The GDP Relationship between South Korea and Japan[*]

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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 South Korea's current Gross Domestic Product (GDP) growth rate is affected by Japan's 10-year ago GDP growth rate? This conjecture has not been statistically researched because estimating the effect of one country's 2010 GDP on the other country's 2020 GDP is unreasonable. 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 between two countries 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, with two simple linear models and one finite distributed lag model. In a distributed lag regression with finite length q where q = 40, I find that the lag weight of Japan's GDP growth rate (24 quarters ago) is 0.2554[**] and the lag weight of Japan's GDP growth rate (32 quarters ago) is -0.2490[**], but I could not find the lag weights of Japan's GDP growth rates (10-year ago: 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 Japan's GDP growth rate on the South Korea's GDP growth rate without any time lag. 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/
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[**]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: Simple Linear Model with t and t

I estimate the following simple linear regression to understand the relationship between GDP growth rates of Japan and South Korea without time lags:

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

where $Rate_{SouthKorea,t}$ is GDP growth rate of South Korea in quarter t; $Rate_{Japan,\mathrm{t}}$ is GDP growth rate of Japan in quarter t; ε_t is error term. 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: Simple Linear Model with t and t-40

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:

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

where $Rate_{SouthKorea,t}$ is GDP growth rate of South Korea in quarter t; $Rate_{Japan,\mathrm{t-40}}$ is GDP growth rate of Japan in quarter t-40; ε_t is error term. 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: Finite Distributed Lag Model

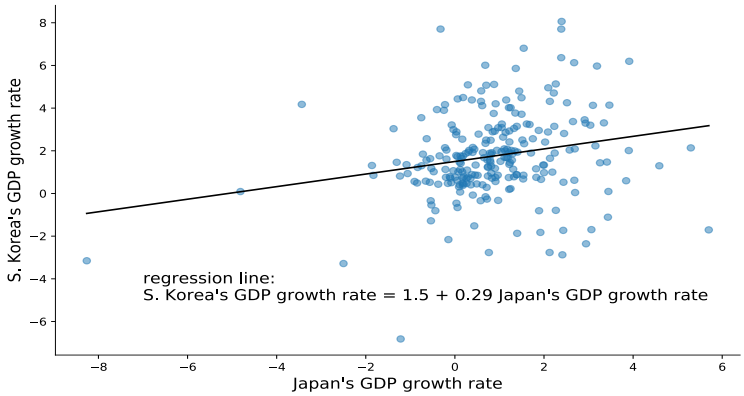
I estimate the following multiple regression to understand whether GDP growth rate of South Korea in quarter t can be predicted based on GDP growth rate of Japan in quarter t-1, t-2, t-3, …, t-38, t-39, t-40:

$$Rate_{SouthKorea,t} = \beta_0 + \beta_1 logNX_{\mathrm{SouthKorea,t}} + \sum_{i=0}^{40} \theta_i Rate_{Japan,t-i} + \varepsilon_t \qquad \mathrm{Model}\ (3)$$

where $Rate_{SouthKorea,t}$ is GDP growth rate of South Korea in quarter t; $logNX_{\mathrm{SouthKorea,t}}$ 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 (lag weigths) are the coefficients of interest that capture the effect of i quarter ago GDP growth rate of Japan on GDP growth rate of South Korea at quarter t. 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

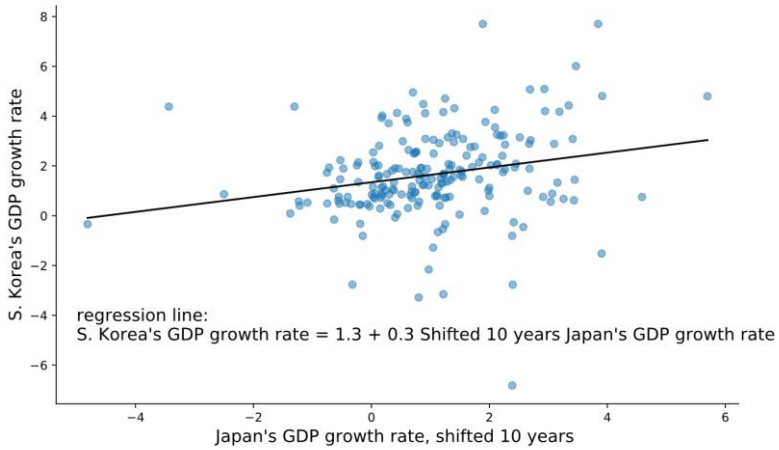
Figure 1: Simple Linear Regression, Model (1)



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 the scatter plot and regression line of model (1) together. The coefficient of interest, b1, is 0.295*** (0.087) and the intercept is 1.5*** (0.147). The result shows that if Japan's GDP growth rate increases by one unit, then the change in South Korea's GDP growth rate is 0.295. Also, there is a positive relationship between GDP growth rates of Japan and South Korea.

Figure 2: Simple Linear Regression, Model (2)

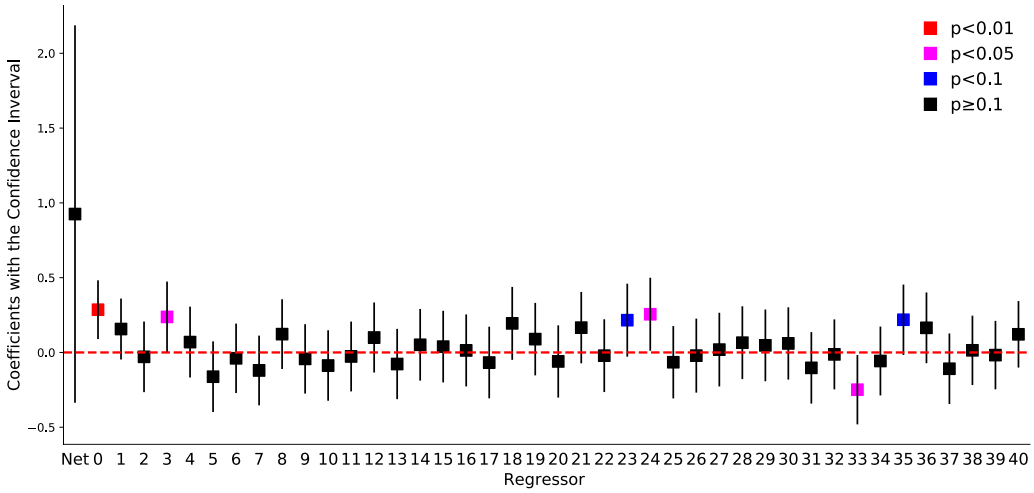


Notes: Results from model (2). The left y-axis is GDP growth rate of South Korea in quarter t (compared to previous quarter, seasonally adjusted), while x-axis is GDP growth rate of Japan in quarter t-40 (compared to previous quarter, seasonally adjusted). The black line is regression line and blue circles are points of x and y.

Figure 2 shows scatter plot and regression line of model (2) together. The coefficient of interest, b1, is 0.298*** (0.091) and the intercept is 1.345*** (0.154). The result shows if Japan's GDP growth rate (40 quarters ago) increases by one unit, then the change in South Korea's current GDP growth rate is 0.298. There is also a positive relationship between GDP growth rate of South Korea in quarter t and GDP growth rate of Japan in quarter t-40.

**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 the confidence interval of each variable. 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 ≥0.1. I excluded the intercept in the figure.

Figure 3 shows each coefficient and confidence interval of the model (3)'s regression result. The coefficients of interest are θ_i that are the lag distribution, where i = 0, 1, 2, 3, ..., 38, 39, 40. 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 the sum of all θ_i is 1.338 which indicates that if Japan's GDP growth rate increases by one unit this quarter, the change in South Korea's GDP growth rate will be 1.338 after 40 quarters. To be specific, θ_0(impact multiplier[2)]) 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 lag weigths that are significant at the 5% level or even at the 10% level, from quarter t-37 to quarter t-40 (θ_{37} to θ_{40}).

Conclusions and directions for future research

From the model (1), I find that there is a positive relationship between GDP growth rates of Japan and South Korea without any time lag. From model (2), I also find that there is a positive relationship between Japan's 10-year ago GDP growth rate and South Korea's current GDP growth rate. From the model (3), I find that if Japan's GDP growth rate increases by one unit this quarter, the change in South Korea's GDP growth rate will be 1.338 after 40 quarters, but there were many lag weights that are not statistically significant at the 5% level or even at the 10% level.

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 Japan's 10-year ago GDP growth rate are not statistically significant. However, this result does not indicate that the conjecture is totally false. In model (3), I use the assumption 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 that can solve correlation problems, and I hope others also get interested in this interesting conjecture, starting from this research.

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*Significant at the 10% level

**Significant at the 5% level

***Significant at the 1% level

[2)] θ_1 is the Impact multiplier which affects South Korea's GDP growth rate instantaneously.