

Structural Change and Financial Instability in an Open Economy*

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

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 by 2007, the Korean economy had become relatively strong to withstand the international monetary crisis.

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

This study concludes that the financial structural robustness and the floating exchange rate system are the main reasons for the Korean economy's relative strength, which withstood the international monetary crisis of 2007.

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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 conduct market-oriented economic reforms and constrictive fiscal policies in consideration of financial support.

In contrast, the subprime loan crisis of 2007 in the US, which triggered 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 had become strong enough to withstand the 2007 international monetary crisis.

Certain Wall Street economists believe that Hyman P. Minsky's financial instability hypothesis 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 proved to be an illusion.

The financial instability hypothesis is a theory of endogenous business cycles. 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 worsened firms' financial condition and increased 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 theorem.¹⁾

The S-shaped saving refers to the saving assumed to be contingent on the difference between 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 (2011) introduced the concept of "the

¹⁾ Semmler (1987) integrated firms' debt and debt payment commitments into a formal nonlinear cycle model. In recent studies of financial instability, the dynamic equation of debt burden was introduced. See, for example, Asada (2006) and Ninomiya and Sanyal (2009); however, the present study disregards debt burden.

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 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 an open economy.

In contrast, Ninomiya (2007) examined the international monetary crisis by developing Asada’s (1995) thesis, suggesting that a stable financial structure is crucially important to the Korean economy. However, he did not do so by undertaking an empirical analysis and considering the structural change in the Korean economy.

The present paper begins by presenting a macrodynamic model in which it examines the structural change and the degree to which international capital mobility affects the dynamic fixed and floating exchange rate systems. Next, it examines the structural change in the Korean economy by applying VAR analysis.

This paper argues that the Korean financial structure has grown more robust since the Asian monetary crisis. The conclusion of this paper explains how the robust financial structure and the floating exchange rate system were the main reasons for the Korean economy’s sufficient strength for withstanding the 2007 international monetary crisis.

2. THE MODEL

2.1. Basic Model

In this section, we present a basic macrodynamic model by following Ninomiya and Tokuda (2011).

Rose (1969), Ninomiya (2007), and Ninomiya and Tokuda (2011) formulated the following equation to determine the interest rate i ,

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

where EX , EB , and EM are the excess demand for goods, bonds, and money, respectively. C is the consumption demand, I is 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

$$C = cY + C_0, \quad 0 < c < 1, \quad C_0 > 0, \quad (2)$$

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

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

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

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

$I_\rho > 0$ implies that investment demand increases when the state of confidence in 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 in the economy, ρ . For example, lender risks decline dramatically when the economy is in “euphoria.” Thus, 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, we obtain

$$i = i(Y, \rho), \quad (6)$$

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

$$i_\rho \equiv \frac{\partial i}{\partial \rho} = -\frac{I_\rho - \mu_\rho H}{I_i + L_i - \mu_i H} \begin{matrix} \geq 0, \\ < 0, \end{matrix}$$

$$i_H \equiv \frac{\partial i}{\partial H} = \frac{\mu}{I_i + L_i - \mu_i H} < 0.$$

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 $I_\rho < \mu_\rho H$, which means that I_ρ is relatively small. We assume that the economy is in boom. If lender risks decline with a rise in the state of confidence in the economy, the supply of loanable funds will increase significantly. If the increase is significant, the interest rate may decline despite the rise in the state of confidence. The decline in the interest rate will promote and excessively encourage investment demand. In contrast, we obtain $i_\rho > 0$ when $I_\rho > \mu_\rho H$. As we mentioned, if lender risks decline with the rise in the state of confidence, the supply of loanable funds will increase proportionately. However, if the increase is not significant, the interest rate would rise rather than decline. The rise in the interest rate will discourage investment demand.

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

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

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

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 net

income Y and interest rate i , which achieves a normal state of confidence in the economy.²⁾ For example, the state of confidence will increase with the decline in the interest rate even though the net income does not change. The change of the state of confidence $\dot{\rho}$ is large when the parameter β is large. 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:

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

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

We assume that H is constant in the dynamic system (S_a) ($H = \bar{H}$). Ninomiya and Tokuda (2011) proved the existence of the closed orbit at certain parameter value 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 . Further, the inequality $I_Y + I_i i_Y > 1 - c$ is usually assumed in the closed Kaldorian business-cycle model.³⁾ In contrast, the inequality $I_Y + I_i i_Y < 1 - c$ is assumed in Ninomiya and Tokuda (2011).⁴⁾

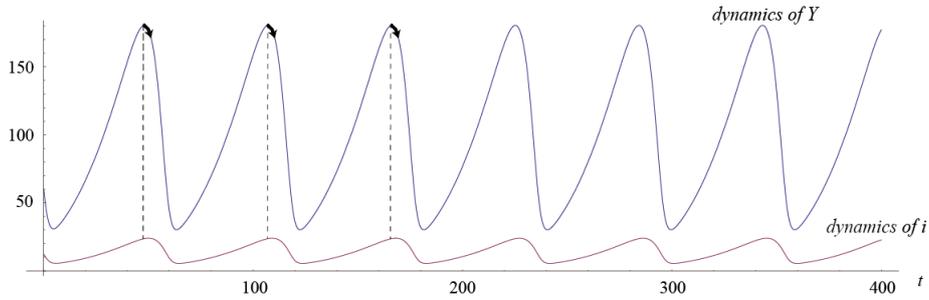
²⁾ Taylor and O’Connell (1985) formulated that $\dot{\rho}$ would depend on the gap between the current interest rate i and the normal long-run interest rate \bar{i} as follows:

$$\dot{\rho} = \beta(i - \bar{i}),$$

where β is a reaction coefficient. They demonstrated that the system becomes unstable if i_ρ is strongly negative. Semmler (1987) noted that the result depends on the coefficient β . 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. They proposed that a high value of the reaction coefficient would be destabilizing for the dynamic system. However, all these studies were not examined empirically.

³⁾ See Asada (1987, 1995). This assumption implies that the marginal propensity to invest, which contains an indirect effect ($I_Y + I_i i_Y$), is relatively larger than the marginal propensity to save ($1 - c$).

⁴⁾ Ninomiya and Tokuda (2011) examined the stability condition and cycle in the dynamic system that includes the dynamic equation of capital stock.

Figure 1 Dynamics of Income and Interest Rate

Source: Ninomiya and Tokuda (2011).

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 business cycle peaks.⁵⁾ However, we are not able to observe such a phase in models of the closed Kaldorian business cycle.

Further, Ninomiya and Tokuda (2011) also proved that the dynamic system (S_a) is unstable when the instability of confidence β is large enough. This operates via the following mechanism. The economy is in a boom, and the state of confidence in the economy, ρ , increases. The interest rate i will fall despite the rise in ρ . Consequently, investment demand I will be stimulated by the fall in the interest rate, and income Y will increase considerably.

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

In contrast, the dynamic system (S_a) is stable when $i_\rho > 0$ by the opposite mechanism.

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

⁵⁾ This phase is consistent with the Sample: 1987Q1-1998Q4 in figure 7.

2.2. Open Economy

The Asian monetary crisis of 1997 proved that the Korean economy is strongly affected by international capital mobility. Figure 4 in section 3 shows that the average instability of confidence was high during the period 1988-1998. Instability of confidence increased during the period 2008-2009 because of the subprime loan crisis in 2007, although the average remained relatively low. However, it seems that the Korean economy was relatively strong despite the international monetary crisis of 2007.

As we see in section 3, the financial structure between 1987 and 1998 is different from that between 1999 and 2011. Further, Korea had adopted the fixed exchange rate system before the crisis of 1997 and has since then adopted the floating exchange rate system. 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 that of Asada (1995) and Ninomiya (2007) as follows:

$$\dot{Y} = \alpha(C + I + J - Y), \quad \alpha > 0, \quad (9)$$

$$\dot{\rho} = \beta[v(Y, i) - \bar{v}], \quad \beta > 0, \quad (8)$$

$$Q = \gamma \left(i + \delta g(\rho) - i_f - \frac{\pi^e - \pi}{\pi} \right), \quad (10)$$

$$g_\rho > 0, \quad \gamma > 0, \quad \delta \geq 0,$$

$$A = J + Q, \quad (11)$$

$$J = J(Y, \pi), \quad J_Y < 0, \quad J_\pi > 0, \quad (12)$$

$$C = cY + C_0, \quad (2)$$

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

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

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 risk. $g_\rho > 0$ means that the rise in the state of confidence in 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 (10) 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 (11) is the definition of the total balance of payment.

2.2.1. Fixed exchange rate system

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

$$\pi = \bar{\pi}, \quad (13)$$

$$\pi^e = \pi, \quad (14)$$

$$\dot{H} = A. \quad (15)$$

Equations (13) and (14) prove that the exchange rate is given. Equation (15) shows that high-powered money becomes an endogenous variable under

the fixed exchange rate system, unless the central bank adopts the so-called sterilization policy.

By sequencing equations (2), (3), (6), (8), and (9)-(15), we obtain the dynamic system of fixed exchange rates (S_b) as follows:

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

$$\dot{\rho} = \beta[v(Y, i(Y, \rho, H)) - \bar{v}] \equiv f_2(Y, \rho, H), \quad (S_b.2)$$

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

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

$$J_b = \begin{pmatrix} f_{11} & f_{12} & f_{13} \\ f_{21} & f_{22} & f_{23} \\ f_{31} & f_{32} & f_{33} \end{pmatrix}, \quad (16)$$

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

$$\lambda^3 + a_1 \lambda^2 + a_2 \lambda + a_3 = 0, \quad (17)$$

where

$$\begin{aligned}
a_1 &= -f_{11} - f_{22} - f_{33} \\
&= -\alpha[I_Y - (1-c) + J_Y + I_i i_Y] - \beta v_i i_\rho - \gamma i_H,
\end{aligned} \tag{18}$$

$$\begin{aligned}
a_2 &= f_{22} f_{33} - f_{23} f_{32} + f_{11} f_{33} - f_{13} f_{31} + f_{11} f_{22} - f_{12} f_{21} \\
&= -\beta v_i i_H \gamma \delta g_\rho + \alpha[I_Y - (1-c) + J_Y] \gamma i_H - \alpha I_i i_H J_Y \\
&\quad + \alpha[I_Y - (1-c) + J_Y] \beta v_i i_\rho - \alpha I_i i_\rho \beta v_Y - \alpha \beta I_\rho (v_Y + v_i i_Y),
\end{aligned} \tag{19}$$

$$\begin{aligned}
a_3 &= -f_{11}(f_{22} f_{33} - f_{23} f_{32}) + f_{21}(f_{12} f_{33} - f_{13} f_{32}) - f_{31}(f_{12} f_{23} - f_{13} f_{22}) \\
&= -\alpha \beta [I_Y - (1-c) + J_Y + I_i i_Y] v_i i_H g_\rho \gamma \delta \\
&\quad + \alpha \beta I_\rho (v_Y + v_i i_Y) (I_\rho - I_i \delta g_\rho) i_H \gamma - (J_Y + \gamma i_Y) \alpha \beta I_\rho v_i i_H.
\end{aligned} \tag{20}$$

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

The above discussion proves the propositions below.

Proposition 1

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

Proof

The degree of international capital mobility is assumed to be sufficiently high ($\gamma \rightarrow \infty$). When the risk of international lenders is sufficiently low ($\delta \rightarrow 0$), 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 $a_1 a_2 - a_3 > 0$. Therefore, the Routh-Hurwitz conditions are satisfied in this case.

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

$$a_2 = -\beta v_i i_H \gamma g_\rho \delta + \dots < 0.$$

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 small ($i_\rho < 0$)⁶⁾ 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 small ($i_\rho < 0$), we obtain

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

⁶⁾ In contrast, the system (S_b) is locally stable under certain conditions when I_ρ is large ($i_\rho > 0$).

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

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 we examine in section 3, figure 4 shows that in Korea the average instability of confidence, β , was high between 1988 and 1998. Assuming that δ also increased between 1997 and 1998, 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 in section 3 demonstrate that the financial structure of the Korean economy between 1987 and 1998 was more fragile than that between 1999 and 2011. Proposition 2 demonstrates that, when the degree of international capital mobility is sufficiently low ($\gamma \rightarrow 0$), the stability of the dynamic system (S_b) depends on the sign of i_p via the same mechanism described in the previous section. We assume that the financial structure was fragile at that time. The domestic financial structure's destabilizing influence would prevent economic stability, even though international capital mobility was severely restricted ($\gamma \rightarrow 0$).⁷⁾

2.2.2. Floating exchange rate system

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

$$A = 0, \quad (21)$$

$$\dot{\pi}^e = \varepsilon(\pi - \pi^e), \quad \varepsilon > 0, \quad (22)$$

$$H = \bar{H}. \quad (23)$$

Equation (21) represents the equilibrium of the total balance of payments.

⁷⁾ These results are consistent with Ninomiya (2007).

Equation (22) formalizes the adaptive expectation hypothesis concerning the expected exchange rate. Equation (23) indicates that high-powered money becomes an exogenous variable in the floating exchange rate system.

The following dynamic system can be obtained by sequencing Equations (2), (3), (6), (8), (9)-(12), and (21)-(23):

$$\dot{Y} = \alpha [cY + C_0 + I(Y, \rho, i(Y, \rho, \bar{H})) + J(Y, \pi) - Y], \quad (24)$$

$$\dot{\rho} = \beta [v(Y, i(Y, \rho, \bar{H})) - \bar{v}], \quad (25)$$

$$A = J(Y, \pi) + \gamma \left[i(Y, \rho, \bar{H}) + \delta g(\rho) - i_f - \frac{\pi^e}{\pi} + 1 \right] = 0, \quad (26)$$

$$\dot{\pi}^e = \varepsilon (\pi - \pi^e), \quad \varepsilon > 0. \quad (27)$$

Solving equation (26) with respect to π gives us the following equation:

$$\pi = \pi(Y, \rho, \pi^e), \quad (28)$$

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

By substituting equation (28) into equations (24) and (27), we show the dynamic system for the floating exchange rate (S_c) as follows:

$$\begin{aligned} \dot{Y} &= \alpha [cY + C_0 + I(Y, \rho, i(Y, \rho, \bar{H})) + J(Y, \pi(Y, \rho, \pi^e)) - Y] \\ &\equiv g_1(Y, \rho, \pi^e; \alpha), \end{aligned} \quad (S_c.1)$$

$$\dot{\rho} = \beta [v(Y, i(Y, \rho, \bar{H})) - \bar{v}] \equiv g_2(Y, \rho; \beta), \quad (S_c.2)$$

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

The Jacobian matrix of this system is given by

$$J_c = \begin{pmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & 0 \\ g_{31} & g_{32} & g_{33} \end{pmatrix}, \quad (29)$$

where

$$g_{11} = \alpha[I_Y - (1-c) + I_i i_Y + J_Y + J_\pi \pi_Y], \quad g_{12} = \alpha(I_\rho + I_i i_\rho + J_\pi \pi_\rho),$$

$$g_{13} = \alpha J_\pi \pi_{\pi^e} > 0, \quad g_{21} = \beta(v_Y + v_i i_Y), \quad g_{22} = \beta v_i i_\rho,$$

$$g_{31} = \varepsilon \pi_Y, \quad g_{32} = \varepsilon \pi_\rho, \quad g_{33} = \varepsilon(\pi_{\pi^e} - 1).$$

We focus only on the case in which the degree of international capital mobility is sufficiently large ($\gamma \rightarrow \infty$).⁸⁾ When γ is sufficiently large, we obtain $g_{33} \rightarrow 0$.⁹⁾

The characteristic equation of this system is

$$\lambda^3 + b_1 \lambda^2 + b_2 \lambda + b_3 = 0, \quad (30)$$

where

⁸⁾ In 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 ($\beta \rightarrow \infty$).

⁹⁾ $g_{31} = \varepsilon \pi_Y = -\varepsilon \left[\frac{(J_Y + \gamma i_Y) \pi}{J_\pi \pi + \gamma} \right],$

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

$$\begin{aligned}
b_1 &= -g_{11} - g_{22} \\
&= \frac{-\alpha}{J_\pi \pi + \gamma} [(I_Y - (1-c) + I_i i_Y - J_\pi i_Y \pi) \gamma + J_\pi \pi (I_Y - (1-c) + I_i i_Y)] \\
&\quad - \beta v_i i_\rho,
\end{aligned} \tag{31}$$

$$\begin{aligned}
b_2 &= g_{11} g_{22} - g_{12} g_{21} - g_{13} g_{31} \\
&= \frac{\alpha}{(J_\pi \pi + \gamma)^2} [(I_Y - (1-c) + I_i i_Y + J_Y - J_\pi i_Y \pi) \beta v_i i_\rho \\
&\quad + (I_\rho + I_i i_\rho - J_\pi (i_\rho + \delta g_\rho) \pi) \beta (v_Y + v_i i_Y) + \varepsilon i_Y \pi] \gamma^2 + \dots,
\end{aligned} \tag{32}$$

$$\begin{aligned}
b_3 &= -g_{13} (g_{21} g_{32} - g_{22} g_{31}) \\
&= g_{13} \frac{\beta \varepsilon}{J_\pi \pi + \gamma} [-(v_Y + v_i i_Y) \delta g_\rho \pi + v_Y i_\rho \pi] \gamma - v_i i_\rho J_Y \pi.
\end{aligned} \tag{33}$$

The above discussion proves the propositions below.

Proposition 3

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 ($\delta \rightarrow 0$). The dynamic system of the floating exchange rates (S_c) becomes locally stable under certain conditions when I_ρ is large ($i_\rho > 0$). In contrast, 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 $b_3 > 0$. Further, if we assume that v_Y is small ($v_Y + v_Y i_Y < 0$), b_3 is also small. We obtain $b_1 b_2 - b_3$ because $b_1 > 0$ and $b_2 > 0$. The above discussion gives us $b_1 > 0$, $b_2 > 0$, $b_3 > 0$, and $b_1 b_2 - b_3 > 0$. Hence, the Routh-Hurwitz conditions are satisfied in this case.

In contrast, 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 ($\gamma \rightarrow \infty$) and the risk of international lenders is sufficiently large ($\delta \rightarrow \infty$).

Proof

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

For $b_1 b_2 - b_3$,

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

The coefficient of γ^4 is positive. Therefore, we obtain $b_1 b_2 - b_3 > 0$ if δ is sufficiently large and $v_Y + v_Y i_Y < 0$.

The above discussion gives $b_1 > 0$, $b_2 > 0$, $b_3 > 0$, and $b_1 b_2 - b_3 > 0$. 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 we will observe in the empirical analysis, the Korean financial structure's robustness has been improving since the Asian monetary crisis. Proposition 3 is consistent with the following empirical results because the dynamics system (S_c) becomes stable when $i_p > 0$.

In contrast, 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 sufficiently strong to withstand the international monetary crisis of 2007. Propositions 3 and 4 are consistent with this fact.

3. EMPIRICAL ANALYSIS

Ninomiya and Tokuda (2011) 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 VAR analysis.

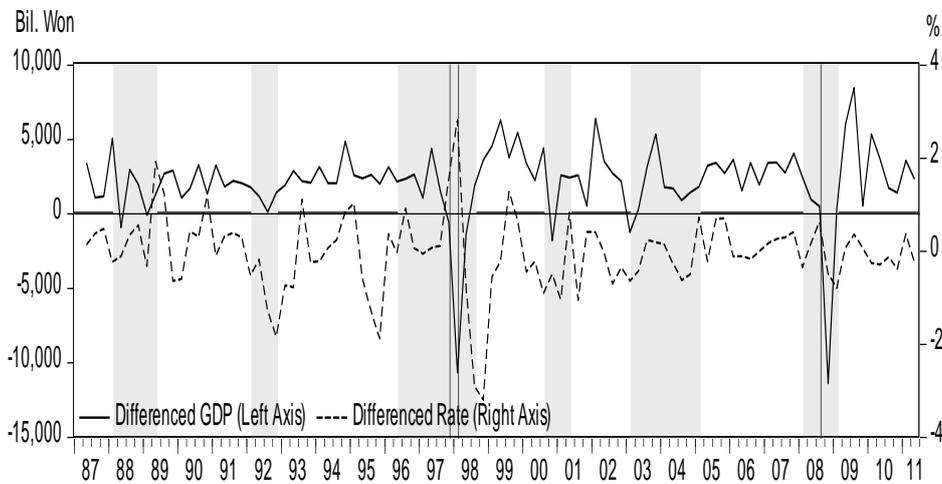
In previous dynamic systems (S_b and S_c), no matter which exchange system is adopted, the symbol i_p and the instability of confidence β are shown to play an important role in the stability of the dynamic system. Here, we examine the changes in the financial structure by using data from the Korean economy. 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.

3.1. Straightforward Observation of Income, Interest Rate, and Change Period of Economic Framework

As shown in figure 1, despite a drop in income Y , there is a phase in which 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 from the period of 1987 to 2011 because of the availability of the data used in later analyses.

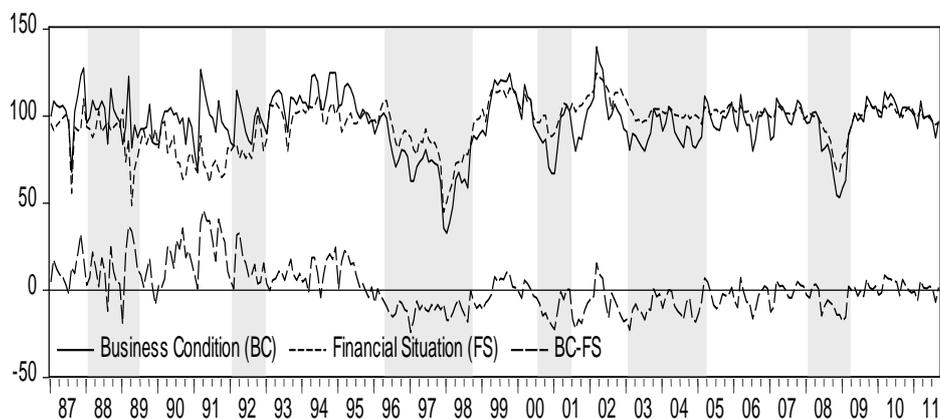
First, we observe the macroeconomic indicators of the income and interest rate movements. We use real GDP and yields of national housing bonds as the income variable and interest rate variable, respectively. Differences from the previous period for each variable are illustrated in figure 2 (see table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

Figure 2 Transition of GDP and Government Bond Yield



Note: Gray zone shows a recession phase. Vertical solid line indicates the time when the decrease in GDP and the rising interest rates were synchronous.

Source: The Bank of Korea.

Figure 3 Transition of Business Condition and Financial Situation

Source: The Bank of Korea.

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 lines.¹⁰⁾ We can interpret these 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 $i_p < 0$ in the business survey index, an indicator of business sentiments. The solid line represents 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 as positive. On this point, we observe both indicators during the period for which we can use the business survey index: Sep. 1984-Sep. 2011.

Figure 3 shows that there was a tendency for BC to be greater than FS (BC

¹⁰⁾ As 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 the possibility for statistical error.

>FS) before the Asian monetary crisis, whereas after the crisis, BC became less than FS ($BC < FS$).¹¹⁾ After the 1980s, with finance and capital transaction liberalization and internationalization, Korea's finance field developed, which the government strongly promoted during negotiations for compliance with the OECD. In contrast, 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 possibly brought the Asian monetary crisis to Korea.¹²⁾ 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 sentiment.

In light of this evidence, after the Asian monetary crisis, a change in the economy's financial structure that reduced previous lender risks is presumed to have occurred. 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 study, we assume that a change in the financial structure occurred during the Asian monetary crisis, and 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 ripple effect on shocks.

¹¹⁾ The average gap in both indicators from 1987 to 1997 is approximately 8.4 and from 1998 to 2011 is approximately -5.5.

¹²⁾ With 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's 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.

3.2. Quantification of Instability of Confidence

The variable defined by the theoretic model called the “state of confidence in an economy” does not exist as observational data. Therefore, to directly evaluate such a variable, it is necessary to define or create a certain proxy variable. We use the volatility model, widely used in finance field at present, and quantify the instability of confidence equivalent to the concept of variance. Strictly speaking, the risks of lenders (financial institutions) and borrowers (businesses) should be separately identified and considered. In this study, however, we take the approach of loosely integrating these two types of risks as confidence instability.

To be more precise, we incorporate a method using the Threshold AutoRegressive Conditional Heteroscedasticity (TARCH) 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 businesses and financial patterns, we now define it as the instability of confidence.

First, figure 3 shows that, at least for the Asian monetary crisis, the pattern $BC > FS$ was stable before the crisis and the pattern $BC < FS$ was stable following the crisis. For simplification, we assume that difference in business condition of the current period has a linear relationship to difference in the financial situation of the current as well as the previous period. This is shown as

$$\Delta BC_t = \alpha_0 + \alpha_1 \Delta FS_t + \alpha_2 \Delta FS_{t-1} + \mu_t, \quad (34)$$

(BC_t : business condition, FS_t : financial situation, μ_t : error term, α_0 : constant, α_1, α_2 : adjustment coefficients)

Equation (34) reveals situations in which there are differences in the association between business expectations for the financial environment and the 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 certain 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 TARCh model as below.

$$\sigma_t^2 = \beta_0 + \beta_1 \mu_{t-1}^2 + \beta_2 \mu_{t-1}^2 d_{t-1} + \beta_3 \sigma_{t-1}^2 \quad \mu_t | \text{Info}_{t-1} \sim N(0, \sigma_t^2). \quad (35)$$

Here, $\beta_0 > 0$, 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. d is an asymmetrical dummy variable. When minus shock is added to previous financing, the asymmetry in that variance of current time becomes large compared with the case in which the plus shock is added.

We assume that the conditional distribution of μ_t is normal and 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 TARCh model are as below.

$$\Delta BC_t = -0.011 + 0.792 \Delta FS_t + 0.133 \Delta FS_{t-1} + \mu_t, \quad (36)$$

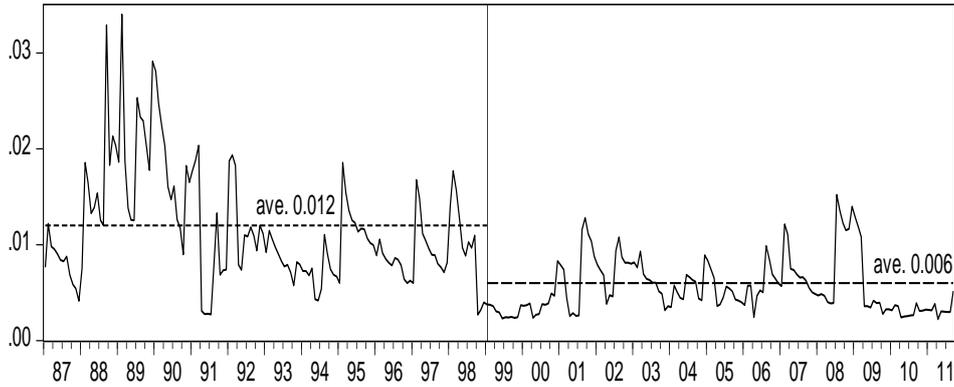
(-2.34) (16.58) (2.66)

$$\sigma_t^2 = 0.0003 - 0.08 \mu_{t-1}^2 + 0.459 \mu_{t-1}^2 d_{t-1} + 0.900 \sigma_{t-1}^2. \quad (37)$$

(2.51) (-5.62) (4.41) (28.06)

The sample period is from 1987M1 to 2011M9, and the numbers in parentheses represent t -values.

The estimation results show that each parameter meets the 1% significance level as well as the sign condition. The estimated financial environment

Figure 4 Conditional Variance σ^2 

Note: This means that the instability of the conviction increases with the increasing numerical value.

expectation conditional variance σ_t^2 (i.e., the proxy variable for the instability of confidence β) (figure 4) exhibits instability until the final stage of the 1990s. We observe that after the Asian monetary crisis the instability stabilized; however, it once again intensified during the period 2008-2009, which saw a sharp economic contraction following the US subprime loan crisis. Moreover, the large fluctuation caused by financial sector sentiments may have triggered several trends: a surge that was smaller and shorter-term than that in the first half, which includes the Asian monetary crisis, business liquidity preference, a significant change in capital positions, and a change in the transmission mechanism from finance to the real economy. In the VAR analysis section, we use the quantified σ^2 to represent the instability of confidence β and incorporate it into the VAR model, dividing the estimation period into two in 1998. We determined the boundary of division from the following four points.

- 1) The size relationship of previous FS and BS
- 2) Stable at lower levels at the time of instability of firm belief, which turned in quantification¹³⁾

¹³⁾ Although β itself is an endogenous variable, we consider the possibility that, triggered by the large shock (the Asian monetary crisis), it changed the economic structure. Further, because the variable quantified by equation (37) was a monthly base, we performed the

3) Secure the degree of freedom to estimate

4) Change time of an exchange system

Having divided the estimation period into two, we compare the differences found in the results of each subsample estimation.

3.3. Analysis Using VAR Model

According to the theoretical model, the macroeconomic variables that form the core of the VAR model include income Y_t , interest rate i_t , investment I_t , and the quantified confidence instability variable β_t .¹⁴⁾ Data sources are as shown in table 1; we use the quarterly data and estimate from the period 1987Q1 to 2011Q2, which is the time frame for which we can obtain continuous data. The data for 1999Q1 are divided into subsamples.

Table 1 Dataset

Variables	Data	Unit	Source
i : Interest Rate	Yields of National Housing Bonds Type1(5-year)	%	The Bank of Korea
Y : Income	GDP (at chained 2005 year prices, SA)	Bil. Won	The Bank of Korea
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

down conversion at the quarter.

¹⁴⁾ Essentially speaking, an analysis, which more closely met the theoretical model, can be performed by adding an exchange rate variable to the empirical model and making it a five-variable model. However, because the sample period of the available data is restricted, the analysis by division will inevitably fall into the shortage of the degree of freedom during the period. Therefore, we believed that the different connotation, obtained by the analysis divided into two periods, included the change effect of an exchange system, and decided to perform structural change analysis that can be performed in restrictions that include the insufficient degree of freedom.

Prior to performing the VAR analysis, we conduct a unit root test for the stationarity of each variable in each subsample by the ADF test. Using a model that includes trends and constants, we confirm that all variables are on differential stationary process, that is $I(1)$. We apply Johansen's cointegration test (maximum eigenvalue test) to various models, but no result strongly supports cointegration. As such, we use log differential variables in the analysis below. To give priority to ensuring the degree of freedom in our VAR model, the 2-term lag model was chosen.¹⁵⁾ From the above process, we specify the following dynamic model. \mathbf{X}_t is an endogenous vector, \mathbf{A}_1 is the coefficient matrix (constant vector omitted), and \mathbf{u}_t is the reduced innovation vector.

$$\begin{aligned}\mathbf{X}_t &= \mathbf{A}_1\mathbf{X}_{t-1} + \mathbf{A}_2\mathbf{X}_{t-2} + \mathbf{u}_t, \\ \mathbf{X}_t &= [\Delta Y_t, \Delta\beta_t, \Delta i_t, \Delta I_t]', \quad \mathbf{u}_t = [u_{Y_t}, u_{\beta_t}, u_{i_t}, u_{I_t}]'. \end{aligned}\tag{38}$$

Innovations are usually correlated, and may be viewed as having a common component that cannot be associated with a specific variable. To interpret the impulses, it is common to apply a transformation \mathbf{P} to the innovations such that they become uncorrelated: $\mathbf{V}_t = \mathbf{P}\mathbf{u}_t \sim (\mathbf{0}, \mathbf{D})$. \mathbf{D} is a diagonal covariance matrix, and \mathbf{P} is the inverse of the lower triangular Cholesky factor of the residual covariance matrix to orthogonalize the impulses.

First, we confirm the Granger causality observable between the four variables — that is, the marginal prediction power for the improvement of each variable — using the estimates of our VAR model and the F -test that we could incidentally perform.¹⁶⁾ Table 2 presents the results of the Granger

¹⁵⁾ According to Akaike's Information Criteria, 1 lag was supported in the first of the half model, and 2 lag in the second half model. Analyzing by respectively different lags becomes complicated. Further, because it was thought appropriate to consider influences before half a year, we chose the 2 lag model.

¹⁶⁾ Granger causality has the characteristic of determining causality on the basis of whether past variables contribute to improving the predictive capacity, i.e., if current circumstances are contingent only on past circumstances in linear systems such as the VAR model.

Table 2 Granger Causality Test

Null Hypothesis:	Sample: 1987Q1-1998Q4		Sample: 1999Q1-2011Q2	
	<i>F</i> -Statistic	Prob.	<i>F</i> -Statistic	Prob.
$\beta \rightarrow Y$	0.200	0.820	7.375	0.002
$Y \rightarrow \beta$	0.380	0.686	8.684	0.001
$i \rightarrow Y$	0.581	0.564	3.036	0.058
$Y \rightarrow i$	3.249	0.049	3.900	0.027
$I \rightarrow Y$	6.808	0.003	0.993	0.378
$Y \rightarrow I$	3.512	0.039	4.955	0.011
$i \rightarrow \beta$	3.481	0.040	0.707	0.499
$\beta \rightarrow i$	0.072	0.931	0.455	0.637
$I \rightarrow \beta$	0.742	0.483	3.005	0.060
$\beta \rightarrow I$	0.568	0.571	13.529	0.000
$I \rightarrow i$	2.029	0.145	0.400	0.673
$i \rightarrow I$	0.548	0.583	1.192	0.313

Notes: The shaded area shows the part in which the null hypothesis is rejected below the 10% significance level. \longrightarrow 1% significance level, $-----\longrightarrow$ 5% significance level, $\cdots\cdots\longrightarrow$ 10% significance level.

causality test. The mutual causality between the variables in Granger terms are weak in the early subsample, with only four directions, Y to i , Y to I , I to Y , and i to β , detected (hereafter, “causality” shall imply Granger terms). As to having affected one of other variables, although the three variables of Y , i , and I are affected by one of other variables with influence. On the other hand, although β is affected from i by influence, it has not affected other variables.

In contrast, we can see a complicated causality between each variable in

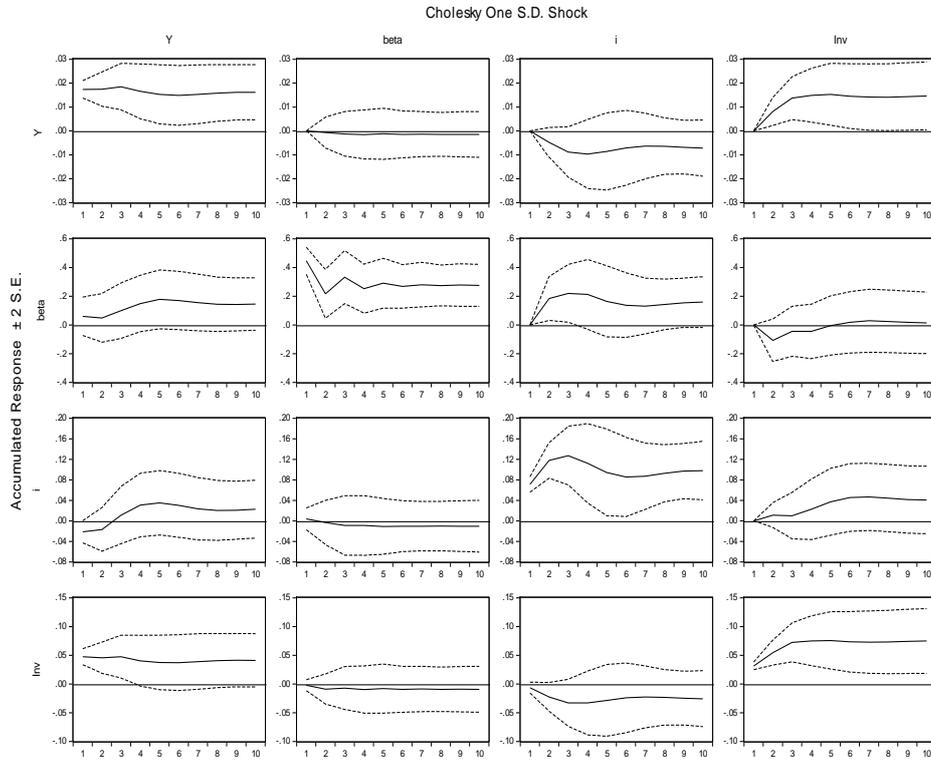
Therefore, we must consider that this is not a typical assessment of the causal relationship between the variables.

the later subsample. β and Y have a feedback relationship with significance at the 1% level, while β and I have a feedback relationship with significance at the 10% level, at least. Y and i also have feedback relationships. Further, one-sided causality was observed in I from Y at the 5% significance level. Similarly, one-sided causality was observed in β from i at the 5% significance level. We can infer that fluctuations in β affect the real economy in terms of investment and GDP. This is probably due to increased fluctuation in the interest rates following developments in financial liberalization.

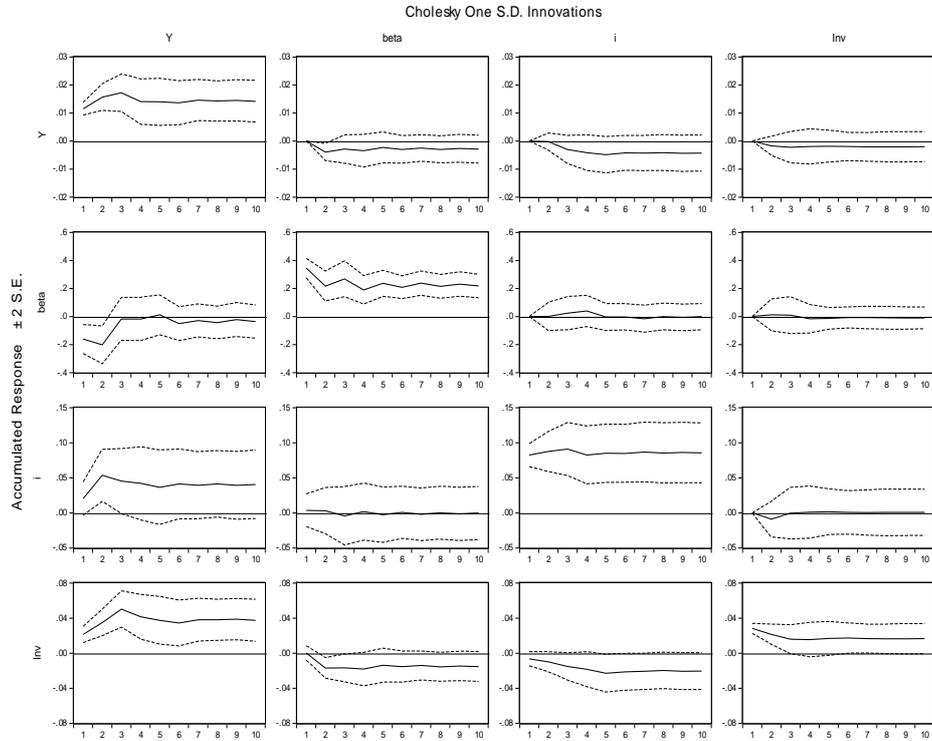
Although we could not confirm β 's effect on any of the main variables in the early subsample, it seems that the influence of β increased in the later subsample with adjustments made to the economic system. β affects ρ in equation ($S_a.2$), while ρ fluctuates with i in equation (6). This transmission mechanism can be interpreted as having materialized following the Asian monetary crisis.¹⁷⁾ 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 these questions by the impulse response function.

Figures 5 and 6 show the impulse response functions for the early subsample (1987-1998) and the later subsample (1999-2011), respectively. Shock (innovation) to the endogenous variable affects not only the variable 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 (2½ years). The solid lines show the accumulated value of an impulse and the dotted lines show ± 2 standard error bands.

¹⁷⁾ To investigate the robustness of the above major results, additional verifications of whether to adopt other models were performed. The adopted models are the model that set the lag to 1, and the five-variable model added in the exchange rate variable. In both models, the one-way causality to β in the first half was confirmed. Further, the complicated mutually cooperative nature of β was confirmed in the later half. These results are considered to support the findings of this section more strongly.

Figure 5 Impulse Response: 1987Q1-1998Q4

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, $Y \uparrow \Rightarrow \rho \uparrow \Rightarrow i \uparrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$ in section 2.1. First, with regard to the instability of confidence, figure 5 shows that the instability increases with positive interest rate shocks during the early subsample. The instability serves as the maximum in the 3rd term, and shows a gradual downward tendency thereafter. However, the influence of plus persists cumulatively after the 10th term (2nd row, 3rd column). Conversely, on the occasion of an instability increase shock, although interest rate is not significant, it falls slightly. We can observe that the reaction that would suppress economic contraction is weak (3rd row, 2nd column).

Figure 6 Impulse Response: 1999Q1-2011Q2

Similarly, only a slight reduction occurs for GDP and investment (1st row, 2nd column, and 4th row, 2nd column, respectively).

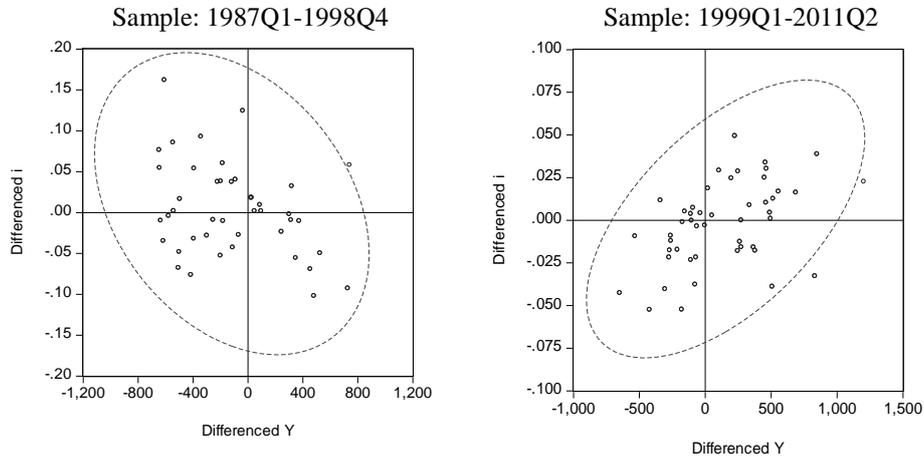
In contrast, figure 6 shows that the instability barely reacts to the increase shock of interest rates in the later subsample (2nd row, 3rd column). Similarly, the reaction of interest rate to the increase shock of the instability barely reacts (3rd row, 2nd column). In contrast, investment shows a clear downward trend. Similarly, although GDP is not significant, it too shows a downward tendency (1st row, 2nd column; 4th row, 2nd column).

Next, we examine the transmission mechanism in section 2.1, $Y \uparrow \Rightarrow \rho \uparrow \Rightarrow i \uparrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$. The direction and movement of each variable in the later subsample can clearly be seen. From the beginning, interest rates react

restrainedly to the overheating of business activity, shown by the rapid increase of Y , and serve as the maximum in the 2nd term (3rd row, 1st column). Although β falls by Y being interlocked with it at the beginning, parallel with a subsequent rise in interest rates, β returns in the 3rd term (2nd row, 1st column). Through this process, increases in investment are restrained, and an upward trend attenuates at approximately three terms (4th row, 1st column), with a consequent moderation in Y itself (1st row, 1st column). Such transmission is weak in the first half sample, probably because the response of the interest rates to the initial shock of economic overheating is unclear. That is, the interest rate level formation process becomes opaque and uncertain during interest rate liberalization.

With the later subsample, the previous Granger causality tests show that the transmission to i exists through Y from the instability of confidence β . In addition, by analysis of the impulse reaction function, even if the instability of confidence increases for a certain reason, it is believed that the system affecting I and Y , which are real economy, has been built. The construction of this system also leads to the stabilization of β itself. As shown in figure 4, this environment is possibly illustrated by the stable movement of σ^2 after 1999. In light of this probability, we can state that the robustness of the Korean financial system improved following the Asian monetary crisis. Therefore, it is considered that the structural change occurred at the end of the 1990s.

To investigate the robustness of the above major results, we used the level variable rather than the log difference variable, and performed additional verification. As a result, nearly the same estimation result was obtained. 1) The bidirection of the beta has been confirmed by the Granger causality test on the later subsample. 2) From the impulse response function, the stable business action by interest rate route has been ascertained in the later subsample. 3) The transmission which suggests that a system such as $Y \uparrow \Rightarrow \rho \uparrow \Rightarrow i \uparrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$ in section 2.1 is stable was checked. Therefore, it can be said that our conclusion has a certain amount of robustness.

Figure 7 Stochastic Simulation

Note: Vertical axis represents the difference in the forecasted interest rate, and horizontal axis represents the difference in the forecasted GDP. Dots are trend removal values.

Finally, we perform the stochastic simulation using the parameter of the VAR model obtained. This technique uses the value of each equation's error term, which constitutes the VAR model as the random number on the basis of the standard error not equal to zero, and solves the model. The number of simulation iteration is set as 1000. After extracting the income variable (Y) and the interest rate variable (i) from the result of the simulation, and taking difference respectively, the resulting scatter diagram is displayed in figure 7. The plotted point is the average value of the trial obtained from the simulation, and the inside of the ellipse expresses the confidence interval of 95%.¹⁸⁾

With the first half of the subsample, Y and i were in negative correlation. This result suggests $i_Y < 0$ and does not meet the assumption shown by equation 6. Further, β 's having been comparatively large suggests that the financial structure of this period was unstable. In contrast, the latter half of the subsample showed a positive correlation. In the period whose β was

¹⁸⁾ During the sample period, because the income and interest rate variables have upward and downward trends, respectively, the detrending points are shown.

stable, the simulation result also shows the potential to react as the theoretical model, wherein interest rates fall (rise) in correlation to a decrease (increase) in income ($i_\gamma > 0$). Accordingly, the simulation results suggested that the financial architecture was stable after a structural change occurred.

4. CONCLUSION

A monetary crisis occurred in Korea in 1997, confronting the Korean economy with great difficulties. A decade later, many nations including Japan were severely affected by the subprime loan crisis of 2007. However, it appears that the Korean economy had become strong enough to withstand the 2007 international monetary crisis.

We presented a macrodynamic model in an open economy by following Ninomiya (2007) and Ninomiya and Tokuda (2011). We examined how structural change, the degree of international capital mobility, and the risk of international lenders affected the dynamic systems of fixed and floating exchange rates. Next, we examined the structural changes in the Korean economy by using a VAR model.

The main conclusions drawn from this study are as follows. First, in the theoretical analysis pertaining to an open economy

- (1) The degree of international capital mobility is assumed to be sufficiently high ($\gamma \rightarrow \infty$). The dynamic system of fixed exchange rates (S_b) becomes locally unstable when the risk of international lenders is sufficiently large ($\delta \rightarrow \infty$).
- (2) 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 ($\delta \rightarrow 0$). The dynamic system of floating exchange rates (S_d) becomes locally stable under certain conditions when I_ρ is large ($i_\rho > 0$). The dynamic system of floating exchange rates (S_d) becomes locally stable when the risk of international lenders is

sufficiently large ($\delta \rightarrow \infty$).

In addition, in the empirical analysis

- (3) We quantified the instability of confidence β , which cannot be observed, and its having shifted high in the state until the final stage of the 1990s was shown. That occurred when the Korean economy received the big shock from the Asian monetary crisis at the end of the 1990s. However, we showed quantitatively that this instability subsided rapidly and stabilized considerably during the 2000s.
- (4) Having divided the entire sample period into the period when β was unstable (early period: 1987-1998) and the period after it stabilized (later period: 1999-2011), we conducted a VAR model-based analysis. A Granger causality test showed that in the later period, β had a causally strong relationship to the real economy. We also confirmed this causal relationship from the impulse response function and the process in which instability is included in financial architecture through the route of the interest rates. Simultaneously, the transition by which any overheating impact on the income elements of the real economy is moderated was verified.
- (5) The simulation was performed using the parameters obtained from the VAR model and found that during the periods when β is stable, there is a significant probability that we can confirm the theoretic response pattern of falling (rising) interest rates with a fall (rise) in income.

The results of the empirical analysis also have an impact of the interpretation of lender risks. Specifically, 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 macro variables. The results demonstrate that after the Asian monetary crisis, the mechanism of economic stabilization through interest rates worked as a consequence of this

structural change. This means that there was a validated built-in stabilizer underpinning the economy even during the period of severe contraction in the economic sentiments caused by the US subprime loan crisis. Considering these conditions, we can see that the strength of the financial system in Korea has further improved.

We believe that these theoretical results are consistent with the empirical implications. In short, we can apply (1) to the empirical results before 1998 and (2) to the empirical results after 1999.

Many nations have suffered from the international monetary crises. New research must examine the structural changes in these nations by applying VAR analysis. The financial instability hypothesis and the formal mathematical models on related topics treat cumulative debt burdens as one of the causes of financial instability. Thus, debt burden must be incorporated within future research. Further, the empirical model used in this study is a closed one that does not include variables that directly express the foreign sector superficially. 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 period of worldwide economic stability, there is a distinct possibility that a worldwide economic slump entangling global economic development may occur. Considering this possibility, we hope to construct an open model that includes the foreign sector as an issue for future consideration.

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