

## Revisiting Export-Output Growth Nexus: Findings from Granger Causality and Leveraged Bootstrap Approach for Japan

### *İhracat-Çıktı Büyümesi Bağlantısının Tekrar İncelenmesi: Japonya İçin Granger Nedensellik ve Bootstrap Yaklaşımından Bulgular*

Harun BAL<sup>(1)</sup>, Emrah Eray AKÇA<sup>(2)</sup>, Abdulla Hil MAMUN<sup>(3)</sup>,  
Murat BAYRAKTAR<sup>(4)</sup>

**Abstract:** The study investigates the causal nexus between export and output growth of Japan to identify the validity of the export-led growth (ELG) hypothesis in a modified theoretical setting. The study is unique in the sense that it takes the Japanese crisis of 1992 into account and also addresses the possible income identification problem that most of the earlier studies largely ignored. The direction and extent to which the explanatory variables, namely, exports, imports, capital expenditure, total labor productivity and a dummy representing the crisis affect the industrial output are investigated employing both Granger causality and Leveraged Bootstrap Simulation Techniques. Both of the approaches suggest that the relationship between exports and output growth is not unidirectional which implies that export promotion cannot be regarded as a tool to promote economic growth for Japan that has important implications for policymakers to set suitable strategies to boost its economic growth.

**Keywords:** Export-led Growth, Granger Causality, Leveraged Bootstrap Approach, Japan.

**Öz:** Bu çalışmada İhracata Dayalı Büyüme (İDB) hipotezinin geçerliliğini test etmek amacıyla ihracat ve çıktı büyümesi arasındaki neden-sonuç ilişkisi modifiye edilmiş teorik bir çerçevede Japonya ekonomisi için incelenmektedir. İDB hipotezinin geçerliliğinin test edilmesi birçok ampirik çalışmaya konu olmakla birlikte, bu çalışmaların çoğunun olası gelir tanımlama problemini göz ardı etmeleri, çalışmamızın temel motivasyon unsurlarından birisi olmuştur. Ayrıca çalışmamız 1992 Japonya ekonomik krizini dikkate alması bakımından da İDB hipotezini test eden diğer çalışmalardan farklılaşmaktadır. Bu doğrultuda çalışmamızda Japonya'nın ekonomik büyümesini temsilen dikkate alınan sanayi çıktısı ve mal ihracatı arasındaki nedensellik ilişkisi, temel kontrol değişkenler kullanılarak Granger nedensellik ve kaldıraçlı Bootstrap Yaklaşımı aracılığıyla analiz edilmektedir. Gerek Granger nedensellik analizinden gerekse Bootstrap yaklaşımından elde edilen bulgular, ihracattan çıktı büyümesine doğru tek yönlü nedenselliğin varlığını doğrulamamaktadır. İhracatı teşvik politikalarının Japonya'nın ekonomik büyümesine ivme kazandırmakta etkin bir araç olarak kullanılamayacağına işaret eden bu bulgu, ekonomik büyümeye hız kazandırmakta uygun stratejiler geliştirmek için politika yapıcılara önemli çıkarımlar sunmaktadır.

**Anahtar Kelimeler:** İhracata Dayalı Büyüme, Granger Nedensellik, kaldıraçlı Bootstrap Yaklaşımı, Japonya.

**JEL Classifications:** C32, F14, F43

<sup>(1)</sup> Çukurova Üniversitesi, İİBF, İktisat Bölümü; [harunbal@cu.edu.tr](mailto:harunbal@cu.edu.tr);

ORCID No: 0000-0003-0878-8253

<sup>(2)</sup> Çukurova Üniversitesi, İİBF, İktisat Bölümü; [emraherayakca@gmail.com](mailto:emraherayakca@gmail.com);

ORCID No: 0000-0003-41905503

<sup>(3)</sup> Tübitak, Çukurova Üniversitesi, İİBF, İktisat Bölümü;

[ahm.economics@gmail.com](mailto:ahm.economics@gmail.com); ORCID No: 0000-0001-6997-4434

<sup>(4)</sup> Çukurova Üniversitesi, İİBF, İktisat Bölümü; [muratbayraktar99@gmail.com](mailto:muratbayraktar99@gmail.com);

ORCID No: 0000-0003-4028-192X

Geliş/Received: 28-05-2019; Kabul/Accepted: 19-09-2019

## 1. Introduction

The spectacular growth of High-Performance Asian Economies (HPAEs) over the last half of the twentieth century makes the export-oriented industrialization increasingly apparent as an alternative way of economic growth. Among the HPAEs, rapid economic growth first begins in Japan immediately after the Second World War, which makes her able to achieve a per-capita income comparable to Western Europe. The scarcity of natural resources along with limited investment opportunities due to the closed economic policy adopted to defend producers at home by restricting imports of goods and services led Japanese economy to witness low rates of growth from the late 1930s to early 1950s (Balçilar and Ozdemir, 2013). There was no alternative to Japan but export to finance its imported raw materials for the manufacturing sector. Accordingly, Japan's export-oriented industrialization policies appeared to be the major contributing factor to economic growth. In the 1950s through the 1990s, Japan pursued widespread strategies ranging from lowered interest rate to reduce export costs to full or partial tariff refunds along with special allotment of credit and import quotas for exporters with an aim to the acquisition of prominent foreign technology and expansion of manufactured exports rapidly to foster economic growth. Manufacturing industries experienced rapid productivity growth that made Japanese products more competitive in world markets. Consequently, the economy maintained an annual export growth of fairly above 16 percent against the economic growth of around 9 percent between the late 1950s and 1960s. Japan continued the expansion of exports even in the face of supply shocks, namely the oil crisis of 1973 and accordingly exports continued to expand at a high annual average rate of over 9 percent against the annual economic growth rate of 4 percent in the 1970s and 1980s. During the late 1980s, outputs of Japanese investment in ASEAN (Association of Southeast Asian Nations) economies that confirmed a large market share of export of this region to European Economic Community and the USA further reinforce the position of Japan (Paul 1996). Japan's trade agreements between 1986 and 1992, as summarized by Gangnes and Craig (2007), also strengthened its competitive position in the world market offering price support for Japanese export.

However, the Japanese economy succumbed to stagnation following the unprecedented increase in real estate and stock prices during 1986 to 1991 that lasted a decade near about until the collapse of the bubble economy and prices of the stock reached to its minimum in 2001. Stock prices dropped further to the historically low levels during the global financial crisis of 2008. Nonetheless, even after the crises, the strong increasing trends of both real Gross Domestic Product (GDP) and real exports for Japan indicate that the two variables are correlated. But authentication of ELG based on visual inspection of the exports and growth performance will be deceptive mainly due to the stagnant growth performance of Japanese economy around 0.91 percent over last twenty five years after the Japanese financial crisis compared to 6.2 percent of earlier three decades prior to the crisis, which was well above 9 percent in 1960s.

Table 1 shows the relative share of exports of Japan in GDP along with the share of imports and it is evident that for the first three decades of the sample period, exports had a greater percentage share in GDP than imports, however, the gap covers gradually and reverses in the first half of the ongoing decade.

**Table 1:** Exports and Imports as Percent of GDP

Decades	Exports of goods and services (% of GDP)	Imports of goods and services (% of GDP)
1980s	12.57	10.73
1990s	9.84	8.33
2000s	13.63	12.43
2010s	16.16	17.57

**Source:** World Bank, World Development Indicators

Despite the decrease in exports over the last five years at 3.4 percent per annum, Japan is still the fourth-largest exporter and importer of the world as of 2017.

ELG of Japan was well documented in most of the studies prior to the Asian financial crisis of 1997-98 (Boltho, 1996; Goto, 2001). Arguments favoring the positive growth effects of export-oriented industrialization, which is referred to as the ELG hypothesis, are many. In general, promoting economies of scale (Helpman and Krugman, 1985), lessening capital constraint (Romer, 1987) and enhancing efficiency through competitiveness (Balassa, 1978), export promotion leads to greater capital formation (Tyler, 1981) and growth in factor productivity (Marin, 1992; Akram and Rath, 2017) that result in economic growth. However, the positive impact of economic growth on exports improving productivity and lessening unit costs and thereby increasing competitiveness has also been suggested by a number of studies (Krugman, 1984; Hatemi-J and Irandoust, 2000; Doyle, 2001; Paul, 2011). Hence the ELG hypothesis has its opposing counterpart, namely, growth led export (GLE), and both way causal nexus will not also be surprising. Which one of the above is appropriate for Japan requires empirical verification that the paper is going to offer.

Earlier empirical literature on the causal nexus between export and growth of output of Japan can be categorized into two- the pre-crisis and post-crisis studies, and results are quite opposing for both the periods (Mahadevan and Suardi, 2008; Zang and Baimbridge, 2012). The contrasting results are liable to certain sources - firstly, variations in the analytical framework, secondly, differences in time horizons taken into account, finally and most importantly, the inclusion of explanatory variables differ largely for alternative models. Apart from the differences in time horizon, most of the studies do not consider the financial crisis of Japan in 1992 following which the Japanese economy spiraled down with the gross output. Furthermore, the studies mainly consider national income or GDP to evaluate the relationship between exports and output growth, and thereby ignore the possible income identification problem that might arise due to the inclusion of exports in national income identity. Therefore, the paper aims to give a profound look to these limitations of earlier studies in examining the export-output causal nexus for Japan.

The study is unique in testing export-output relation for Japan on following terms- it avoids the possible problem that may arise from income identification using the industrial output instate of GDP, uses labor productivity as an important force to economic growth and considers the sluggish growth of Japanese economy since Japanese financial crisis assigning dummy variable. Furthermore, most of the studies applied only one method of causality analysis, Granger, Toda-Yamamoto or others, while in this study, along with Granger causality test, the Leveraged Bootstrap

approach has been applied in order to arrive at a more precise decision.

Organization of the rest of the study is as follows. Following the introduction, section two offers a review of previous studies on ELG of the Japanese economy. Describing methodology and empirical results in section three, the study ends with summarizing key findings.

## 2. Literature Review

Studies examining the relationship between export and output growth is substantially rich. Shan & Sun (1998) offer an extensive investigation on the studies of the ELG proposition both for developing and developed economies, while Mamun, Bal & Akca (2019), Malhotra & Kumari (2016) and Parida and Sahoo (2007) offer a review of the economic literature on East Asia adhering to ELG. In a more recent study, Adeel-Farooq et al. (2017) summarize the empirical evidence on the link between openness in trade and output growth of South Asian economies that largely reflect the export-output growth nexus of these economies.

Studies on ELG of Japan are numerous with inconclusive results. A group of studies that do not support ELG of Japan includes Fawson and Chang (1994), Hatemi-J (2002), Konya (2004), Awokuse (2006), Mahadevan and Suardi (2008) and Malhotra and Kumari (2016). Among the studies, Hatemi-J (2002) and Awokuse (2006) find exports and GDP growth (productivity) is bidirectional in Japan while Konya (2004) and Malhotra and Kumari (2016) argue for GLE. However, studies in support of ELG of Japan include Boltho (1996), Zang & Baimbridge (2012) and Balcilar and Ozdemir (2013). Table 2 summarises the data, methodology, and conclusions from a set of studies propelled from 1994 to 2016 for Japan in order to have an extensive review on causality between exports and growth.

**Table 2:** A Brief Review of the Economic Literature on Japan

Study	Sample Period	Methodology	Variables	Conclusion
Fawson & Chang (1994)	1970:1-1992:2 quarterly data	Granger-causality	Exports and GDP	Doesn't support ELG hypothesis
Boltho (1996)	1913-1937, 1952-1973 and 1973-90	Granger-causality	GDP, exports and imports	Doesn't support ELG hypothesis, domestic forces propelled longer-run growth
Hatemi-J (2002)	1966:1-1999:1 quarterly data	VAR	GDP, exports	Bidirectional causality between exports and GDP growth
Konya (2004)	1960-1997	VAR	GDP, exports and trade openness	Rejects ELG and supports that growth causes exports

Awokuse (2006)	1960:1-1991:4, quarterly data	VAR	Industrial production index, Exports, Productivity, terms of trade, gross capital formation	Bidirectional causality between exports and GDP growth
Mahadevan & Suardi (2008)	1957:1-2005:2, quarterly data	Johansen Cointegration	GDP, exports and imports	Reject ELG hypothesis and support import-led growth
Zang & Baimbridge (2012)	1957-2003	VAR	GDP, exports and imports	Support ELG hypothesis
Balcilar & Ozdemir (2013)	1957:1-2009:1 quarterly data	Bootstrap-time varying causality	GDP, exports	Support ELG hypothesis
Malhotra and Kumari (2016)	1980-2012	Johansen Cointegration	GDP per capita, exports, imports, gross capital formation, dummies for Asian and Global Economic Crisis	Does not support ELG hypothesis

Except for the studies of Zang & Baimbridge (2012) and Balcilar & Ozdemir (2013), all other studies rejected the unidirectional relation from exports to economic growth which is necessary to validate the ELG hypothesis. Moreover, Malhotra & Kumari (2016) used dummies for Asian and Global Financial Crisis of 1997-98 and 2008-09, respectively, which was found to be statistically insignificant. But the true fact is that Japanese financial crisis that affects the economy in 1992 spreads to date and while the other Asian economies have been able to combat the Asian financial crisis and even turn about after the Global Financial Crisis, Japanese economy is still passing through a sluggish growth lower than 1 percent which is slower than growth in other major developed economies. Thus, using dummies for Japanese financial crisis will be more meaningful to obtain appropriate results while testing ELG hypothesis for Japan.

### 3. Data Set, Methodology and Empirical Findings

The study analyzes ELG hypothesis for Japan employing time series data at quarterly frequency during the period 1982Q1-2016Q4 (T=140). Table 3 shows the variables used for the analysis with their necessary explanations. All the seasonally adjusted variables are used in the logarithmic form so as to avoid the problem of heteroscedasticity.

**Table 3.** Variables, Descriptions, and Sources

Indicator	Variable	Description	Source
<i>Industrial Output</i>	<i>IND</i>	Industrial Production, Seasonally Adjusted, Index, 2010=100	
<i>Exports</i>	<i>EXP</i>	Exports of Goods and Services, Seasonally Adjusted, Annualized Rate, National Currency	IMF-IFS, 2017
<i>Imports</i>	<i>IMP</i>	Imports of Goods and Services, Seasonally Adjusted, Annualized Rate, National Currency	
<i>Capital Expenditure</i>	<i>CAP</i>	Gross Capital Formation, Seasonally Adjusted, Annualized Rate, National Currency	
Total Labor Productivity	<i>TLP</i>	Total Labor Productivity, Seasonally Adjusted, Index, 2010=1	FRED, 2017
Dummy	<i>DUM</i>	Japanese Financial Crisis, 1992	

The theoretical model of the study derived from the relevant literature is as follows:

$$IND = f(EXP, CAP, TLP, IMP, DUM) \quad (1)$$

A long-run linear regression model is developed in this study to examine the direction and extent to which the explanatory variables affect the industrial output within the framework of an integrated approach, which is as follows:

$$\ln IND_t = \beta_0 + \beta_1 \ln EXP_t + \beta_2 \ln CAP_t + \beta_3 \ln TLP_t + \beta_4 \ln IMP_t + \beta_5 DUM + \varepsilon_t \quad (2)$$

Variables encoded in equation 2 are as described in table 3 while  $t$  stands for time (quarter),  $\beta_0$  for constant and  $\varepsilon_t$  indicates the white noise process with mean equals zero. In testing the relationship between exports and output growth, the study takes industrial production into account in place of national income to get rid of the income identification problem. This is because these two variables are frequently used interchangeably in researches examining the causality within exports and growth of output (Shan and Sun, 1998; Mamun and Nath, 2005; Awokuse, 2006; Tang, 2013; Mamun et al., 2019). While the export-growth relationship is analyzed within the context of ELG hypothesis, potential capital, labor productivity, and import variables are also expected to affect output growth and hence introduced as independent variables in the econometric model. In addition, a crisis dummy variable is added to the model to show the Japanese financial crisis of 1992. In the process of analysis for determining the short term as well as long-term relationships between exports and economic growth, initially, Augmented Dickey-Fuller (ADF) t-tests and Phillips-Perron (PP) Z ( $t_\alpha$ ) tests have been performed in order to identify the order of integration of the series and the test results are presented in Table 4.

**Table 4.** ADF and PP Test Results for Stationarity

Variables	Test in	Includes	ADF		PP	
			t-statistic	p-value	t-statistic	p-value
IND	Level	Intercept	-2,662[1]	0,083	2,297[8]	0,174
		Trend, Intercept	-2,726[1]	0,228	1,994[7]	0,599
	First Difference	Intercept	-7,966[0]	0,000*	7,384[15]	0,000*
		Trend, Intercept	-8,003[0]	0,000*	7,453[17]	0,000*
EXP	Level	Intercept	-1,183[1]	0,681	-1,053[3]	0,733
		Trend, Intercept	-3,232[4]	0,083	-2,643[0]	0,262
	First Difference	Intercept	-5,735[4]	0,000*	-8,612[7]	0,000*
		Trend, Intercept	-5,716[4]	0,000*	-8,575[7]	0,000*
CAP	Level	Intercept	-1,911[4]	0,327	-2,163[7]	0,221
		Trend, Intercept	-1,492[4]	0,828	-1,471[7]	0,835
	First Difference	Intercept	-3,103[4]	0,028**	-8,784[5]	0,000*
		Trend, Intercept	-8,735[0]	0,000*	-9,124[5]	0,000*
TLP	Level	Intercept	-2,939[0]	0,044**	-2,555[2]	0,105
		Trend, Intercept	-1,667[0]	0,761	-1,721[2]	0,736
	First Difference	Intercept	11,637[0]	0,000*	11,848[2]	0,000*
		Trend, Intercept	12,234[0]	0,000*	-	0,000*
IMP	Level	Intercept	-0,448[4]	0,896	-0,283[3]	0,923
		Trend, Intercept	-2,978[4]	0,142	-2,719[4]	0,231
	First Difference	Intercept	-5,113[4]	0,000*	-8,045[2]	0,000*
		Trend, Intercept	-5,226[4]	0,000*	-8,112[2]	0,000*

**Note:** The notations \*, \*\* show test statistics are statistically significant at 1% and 5% level of significance, respectively. The numbers in brackets represent the number of lags included in the test regression to ensure white noise error (for the ADF tests) and the choice of truncational lag length in the test (for the PP tests).

Unit root test results find none of the variables stationary at the level for both with trend processes and without trend processes; however, they become stationary at first difference level and therefore long-term information disappear. Consequently, regression analysis based on first differenced variables will not display an equilibrium relationship in the long-run. Series that contain stochastic trend are likely to hold a common stochastic trend, in other words, the series may be cointegrated. Therefore, cointegration techniques are argued to be suitable for analyzing long-term relationship among the variables. Despite the non-stationary series of the economic fundamentals, cointegration analysis may help determine a linear combination of the series which that is stationary and thereby help content long-term information. Premised on this,

the possible cointegrating relation within the variables is being researched adopting Johansen cointegration method for cointegration analysis. This approach estimates the association between non-stationary series in the long-term by employing maximum probability procedure forecasting the numbers and parameters of cointegration relationship (Asteriou and Hall, 2011). Johansen and Juselius (1990) follow the VAR approach to examine the long-term relationship among variables. The VAR equation takes the following form:

$$Y_t = \mu + Z_1 Y_{t-1} + Z_2 Y_{t-2} + \dots + Z_\rho Y_{t-\rho} + \varepsilon_t \quad (3)$$

Where  $Y_t$  is an  $(n \times 1)$  vector of  $I(1)$  and/or  $I(0)$  variables and  $\mu$  is an  $(n \times 1)$  vector of constants. Equation 3 can be reformulated in a vector error-correction model (VECM) as:

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \dots + \Gamma_{\rho-1} \Delta Y_{t-\rho+1} + \Pi Y_{t-1} + \varepsilon_t \quad (4)$$

Where  $\Gamma_i = (I - Z_1 - Z_2 - \dots - Z_\rho)$  ( $i=1, 2, \dots, \rho-1$ ) and  $\Pi = -(I - Z_1 - Z_2 - \dots - Z_\rho)$

Since  $\varepsilon_t$  is stationary, the rank  $r$  of the long-run matrix  $\Pi$  determines the number of linear combinations of  $Y_t$  that are stationary. The number of cointegrating vectors ( $r$ ) is determined according to trace and maximum eigenvalue test statistics. Trace and maximum eigenvalue test statistics can be found as:

$$Trace = -T \sum_{i=r+1}^n \ln(1 - \lambda_i) \quad (5)$$

$$\lambda \max = -T \ln(1 - \lambda_{r+1}) \quad \text{eigenvalues as } \lambda_i, I = 1, 2, \dots, n \quad (6)$$

The Johansen approach was essentially evolved under the assumption that the stochastic disturbance terms follow normal distribution and the optimum lag length chosen for the VAR in Equation 3 ensures white noise errors. Optimal lag length in VAR analysis performed for cointegration analysis is found to be 1 (please see Table 5). The VAR itself is stationary as the inverse roots lie within the unit circle that allows proceeding for investigating the cointegrating relationship among the variables.

**Table 5.** VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
1	2291,55	NA	4,47*	-34,43*	-33,65*	-34,12*
2	2313,78	40,38	5,53	-34,23	-32,65	-33,58
3	2338,59	42,81	6,61	-34,05	-31,68	-33,09

**Note:** The notation \* indicates lag order selected by the criterion.

**Table 6.** Autocorrelation and Heteroskedasticity Test Results

Autocorrelation		Heteroscedasticity	
Lags	p-value	Chi-square	p-value
1	0,119		
2	0,338	1429,43	0,204
3	0,062		
4	0,346		

With regard to diagnostic checks, it is observed that there is no autocorrelation among errors for any of the lag orders tested and heteroscedasticity is not an issue (please see Table 6) and that the model ensures the stability condition. Johansen cointegration test results are shown in Table 7.



**Table 7.** Johansen Cointegration Test Results

Number of Cointegration	Trace Test			Maximum Eigen Test		
	Test Statistics	Critical Value (%5)	P-values	Test Statistics	Critical Value (%5)	P-values
r=0	133,59**	95,754	0,000	51,091**	40,077	0,001
r≤1	81,503**	69,819	0,004	32,993	33,877	0,064
r≤2	48,511**	47,856	0,043	17,419	27,584	0,544
r≤3	31,092**	29,797	0,035	16,751	21,132	0,184
r≤4	14,341	15,495	0,074	15,555	14,265	0,065
r≤5	0,786	3,841	0,375	0,786	3,841	0,375

**Note:** The notation \*\* shows the null hypothesis that the presence of cointegration relationship is rejected at 5% level of significance. p-values are Mackinnon –Haug-Michelis (1999) p-values.

As the Trace and maximum eigenvalue test results suggest, there are cointegrating relationships among the variables. Normalized cointegration equation is showed in equation 7 (the numbers in parenthesis indicate t statistics).

$$\ln IND_t = 0,489 \ln EXP_t + 0,364 \ln CAP_t + 0,367 \ln TLP_t - 0,295 \ln IMP_t - 0,039 DUM_t \quad (7)$$

(-8,215)      (-10,340)      (-4,133)      (7,504)      (5,315)

The signs of long-term coefficients for all variables are compatible with theoretical expectations and appear to be statistically meaningful. Accordingly, it is evident that an increase in exports contributes positively to the growth of Japanese economy in the long-run. While gross capital formation and total labor productivity have positive influences on output, the impact of imports is negative. In addition, it is also apparent that the dummy representing the Japanese financial crisis of 1992 is statistically significant and affects industrial output negatively. After identifying the long-term association employing the co-integration method, an error correction model (ECM) is used to investigate if deviations in output growth in the short-run converge towards its long-term equilibrium. The error correction coefficient stands to show the speed of adjustment when growth rate (or export growth) deviates from the equilibrium in the long run in period t-1. Alternatively, the long-run causal effect with respect to the relationship of the cointegration processes in the long-run equilibrium is represented by the error correction term (Mamun and Nath 2005, 363). VECM can be presented as:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=1}^{p-1} \alpha_{2i} \Delta X_{t-i} + \sum_{i=1}^{p-1} \alpha_{3i} \Delta X_{t-i} + \dots + \phi_1 ECT_{t-1} + \varepsilon_{1t} \quad (8)$$

$$\Delta X_t = \beta_0 + \sum_{i=1}^{p-1} \beta_{1i} \Delta X_{t-i} + \sum_{i=1}^{p-1} \beta_{2i} \Delta Y_{t-i} + \sum_{i=1}^{p-1} \beta_{3i} \Delta Y_{t-i} + \dots + \phi_2 ECT_{t-1} + \varepsilon_{2t} \quad (9)$$

Where  $ECT$  shows the residuals of the long-run cointegration relationship and thereby  $ECT_{t-1}$  represents error correction term. The ECM analysis produces an error correction coefficient ( $t\_stat = -3,854$ ) between zero and one which is negative (-0,269) and statistically significant. This result indicates that the instability in the short-term fixes in the long run and there prevails a long-run causal relationship between the dependent variable and independent variables. In a descriptive sense, a unidirectional causality

from exports to output growth in the short term is necessary for ELG hypothesis to be valid (Shan and Sun 1998, 1063).

The success of export-oriented trade policies largely depends on the direction and sign of causality between export and output. A unidirectional positive causal relationship from export to output confirms ELG, which suggests export-promoting policies to be supportive to enhance economic growth. When the causality between export and output is bidirectional, the second-round effects it produces from economic growth to exports, in turn, reinforce economic growth. However, export-promoting policies prove to be ineffective in the presence of unidirectional causality running from output to export that validates GLE hypothesis which suggests policymakers to focus on policies that promote economic growth. Countries operating at the primary development stage may find it true where the growth of domestic output is the prerequisite for goods exporting beyond domestic consumption (Balcilar and Ozdemir, 2013).

The study primarily employs short-term Granger causality test on ECM with an aim to check the presence of a causal association between exports and growth of output. Whether information set on a variable uplift the forecasting of another variable defines Granger non-causality. In this view, a variable Granger causes another variable, if the available information on the second variable improves the prediction of the first, otherwise not. Available information on the second variable usually contains all the past values and Granger non-causality is tested as of whether the lagged values corresponding to past of the variable are significant or not. The short-run Granger non-causality from export to output growth is examined by the use of Wald (F) test (joint restriction test) marked as in equation 8. Similarly, the null hypothesis of non-causality from output growth to export is tested as in equation 9. VECM Granger causality test results are summarized in Table 8.

**Table 8.** VECM Granger Causality/Block Exogeneity Wald Test Results

H <sub>0</sub> :	Chi-sq	P-values for WALD
EXP $\nRightarrow$ IND	0,268	0,604
IND $\nRightarrow$ EXP	0,168	0,681
CAP $\nRightarrow$ IND	0,071	0,791
TLP $\nRightarrow$ IND	3,579*	0,058
IMP $\nRightarrow$ IND	0,532	0,466

**Note:** The notation  $\nRightarrow$  implies non-Granger causality. The notation \* shows the statistics are significant at the 10% level and thus reject the null hypothesis of the presence of a casual relationship.

The results of the VECM Granger causality analysis indicate that no causality exists from exports to output growth and from output growth to exports in the short run. The only statistically significant unidirectional causal relationship found in the short run is from total labor productivity to output. Traditional F-test for testing Granger non-causality in order to determine whether some parameters of the model are jointly zero, e.g., in the form of a causality test (in a stable VAR model) is not valid in a regression context when the variables are integrated and the test statistic does not follow an ideal asymptotic distribution. Consequently, a variant of alternative approaches has been

evolved attempting to enhance the size and power of the Granger no-causality test (Shan and Sun 1998).

Toda and Yamamoto (1995) found that when the series in the system are not stationary, the result of this test used for the Granger causality test may not be valid as the traditional F-statistic would not have a standard distribution. According to Toda and Yamamoto (1995), despite the series are not stationary, the VAR model in which the level values of the series are included can be estimated and the standard WARD test can be applied. Toda and Yamamoto (1995) developed a procedure that utilizes a modified WARD (MWALD) test for restrictions on the parameters of a VAR(k), or MWALD procedure (where k is the lag length in the system). The test follows an asymptotic  $\chi^2$  distribution when a VAR (k+dmax ) is estimated, where dmax stands for maximal order of integration suspected to occur in the system. For a sample of 50 or more observations, the performance of MWALD test is comparable to the LR and WARD tests in terms of size and power if the appropriate number of lags are identified for estimating k + dmax and no necessary variables are omitted (Shan and Sun, 1998, 1060). This procedure is particularly useful for its congeniality whether the VAR is stationary (around a deterministic trend), integrated of arbitrary order, or cointegrated of arbitrary order. Accordingly, one can test the linear or nonlinear restrictions on the coefficients by estimating a levels VAR and employing the Wald criterion, paying little attention to the integration and cointegration properties of the time series data in hand ((Toda and Yamamoto 1995, 227). Estimated VAR (p + d) model in the Toda-Yamamoto approach can be presented as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{p+d} \alpha_{1(i+d)} Y_{t-(i+d)} + \sum_{i=1}^{p+d} \alpha_{2(i+d)} X_{t-(i+d)} + \sum_{i=1}^{p+d} \alpha_{3(i+d)} X_{t-(i+d)} + \dots + \varepsilon_{1t} \quad (10)$$

$$X_t = \beta_0 + \sum_{i=1}^{p+d} \beta_{1(i+d)} X_{t-(i+d)} + \sum_{i=1}^p \beta_{2(i+d)} Y_{t-(i+d)} + \sum_{i=1}^p \beta_{3(i+d)} Y_{t-(i+d)} + \dots + \varepsilon_{2t} \quad (11)$$

The null hypotheses “no Granger causality from  $X_t$  to  $Y_t$ ” for equation 10 and “no Granger causality from  $Y_t$  to  $X_t$ ” for equation 11 are defined by  $H_0 : \alpha_{2i} = 0$  ve  $H_0 : \beta_{1i} = 0$ , respectively and MWALD (F-test) test is applied. The MWALD test statistic follows asymptotic  $\chi^2$  distribution with degrees of freedom equals p, the number of restrictions to be tested. However, utilization of bootstrap distributions rather than asymptotic  $\chi^2$  distribution leads to more precise inference based on Toda-Yamamoto test statistic as demonstrated by Hacker and Hatemi-J (2006). Consequently, the study will apply the bootstrap simulation techniques so as to produce critical values in testing causality between integrated variables. It is worth mentioning that the technique relies on the empirical distribution of underlying data set and is not sensitive to the normality assumption. Moreover, it is suitable to apply even for non-stationary data and has superior small sample properties compared to standard tests. The presence of autoregressive conditional heteroscedasticity (ARCH) is another important aspect that should be taken into account (Hatemi-J and Irandoust, 2005). The study applies the bootstrap version of Toda and Yamamoto (1995) modified causality tests as it possesses certain advantages, particularly, its applicability to I(1) variables regardless of whether they are cointegrated or not (Hacker and Hatemi-J 2006). The bootstrap technique, introduced by Efron (1979), is subject to resampling the data set to estimate the distribution of a test statistic. Use of

this distribution reduces bias in inference offering more precise critical values. Table 9 summarizes test results based on Bootstrap simulation techniques.

**Table 9.** Results of Causality Test Based on Bootstrap Simulation Techniques

The Null Hypothesis	MWALD	1% bootstrap critical value	5% bootstrap critical value	10% bootstrap critical value
EXP $\neq$ > IND	0,124	14,713	3,949	3,037
IND $\neq$ > EXP	3,104	7,525	3,295	2,308*
CAP $\neq$ > IND	4,678	7,230	3,602**	2,584*
TLP $\neq$ > IND	2,360	7,159	3,857	2,163*
IMP $\neq$ > IND	5,954	9,944	6,162	4,454*

**Note:** The notation  $\neq$  > implies non-Granger causality. The notation \*\*\*, \*\*, \* shows that the null hypothesis (the presence of casualty relationship) is rejected at 1%, 5% and 10% level of significance respectively. MWALD is the modified Wald test, which described in equation 10 and 11. The lag order of the VAR model, p, was set to one. Also, the augmentation lag, d, was set to one since each variable contains one unit root.

According to the test results based on Bootstrap Simulation Techniques, there is no causality found from exports to output growth, however, a positive causal relationship from output growth to exports has been detected. Though the rise in exports has a positive contribution to economic growth in the long run, the absence of positive causal relation from exports to output growth in the short run confirmed both by Granger and Bootstrap Simulation Techniques test results reject the validity of ELG hypothesis for Japan.

#### 4. Concluding Remarks

The growth performance of Japanese economy from the 1950s through 1990s following its strategies for acquiring advanced foreign technology and expansion of manufacturing exports and strong correlation between exports and output even after the Japanese financial crisis of 1992 makes it imperative to investigate whether ELG hypothesis is valid for Japan. Employing the Johansen cointegration model to identify long-run association among the variables under consideration using quarterly data for the period 1982 to 2016, the study finds cointegrating relationships among the variables. The study also finds the system stable in the long run as it has a tendency to correct its short-run disequilibrium in the long run for Japan. With regard to ELG of the Japanese economy, the results of both Granger and Leveraged Bootstrap Approaches on causality analysis reject the unidirectional relationship from exports to output growth which is necessary to validate ELG hypothesis and thereby find no evidence to support Japanese growth to be export-led. The absence of unidirectional causal relationship from exports to output implies that export promotion cannot be regarded as a tool to promote economic growth for Japan that has important implications for policymakers to set suitable strategies to boost its economic growth.

## 5. References

- Adeel-Farooq, R. M., Abu Bakar, N. A. and Raji, J. O. (2017). Trade openness, financial liberalization and economic growth: the case of Pakistan and India, *South Asian Journal of Business Studies*, 6(3), 1–21. doi: 10.1108/SAJBS-06-2016-0054.
- Akram, V. and Rath, B. N. (2017). Export Diversification and Sources of Growth in Emerging Market Economies, *Global Economy Journal*, 17(3). doi: 10.1515/gej-2017-0018.
- Asteriou, D. and Hall, S. G. (2011). *Applied Econometrics*. Second Edi. Palgrave Macmillan.
- Awokuse, T. O. (2006). Export-led growth and the Japanese economy: Evidence from VAR and directed acyclic graphs. *Applied Economics*, 38(5), 593–602. doi: 10.1080/00036840600619594.
- Balassa, B. (1978). Exports and economic growth Further evidence. *Journal of Development Economics*, 5(2), 181–189. doi: 10.1016/0304-3878(78)90006-8.
- Balcilar, M. and Ozdemir, Z. A. (2013). The export-output growth nexus in Japan: A bootstrap rolling window approach. *Empirical Economics*, 44(2), 639–660. doi: 10.1007/s00181-012-0562-8.
- Boltho, A. (1996). Was Japanese growth export-led?. *Oxford Economic Papers*, 48(3), 415–432. doi: <https://doi.org/10.1093/oxfordjournals.oep.a028576>.
- Chandra Parida, P. and Sahoo, P. (2007). Export-led Growth in South Asia: A Panel Cointegration Analysis. *International Economic Journal*, 21(2), 155–175. doi: 10.1080/10168730701345414.
- Doyle, E. (2001). Export-Output Causality and the Role of Exports in Irish Growth: 1950–1997. *International Economic Journal*, 15(3), 31–54. doi: 10.1080/10168730100080018.
- Efron, B. (1979). Bootstrap Methods: Another Look at the Jackknife. *The Annals of Statistics*, 7(1), 1–26. doi: 10.1214/aos/1176344552.
- Fawson, C. and Chang, T. (1994). *Cointegration, Causality, Error-Correction, and Export-Led growth in six countries: Japan, Philippines, South Korea, Taiwan, United Kingdom and United States*. Economics Research Institute Study Paper, 94(9). Retrieved from: <https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1038&context=eri>.
- FRED (2017) *Federal Reserve Economic Data*. Available at: <https://fred.stlouisfed.org/>.
- Gangnes, B. and Craig, P. (2007). Have US–Japan Trade Agreements Made a Difference? *Journal of the Asia Pacific Economy*, 12(4), 548–566. doi: <https://doi.org/10.1080/13547860701594277>.
- Goto, J. (2001). *A note on the Japanese trade policy and economic development: Secrets behind an economic miracle*, World Bank Site Resources.
- Hacker, R. S. and Hatemi-J, A. (2006). Tests for causality between integrated variables using asymptotic and bootstrap distributions: Theory and application. *Applied Economics*, 38(13), 1489–1500. doi: 10.1080/00036840500405763.
- Hatemi-J, A. (2002). Export performance and economic growth nexus in Japan: A bootstrap approach. *Japan and the World Economy*, 14(1), 25–33. doi: 10.1016/S0922-1425(01)00071-8.
- Hatemi-J, A. and Irandoust, M. (2000). Time-series evidence for balassa’s export-led growth hypothesis. *Journal of International Trade and Economic*

- Development*, 9(3), 355–365. doi: 10.1080/09638190050086195.
- Hatemi-J, A. and Irandoust, M. (2005), Energy Consumption and Economic Growth in Sweden: A Leveraged Bootstrap Approach, (1965-2000). *International Journal of Applied Econometrics and Quantitative Studies*, 2(4). Available at: <https://core.ac.uk/download/pdf/6788389.pdf>.
- Helpman, E. and Krugman, P. R. (1985). *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy*, The MIT Press. doi: 10.1016/0022-1996(86)90014-0.
- IMF (2017) *International Financial Statistics*, IMF. Available at: <http://data.imf.org/?sk=5DABAFF2-C5AD-4D27-A175-1253419C02D1>.
- Johansen, S. and Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration — With Applications To The Demand For Money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169–210. doi: 10.1111/j.1468-0084.1990.mp52002003.x.
- Konya, L. (2004). Export-led growth, growth-driven export, both or none? Granger causality analysis on OECD countries. *Applied Econometrics and International Development*, 4(1), 73–94. doi: 10.2139/ssrn.254090.
- Krugman, P. (1984). Import protection as export promotion: International competition in the presence of oligopoly and economies of scale, in Kierzkowski, H. (ed.) *Monopolistic competition and international trade*. Oxford University Press, 180–93.
- Mahadevan, R. and Suardi, S. (2008). A dynamic analysis of the impact of uncertainty on import- and/or export-led growth: The experience of Japan and the Asian Tigers. *Japan and the World Economy*, 20(2), 155–174. doi: 10.1016/j.japwor.2006.10.001.
- Malhotra, N. and Kumari, D. (2016). Export Performance and Economic Growth in East Asian Economies – Application of Cointegration and Vector Error Correction Model. *Eurasian Journal of Business and Economics*, 9(18), 135–152. doi: <https://doi.org/10.17015/ejbe.2016.018.08>.
- Mamun, A., Bal, H., & Akca, E. E. (2019). The export-output growth nexus in Bangladesh: a leveraged bootstrap approach. *Journal of Asia Business Studies*, 13(2), 196-213. doi: 10.1108/JABS-09-2017-0159
- Mamun, K. A., and Nath, H. K. (2005). Export-Led Growth in Bangladesh: A Time Series Analysis. *Applied Economics Letters*, 12 (6), 361–64. <https://doi.org/10.1080/13504850500068194>.
- Marin, D. (1992). Is the Export-Led Growth Hypothesis Valid for Industrialized Countries? *The Review of Economics and Statistics*, 74(4), 678. doi: 10.2307/2109382.
- Paul, B. P. (2011). ‘Revisiting Export-Led Growth for Bangladesh: A Synthesis of Cointegration and Innovation Accounting. *International Journal of Economics and Finance*, 3(6). doi: 10.5539/ijef.v3n6p3.
- Paul, E. (1996). Japan in Southeast Asia: A geopolitical perspective’, *Journal of the Asia Pacific Economy*, 1(3), 391–410. doi: 10.1080/13547869608724598.
- Romer, P. M. (1987) ‘Growth Based on Increasing Returns Due to Specialization. *The American Economic Review*, 77(2), pp. 56–62. doi: 10.2307/1805429.
- Shan, J. and Sun, F. (1998). On the export-led growth hypothesis: the econometric evidence from China. *Applied Economics*, 30(8), 1055–1065. doi: 10.1080/000368498325228.
- Tang, C. F. (2013), A revisit of the export-led growth hypothesis in Malaysia using the leveraged bootstrap simulation and rolling causality

- techniques. *Journal of Applied Statistics*, 40(11), pp.2332-2340.
- Toda, H. Y. and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1–2), 225–250. doi: 10.1016/0304-4076(94)01616-8.
- Tyler, W. G. (1981). Growth and export expansion in developing countries. Some empirical evidence. *Journal of Development Economics*, 9(1), 121–130. doi: 10.1016/0304-3878(81)90007-9.
- Zang, W. and Baimbridge, M. (2012). Exports, imports and economic growth in South Korea and Japan: A tale of two economies. *Applied Economics*, 44(3), 361–372. doi: 10.1080/00036846.2010.508722.