

## A Sensitivity Analysis Regarding the Impacts of Trade Openness and Globalization Growth: Empirical Evidence from Korea\*

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### Abstract

*By using the annual time series data from 1986 to 2008 in South Korea (hereafter Korea) we will examine the possibility that the difference in trade liberalization is causal to the differentials in growth and measure the sensitivity of growth to changes in trade liberalization. For the estimation, we will use both alternative measures of trade liberalization; imports for the total factor cost of national income for trade openness (hereafter openness) and the sum of exports and imports for the total factor cost of national income for trade globalization (hereafter globalization). The regression results suggest that both openness and globalization make a substantial contribution towards Korea's economic growth. In a comparison between these two indicators of trade liberalization, openness is more sensitive to growth. A negative and statistically significant error correction term implies that the null hypothesis of no co-integration is rejected when one period lag is used. The existence of co-integration means that openness and globalization policies can be targeted in order to bring about a desired long-run effect as well as a short run effect on growth.*

**Keywords:** Trade Openness, Trade Globalization, Growth, Sensitivity Analysis, Error Correction Model

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## I. INTRODUCTION

A variety of studies show that export-oriented policies lead to better growth performance than policies favoring import substitution because export-oriented policies, which provide similar incentives to sales in domestic and in foreign markets, lead to resource allocation according to comparative advantage, allow for greater capacity utilization, permit the exploitation of economies of scale, generate technological improvements in response to competition abroad and, in labor-surplus countries, contribute to increased employment. For example, by using the pooled data on 10 export-oriented countries including Korea which have already established an industrial base covering the years 1960-1973, Balassa (1978) found that a 1 percent increase in the rate of growth of exports appears to be associated with a 0.05 of a 1 percent increase in the rate of growth of the Gross National Product (t-statistics=3.34).

Greenaway and Nam (1988) have pointed out that Korea has been an open and outward-oriented economy for many years now. More recently, Ha et al.(2010) argue that as the 1997-1998 financial crisis ensued, domestic demand languished, prompting even greater emphasis on export promotion. Since then, Korea has increasingly relied on external demand to drive growth. For example, statistical data regarding the Korean economy from 1986 to 2008, provided by the Korea National Statistical Office and Korea Institute for Industrial Economics and Trade, demonstrates that Korea recorded 38.8% in the ratio of exports to the total factor cost of national income, whereas it recorded 35.7% in the ratio of imports to the total factor cost of national income. This implies that Korea has a lower level of imports when compared to its level of exports.

On the contrary, Edward (1998) provides evidence that countries that are more open to the rest of the world have a greater ability to absorb technological advances that are generated in leading nations. For example, based on the instrumental weighted least squares estimate of the total factor productivity growth, he proposes that after controlling for the log of initial per capita Growth Domestic Product and the initial level of human capital measured as the mean number of years of education, more open countries have tended to have faster productivity growth. The t-statistic is estimated to be 2.95, which is significant at  $\alpha=1\%$  on a two-tailed test. For the empirical work, he uses an average import tariff as a measure of the level of openness reported by UNCTAD. This has a negative effect, so that a lower value in the variable is associated with more relative trade openness.

Imports may be very important to growth since significant export growth is usually associated with rapid import growth. Furthermore, the export-growth analyses excludes imports which may be subject to the classic omitted variable problem. The fundamental causal relationship may actually be between imports and growth (Awokuse, 2008).

Although several studies including Ha et al. (2010, p.18) have shown the importance of exports for Korea's economy, no empirical work has been dedicated

specifically to Korean imports. It is therefore of importance to shed light on this question, especially for Korea which has experienced rapid growth along with a high rate of export growth.

On this basis, we classify trade liberalization by the amount of import openness (hereafter openness) and by the amount of globalization. ((Rephrase) I don't understand what this is saying) Given the accessible indicators of trade liberalization, the amount of imports as a share of the total factor cost of national income stand as a proxy for openness, while the sum of exports and imports for the total factor cost of national income is a proxy for globalization (e.g., Yanikkaya, 2003; Awokuse, 2008). The initial option for openness has been amplified by globalization i.e. Korea's participation in the new wave of trade liberalization which began during the end of the 1990's.

By using the unique openness and globalization level annual time series data for the period 1986 to 2008 from Korea, the analysis takes into account the possibility that both openness and globalization affect growth. We then compare the sensitivity of growth to change in each of the two indicators of trade liberalization.

The remainder of the paper is organized as follows. Section 2 develops the analytical framework. Section 3 describes the data used. Section 4 presents and discusses the empirical results, and concluding remarks are given in Section 5.

## II. Analytical Framework

In order to test for the null hypothesis that the difference in both openness and globalization are causal to the differentials in growth, and to compare the sensitivity of growth to a change in each of the two indicators of trade liberalization, the following function can be formulated (Frankel and Romer, 1999; Hall and Jones, 1999):

$$gFCY_t = f(gFCY_{t-1}, TRADE_t, Z_t) \quad (1)$$

Where  $g$  denotes the growth in each variable (e.g.  $gFCY_t$  denotes the growth rate of  $FCY_t$ ).  $FCY_t$  denotes the total factor cost of national income.  $TRADE_t = (OPEN_t, GLOBAL_t)'$  refers to the row vector of the two indicators of trade liberalization (Awokuse, 2008; Yucel, 2009).  $OPEN$  and  $GLOBAL$  represent openness and globalization, respectively. The estimated Pearson correlation coefficient between  $OPEN_t$  and  $GLOBAL_t$  is 0.96, suggesting that the two indicators of trade liberalization are highly correlated. Therefore, these indicators are included in separate regressions.

Meanwhile, vector  $Z_t$  includes the following control variables (Barro and Sala-i-Martin, 2001):  $PC_t$  (unfair trade practices as a proxy for business corruption),

$GCt$  (the number of exposures as a result of audit and inspection in the public sector as a proxy for public sector corruption),  $GOVTt$  (the ratio of the consolidated expenditure to the total factor cost of national income as a proxy for the size of government),  $It$  (the ratio of the total investment to the total factor cost of national income), and  $TECHt$  (the number of patents as a proxy for technological development).

We include a lagged dependent variable (i.e., lagged growth) as an explanatory variable to limit the potential impact of reversed causality (Stel et al., 2005).  $t$  represents year.

Equation (1) represents the well-behaved production function exhibiting all diminishing returns to inputs.

An error correction model (ECM) also allows us to study the short-run dynamics in the relationship between growth and openness, and between growth and globalization. For example,

$$\Delta gFCY_t = g(\Delta gFCY_{t-1}, \Delta TRADE_t, \Delta Z_t, S_{t-1}) \quad (2)$$

where  $S_{t-1}$  denotes the error correction term (see Wooldridge, 2000). The parameters of the equations are estimated using the annual time series for the period of 1986-2008.

Furthermore, each equation is also estimated by using a maximum likelihood procedure (ML) which assumes that there is a first order serial correlation in the disturbance term.

### III. DATA

Table 1 provides a description of the variables used in the model. Least squares regression assumes that the dependent variable and (less critically) the independent variables are normally distributed. This assumption is reasonably satisfied by the data used in the study. Table 1 contains the commonly used Kolmogorov and Smirnov tests for normality and shows that the tests fail to reject the hypothesis of normal distribution for both growth and trade liberalization indicators (i.e., openness and globalization). Moreover, neither of the two indicators, trade liberalization or growth show significant skewness (Black, 2001).

**Table 1.**  
Definition of variables

Variable	Mean (SD)	Normality K-S (z value) <sup>1</sup>	Test Skewness
$FCY^2$ = The total factor cost of national income	382,693 (220,086)	Accept $H_0$ (0.450)	0.280
$gFCY^3$ =Growth	11.257 (6.128)	Accept $H_0$ (0.401)	-0.158
$IMPORT^4$ =Imports	148,220 (113,430)	Accept $H_0$ (0.677)	1.206
$OPEN=IMPORT/FCY^5$ =Imports for the total factor cost of national income	35.689 (7.046)	Accept $H_0$ (0.841)	2.115
$EXIM^6$ =The sum of exports and imports of goods and services	309,560 (235,264)	Accept $H_0$ (0.670)	1.063
$GLOBAL=EXIM/FCY^7$ =The sum of exports and imports for the total factor cost of national income	74.462 (15.270)	Accept $H_0$ (0.520)	1.296
$PC^8$ =Business Corruption	0.321 (0.144)	Accept $H_0$ (0.731)	0.979
$GC^9$ =Public Sector Corruption	4.958 (1.965)	Accept $H_0$ (0.626)	-0.414
$FISCAL^{10}$ =Consolidated Expenditure	103,818 (68,916)	Accept $H_0$ (0.610)	0.388
$GOVT=FISCAL/FCY^{11}$ =Consolidated Expenditure to the total factor cost of national income	25.345 (3.884)	Accept $H_0$ (0.909)	0.055
$INV^{12}$ = The total investment	132,532 (68,961)	Accept $H_0$ (0.425)	0.193
$I=INV/FCY^{13}$ =The total investment for the total factor cost of national income	36.053 (4.729)	Accept $H_0$ (0.766)	0.117
$TECH^{14}$	82.589 (53.995)	Accept $H_0$ (0.725)	0.329

- Notes: 1. Kolmogorov-Smirnov Test. The alternatives are:  $H_0$ =the fit so fanormal distribution to the sample data is adequate .By"Accept  $H_0$ " westrictly mean "cannot reject  $H_0$ ".The  $\alpha$  risk is controlled at 0.01 on a two-tailed test.
- 2, 4, 6,10,12. In billions of Korean Won.
3. The year-over-year growth rate, expressed as a percentage.
8. In thousands. The number of unfair trade
9. In thousands. The number of exposures as a result of audits and inspections in the public sector.
- 5,7,11,13. Unit: %.
14. In thousands. The number of patents.

Source: 2,4,6,12. Korea National Statistical Office and Korea Institute for Industrial Economics and Trade.

8. *Annual Statistical Reports*, The KoreaFairTradeCommission.

9. *Annual Audit Reports*, The Board of Audit and Inspection for Korea.

10. *Consolidated Central Government Financial Statistics*, Ministry of Strategy and Finance.

14. *Application by year*, Korean Intellectual Property Office.

This study uses trade intensity (exports plus imports as a share of the total factor cost of national income) as the measure of globalization, which refers to the integration of the goods market through international trade (e.g., Yanikkaya, 2003). This study also includes imports in the total factor cost of national income for openness (Awokuse, 2008).

Corruption implies that the agent (an official) entrusted with carrying out a task by the principal (the public) engages in some sort of malfeasance for private enrichment, which is difficult to monitor for the principal (Bardhan, 1997).

On this basis, we classify corruption into the two categories of business and public sector. Given the accessible corruption indicators, the amount of unfair trade stands as a proxy for business corruption, while the number of exposures (hereafter public sector corruption) as a result of audits and inspections in the public sector is a proxy for public sector corruption.

In the literature, the most commonly used method to measure the size of a government is a ratio of government expenditure to the GDP (e.g., Grossman, 1988). Following beyond literature, in this study, the proxy for the size of government is calculated as the ratio of consolidated expenditure to the total factor cost of national income.

Korea's financial crisis at the end of 1997 was reflected in the gFCY variable. The level of government regulation was reflected in the FISCAL/FCY variable. Physical capital was reflected in the I variable (Haavelmo, 1960: p.3; Bloom et al., 2004: p.7).

This study uses the number of patents rather than the internet users as a proxy for physical technology because of data availability.

#### IV. Estimated Results

This study deals with the functional form issue by using the Box-Cox transformation framework and the Theil maximum adjusted multiple determination

(Adj.R<sup>2</sup>) criterion in Table 2. The double-natural logarithmic model run by OLS (Ordinary Least Squares) is implied in the estimated regressions for growth.

**Table 2.**

Non-Nested Test of Double Logarithmic versus Linear Models of Growth: OLS estimates

Equation <sup>1</sup>	Box-	Cox <sup>2</sup>	Theil <sup>3</sup>	
	Logarithmic model (H <sub>1</sub> )	Linear model (H <sub>0</sub> )	Logarithmic model (H <sub>1</sub> )	Linear model (H <sub>0</sub> )
(1)	RSS=0.065 Reject H <sub>0</sub>	RSS=1.458	Adj.R <sup>2</sup> =0.855 Reject H <sub>0</sub>	Adj.R <sup>2</sup> =0.803
(2)	RSS=0.077 Reject H <sub>0</sub>	RSS=1.478	Adj.R <sup>2</sup> =0.829 Reject H <sub>0</sub>	Adj.R <sup>2</sup> =0.800

Notes: 1. Equation (1) includes the openness (*OPEN<sub>t</sub>*), whereas equation (2) includes the globalization (*GLOBAL<sub>t</sub>*).

2. The Box-Cox procedure as described by Maddala (1977, p.317). For example, the Box-Cox procedure for the growth function (1) involves dividing each *gFCY<sub>t</sub>* by the geometric mean of the *gFCY<sub>t</sub>*'s; the exponential of the mean of the natural logarithm of *gFCY<sub>t</sub>*. Then we estimate the two equations (double natural logarithmic and linear) and choose the one with the smaller residual sum of squares (RSS). The value of *lngFCY* in 1997 Asian financial crisis appears to be less than zero. Therefore, the prediction of the double natural logarithmic model for the non-nested tests are obtained by relying upon the first-order Taylor series approximation  $\ln(1+X) \approx X$ ;  $\ln gFCY = \ln(1+gFCY-1) \approx gFCY-1$ .
3. The Theil maximum adjusted multiple determination criterion as described by Maddala (1992 .497). For example, the estimated value of Adj.R<sup>2</sup> for the growth function is larger in the double natural logarithmic model (Adj.R<sup>2</sup>=0.855) than in the linear model (Adj.R<sup>2</sup>=0.803), this suggests that the linear model can be rejected.

Although the equation (1) is estimated by using the ML as well as the OLS methods, we analyze the OLS results more than the ML results because the OLS estimation does not suffer from autocorrelation; D.W.=2.177 and 1.967, respectively. Furthermore, the standard errors of the estimates (SEE) for the OLS are smaller than those for the ML. The use of SEE is also based on the overall model performance.

**Table 3.**  
Estimates of the Growth Equation<sup>1</sup>

Independent Variables	Dependent		Variable: $lngFCY_t$	
	OLS (1)	(2)	ML <sup>2</sup> (1)	(2)
$lngFCY_{t-1}$	-0.369 (0.104) <sup>***</sup>	-0.337 (0.112) <sup>***</sup>	-0.322 (0.114) <sup>**</sup>	-0.344 (0.114) <sup>***</sup>
$lnOPEN_t$	4.269 (1.376) <sup>***</sup>	-	4.583 (1.324) <sup>***</sup>	-
$lnGLOBAL_t$	-	3.671 (1.480) <sup>**</sup>	-	3.614 (1.555) <sup>**</sup>
$lnPC_t$	-1.666 (0.308) <sup>***</sup>	-1.684 (0.338) <sup>***</sup>	-1.746 (0.283) <sup>***</sup>	-1.661 (0.357) <sup>***</sup>
$lnGC_t$	-0.650 (0.304) <sup>*</sup>	-0.711 (0.327) <sup>**</sup>	-0.607 (0.271) <sup>**</sup>	-0.714 (0.349) <sup>*</sup>
$lnGOVT_t$	-12.902 (2.613) <sup>***</sup>	-12.204 (2.807) <sup>***</sup>	-12.635 (2.553) <sup>***</sup>	-12.236 (2.941) <sup>***</sup>
$lnI_t$	6.039 (1.524) <sup>***</sup>	8.111 (1.653) <sup>***</sup>	5.705 (1.497) <sup>***</sup>	8.156 (1.724) <sup>***</sup>
$lnTECH_t$	1.301 (0.381) <sup>***</sup>	1.486 (0.409) <sup>***</sup>	1.209 (0.344) <sup>***</sup>	1.500 (0.435) <sup>***</sup>
AR1	-	-	-0.242 (0.329)	0.041 (0.309)
Constant	1.162 (10.428)	-9.852 (11.833)	21.615 (12.267)	-9.678 (12.355)
R <sup>2</sup> (Adj.R <sup>2</sup> )	0.906 (0.855)	0.889 (0.829)	-	-
F(7,13)	17.840 <sup>***</sup>	14.819 <sup>***</sup>	-	-
D.W.	2.177	1.967	-	-
SEE	0.567	0.616	0.582	0.641
Log likelihood	-	-	-13.942	-15.964
AIC	-	-	45.885	49.927

Notes: 1. Values in parentheses are the estimated absolute standard errors of the regression coefficients. \*\*\*, \*\*, and \* denotes the significance at 1%, 5%, and 10% levels on a two-tailed test, respectively. In the regression equations (1) and (2) use OLS, the estimated D.W. (Durbin-Watson) value lies between  $d_U$  (2.290) and the value of  $4-d_U$  (1.710). Therefore, the null hypothesis of no autocorrelation is not rejected at the 5% level of significance (the number of observations = 21), implying that the models are correctly specified.

2. Two regressions are estimated by using ML assuming the first order serial correlation in the disturbance term. The numbers for the iterations are 6 and 5 for regressions (1) and (2), respectively.

In Table 3, the regression results suggest that more openness and globalization are proportionately associated with higher growth. For example, the OLS estimates suggest that a 1 per cent increase in both openness and globalization raises growth by 4.269 and 3.671 per cent, respectively. In a comparison between openness and globalization, the latter has a minor effect on growth (t-statistics=3.102 and 2.413, respectively). These results reflect the fact that imported capital goods have a greater impact on growth. An implication of this is that import openness (i.e., import to the total factor cost of national income) is more sensitive to economic growth than export openness (i.e., exports to the total factor cost of national income);

OLS

$$\begin{aligned} \ln gFCY_t = & -13.662 - 0.318 \ln gFCY_{t-1} + 3.065 \ln XOPEN_t - 1.722 \ln PC_t - 0.799 \ln GC_t - \\ & 11.028 \ln GOVT_t \\ & (13.484) \quad (0.118)^{**} \quad (1.521)^* \quad (0.366)^{***} \quad (0.339)^{**} \\ & (2.821)^{***} \\ & + 9.338 \ln I_t + 1.606 \ln TECH_t \\ & (2.016)^{***} \quad (0.437)^{***} \\ & R^2(\text{Adj.}R^2) = 0.875(0.808), F(7,13) = 12.998^{***}, D.W. = 1.813, SEE = 0.653 \end{aligned}$$

ML

$$\begin{aligned} \ln gFCY_t = & -13.042 - 0.363 \ln gFCY_{t-1} + 2.620 \ln XOPEN_t - 1.439 \ln PC_t - 0.776 \ln GC_t - \\ & 11.198 \ln GOVT_t \\ & (14.043) \quad (0.106)^{***} \quad (1.654) \quad (0.416)^{***} \quad (0.436)^* \\ & (3.008)^{***} \\ & + 9.767 \ln I_t + 1.697 \ln TECH_t \\ & (2.073)^{***} \quad (0.528)^{***} \\ & AR1 = 0.333(0.275), SEE = 0.668, \text{Log likelihood} = -16.848, AIC = 51.695 \end{aligned}$$

where *XOPEN* stands for export openness.

The results are consistent with Edward's study (1998) that more open countries experience faster productivity growth. Yucel (2009) also conducts Granger causality tests using monthly time-series data for Turkey over the period 1989 to 2007. His results show that Turkey's trade globalization measured as the ratio of the sum of the

exports and imports to GDP Granger causes growth at the 0.05 level of significance. His finding also supports the theoretical approach in which trade globalization can have a positive effect on economic performance in developing countries.

The OLS estimates suggest that each of the estimated coefficients for business corruption ( $\ln PC$ ) and public sector corruption ( $\ln GC$ ) are negative and significant, as expected. This result is consistent with the usual findings of previous studies that the lower the level of corruption in a country is, the higher the level of economic development will be.

For example, Abed and Davoodi (2000), based on single cross-sectional data for 25 countries from the 1999 International Monetary Fund staff and World Development Indicators (World Bank), present the results of OLS regressions in which the anti-corruption index which has a scale from 0 to 10 (highly corrupt=0; highly clean=10) is regressed for the per capita real growth rate. They find that lower corruption is significantly associated with higher growth; a one unit increase on the corruption index increases the growth rate by 2.64% at the 0.01 level of significance. Variations in the initial per capita real GDP, initial life expectancy, the ratio of fiscal balance to GDP, and inflation are controlled.

This finding indicates that increased government size ( $GOVT_t$ ) is negatively associated with growth. An implication of this is that a big government per se may not necessarily raise the growth rate. This is primarily due to red tape. Thus, it should be well run with an efficient judiciary. This result is consistent with Grossman's evidence (1988). Employing annual time-series data covering the period 1929-1982 for the United States, Grossman uses the non-linear model estimate using two staged least squares that the ratio of government expenditure to GDP as a proxy for the size of government is negatively and significantly related to growth (t-statistics=2.577); the negative impact of government arising from the welfare loss generating distortions and the unproductive use of resources in rent-seeking activities is significant. This result is also in line with Higgs' argument which explains the failure of big government (Higgs, 2010).

$\ln I_t$  is positively and significantly related to growth. This implies that a higher investment is, as predicted by all previous studies, associated with a higher growth. For example, when using cross-country panel data on 85 countries covering 1990-2000, Gwartney et al. (2006) found that both private and public investments as a share of GDP were positively and significantly related to the average annual growth rate of per capita GDP (t-statistic=3.93 and 2.82, respectively). Rogers (2003) also argues that investment and growth are closely linked and that policies that hinder investment may well reduce growth.

In Table 3, the estimated coefficient of  $\ln TECH_t$  maintains a theoretically expected

positive sign and is statistically significant at the 0.01 level on a two-tailed test. This result is in line with Jorgenson and Vu's results (2005) that the amount of investment in information technology (*IT*) on economic growth is striking in all countries, but especially in industrialized economies and developing areas in Asia.

**Table 4.**  
Estimates of the Error Correction Terms

	$S_{t-1}$	Error		(0.083)*** Correction Term		
		(1) D.W.	SEE	$S_{t-1}$	(2) D.W.	SEE
OLS	-0.346 (0.177)*	2.175	0.586	-0.318 (0.170)*	2.157	0.596
ML	-0.314 (0.154)*	-	0.590	-0.291 (0.144)*	-	0.600

Notes:1. See Notes 1 in Table 3. In the regression equations (1) and (2) using OLS, the estimated D.W. (Durbin-Watson) the value lies between  $d_U(2.244)$  and the value of  $4-d_U(1.756)$ . Therefore, the null hypothesis of no autocorrelation is not rejected at the 1% level of significance (the number of observations=21), implying that the models are correctly specified.

Given the above results, this study has estimated the ECM by using the OLS and ML. The estimated ECM results in Table 4 under the columns (1) and (2) indicate that the error correction coefficient for both openness and globalization are negative and significant. A negative and statistically significant error correction term implies that the null hypothesis has no co-integration and is rejected at the 10% level when one period lag is used (Ansari and Ahmed, 2007).

This implies, for example, that growth during the previous period has overshoot the equilibrium; and will fall by 0.318%~0.346% on average in the next year (Wooldridge, 2000). The existence of co-integration means that openness and globalization policies can be targeted to bring about the desired long-term effect as well as a short-run effect on growth .

## V. CONCLUDING REMARKS

This paper's main objectives were to explore the possibility that two indicators of trade liberalization affect growth and to measure the sensitivity of growth on the amount of change in trade liberalization.

For this estimation, our study uses both alternative measures of trade liberalization; imports to the total factor cost of national income for openness and the sum of exports and imports to the total factor cost of national income for globalization. The data for this investigation comes from the Korea National Statistical Office and the Korea Institute for Industrial Economics and Trade. The model is estimated by using the annual time series data from 1986 to 2008 in Korea.

The most important results and analysis of the OLS estimates can be drawn. First, the empirical results are consistent with the hypothesis that after controlling for the level of business and public sector corruptions, government size, investment, and technology, more openness and globalization are proportionately associated with higher growth, a finding that is in the prediction of the new growth theory about the potential long-run effects of trade on growth. To summarize, greater trade liberalization, whether it is associated with (import) openness or globalization, has an important influence upon growth.

In a comparison between the two indicators of trade liberalization, openness appears to be more sensitive to growth than globalization. A negative and statistically significant error correction term implies that the null hypothesis of no co-integration is rejected when one period lag is used. The existence of co-integration means that openness and globalization policies can be targeted to bring about a desired long-run effect as well as a short run effect on growth.

Both business and public sector corruption, and the size of the government have a detrimental effect on growth, whereas both investment and physical technology have a beneficial effect.

Our results are subject to a number of constraints which should be taken into account before one attains a strong conviction to the above conclusions. For example, given the date limitations, an ideal measure of business corruption is not obtained. Hopefully, the conclusion that we reached here will stimulate further research and discussion in resolving these issues.

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