Comovement of Won/Dollar Exchange Rates with Yen/Dollar Exchange Rates

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Abstract

The paper investigates how the degree of comovement between yen/dollar and won/dollar exchange rates has changed over time, by estimating a TVP-VAR model with stochastic volatility. According to the empirical results, a comovement phenomenon was consistently increasing between 1991 and 2002, while decreasing from 2005. It came alive from 2012. Comovement and Korean export changes have more negative correlations in a decoupling period than a coupling period. On the other hand, comovement and Korean import changes have more negative correlations in the coupling period than the decoupling period. It implies that if a recent comovement trend will be persisting in the near future, Korean trade balance can be improved further. However, these correlations vary depending on Korean trade partners and products.

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Keywords: comovement, TVP-VAR, correlation, decoupling, causality

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Ⅰ. Introduction

As the recent Japanese economy falls into prolonged recession and the Bank of Japan strongly carries out quantitative easing to overcome this difficult situation, yen/dollar exchange rates tend to be increasing consistently. It is well known from the past that the Korean main export products such as auto and electronic goods are in competition with those of Japan in terms of export prices. Therefore, as soon as yen value becomes depreciated, some Korean economists worry about decline in price competitiveness of Korean export products.

Figures 1, 2, and 3 show the movements of yen/dollar, won/dollar, and won/yen exchange rates, respectively. Yen/dollar exchange rates hit a low in October 2011 at 76.61 yen to the dollar and again rose persistently to 116.15 yen to the dollar in November 2014, as displayed in Figure 1. This trend was similar to that of the period between 1995 and 1998 in which a weak yen phenomenon was persistently appeared after reversal of a high yen phenomenon. In particular, since Korea experienced the currency crisis and got bailout from IMF in November 1997, Korean fear about a weak yen phenomenon could not be merely considered as excessive stress. According to the traditional currency crisis theory, as expansionary fiscal and monetary policies aggravate current account and then exhaust foreign exchange reserves, a speculative attack suddenly occurs and currency value depreciates sharply. In case of Korea, current account deficit amounted to 20 billion dollars which were greatly bigger than expected originally in 1996 and several major Korean companies became bankrupt because of depression in 1997. As the currency crisis theory suggested, this situation generated a speculative attack in Korea and won/dollar exchange rates skyrocketed. However, even if yen value decreased sharply in 2014, Korea achieved one trillion dollar trade, maximum export, and maximum surplus for two years in a row. In light of this, decline in yen value is less serious for Korea than some Korean economists worry. But, it must be examined in various aspects. First of all, yen value can be depreciated further in the future. On the other hand, it was remarkable that KOPSI and won value dropped sharply in those days of the 2008 global financial crisis, although yen value was in ascending process and Korean current account was in surplus. In addition, the Fed lowered the federal funds rate after early 1995, while is now expected to raise it after mid-2015. A low oil price in 1990s helped Korea to overcome the 1997 currency crisis. However, the low oil price of late years seems to be less contributing to Korean economic growth owing to reorganization of Korean industrial structure and so on.

In regards to recent rising of yen/dollar exchange rates, one of the current issues that attract our

concern is the fact that won/dollar exchange rates are changed to an upward trend in spite of Korean trade surplus. Won /dollar exchange rates also increased as soon as yen/dollar exchange rates went up after the mid-1990s. Especially, as shown in Figure 3, won/yen exchange rates approximately maintained the odds of 10 to 1 during the period from the early 2000s to the end of 2004 by the Korean comovement policy. But yen/dollar exchange rates increased from 2005, since Japanese economy did not escape from prolonged recession, while won/dollar exchange rates decreased because of current account surplus and inflow of foreign capital in Korea. Accordingly, won/dollar exchange rates decoupled from yen/dollar exchange rates. But, as the global financial crisis occurred, movements of yen/dollar and won dollar exchange rates were reversed and a decoupling phenomenon became more severe. As yen/dollar exchange rates soar sharply because of Japanese quantitative easing in recent years, won/dollar exchange rates tend to be rising following yen/dollar exchange rates.

This study tries to systematically analyze a comovement phenomenon of yen/dollar and won/dollar exchange rates by estimating a time-varying parameter (TVP) VAR model with stochastic volatility. It investigates to what extent a contemporaneous cause-and-effect relationship between yen/dollar and won/dollar exchange rates are changed with the course of time and how far won/dollar exchange rates dynamically respond to shocks to yen/dollar exchange rates at each point in time. As domestic and foreign stock prices largely influenced won/dollar exchange rates after complete opening of Korean stock market in 1998, Dow Jones index is used as a control variable in the paper. In addition, it also compares how correlations between estimates of comovement parameters and exports or imports are different depending on Korean trade partners or products during coupling and decoupling periods, respectively.

The empirical results show that comovement has been continuously rising between 1991 and 2002, while falling from 2005. It reappeared from 2012. Comovement changes have bigger negative correlations with export changes in a decoupling period than a coupling period. In correlations between comovement and import changes, the reverse is the case. So, if a recent comovement trend is persisting in the near future, total Korean trade surplus can be improved more. On the other hand, correlations between these variables vary depending on trade partners and products.

The subsequent sections of the paper are organized as follows. Section Ⅱ reviews references for both TVP VAR models and comovement of financial variables. Section Ⅲ explains the estimation method of a TVP VAR model with stochastic volatility. Section Ⅳ estimates the timing-varying parameters which measure the degree of comovement between yen/dollar and won/dollar

exchange rates and then analyzes impulse responses at each point in time. In Section Ⅴ, it investigates to what extent correlations of their comovement coefficients with Korean exports or imports depending on its trade partners and products are different between coupling and decoupling periods. Section Ⅵ summarizes and concludes the paper.

Ⅱ. Literature Reviews

This section simply reviews the research literature which is concerned with TVP-VAR models and comovement of financial markets. Since Cogley and Sargent (2001, 2005) and Primiceri (2005) analyzed the U.S. monetary policy using TVP-VAR models, a lot of research on macroeconomics and financial fields investigated a time-varying economic phenomenon following them. Cogley and Sargent (2001) estimated a three variable model with time-varying parameters under the assumption that variance was constant. Cogley and Sargent (2005) extended it to a model with stochastic volatility. Cogley and Sargent (2005) assumed that the parameters representing contemporaneous causality were constant, whereas Primiceri (2005) analyzed the case in which all parameters were time-varying. As similar research papers, there are Benati (2008), Benati and Surico (2008), Canova and Gambetti (2009), Clark and Terry (2010), Nakajima (2011), Nakajima, Kasuya, and Watanabe (2011), and Prieto, Eickmeier, and Marcellino (2013). Because fundamental economic structure and volatility of macroeconomic shock had a time-varying characteristic, these studies showed that TVP-VAR models with stochastic volatility were superior to the other models in which their parameters were constant. Korobilis (2009) and Baumeister, Liu, and Mumtaz (2010) extended these models to TVP-FAVAR (factor-augmented VAR).

Studies on comovement chiefly focused on international financial markets and especially analyzed comovement among countries in stock markets. One of interesting points was that they didn't explicitly define comovement, even though they included it in the title (e.g. see Barberis, Shleifer, and Wurgler, 2005; Forbes and Rigobon, 2002; Baele, Bekaert, and Inghelbrecht, 2010). Besides, they employed various estimation methods to measure it. Wiktionary defines comovement as the correlated or similar movement of two or more entities and many papers in this field generally measure it with correlation coefficients. But heteroskedasticity or nonlinear relationships can produce biased estimates of correlation coefficients (e.g. see Loretan and English, 2000; Poon,

Rockinger, and Tawn, 2004). In recent years, multivariate GARCH-type models were used to estimate correlation coefficients dynamically. In addition to correlation coefficients, nonparametric estimation methods such as "concordance" (Harding and Pagan, 1999), "cohesion" (Croux, Forni, and Reichlin, 2001), and "co-exceedances" (Bae, Karolyi, and Stulz, 2003) were also employed to measure comovement of financial variables.

By contrast with stock markets, we could not find many studies on comovement in foreign exchange markets in case of developed countries. Exceptional cases were Bollerslev (1990) and Engle (2002). On the other hand, there existed relatively a lot of research written in Korean on this field, as won/dollar exchange rates were known to be much influenced by yen/dollar exchange rates. But, these studies were confined in estimating correlation coefficients, VAR-GARCH models with constant mean parameters, and simple models with time-varying parameters because of difficulties in estimation. Correlation coefficients are estimated in a bivariate context and correlations don't imply causality. As already well known, yen/dollar exchange rates cause won/dollar exchange rates in the Granger causality test, while the reverse is not the case. Furthermore, causal relations are dynamically changed at each point in time. Therefore, this study analyzes how far won/dollar exchange rates have directly or wholly contemporaneous cause-and-effect relationships with yen/dollar exchange rates, and how much the former is dynamically influenced by the latter by estimating a multivariate TVP-VAR model which is not used until now in this field. It also examines how much the coefficients which stand for the degree of comovement are correlated with Korean exports or imports in its main trade products and between Korea and its major trade partners.

Ⅲ. Estimation Model and Method

1. Estimation Model

The paper considers the following reduced-form model.

$$y_t = c_t + \mathrm{B}_{1,t} y_{t-1} + \cdots + \mathrm{B}_{p,t} y_{t-p} + u_t \equiv X_t' \theta_t + u_t \qquad (1)$$

where y_t is a 3×1 vector of observed endogenous variables. Dow Jones index returns, yen/dollar exchange rate changes, and won/dollar exchange rate changes are used in a basic model. The parameter c_t is a 3×1 vector of time-varying coefficients that multiply constant terms and $B_{i,t}$ (i=1, 2,⋯, p) are 3×3 matrices of time-varying coefficients. In $X_t^{'} = I_3 \otimes [1, y_{t-1}^{'}, \cdots y_{t-p}^{'}]$, $\otimes$ denotes the Kronecker product and θ_t represents a vector of all coefficients. u_t are the VAR's reduced-form innovations with zero mean and time-varying covariance matrix Σ_t. Like in Primiceri (2005), covariance matrix Σ_t is expressed as follows.

$$\Sigma_t = A_t^{-1} H_t (A_t^{-1})' \tag{2}$$

where A_t is the lower triangular matrix which represents contemporaneous relations between cause and effect in structural VAR models and H_t is the diagonal matrix. The time-varying matrices A_t and H_t are defined as follows.

$$A_t = \begin{bmatrix} 1 & 0 & 0 \\ \alpha_{21,t} & 1 & 0 \\ \alpha_{31,t} & \alpha_{32,t} & 1 \end{bmatrix}, \quad H_t = \begin{bmatrix} h_{1,t} & 0 & 0 \\ 0 & h_{2,t} & 0 \\ 0 & 0 & h_{3,t} \end{bmatrix} \tag{3}$$

Based on these equations, equation (1) is expressed as follows.

$$y_t = X_t^{'}\theta_t + A_t^{-1} H_t^{1/2} \varepsilon_t, \quad Var(\varepsilon_t) = I_3 \tag{4}$$

As in Primiceri (2005), it is assumed that the time-varying parameters θ_t, α_t, and h_t follow a random walk without drift.

$$\theta_t = \theta_{t-1} + \eta_t \tag{5}$$

$$\alpha_t = \alpha_{t-1} + \xi_t \tag{6}$$

$$h_t = h_{t-1} + \tau_t \tag{7}$$

where η_t, ξ_t, and τ_t are white Gaussian noises with zero mean and covariance matrix Q, S, and W, respectively. Vectors of innovations [ε_t', η_t', ξ_t', τ_t']' are also assumed to follow a joint normal distribution with zero mean and the following covariance matrix.

$$V = Var\left(\begin{bmatrix}\varepsilon_t\\ \eta_t\\ \xi_t\\ \tau_t\end{bmatrix}\right) = \begin{bmatrix}I_3 & 0 & 0 & 0\\ 0 & Q & 0 & 0\\ 0 & 0 & S & 0\\ 0 & 0 & 0 & W\end{bmatrix} \tag{8}$$

2. Model Estimation

The model which is composed of eight equations from (1) to (8) is estimated, by using a Gibbs sampling algorithm, a variant of Markov chain Monte Carlo (MCMC). The priors for the initial states of reduced-form VAR coefficients B, simultaneous relations A, and log Volatility H are assumed to be normally distributed. It is assumed that the priors for the hyperparameters Q, S, and W are distributed as independent inverse Wishart. In order to specify the prior distributions, OLS estimates of a time invariant VAR model are derived, using a pre-sample of 60 observations during 5 years before 1990, the starting year of analysis period. Gibbs sampling is carried out stage by stage to draw B, A, H, and hyperparameters (Q, S, W) in order. 20,000 Gibbs sampling replications are employed, discarding the first 19,500 as burn-in.

Ⅳ. Estimation Results

This study uses the monthly average data of Dow Jones index, yen/dollar exchange rates, and won/dollar exchange rates. The sample period is from January 1990 to November 2014 and the sample size is 299. Each of these data has a unit root, but is not typically cointegrated with the explanatory variables. The paper therefore uses percentage changes which are multiplied by 100 after log difference of these data. Table 1 lists the mean and the standard deviation of percentage changes of three variables. As the currency and global financial crises occurred over the sample period (1990.02-2014.11) and hence regime switching possibility could exist, it is divided into the

five sub-periods on the basis of these two crisis periods-the pre-currency crisis period (1990.02-1997.10), the currency crisis period (1997.11-1998.12), the period from the post-currency crisis to the pre-global financial crisis (1999.01-2007.08), the global financial crisis period (2007.09-2009.06), and the post-global financial crisis period (2008.07-2014.11).[1]

The monthly average return of Dow Jones index is 0.632% for the whole analysis period (1990.02-2014.11) and has positive values in the other four sub-periods except the global financial crisis period. Because of the Fed's quantitative easing policy, it also rose even after the global financial crisis as much as the 1990s which was called "the new economy" period. The monthly average change of yen/dollar exchange rates has negative values for all periods except the global financial crisis period. Particularly, yen value rose the most during the global financial period. On the other hand, the monthly average change of won/dollar exchange rates has a positive value for the whole period. Won value was inclined to decrease for the 1990s, while increase for the 2000s except the global financial crisis period. Won/dollar exchange rates and Dow Jones index also tended to move in the same direction for the 1990s, while in the opposite direction for the 2000s. Movements of won/dollar and yen/dollar exchange rates were not stable throughout the period considered.

In case of standard deviation, its size also varies depending on the specific period. The standard deviation of Dow Jones index returns is the biggest in the global financial crisis period, whereas those of yen/dollar and won/dollar exchange rates are the largest in the currency crisis period. The standard deviation of won/dollar exchange rates is greater than that of yen/dollar exchange rates over the whole period and the two crisis periods.

As mentioned above, because the mean and the standard deviation of these variables are time-varying and have a characteristic of regime switching, this study analyzes comovement between yen/dollar and won/dollar exchange rates with a TVP-VAR model with stochastic volatility rather than time invariant VAR models.

1. Comovement Coefficients

This study estimates the TVP-VAR model with stochastic volatility which has three variables

[1] As the Fed began to sharply lower the federal funds rate from September 2007 in order to stabilize the U.S. subprime mortgage turmoil, this study considered it as the starting point of the global financial crisis.

and two time lags chosen according to AIC and AICc. First of all, as its main concern is to analyze how much won/dollar exchange rates comove together with yen/dollar exchange rates, it investigates the estimates of $\alpha_{32,t}$ among A_t elements in equation (3). Because an equation for won/dollar exchange rates is expressed as $y_{3,t} = -\alpha_{31,t}y_{1,t} - \alpha_{32,t}y_{2,t} + \cdots$ in the structural VAR model, Figure 4 shows the estimates of $-\alpha_{32,t}$, a comovement coefficient of won/dollar exchange rates with yen/dollar exchange rates. It displays how many percentage points won/dollar exchange rates directly increase in the contemporaneous period when yen/dollar exchange rates rise by one percentage point. The solid line in Figure 4 represents the median of 500 estimates obtained by simulation. The dotted lines located above and below in solid line show both 16th and 84th percentiles. The median estimates of a comovement coefficient $-\alpha_{32,t}$ started at 0.078 in April 1990, went down below zero in February 1991, and arrived at a low of -0.056 in October 1991. Annual goods and current balances had surpluses during the period between 1986 and 1989, but turned to deficits from 1990. As monthly goods and current balances totally had deficits from 1991, the median estimates of $-\alpha_{32,t}$ started to rise from November 1991. Since then, a comovement of won/dollar exchange rates with yen/dollar exchange rates was persistently rising and the median estimate of $-\alpha_{32,t}$ reached its peak of 0.480 in August 2002. It temporally dropped down to 0.395 in November 2003, while again rose to 0.437 in November 2004. After that time, it began to consistently go down. The period from the early 2000s to November 2004 was the period in which won/yen exchange rates maintained a ratio of about 10 won to 1 yen. As Japan didn't get out of the economic recession, yen/dollar exchange rates rose from 2005. On the other hand, as an inflow of foreign capital and a current balance surplus continuously maintained in Korea, won/dollar exchange rates began to decrease. Consequently, the median estimates of $-\alpha_{32,t}$ also went down. However, during the global financial crisis period, yen/dollar exchange rates went down, while won/dollar exchange rates went up because of an outflow of foreign capital in Korea. The median estimates of comovement coefficients $-\alpha_{32,t}$ went down further. But, as Japan strongly carried out the economic policy with a weak yen, yen/dollar exchange rates started to again rise from a low of 76.61 yen to dollar in October 2011. The median estimates also rose from a staggered low of 0.032 in November 2012. Accordingly, won/dollar exchange rates and the median estimates of $-\alpha_{32,t}$ were rising until November 2014.[2]

[2] Figure A1 in Appendix shows the median estimates of $-\alpha_{31,t}$ which indicate contemporaneous

The whole sample period can be divided into a coupling period (1991.10-2002.08), a decoupling period (2004.11-2012.11), and a re-coupling period (2012.12-2014.11), as shown in Figure 4.

2. Impulse Response

Next, the paper examines how won/dollar exchange rates respond to structural shocks to yen/dollar exchange rates. The impulse response functions at each point in time are expressed as the following difference between two conditional expectations.

$$IRF_t = E(y_{t+k}|\Psi_t, y_{t-1}, \mu) - E(y_{t+k}|\Psi_t, y_{t-1}) \quad (9)$$

where Ψ_t indicates all the parameters and hyperparameters of a VAR model. k and μ respectively imply a forecasting period and a structural shock. The first term in equation (9) represents k step ahead predictive values of endogenous variables under the condition that each structural shock occurs. The second term implies the predictive values when a structural shock is equal to zero.

Figure 5 shows time varying cumulative responses of won/dollar exchange rate changes to the one standard deviation shock of yen/dollar exchange rate changes in three dimensional space. The y axis describes the 296 periods from April 1990 to November 2014 and the x axis depicts the forecasting periods of k=24. The z axis represents the cumulative impulse responses of won/dollar exchange rate changes over the 24 months at each point in time t. Figure 6 shows the cases of k=0 and k=24 which are extracted from the cumulative impulse responses in Figure 5 in order to avoid complexity. Figure 4 shows only contemporaneous and direct cause-and-effect relationships, whereas the case of k=0 in Figure 6 includes indirect causality as well as direct causality at the same time. It is represented as the median estimate of $-\alpha_{32,t}$ multiplied by its standard deviation, because yen/dollar exchange rates are located next to yen/dollar exchange rates in order of

cause-and-effect relationships between Dow Jones Index and won/dollar exchange rates. They had positive values in the early 1990s, but negative values after that time. Their negative causality became bigger until the post-global financial crisis period and reached a low in March 2010. Since then, it again became weaker. Even in case of using KOSPI instead of Dow Jones Index, the movement of comovement coefficient estimates indicating contemporaneous cause-and-effect relationships between yen/dollar and won/dollar exchange rates is similar. Figure A2 in Appendix shows the estimation results in case of using three variables in order of yen/dollar exchange rates, KOSPI, and won/dollar exchange rates.

variables.

Figure 7 describes the averages of time-varying impulse responses in each of the five sub-periods into which the whole period is divided on the basis of the currency and global financial crises. That is, it shows the average of impulse responses at each point in time over the whole period (1990.04-2014.11), the pre-currency crisis period (1990.04-1997.10), the currency crisis period (1997.11-1998.12), the period from the post-currency crisis to the pre-global financial crisis (1999.01-2007.08), the global financial crisis period (2007.09-2009.06), and the post-global financial crisis period (2009.07-2014.11). In Figure 7, the solid line implies the average of median estimates and the dotted lines indicate the averages of 16^{th} percentile and 84^{th} percentile estimates. Figure 8 displays only the averages of median estimates over the five sub-periods in order to compare a relative size. The response of won/dollar exchange rate changes to one standard deviation shock of yen/dollar exchange rate changes is the biggest during the period from the post-currency crisis to the pre-global financial crisis, while the smallest during the post-global financial period. As already mentioned before, the post-global financial crisis period includes both decoupling and coupling periods. Therefore, it is not right to mention that comovement between won/dollar and yen/dollar exchange rates is absolutely weak over the post-global financial crisis period.

Ⅴ. Correlation Analysis

This section examines correlations between comovement and exports or imports. In this study, a comovement coefficient $-\alpha_{32,t}$ represents a contemporaneous and direct cause-and-effect relationship and is equal to responses of won/dollar exchange rate changes to one-unit shocks of yen/dollar exchange rate changes at time 0. As impulse responses are rising over time except a very short period in which they are negative, this study investigates correlations between the median estimates of $-\alpha_{32,t}$ and exports or imports.

1. Correlations between Comovement and Exchange Rates

Table 2 shows correlations between the median estimate changes of $-\alpha_{32,t}$ and foreign exchange rate changes. The correlation coefficients of the median estimate changes of $-\alpha_{32,t}$ with

won/dollar, yen/dollar, and won/yen exchange rate changes are 0.014, 0.124, and -0.074 respectively over the whole period. Yen/dollar exchange rate changes have the highest positive correlation with the median estimate changes of $-\alpha_{32,t}$. Because $-\alpha_{32,t}$ is an indicator to show how much contemporaneous won/dollar exchange rates vary when yen/dollar exchange rates rises by one percentage point, their correlation coefficients have positive values from the viewpoint of Korean export price competitiveness. On the other hand, as Korean export price competitiveness against Japan goes down when won/yen exchange rates fall, the median estimate changes of $-\alpha_{32,t}$ have negative correlations with won/yen exchange rate changes. But signs as well as sizes of correlation coefficients are not constant for the five sub-periods into which the whole period is divided on the basis of the currency and global financial crises. Absolute values of correlation coefficients in the post-global financial crisis period are a little greater than those in the whole period. Monthly yen/dollar exchange rates rose by 0.283 % during this period on average, as shown in Table 1. But Figure 1 shows that yen/dollar exchange rates have fallen at first, but risen afterwards. Hence, the median estimates of $-\alpha_{32,t}$ also moved in the same direction.

When the sample period is divided into a coupling period (1991.10-2002.08) and a decoupling period (2004.11-2012.11), as Figure 4 and Table 2 display, a correlation coefficient between median estimate changes of $-\alpha_{32,t}$ and yen/dollar exchange rate changes is 0.116 during the former period, but -0.040 during the latter period. Up and Down in Table 2 indicate the coupling and decoupling periods, respectively. Yen/dollar, won/dollar, and won/yen exchange rate changes are -0.093%, 0.368%, and 0.461% during the coupling period, while -0.307%, -0.051%, and 0256% during the decoupling period, respectively. The average of median estimates of $-\alpha_{32,t}$ during the period from January 1999 to August 2007 is 0.384 and the biggest among the five sub-periods. Figure 3 indicates that won/yen exchange rates have maintained about the ratio of 10 won to 1 yen until December 2004 and after that time fallen. The average of median estimates of $-\alpha_{32,t}$ during the period from January 1999 to December 2004 rose to 0.402. Yen/dollar, won/dollar, and won/yen exchange rate changes during this period are -0.105%, -0.084%, and 0.021%, respectively.

2. Correlations between Comovement and Exports-Imports

Table 3 shows correlations between the median estimate changes of $-\alpha_{32,t}$ and export or import changes between Korea and its major trade countries. Contrary to expectations, correlations

between the median estimate changes of $-\alpha_{32,t}$ and export changes have negative values over the whole period. These results come from the fact that won/dollar exchange rate and export changes have negative correlations over the whole period. In case of import changes, the result is similar. These negative correlations were particularly bigger during the currency crisis and global financial crisis periods among the five sub-periods. In case of export changes, a correlation coefficient during the post-global financial crisis period is -0.152. Its absolute value becomes bigger, compared to the other normal periods, because this period includes a decoupling period. When the whole period is divided into the coupling and decoupling periods in order to take a close look at this, a correlation coefficient in case of export changes is -0.061 and -0.223 in the coupling and decoupling periods, respectively. It implies that a decreasing rate of exports during the coupling period is smaller than that during the decoupling period. This result is confirmed from the fact that a correlation coefficient between won/dollar and yen/dollar exchange rate changes over the coupling period is bigger than that over the decoupling period (0.244>-0.119) and their correlations with the median estimate changes of $-\alpha_{32,t}$ are bigger during the coupling period, as already shown in Table 2. A correlation coefficient between the median estimate changes of $-\alpha_{32,t}$ and import changes is -0.098 and -0.056 in the coupling and decoupling periods, respectively. Imports decrease during the coupling period more than the decoupling period. Therefore, if comovement will persistently increase in the future, Korean goods balance will be improved further. Its pattern in cases of Korean exports to China and the U.S. is similar to that in case of total exports. But in case of Korean exports to Japan, it is different. Its pattern in cases of imports from China and Japan is similar to that in case of total imports, but different from that in case of Korean imports from the U.S.

Tables 4 and 5 show correlations between the median estimate changes of $-\alpha_{32,t}$ and export or import changes in the best 10 Korean export goods which are chosen among the 2-digit HSK codes.[3] Their patterns in case of total exports or imports in the best 10 Korean export goods are similar to those in Table 3. A correlation between $-\alpha_{32,t}$ estimate changes and total export changes has a bigger negative value in the decoupling period more than the coupling period. The results are similar in cases of 8 products except plastics and articles of iron or steel. On the contrary, a correlation between $-\alpha_{32,t}$ estimate changes and total import changes has a bigger negative

[3] As comovement can have its impact on future's exports or imports because of time lag, the paper also examines the correlations between comovement coefficients and monthly average exports or imports during the period from present to 3, 6, and 12 months ahead. But significant correlations between these variables could not be found any more.

value in the coupling period more than the decoupling period. The result is similar in cases of mineral fuels, optical machinery, plastics, organic chemicals, iron and steel, and articles of iron or steel. But it is different in cases of electrical machinery, vehicles, machinery and computer, and ships which are the first, second, third, and fifth Korean exports in order. For example, in case of electrical machinery, its correlation coefficient is 0.135 and 0.029 during the coupling and decoupling periods, respectively. Both of their correlation coefficients have positive values which are different from those in the other import items. In case of electrical machinery, a correlation coefficient between won/dollar exchange rate changes and import changes is -0.065 and -0.213 during the coupling and decoupling periods, respectively. It implies that its imports decrease during the decoupling period more than the coupling period when won/dollar exchange rates rise. The reverse is the case in the other products. In summary, their correlations don't have same patterns with those of total exports or imports, as is the case in correlations between comovement and Korean trade with its major trade countries.

Ⅵ. Conclusions

This study analyzes the degree of comovement between yen/dollar and won/dollar exchange rates using monthly Dow Jones index, yen/dollar exchange rate, and won/dollar exchange rate data over the period from January 1990 to November 2014. It investigates how far contemporaneous causality between yen/dollar and won/dollar exchange rates has varied over time and a shock to yen/dollar exchange rates has dynamically influenced won/dollar exchange rates at each point in time, by estimating a TVP-VAR model with stochastic volatility. It also compares to what extent median estimates of comovement coefficients are closely correlated with exports or imports between Korea and its main trade countries or in the best 10 Korean exports selected among 2-digit HSK codes over coupling and decoupling periods.

A median estimate of $-\alpha_{32,t}$ indicating contemporaneous causality began to rise from November 1991, as soon as goods and current balances recorded deficit and reached its peak of about 0.480 in August 2002. After that time, it temporarily dropped and rose, but consistently started to go down again from November 2004. As Japan strongly carries out a weak yen policy, it is rising from November 2001 until a recent date.

The paper also divides the whole sample period into five sub-periods on the basis of the

currency and global financial crisis periods and then examines an average of impulse response functions at each sub-period. According to the empirical results, responses of won/dollar exchange rate changes to one standard deviation shock of yen/dollar exchange rate changes are the biggest during the period from the post-currency crisis to the pre-global financial crisis (1999.01-2007.08). It was well known that Korea implicitly carried out a exchange rate policy which maintained a ratio of 10 won to 1 yen. On the other hand, responses of won/dollar exchange rate changes to a shock of yen/dollar exchange rate changes are the smallest during the post-global financial crisis period (2009.07-2014.11). This period includes both decoupling and coupling periods together. Therefore, it is not reasonable to suggest that comovement of won/dollar exchange rates with yen/dollar exchange rates is constantly weak over this period.

A correlation coefficient between estimate changes of comovement coefficients and yen/dollar exchange rate changes is 0.116 during a coupling period, while -0.040 during a decoupling period. Increasing rates of comovement and exports have the bigger negative correlation during the decoupling period than the coupling period. But, in case of increasing rates of comovement and imports, the reverse is true. Accordingly, as far as a comovement trend maintains henceforth, Korean goods balance can be improved further.

Correlations between comovement coefficients and exports-imports between Korea and its main trade partners or in the best 10 Korean exports chosen among 2-digit HSK codes don’t have same patterns with case of total exports-imports and differs depending on what trade partners and products are. These results come from the fact that correlations between exchange rates such as yen/dollar and won/dollar and exports-imports differ with periods, trade partners, and products.

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Table 1. Mean and Standard Deviation of Percentage Changes (%)

		1990.02-2014.11	1990.02-1997.10	1997.11-1998.12	1999.01-2007.08	2007.09-2009.06	2009.07-2014.11
Mean	Dow Jones	0.632**	1.158**	0.975**	0.368	-1.965	1.107**
	Yen/Dollar	-0.075	-0.195	-0.227	-0.004	-0.861	0.283
	Won/Dollar	0.159	0.327**	1.918	-0.249	1.365	-0.216
Standard Deviation	Dow Jones	3.495	2.785	4.789	3.354	6.074	2.752
	Yen/Dollar	2.704	2.920	4.586	2.262	3.170	2.346
	Won/Dollar	3.238	0.714	12.094	1.801	4.916	1.853

Notes: 1) ** denotes significant at the 1% level.

Table 2. Correlation Coefficients between Comovement and Exchange Rates

	1990.02-2014.11	1990.02-1997.10	1997.11-1998.12	1999.01-2007.08	2007.09-2009.06	2009.07-2014.11	Up	Down
Won/Dollar	0.014	-0.085	0.071	0.045	-0.030	0.027	0.016	-0.020
Yen/Dollar	0.124*	0.272**	0.396+	-0.080	-0.052	0.139	0.116	-0.040
Won/Yen	-0.074	-0.371**	-0.081	0.131	0.003	-0.096	-0.063	0.010

Notes: 1) Comovement is measured by a median estimate of $-\alpha_{32,t}$.
2) Up indicates a coupling period (1991.10-2002.08).
3) Down indicates a decoupling period (2004.11-2012.11).
4) Numbers indicate correlation coefficients of percentage changes.
5) +, *, and ** denote significant at the 10%, 5%, and 1% levels, respectively.

Table 3. Correlation Coefficients between Comovement and Exports–Imports between Korea and its Main Trade Partners

		1990.02-2014.11	1990.02-1997.10	1997.11-1998.12	1999.01-2007.08	2007.09-2009.06	2009.07-2014.11	Up	Down
Exports	Total	-0.077	-0.032	-0.233	-0.029	-0.468+	-0.152	-0.061	-0223*
	China	-0.029	0.005	-0.397	-0.036	-0.187	-0.138	-0.001	-0.106
	U.S.	-0.079	-0.089	-0.406	0.005	-0.447+	-0.040	-0.084	-0.046
	Japan	-0.081	-0.069	-0.481	-0.018	-0.350	-0.111	-0.117	-0.144
Imports	Total	-0.089	-0.088	-0.184	-0.074	-0.167	-0.070	-0.098	-0.056
	China	-0.069	-0.127	-0.261	-0.051	0.000	0.014	-0.084	-0.061
	U.S.	-0.122*	-0.114	-0.409	0.003	-0.530*	-0.136	-0.167+	-0.163
	Japan	-0.105+	-0.053	-0.060	-0.158	-0.390	-0.090	-0.093	-0.154

Notes: 1) Comovement is measured by a median estimate of $-\alpha_{32,t}$.
2) Up indicates a coupling period (1991.10-2002.08).
3) Down indicates a decoupling period (2004.11-2012.11).
4) Numbers indicate correlation coefficients of percentage changes.
5) + and * denote significant at the 10% and 5% levels, respectively.

Table 4. Correlation Coefficients between Comovement and Exports in the Best 10 Korean Export Products

HS2	1990.02-2014.11	1990.02-1997.10	1997.11-1998.12	1999.01-2007.08	2007.09-2009.06	2009.07-2014.11	Up	Down
Total	-0.059	-0.018	-0.183	-0.012	-0.475^{+}	-0.150	-0.022	-0.231*
Electrical Machinery	-0.003	-0.022	-0.571^{+}	0.051	-0.204	0.053	0.122	-0.028
Vehicles	-0.049	-0.006	-0.230	-0.091	-0.246	-0.069	-0.079	-0.108
Machinery & Computer	-0.034	0.054	-0.319	-0.018	-0.293	-0.141	0.012	-0.117
Mineral Fuels	-0.054	0.0298	-0.189	-0.129	-0.449^{+}	-0.086	0.011	-0.166
Ships	-0.040	0.006	-0.175	-0.006	-0.197	-0.089	-0.030	-0.147
Optical	-0.070	-0.054	-0393	0.025	-0.449^{+}	-0.128	-0.095	-0.159
Plastics	-0.055	-0.053	-0.511	-0.35	-0.088	-0.079	-0.085	-0.064
Organic Chemicals	-0.054	-0.018	-0.369	-0.018	-0.443^{+}	-0.174	-0.045	-0.159
Iron and Steel	-0.005	0.002	0.153	0.049	-0.574*	-0.082	0.044	-0.199^{+}
Articles of Iron or Steel	-0.127*	-0.095	-0.103	-0.213*	-0.132	-0.045	-0.137	-0.092

Notes: 1) Comovement is measured by a median estimate of $-\alpha_{32,t}$.
2) Up indicates a coupling period (1991.10-2002.08).
3) Down indicates a decoupling period (2004.11-2012.11).
4) Numbers indicate correlation coefficients of percentage changes.
5) $^{+}$ and * denote significant at the 10% and 5% levels, respectively.

Table 5. Correlation Coefficients between Comovement and Imports in the Best 10 Korean Export Products

HS2	1990.02-2014.11	1990.02-1997.10	1997.11-1998.12	1999.01-2007.08	2007.09-2009.06	2009.07-2014.11	Up	Down
Total	-0.084	-0.111	-0.208	-0.023	-0.147	-0.074	-0.101	-0.032
Electrical Machinery	-0.011	-0.038	0.143	0.044	0.019	-0.067	0.135^{+}	0.029
Vehicles	-0.079	-0.046	-0.114	-0.057	-0.361	-0.021	-0.138	-0.152
Machinery & Computer	-0.107^{+}	-0.053	-0.272	-0.112	-0.394	-0.028	-0.112	-0.155
Mineral Fuels	-0.102^{+}	-0.203^{+}	-0.264	0.050	-0.175	-0.066	-0.168^{+}	-0.135
Ships	-0.066	-0.098	0.327	-0.092	0.049	-0.090	-0.022	-0.082
Optical	-0.105^{+}	-0.086	-0.492	-0.068	-0.210	-0.063	-0.154	-0.061
Plastics	-0.060	-0.066	-0.164	-0.088	-0.101	-0.021	-0.138	-0.026
Organic Chemicals	-0.069	-0.119	-0.280	0.022	0.017	-0.043	-0.116	-0.024
Iron and Steel	0.005	-0.004	0.391	0.075	-0.258	0.136	-0.052	0.092
Articles of Iron or Steel	-0.079	-0.090	-0.175	-0.037	-0.310	-0.053	-0.164^{+}	0.043

Notes: 1) Comovement is measured by a median estimate of $-\alpha_{32,t}$.
2) Up indicates a coupling period (1991.10-2002.08).
3) Down indicates a decoupling period (2004.11-2012.11).
4) Numbers indicate correlation coefficients of percentage changes.
5) $^{+}$ denotes significant at the 10% level.

Figure 1. Yen/Dollar Exchange Rates

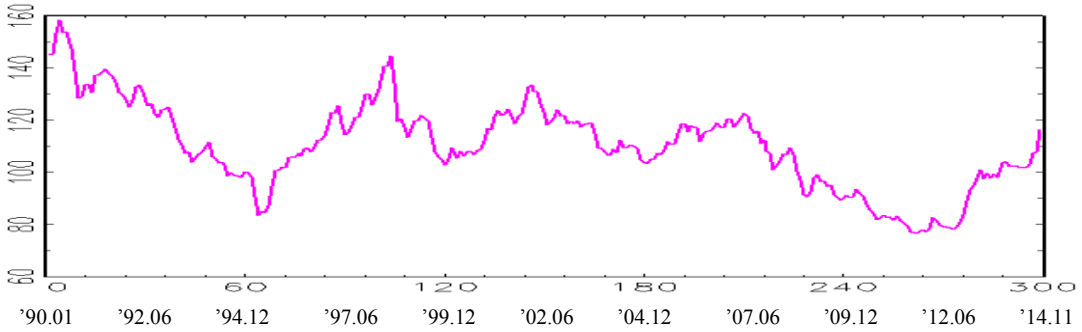

Figure 2. Won/Dollar Exchange Rates

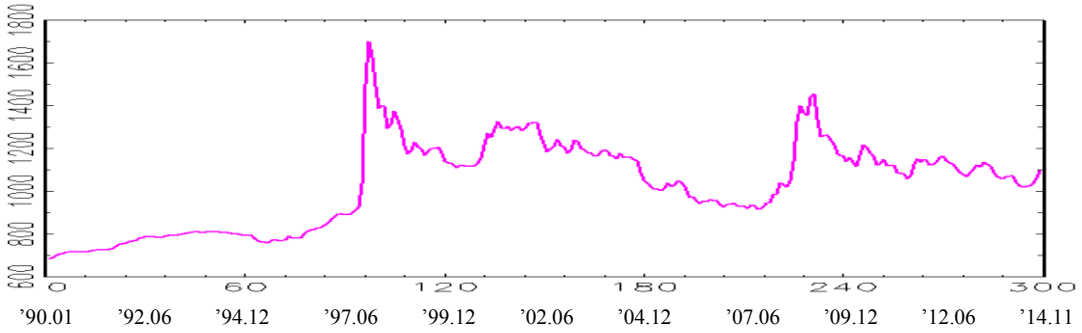

Figure 3. Won/Yen Exchange Rates

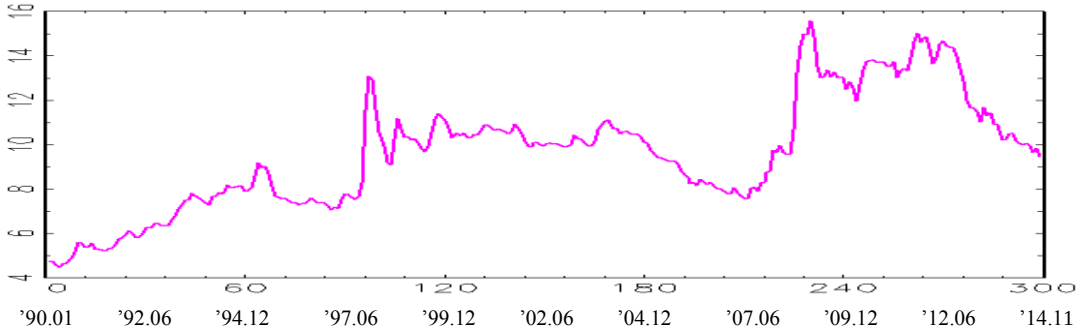

Figure4. Estimates of $-\alpha_{32,t}$

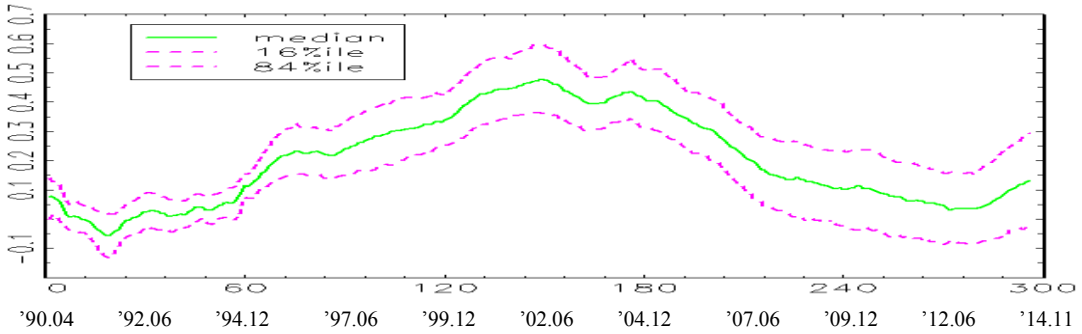

Figure 5. Impulse Response Curves

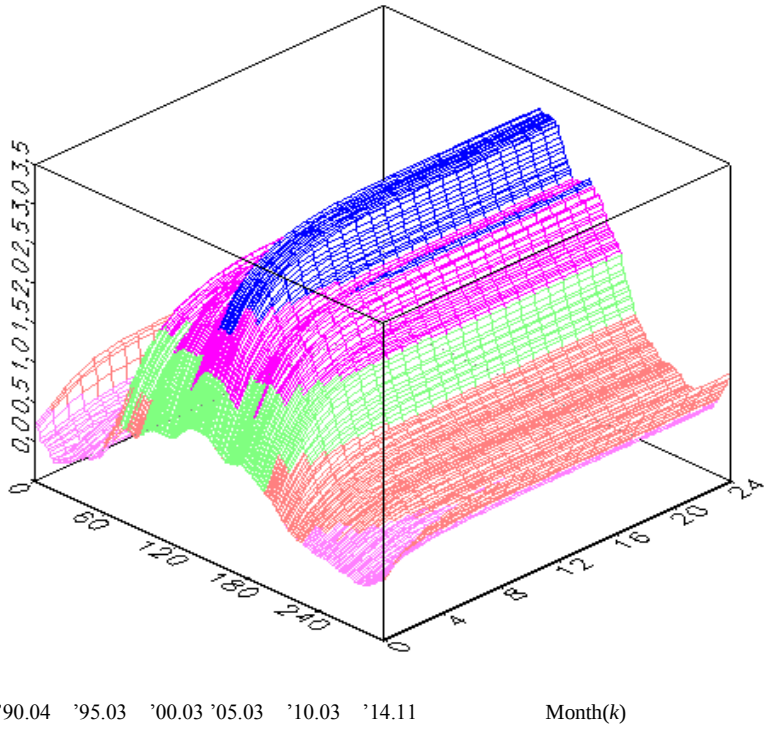

Figure 6. 0 (*k*=0) and 24 (*k*=24) Months-Ahead Impulse Response Curves

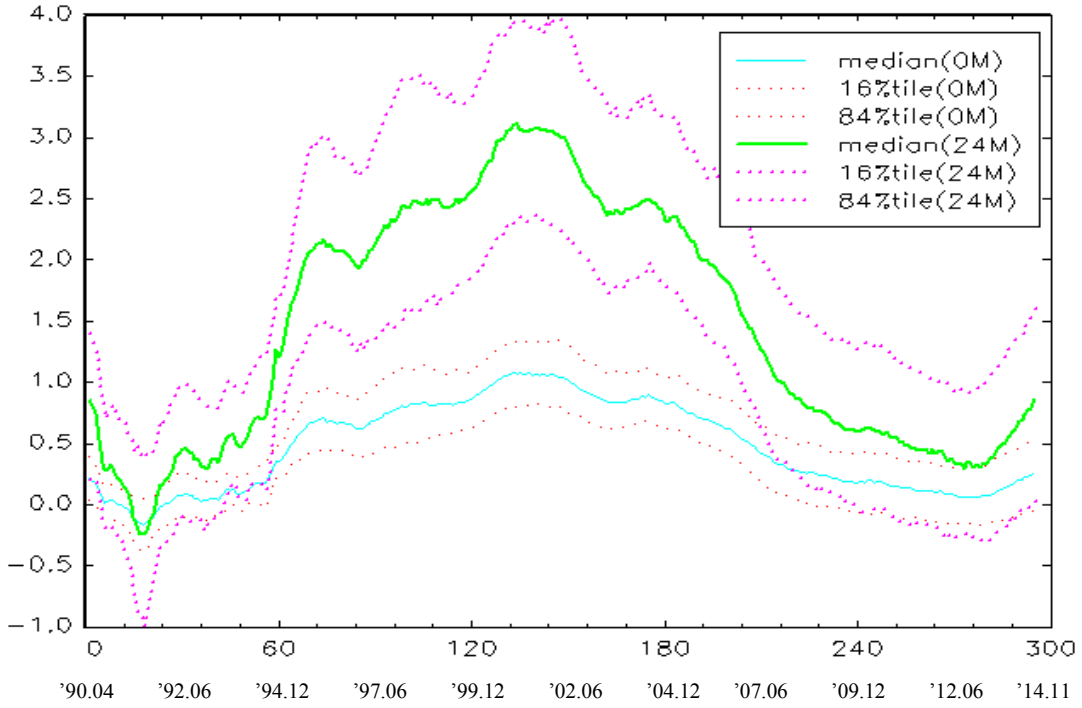

Figure 7. Impulse Response Curves in the Whole Period and Five Sub-Periods

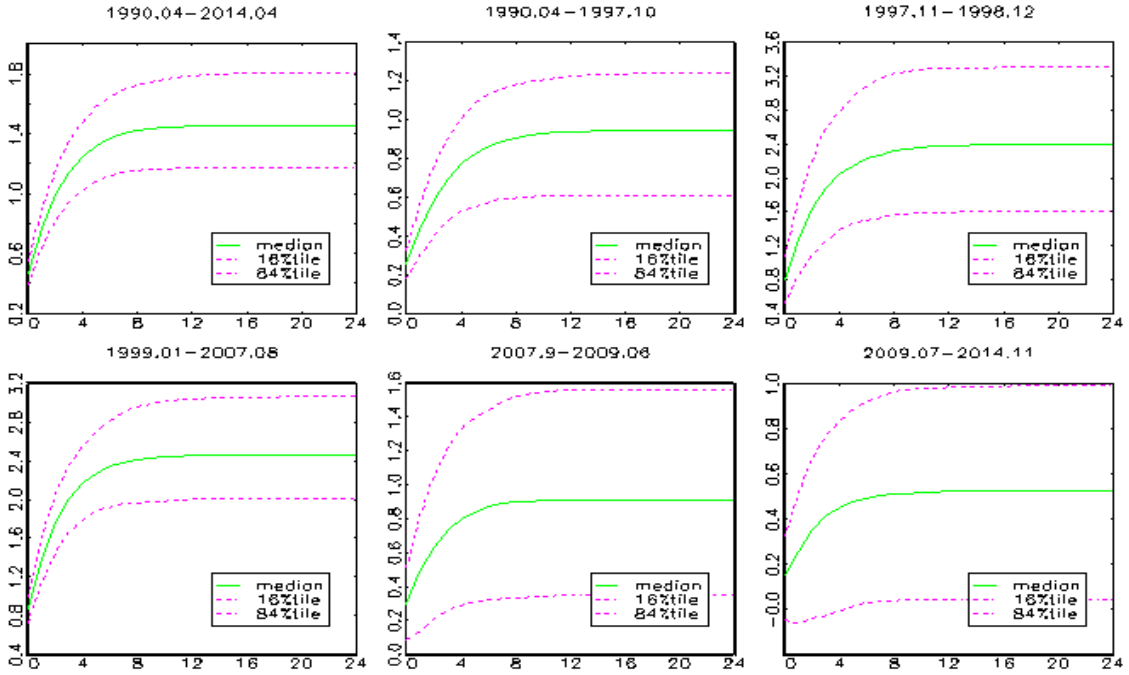

Figure 8. Impulse Response Curves in the Whole Period and Five Sub-Periods

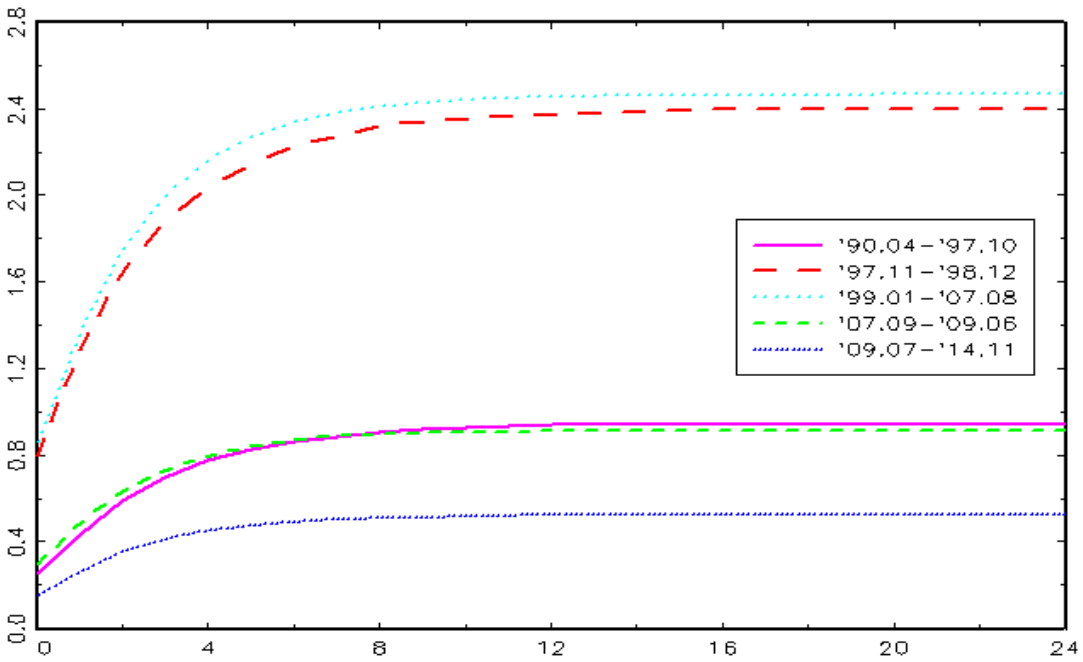

Figure A1. Estimates of $-\alpha_{32,t}$ (Dow Jones Index ⇒ Won/Dollar)

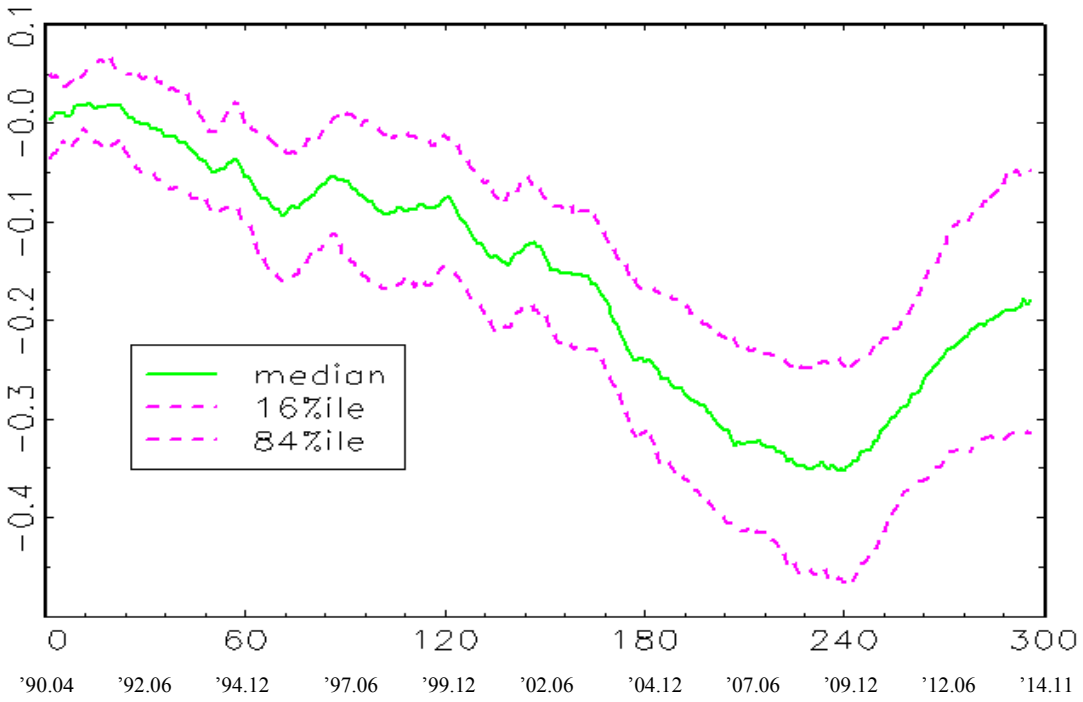

Figure A2. Estimates of $-\alpha_{32,t}$ (Variables: Yen/Dollar, KOSPI, Won/Dollar)