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Study on Causal Nexus between Export, Import and Economic Growth by Frequency-Domain Approach: Evidence from Selected East and Southeast Asian Economies

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Abstract

In this study, frequency domain Granger causality test and generalized forecast error variance decomposition are employed to check the causal direction and contribution of exports and imports to economic growth for eight economies. Granger results show: in the short run, (a) Japan, Indonesia, and Thailand support growth-led import, Malaysia supports import-led growth, and Singapore supports bidirectional causal connection between imports and economic growth; (b) Indonesia supports growth-led export, the Philippines and Thailand support export-led growth, and Hong Kong SAR and Singapore support mutual causality between exports and economic growth; in the long run, (c) Indonesia and Thailand support growth-led import, Japan, Hong Kong SAR, and Singapore support import-led growth, and South Korea supports a two-way causality nexus between imports and economic growth; (d) South Korea and Indonesia support growth-led export, Japan, Hong Kong SAR, and Singapore support export-led growth, and Thailand supports bidirectional causality between exports and economic growth. Variance decomposition results indicated that in Japan, South Korea, Malaysia, Indonesia, and the Philippines, imports explain a larger part of economic growth than exports; in Hong Kong SAR and Singapore, exports have a larger impact than imports on economy; in Thailand, exports and imports are almost at the same importance level.

Keywords: *Import-led growth; export-led growth; frequency domain Granger causality test; generalized forecast error variance decomposition.*

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1. INTRODUCTION

Plenty of empirical investigations has discussed the benefit of trade for economic growth. Usually, exports are regarded as engines to drive a country's economic growth. Exports, as part of aggregate output, can directly promote output growth. The demand for export products in a foreign market can increase overall output growth by raising employment and income. Moreover, export growth plays an important role in efficiently allocating resources, utilizing greater capacity, using scale economy, and improving technologies in a country (Helpman and Krugman 1985; Awokuse 2008). Additionally, the growth of exports increases a country's foreign exchanges, with which more intermediate goods and advanced technologies can be imported. They, in turn, spur output growth (Esfahani 1991).

Compared with exports, imports contribute to the economy in different ways and may have disparate effects on the growing economy. In many developing countries, imports of semi-finished products are needed for product manufacturing. The imports of cutting-edge foreign technologies and knowledge also possess a long-term effect on economy growth (Coe and Helpman1995). Foreign research & development knowledge is a source of output growth. The advanced technologies are often bound with high-end machines and equipment that work as significant production factors (Mazumdar 2001). It is possible to assume that the imports of technology may have a more crucial impact on the economy than exports. Additionally, because of fierce competition, imports can have an impact on domestic innovation. The imports of foreign competing products create competitive pressure for domestic firms. The pressure stimulates firms to pay more attention to R&D and innovation. Innovations, in turn, facilitate productivity and economic growth (Lawrence and Weinstein 2001).

Abundant researches examine the Granger causality connections between trade and economic growth. A large number of researchers get a positive effect of trade on the economy growth; however many of them have different arguments about the causal link direction. Moreover, most early researches mainly investigate the causal connections between exports and economic growth yet ignores the contribution of imports. This article chooses eight economies, i.e. Japan, South Korea, Hong Kong SAR (China), Singapore, Malaysia, Indonesia, the Philippines, Thailand, and takes into account the contribution of exports and imports to their economy.

One frequently-used approach is Granger causality test among previous studies on causality between trade and economic growth (Aluko and Adeyeye 2020). This article adopts frequency domain Granger causality test (Breitung and Candelon 2006), which has a few obvious advantages over traditional ones. The BC causality test can help to figure out the causal connections between imports/exports and economic growth by applying a two-variable vector autoregressive (VAR) model. By using the frequency domain method, the possible changes of causality nexus over time between exports/imports and economic growth are taken into consideration. The BC Granger test can tell the direction of causality, but it cannot explain whether exports or imports play a larger role in economic growth. Hence, besides Granger test, generalized forecast error variance decomposition (Lanne and Nyberg2016) is used in this article to analyze the contribution level of exports and imports to economic growth in the eight chosen economies.

This paper contains 5 parts. Part One introduces the research background, purpose, and reasons of using BC Granger test and generalized forecast error variance decomposition in this article. Part Two summarizes the previous studies regarding the causal relationship between exports/imports and economic growth of the eight selected economies. Part Three explains the data source, descriptive statistics of trade (exports/imports) and economic growth trend for those economies, as well as the methodology used in this research. Part Four shows the empirical results of BC Granger test and variance decomposition and Part Five draws a conclusion for the whole study. From the test results of BC Granger and generalized forecast error variance decomposition, it can be seen that imports/exports may play a different role in a nation's or a region's economic growth. A deeper understanding about trade factors (exports/imports) of economic growth can give some references for policymakers. Moreover, for further study, this paper can give some references for analyzing the contribution of some important industries' trade to its economy.

2. LITERATURE REVIEW

There are abundant researches exploring the causality connections between exports and economic growth, and some researches studying the causal relation of imports to economic growth. Zang and Baimbridge (2012) implemented the VAR model and confirmed the ELG hypothesis in Japan from 1957 to 2003. However, Ghartey (1993) and Awokuse (2006) pointed out that a bidirectional causal link between exports and economic growth existed in Japan. Lawrence and Weinstein (2001) used the data from 1964 to 1985 to investigate whether there was import-led growth or export-led growth in Japan and Korea. In Japan, imports contributed largely to its fast growing economy, and in Korea, there is a positive yet insignificant impact from imports to exports. They indicated that greater imports could stimulate the innovation of similar local products. Islam et al. (2012) concluded that a short-run mutual causality between imports and economic growth existed in Japan during 1971-2006. Glasure and Lee (1999) argued that South Korea experienced growth-led export by using the VAR approach. However, Bahmani-Oskooee et al. (1991), Bahmani-Oskooee (1993), Jin and Shih (1995), Shan and Sun(1998), Ekanayake (1999), Konya (2000), Awokuse (2005), and Islam et al.(2012) found mutually caused relation between exports and economic growth in South Korea. Moreover, Zang and Baimbridge (2012) pointed out that during 1963 to 2003 South Korea experienced a mutually causal connection between imports and economic growth. Xu (1996)and Mahadevan and Suardi (2008) gave support to the export-led growth hypothesis in Hong Kong SAR, yet Tang et al. (2015) pointed out that the export-led growth was unstable. Jin and Shih (1995), Shan and Sun (1998), and Tang (2006) argued exports and economy growth were mutually caused in Hong Kong SAR.

Furthermore, Mahadevan and Suardi (2008) found both export-led and import-led growth in Hong Kong SAR over 1973-2005. Bahmani-Oskooee (1993), and Jin and Shih (1995) indicated that the causal nexus between exports and economic growth was bilateral, and Mahadevan (2009) found strong evidence for import-led growth by using the method of Toda and Yamamoto (1995). With a very high trade-to-GDP ratio, undoubtedly trade plays an important role in Singapore's economic growth. Tan et al (2007) gave evidence to support export-led growth hypothesis Singapore during 1958-1997. However, Mahadevan (2009) supported import-led growth by using the method of Toda and Yamamoto (1995), and got one mutual causal connection between exports and imports and an indirect effect of exports on economic growth through imports by using VECM method in Singapore.

Some researchers supported growth-led exports hypothesis for Malaysia, such as Khalafalla and Webb (2001), Lim and Ho (2013), Hassan and Murtala (2016) and Akter and Bulbul (2017). However, Keong et al. (2003), and Marwah and Tavakoli (2004) got a positive effect of imports on growing economy of Malaysia. The studies of Khalafalla and Webb (2001), Mahadevan (2007), Akter and Bulbul (2017) also supported import-led growth hypothesis in Malaysia. Whereas Kogid et al. (2011), Islam et al. (2012), Hashim and Masih (2014) showed a mutually causal link between imports and economy growth. Bahmani-Oskooee et al. (1991) and Dodaro (1991) found support for export-led growth in Indonesia. Marwah and Tavakoli (2004) indicated that imports had marked effects on economic growth over 1970-1998 in Indonesia. Islam et al. (2012) also implied that there was a short &long-run mutually-caused link between imports and economy growth in Indonesia. Xu (1996) indicated a positive causality link from exports to GDP growth over 1951-1990 in the Philippines but Bahmani-Oskooee (1993) and Ekanayake (1999) argued this causal link existed mutually in their studies. Marwah and Tavakoli (2004) indicated that imports possessed a strong positive effect on the economy over 1970–1998 in the Philippines.

Moreover, Islam et al. (2012) found a short-and long-run mutual causality connection in the Philippines between imports and economy, based on data from 1971-2006. Xu (1996), Tan et al. (2007) and Jiranyakul (2010) found support to export-led growth hypothesis for Thailand. Yet, Bahmani-Oskooee et al. (1991), Bahmani-Oskooee (1993), and Ekanayake (1999) argued this causal relation between exports and economic growth in Thailand was bidirectional. Marwah and Tavakoli (2004) implied a strongly positive effect of imports on economic growth in Thailand during 1970-1998. Islam et al. (2012) found a short-run bidirectional causality connection between imports and economy growth in Thailand during1971-2006.

It can be found that a lot of researches have been completed to study the relation between export and economic growth for the selected 8 economies, yet most of them ignored the contribution of imports and the most employed methodology is Granger causality test. This article adopts frequency domain Granger causality test (Breitung and Candelon 2006) by applying a two-variable vector autoregressive (VAR) model, which hasn't been used to test the causal nexus between trade and economic growth for those selected economies and has a few obvious advantages over traditional ones. Moreover, generalized forecast error variance decomposition (Lanne and Nyberg2016) is used in this article to analyze the contribution level of exports and imports to economic growth in the eight selected economies.

3. DATA AND METHODOLOGY

3.1 Data

The data of this research are collected from the World Bank's WDI. Annual data over 1970-2018 of exports of goods and services, imports of goods and services, GDP per capita from eight Asian economies (Japan, South Korea, Hong Kong SAR China, Singapore, Indonesia, Malaysia, the Philippines, Thailand) are chosen to be analyzed. In this article, GDP per capita refers to economic growth, exports refer to exports of goods and services, and imports refer to imports of goods and services. All the data used in the Granger causality model and variance decomposition are at constant 2010 US$ price. To obtain better statistical properties, we take natural logarithms of all variables in the model.

3.2 Descriptive statistics

Figures 1-8 are the GDP and Trade growth trends for the 8 economies from 1970-2018. Here EXP refers to exports of goods and services, IMP imports of goods and services, TV trade volume (total value of imports and exports of goods and services). The data (GDP, EXP, IMP, TV) used to illustrate the figures are at current value. Table 1 shows the Trade-to-GDP ratio of the 8 economies.

The trade and GDP growth can be seen from the figures and tables. In Japan, the growth of imports and exports is consistent and the total value is close to each other; GDP is growing fast since 1970 and reaches a peak of 6272 billion $ at 2012; the ratio of trade to GDP is increasing from 1970 and keeping below 30% in most of the year before 2006; after 2006, the ratio is mostly above 30%. In South Korea, the exports grow consistently with imports, and the exports volume is close to imports volume for a long time, yet after 2009 the exports grow slightly higher than imports; the GDP also grows rapidly from 1970 to $1725 billion in 2018; the trade-to-GDP rate is above 50% in most years after 1972 and over 100% in 2011 & 2012, while it becomes above 70% after 2015.

In Hong Kong SAR, the exports and imports volume is very close in almost every year during1970-2018; yet the exports volume, as well as imports volume, is growing higher than Hong Kong SAR's GDP from 1987, and the gap is obviously increasing larger after 2003; the trade-to-GDP ratio increases from 178.67% in 1970 to above 200% after 1986, and from 2004, the ratio becomes above 300% and over 400% during 2010-2014. In Singapore, the volume of exports and imports is also very close from 1970 to 2003, and after 2003, the exports grow obviously slightly higher than imports; the volume of its imports or exports has always been higher than GDP since 1970, and this gap has been getting bigger since 2003; the trade-to-GDP ratio in most of the years since 1970 is over 300%, and in some years this ratio is more than 400%.

In Malaysia, the exports and imports grow consistently and are close to each other after 1970, yet the exports volume grows higher than imports after 1998; the trade-to-GDP ratio is over 100% after 1980, and in some years, it's more than 200%. In Indonesia, the exports and imports grow consistently and are close to each other during 1970-2018; the trade-to-GDP ratio during 1991 is 2008 above 50% mostly while after 2008 it decreases to 30% ~ 50%. In the Philippines, both exports increase in pace with imports from 1970, but after 2011 imports grow slightly faster than exports; before 1987, the trade-to-GDP ratio is mostly below 50% and after that it ranges among 50% ~ 100%. In Thailand, exports also increase in pace with imports from 1970, but after 2013, the exports volume rises slightly faster than imports; the trade-to-GDP ratio grow gradually from 34% in 1970 to 100% in 1998, and after 1999 it keeps at 110% ~140%. Although the trade-to-GDP ratio of each economy has a relatively large difference, it is obvious that the imports and exports of basically all eight economies here have maintained simultaneous growth for a long period of time. Therefore, it is not appropriate to only mention the contribution of imports to these economies while ignoring the role of imports.

3.3 Unit root test

Whether the structural mutation is considered or not may lead to different conclusions from the unit root test, and various economies often have noticeable structural changes due to political and policy factors during economic development. Therefore, to make more reliable conclusions, two methods are used to perform unit root tests for each variable. One is DF-GLS (Elliott et al. 1996) without considering structural mutation. This method has higher testing power than ADF test, and PP tests. The other method that considers the structural mutation is Zivot and Andrews (1992). This method allows the existence of intercepts and/or linear trends with structural mutations. The unit root test results are shown in Table 2.

3.4 Estimation methodology

We adopt the Granger causality test with frequency domain and generalized forecast error variance decomposition to check the causal direction and analyze the explanation level of exports and imports to economic growth. The bcgcausality of Stata 16 is used to test the Granger causality and a plug-in GFEVD of Eviews 10 is used to get the variance decomposition in this paper.

3.4.1 Granger test with frequency domain.

The frequency-domain Granger causality test method proposed by Breitung and Candelon (2006) is used to study the causal direction between import and economic growth, export and economic growth. This paper establishes a three-variable VAR (p) model including logarithm of GDP per capita (lngdp), the logarithm of import (lnimp) and the logarithm of export (lnexp). The model is shown as follows:

$$\begin{bmatrix} \ln gdp_t \\ \ln imp_t \\ \ln \exp_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \beta_{20} \\ \gamma_{30} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \beta_{11} & \gamma_{11} \\ \beta_{21} & \gamma_{21} & \alpha_{21} \\ \gamma_{31} & \alpha_{31} & \beta_{31} \end{bmatrix} \begin{bmatrix} \ln gdp_{t-1} \\ \ln imp_{t-1} \\ \ln \exp_{t-1} \end{bmatrix} + \cdots + \begin{bmatrix} \alpha_{1p} & \beta_{1p} & \gamma_{1p} \\ \beta_{2p} & \gamma_{2p} & \alpha_{2p} \\ \gamma_{3p} & \alpha_{3p} & \beta_{3p} \end{bmatrix} \begin{bmatrix} \ln gdp_{t-p} \\ \ln imp_{t-p} \\ \ln \exp_{t-p} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{bmatrix} \quad (1)$$

Here, p is the lag order, which is the error.

The formula in the above VAR model,falsecan be expressed as

$$\ln gdp_t = \alpha_{10} + \alpha_{11} \ln gdp_{t-1} + \cdots + \alpha_{1p} \ln gdp_{t-p} + \beta_{11} \ln imp_{t-1} + \cdots + \beta_{1p} \ln imp_{t-p}$$

$$+\gamma_{11} \ln exp_{t-1} + \cdots + \gamma_{1p} \ln exp_{t-p} + e_{1t} \tag{2}$$

Based on the above equation, BC Granger causality test is used to test whether falsehas predictive function on falseand the basic idea is as follows:

The null hypothesis: $M_{\ln imp \to \ln gdp | \ln exp}(w) = 0$ (3)

That is, when frequency=w, falsewon't cause the change of false

This hypothesis is equivalent to the following linear hypothesis.

$$H_o : R(w)\beta = 0$$

$$\beta = [\beta_{11}, \ldots, \beta_{1p}]' \;,\; R(w) = \begin{bmatrix} \cos(w)\cos(2w)\cdots\cos(pw) \\ \sin(w)\sin(2w)\cdots\sin(pw) \end{bmatrix} \tag{4}$$

Wald test can be used to check above hypothesis. If the null hypothesis is rejected, it indicates that lnimp_t will cause the change of lngdp_t; otherwise, lnimp_t will not cause any changes of lngdp_t.

A key issue in the VAR model modeling process is how to select the lag order. This article determines the lag explanation according to the following procedure. According to the research of Lemmens et al. (2008), when using the frequency domain Granger causality test, the relative optimal lag order selected by using Bayesian information criterion (BIC) performs best. Therefore, this paper first uses BIC as the information criterion, selects the initial value p0 of the lag order, then estimates the VAR (p0) model and checks whether autocorrelation exists in the residuals.

If there is no autocorrelation, then the optimal lag order is determined as p=p0. Otherwise, increase the lag order one by one until the residuals have no autocorrelation. Suppose that when the lag order p=p0+k-1, the residuals of the VAR (p0+k-1) model has autocorrelation, and the residuals of the VAR (p0+k) model do not have autocorrelation, then the most optimal-lag order is determined as p=p0+k.

Since the integration order of each variable may be a mixture of I(0) and I(1), or both are I(1), this may lead to Wald test statistics have no standard limit distribution. We use the methods proposed by Toda and Yamamoto (1995) and Dolado and

Lutkepohl (1996) to solve this problem by adding an additional lag item to the optimal lag length of the VAR model. In other words, instead of using the VAR (p) model, the VAR (p+1) model is used to test the constraints. This method can be applied to establish standard inferences for frequency domain causality test (Breitung and Candelon2006).

3.4.2. Generalized variance decomposition

This article additionally uses the generalized variance decomposition method proposed by Lanne and Nyberg (2016) to get some useful conclusions about the relative importance of import/export to economic growth. This method has obvious advantages over traditional variance decomposition and other generalized variance decomposition methods. On the one hand, the analysis results of the traditional variance decomposition method will be affected by the variable ranking in the model, but the results of the method proposed by Lanne and Nyberg (2016) will not be affected by the variable ranking. Secondly, although the traditional generalized variance decomposition (such as Pesaran and Shin 1998) solves the problem of variable ranking, the sum of the elements of each row of the variance decomposition table may not be equal to 1, that is to say, the sum of the contributions of each variable to the variance of the prediction error may not be equal to 1. This will cause some difficulties in the interpretation of the results. The generalized variance decomposition method proposed by Lanne and Nyberg (2016) solves this problem and can ensure that the sum of the contributions of various variables to the variance of the prediction error is equal to 1. The variance decomposition method requires that the VAR model is stationary with covariance. In order to ensure that this condition is met, each variable of the VAR model is a I(0) variable, namely dlngdp, dlnexp and dlnimp. The results of generalized variance decomposition of various economies are shown in the table 4.

4. EMPIRICAL RESULTS

The Granger causality analyses are completed over one full sample (data over 1970-2018) for the chosen eight economies. Furthermore, generalized variance decomposition (Lanne and Nyberg 2016) is employed to analyze the explanation level of imports and exports to GDP per capita growth. The results of this study can provide some useful information for trade policymakers about the causal association between exports/imports and economic growth in the short/long run and about the contribution level of exports and imports to their economic growth.

Table 3 shows the frequency domain Granger causality test results between imports/exports and economic growth for the chosen 8 economies over 1970-2018. The results indicate in Japan, only a short-run unidirectional causal nexus exists from economic growth to imports; however, in the long run, there is one causal relationship from imports to economic growth, and one causal link from economy growth to exports. In Korea, in the short run, no causal connection exists between imports or exports and economic growth, while a feedback association between imports and economic growth and a causal nexus from economic growth to exports are found in the long run.

In Hong Kong SAR, in the short run, no causal link exists between imports and economic growth, but a bilaterally causal association between exports and economic growth; in the long run, a Granger causal connection from imports to economic growth and a causal link from exports to economic growth are found. In Singapore, in the short run, a bidirectional causal relation exists between imports/exports and economic growth; however, in the long run the causal link is only from imports and exports to economic growth. In Malaysia, in the short run, a causal link of imports to economic growth exists and no causal relationship is found between exports and economic growth; yet in the long run, no causality is found between imports or exports and economic growth. In Indonesia, the Granger causal relationship is unidirectional from economic growth to imports and to exports in the short and long run. In the Philippines, there is only a causality link of exports to economic growth in the short run, yet no causality nexus between imports and economy growth. In Thailand, in the short run, exports cause economic growth and economic growth causes imports; in the long run, economic growth also leads to imports, and exports and economic growth are mutually caused.

4.1 Interpretation of generalized variance decomposition results

Table 4 shows the results of the generalized forecast error variance decomposition of 1-10 periods for the chosen 8 economies. In Japan, the impact of economic growth (DLNGDP) itself has the largest relative contribution to its forecast error variance, with a contribution rate maintained at about 68%, followed by import growth (DLNIMP), with a contribution rate held at about 24%. However, export growth (DLNEXP) has the least impact on economic growth, around 6%. Here, it can be seen that in Japan, import has a larger impact on economic growth than export. In South Korea, the impact of economic growth (DLNGDP) itself has the largest relative contribution to its forecast error variance, with a contribution rate at about 55%, followed by import growth (DLNIMP), with a contribution rate at about 32%, and then the export growth (DLNEXP) with a contribution rate at about 12%. It can be seen that in South Korea, import plays a more important role than export in economic growth.

In Hong Kong SAR, the impact of economic growth (DLNGDP) itself has the largest relative contribution to the variance of its forecast error variance, followed by export growth (DLNEXP), and then by import growth (DLNIMP). From a specific quantitative point of view, the relative contribution rate of the impact of economic growth itself to economic growth is maintained at about 44%, and the relative contribution rate of the export growth to economic growth is maintained at about 30%, yet the relative contribution rate of import growth to economic growth is maintained at about 26%. It can be concluded that for the Hong Kong SAR, export growth has a greater impact on economic growth than import growth. In Singapore, the impact of economic growth (DLNGDP) itself has the largest relative contribution to its forecast error variance, with a contribution rate at about 52%, followed by export growth (DLNEXP) with a contribution rate at about 27%, and then import growth (DLNIMP) with the least contribution rate at 21%, which implies that in Singapore, export has a greater impact than import on economic growth.

In Malaysia, the impact of economic growth (DLNGDP) itself has the largest relative contribution to its forecast error variance, with a contribution rate around 44%, followed by import growth (DLNIMP) with a contribution rate around 33%, and then export growth (DLNEXP) with a contribution rate around 22%. The results indicate that both import and export play a very important role in Malaysia's economy and import plays a greater role than export in its economic growth. In Indonesia, the impact of economic growth (DLNGDP) itself has the largest and dominant contribution to its forecast error variance, followed by import growth (DLNIMP), and then export growth (DLNEXP). The relative contribution rate of the impact of economic growth itself to economic growth dominates, maintaining at about 91%, while the contribution rate of import to economic growth only accounts for about 7%.

The contribution rate of export is less than 1%. It can be concluded that neither imports nor exports in Indonesia play a very important role in its economy. In the Philippines, the impact of economic growth (DLNGDP) itself has the greatest relative contribution to its forecast error variance, with a contribution rate at about 61%, followed by import growth (DLNIMP) with a contribution rate at about 23%, and then export growth (DLNEXP) with a rate at about 14%, which indicates import has a larger impact than export on economic growth. In Thailand, economic growth (DLNGDP) itself has the largest relative contribution to its forecast error variance, with a contribution rate at about 54%. The contribution rate of export growth (DLNEXP) and import growth (DLNIMP) to economic growth is almost similar, keeping at 23% and 22% respectively, which implies that in Thailand, both export and import are almost equally important to its economy.

5. CONCLUSION

We can draw the following conclusions according to the empirical results above. Over1970-2018, Japan supports short-run growth-led import yet long-run import-led and export-led growth, South Korea long-run feedback relation between imports and economic growth and long-run growth-led export, Hong Kong SAR short-run feedback relation between exports and economic growth and long-run import-led and export-led growth, Singapore short-run feedback relation between imports/exports and economic growth, and long-run import-led and export-led growth, Malaysia only short-run import-led growth, Indonesia both growth-led imports and exports in the short and long run, the Philippines only short-run export-led growth, Thailand short-and long-run growth-led import, short-run export-led growth and long-run feedback relation between exports and economic growth.

The results of variance decomposition indicate that for all the eight economies, the impact of economic growth itself has the largest relative contribution to its forecast error variance. The contribution rates of economic growth (DLNGDP) to itself are around 68% in Japan, 55% in South Korea, 43% in Hong Kong SAR, 51% in Singapore, 44% in Malaysia, 91% in Indonesia, 61% in the Philippines, 54% in Thailand. In some economies, the import plays a more important role than export in its economy, such as Japan (DLNIMP at 24%, DLNEXP at 7%), South Korea (DLNIMP at 32%, DLNEXP at 12%), Malaysia (DLNIMP at 33%, DLNEXP at

22%), Indonesia (DLNIMP at 7%, DLNEXP at 0.7%), the Philippines (DLNIMP at 23%, DLNEXP at 14%). In some economies, the export has a larger impact on its economy, such as Hong Kong SAR (DLNEXP at 29%, DLNIMP at 26%), Singapore (DLNEXP at 27%, DLNIMP at 21%). However, in Thailand, the export and import contribute almost a same rate (DLNEXP at 23%, DLNIMP at 22%) to its economic growth, which implies that for Thailand's economy, export and import are at the same importance level. For further study, this paper can give some references for analyzing the contribution of some important industries' trade to its economy.

Data availability statement

The data that support the findings of this study are openly available in the World Bank's WDI at [https://data.worldbank.org/indicator].

Competing interest
All authors declare no competing interest about this research.

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Table 1: Trade-to-GDP ratio

Year	Japan	S. Korea	HK SAR	Singa-pore	Malaysia	Indone-sia	Philip-pines	Thailand
1970	19.57%	32.56%	178.67%	271.06%	86.88%	28.68%	42.62%	34.40%
1971	19.92%	35.69%	174.51%	259.30%	79.49%	31.06%	40.87%	34.80%
1972	18.15%	38.04%	160.83%	229.05%	73.38%	35.41%	39.15%	37.37%
1973	19.30%	51.58%	164.53%	245.73%	77.33%	39.53%	44.66%	38.65%
1974	26.90%	55.53%	168.48%	313.96%	96.39%	50.42%	52.37%	45.54%
1975	24.60%	53.98%	161.21%	283.57%	90.65%	44.52%	48.13%	41.34%
1976	25.33%	53.88%	168.20%	305.90%	93.20%	43.01%	44.58%	42.94%
1977	23.63%	53.93%	160.19%	326.98%	92.78%	43.57%	45.18%	45.34%
1978	19.73%	54.22%	170.15%	334.60%	92.55%	42.71%	45.60%	44.00%
1979	23.14%	54.54%	177.97%	375.01%	103.15%	53.66%	48.20%	51.87%
1980	27.23%	65.53%	178.01%	410.94%	112.59%	52.65%	52.04%	54.48%
1981	27.63%	67.13%	182.58%	399.78%	110.86%	53.18%	51.01%	53.97%
1982	27.29%	60.23%	169.17%	372.54%	110.46%	48.68%	46.47%	47.55%
1983	25.06%	57.91%	186.33%	333.15%	108.02%	56.56%	49.42%	47.38%
1984	26.34%	57.37%	199.91%	313.12%	106.63%	50.11%	49.10%	48.07%
1985	24.60%	52.66%	197.80%	304.14%	104.68%	44.72%	45.91%	49.16%
1986	18.15%	60.11%	200.31%	294.83%	106.50%	41.01%	48.70%	49.17%
1987	17.11%	63.00%	215.13%	325.04%	111.92%	46.97%	52.86%	57.23%
1988	17.19%	58.70%	231.34%	359.87%	122.62%	47.25%	55.33%	67.41%
1989	18.87%	52.91%	225.20%	347.57%	136.69%	49.08%	58.38%	72.41%
1990	19.66%	50.75%	226.00%	344.33%	146.89%	52.89%	60.80%	75.78%
1991	18.07%	49.83%	231.87%	323.89%	159.31%	54.84%	62.18%	78.47%
1992	17.33%	48.76%	240.13%	311.31%	150.61%	57.43%	63.16%	77.95%
1993	16.01%	46.92%	233.97%	313.42%	157.94%	50.52%	71.17%	77.75%
1994	15.81%	48.67%	237.43%	316.22%	179.90%	51.88%	73.96%	81.25%
1995	16.39%	52.46%	256.90%	345.46%	192.11%	53.96%	80.54%	89.76%
1996	18.25%	52.65%	244.85%	334.91%	181.77%	52.26%	89.80%	84.27%
1997	19.78%	57.52%	233.44%	323.86%	185.67%	55.99%	108.25%	95.05%
1998	19.00%	68.50%	221.13%	312.08%	209.49%	96.19%	98.66%	100.24%
1999	18.13%	59.76%	220.27%	336.48%	217.57%	62.94%	94.91%	100.71%
2000	19.56%	66.10%	247.65%	364.36%	220.41%	71.44%	85.15%	121.30%
2001	19.56%	62.22%	240.85%	349.29%	203.36%	69.79%	84.90%	120.27%
2002	20.45%	58.35%	256.00%	349.75%	199.36%	59.08%	83.84%	114.97%
2003	21.33%	61.17%	292.45%	377.22%	194.20%	53.62%	87.57%	116.69%

2004	23.66%	70.02%	326.84%	401.52%	210.37%	59.76%	87.13%	127.41%
2005	26.23%	68.32%	342.69%	420.43%	203.85%	63.99%	83.85%	137.85%
2006	30.02%	70.65%	359.21%	425.36%	202.58%	56.66%	80.85%	134.09%
2007	32.82%	73.87%	362.15%	394.29%	192.47%	54.83%	73.64%	129.87%
2008	34.13%	95.52%	376.66%	437.33%	176.67%	58.56%	67.68%	140.44%
2009	24.39%	86.13%	348.40%	358.19%	162.56%	45.51%	60.89%	119.27%
2010	28.50%	91.40%	404.77%	369.69%	157.94%	46.70%	66.10%	127.25%
2011	30.19%	105.57%	421.85%	379.10%	154.94%	50.18%	60.80%	139.68%
2012	30.47%	105.46%	430.57%	369.21%	147.84%	49.58%	57.84%	137.67%
2013	33.98%	97.95%	442.62%	367.04%	142.72%	48.64%	55.82%	132.46%
2014	37.43%	90.61%	425.98%	360.47%	138.31%	48.08%	57.47%	130.91%
2015	35.43%	79.13%	389.41%	329.47%	131.37%	41.94%	59.14%	124.84%
2016	31.31%	73.60%	371.75%	303.32%	126.90%	37.42%	61.78%	120.58%
2017	34.42%	77.12%	376.83%	315.74%	133.16%	39.36%	68.17%	120.89%
2018	36.64%	78.99%	376.93%	325.34%	130.43%	43.07%	72.16%	120.88%

Table 2 : Results of unit root test

	DF-GLS method			Zivot and Andrews method		
Country or region	lngdp	lnimp	lnexp	lngdp	lnimp	lnexp
Hong Kong SAR, China	I(1)	I(1)	I(1)	I(1)w	I(1)	I(1)
Indonesia	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)
Japan	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)
Korea, Rep.	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Malaysia	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Philippines	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Singapore	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Thailand	I(2)	I(1)	I(1)	I(1)	I(1)	I(1)

Note: The determination of the lag order after the DF-GLS test is determined by SC minimum; the determination of the lag order by the Zivot and Andrews test is determined by the BIC minimum. The results given in the table are the results of the mutation in both intercept and linear trend. The significance here is at 5% level.

Table 3 Granger causality test results over 1970-2018

	Frequency w=2.5						Frequency w=0.01					
Country or region	lnimp-> lngdp	lngdp-> lnimp		lnexp-> lngdp	lngdp -> lnexp		lnimp-> lngdp	lngdp-> lnimp		lnexp-> lngdp	lngdp -> lnexp	
	F-statistic (P value)	F-statistic (P value)	Support	F-statistic (P value)	F-statistic (P value)	Support	F-statistic (P value)	F-statistic (P value)	Support	F-statistic (P value)	F-statistic (P value)	Support
Japan	2.3143	8.3732	GLIH	0.4971	1.8484	NH	8.2601	1.1227	ILGH	6.5207	1.0259	ELGH
	(0.3144)	(0.0152)**		(0.7799)	(0.3969)		(0.0161)**	(0.5704)		(0.0384)**	(0.5987)	
South Korea	1.6588	4.6028	NH	0.1330	2.7718	NH	19.6755	15.9937	FH	3.2603	8.1420	GLEH
	(0.4363)	(0.1001)		(0.9357)	(0.2501)		(0.0001)*	(0.0003)*		(0.1959)	(0.0171)**	
Hong Kong SAR, China	0.1688	0.9833	NH	0.0852	1.2975	FH	7.9821	4.4807	ILGH	7.3714	2.7258	ELGH
	(0.9191)	(0.6116)		(0.9583)	(0.5227)		(0.0185)**	(0.1064)		(0.0251)**	(0.2559)	
Singapore	13.2813	9.8653	FH	8.1030	9.1767	FH	12.4370	2.4147	ILGH	12.8749	2.4807	ELGH
	(0.0013)*	(0.0072)*		(0.0174)**	(0.0102)**		(0.0020)*	(0.2990)		(0.0016)*	(0.2893)	
Malaysia	7.5966	1.5143	ILGH	1.9025	0.7771	NH	4.0695	0.2108	NH	4.0336	0.9394	NH
	(0.0224)**	(1.5143)		(0.3863)	(0.6780)		(0.1307)	(0.8999)		(0.1331)	(0.6252)	
Indonesia	0.3596	41.2016	GLIH	0.2279	17.2052	GLEH	0.6294	10.8656	GLIH	0.3601	8.4449	GLEH
	(0.8354)	(0.0000)*		(0.8923)	(0.0002)*		(0.7300)	(0.0044)*		(0.8352)	(0.0147)**	
The Philippines	2.8575	4.4894	NH	7.9733	1.4714	ELGH	1.1813	0.5336	NH	1.5381	6.3202	NH
	(0.2396)	(0.1060)		(0.0186)**	(0.4792)		(0.5540)	(0.7658)		(0.4635)	(6.3202)	
Thailand	1.5439	10.2427	GLIH	4.9374	2.8630	ELGH	4.6028	7.2425	GLIH	12.9251	7.1275	FH
	(0.4621)	(0.0060)*		(0.0847)***	(0.2389)		(0.1001)	(0.0267)**		(0.0016)*	(0.0283)**	

Note: *indicates significant at 1% level, ** indicates significant at 5% level, *** indicates significant at 10% level ILGH, GLIH, FH, NH refers to import-led growth hypothesis, growth-led import hypothesis, feedback hypothesis, and neutrality hypothesis respectively. ELGH, GLEH, FH, NH refers to export-led growth hypothesis, growth-led export hypothesis, feedback hypothesis, and neutrality hypothesis respectively.

Table 4 Variance decomposition of DLNGDP

Japan

	DLNGDP	DLNEXP	DLNIMP
1	66.59771	7.091125	26.31116
2	68.72605	6.606788	24.66716
3	68.62836	6.895745	24.47589
4	68.62156	6.903432	24.47501
5	68.61946	6.905381	24.47516
6	68.6194	6.905391	24.47521
7	68.6194	6.90539	24.47521
8	68.6194	6.90539	24.47521
9	68.6194	6.90539	24.47521
10	68.6194	6.90539	24.47521

South Korea

	DLNGDP	DLNEXP	DLNIMP
1	57.2195	7.067993	35.71251
2	55.82874	11.09066	33.0806
3	55.29991	12.09362	32.60648
4	55.1709	12.32328	32.50582
5	55.14141	12.37512	32.48347
6	55.13476	12.38677	32.47847
7	55.13327	12.38939	32.47734
8	55.13293	12.38997	32.47709
9	55.13286	12.39011	32.47704
10	55.13284	12.39013	32.47702

Hong Kong SAR

	DLNGDP	DLNEXP	DLNIMP
1	44.33489	29.75808	25.90703
2	43.97205	29.89618	26.13178
3	43.94203	29.90599	26.15198
4	43.94022	29.90654	26.15325
5	43.94012	29.90657	26.15332
6	43.94011	29.90657	26.15332
7	43.94011	29.90657	26.15332
8	43.94011	29.90657	26.15332
9	43.94011	29.90657	26.15332
10	43.94011	29.90657	26.15332

Singapore

	DLNGDP	DLNEXP	DLNIMP
1	49.83348	27.34429	22.82223
2	50.92614	27.6199	21.45396
3	51.58203	27.24454	21.17343
4	51.5769	27.27742	21.14568
5	51.5822	27.27349	21.14431
6	51.57893	27.27877	21.14229
7	51.57866	27.27888	21.14246
8	51.57863	27.27893	21.14244
9	51.57874	27.27886	21.1424
10	51.57874	27.27886	21.1424

Malaysia

	DLNGDP	DLNEXP	DLNIMP
1	45.86051	21.0346	33.10488
2	45.96499	21.20767	32.82733
3	44.81764	21.68971	33.49265
4	45.07162	21.53554	33.39283
5	44.24724	22.13348	33.61927
6	44.23174	22.19191	33.57635
7	44.16677	22.20171	33.63152

Indonesia

	DLNGDP	DLNEXP	DLNIMP
1	91.58933	0.613232	7.797435
2	92.04805	0.626412	7.325541
3	92.00146	0.672703	7.325837
4	91.9946	0.67548	7.329915
5	91.99411	0.675673	7.330215
6	91.99411	0.675671	7.330222
7	91.99411	0.675671	7.330221

8	44.09402	22.30863	33.59735
9	44.09744	22.30675	33.5958
10	44.102	22.30438	33.59362

8	91.99411	0.675671	7.33022
9	91.99411	0.675671	7.33022
10	91.99411	0.675671	7.33022

the Philippines

	DLNGDP	DLNEXP	DLNIMP
1	57.11504	18.44362	24.44134
2	61.55484	14.31935	24.1258
3	61.80273	14.19464	24.00264
4	61.52103	14.69074	23.78824
5	61.50465	14.70574	23.78961
6	61.48503	14.74513	23.76984
7	61.48067	14.75116	23.76817
8	61.48038	14.75104	23.76858
9	61.47816	14.75451	23.76733
10	61.47812	14.75449	23.7674

Thailand

	DLNGDP	DLNEXP	DLNIMP
1	64.75009	8.474794	26.77512
2	62.40311	14.18987	23.40702
3	54.5308	23.43154	22.03766
4	54.86	23.2644	21.8756
5	54.72081	23.24755	22.03165
6	54.65448	22.97562	22.3699
7	54.75535	22.89722	22.34742
8	54.69127	23.00221	22.30652
9	54.68343	23.01631	22.30025
10	54.67899	23.01329	22.30772

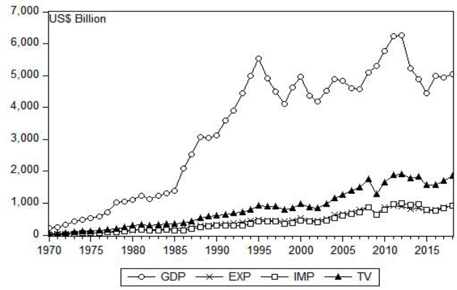

Fig.1 Japan's GDP and Trade during 1970-2018

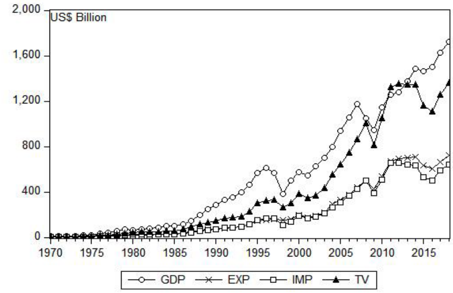

Fig.2 S. Korea's GDP and Trade during 1970-2018

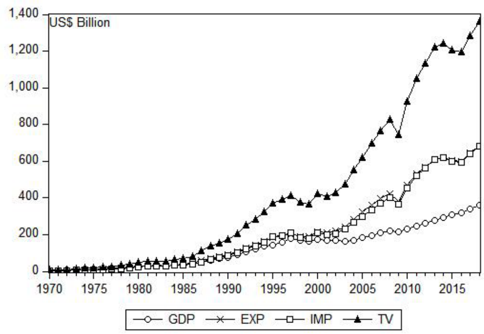

Fig. 3 HK's GDP and Trade during 1970-2018

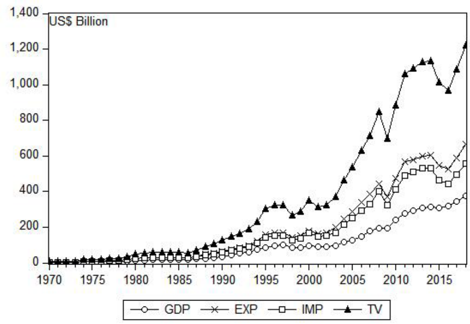

Fig.4 Singapore's GDP and Trade during 1970-2018

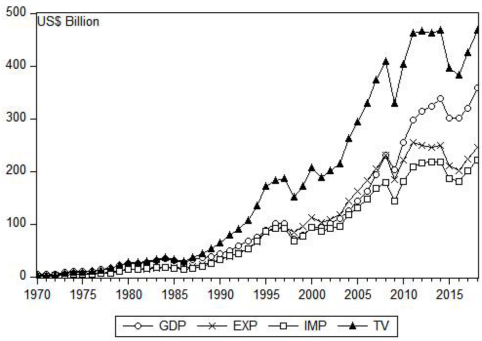

Fig.5 Malaysia's GDP and Trade during 1970-2018

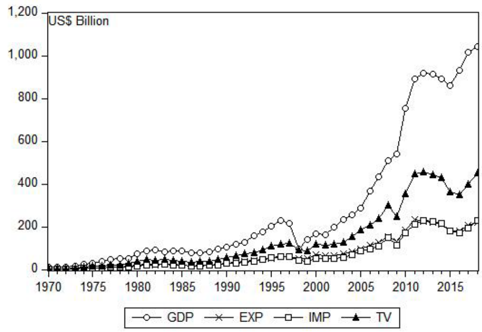

Fig.6 Indonesia's GDP and Trade during 1970-2018

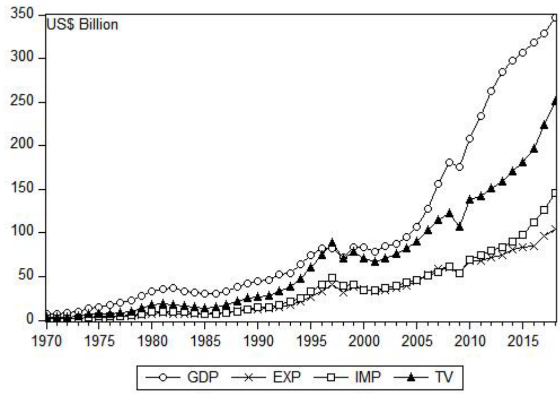

Fig.7 Philippines' GDP and Trade during 1970-2018

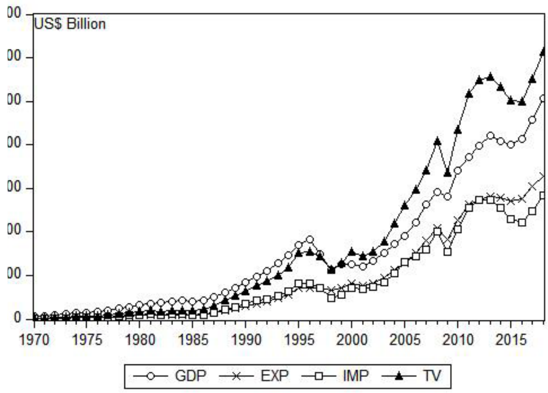

Fig. 8 Thailand's GDP and Trade during 1970-2018