

# The Study of Changes of the Technology Based Export-led Growth Model in East Asia

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**Abstract:** Based on augmented Cobb-Douglas production function and from the point of view on supply, this essay builds an exported manufactures-led growth model, in which exported manufactures substitute the general export as the agent of technical spillover in the foreign trade. The amended model tests, due to changes of technology spillover, the changes of growth models of East Asian emerging economies (EAEE) before, during and after the 2008 global financial crisis. The results of empirical dynamic panel model illustrate that the manufactures exporting of EAEE has positive relation with the economy growth in the long run. Therefore the export-led growth model does spillover positively to the economy growth in East Asia and promotes the efficiency of growth. However, the effect of technology spillover has faded significantly after the global financial crisis, which means that manufactures export plays less roles on pushing the output. It is time, therefore, to transfer the economy growth model in this area at the era of global economic adjustment.

**Keywords:** export-led growth; technology spillover effect; expansion effect; bias- corrected LSDV

Since the World Bank published “The East Asian miracle: economic growth and public policy” in 1993, the export-led growth model adopted by many East Asian countries has set an example for emerging economies. This growth model first originated from Germany and Japan after World War II, later it was duplicated by the Four Little Dragons in Asia in the 1980s, and during the 1990s emerging economies in South East Asia together with China mainland joined the camp of export-led growth. This export-led growth model used to extraordinarily enhance the economic prosperity of East Asia, and was once recognized as the characteristic growth model of this region. Yet different from the traditional growth model dominated by endogenous factors, it is a typical growth model depending on exogenous factors. People started to throw doubt on this growth miracle after the 1997-98 Financial Crisis broke out, which heavily struck Asia. However the doubt was soon left behind as East Asia economy soon recovered, and great benefit brought by the export-led growth model was again shared by many countries until the 2008 global financial crisis. The global economic environment has changed dramatically ever after the 2008 crisis, and this time faced with huge insufficiency of external demand, can the export-led growth model of emerging economies sustain? Some researchers hold the belief that the economy rebalancing of developed countries would make it hard for the export-led growth model to sustain, and it is a must for East Asia to transfer from the export-led exogenous growth to domestic demand-led endogenous growth. But nowadays under new circumstances, whether the export-led growth model should be completely abandoned or effectively reformed? To answer this question should analyze the whole thing thoroughly.

## 1 Literature Review

Neoclassical economics agrees that there exists strong linkage between foreign trade and economic growth. Balassa (1978), and Helpman and Krugman(1985) point out that foreign trade

can be a main driving force of economic growth due to effects such as economy of scale, specialization of production, improvement of productivity and learning by doing. These development economics theories build a theoretical foundation for the export-led growth hypothesis, while the successful practice of this hypothesis was later carried out by emerging economies in Asia. Early before the Asian financial crisis, lots of literature regarded the export-led growth model as an indispensable prerequisite for the taking-off of East Asia economy.

However, after the 1997 Asian financial crisis, many scholars claimed the ending up of export-led growth. For example, researchers such as Stiglitz and Yusuf (2001)<sup>[1]</sup>, Blecker (2002)<sup>[2]</sup> and Palley (2002)<sup>[3]</sup> systematically evaluated the export-led growth model. But the Asian financial crisis turned out to be a great opportunity for the export-led growth model to win its position in Asia – “the Asian crisis of 1997-98 set the scene for the current export-led growth strategy of China and other emerging markets”<sup>①</sup>. Ever since the crisis, East Asia economy had enjoyed an economic boost and the growing feast lasted until the eve of 2008 global financial crisis. The financial crisis made the growth model of East Asia, which was excessively dependent on export, the spotlight of criticism. He et al(2009)<sup>[4]</sup>, and Palley (2011)<sup>[5]</sup> - a firm opponent of export-led growth model, all agreed that the conditions supporting export-led growth have been depleted. But meanwhile, some researchers found it was problematic to simply deny the export-led growth model. He and Zhang(2010)<sup>[6]</sup>, Hye (2012)<sup>[7]</sup> and Hye et al (2013)<sup>[8]</sup>, Zhao and Zhang (2012)<sup>[9]</sup> found that even under the shock of 2008 global financial crisis, the export-led growth model in East Asia can sustain in the long term, and export’s promotion to economic growth cannot be ignored. The third branch of literature reach a mixed conclusion, researchers such as Medina-Smith (2001)<sup>[10]</sup>, and Dreer and Herzer (2013)<sup>[11]</sup> hold the opinion that export does not necessarily lead to economic growth, and the relation between the two can be far from clear.

The literatures above demonstrate controversy towards exported-led growth model. In general, most researchers tend to believe that this growth model used to play an important role in the process of East Asian industrialization, but it is no longer applicable for many reasons nowadays. There are some problems in these researches, however. First, most of the literature analyzed the export-led growth model in East Asia based on statistical data or from a theoretical angle. Second, a large part of the work paid no attention to the impact of 2008 global financial crisis on the export-led growth model in East Asia. Third, as far as empirical study is concerned, many empirical researches were built on the traditional general equilibrium models, or they skipped over the theoretical deduction and tested the econometrical relation between economic growth and export directly, ignoring the influence of technical progress on economic growth which is potentially embedded in the export-led growth model. In essence, behind the long-term rapid growth of East Asia emerging economies, the technical spillover effect, brought by export especially manufactures export, is indispensable. In order to analyze the technical progress and the boost of labor productivity brought by export, this paper builds a manufactures export-led growth model based on augmented Cobb-Douglas production function. Within a dynamic panel model which has stronger explanatory power, this paper examines the changes of growth models of 9 East Asian emerging economies (EAEE) due to changes of technical spillover before, during and after the 2008 global financial crisis.

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<sup>①</sup> Hunt C.. Financial Turmoil and Global Imbalances: The End of Bretton Woods II? Reserve Bank of New Zealand: Bulletin, Vol. 71(3), Sept. 2008: 44-55, P47. Zealand: Bulletin, 2008, (3) 8: 44-55, p45

## 2 The contribution of export to the economic growth of EAEEs

The development strategy of EAEEs is characterized by strong external orientation, which denotes that foreign trade especially export has become the main driving force of economic growth in recent years. The contribution of export to the economic growth of EAEEs is not only reflected by the direct effect namely the scale of export promotes the economic growth, but also by the indirect effect i.e. export leads to economic growth through technical progress and its externality.

EAEEs have enjoyed rapid growth in export and the incurred economic growth for many years, and the direct contribution of export to economic growth is rather significant. A main characteristic of the export-led growth model is the rapid export growth. Figure 1 illustrates the average export growth rates of EAEEs before and after the financial crisis. Figure 1 shows that before the global financial crisis, most EAEEs maintained high export growth rates. The export growth in China mainland was most prominent, and the average annual growth rate during 2000-2006 reached as high as 26.5%. Affected by the global financial crisis, the export growth rates in all the EAEEs decreased significantly. In Hong Kong China, Malaysia and the Philippines, the export growth rates turned negative. But as the global economy recovered, the export of EAEEs quickly returned to normal. The export growth rates in Malaysia and the Philippines even surpassed the original level before the global financial crisis.<sup>②</sup> However, another intuitive conclusion can be drawn from this picture: the growth story of East Asia in the past years reveals a major drawback inside the export-led growth model, i.e. due to the synchronization between economic growth and world economic cycle, once a global financial crisis causes external demand to collapse, export in EAEEs will shrink severely at heel.

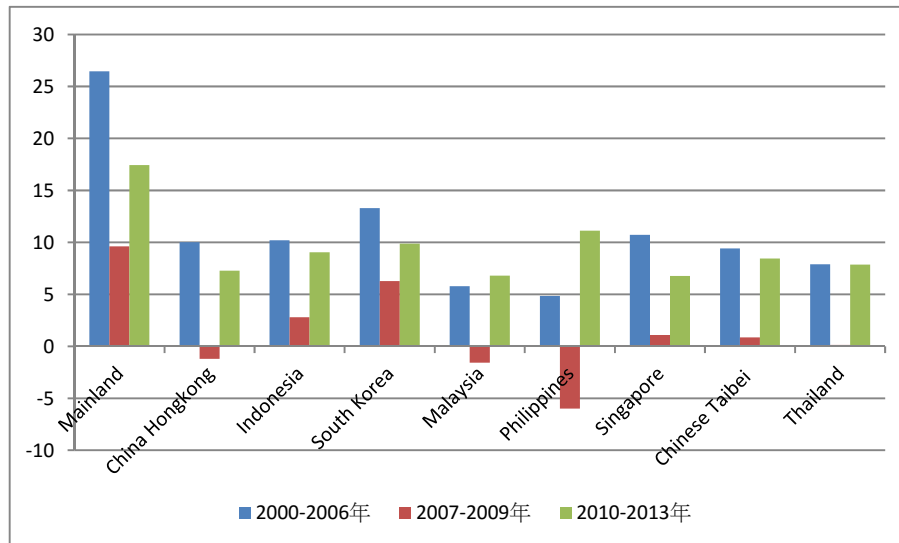


Figure 1 Average export growth rates of EAEEs during 2000-2013 (%)

Note: Year 2007-2009 are regarded as the period of financial crisis.

Source: Wind database.

Beside direct contribution to economic growth of East Asia, more importantly, trade indirectly

<sup>②</sup> The main reason could be that export of these two economies decreased heavily during financial crisis, which resulted in a critically low calculation base for the post-crisis period.

promotes this area’s economic development. The vitality of export-led growth model lies in that, to maintain global competitiveness of exported products, the “learn by doing” effect of export industry will boost labor productivity and indirectly promote the development of other industries and thus speed up the economic growth. EAEEs have been firmly carrying out the export-led development strategy for many years. Since developed countries such as Europe and the US are the main destinations for EAEEs’ exports, most of the exported products are manufactures with certain technical content. According to Figure 1, since 2000, the average proportion of manufactures in general export is above 50% in other 7 EAEEs except Indonesia. This proportion is above or close to 90% in Chinese Taipei, Mainland China and the Philippines. Generally, the proportion of manufactures export in general export in most EAEEs remains almost unchanged after the financial crisis. Indeed, the proportions of Singapore, South Korea and Mainland China have increased instead. In Singapore, the proportion of manufactures export in general export increases by nearly 20%. The proportion declines to some degree in Indonesia and Malaysia. It can be deduced that, different from the significant decline of export growth rates, the proportions of manufactures export in general export maintain almost the same level as before in most EAEEs.

**Table 1 the proportions of manufactures export in aggregate export in EAEEs (%)**

	Mainland China	Indonesia	South Korea	Malaysia	Philippines	Singapore	Thailand	Chinese Taipei
2000Q1 -2009Q2	92.76	43.23	73.34	80.95	89.80	47.40	75.39	98.72
2009Q3 -2014Q2	94.96	36.61	79.06	75.22	90.16	67.25	72.54	98.80
<b>Total average</b>	<b>93.52</b>	<b>40.95</b>	<b>75.32</b>	<b>78.97</b>	<b>89.93</b>	<b>54.24</b>	<b>74.41</b>	<b>98.74</b>

Source: calculated using data obtained from the Wind database.

### 3 Theoretical framework of export-led growth based on technical spillover

There are mainly two empirical methods to test export-led growth. The traditional empirical test is built on the basis of the national income identity. There are two major problems with the first method. First, using national income identity to measure the contribution of export to economic growth is based on the changes the accounting method of national income, which ignores the causal or theoretical relation between export and economic growth (He and Zhang, 2010) [6]. Second, the measurement of national income is only suitable for analyzing short-term economic fluctuations, while the production function is more applicable for long-term economic growth (Zhang, 2013)[12]. The other empirical method is to straightly test the causal relation between export growth and economic growth. But this test of causal relation does not study the theoretical relation between the two variables, and it fails to take other factors that might influence economic growth into consideration during the empirical test.

The export-led growth hypothesis implies that output can be boosted by export and incurred improving of productivity. Therefore, the economic growth of one country comes not only from its labor and capital inputs, but also from export expansion. In order to overcome the flaw that the national income identity fails to reflect export, Feder (1982) [13] is the first person who used the two-sector model to report the possible influence that export might have on labor productivity and economic growth. Levin and Raut (1997) [14] incorporated technical spillover effect in the endogenous economic growth model explicitly and employed the technical spillover effect of export as a proxy for TFP in the production function. Based on previous researches, this paper

builds an augmented Cobb-Douglas production function, i.e. a three-factor model in which labor force, capital, and export are included.

A typical Cobb-Douglas production function can be described as:

$$Y_{it} = A_{it} L_{it}^{\beta_1} K_{it}^{\beta_2} \quad (1)$$

Where  $Y_{it}$ ,  $L_{it}$  and  $K_{it}$  represent output, labor input and capital input of economy  $i$  at time  $t$  respectively.  $A_{it}$  is the parameter denoting TFP. And coefficient  $\beta_1$  and  $\beta_2$  denote the production elasticity of labor and capital of economy  $i$  respectively.

Suppose the parameter of TFP can be written as a function of export:

$$A_{it} = a_0(1 + \beta_3 E_{it}) X_{it}^{\beta_4} \quad (2)$$

Where  $a_0$  is a constant.  $E_{it}$  and  $X_{it}$  denote the proportion of export to output and export itself of economy  $i$  at time  $t$  respectively. Coefficient  $\beta_3$  denotes the output increment resulting from the enhanced factor input by the export sector itself, and coefficient  $\beta_4$  stands for the technical spillover effect of export sector to non-export sector.

Substituting Equation (2) into Equation (1) and take the logarithm of both sides, we get the logarithmic form of the augmented Cobb-Douglas production function:

$$\ln Y_{it} = a_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \ln(1 + \beta_3 E_{it}) + \beta_4 \ln X_{it} \quad (3)$$

Since equation  $\ln(1 + E) \approx E$  holds when  $E$  is relatively small, Equation (3) can be approximately rewritten as:

$$\ln Y_{it} = a_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 E_{it} + \beta_4 \ln X_{it} \quad (4)$$

As pointed out by He and Zhang(2010)<sup>[6]</sup>and Dreer and Herzer(2013)<sup>[11]</sup>, export is a natural constituent of a country's output, and therefore even if export has no labor productivity effect, there is inevitably spurious positive correlation between export and output. Dreer and Herzer(2013)<sup>[11]</sup>suggest to deduct export from national income and substitute the gross production  $Y_{it}$  in Equation (4) with output that does not include export (non-export production). That is

$$N_{it} = Y_{it} - X_{it} \quad (5)$$

Thus we obtain Equation (6):

$$\ln N_{it} = a_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 E_{it} + \beta_4 \ln X_{it} \quad (6)$$

It is of vital importance to explain the economic implication of coefficients  $\beta_3$  and  $\beta_4$ .  $\beta_3 > 0$  means that expansion of export promotes economic growth of economy  $i$ ; while  $\beta_3 < 0$  means that export expansion makes negative contribution to economic growth.  $\beta_4 > 0$  implies that the growth effect of export exceeds the mere expansion of export scale whereas export also enhances labor productivity;  $\beta_4 > 0$  means that export harms labor productivity rather than enhancing it. Especially,  $\beta_4$  can be interpreted as the short-term elasticity of manufactures export's technical spillover to economic growth, while  $\beta_4/(1 - \alpha_1)$  can be interpreted as its long-term elasticity.

In view of the characteristics of economic growth in EAEEs, this paper conducts further amendments to the export-led growth model. First, we substitute export  $X$  in the original model with manufactures export  $MX$ . Accordingly, we change the non-export output on the left side of

Equation (6) to non-manufacture output, i.e. we have  $N_{it} = Y_{it} - MX_{it}$ . Second, we add the 2008 global financial crisis (denoted by D) to the model and take into consideration the process where external shock passes to economic through export. Third, we bring in lagged terms of the independent variable and thus transfer the originally static panel model to a dynamic one.

Ultimately, this paper tests the export-led growth model based on manufactures export, and the model is described as follows:

$$\ln N_{it} = \alpha_0 + \alpha_1 \ln N_{i,t-1} + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 E_{it} + \beta_4 \ln MX_{it} \quad (7) \\ + \beta_5 (D_{1t} * \ln MX_{it}) + \beta_6 (D_{2t} * \ln MX_{it}) + \eta_i + \varepsilon_i$$

In this amended model,  $(D * \ln MX)$  represents the interaction between manufactures export MX and the dummy variable D. The first interaction term  $(D_{1t} * \ln MX_{it})$  measures the effect of 2008 global financial crisis on manufactures export, while the second interaction term  $(D_{2t} * \ln MX_{it})$  measures their interaction after the financial crisis. Following the criterion used by major existing literatures, we define the period from the second quarter of 2007 to the second quarter of 2009 as the breakout of 2008 global financial crisis and the period after the third quarter of 2009 as the recovery stage. Therefore,  $D_{1t} = 1$  when  $t \in [2007\text{ Q2}, 2009\text{ Q2}]$ ; otherwise  $D_{1t} = 0$ . Similarly,  $D_{2t} = 1$  when  $t \geq 2009\text{ Q3}$ ; otherwise  $D_{2t} = 0$ .  $\eta$  denotes individual fixed effects and  $\varepsilon$  denotes the error term.

#### 4 Empirical test

Panel analysis is conducted to test Equation (7). Fixed-effect model and random effect model are two common methods used for panel data estimation. But since Equation (7) contains the lagged terms of dependent variable, and the panel data used in this paper exhibits the characteristic of large T and small N, the bias- corrected least square dummy variable (LSDV) model is preferred.

The time series data are collected mainly from Wind database, and the sample period is from 2000Q1 to 2014Q2. The unit of measurement is million dollars for variables other than employed labor force (unit: thousand people) and the proportion of manufactures export to GDP. According to the settings of the model, logarithmic values are taken for all variables other than employed labor force and the proportion of manufactures export to GDP. Data not available in the Wind database are obtained from various official websites such as National Bureau of Statistics of involved economies and the World Bank.

Next we use Stata12.0 to test Equation (7) with the bias-corrected LSDV method. In order to obtain the stand errors, the bootstrap value is set as 100. The testing results are shown in Table 2. Since in the bias-corrected LSDV model Sargan test cannot be employed to test the validity of variable estimation, Table 2 also presents estimation the results of fixed effect model based on panel data that measures individual effects and panel OLS that takes no account of individual effects.

**Table 2 The empirical results of dynamic panel for EAEEs**

Explanatory variables	Bias-corrected LSDV	Fixed effect panel model	Panel OLS
$\ln N_{t-1}$	0.52*** (15.56)	0.50*** (4.44)	0.75*** (45.17)
$\ln L$	0.43*** (4.07)	0.45* (2.27)	0.02*** (2.81)
$\ln K$	0.15*** (8.49)	0.16* (2.00)	0.20*** (14.63)
$E$	0.21*** (5.60)	0.22** (2.94)	0.02* (1.67)
$\ln MX$	0.15*** (6.18)	0.16** (2.30)	0.02* (1.77)
$D_1 * \ln MX$	0.001 (0.99)	0.001 (0.45)	0.00 (0.40)
$D_2 * \ln MX$	0.002** (2.18)	0.002 (0.82)	0.00 (0.76)

Note: 1. Figures in the parentheses are the Z values for the bias-corrected LSDV model, while figures in the parentheses are the t values for ordinary fixed-effect model and OLS model respectively.

2. \*\*\*, \*\*and\* denote significance levels of 1%, 5% and 10% respectively.

As seen from Table 2, the lagged variable  $\ln N_{t-1}$  has the coefficient of 0.52 in the bias-corrected LSDV model. The bias of GMM estimation for relative small number of cross-section data has been corrected between the estimation of OLS model (0.75) and fixed-effect model (0.50). Thus estimates of the bias-corrected LSDV model is proven reasonable. From the significance levels and signs of coefficients estimated in three models above, the bias-corrected LSDV is the most ideal estimation.

The results of bias-corrected LSDV demonstrate that:

First, the contribution of manufactures export expansion to economic growth of EAEEs amounts is 21%, implying that manufactures export indeed promotes economic growth in East Asia. The coefficient of manufacture export's technical spillover effect is 0.15, suggesting that export-led economic growth model does have positive spillover effect to the economic growth of EAEEs. But during the sample period, the manufacture export's expansion effect (0.21) is larger than its technical spillover effect (0.15) in East Asia region.

Second, during the 2008 global financial crisis, the elasticity coefficient of manufactures export's technical spillover to economic growth in East Asia is rather small and statistically insignificant. Though the spillover effect of manufactures export turns significant after the crisis, it is still relatively so small that it can almost be ignored.

Third, fitting result of the model shows that the short-term elasticity of manufactures export's technical spillover to economic growth is 0.15 while in the long term this numerical value becomes  $0.15 / (1 - 0.52) = 0.31$ . Namely the long-term elasticity is larger than its short-term counterpart. It can be concluded that, in the past decades, the technical spillover of manufactures export has made relatively higher long-term contribution to economic growth.

## 5 Conclusions and policy implications

By using augmented Cobb-Douglas production function, this essay builds a dynamic panel model and employs the bias-corrected LSDV method to analyze the export-led growth model of EAEEs since 2000. The following conclusions are reached based on empirical result:

First, the export-led growth model of EAEEs is the manufactures export-led growth model in nature. The long-term elasticity of manufactures export's technical spillover to output is 0.3. This suggests that the main category of export in East Asia is manufactures, which to some extent promotes the technical progress in this region, and that is why East Asia can maintain rapid economic growth for more than 10 years.

Second, East Asia relies on the expansion of export to promote economic growth primarily, while the technical spillover effect of export is relatively weaker. That fact, the expansion effect of manufactures export surpasses the technical spillover effect, indicates that the current growth model in East Asia can finance the substantial investment needed during the industrialization process, however the positive technical spillover does not reward the industry upgrading more efficiently.

Third, facilitating role of manufactures export's technical spillover effect has crippled significantly after the global financial crisis. And the quantity expansion of manufacture export can't promote the economic growth in this region in the long run. This might be related to the unreasonable economy structures, especially the improper structures of exports in East Asia.

The conclusions above provide important policy implications to EAEEs. The empirical results show that, the development strategy of "high density investment and export orientation" practiced by East Asia at the beginning of the second half of last century can still apply to this area partly. However, since current global economic environment has undergone huge changes and meanwhile the contribution of manufactures export to the economic growth of East Asia does decrease after the global financial crisis, the current growth model has to be revised.

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