

The GDP Relationship between South Korea and Japan*

Principal Investigator: Lee, Jae Hoon[†] (lee963@wisc.edu, group#: 27)

In South Korea, many people believe that South Korea falls into recession if Japan fell into recession a decade ago. Then, can we verify whether the current GDP growth rate of South Korea is affected by 10-year ago GDP growth rate of Japan? This conjecture has not been statistically researched because estimating the effect of one country's 2010 Gross Domestic Product (GDP) on the other country's 2020 GDP is awkward. However, Japan and South Korea share similar cultures and have close economic relationship. Also, there is an about 10-year time lag of the labor force structure because Japan experienced baby booms in 1947-1949 and South Korea experienced baby booms in 1955-1963. Therefore, the research aims to estimate the effects of Japan's previous GDP growth rates on South Korea's current GDP growth rate, by using simple regression approaches. In a regression of Japan's previous GDP growth rates ($t-1, t-2, t-3, \dots, t-38, t-39, t-40$ quarters) on South Korea's GDP growth rate at time t , I find that the coefficient of GDP growth rate of Japan (24 quarters ago) is 0.2554** and the coefficient of GDP growth rate of Japan (32 quarters ago) is -0.2490**, but I could not find the coefficients of GDP growth rate of Japan (from 37 to 40 quarters ago) that are significant at the 5% level or even at the 10% level.

Analysis

I use data on quarterly GDP growth rates of Japan and South Korea and net exports of South Korea, from Quarterly National Accounts (OECD, 2020)¹⁾. Unfortunately, the data does not contain GDP growth rates before 1960-Q2, so I limit the data set from 1960-Q2 to 2020-Q3. Table 1 shows the summary statistics of the data. The number of observations is 242 when I regress the current GDP growth rate of Japan on the current GDP growth rate of South Korea. When I regress the previous 40 quarters GDP growth rates of Japan on the current GDP growth rate of South Korea, the number of observations is 202 (10 years = 40 quarters, 242 quarters – 40 quarters = 202 quarters).

Table 1: Summary Statistics

	S. Korea GDP Growth Rate	Japan GDP Growth Rate	Japan GDP Growth Rate (10-year ago)	S. Korea Log Net Exports
N	242	242	202	242
Mean	1.759	0.882	1.045	- 0.268
Min	- 6.818	- 8.262	- 4.813	- 2.266
25%	0.717	0.110	0.188	- 0.372
50%	1.591	0.807	0.957	- 0.033
75%	2.888	1.543	1.869	0.113
Max	8.061	5.698	5.698	0.470

Notes: N is the number of observations.

GDP is from expenditure approach (current price) and growth rates are compared to previous quarter, seasonally adjusted.

log Net Exports = log(Exports) – log(Imports)

*Python code and the newest version of the paper are also available on my personal website <https://EconJHL.com/>

[†]Second-year Master of Economics Student at University of Wisconsin – Madison

**Significant at the 5% level

¹⁾ OECD (2020), 1960-2020 Quarterly National Accounts. doi: 10.1787/b86d1fc8-en (Accessed on 09 December 2020)

Analysis.1 OLS: Current and Current

I estimate the following simple linear regression to understand the relationship between GDP growth rates of Japan and South Korea:

$$Rate_{SouthKorea,t} = \beta_0 + \beta_1 Rate_{Japan,t} + \varepsilon_t \quad \text{Model (1)}$$

where $Rate_{SouthKorea,t}$ is GDP growth rate of South Korea in quarter t; $Rate_{Japan,t}$ is GDP growth rate of Japan in quarter t. The β_1 is the coefficient of interest that captures the effect of GDP growth rate of Japan on GDP growth rate of South Korea, without any time lag.

Analysis.2 OLS: Current and 10-year ago

I estimate the following simple linear regression to understand the relationship between 10-year ago GDP growth rate of Japan and current GDP growth rate of South Korea:

$$Rate_{SouthKorea,t} = \beta_0 + \beta_1 Rate_{Japan,t-40} + \varepsilon_t \quad \text{Model (2)}$$

where $Rate_{SouthKorea,t}$ is GDP growth rate of South Korea in quarter t; $Rate_{Japan,t-40}$ is GDP growth rate of Japan in quarter t-40. The β_1 is the coefficient of interest that captures the effect of 40 quarters ago GDP growth rate of Japan on current GDP growth rate of South Korea.

Analysis.3 OLS: Current and Past

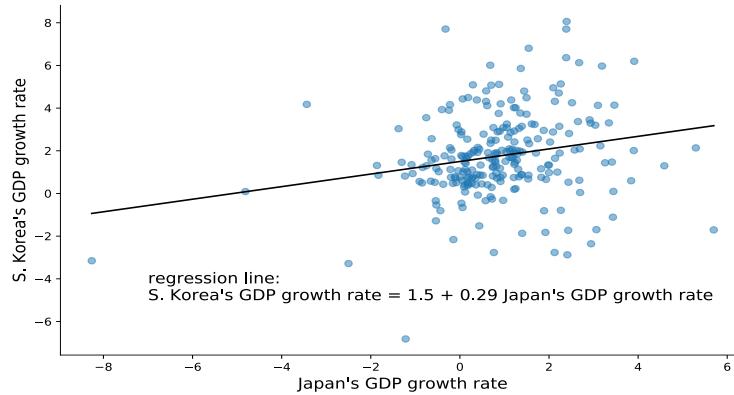
I estimate the following multiple regression to understand whether GDP growth rate of South Korea at quarter t can be predicted based on GDP growth rate of Japan at quarter t-1, t-2, t-3, ..., t-38, t-39, t-40:

$$\begin{aligned} Rate_{SouthKorea,t} = & \beta_0 + \beta_1 logNX_{SouthKorea,t} \quad \text{Model (3)} \\ & + \sum_{i=0}^{40} \theta_i Rate_{Japan,t-i} + \varepsilon_t \end{aligned}$$

where $Rate_{SouthKorea,t}$ is GDP growth rate of South Korea in quarter t; $logNX_{SouthKorea,t}$ is log net exports of services and goods of South Korea in quarter t; $Rate_{Japan,t-i}$ is GDP growth rate of Japan in quarter t-i. The θ_i are the coefficients of interest that capture the effect of i quarter ago GDP growth rate of Japan on current GDP growth rate of South Korea. For the simplicity, I assume GDP growth rate of Japan in quarter t-i is not correlated with GDP growth rate of Japan in quarter t-j where j = 0, 1, 2, ..., 38, 39, 40 and i ≠ j.

Results

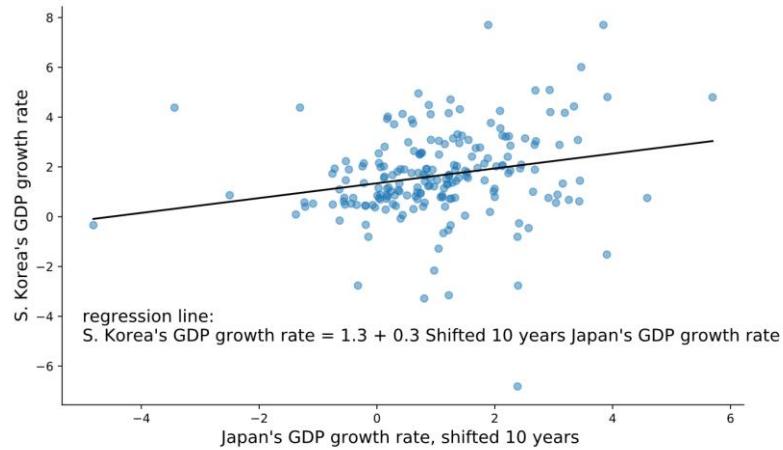
Figure 1: Simple Linear Regression, Model (1)



Notes: Results from model (1). The left y-axis is GDP growth rate of South Korea (compared to previous quarter, seasonally adjusted), while x-axis is GDP growth rate of Japan (compared to previous quarter, seasonally adjusted). The black line is regression line and blue circles are points of x and y.

Figure 1 shows scatter plot and regression line together, using model (1). The coefficient of interest, b1, is 0.295*** (0.087) and intercept is 1.5*** (0.147). The result shows that there is a positive relationship between GDP growth rates of Japan and South Korea at same quarter t.

Figure 2: Simple Linear Regression, Model (2)

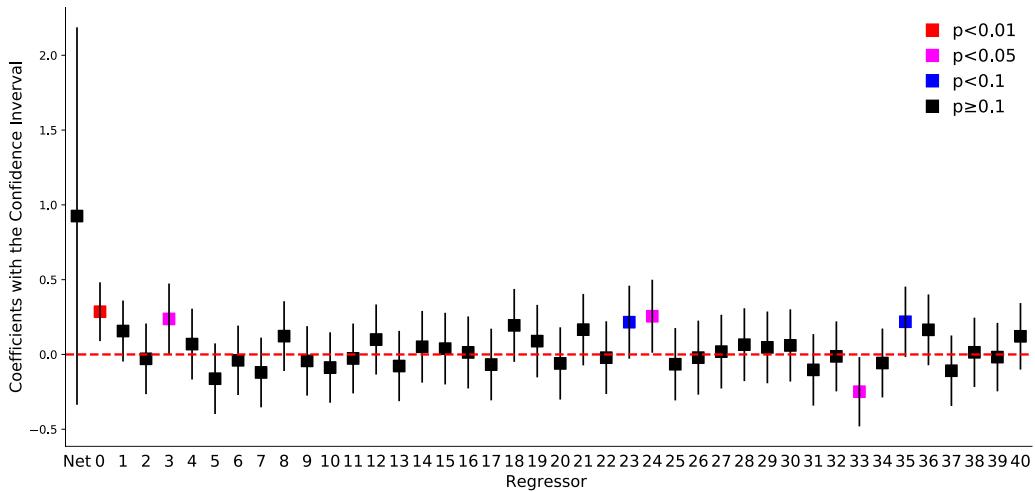


Notes: Results from model (2). The left y-axis is GDP growth rate of South Korea (compared to previous quarter, seasonally adjusted), while x-axis is GDP growth rate of Japan (compared to previous quarter, seasonally adjusted). The black line is regression line and blue circles are points of x and y.

Figure 2 shows scatter plot and regression line together, using model (2). The coefficient of interest, b1, is 0.298*** (0.091) and intercept is 1.345*** (0.154). The result shows that there is also a positive relationship between GDP growth rate of South Korea at quarter t and GDP growth rate of Japan at quarter t-40. Also, I could find that coefficients of interest are similar in Figure 1 and Figure 2.

**Significant at the 5% level

Figure 3: Multiple Linear Regression, Model (3)



Notes: Results from model (3). The y-axis is values of coefficients, while x-axis is explanatory variables. Black vertical line indicates confidence interval. Net is log net exports of South Korea; 0 is GDP growth rate of Japan in t-0 quarter; 1 is GDP growth rate of Japan in t-1 quarter; ...; 40 is GDP growth rate of Japan in t-40 quarter. The blue square is where $p < 0.1$; pink square is where $p < 0.05$; red square is where $p < 0.01$; black square is where $p \geq 0.1$. I excluded intercept in the figure.

Figure 3 shows each coefficient from the regression result using model (3). The coefficients of interest are θ_i that are GDP growth rate of Japan in quarter t-i. The x-axis shows each variable: Net is log net exports of South Korea; 0 is θ_0 ; 1 is θ_1 ; ...; 40 is θ_{40} . I find that θ_0 is 0.286^{***} ; θ_3 is 0.238^{**} ; θ_{23} is 0.216^* ; θ_{24} is 0.255^{**} ; θ_{33} is -0.249^{**} ; θ_{35} is 0.219^* . However, I could not find the coefficients of GDP growth rate of Japan (θ_{37} to θ_{40}) that are significant at the 5% level or even at the 10% level.

Conclusions and directions for future research

From the model (1) and model (2), I find that there is a positive relationship between GDP growth rates of Japan and South Korea at same quarter t, and even between 10-year ago GDP growth rate of Japan and current GDP growth rate of South Korea. From the model (3), however, I find the effects of 10-year ago GDP growth rate of Japan on GDP growth rate of South Korea are not statistically significant.

The research question is whether the current GDP growth rate of South Korea is affected by 10-year ago GDP growth rate of Japan. The main result of the research is that the effects of 10-year ago GDP growth rate of Japan are not statistically significant, rather than the conjecture is totally false. In model (3), I assume that GDP growth rate of Japan in quarter t-i is not correlated with GDP growth rate of Japan in quarter t-j. Therefore, further research should be conducted with more precise models, and I hope others also get interested in this conjecture from this research.

*Significant at the 10% level

**Significant at the 5% level

***Significant at the 1% level