2}}K_2(\lambda_2 L_2)^{1-\alpha 2} \quad (30)$$

Trades only occur when each country has benefited from it. In other words, the new output must be larger than the original level for each country.

Or

$$\theta_1^k {\theta_1^l}^{1-\alpha 1}(\frac{i_1}{i_2})^{\frac{1}{2}}(\frac{\lambda_2}{\lambda_1})^{\frac{1-\alpha 1}{2}}(\frac{w_1}{w_2})^{\frac{1-\alpha 1}{2}} > 1 \quad (31)$$

$$\theta_2^k {\theta_2^l}^{1-\alpha 2}(\frac{i_2}{i_1})^{\frac{1}{2}}(\frac{\lambda_1}{\lambda_2})^{\frac{1-\alpha 2}{2}}(\frac{w_2}{w_1})^{\frac{1-\alpha 2}{2}} > 1 \quad (32)$$

Note that these conditions must be satisfied for profit maximization

$$\theta_1^k + \theta_2^k = 1 \text{ and } \theta_1^l + \theta_2^l = 1$$

It is easy to prove that (31) and (32) cannot be satisfied simultaneously if the two countries are the same. Therefore, economic integration, in this case, is not profitable.

If the two countries are different, it is very hard to find the solutions. This is the drawback of this model.

Now, assume that economic integration also includes the exchange of knowledge. The learning coefficient (how fast that knowledge is created by accumulated capital) is λ_i (λ_i has the same specification as in one-way integration).

Following the previous steps, we have the conditions under which trades occur

$$\theta_1^k {\theta_1^l}^{1-\alpha 1} \left(\frac{i_1}{i_2}\right)^{\frac{1}{2}} \left(\frac{\lambda_i}{\lambda_1}\right)^{1-\alpha 1} \left(\frac{w_1}{w_2}\right)^{\frac{1-\alpha 1}{2}} > 1 \tag{33}$$

$$\theta_2^k {\theta_2^l}^{1-\alpha 2} \left(\frac{i_2}{i_1}\right)^{\frac{1}{2}} \left(\frac{\lambda_i}{\lambda_2}\right)^{1-\alpha 2} \left(\frac{w_2}{w_1}\right)^{\frac{1-\alpha 2}{2}} > 1 \tag{34}$$

Note that, like the previous case, the same conditions must be satisfied for the profit maximization

$$\theta_1^k + \theta_2^k = 1 \text{ and } \theta_1^l + \theta_2^l = 1$$

Equation (33) and (34) confirm the previous conclusion that two identical countries cannot have benefited from economic integration.

4 Conclusions

This paper applies the AK learning-by-doing model to clarify the impacts of economic integration on endogenous growth. We define two types of economic integrations, namely one-way and two-way integration. In each case, we assume different situations whether integration changes the learning coefficient. The results show that in all cases if the two countries are identical, there will be no benefit from economic integration. This conclusion is well aligned with the theoretical aspect. Between the two identical countries, there will be no comparative advantages. Therefore, the benefit of trades will disappear. On the other hand, one country should open to others that have a lower cost of capital, lower wage or higher learning coefficient. If the two countries are different (in terms of cost of capital, wage or learning coefficient), they both might benefit from economic integration under some specific circumstances. This model, however, disregards the problem regarding the case of two different countries. Besides, we assume that one country must use foreign input factors once it integrates with other countries. It also fails to consider the degree of integration, the allowance of goods

trading, and a careful analysis of maximization of consumer's utility. However, from the results, we can propose some recommendations for policymakers. Firstly, the learning coefficient is extremely important, and it decides the productivity of labor and the effectiveness of capital accumulated. Therefore, we have to increase this coefficient to better prepare for economic integration. Secondly, one of the most essential elements that brings about the advantages when integration is the ability to attract low-cost capital and skillful labor from foreign countries. This is very reasonable regarding the financial aspect. Hence, we should focus on solutions to do that. Finally, it is not profitable to trade with countries that have the same level of labor wage, cost of capital, and learning coefficient. This has been confirmed by the results of the theoretical model.

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