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Structural Change and Financial Instability in an Open Economy

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Abstract

This paper examines the financial structural change in the Korean economy by applying the VAR analysis. It also studies the degree to which international capital mobility affects the dynamic fixed and floating exchange rate systems.

Before 1997, the Korean financial structure was fragile and the risks associated with international lenders were a trigger for the monetary crisis under the fixed exchange rate system. However, it appears that after 2007, the Korean economy became strong enough to withstand the international monetary crisis.

Using empirical analyses, this paper argues that the Korean financial structure has become robust and has improved since the monetary crisis of 1997 and the financial structural robustness has indeed made the dynamic system of the floating exchange rate stable.

This paper concludes that the financial structural robustness and the floating exchange rate system are the main reasons why the Korean economy has been strong enough to withstand the international monetary crisis of 2007.

JEL classification: F41, F31, F32, C32, Key Words: structural change, instability of confidence, VAR analysis

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1.Introduction

A monetary crisis broke out in Korea in 1997, which posed great difficulties for the country's economy. The International Monetary Fund required Korea to carry out market-oriented economic reforms and constrictive fiscal policies in consideration of financial support.

On the other hand, the subprime loan crisis of 2007 in the USA, which took lead in the market-oriented economic reform, marked the beginning of an international monetary crisis. Many nations such as Iceland have suffered from the crisis; the Japanese economy has also been severely affected. However, it appears that the Korean economy was strong enough to withstand the international monetary crisis of 2007.

Some economists on the Wall Street think that the financial instability hypothesis proposed by Hyman, P. Minsky deserves consideration (Lahart (2007)). The hypothesis had been ignored before the international monetary crisis because of the general perception that the US was in an era of sustained prosperity, which might be an illusion.

The financial instability hypothesis is a theory of endogenous business cycle. Taylor and O'Connell (1985) presented a simple macroeconomic model of financial instability and proved that an economy would fall into a financial crisis if the decline in the expected profit rates aggravated the financial condition of firms and increased the household preference for liquidity. Semmler (1987) interpreted their idea as a nonlinear "S-shaped" saving function and presented a financial cycle by applying the Hopf-bifurcation theorem¹.

The S-shaped saving refers to the saving that is assumed to depend on the difference between the current income and its normal level. For example, bank loans increase in an expanding economy because of the decline in lender risks. Ninomiya and Tokuda (2010) introduced the concept of "the instability of confidence" and incorporated the factor of lender risks into a macrodynamic model of financial instability for illustrating financial cycle and instability. By applying the VAR analysis, they also showed that the instability of confidence increased in the mid-1990s and changed the financial structure of the Japanese economy. However, they focused only on the Japanese economy without discussing the open economy.

On the other hand, Ninomiya (2007) examined the international monetary crisis by developing the thesis of Asada (1995), suggesting that a stable financial structure is supremely important to the Korean economy. However, he did not so by undertaking an empirical analysis and considering the structural change in the Korean economy.

This paper begins by presenting a simple macrodynamic model by following Ninomiya and Tokuda (2010) and detailing the structural change in the Korean economy by applying the VAR analysis. Next, it will examine the structural change and the degree to which international capital mobility affects the dynamic fixed and floating exchange rate systems.

This paper argues that the Korean financial structure has grown more robust since the Asian monetary crisis. The conclusion of this paper will explain how the robust financial

¹Semmler (1987) integrated firms' debt and debt payment commitments into a formal nonlinear cycle model. In the recent studies of financial instability, the dynamic equation of debt burden was introduced. See, for example, Asada (2006) and Ninomiya and Sanyal (2009). However, we will disregard the debt burden in this paper.

structure and the floating exchange rate system were the main reasons why the Korean economy was strong enough to withstand the international monetary crisis of 2007.

2. Basic model and empirical study

2.1 Basic model

In this section, we present a basic macrodynamic model by following Ninomiya and Tokuda (2010) and examine the structural change in the Korean economy by applying the VAR analysis.

Rose (1969), Ninomiya (2007), and Ninomiya and Tokuda (2010) formulated the following equation to determine the interest rate i,

$$EB = -[EX + EM] = -[(C + I - Y) + (L - M)] = 0$$
(1)

where EX is the excess demand for goods, EB is the excess demand for bonds, EM is the excess demand for money, C is the consumption demand, I is the investment demand, Y is the net income, M is the money supply, and L is the demand for money.

The consumption function, investment function, money demand function, and money supply function are defined as

$$C = cY + C_0, \quad 0 < c < 1, \quad C_0 > 0, \tag{2}$$

$$I = I(Y, i, \rho), \quad I_Y \equiv \frac{\partial I}{\partial Y} > 0, \quad I_i \equiv \frac{\partial I}{\partial i} < 0, \quad I_\rho \equiv \frac{\partial I}{\partial \rho} > 0, \quad (3)$$

$$L = L(Y, i), \quad L_Y \equiv \frac{\partial L}{\partial Y} > 0, \quad L_i \equiv \frac{\partial L}{\partial i} < 0,$$
 (4)

$$M = \mu(i,\rho)\overline{H}, \quad \mu_i \equiv \frac{\partial\mu}{\partial i} > 0, \quad \mu_\rho \equiv \frac{\partial\mu}{\partial\rho} > 0, \tag{5}$$

(6)

where c is the marginal propensity to consume, C_0 is the basic consumption, ρ is the state of confidence for an economy, μ is a monetary multiplier, H is a high-powered money that is assumed to be constant in this section $(H = \bar{H})$.

 $I_{\rho} > 0$ implies that the investment demand increases when the state of confidence for the economy increases. This is referred to as "animal spirits," which co-exist with many investment opportunities. $\mu_{\rho} > 0$ shows the behavior of commercial banks. In short, lender risks depend on the state of confidence for the economy, ρ . For example, lender risks decline dramatically when the economy is in "euphoria." If so, the money supply would increase considerably with the increase in bank loans.

By ordering Equations (1)–(5) and solving them with respect to the interest rate i gives

$$i = i(Y, \rho),$$

$$i_Y \equiv \frac{\partial i}{\partial Y} = -\frac{I_Y - (1 - c) + L_Y}{I_i + L_i - \mu_i H} > 0, \quad i_\rho \equiv \frac{\partial i}{\partial \rho} = -\frac{I_\rho - \mu_\rho H}{I_i + L_i - \mu_i H} \ge 0,$$

The sign of i_{ρ} depends on those of I_{ρ} and μ_{ρ} . As mentioned above, I_{ρ} is the animal spirits or the investment opportunity and μ_{ρ} is the behavior of commercial banks. For example, we obtain $i_{\rho} < 0$ when $I_{\rho} < \mu_{\rho}H$. We assume that the economy is in boom. If lender risks decline with the rise in the state of confidence for the economy, the supply of

loanable funds will increase tremendously. If the increase is significant, the interest rate may decline despite the rise in the state of confidence. Furthermore, we assume $i_Y > 0$ in this paper².

The dynamic equations for the net income *Y* and the state of confidence ρ are formulated as follows:

$$\dot{Y} = \alpha(C+I-Y), \quad \alpha > 0,$$
(7)

$$\dot{\rho} = \beta [v(Y,i) - \overline{v}], \quad v_Y \equiv \frac{\partial v}{\partial Y} > 0, \quad v_i \equiv \frac{\partial v}{\partial i} < 0, \quad \beta > 0, \tag{8}$$

Equation (7) describes the quantity-adjustment process of the goods market and α is the parameter. \bar{v} in Equation (8) is the combination of the net income *Y* and the interest rate *i*, which achieves a normal state of confidence for the economy³. For example, the state of confidence will increase with the decline in the interest rate even though the net income does not change. The parameter β is called "the instability of confidence."

By ordering Equations (2), (3), (6), (7), and (8), the following dynamic system (S_a) is obtained:

$$\dot{Y} = \alpha [cY + C_0 + I(Y, i(Y, \rho)) - Y]$$
 (S_a.1)

$$\dot{\rho} = \beta[v(Y, i(Y, \rho)) - \overline{v}] \tag{S_a.2}$$

Ninomiya and Tokuda (2010) proved the existence of the closed orbit at certain parameter value β by applying the Hopf-bifurcation theorem. This financial cycle is different from the closed Kaldorian business-cycle models, in which there is a closed orbit at certain parameter value α . Moreover, the inequality $I_Y + I_i i_Y > 1 - c$ is usually assumed in the closed Kaldorian business-cycle model⁴. On the contrary, the inequality $I_Y + I_i i_Y < 1 - c$ is assumed in Ninomiya and Tokuda (2010).



²Ninomiya (2007) examined the case of $i_{Y} < 0$.

³Taylor and O'Connell (1985) formulated that $\dot{\rho}$ would depend on the gap between the current interest rate and the normal long-run interest rate. Equation (8) is similar to what Franke and Asada (1994) have proposed. They postulated that the dynamic equation for the state of confidence would depend on the risk premium.

⁴Asada (1987, 1995). This assumption implies that the marginal propensity to invest, which contains indirect effect $(I_Y + I_i i_Y)$, is relatively large than the marginal propensity to save (1-c).

Figure 1 is a numerical simulation of the dynamic system (S_a) when $i_{\rho} < 0$. It is quite easy for us to find that the interest rate increases despite the decrease in income immediately after the peak of the business cycle is reached. In contrast, we are not able to observe such a phase in models of the closed Kaldorian business cycle.

Furthermore, Ninomiya and Tokuda (2010) also proved that the dynamic system (S_a) is unstable when the instability of confidence β is large enough. This works via the following mechanism. The economy is in a boom, and the state of confidence for the economy, ρ , enhances. The interest rate *i* will fall despite the rise in ρ . Consequently, the investment demand *I* will be promoted by the fall in the interest rate and the income *Y* will increase considerably.

 $Y \uparrow \Rightarrow \rho \uparrow \Rightarrow i \downarrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \text{ (Unstable)}$

On the contrary, the dynamic system (S_a) is stable when $i_{\rho} > 0$ by the opposite mechanism.

 $Y \uparrow \Rightarrow \rho \uparrow \Rightarrow i \uparrow \Rightarrow I \downarrow \Rightarrow Y \downarrow \text{ (Stable)}$

2.2 Empirical analysis

Ninomiya and Tokuda (2010) presented the structural change in the Japanese economy that occurred in the mid-1990s. We will examine the structural change in the Korean economy by applying the VAR analysis.

In the basic model above, the symbol i_{ρ} and the instability of confidence β are shown to play an important role in the stability of the dynamic system. Here, we examine the changes in the financial structure by using data from the Korean economy. One characteristic of this analysis is that it is a subsample comparative analysis that focuses on the creation of proxy variables, which show the instability of confidence, and the VAR model, which introduces these proxy variables.

Straightforward observation of income, interest rate, and change time of economic framework

As stated before, despite a drop in income Y, there is a phase where the interest rate i rises because of an increase in lender risk. In general, we often observe this type of situation at times when confidence in the economy is fragile. We examine this point using data on the Korean economy for the period from 1987 because of the availability of the data used in later analyses.

First, we observe the macroeconomic indicators of the income and interest rate movements. We use the real GDP as the income variable and the yields of national housing bonds as the interest rate variable. Changes from the previous period for each variable are given in Figure 2 (see Table 1 for details on each indicator).

There were three periods in which a fall in the GDP of the previous period was accompanied by a rise in the interest rates: the 4th quarter of 1997 (hereinafter 1997Q4), 1998Q1, and 2008Q3.

These periods are shown in Figure 2 by solid vertical lines⁵. We can interpret these

⁵As GDP has a fairly consistent upward trend, it would be difficult to extract periods in which $Y\uparrow \rightarrow i\downarrow$ by setting an arbitrary trend. In this section, we choose to extract periods during which $Y\downarrow \rightarrow i\uparrow$, thus limiting



Figure 2 Transition of GDP and government bond yield

periods as corresponding to the economic transitions associated with the Asian monetary crisis in the latter half of the 1990s and the subprime loan crisis in the latter half of the 2000s.

Next, we examine Figure 3, which shows the association with periods in which $i_{\rho} < 0$ in the business survey index, an indicator of business sentiments. The solid line represents

the possibility for statistical error.

business conditions (BC) and the dotted line represents financial situations (FS). In general, we can assume that the economy is good in situations where businesses view the financial environment for loans to be positive. On this point, we observe both indicators during the period for which we can use the business survey index: Sep. 1984–Sep. 2010.

Figure 3 shows that there was a tendency for BC to be greater than FS (BC > FS) before the Asian monetary crisis, while after the crisis, BC became less than FS (BC < FS)⁷. After the 1980s, Korea achieved rapid development in the field of finance following finance and capital transaction liberalization and internationalization, which the government promoted and urged strongly during negotiations for accession to the OECD. On the other hand, this rapid development also had the drawback of eliciting undisciplined liberalization and internationalization in the absence of adequate risk management. The association between the financial system and the real economy became unstable as the financial system was being shaped, as reflected in the observable evidence of BC > FS. This destabilized situation likely brought the Asian monetary crisis to Korea⁸. However, the situation was brought under IMF management after the monetary crisis, and confidence in the financial environment was restored with financial cooperation and support. The shift to BC < FS reflects this change in the sentiment.

In light of this observable evidence, after the Asian monetary crisis, a change in the financial structure of the economy is presumed to have occurred that reduced previous lender risks. If this is the case, then models that ignore changes in economic financial structures cannot accurately describe them before and after the changes. In this paper, we assume that a change in the financial structure occurred during the Asian monetary crisis, and we describe and compare the economic structure before and after this change.

In the theoretical model below, while defining the dynamic state of ρ , we quantitatively value β , which plays a critical role as "the instability of confidence," and make this the basis for dividing the period into two parts. We also construct a VAR model and examine the causality and the ripple effect on shocks.

Quantification of instability of confidence

As the instability of confidence β is unobservable, we need to use some proxy variables. Here, we incorporate a generalized auto regressive conditional heteroscedasticity (GARCH) model, which is a volatility variation model, to quantify this value. Strictly speaking, the risks of lenders (financial institutions) and borrowers (businesses) should be separately identified and considered. In this paper, however, we take the approach of loosely integrating these two types of risks as confidence instability.

We incorporate a method using the GARCH model to quantify the variable by using the business survey index introduced earlier as a source for extracting β . Having used the method for time-series analysis to identify the discrepancy in past business and financial patterns, we now define it as the instability of confidence.

⁷The average gap in both indicators from 1987 to 1997 is about 8.4 and from 1998 to 2010 is about -5.8. ⁸With respect to the formation of the Korean economy, Ko (2000) provides a detailed analysis of how the paralysis of the function provided a check on chaebol over-investment and over-borrowing that resulted from significant changes in the economic system in the 1990s, including industrial liberalization and diversification of chaebol capital acquisition, led to the monetary crisis.

First, Figure 3 shows that, at least for the Asian monetary crisis, the pattern BC > FS was stable before the crisis, and that the pattern BC < FS was stable following the crisis. For simplification, we assume a linear relationship between the financial situation during an arbitrary point in time and the business condition before the same time point, as well as a construction boom dummy (1989Q1–1991Q4). In other words, this is shown as

$$FS_t = \alpha_0 + \alpha_1 BC_{t-1} + \alpha_2 Dum_t + \mu_t \tag{9}$$

(*FS_t*: financial situation, *BC_t*: business condition, *Dum_t*: construction boom dummy, μ_t : error term, α_0 : constant, α_1 , α_2 : adjustment coefficients)

Equation 9 shows situations in which there are differences in the association between business expectations for the financial environment and their perception of the economic climate by variance in μ_t . The error term in μ_t represents the disturbing and/or irregular factors and the variance in these factors represents uncertainty about the financial environment. In other words, increases in the variance of the error term mean that some factors non-explainable by the assessments of economic conditions heavily influence the expectations of the financial environment. The increases also show that the instability of confidence for the economy is increasing.

This error term variance is not stable throughout the period, but has a tendency to continually increase whenever a large shock occurs. To model the heterogeneity of error term variance, we use a GARCH model as below.

$$\sigma_t^2 = \omega + \alpha \sigma_{t-1}^2 + \beta \mu_{t-1}^2 \qquad \mu_t \left| \text{Info}_{t-1} \sim N(0, \sigma_t^2) \right|$$
(10)

Here, $\omega > 0$, μ is the prediction error during a previous period. Info_{t-1} denotes information that is set at the t – 1 term and is a usable information set.

We assume that the conditional distribution of μ_t is normal and that the conditional variance σ_t^2 is heterogeneous, depending on past shocks as well as μ_{t-1} and σ_{t-1}^2 . The financial instability factors estimated by this GARCH model are as below.

$$FS_{t} = 76.318 + 0.254BC_{t-1} - 21.222Dum_{t} + \mu_{t}$$
(11)

$$\sigma_t^2 = 3.349 + 0.616\mu_{t-1}^2 + 0.450\sigma_{t-1}^2$$
(12)

The sample period is from 1984Q1 quarter to 2010Q3 quarter, and the numbers in parentheses represent the t-values.

The estimation results show that each parameter meets the 1% significance level as well as the sign condition. The estimated financial environment expectation conditional variance σ_t^2 (i.e., the proxy variable for the instability of confidence β) (Fig. 4) shows instability until the first half of the 1990s. It fluctuated widely during the Asian monetary crisis and then stabilizes. Instability once again intensified during the period 2008–2009, which saw a sharp economic contraction following the U.S. subprime loan crisis. However, the volume was smaller and shorter-term as compared to that during the Asian monetary crisis period. The large fluctuation caused by financial sector sentiments may have triggered a surge in business liquidity preference and a significant change in capital positions while fostering a change in the transmission mechanism from finance to the real economy. In the next section, we simulate the instability of confidence β from the quantified σ^2 and incorporate this into

we simulate the instability of confidence β from the quantified σ^2 and incorporate this into the VAR model, dividing the estimation period 1998Q1 into two. The division point was determined by considering the magnitude relationship between FS and BS indicated earlier, the period in which the quantified confidence instability is increasing, as well as by the obtained samples⁹. Having divided the estimation period into two, we compare the differences found in the results of each subsample estimation.



Analysis using VAR model

According to the theoretical model, the macroeconomic variables that form the core of the VAR model include the interest rate i_t , income Y_t , investment I_t , and the previously explained quantified confidence instability variable β_t . Data sources are as shown in Table 1. We use the quarterly data and estimate from the period 1987Q1 to 2010Q3, which is the time frame for which we can obtain continuous data. The data for 1998Q1 are divided into subsamples.

Table 1 Dataset						
Variables	Variables Data		Source			
<i>i</i> : interest rate	Yields of National Housing Bonds Type1(5-year)	%	The Bank of Korea			
<i>Y</i> : income	Y: income GDP (at chained 2005 year prices, SA)		The Bank of Korea			
<i>I</i> : investment	Gross Fixed Capital Formation (SA)	Bil.Won	OECD			
β : Instability of confidence	Business Condition	Index	The Bank of Korea			
	Financial Situation	Index	The Bank of Korea			

Prior to performing the VAR analysis, we conduct a unit root test for the stationarity of each variable in each subsample through the ADF test. Using a model that includes trends and constants, we confirm that almost all variables are on a level stationarity. We apply Johansen's cointegration test (maximum eigenvalue test) to various models, but no result strongly supports cointegration. As such, we use level variables in the analysis below. To

⁹Although β itself is an endogenous variable, we consider the possibility that, triggered by a large shock, it changed the economic structure.

give priority to ensuring the degree of freedom in our VAR model, we use one term lag. From the table above, we specify the following dynamic model. X_t is an endogenous vector, A_1 is coefficient vector (constants omitted), and u_t is the reduced innovation vector.

$$\mathbf{X}_{t} = \mathbf{A}_{1}\mathbf{X}_{t-1} + \mathbf{u}_{t}$$

$$\mathbf{X}_{t} = \begin{bmatrix} i_{t}, Y_{t}, I_{t}, \beta_{t} \end{bmatrix}', \quad \mathbf{u}_{t} = \begin{bmatrix} u_{it}, u_{Yt}, u_{It}, u_{\beta t} \end{bmatrix}'$$
(13)

First, we confirm the Granger causality observable between the four variables—in other words, the marginal prediction power for the improvement of each variable—using the estimates of our VAR model and the F-test that we can perform incidentally¹¹. Table 2 shows the results of the Granger causality test. The mutual causality between the variables in Granger terms are weak in the early subsample, with only two directions, *I* to *Y* and *I* to β , detected (heretofore "causality" shall imply in Granger terms). In addition, *i* is not determined by the market to the extent implied by financial liberalization; as a result, we can infer that causality could not be detected.

	Sample: 1987Q1 1997Q4		Sample: 1998Q1 2010Q3		
Null Hypothesis:	F-Statistic	Prob.	F-Statistic	Prob.	
$Y \not\rightarrow i$	0.655	0.525	2.752	0.074	
$i \not\rightarrow Y$	1.596	0.216	2.848	0.068	
I → i	0.670	0.518	1.161	0.323	
<i>i</i> → <i>I</i>	0.129	0.879	6.974	0.002	
$\beta \not\rightarrow i$	0.544	0.585	4.935	0.011	
$i \not\rightarrow \beta$	1.206	0.311	8.739	0.001	
$I \twoheadrightarrow Y$	4.716	0.015	11.448	0.000	
$Y \not\rightarrow I$	0.958	0.393	16.970	0.000	
$\beta \not\rightarrow Y$	1.758	0.186	0.585	0.561	
$Y \not\rightarrow \beta$	2.024	0.147	2.272	0.115	
$\beta \not\rightarrow I$	0.447	0.643	0.374	0.690	
$I \not\rightarrow \beta$	5.596	0.008	2.577	0.087	
	$i \qquad \qquad$		Y		
			β		

 Table 2
 Granger Causality Test

*The shaded area shows the part where the null hypothesis is rejected below 10% significance level.

 $\stackrel{}{\times}$ 1% significance level, $\stackrel{}{\longrightarrow}$ 5% significance level, $\stackrel{}{\longrightarrow}$ 10% significance level On the other hand, we can see a complicated causality between the macroeconomic variables in the later subsample. *i* and *Y* have a feedback relationship with significance at the 10% level, while *I* and *Y* have a feedback relationship with significance at the 1% level. This is likely due to increased fluctuation in the interest rates following developments in

¹¹Granger causality has the characteristic of determining causality on the basis of whether past variables contribute to improving the predictive capacity, if current circumstances depend only on past circumstances in linear systems such as the VAR model. Therefore, we must consider that this is not an assessment of the cause–effect relationship between the variables in the usual sense.

financial liberalization. We also find that there is one-sided causality from *i* to *I* with significance at the 1% level. In terms of association with confidence instability β , there is a feedback relationship between *i* and β and one-sided causality between *I* and β at the 10% significance level. We can infer that fluctuations in β affect the real economy in terms of investment and GDP through the interest rates.

Although we could not confirm β 's effect on any of the main variables in the early subsample, it seems that the presence of β grew in the later subsample with adjustments made to the economic system. β affects ρ in Equation (S_a .2) while ρ fluctuates with *i* in Equation 6. This transmission mechanism can be interpreted as having materialized following the Asian monetary crisis. Although causality was detected through the Granger

causality test, the degree of quantitative impact and time-series changes could not be determined. Next, we examine the impulse response function.

Figures 5 and 6 show the impulse response functions for the early subsample (1987–1997) and the later subsample (1998–2010), respectively. Shock (innovation) to the endogenous variable affects not only these variables but also other endogenous variables through the dynamic lag structure of the VAR model. By using the impulse response function, we quantify the effects of the shock in the current period and movements in the endogenous variables over the preceding 10 periods ($2\frac{1}{2}$ years).

As the limitation of space prohibits a complete review of the effects on endogenous variables, we examine here the shock and subsequent response by focusing on the empirical results relating to confidence instability and the transmission mechanism from page 4 to 5. First, with regard to the instability of confidence, Figure 5 shows that the instability increases with positive interest rate shocks during the early subsample. There is a subsequent slight downward trend, although this is statistically insignificant. However, there is a residual positive effect even after 10 periods (4th row, 1st column). Conversely, the interest rates plummet when there is an increase in instability shock, which results in a restraint on economic contraction (1st row, 4th column). No obvious effect could be seen on GDP or investment (2nd row, 4th column; 3rd row, 4th column).

On the other hand, Figure 6 shows noticeably greater instability in response to a larger interest rate shock in the later subsample $(4^{th} \text{ row}, 1^{st} \text{ column})$. This effect, however, is relatively short-term, disappearing around the fifth subsequent period. Conversely, the interest rates drop when there is increase in instability shock, although not to the extent seen in the earlier period, and the lower interest rates act as an absorber for the deteriorating sentiment $(1^{st} \text{ row}, 4^{th} \text{ column})$. As a result, the investment initially falls, but recovers after the third subsequent period $(3^{rd} \text{ row}, 4^{th} \text{ column})$. In addition, although statistically insignificant, there is a slight tandem climb in GDP.

Next, we look at the transmission mechanism on page 5, namely $Y\uparrow \Rightarrow \rho\uparrow \Rightarrow i\uparrow \Rightarrow I\downarrow \Rightarrow Y\downarrow$. The direction and movement of each variable in the later subsample can clearly be seen. The interest rates act as a restraint in response to economic overheating, as indicated by the surge in Y (1st row, 2nd column). As a result, the instability of confidence β rises after the second period (4th row, 2nd column). After the changes indicated in Equation (S_a.2), ρ falls and the interest rates rise, peaking in the third period. Through this process, increases in



Figure 5 Impulse Response: 1987Q1–1997Q4

irate, Y:GDP, Inv: Investment, beta: Instability of confidence ⅔

Solid line represents the impulse response of each shock. Dotted line represents one standard error margin band.

investment are restrained and the effect disappears by the fifth period $(3^{rd} row, 2^{nd} column)$, with a consequent moderation in *Y* itself $(2^{nd} row, 2^{nd} column)$. This series of transmissions is not observable in the early subsample, probably because the response of the interest rates to the initial shock of economic overheating is unclear. In other words, the interest rate level formation process becomes opaque and uncertain during interest rate liberalization. The basis for this is likely the fact that the reaction of the interest rates to investment shocks is unclear.

The previous Granger causality test indicates that during the later period, the transmission from the instability of confidence β to the interest rate *i* is critical. In addition, the impulse response function shows that despite a rise in the instability of confidence triggered by some apparent causes, a system developed in which the negative effects on the real economy, *I* and *Y*, did not occur, because of the appropriate response of the interest rates. The construction of this system also leads to the stabilization of β itself. As shown in Figure 4, this environment is likely illustrated by the stable movement of σ^2 after 1999. In light of this, we can say that the robustness of the Korean financial system improved following the Asian monetary crisis.

Finally, we used the parameters gained in the VAR model to conduct the final test. This is not a test in which we obtain predictive values by using actual measurement values as a reference; rather, it is a test in which we use predictive values from the early period to calculate future predictions. Figure 7 shows a scatter plot of the differences in the income and the interest rates extracted from the predictive values drawn from the test. Each dot represents the predictive value obtained from the test, and the interior of the ellipse represents the 95% confidence interval.



Figure 7 Final Test

*Vertical axis represents the difference in the forecasted interest rate and horizontal axis represents the difference in the forecasted GDP.

For the first half of the subsample, we observe that the points are equally divided between the first quadrant, which depicts a concurrent rise in both GDP and the interest rates, and the forth quadrant, in which GDP is increasing and the interest rates are falling. There are no points visible, however, in the second and third quadrants. On the other hand, in the latter half of the subsample, many points appear in the third quadrant, in which both GDP and the interest rates are falling. The test also shows that when β is stable, there is a high probability that we can confirm the normal reaction of a drop in the interest rates with a fall in income.

3. Open economy

The Asian monetary crisis of 1997 showed that the Korean economy is strongly affected by the international capital mobility. As Figure 4 shows, the instability of confidence increased during the periods 1997–1998 and 2008–2009 because the Asian monetary crises occurred in 1997 and the subprime loan crisis occurred in 2007. However, it seems that the Korean economy was strong enough despite the international monetary crisis of 2007.

In the previous section, we observed that the financial structure between 1987 and 1997 is different from that between 1998 and 2010. Furthermore, Korea had adopted the fixed exchange rate system before the crisis of 1997 and has adopted the floating exchange rate system since the crisis of 1997. Therefore, we will examine the macrodynamic models of financial instability in the fixed and floating exchange rate systems.

We construct a macrodynamic model in an open economy by developing Asada (1995) and Ninomiya (2007) as follows:

$$\dot{Y} = \alpha(C + I + J - Y), \quad \alpha > 0, \tag{14}$$

$$\dot{\rho} = \beta[v(Y,i) - \overline{v}], \quad \beta > 0, \tag{15}$$

$$Q = \gamma \left(i + \delta g(\rho) - i_f - \frac{\pi^e - \pi}{\pi} \right), \tag{16}$$

$$g_{\rho} > 0, \quad \gamma > 0, \quad \delta \ge 0,$$

$$A = J + Q, \tag{17}$$

$$J = J(Y,\pi), \ J_Y < 0, \ J_\pi > 0,$$
(18)

$$C = cY + C_0, \tag{2}$$

$$I = I(Y, \rho, i), \quad I_Y > 0, \quad I_\rho > 0, \quad I_i < 0, \tag{3}$$

$$i = i(Y, \rho, H), \quad i_Y > 0, \quad i_o \ge 0, \quad i_H < 0,$$
 (6)

where J is the balance of the current account (net export), Q is the balance of the capital account, A is the total balance of payment, π is the value of a unit of foreign currency in terms of domestic currency, π^e is the expected exchange rate in the near future, and i_f is the expected rate of return for holding foreign bonds, excluding the influence of exchange risk.

The parameter γ represents the degree of international capital mobility, $g(\rho)$ represents the risk of international lenders, and δ expresses the degree of the risk. $g_{\rho} > 0$ means that the rise in the state of confidence for the economy reduces the risk of international lenders. Although δ is apparently different from the instability of confidence β , δ might also be high when β is high.

Equation (16) shows that the balance of the capital account is determined by the

difference between the domestic interest rate and the expected rate of return of foreign bonds. Equation (17) is the definition of the total balance of payment.

3.1 Case of fixed exchange rate system

First, we will examine the case of fixed exchange rate system. In this system, three equations are added:

$$\pi = \bar{\pi},\tag{19}$$

$$\pi^e = \pi, \tag{20}$$

$$\dot{H} = A. \tag{21}$$

Equations (19) and (20) prove that the exchange rate is given. Equation (21) shows that the high-powered money becomes an endogenous variable under the fixed exchange rate system, unless the central bank adopts the so-called sterilization policy.

By ordering Equations (2), (3), (6), and (14)–(21), we obtain the dynamic system of fixed exchange rates (S_b) as follows:

$$Y = \alpha[cY + C_0 + I(Y, i(Y, \rho, H)) + J(Y, \overline{\pi}) - Y] \equiv f_1(Y, \rho, H), \qquad (S_b.1)$$

$$\dot{\rho} = \beta[\nu(Y, i(Y, \rho, H)) - \overline{\nu}] \equiv f_2(Y, \rho, H) \qquad , \qquad (S_b.2)$$

$$\dot{H} = J(Y,\bar{\pi}) + \gamma[i(Y,\rho,H) + \delta g(\rho) - i_f] \equiv f_3(Y,\rho,H)$$
(S_b.3)

The Jacobian matrix of the system (S_b) at the equilibrium point can be expressed as

$$J_{b} = \begin{pmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{pmatrix}$$
(22)

where

$$f_{11} = \alpha [I_Y - (1 - c) + J_Y + I_i i_Y], \quad f_{12} = \alpha (I_\rho + I_i i_\rho), \quad f_{13} = \alpha I_i i_H,$$

$$f_{21} = \beta (v_Y + v_i i_Y), \quad f_{22} = \beta v_i i_\rho, \quad f_{23} = \beta v_i i_H,$$

$$f_{31} = J_Y + \gamma i_Y, \quad f_{32} = \gamma (i_\rho + \delta g_\rho), \quad f_{33} = \gamma i_H.$$

The characteristic equation of the dynamic system is

$$\lambda^3 + a_1 \lambda^2 + a_2 \lambda + a_3 = 0 \qquad (23)$$

where

$$a_{1} = -f_{11} - f_{22} - f_{33}$$

= $-\alpha [I_{Y} - (1 - c) + J_{Y} + I_{i}i_{Y}] - \beta v_{i}i_{\rho} - \gamma i_{H},$ (24)

$$a_{2} = f_{22}f_{33} - f_{23}f_{32} + f_{11}f_{33} - f_{13}f_{31} + f_{11}f_{22} - f_{12}f_{21}$$

= $-\beta v_{i}i_{H}\gamma\delta g_{\rho} + \alpha [I_{\gamma} - (1-c) + J_{\gamma}]\gamma i_{H} - \alpha I_{i}i_{H}J_{\gamma}$
+ $\alpha [I_{\gamma} - (1-c) + J_{\gamma}]\beta v_{i}i_{\rho} - \alpha I_{i}i_{\rho}\beta v_{\gamma} - \alpha\beta I_{\rho}(v_{\gamma} + v_{i}i_{\gamma}),$ (25)

$$a_{3} = -f_{11}(f_{22}f_{33} - f_{23}f_{32}) + f_{21}(f_{12}f_{33} - f_{13}f_{32}) - f_{31}(f_{12}f_{23} - f_{13}f_{22})$$

$$= -\alpha\beta[I_{Y} - (1 - c) + J_{Y} + I_{i}i_{Y}]v_{i}i_{H}g_{\rho}\gamma\delta$$

$$+\alpha\beta I_{\rho}(v_{Y} + v_{i}i_{Y})(I_{\rho} - I_{i}\delta g_{\rho})i_{H}\gamma - (J_{Y} + \gamma i_{Y})\alpha\beta I_{\rho}v_{i}i_{H}.$$

(26)

The inequality $I_Y + I_i i_Y < 1 - c$ is assumed in this paper.

The above discussion proves the below propositions.

Proposition 1

The degree of international capital mobility is assumed to be sufficiently high $(\gamma \to \infty)$. The dynamic system of fixed exchange rates (S_b) becomes locally stable under some conditions when the risk of international lenders is sufficiently low $(\delta \to 0)$. On the contrary, the dynamic system (S_b) becomes locally unstable when the risk of international lenders is sufficiently large $(\delta \to \infty)$.

Proof.

The degree of international capital mobility is assumed to be sufficiently high $(\gamma \to \infty)$. When the risk of international lenders is sufficiently low $(\delta \to 0)$, we obtain

$$a_1 = -\gamma i_H + \dots > 0,$$

$$a_2 = \alpha [I_Y - (1 - c) + J_Y] \gamma i_H + \dots > 0,$$

$$a_3 = \alpha \beta I_\rho v_Y i_H \gamma - \alpha \beta J_Y I_\rho v_i i_H,$$

$$a_1 a_2 - a_3 = -\alpha [I_Y - (1 - c) + J_Y] i_H^2 \gamma^2 + \dots > 0.$$

If we assume that v_Y is small, we obtain $a_3 > 0$. The above discussion gives us $a_1 > 0$, $a_2 > 0$, $a_3 > 0$, and $a_1a_2 - a_3 > 0$. Therefore, the Routh-Hurwitz conditions are satisfied in this case.

On the contrary, when the risk of international lenders is sufficiently large ($\delta \rightarrow \infty$), we obtain

$$a_2 = -\beta v_i i_H \gamma g_o \delta + \cdots < 0$$

Therefore, the Routh-Hurwitz conditions are not satisfied in this case. Q.E.D.

Proposition 2

The international capital mobility is assumed to be sufficiently low $(\gamma \rightarrow 0)$. The dynamic system of the fixed exchange rate system (S_b) is locally unstable when I_{ρ} is sufficiently small $(i_{\rho} < 0)^{12}$ and the degree of the instability of confidence is large $(\beta \rightarrow \infty)$. *Proof.*

If the international capital mobility is sufficiently low $(\gamma \rightarrow 0)$ and I_{ρ} is sufficiently small $(i_{\rho} < 0)$, we obtain

$$a_1 = -\beta v_i i_\rho + \cdots < 0.$$

Therefore, the Routh–Hurwitz conditions are not satisfied. Q.E.D.

¹²On the contrary, the system (S_b) is locally stable under some conditions when I_ρ is sufficiently large $(i_\rho > 0)$.

Proposition 1 demonstrates that the stability of the dynamic system (S_b) depends on the degree of the risk of international lenders δ when the degree of international capital mobility is sufficiently high ($\gamma \rightarrow \infty$). As examined in the previous section, Figure 4 shows that the instability of confidence β increased between 1997 and 1998 in Korea. Assuming that δ also increased during that time, Proposition 2 is consistent with the Asian monetary crisis in Korea in 1997. The risk of international lenders δ was a trigger for the crisis.

The empirical results show that the financial structure of the Korean economy between 1987 and 1997 was more fragile than that between 1998 and 2010. Proposition 2 demonstrates that the stability of the dynamic system (S_b) depends on the sign of i_{ρ} via the same mechanism as that described in the previous section when the degree of international capital mobility is sufficiently low $(\gamma \rightarrow 0)$. We assume that the financial structure was fragile at that time. The destabilizing influence of the domestic financial structure would prevent economic stability even though the international capital mobility was shut off $(\gamma \rightarrow 0)^{13}$.

3.2 Case of the floating exchange rate system

Next, we will examine the floating exchange rate system. In this system, three equations are added:

$$A = 0, \tag{27}$$

$$\dot{\pi}^e = \varepsilon(\pi - \pi^e), \quad \varepsilon > 0, \tag{28}$$

$$H = \overline{H}.$$
 (29)

Equation (27) represents the equilibrium of the total balance of payment. Equation (28) formalizes the adaptive expectation hypothesis concerning the expected exchange rate. Equation (29) indicates that the high-powered money becomes an exogenous variable in the floating exchange rate system.

The following dynamic system can be obtained by ordering Equations (2), (3), (6), (14)–(18), and (27)–(29):

$$\dot{Y} = \alpha \Big[cY + C_0 + I(Y, \rho, i(Y, \rho, \overline{H})) + J(Y, \pi) - Y \Big],$$
(30)

$$\dot{\rho} = \beta[\nu(Y, i(Y, \rho, \bar{H})) - \bar{\nu}], \qquad (31)$$

$$A = J(Y,\pi) + \gamma \left[i(Y,\rho,\bar{H}) + \delta g(\rho) - i_f - \frac{\pi^e}{\pi} + 1 \right] = 0,$$
(32)

$$\dot{\pi}^e = \varepsilon(\pi - \pi^e), \quad \varepsilon > 0. \tag{33}$$

(34)

Solving Equation (32) with respect to π gives us the following equation:

$$\pi = \pi(Y, \rho, \pi^e),$$

$$\pi_Y = -\frac{(J_Y + \gamma i_Y)\pi}{J_\pi \pi + \gamma}, \quad \pi_\rho = -\frac{\gamma(i_\rho + \delta g_\rho)\pi}{J_\pi \pi + \gamma}, \quad \pi_{\pi^e} = \frac{\gamma}{J_\pi \pi + \gamma} > 0.$$

By substituting Equation (34) into Equations (30) and (33), we show the dynamic system for the floating exchange rate (S_c) as follows:

¹³These results are consistent with Ninomiya (2007).

$$\dot{Y} = \alpha[cY + C_0 + I(Y, \rho, i(Y, \rho, \bar{H})) + J(Y, \pi(Y, \rho, \pi^e)) - Y]$$
(S.1)

$$\equiv g_1(Y,\rho,\pi^e;\alpha)$$

$$\dot{\rho} = \beta[\nu(Y, i(Y, \rho, \overline{H})) - \overline{\nu}] \equiv g_2(Y, \rho; \beta) \tag{S_c.2}$$

$$\dot{\pi}^e = \mathcal{E}[\pi(Y,\rho,\pi^e) - \pi^e] \equiv g_3(Y,\rho,\pi^e;\gamma,\delta) \tag{S_c.3}$$

The Jacobian matrix of this system is given by

$$J_{c} = \begin{pmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & 0 \\ g_{31} & g_{32} & g_{33} \end{pmatrix},$$
(35)

where

$$\begin{split} g_{11} &= \alpha [I_{Y} - (1 - c) + I_{i}i_{Y} + J_{Y} + J_{\pi}\pi_{Y}], \ g_{12} &= \alpha (I_{\rho} + I_{i}i_{\rho} + J_{\pi}\pi_{\rho}), \\ g_{13} &= \alpha J_{\pi}\pi_{\pi^{e}} > 0, \ g_{21} &= \beta (v_{Y} + v_{i}i_{Y}), \ g_{22} &= \beta v_{i}i_{\rho}, \\ g_{31} &= \varepsilon \pi_{Y}, \ g_{32} &= \varepsilon \pi_{\rho}, \ g_{33} &= \varepsilon (\pi_{\pi^{e}} - 1), \end{split}$$

We only focus on the case where the degree of international capital mobility is sufficiently large $(\gamma \to \infty)^{14}$. When γ is sufficiently large, we obtain $g_{33} \to 0^{15}$.

The characteristic equation of this system is

$$\lambda^3 + b_1 \lambda^2 + b_2 \lambda + b_3 = 0, (36)$$

where

$$b_{1} = -g_{11} - g_{22}$$

$$= \frac{-\alpha}{J_{\pi}\pi + \gamma} \Big[(I_{Y} - (1 - c) + I_{i}i_{Y} - J_{\pi}i_{Y}\pi)\gamma + J_{\pi}\pi(I_{Y} - (1 - c) + I_{i}i_{Y}) \Big] \qquad (37)$$

$$-\beta v_{i}i_{\rho}$$

$$b_{2} = g_{11}g_{22} - g_{12}g_{21} - g_{13}g_{31}$$

$$= \frac{\alpha}{(J_{\pi}\pi + \gamma)^{2}} \Big[(I_{Y} - (1 - c) + I_{i}i_{Y} + J_{Y} - J_{\pi}i_{Y}\pi)\beta v_{i}i_{\rho} \qquad (38)$$

$$+ \Big(I_{\rho} + I_{i}i_{\rho} - J_{\pi}(i_{\rho} + \delta g_{\rho})\pi \Big)\beta(v_{Y} + v_{i}i_{Y}) + \varepsilon i_{Y}\pi]\gamma^{2} + \cdots$$

$$g_{31} = \varepsilon \pi_{\gamma} = -\varepsilon \left[\frac{(J_{\gamma} + \gamma i_{\gamma})\pi}{J_{\pi}\pi + \gamma} \right]$$
$$g_{33} = \varepsilon (\pi_{\pi^{e}} - 1) = \varepsilon \left[\frac{\gamma}{J_{\pi}\pi + \gamma} - \frac{J_{\pi}\pi + \gamma}{J_{\pi}\pi + \gamma} \right] = \varepsilon \left[\frac{-J_{\pi}\pi}{J_{\pi}\pi + \gamma} \right]$$

¹⁴In the case where the degree of international capital mobility is sufficiently low ($\gamma \rightarrow 0$), the dynamic system of floating exchange rates (S_c) becomes locally stable when I_{ρ} is large ($i_{\rho} > 0$) and unstable when I_{ρ} is small ($i_{\rho} < 0$) and the degree of the instability of confidence is large ($\beta \rightarrow \infty$).

$$b_{3} = -g_{13}(g_{21}g_{32} - g_{22}g_{31})$$

= $g_{13}\frac{\beta\varepsilon}{J_{\pi}\pi + \gamma} \Big[\{-(v_{Y} + v_{i}i_{Y})\delta g_{\rho}\pi + v_{Y}i_{\rho}\pi\}\gamma - v_{i}i_{\rho}J_{Y}\pi \Big]$ (39)

The above discussion proves the below propositions.

Proposition 3

The degree of international capital mobility is assumed to be sufficiently high $(\gamma \to \infty)$ and the risk of international lenders is assumed to be sufficiently low $(\delta \to 0)$. The dynamic system of the floating exchange rates (S_c) becomes locally stable under some conditions when I_{ρ} is large $(i_{\rho} > 0)$. On the contrary, the dynamic system of floating exchange rates (S_c) becomes locally unstable when I_{ρ} is small $(i_{\rho} < 0)$.

Proof.

The degree of international capital mobility is assumed to be sufficiently high $(\gamma \rightarrow \infty)$ and the risk of international lenders is assumed to be sufficiently low $(\delta \rightarrow 0)$.

In the case where I_{ρ} is large $(i_{\rho} > 0)$, we assume $I_{\rho} + I_i i_{\rho} < 0$ although I_{ρ} is large. Under these assumptions, we obtain $b_1 > 0$, $b_2 > 0$, and $b_3 > 0$. Furthermore, if we assume that v_Y is small $(v_Y + v_i i_Y < 0)$, b_3 is also small. We obtain $b_1b_2 - b_3$ because $b_1 > 0$ and $b_2 > 0$. The above discussion gives us $b_1 > 0$, $b_2 > 0$, $b_3 > 0$, and $b_1b_2 - b_3 > 0$. Hence, the Routh-Hurwitz conditions are satisfied in this case.

On the contrary, we obtain $b_3 < 0$ when I_{ρ} is small $(i_{\rho} < 0)$. Therefore, the Routh–Hurwitz conditions are not satisfied in the case where I_{ρ} is small $(i_{\rho} < 0)$. Q.E.D.

Proposition 4

The dynamic system of floating exchange rates (S_c) becomes locally stable when the degree of international capital mobility is assumed to be sufficiently high $(\gamma \to \infty)$. The dynamic system of floating exchange rates (S_c) becomes locally stable when the risk of international lenders is sufficiently large $(\delta \to \infty)$.

Proof.

If the degree of international capital mobility is assumed to be sufficiently high $(\gamma \to \infty)$, we obtain $b_1 > 0$. If the degree of the risk of international lenders is sufficiently large $(\delta \to \infty)$, we obtain $b_2 > 0$ despite $i_{\rho} < 0$. We also obtain $b_3 > 0$ under $v_Y + v_i i_Y < 0$ if δ is sufficiently large.

About $b_1b_2 - b_3$,

$$b_1 b_2 - b_3 = \frac{\alpha^2}{(J_\pi \pi + \gamma)^4} [\{I_Y - (1 - c) + I_i i_Y - J_\pi i_Y \pi\} J_\pi \delta g_\rho \pi \beta (v_Y + v_i i_Y) + \cdots] \gamma^4 + \cdots$$

The coefficient of γ^4 is positive. Therefore, we obtain $b_1b_2 - b_3 > 0$ if δ is sufficiently large and $v_Y + v_i i_Y < 0$.

The above discussion gives $b_1 > 0$, $b_2 > 0$, $b_3 > 0$, and $b_1b_2 - b_3 > 0$. The Routh–Hurwitz conditions are satisfied in this case. Q.E.D.

Proposition 3 indicates that the stability of the dynamic system (S_c) depends on the sign

of i_{ρ} when the degree of the risk of international lenders is sufficiently small ($\delta \rightarrow 0$). As observed in the empirical analysis, the robustness of the Korean financial structure has been improving since the Asian monetary crisis. Proposition 3 is consistent with the empirical results because the dynamics system (S_c) becomes stable when $i_{\rho} > 0$.

On the other hand, Figure 4 shows that the instability of confidence rose when the subprime crisis occurred. Therefore, the risk of international lenders might have increased simultaneously. However, Proposition 4 states that the dynamic system (S_c) stabilizes when the risk of international lenders is sufficiently large $(\delta \rightarrow \infty)$.

Korea has adopted the floating exchange rate system since the Asian monetary crisis. It appears that the Korean economy was strong enough to withstand the international monetary crisis of 2007. Propositions 3 and 4 are consistent with this fact.

4.Conclusion

A monetary crisis broke out in Korea in 1997, confronting the Korean economy with great difficulties. A decade later, many nations including Japan have been severely affected by the subprime loan crisis of 2007. However, it appears that the Korean economy was relatively strong enough to withstand the international monetary crisis.

We present a simple macrodynamic model by following Ninomiya and Tokuda (2010) and examine the structural change in the Korean economy by using a VAR model. We examine how the structural change, the degree of international capital mobility, and the risk of international lenders affect the dynamic systems of fixed and floating exchange rates.

The main conclusions drawn from this paper are as follows. First, in the empirical analysis,

- (1) we quantify the instability of confidence β and find that the period of 1998 saw an extreme rise in the instability that coincides with the period when the Korean economy was dealt with a heavy blow by the Asian monetary crisis. However, we show quantitatively that this instability subsided rapidly and stabilized considerably during the 2000s.
- (2) Having divided the sample period into the times when β was unstable (early period: 1987–1997) and the period after it stabilized (later period: 1998–2010), we conduct a VAR model-based analysis. A Granger causality test shows that in the later period, β is causally related to the real economy. We also confirm this causal relationship from the impulse response function, the process in which instability is absorbed through the route of the interest rates, and any contagion impact on the investment and income elements of the real economy is prevented.
- (3) We conduct the final test using the parameters obtained from the VAR model and find that during the periods when β is stable, there is a significant possibility that we can confirm the normal response pattern of falling (rising) interest rates with a fall (rise) in income.

The results of the empirical analysis also affect lender risks. Namely, the analysis introduces the possibility that although β itself does not function as an endogenous variable

that impacts macroeconomic variables, large-scale fluctuations can change the economic structure encompassing the macrovariables. The results show that following the Asian monetary crisis, the mechanism of economic stabilization through lower interest rates worked as a consequence of this structural change. This means that there was a powerful built-in stabilizer underpinning the economy even during the period of severe contraction in the economic sentiments caused by the U.S. subprime loan crisis. Considering this, we can see that the strength of the financial system in Korea has further improved.

In addition, in the theoretical analysis in an open economy,

- (4) the degree of international capital mobility is assumed to be sufficiently high (γ → ∞). The dynamic system of fixed exchange rates (S_b) becomes locally unstable when the risk of international lenders is sufficiently large (δ → ∞).
- (5) The degree of international capital mobility is assumed to be sufficiently high (γ → ∞) and the risk of international lenders is assumed to be sufficiently low (δ → 0). The dynamic system of floating exchange rates (S_c) becomes locally stable under some conditions when I_ρ is large (i_ρ > 0). The dynamic system of floating exchange rates (S_c) becomes locally stable when the risk of international lenders is sufficiently large (δ → ∞).

We believe that these theoretical results are consistent with the empirical implications. In short, we can apply Equation (4) to the empirical results before 1997 and Equation (5) to the empirical results after 1997.

Many nations have suffered from the international monetary crises. New research must examine the structural changes in these nations by applying the VAR analysis. The financial instability hypothesis and the formal mathematical models on the related topics treat cumulative debt burden as one of the causes of financial instability. Debt burden must be incorporated within the future research. Furthermore, the empirical model used in this paper is a closed model that does not include variables that directly express the foreign sector. However, the level of the Korean economy's dependence on trade as of 2009 was 80%, and as such, the actual structure of the Korean economy is heavily impacted by trading partner conditions and exchange rates. Although the period used in this empirical analysis includes the time of worldwide economic stability, there is a distinct possibility that a worldwide economic slump entangling global economic development may occur. Considering this, we hope to construct an open model that includes foreign sector as an issue to be considered in the future.

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