On the Beggar Thy Neighbor Effect of Japanese Cheap Yen: GVAR Approach*

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This paper investigates into whether there exists beggar thy neighbor effect of the Japanese cheap yen on its neighbor countries. We perform GVAR (Global Vector Auto-regression) and GVC (Global Value Chain) analysis on 19 countries with a focus on Korea, China, Japan and the US, Japan and find out that Japanese cheap yen has beggar thy neighbor effect. According to the Generalized Impulse Response Function Analysis (GIRF), Japan turns out to be the main beneficiary of cheap yen, who enjoys sharpest increase in GDP, China is also identified as one of the beneficiaries with a mild positive effect in GDP. But the most damaged from cheap yen turns out to be Korea, which has to suffer the most severe decrease in GDP and falling equity prices. The reason of these results can be explained by the degree of competition and compensation in the global chain of production. As Japan and Korea have higher degree of competition in the word's final product market, Korea loses market share by the cheap yen, while Japan and China have lower degree of competition in the world's final product market but have higher degree of compensation in raw materials and intermediate input market, the gains in raw materials and intermediate input market from cheap yen for China dominates the loss of final product markets.

KEYWORD: GVAR, GVC, Japan low cheap Yen, Devaluation, Depreciation, Abenomics, Generalized Impulse Response Function, Beggar thy neighbor

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I. Introduction

The increasing degree of economic integration of world economies makes small open economies more vulnerable to external shocks. Most of the small open economies in the world are now under serious shocks that come from the world's major three countries, Japan, China and US, in the form of Abenomics, Chinese hard landing, and the US tapering, which raises the fear that this time might be different.

Since the 2008 global financial crisis, major economies of the world, including the US, Euro and Japan, had begun non-conventional monetary policy, called quantitative easing. The US is now in the stage of tapering the Q.E by raising the federal funds rate, but EURO and Japan is still in the process of QE.

Japan, as the economic recovery doesn't meet the expected level, had tried to perform the 2nd round quantitative and qualitative easing since its launching (QQE2) in 2012. This QQE2 has accelerated the weakness of Japanese yen (As the QQE2 did not come up to its expectations, Japanese government performed additional qualitative and quantitative easing 2). In early 2016, Bank of Japan even announced to lower its interest rate to minus 0.1 percent.

The Abenomics consists mainly of three platforms: first is a massive injection of fresh money from the BOJ by expansionary monetary policy, second is the big new public works spending, and third is the structural reforms intended to fix inefficiencies in the Japanese economy.

The main channel of Abenomics is to inject massively fresh money into the Japanese economy through easy monetary policy. Through easy monetary policy, Japan tries to lower interest rates (long term) and the value of yen. Massive inflow of new money will make yen cheaper than other major currencies and then it is expected to boost Japanese export, thereby reviving the export driven economy.

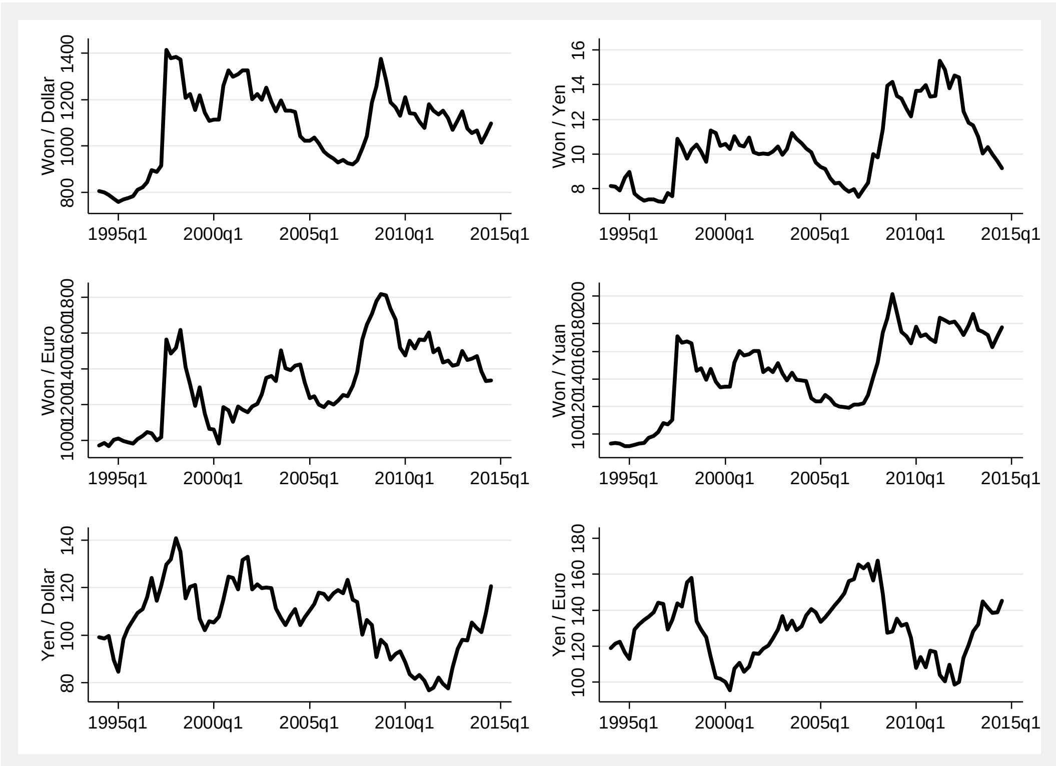
Under Abenomics, cheap yen policy is expected to continue. This Japanese weak yen policy, which is intended to boost Japanese GDP by increasing its exports resembles the beggar thy neighbor policy in the 1930s where many of the world countries adopted weak exchange rate policy to increase their exports. In other words, if the yen weakens in an accelerating way, then the export of Korea and China, which have high degree of competition in export market, may be hurt by the weaker than normal level of yen, resulting in the decrease of GDP of surrounding countries. In this sense, the weak yen policy can be regarded as the beggar thy neighbor exchange rate policy.

We want to estimate the impact of cheap yen on the GDP of the rest of the world, with a special focus on Korea, China, Japan, and the US.

On this ground, this study tried to investigate the effect of cheap yen around the countries, and tries to find out whether there exits beggar thy neighbor effect from the cheap yen policy. To do this work we want to employ GVAR analysis base on Global Value Chain (hence forth 'GVC') approach.

<Figure 1> shows the trend of won/dollar, won/yen, won/euro, won/yuan, yen/dollar, yen/euro exchange rates. According to <Figure 1>, Japanese yen/dollar exchange rate shows sharp depreciation since 2012.

<Figure 1> Exchange rates of neighboring countries



If we try to do literature review on the issue of Beggar thy neighbor effect of the depreciation of yen, we can only find very few recent literature on this issue. Even though there have been lots of controversies on this issue, it is hard to find rigorous empirical analysis which investigated on this subject recently.

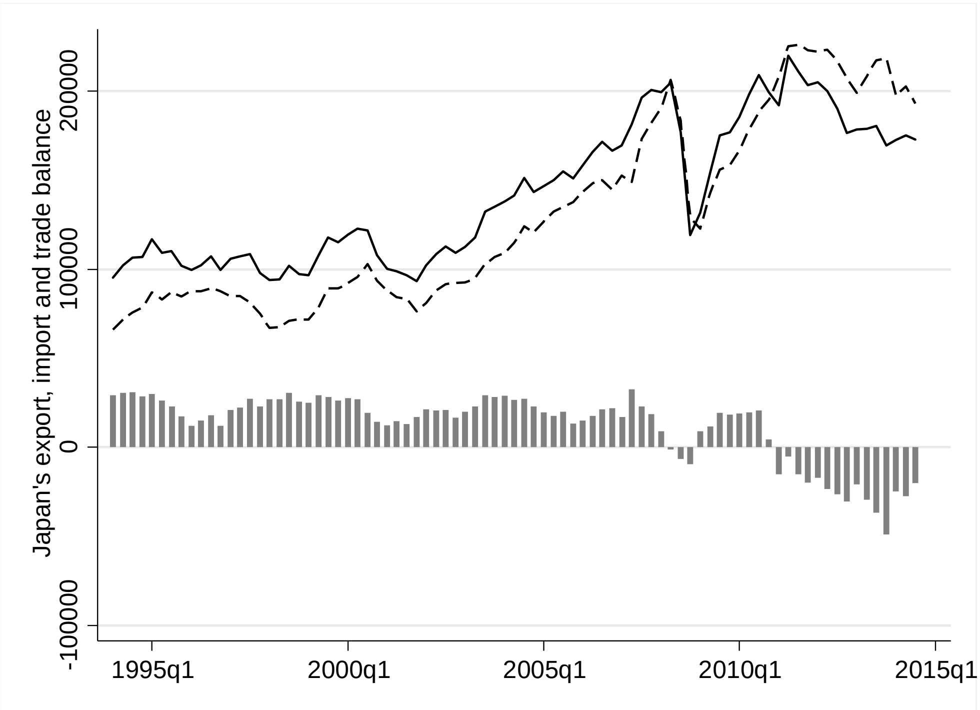
As the premise of beggar thy neighbor effect is the export growth that comes from currency depreciation, most of the previous studies analyze the effect of deprecation of yen in connection with the amount of the export and import of Japan.

Maćkowiak(2006) estimated the effects of Japanese monetary policy shocks on East Asia by using SVAR models. Maćkowiak(2006) reports that Japanese monetary policy shocks explain only a modest fraction of the variance in real output, trade balances and exchange rates in East Asia, and concludes that he can hardly find evidence of beggar thy neighbor effects of Japanese monetary policy on East Asia.

Chin(2013) approached the impact of Japanese cheap yen on the GDP of neighbor countries by estimating the elasticities of import and export demand functions of Japan. Chin(2013) estimated that Marshall–Learner condition holds for Japan, and concludes that depreciation of yen will result in an improvement in trade balance of Japan, which can be inferred as the evidence of the presence of beggar thy neighbor effects of cheap yen.

Fukuda and Doita(2015) analyze the effect of cheap yen on Japanese export and find that despite the yen's sharp depreciation since the Abenomics started, as can be seen from <Figure 2>, Japan's exports did not show significant improvement. Their results indirectly deny the presence of beggar thy neighbor effects of Japanese cheap yen on the rest of the world. They explain the reason of this phenomenon by the weak external demand and increased overseas production.

<Figure 2> Japanese export, import and trade balance



Shimizu and Sato(2015), by using ARDL model, point that the effect of depreciation of the yen has weakened during the Abenomics period, which indirectly denies the presence of beggar thy neighbor effects of Japanese yen on other countries. They also attributed the reason of this phenomenon to the increase of Japanese overseas production. However, on Korea and Japan's relationship, they analyze that depreciation of yen increases the competitiveness of Japanese product, which partially acknowledges the presence of beggar thy neighbor effects of Japanese cheap yen between Korea and Japan.

Kobayashi(2014) also points the phenomenon that Japanese export does not increase to the expected level despite the sharp depreciation of yen, which also indirectly negates the spillover effect of Japanese cheap yen to other countries. Kobayashi(2014) attributes the reason of this phenomenon to Japanese companies pricing to market behavior and Japanese companies expanding of overseas production.

As above studies have commonly used conventional trade statistics in their analysis, they have the same limitation in their analysis for beggar thy neighbor effect of cheap yen.

In estimating the presence of beggar thy neighbor effect of Japanese cheap yen, we made two major contributions to the existing literature.

First, we employ GVC(Global Value Chain) approach in measuring the linkage of a country to the other countries. Most of the studies regard traditional trade statistics in their analysis. Conventional trade statistics, based on the amount of simple export and imports that pass customs clearance, are calculated without the considering the trade of intermediate goods and services for final export.

However, in a world of vertically integrated global production system, traditional trade statistics can be a misleading indicator of a country's dependence on trade. For example conventional export statistics is measured in gross terms, double counting intermediate inputs, instead of value added basis like GDP calculation. In other words, conventional market value of total export includes the intermediate goods, which are imported for exports, are double counted. In this sense, it would be incorrectly count the amount of export. This causes the problem of double counting of calculation, which may cross country borders many times before they become finalized. To make remedy for this problem, we employ GVC approach which will be describe later.

Secondly, we employ GVAR(Global Vector Autogression); an econometric methodology which has not been used in the estimation of the presence of beggar thy neighbor effect before. The GVAR model is introduced by Pesaran, Schuermann, and Weiner (2004) (henceforth PSW) and further developed by Dées, di Mauro, Pesaran, and Smith (2007) (henceforth DdPS).

The GVAR is a global model linking individual country vector error-correcting models in which the domestic variables are related to the country-specific foreign variables as an approximation to the common factor model. It allows the estimation of the long-run and shot-run relationships among the countries with complex interactions and interdependencies at an international level in a transparent way, avoiding the curse of dimensionality in a large system.

We will be analyze the Generalized Impulse Response Function obtained from giving a cheap yen shock to the built up GVAR system.

For this purpose, the rest of this chapter is organized as follows. Chapter 2 presents the underlying mechanics of the GVC and GVR methodology. Chapter 3 describes the results obtained by the generalized impulse response function analysis. Chapter 4 summarizes and concludes our study.

II. Empirical Model

2.1 The GVC model

In this study, we want to use trade matrix based on global value chains, which measures the amount of trade in terms of export and import of value added basis(hence forth 'GVC basis').

So far most of empirical studies which includes measuring the degree of a country's engagement in global trade have used conventional trade statistic which uses the amount of export and import based on customs clearance basis(hence for the 'CC basis').

However, as CC basis trade statistic is measured in gross terms instead of value added terms, it has a critical defect that it overestimates the trade volume among the countries by double counting. For example, trade volume of the countries engaged in processing trade by CC basis, such as Mexico and China, is generally overestimated due to re-exporting of imported materials, capital goods and others from abroad.

If we construct GVAR model by CC basis trade statistic, it may be misleading the impacts of shock. The role of, or influential power of the countries who engaged in process trade may be overestimated by double or triple counting of trade volume. Therefore we tried to reduce "biases" come from the international linkage of trade between countries by using GVC basis trade statistic.

We start with the methodology for measuring trade in value added[1]. That is, we want to know how much of value added of a particular country come from another country's consumption from it. Based on the equilibrium state of an input-output approach composed of C countries and G industries, the basic relationship can be expressed as follows.

$$\mathrm{x} = \mathrm{Ax} + \mathrm{f} = \mathrm{Lf} \qquad \text{eq. (1)}$$

where x denotes a CG×1 vector of gross output. A is a CG×CG matrix of technical input-output coefficients with each element denoting the input used in a particular industry in one country per unit of gross output. f denotes the CG×1 vector of final demand. The second part of right hand side denotes equation rearranging such that gross output is written as a function of the Leontief inverse matrix, $\mathrm{L} = (\mathrm{I} - \mathrm{A})^{-1}$, and the final demand vector f. For three countries and using partitioned matrices this equation can be written as follows.

To understand the concept of trade in value added, we can express this equation using partitioned matrix for three countries without compromising the characteristics of a generalized model.

$$\begin{pmatrix} X^s \\ X^t \\ X^r \end{pmatrix} = \begin{pmatrix} A^{rr}, A^{rs}, A^{rt} \\ A^{sr}, A^{ss}, A^{st} \\ A^{tr}, A^{ts}, A^{tt} \end{pmatrix} \begin{pmatrix} X^s \\ X^t \\ X^r \end{pmatrix} + \begin{pmatrix} f^s \\ f^t \\ f^r \end{pmatrix} = \begin{pmatrix} L^{rr}, L^{rs}, L^{rt} \\ L^{sr}, L^{ss}, L^{st} \\ L^{tr}, L^{ts}, L^{tt} \end{pmatrix} \begin{pmatrix} f^{rr} + f^{rs} + f^{rt} \\ f^{sr} + f^{ss} + f^{st} \\ f^{tr} + f^{ts} + f^{tt} \end{pmatrix} \qquad \text{eq. (2)}$$

Where $x^c (c = r, s, t)$ denotes the G×1 vector of gross output in country c, L^{cd} the respective G×G submatrix of the Leontief inverse matrix and f^{cd} the G×1 vector of final demand of country d in country c.

Pre-multiplying this equation with a 1×CG vector of value added coefficients (value added per unit of gross output v), gives us value added created from final demand and will be used to calculate trade in value added.

1. For more detail, see Stehrer(2012)

$$TVA = \begin{pmatrix} v^{rr}, 0, 0 \\ 0, v^{ss}, 0 \\ 0, 0, v^{tt} \end{pmatrix} \begin{pmatrix} L^{rr}, L^{rs}, L^{rt} \\ L^{sr}, L^{ss}, L^{st} \\ L^{tr}, L^{ts}, L^{tt} \end{pmatrix} \begin{pmatrix} f^{rr} + f^{rs} + f^{rt} \\ f^{sr} + f^{ss} + f^{st} \\ f^{tr} + f^{ts} + f^{tt} \end{pmatrix} \qquad \text{eq. (3)}$$

Export in value added of the country r to all other countries include value added created in country r to satisfy final demand in countries s and t. Selecting the appropriate terms in the above equation gives following.

$$TVA_X^r = \begin{pmatrix} v^{rr}, 0, 0 \\ 0,0,0 \\ 0,0,0 \end{pmatrix} \begin{pmatrix} L^{rr}, L^{rs}, L^{rt} \\ L^{sr}, L^{ss}, L^{st} \\ L^{tr}, L^{ts}, L^{tt} \end{pmatrix} \begin{pmatrix} 0 + f^{rs} + f^{rt} \\ 0 + f^{ss} + f^{st} \\ 0 + f^{ts} + f^{tt} \end{pmatrix} \qquad \text{eq. (4)}$$

Imports in value added of country r from all other countries should account for value added created in countries s and t to satisfy final demand of country r. Selecting the appropriate terms the equation has to be written as,

$$TVA_M^r = \begin{pmatrix} 0, 0, 0 \\ 0, v^{ss}, 0 \\ 0, 0, v^{tt} \end{pmatrix} \begin{pmatrix} L^{rr}, L^{rs}, L^{rt} \\ L^{sr}, L^{ss}, L^{st} \\ L^{tr}, L^{ts}, L^{tt} \end{pmatrix} \begin{pmatrix} f^{rr} + 0 + 0 \\ f^{sr} + 0 + 0 \\ f^{tr} + 0 + 0 \end{pmatrix} \qquad \text{eq. (5)}$$

Net trade in value added is defined as the difference between exports and imports in value added.

$$TVA_N^r = TVA_X^r - TVA_X^r \qquad \text{eq. (6)}$$

Exports, imports and net trade in value added for other countries, s, t can be derived analogously.

The differences between the trade matrix obtained by the traditional way versus GVC approach will be described in chapter 3. Employing this GVC approach, we calculate the GVC matrix for 19 countries and during 2009-2011 and apply it in constructing GVAR model.

2.2 The GVAR model

We use GVAR model specification developed by DdPS and PSW in this study. The GVAR can be briefly summarized as a two-step procedure. In the first step, individual country-specific models are estimated conditional on the rest of the world. These models are VAR models augmented by the vector of star(*) variables, which represents country specific foreign variables.

In the second step, individual country VARX* models are stacked and solved simultaneously as one large global VAR model. The solution can be used for shock scenario analysis and forecasting as is usually done with standard VAR models. It enables us to estimate the propagation of economic shock in a global setting systematically.

The first step in GVAR modelling is to constructs country specific foreign variables from the domestic variables, which are used as a proxy for common unobserved factors and at the same time allows us to estimate the country specific endogenous variables dealing with the problem of curse of dimensionality.

To describe GVAR model presented by DdPS and PSW briefly, it is assumed that there are $\mathrm{N}+1$ states, indexed by $\mathrm{i}=0,1,2,\ldots,\mathrm{N}$. For each country, we assume $\mathrm{k_i}\times 1$ country specific macroeconomic variable $\mathrm{x_{it}}$, comprising real GDP, inflation, real equity prices, real exchange rate, nominal short term interest rates, and nominal long term interest rates over time, t = 1, 2, …, T, and across the N + 1 countries.

DdPS and PSW construct $\mathrm{k_i^*}\times 1$ country specific foreign variables $\mathrm{x_{it}^*}=\sum_{\mathrm{j=0}}^{\mathrm{N}}\mathrm{w_{ij}x_{jt}}$, where $\mathrm{w_{ij}}$, j = 0, 1, …, N, means the trade weight(the share of country j in the total trade of country i such that $\mathrm{w_{ii}}=0$ and $\sum_{\mathrm{j=0}}^{\mathrm{N}}\mathrm{w_{ij}}=1$. The weights are predetermined, and are meant to capture the importance of country j for the i*th* economy. Most of studies use trade weight obtained from the CC basis, but in our study, we use average trade weight calculated by the GVC basis. We want to emphasize that this trial is our contribution to the existing literature.

For simplicity, if we confine our exposition here to a 2nd-order dynamic specification, then each country includes a set of domestic, as well as foreign-specific variables, the number of which can vary across countries. Specifically, for country i, consider the VARX* (2, 2) structure is given by

$$\mathbf{x}_{it} = \mathbf{a}_{i0}+\mathbf{a}_{i1}t+\mathbf{\Phi}_{i1}\mathbf{x}_{i,t-1}+\mathbf{\Phi}_{i2}\mathbf{x}_{i,t-2}+\mathbf{\Lambda}_{i0}\mathbf{x}_{it}^*+\mathbf{\Lambda}_{i1}\mathbf{x}_{i,t-1}^*+\mathbf{\Lambda}_{i2}\mathbf{x}_{i,t-2}^*+\mathbf{u}_{it}, \quad \text{eq. (7)}$$

where $\mathbf{x}_{it}$ is a $k_i\times 1$ vector of domestic variables, $\mathbf{x}_{it}^*$ is a $k_i^*\times 1$ vector of foreign variables, and $\mathbf{u}_{it}$ is a serially uncorrelated and cross-sectionally weakly dependent process.

This country specific model can be consistently estimated separately under the condition of the weak exogeneity of country specific foreign variables$\mathbf{x}_{it}^*$ with respect to $\mathbf{x}_{it}$. This weak exogeneity condition of $\mathbf{x}_{it}^*$ with respect to $\mathbf{x}_{it}$ makes the individual country model decouple from the whole system and allows us to estimate the individual country model consistently without estimating the whole system simultaneously[2].

It is also estimated by taking account of the integration properties of the series $\mathbf{x}_{it}$ and $\mathbf{x}^*_{it}$, treating $\mathbf{x}^*_{it}$ as weakly exogenous I(1) with respect to the parameters of this model. It allows us to distinguish between short-run and long-run relations and interpret the long-run relations as co-integrating.

To construct the GVAR model, we group both the domestic and foreign variables as

$$\mathbf{z}_{it} = \begin{pmatrix} \mathbf{x}_{it} \\ \mathbf{x}^*_{it} \end{pmatrix}. \qquad \text{eq. (8)}$$

Then we can get the corresponding error-correction form, VECMX* of eq. (7), expressed as

$$\Delta\mathbf{x}_{it} = \mathbf{c}_{i0} - \boldsymbol{\alpha}_i\boldsymbol{\beta}'_i\left[\mathbf{z}_{i,t-1} - \boldsymbol{\gamma}_i(t-1)\right] + \boldsymbol{\Lambda}_{i0}\Delta\mathbf{x}^*_{it} + \boldsymbol{\Gamma}_i\Delta\mathbf{z}_{i,t-1} + \mathbf{u}_{it}, \qquad \text{eq. (9)}$$

where $\boldsymbol{\alpha}_i$ is a $k_i \times r_i$ matrix of rank r_i, and $\boldsymbol{\beta}_i$ is a $(k_i + k^*_i) \times r_i$ matrix of rank r_i. We can estimate eq.(9) based on reduced rank regression, and get the estimates of the speed of adjustment coefficients, $\boldsymbol{\alpha}_i$, and the cointegrating vectors, $\boldsymbol{\beta}_i$, for each country model.

After the estimation is done on a country-by country basis, we want to build up the GVAR model for the world as a whole (in terms of a $k \times 1$ global variable vector, $k = \sum_{i=0}^{N} k_i$), taking account of the fact that all the variables are endogenous to the system as a whole.

Starting from the country-specific VARX(2,2) models in eq.(7), where as before $\boldsymbol{z}_{it} = (\mathbf{x}'_{it}, \mathbf{x}^{*\prime}_{it})'$ then we can write eq. (7) for each economy as

$$\mathbf{A}_{i0}\mathbf{z}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \mathbf{A}_{i1}\mathbf{z}_{i,t-1} + \mathbf{A}_{i2}\mathbf{z}_{i,t-2} + \mathbf{u}_{it}, \qquad \text{eq. (10)}$$

where

$$\mathbf{A}_{i0} = (\mathbf{I}_{k_i}, -\boldsymbol{\Lambda}_{i0}), \quad \mathbf{A}_{i1} = (\boldsymbol{\Phi}_{i1}, \boldsymbol{\Lambda}_{i1}), \qquad \mathbf{A}_{i2} = (\boldsymbol{\Phi}_{i2}, \boldsymbol{\Lambda}_{i2}).$$

Then by collecting all of the domestic (endogenous) variables together, we can create the global vector $\mathbf{x}_t = (\mathbf{x}'_{0t}, \mathbf{x}'_{1t}, \ldots, \mathbf{x}'_{Nt})'$ with the dimension $k \times 1$.

We can then use the link matrices $\mathbf{W}_i$ defined by the country-specific trade weights w_{ij} to obtain the identity

$$\mathbf{z}_{it} = \mathbf{W}_i\mathbf{x}_t, \qquad \text{eq. (11)}$$

where $\mathbf{W}_i$ is a matrix with dimensions $(k_\mathrm{i} + k^*_\mathrm{i}) \times k$. This matrix $\mathbf{W}_i$ can be interpreted as a link matrix that allows each country model to be written in terms of the global variable vector $\mathbf{x}_t$. If we use the identity given by eq. (11), then eq.(10) can be written as

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2. To see the proof, read the appendix of DdPS.

$$\mathbf{A}_{i0}\mathbf{W}_i\mathbf{x}_t = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \mathbf{A}_{i1}\mathbf{W}_i\mathbf{x}_{t-1} + \mathbf{A}_{i2}\mathbf{W}_i\mathbf{x}_{t-2} + \mathbf{u}_{it}, \qquad \text{eq. (12)}$$

for i = 0, 1, 2, …, N.

Then by stacking up each country specific models in eq.(12), we can get eq.(13),

$$\mathbf{G}_0\mathbf{x}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \mathbf{G}_1\mathbf{x}_{t-1} + \mathbf{G}_2\mathbf{x}_{t-2} + \mathbf{u}_t, \qquad \text{eq. (13)}$$

where

$$\mathbf{G}_0 = \begin{pmatrix} \mathbf{A}_{00}\mathbf{W}_0 \\ \mathbf{A}_{10}\mathbf{W}_1 \\ \vdots \\ \mathbf{A}_{N0}\mathbf{W}_\mathrm{N} \end{pmatrix}, \mathbf{G}_1 = \begin{pmatrix} \mathbf{A}_{01}\mathbf{W}_0 \\ \mathbf{A}_{11}\mathbf{W}_1 \\ \vdots \\ \mathbf{A}_{N1}\mathbf{W}_\mathrm{N} \end{pmatrix}, \mathbf{G}_2 = \begin{pmatrix} \mathbf{A}_{02}\mathbf{W}_0 \\ \mathbf{A}_{12}\mathbf{W}_1 \\ \vdots \\ \mathbf{A}_{N2}\mathbf{W}_\mathrm{N} \end{pmatrix},$$

$$\mathbf{a}_0 = \begin{pmatrix} \mathbf{a}_{00} \\ \mathbf{a}_{10} \\ \vdots \\ \mathbf{a}_{\mathrm{N}0} \end{pmatrix}, \mathbf{a}_1 = \begin{pmatrix} \mathbf{a}_{01} \\ \mathbf{a}_{11} \\ \vdots \\ \mathbf{a}_{\mathrm{N}1} \end{pmatrix}, \mathbf{u}_\mathrm{t} = \begin{pmatrix} \mathbf{u}_{0\mathrm{t}} \\ \mathbf{u}_{1\mathrm{t}} \\ \vdots \\ \mathbf{u}_{\mathrm{Nt}} \end{pmatrix}.$$

The $\mathbf{G}_0$ matrix has dimension $k \times k$ and it depends on the trade weights and parameter estimates. If $\mathbf{G}_0$ is nonsingular, then by pre multiplying eq. (13) by $\mathbf{G}_0^{-1}$, we can the GVAR model in its reduced form as

$$\mathbf{x}_t = \mathbf{b}_0 + \mathbf{b}_1 t + \mathbf{F}_1\mathbf{x}_{t-1} + \mathbf{F}_2\mathbf{x}_{t-2} + \boldsymbol{\varepsilon}_t, \qquad \text{eq. (14)}$$

where

$$\mathbf{F}_1 = \mathbf{G}_0^{-1}\mathbf{G}_1, \mathbf{F}_2 = \mathbf{G}_0^{-1}\mathbf{G}_2,$$
$$\mathbf{b}_0 = \mathbf{G}_0^{-1}\mathbf{a}_0, \mathbf{b}_1 = \mathbf{G}_0^{-1}\mathbf{a}_1, \boldsymbol{\varepsilon}_t = \mathbf{G}_0^{-1}\mathbf{u}_\mathrm{t}.$$

Eq. (14) can be solved recursively and used for our purpose of generalized impulse response function analysis. For further details, see PSW and DdPS.

2.3 The Data

In this paper, we use quarterly data for 19 countries from 1972 Q2 to 2013 Q1. Following the DdPS (2007), we specify domestic and foreign variables included in the country-specific models as

$y_{it} = \ln(GDP_{it}/CPI_{it}),$

$p_{it} = \ln(CPI_{it})\,, eq_{it} = \ln(EQ_{it}/CPI_{it}),$

$e_{it} = \ln(E_{it}),$

$\rho_{it}^S = 0.25 \times \ln\left(1 + R_{it}^S/100\right),$

$\rho_{it}^L = 0.25 \times \ln(1 + R_{it}^L/100),$

$p_t^O = \ln(P_t^O)$,

where

GDP_{it} = Nominal Gross Domestic Product of country i during period t, in domestic currency;

CPI_{it} = Consumer Price Index in country i at time t;

EQ_{it} = Nominal Equity Price Index;

E_{it} = Exchange rate of country i at time t in terms of US dollars;

R_{it}^S = Nominal short-term rate of interest per annum, in percent;

R_{it}^L = Nominal long-term rate of interest per annum, in percent;

P_t^O = Price of oil (in USD).

P_t^m = Price of materials (in USD).

P_t^t = Price of metals (in USD).

<Table 1 > Countries and Regions Included in GVAR model

Major	Euro	Rest of Western Europe	Latin	Asia	Rest of the World
USA	Germany	UK	Mexico	Korea	Turkey
China	France	Sweden		Indonesia	
Japan	Italy			India	
	Netherlands				
Other Developed	Belgium				
Canada	Austria				
Australia	Finland				
Number of countries	7	2	1	3	1

2.4 Country-specific models

In GVAR modeling, country specific model is constructed using the country specific foreign variables. Most of Individual countries include $y, \Delta p, e - p, eq, \rho^S$ and ρ^L as domestic variables, and country specific foreign variables. DdPS constructed the country-specific foreign variables using trade weights base on GVC basis trade statistic. In this paper, the GVC basis trade weights are also calculated based on the average trade flows computed over the three years 2009-2011.

We tested the integration properties of the domestic variables $\mathbf{x}_{it}$ and country specific foreign variables $\mathbf{x}_{it}^*$ by using standard Dickey-Fuller tests and Park and Fuller(1995) weighted symmetric ADF type tests, at the 5% significance level. The result shows that the majority of the variables are unable to reject the null of non-stationarity.

The lag order of individual VARX* models is determined according to the Akaike information criterion, with the maximum lag length 2 for domestic variables and 1 for foreign variables. For majority of the countries, a VARX*(2,1) specification is used. If we assume the weak exogeneity $\mathbf{x}_{it}^*$, the corresponding error correction form of the country-specific VARX* models in eq.2 is estimated separately for each country conditional on $\mathbf{x}_{it}^*$, allowing cointegration both within domestic variables $\mathbf{x}_{it}$ and across $\mathbf{x}_{it}$ and $\mathbf{x}_{it}^*$ based on reduce-rank regression.

After the estimates of $\boldsymbol{\beta}_i$ is obtained, we can get the consistent estimates of the remaining parameters of VECMX* by OLS, then recover the corresponding VARX* form in eq. (7). We can combine these country specific VARX* models using the link matrix $\mathbf{W}_i$ defined in eq.(11)

2.5 Testing for weak exogeneity of country specific foreign variables.

The key assumption underlying the above estimation strategy is the weak exogeneity of country specific foreign variables $\mathbf{x}_{it}^*$ with respect to the long-run parameters of the conditional model. This assumption allows us to estimate each country individually and to combine those only at a later stage.

The meaning of this assumption is that each individual country (except the U.S.) is actually such a small economy with respect to the rest of the world that each individual country gets long run feedback from the rest of the world, but it does not give long run feedback to the rest of the world, without ruling out contemporaneous and lagged short run feedbacks between them.

As is described earlier, country specific foreign variables are computed as weighted averages of the corresponding domestic variables of all countries, with the weights also being country-specific.

A formal test of weak exogeneity of the country-specific foreign variables can be carried out by a test of the joint significance of the estimated error-correction terms in auxiliary equations for the country-specific foreign variables, $\mathbf{x}_{it}^*$. In particular, for each ℓth element of $\mathbf{x}_{it}^*$ the following regression is carried out

$\Delta x_{it,l}^* = a_{i,l} + \sum_{j=1}^{r_i} \delta_{ij,l}\, ECM_{ij,t-1} + \sum_{k=1}^{s_i} \boldsymbol{\phi}'_{ik,l} \Delta \mathbf{x}_{i,t-k} + \sum_{m=1}^{n_i} \boldsymbol{\psi}'_{im,l}\, \Delta \mathbf{x}_{i,t-m}^* + \eta_{it,l}$ eq. (15)

where $ECM_{ij,t-1}$, j = 1, 2, …, r_i, are the estimated error-correction terms corresponding to the r_i co-integrating relations found for the ith country model. The test for weak exogeneity is to test whether there is no long run feedback from $\mathbf{x}_{it}$ to $\mathbf{x}_{it}^*$, while foreign variables $\mathbf{x}_{it}^*$ are long run forcing $\mathbf{x}_{it}$. Therefore the test for weak exogeneity of $\mathbf{x}_{it}^*$ is an F-test of the joint hypothesis that the coefficients of ECM term $\delta_{ij,l} = 0, j = 1, 2, \ldots, r_i$, on the eq.(15) . The test results for the focus countries are summarized in <Table 2>.

Weak exogeneity test results shows that at 5% significance level, only 6 cases out of 102 regressions, the null hypothesis of weak exogeneity assumption is rejected. These results validate our GVAR estimation.

<Table 2 > Weak Exogeneity Test Result

Country	F test	Critical Value (5%)	y^*	Δp^*	eq^*	$e^* - p^*$	ρ^{*S}	ρ^{*L}	p^{0*}	p^{m*}	p^{t*}
AUSTRALIA	F(5,106)	2.30	0.99	0.91	1.00		0.23	0.62	0.74	3.49	0.69
CANADA	F(3,115)	2.68	1.88	3.96	1.14		0.35	0.64	0.97	1.19	0.62
CHINA	F(2,118)	3.07	0.40	0.17	0.08		0.84	1.11	0.56	0.20	1.17
EURO	F(2,116)	3.07	1.84	0.86	0.91		1.97	0.52	1.56	1.43	4.26
INDIA	F(2,117)	3.07	0.79	2.11	2.04		1.38	1.57	1.37	1.00	0.12
INDONESIA	F(3,107)	2.69	0.43	0.47	1.10		0.83	0.06	0.69	1.33	2.00
JAPAN	F(2,116)	3.07	0.85	1.17	1.35		0.04	0.92	1.09	0.96	2.39
KOREA	F(4,114)	2.45	0.99	0.74	2.46		1.33	0.91	1.68	0.66	0.29
MEXICO	F(3,117)	2.68	0.93	3.00	1.00		1.00	1.18	1.10	0.54	2.41
SWEDEN	F(2,116)	3.07	0.14	0.15	0.54		0.93	0.72	0.21	0.30	1.55
TURKEY	F(1,119)	3.92	1.59	0.72	0.08		0.01	3.62	1.46	0.40	0.05
UK	F(3,115)	2.68	1.55	2.32	0.43		1.54	2.85	0.54	0.27	2.63
USA	F(2,120)	3.07	0.54	6.97		0.08			0.56	3.21	2.43

III. Generalized Impulse Response Function Analysis

3.1 GVC basis trade matrix

We calculate the GVC basis trade matrix and compare it with the CC basis trade matrix. They are listed on the appendix as table 1 and 2 and summary results focusing on Korea, China, Japan and the US, are displayed in <Table 3>. Comparing the CC basis and GVC basis matrix itself can make us deepen our understanding the trade relationship among the countries.

<Table 3> Summary of CC basis trade matrix and GVC basis trade matrix

	Weight of Korea		Weight of China		Weight of Japan		Weight of US	
	CC	GVC	CC	GVC	CC	GVC	CC	GVC
Korea			0.315	0.355	0.107	0.175	0.212	0.167
China	0.052	0.134			0.126	0.191	0.346	0.248
Japan	0.068	0.105	0.310	0.347			0.280	0.216
US	0.043	0.039	0.160	0.206	0.086	0.080		

First, according to <Table 3>, the trade weight among Korea, China and Japan GVC basis is larger than CC basis. For example for Korea, the weight of China in Korea's trade is 0.315 by the CC basis, but according to the GVC basis, it rises to 0.355. The same phenomenon also holds for China. Korea's trade weight among China's trade is only 0.052 according to CC basis, but Korea's weight rises to 0.134 by the GVC basis.

Second, on the contrary the trade weight of the US that takes among Korea, China and Japan's trade becomes smaller when we use GVC basis. For example, the trade weight of the US among China's trade is 0.346 according to the CC basis, but it falls down to 0.248 if we use GVC basis.

These results can be interpreted in that Korea, China and Japan are more interconnected with each other in trade than they are measured by conventional trade statistic, but they are less connected with the US by trade than are shown outwardly.

To investigate the implications of three different external shocks, we make use of the Generalized Impulse Response Function (GIRF), proposed in Koop, Pesaran and Potter

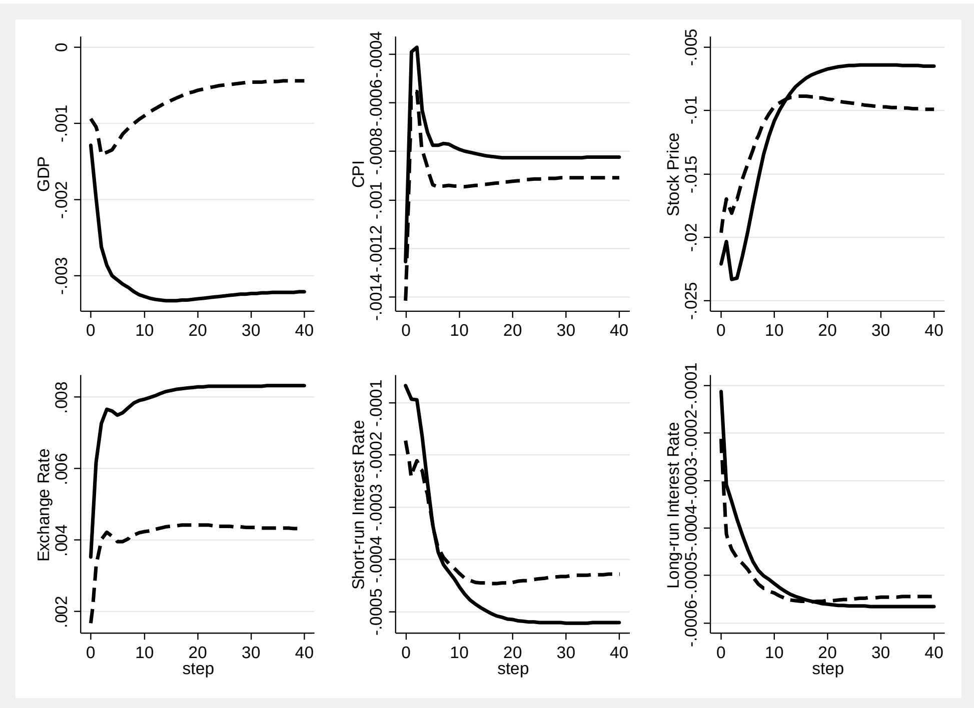
(1996). The GIRF was originally developed for non-linear models, and Pesaran and Shin (1998) extended its application for multivariate time series models. The GIRF is an alternative to the Orthogonalized Impulse Responses (OIR) of Sims (1980). The advantage of GIRF over OIR is that the GIRF is invariant to the ordering of the variables and the countries in the GVAR model, which is clearly an important merit compared to OIR. As we are interested in analyzing the time profile of the effect of major 3 shocks to Korean economy, we will focus on the GIRF of our constructed GVAR.

If we compare the differences in the GIRFs obtained by CC basis trade matrix and GVC basis trade matrix from <Figure 3> to <Figure 6>, the differences of GIRFs between using CC and basis and GVC basis trade matrix will become clearer.

For an example, looking at <Figure 3>, Korea's GIRF of GDP obtained by CC basis and GVC basis trade matrix show significantly different movement.

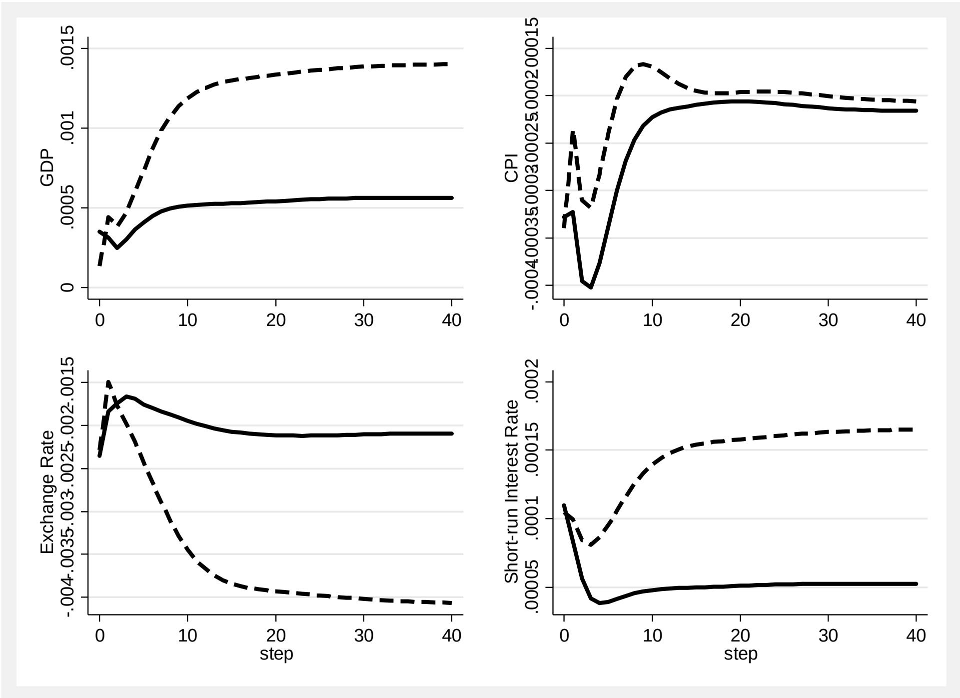
These results support our use of GVC basis trade matrix. Therefore these results leads us to describe the empirical results based obtained from GVC basis as below.

<Figure 3> GIRFs of yen shock obtained by CC basis vs GVC basis: Korea



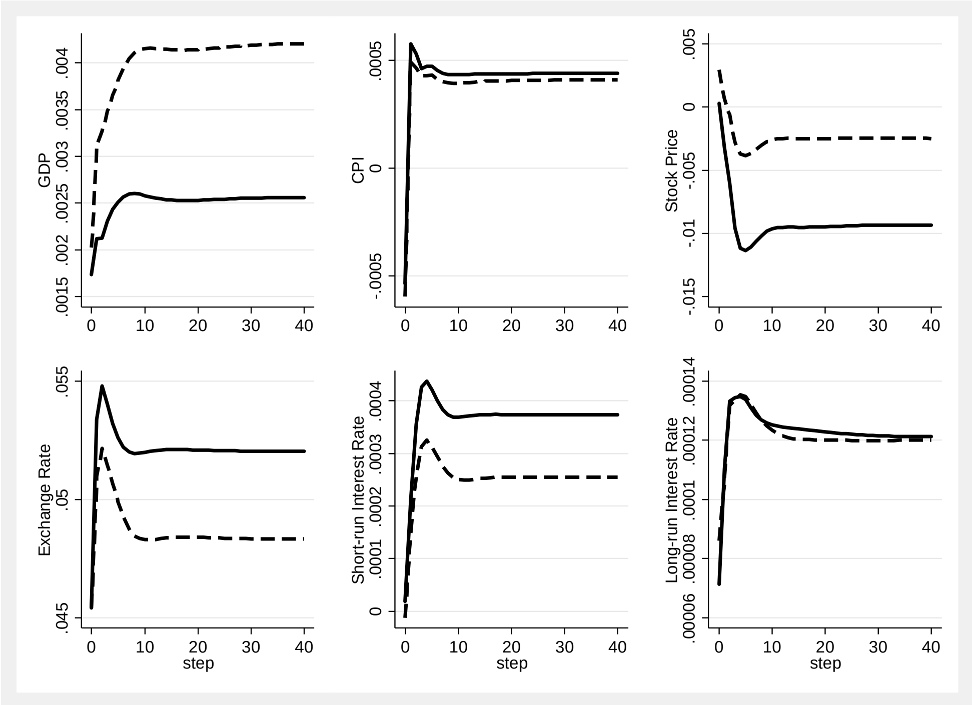
Note: _ _ _ _ denotes CC basis, —— denotes GVC basis

<Figure 4> GIRFs of yen shock obtained by CC basis vs GVC basis: China



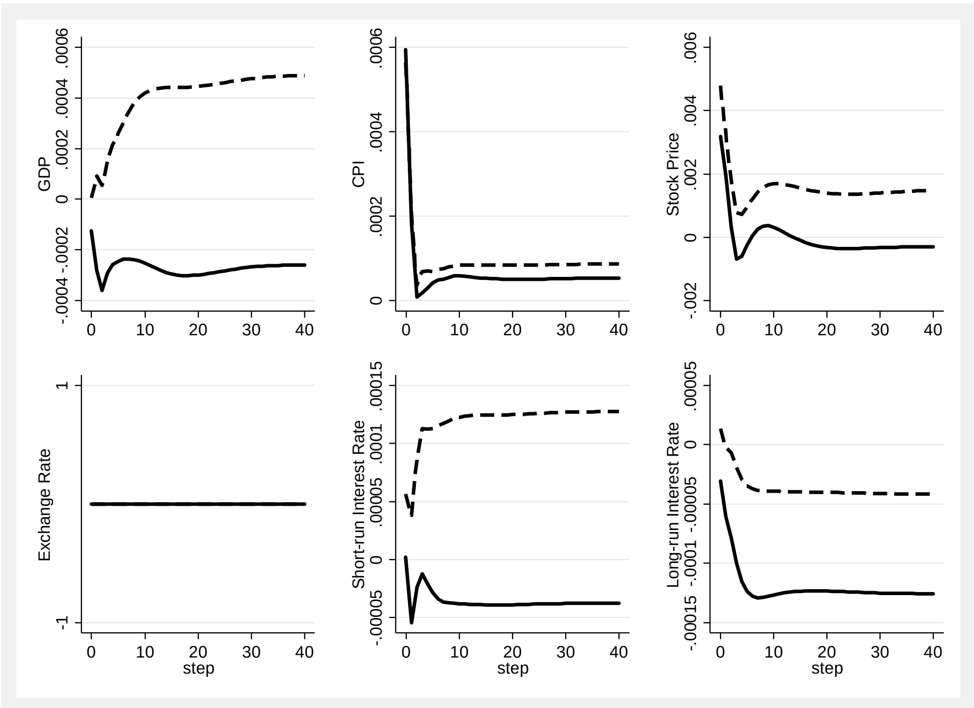
Note: _ _ _ _ denotes CC basis, —— denotes GVC basis

<Figure 5> GIRFs of yen shock obtained by CC basis vs GVC basis: Japan



Note: _ _ _ _ denotes CC basis, —— denotes GVC basis

<Figure 6> GIRFs of yen shock obtained by CC basis vs GVC basis: the US



Note: _ _ _ _ denotes CC basis, —— denotes GVC basis

3.2 Shock to Japan's Exchange Rate on GDP

The dynamics of cheaper yen shock to the world economy is shown from <Figure 7> to <Figure 10>. Shock is given in the form of one standard deviation of yen/dollar exchange rate devaluation to our built up GVAR system.

Looking at <Figure 7>, by the cheaper yen shock appears, Korea seems to be the most seriously affected country, while China and Australia as the beneficiary countries and the US as a little negatively affected and EURO as almost unaffected.

On impact, Korea's GIRF falls down most deeply than any other countries in the world. It seems to show the competitive relationships between Korea and Japan in the world final product market. That is, cheaper yen means cheaper Japanese products in the world market, which means the erosion of Koreas export market[3].

However, if we look at the case of China, the GDP of China shows a slight increase after a cheaper yen shock. Australia also seems to enjoy similar positive effects on GDP from cheaper yen shock.

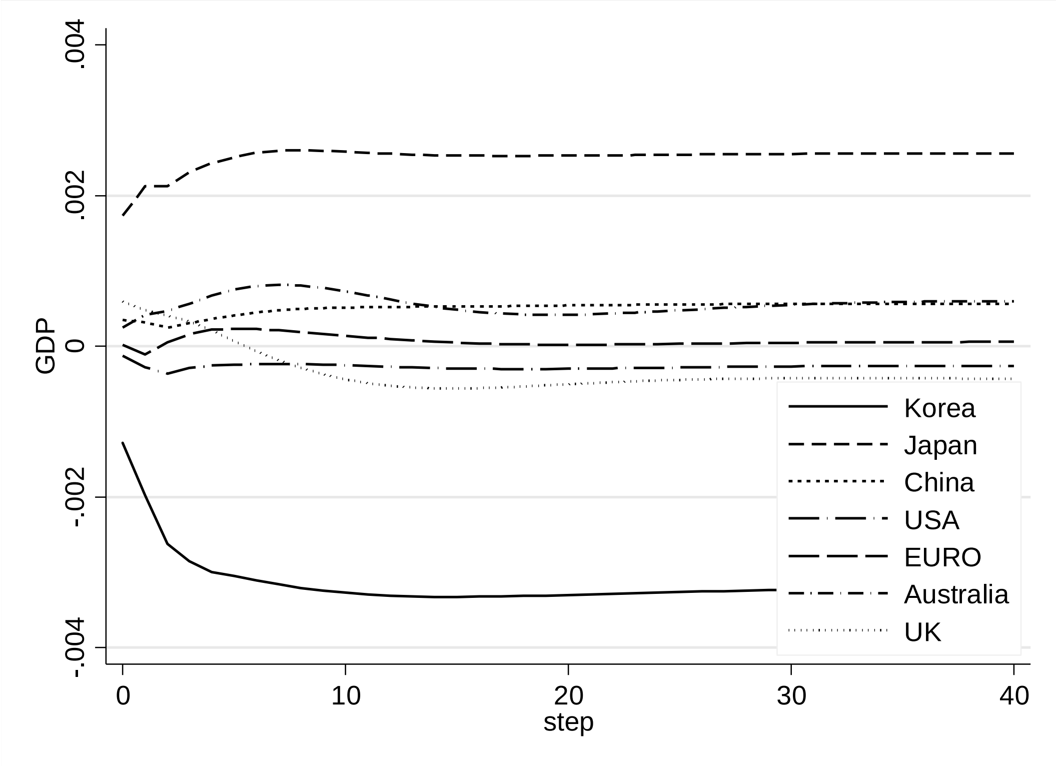
The slight increase of China's GDP by cheap yen can be interpreted in the global supply chain for producing final product. Compared with Korea, China has less competitive relationship with Japan in final product market, but has more complementary relationship with Japan in raw materials and intermediate input market. Through cheaper yen, China can enjoy cheaper imported input from Japan and get higher revenue from export of raw materials and intermediate products, which may yield to mild increase of China's income.

A slight increase of GDP in Australia also can be interpreted from the increase of revenue by exporting raw materials to Japan. The US and EURO seem to have a little negative effect on income.

However, as the impulse responses of these countries are centered around zero, these results need to be checked by bootstrapping.

<Figure 7> Shock to Japan's Exchange Rate on GDP

3. Korea has ESI (Export Similarity Index) around 0.5 with Japan. This figure means that in world market, almost 50% of Korea's export has the same 6 digit HS code, thereby competing with Japanese exports.



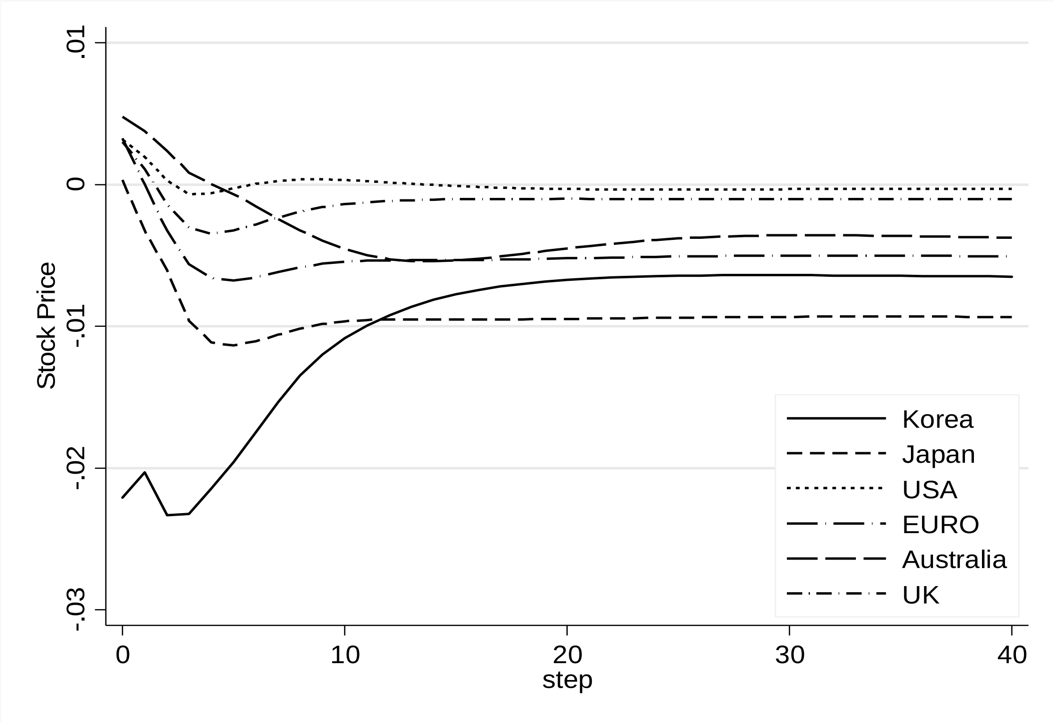
3.3 Shock to Japan's Exchange Rate on Stock Market

Looking at <Figure 8>, in the short run, cheap yen has a negative effect on world stock market, lowering the stock prices of most of the world countries except Japan, while it seems to have positive effect on Japanese stock price level.

Looking at the stock market from <Figure 8>, the cheaper yen shock to the other equity markets, including Korean, is rather quick and significant. However, on impact, Korea's equity market falls most deeply, but Korea's stock market appears to bounce back most quickly than any other countries in the world. In other worlds, cheaper yen has significant negative effect on Korea's stock market, however, accompanied by the most rapid recovery.

This result can be interpreted from the global investor's behaviour to avoid risk, who have regarded Korea's stock market as their cash vault in emerging markets which means that they can withdraw their investment from Korean stock market whenever they want to readjust their asset portfolio in emerging markets.

<Figure 8> Shock to Japan's Exchange Rate on Real Equity Prices

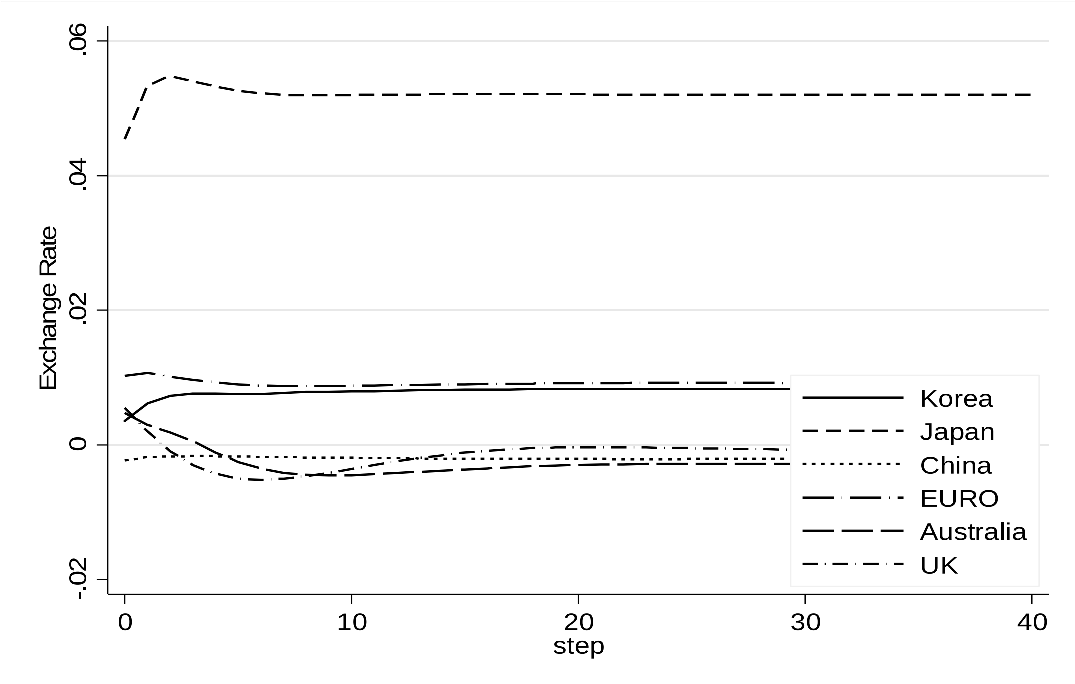


3.4 Shock to Japan's Exchange Rate on Exchange Rates

From <Figure 9>, as has been expected, cheaper yen appreciates Korean won in a significant magnitude. On the inflation and short terms interest rates, GIRF shows that cheaper yen doesn't have any significant effect on Korean economy.

Cheap yen also affects other countries' real exchange rates. Looking at <Figure 8>, cheap yen raises the value of Korean won and EURO, while exchange rates of other country, including Chinese yuan, seem to be unaffected.

<Figure 9> Shock to Japan's Exchange Rate on Real Exchange Rates



3.5 Bootstrap Estimates of the GIRFs on GDP

According to the GVAR impulse response analysis, the cheap yen turns out to have large effect on the GDP of world countries, especially for Korea. In this sense, cheap may have beggar thy neighbor effect. This result can be confirmed by the bootstrapping analysis of the GIRF analysis.

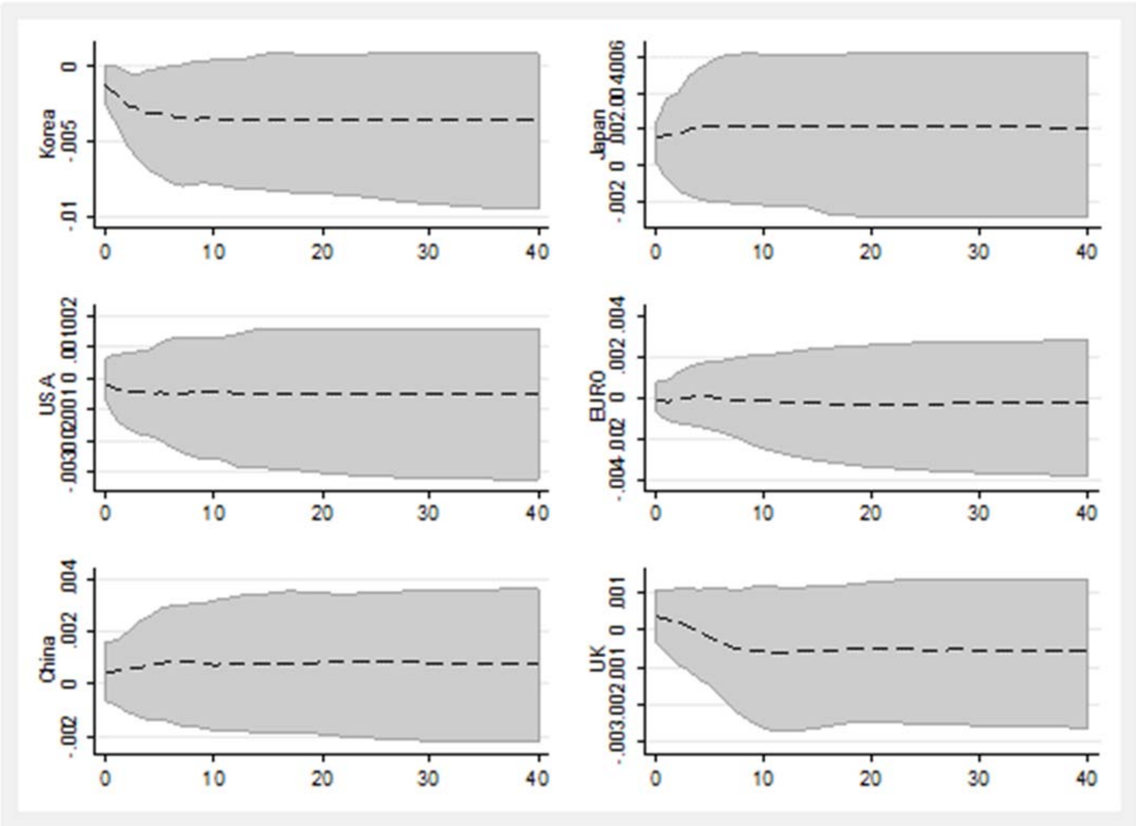
<Figure 10> shows the bootstrapping result of the GIRFs on GDP. According to the bootstrapping result, GIRF does not include zero even 95% confidence interval area, while other countries include zero within 95% confidence interval. Unlike other countries, only Korea's GIRF does not include zero with 95% confidence interval. This result reconfirms t that yen depreciation reduces Korea's GDP surely with 95% confidence level.

However, as the bootstrapping results of China, the US and Japan include zero within 95% confidence interval, the validity of the results may be limited.

This result can be interpreted in the context of the degree of competition in final product export market and intermediate goods market. For the case of Korea, Korea has high degree of completion in final product export market with Japan, while China has lower degree of competition in final product export market. By a comparative analysis of the industry-specific exchange rate between Japan and Korea, Shimizu and Sato(2015) also point out that the recent depreciation of the yen has improved export price competitiveness of the Japanese manufacturing sectors.

In addition, cheap yen has positive effects on raw material exporting countries like Australia on their income.

<Figure 10> Bootstrapping estimates of the GIRFs on GDP



IV. Conclusion

In this paper we try to analyze whether there exists beggar thy neighbor effect in Japan's cheap yen policy on world's 19 major countries by the GVC and GVAR approach.

Our empirical results show that beggar thy neighbor effect of cheap yen exists. The most benefited country is Japan and the most seriously damaged turns out to be Korea among the world's 19 major countries. The result that Korea is the most seriously damaged country is also confirmed by bootstrapping experiment. China is classified as the beneficiary, while the US as a little negatively affected and EURO as unaffected.

We try to interpret these results in the context of the degree of competition and compensation among the participant countries in the global supply chain for final product. The reason why Korea becomes the most serious damaged is explained by the high degree of competition between Korea and Japan in the world final product, where cheaper yen gives a critical competitive edge to Japanese product undermining Korea's final product export market.

In the same way, the reason why China receives some benefits from cheap yen is interpreted in its lower degree of competitiveness in final product market and higher degree of compensation in raw materials and intermediate product market with Japan.

The contribution of this paper is two things. First, this paper use GVR model in investigating the presence of beggar thy neighbor effect and second this paper use GVC approach in constructing GVAR model, which have not been used in previous literature on this issue before.

Finally, we hope this study could be a small reference in establishing exchange rate policies around the world countries.

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Appendix

<Table 1> Customs clearance (CC) basis trade matrix

Country	AUSTRALIA	CANADA	CHINA	EURO	INDIA	INDONESIA	JAPAN	KOREA	MEXICO	SWEDEN	TURKEY	UK	USA
AUSTRALIA	0	0.033	0.341	0.092	0.04	0.029	0.196	0.07	0.009	0.005	0.006	0.044	0.136
CANADA	0.012	0	0.076	0.092	0.016	0.005	0.043	0.012	0.027	0.006	0.004	0.043	0.664
CHINA	0.047	0.047	0	0.207	0.051	0.023	0.126	0.052	0.022	0.008	0.022	0.049	0.346
EURO	0.033	0.042	0.206	0	0.032	0.014	0.059	0.032	0.023	0.043	0.043	0.185	0.287
INDIA	0.032	0.042	0.099	0.244	0	0.023	0.05	0.015	0.011	0.015	0.026	0.086	0.356
INDONESIA	0.056	0.019	0.201	0.164	0.052	0	0.213	0.07	0.01	0.004	0.018	0.035	0.156
JAPAN	0.037	0.035	0.31	0.142	0.02	0.031	0	0.068	0.023	0.006	0.014	0.035	0.28
KOREA	0.028	0.029	0.315	0.17	0.022	0.027	0.107	0	0.025	0.008	0.025	0.032	0.212
MEXICO	0.01	0.069	0.043	0.095	0.008	0.003	0.021	0.007	0	0.003	0.004	0.015	0.722
SWEDEN	0.03	0.03	0.134	0.387	0.02	0.013	0.037	0.024	0.012	0	0.017	0.095	0.201
TURKEY	0.015	0.022	0.068	0.561	0.02	0.01	0.024	0.013	0.008	0.018	0	0.114	0.126
UK	0.03	0.05	0.08	0.447	0.021	0.006	0.034	0.017	0.011	0.023	0.023	0	0.257
USA	0.035	0.192	0.16	0.224	0.034	0.012	0.086	0.043	0.103	0.013	0.01	0.089	0

<Table 2> Global value chain (GVC) basis trade matrix

Country	AUSTRALIA	CANADA	CHINA	EURO	INDIA	INDONESIA	JAPAN	KOREA	MEXICO	SWEDEN	TURKEY	UK	USA
AUSTRALIA	0	0.01	0.321	0.111	0.056	0.033	0.201	0.087	0.008	0.009	0.003	0.047	0.113
CANADA	0.005	0	0.085	0.062	0.006	0.004	0.032	0.015	0.039	0.004	0.003	0.037	0.71
CHINA	0.058	0.025	0	0.211	0.039	0.029	0.191	0.134	0.016	0.008	0.01	0.033	0.248
EURO	0.019	0.022	0.216	0	0.039	0.012	0.062	0.033	0.019	0.076	0.056	0.241	0.205
INDIA	0.056	0.015	0.234	0.253	0	0.062	0.054	0.058	0.009	0.009	0.014	0.052	0.183
INDONESIA	0.05	0.012	0.215	0.111	0.079	0	0.242	0.122	0.005	0.005	0.009	0.015	0.134
JAPAN	0.072	0.023	0.347	0.123	0.017	0.05	0	0.105	0.015	0.005	0.003	0.024	0.216
KOREA	0.053	0.017	0.355	0.107	0.032	0.044	0.175	0	0.02	0.004	0.009	0.016	0.167
MEXICO	0.003	0.036	0.097	0.058	0.006	0.002	0.033	0.027	0	0.002	0.001	0.007	0.727
SWEDEN	0.013	0.01	0.066	0.648	0.014	0.004	0.021	0.013	0.005	0	0.017	0.111	0.078
TURKEY	0.007	0.011	0.133	0.527	0.031	0.012	0.026	0.035	0.004	0.021	0	0.081	0.112
UK	0.019	0.034	0.096	0.581	0.022	0.004	0.029	0.011	0.006	0.032	0.02	0	0.145
USA	0.014	0.234	0.206	0.161	0.022	0.011	0.08	0.039	0.174	0.007	0.007	0.045	0

<국문초록>

엔저의 근린 궁핍화 효과분석: GVAR 접근법

최두열
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<요약>

본 연구는 부가가치 무역(Global Value Chain)에 기반을 둔 GVAR모형에 의하여 엔저가 한국 등 19개 주요 국가들의 수출시장을 잠식함에 따라 주변국들의 소득을 감소시키는 근린 궁핍화 효과가 존재하는지 여부를 분석하고자 하였다. 추정결과 엔저는 근린궁핍화 효과를 가지고 있는데 가장 큰 피해 대상자는 한국으로 나타났으며 가장 큰 수혜 대상자는 일본으로 나타났다. 그 밖에 중국의 경우는 약간의 긍정적 영향을 받지 않는 것으로 나타났다. 그 이유는 한국과 일본은 최종재 시장에서 경합도가 높음에 따라 엔저에 의한 한국의 국제 시장 점유율 상실효과가 커서 소득 감소효과가 크게 나타나는 반면, 일본과 중국은 최종재 시장에서 경합도가 높지 않은 동시에 원자재 및 중간재 부분에 있어서 상호 보완관계를 이루고 있기 때문에 엔저로 인한 소득 증대 효과가 엔저로 인한 소득 감소효과를 상쇄하기 때문인 것으로 보인다.

주제어: Global Vector Autoregression (GVAR), Global Value Chain (GVC), 엔저, 엔화절하, 아베노믹스, 일반화된 충격 반응 함수, 근린 궁핍화 효과