The Segmentation of Loan Interest Rates by Regional Financial Institutions:A Panel Cointegration Analysis

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Abstract

Whether there are the segmentations of loan interest rates among regional financial markets in Japan or not is the important issue on Japanese regional banking, especially during the period of financial crises in 1990s. The main purpose of this paper is to show the answer to the question. We analyze the data of the loan interest rates of regional financial institutions after the collapse of bubble economy during FY 1992 and FY2007 by the methods of panel cointegration tests. As a result, we found the cointegrating relationships between spreads of loan interest rates of Japanese regional financial institutions and logarithmic values of nominal gross prefectural products in whole Japan. Furthermore, We estimated the error correction model including four explanatory variables based on short-run dynamics such as NPL ratio, land price index, SMEs' business confidence DIs and Herfindahl index of loan share in prefectures. Such factors prevent them from lending to their local SMEs since the collapse of the bubble economies, but Japanese regional financial institutions had managed to adjust their loan interest rates to their local economic conditions.

Field of Research: Regional Banking
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1. Introduction

Loan interest rates of regional financial institutions are affected by not only economic condition but by other many factors such as credit risks of borrowers, risk tolerance of financial institutions, competition intensities of loan markets, regional business cycles, changes of policy interest rates, duration of loans, and so on and so forth. And a variety of regional factors would make much difference of loan interest rates among some regions in countries against “Law of One Price”.

The purpose of this paper is to examine whether there are the segmentations of loan interest rates among regional financial markets in Japan in the long run since the collapse of bubble economy by panel cointegration analysis. In those days, especially in the late 1990s, it is often pointed out that Japanese financial system were in dysfunctional state.

And we use the method of panel cointegration analysis which is effective to find long-term equilibrium among variables. Cointegration analysis generally requires a large number of observations. But the data on the loan assets of financial institutions are limited to low frequency ones; only annual and biannual data are available in Japan. Panel data of regional financial institutions enable us to analyze the relationships by inclusion many cross-sectional variation and compensating for the insufficient degrees of freedom.
This paper is organized as follows. Section 2 presents the overview of relevant literature. Section 3 presents a description of our sample and the variables. Section 4 presents the results of our empirical analyses, or unit root test and panel cointegration test of the data. Section 5 concludes.

2. Literature Review

Numerous attempts have been made by researchers to apply panel cointegration analyses widely to a variety of study objects. Additionally Nagahata et al (2004) estimated long-run equilibrium relationships of land prices using a panel cointegration analysis and estimate an error-correction model (ECM) for them and the ECM finds that deviations from the long-run equilibrium and non-performing loans have an effect on the fluctuation of real land prices.
Furthermore Nakamura and Saita (2007) found the cointegrating relationships between the discounted present value of land calculated based on the macro-economic indicators and land price indicators. The ECM Nakamura and Saita (2007) estimated finds that not only the changes in the discounted present value of land, but also the changes in the demographic factor and bank lending have an effect on the fluctuation of real land prices.

It is generally pointed out that increases of nonperforming loan (hereafter called “NPL”) ratio have harmful effects on the sound lending activities of Banks. For example, Sekine et al (2003) pointed out that in the 1990s, many banks including some regional financial institutions did not write off the NPLs aggressively enough by their forbearance policy.

As mentioned in section 1, whether there are segmentations of regional loan markets or not is one of the important topics on the regional finance. Kano and Tsutsui (2003) shows that the markets for regional commercial banks in Japan are not segmented and while those of shinkin banks are by the use of the data of FY 1996. Meanwhile Ishikawa and Tsutsui (2005) shows that loan markets in Japan are segmented as a whole by prefecture from FY 1990 until FY 2001 by the estimation of the supply and demand curves of loans by the regional financial institutions.

And relationship lending is regarded as an effective solution against such problems for regional financial institutions to keep their sound lending even in the worse economic situation. As Petersen and Rajan (1995) pointed out, relationship lending makes their SME and regional lending feasible because soft information generated during the relationship produces rents for the bank later in the relationship and permits the early losses to be offset. The function is known as intertemporal smoothing of relationship lending.

3. Data, Variables and Hypothesis

In this work we assume that there are equilibriums between spreads of loan interest rates and logarithmic values of nominal prefectural economic products as we show below. We use the two kinds of proxy variables. One is “$SPREAD_{i,t}$” which is the spread between loan interest rates of regional financial institutions and risk free rates And the other is “$Log(NGPP)_{j,t}$” which is the proxy of the logarithmic value of nominal gross prefectural products. The index i of “$SPREAD_{i,t}$ indicate individuals of regional financial institutions while those of j of “$Log(NGPP)_{j,t}$” indicate individuals of 47 prefectures in Japan.

We made the model of reduced forms to describe the relationship between them. Firstly, regional loan demand and supply functions could be specified as follows;
Loan demand function

$$L_{i,t}^{d} = \alpha_0 + \alpha_1 loanrate_{i,t} + \alpha_2 \ln\left(NGPP\right)_{j,t} + \mu_{i,t}^{d} \qquad (1)$$

Loan supply function

$$L_{i,t}^{s} = \beta_0 + \beta_1 loanrate_{i,t} + \beta_2 rf_{i,t} + \mu_{i,t}^{s} \qquad (2)$$

where r_f is risk free interest rate such as average yields of Japanese government bonds and two kinds of Ls are the loan outstanding. We could introduce the reduced form of those functions as follows

$$r_{i,t} - rf_{i,t} = spread_{i,t} = \gamma_0 + \gamma_1 \ln(NGPP)_{j,t} + \mu_{i,t} \quad (3)$$

During this period many regional financial institutions had disappeared by mergers and bankruptcies in Japan. We cut out the data of disappeared regional financial institutions because we need use balanced panel data for the unit-root tests and the panel cointegration tests. The number of survived regional financial institutions is 388 diminished from 592.

“Regional Financial Institution” we call in this work consists of three kinds of business categories: regional banks, second-tier regional banks and shinkin banks as table 1-1 shows. The sources for all of these data are Ginko Zaimu Shohyo Bunseki (*Analysis of Financial Statements of All Banks*) by the Japanese Bankers Association and Zenkoku Shinyo Kinko Zaimu Shohyo (*Financial Statements of Shinkin Banks in Japan*) by Financial Book Consultants, Ltd. And the variables “Log(NGPP) $_{j,t}$” are data from System of Prefectural Account which are estimated figures of aggregated economic activities by prefecture in reference to System of National Accounts (SNA). Cabinet Office, Government of Japan aggregate System of Prefectural Account of 47 prefectures and release “Annual Report on Prefectural Accounts”. We show the empirical results of several kinds of tests to analyze the long-term relationships between the data in section 4 as follows.

4. The Empirical Result

4.1. Unit Root Test

First of all we test for the presence of a unit root to verify if the variables are non-stationary or not. Recently several kinds of unit root test for panel data being introduced in the previous literatures, we adopted two kinds of test: Im, Pesaran and Shin (IPS) test and Augmented Dickey Fuller (ADF) test. Both of them are established tools in panel data analysis. Refer to Im, Pesaran and Shin(2003), and Maddala and Wu(1999) respectively.

Those tests consider the following basic ADF specification:

$$\Delta y_{i,t} = \alpha y_{i,t-1} + \sum_{j=1}^{p_i} \gamma_{ij} \Delta y_{i,t-j} + \beta_0 + \beta_1 t + \beta_2 x_{i,t} + \varepsilon_{i,t} \quad (4)$$

where β_0 is a constant, $\beta_1 t$ is a time trend, p_i is the appropriate lag order, $x_{i,t}$ is the

explanatory variables and $\Delta y_{i,t}$ is the explained variable. The null hypothesis of both IPS and ADF test is that $H_0 : \alpha_i = 0, \text{for all i}$ against the alternative hypothesis $H_1 : \alpha_i < 0,$ $\text{for at least one i}$. Table 4-1 shows the results of the panel unit root tests. The lag length employed in those unit root tests are selected by the Akaike Information Criterion. Judging from the result, it is reasonable to suppose that the both of "$SPREAD_{i,t}$" and "$Log(NGPP)_{j,t}$" are I(1).

Because the tests for the first differences of those variables suggest that the both kinds of null hypotheses of the existence of unit root are strongly rejected at 1 percent significance levels while those for the floors suggest that the null hypotheses are not rejected at least in the result of ADF test, on which we put the priority. In addition, the results of unit root tests for the residuals of the equation (3) are reported in Table 4-2. These results also show us that the residuals are also I(1).

4.2. Panel Cointegration Test

In this work we applies the panel cointegration tests developed by Westerlund (2007). In this test, we suppose a data generating process in the form as follows:

$$\Delta y_{i,t} = \phi_i * ECT_{i,t-1} + \sum_{j=1}^{p_i} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=-q_i}^{p_i} \beta_{ij} \Delta x_{i,t-j} + \delta_i' d_t + \varepsilon_{i,t} \qquad (5)$$

where d_t contains the deterministic components, for which there are three cases as follows. In the first case, $d_t = (1, t)'$ so $\Delta y_{i,t}$ is generated with both a constant and a time trend; in the second case, $d_t = 1$ so $\Delta y_{i,t}$ is generated with a constant; and in the third case, $d_t = 0$ so (2) has no deterministic terms. In this work we set $d_t = 1$ so that the data generating model include a constant without a time trend.
The parameter ϕ measures the speed which the system returns to its equilibrium after a sudden shock. We require the parameter ϕ to be negative to have a cointegration relationship among the variables. If the parameter ϕ is equal to zero, there is no cointegration.

Westrelund (2007) developed four new panel cointegration tests that are based on structural dynamics and do not impose any common-factor restriction. The idea is to test the null hypothesis as $H_0 : \phi_i = 0$ for all i, by inferring whether the error-correction term in the panel error-correction model as shown above is equal to zero. The four kinds of tests can be

divided into two groups by the difference of the alternative hypotheses. The two tests called group-mean tests are designed to test the alternative hypothesis that at least one unit is cointegrated as $H_1^G : \phi_i < 0$ for at least one i, while the other two called panel tests are designed to test the alternative hypothesis that the panel is cointegrated as a whole as $H_1^P : \phi_i = \phi < 0$ for all i.

The two kinds of group-mean tests can be calculated by:

$$G_{\mathrm{T}} = \frac{1}{N}\sum_{i=1}^{N}\frac{\hat{\phi}_i}{SE\left(\hat{\phi}_i\right)} \qquad (6)$$

$$G_{\alpha} = \frac{1}{N}\sum_{i=1}^{N}\frac{T\hat{\phi}_i}{\hat{\phi}_i} \qquad (7)$$

The two kinds of panel tests can be calculated by:

$$P_{\mathrm{T}} = \frac{\hat{\phi}}{SE\left(\hat{\phi}\right)} \qquad (8)$$

$$P_{\alpha} = T\hat{\phi} \qquad (9)$$

And in this work we need to take consideration of the cross-sectional dependence because their loan interest rates and loans outstanding have affection among them one another to some extent as preceding studies pointed. To avoid this problem we introduced bootstrap into the test to get the robust critical values for the test statistics. The number of replication for the bootstrap is 400, and the both number of lags and leads are set 1 simply.

Table 4-3 shows the results of these panel cointegration tests using three kinds of Kernel windows. As for the test of the statistic values of G_{T} and P_{T}, the null hypotheses are rejected (using a 5% significance level) in most cases, while they are not rejected in all the tests of the statistic values of G_{α} and P_{α}. Judging from the results, it is reasonable to suppose that "$\mathrm{SPREAD}_{i,t}$" and "$\log(\mathrm{NGPP})_{j,t}$", are cointegrated even though null hypotheses are not perfectly rejected.

Now we can introduce an error correction model. It is as follows:

$$\Delta SPREAD_{i,t} = \beta_0 - \phi * ECT_{i,t-1} + \beta\Delta\log(\mathrm{NGPP})_{j,t} + \lambda\Delta z_t + \varepsilon_t \qquad (10)$$

where, ECT_{t-1} stands for Error Correction Term. This means that relational expression $\Delta SPREAD_{i,t} = \beta_0 + \beta\Delta\log(NGPP)_{j,t} + \lambda\Delta z_t$ is effective in the long run, but actually $\mathrm{ECT}_{i,t-1}$

occurs as a deviation from the long-term equilibrium. In other words, $ECT_{i,t-1}$ is the difference between actual spread and its long-term equilibrium value, that is $(SPREAD - SPREAD*)_{i,t-1}$.

ΔZ_t are the explanatory variables based on short-run dynamics as we stated. These variables widen the gap between the equilibrium and the non-equilibrium. As mentioned above, considering the characteristics of regional financial institutions as risk-averters, the variables which have much effect on the competition in the regional loan markets and the loan demands and regional economic situation are plausible as proxy variables forΔZ_t. We describe the proxy variables for ΔZ_t estimations of ECM later.

4.3. Estimation of Error Correction Model

In this subsection We estimate an error correction models －hereinafter called ECM－based upon the long-run equilibrium of the relationships between variables in Model 3 in which cointegrating relationships among variables were found in the previous section. Again, let us show the ECM as the equation (10). It is as follows:

$$\Delta SPREAD_{i,t} = \beta_0 - \phi * ECT_{i,t-1} + \beta \Delta \log(\mathrm{NGPP})_{\mathrm{j,t}} + \lambda \Delta z + \varepsilon_{i,t} \qquad (11)$$

where i = 1……N is the number of regional financial institutions, j = 1……N is the number prefectures and t= 1……T is the number of periods.

We consider the following four variables as suitable ones for ΔZ of ECM.

1. $NPL_{i,t-1}$: One period lagged variables of $NPL_{i,t}$

The variables $NPL_{i,t-1}$ are the one period lagged variable of $NPL_{i,t}$ and considered to have much effect on the activity of regional financial institutions in the short run. The data of risk management loans of individual Shinkin banks are not available before FY 1998. Therefore we adopted an alternate solution for missing data of individual shinkin banks as follows;

① At first we calculated average NPL ratios of regional commercial banks (regional banks and second-tier regional banks) in 47 Japanese prefectures from FY1992 until FY2007.

② We substitute the NPL ratios of them by prefecture for the NPL ratios of individual shinkin banks sorted by prefecture as well from FY 1992 until FY 1997 .

2.$\Delta ACLP_{j,t}$: Change rates of the average commercial land prices by prefecture

The variables $\Delta ACLP_{j,t}$ are the yearly change rates of the average commercial land prices. The fluctuations of land prices are thought to have much effect on the activities of regional

financial Institutions.

3. $SMEDI_{j,t}$: SMEs' business confidence DIs

The SMEs' business confidence DI of Japan has been released by SMRJ every quarter since 1980. At first we transformed the quarterly DIs into yearly DIs by calculating the average values on a fiscal year basis. The regional DIs have been released since FY 1994 and those in FY 1992 and FY 1993 are not acquirable. As a workaround we substituted the DI of the whole country for them.
All the regional DIs are negative and the mean of them is -21.694 as table 4-10 shows. SMEs' business confidences had been exacerbated from FY1992 to FY2007 as a general trend.

4. $HHI_{j,t-1}$: one period lagged variables of the Herfindahl-Hirschman Index of loans outstanding of regional financial institutions by prefecture or $HHI_{j,t}$

Table 4-4 is the descriptive statistics of ECM and Figure 4-1 illustrates the fluctuations of the variables of ECM. In estimation of ECM, we used Random Coefficient Model to allow for heterogeneity in parameters.

The result of ECM is posted in Table 4-5. In test of parameter constancy of the model, null hypothesis that there is homogeneity of parameters was rejected. All estimated coefficients except for $HHI_{j,t-1}$ are significant and have expected signs.

The coefficient of $ECT_{i,t-1}$ is -0.6352, negative and more than -1. This shows that the sign of $ECT_{i,t-1}$, which is deviations from the long-run equilibriums, are matching theoretically.
The coefficient of $\Delta Log(NGPP)_{j,t}$ is +0.0152, significantly positive. In previous section we found cointegrating relationship between the risk premium and logarithmic values of gross prefectural product. It is appropriate to think that when regional economies expand (recess), the risk premium that regional financial institutions take increase (decrease) during the periods from FY 1992 to FY 2007.

The coefficient of $NPL_{i,t-1}$ is +0.0071, positive, although its significance is at a little more than 1%. This means that NPL ratios could be an adequate index for the degree of risk-taking on judging from the sign condition. It is natural that the more nonperforming loans financial institutions have the more risk premium they also take. Therefore as a whole the valuations of existing loans by the regional financial institutions function well. But the significance at a little more than 10% level of the coefficient leads to our presumption that regional financial

institutions have their limits to evaluate their loans.

The coefficient of $\Delta ACLP_{j,t}$ is -0.0025, significantly negative, although its p-value is rather high, 0.056. It means that when land prices are falling as we have seen in '90s in Japanese economy, regional financial institutions tend to take much credit risks in the short run.

The coefficient of $SMEDI_{j,t}$ is -0.0005, significantly negative. This means that while the business confidence of SMEs get worse, regional financial institutions take risks in the short run. Those which make a point of putting relationship lending into practice would take more risks in spite of the deterioration of the index in the short run.

The coefficient of $HHI_{j,t-1}$ is 0.01262, not significant and positive. This means that the intensities of competitions for loans in prefectures do not have any effects significantly on the risk premium which regional financial institutions take in the short run. But because of the positive sign condition it is plausible that if the competitions got less fierce, regional financial institutions would take more risk in the short run.

5. Conclusion

In this work, to begin with, we first examined whether there are cointegrating relationship between "$SPREAD_{i,t}$" and "$\log(NGPP)_{j,t}$" or not. The former variables are loans interest rates of Japanese regional financial institutions minus the average subscription yields of Japanese government bonds in the same fiscal years, and the latter variables are logarithmic values of nominal gross prefectural products from FY 1992 till FY2007.

After all we found the cointegrating relationship between them. It means that it is appropriate to say that as a whole there are segmentations in Japanese regional loan markets against "Law of One Price".

Then we estimate ECM including four explanatory variables based on short-run dynamics. And we found that both the increase of NPL ratio of regional financial institutions and the falls of land prices and SMEs' business confidence DIs tend to break long-term equilibriums between "$SPREAD_{i,t}$" and "$Log(NGPP)_{j,t}$", meanwhile Herfindahl herschman index don't have significant affection.

In Japan since the collapse of the bubble economies, some regional financial institutions had disappeared by mergers and bankruptcies. Increases of their nonperforming loans, shrinking of their assets and decreases of the demands for their loans have prevented them from

lending to SMEs and the local companies. Some became too risk-avert to take risks to increase their loans, as it were in dysfunctional state. Such lending attitudes suffocate regional economies where they act at home.

But as a whole Japanese regional financial institutions had managed to adjust their loan interest rates to their regional economic situations through relationship lending to enhance their community based banking activities. It is important for activation of the whole economy in Japan to enhance function of relationship lending.

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Table 1-1 The Business Categories of Financial Institutions of Japan and the Definition of Regional Financial Institutions in this paper

Business categories				Definition and characteristics	The number of banks at the end of FY1992	The number of banks at the end of FY2007
Regional Financial Institutions in this paper	**Regional Financial Institutions**	**Commercial Banks**	City Banks	Banks whose head offices or central branches are located in major cities and have presences nationwide.Especially the present top 3 banks are called Megabanks. These banks are also the cores of three gigantic financial groups.	11	6
			Regional Banks	Banks which are members of Regional Banks Association of Japan. Most of them are the largest banks in the prefectures where their head offices are located.	64	64
			Second-tier Regional Banks	Banks which are members of The Second Association of Regional Banks. Compared with Regional Banks, most of them are smaller.	71	45
		cooperative financial institutions	Shinkin Banks	A type of cooperative financial institution serving SME, local residents and local community. Anyone who lives, works, or has an office in the region served by the bank can become a member. However, companies with over 300 employees are prohibited from membership.	435	281
			Credit Unions, JA banks, Labor credit association… etc			

Table 4-1 Results of Unit Root Tests of variables and Our Judgment

	$SPREAD_{i,t}$		$\log(NGPP)_{j,t}$	
Im, Pesaran and Shin test (IPS test)				
Level	-0.39		-2.04	**
1st difference	-39.70	***	-29.45	***
ADF test- Fisher Chi-square				
Level	672.58		728.85	
1st difference	2,713.97	***	2,189.04	***
Judgment	I(1)		I(1)	

"***", "**" and "*" denote statistical significance at the 1%, 5% and 10% levels, respectively
Null and alternative hypotyeses of thosetests are as follow:
H0:each series contains a unit root, H1:some of the individual series contains a unit root
In any test, the base model for the residual include both their constant terms and time trends

Table 4-2 Results of Unit Root Tests of residuals and Our Judgment

	explainted variable: $SPREAD_{i,t}$	
Im, Pesaran and Shin test (IPS test)		
Level	-0.31	
1st difference	-44.79	***
ADF test - Fisher Chi-square		
Level	668.83	
1st difference	2,722.27	***
Judgment	I(1)	

"***", "**" and "*" denote statistical significance at the 1%, 5% and 10% levels, respectively
In any test, the base model for the residual include both their constant terms and time trends

Table 4-3 Results of Cointegration Tests and Our Judgment

Variables: $SPREAD_{i,t}$ and $\log(NGPP)_{j,t}$

Kernel window	Statistics	Value	Z-value	p-value	robust p-value	
1	Gt	-2.355	-12.662	0.000	0.053	*
	Ga	-4.172	10.749	1.000	0.315	
	Pt	-39.41	-10.959	0.000	0.035	**
	Pa	-4.38	-0.665	0.253	0.150	
2	Gt	-2.355	-12.662	0.000	0.053	*
	Ga	-3.78	12.166	1.000	0.398	
	Pt	-36.841	-8.374	0.000	0.048	**
	Pa	-3.522	3.142	0.999	0.358	
3	Gt	-2.355	-12.662	0.000	0.048	**
	Ga	-3.448	13.368	1.000	0.438	
	Pt	-35.813	-7.341	0.000	0.040	**
	Pa	-3.516	3.17	0.999	0.255	

"***", "**" and "*" denote statistical significance at the 1%, 5% and 10% levels, respectively
In any test, the base model for the residual include their constant terms without their time trends
The lag length employed in those unit root tests are selected by the Akaike Information Criterion

Table 4-4 Descriptive Statistics for ECM

	obserbations	Mean	Maximum	Minimum	Std. Dev.
$\triangle SPREAD_{i,t}$ (%)	5,820	-0.0082%	5.227%	-4.544%	0.5244
ECT_{t-1}	5,432	0.018	0.042	-0.012	0.011
$\Delta log(NGPP)$ j,t	5,820	0.004	0.185	-0.151	0.024
$NPL_{i,t-1}$(%)	5,820	5.61%	27.20%	0.04%	0.044
$\Delta ACLP_{j,t}$(%)	6,208	-9.052%	28.080%	-54.207%	0.097
$SMEDI_{j,t}$	6,208	-20.694	-10.575	-31.850	4.874
$HHI_{j,t-1}$	5,820	0.333	0.776	0.041	0.168

Figure 4-1 Grahps of mean value of variables of ECM

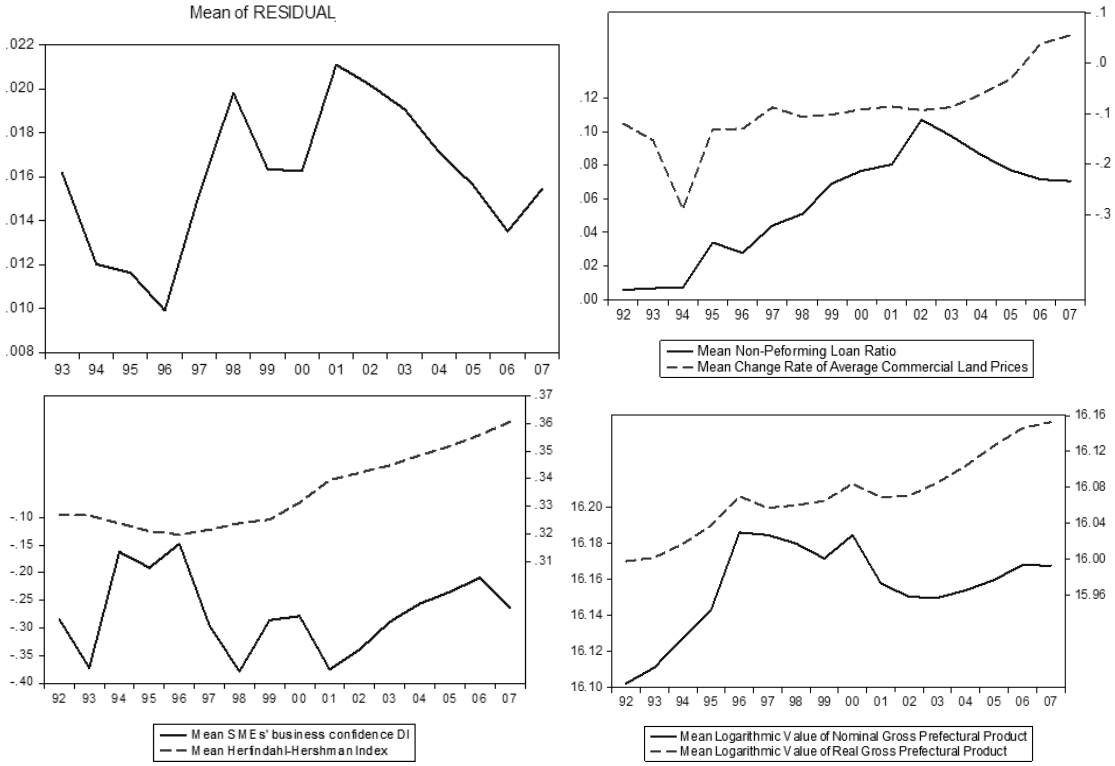

Table 4-5 Result of ECM

	explained variable $\Delta SPREAD_{i,t}$		
Explanatory variables			
ECT_{t-1}	-0.6352	(0.0000)	***
Δlog(NGPP) j,t	0.0152	(0.0010)	***
$NPL_{i,t-1}$	0.0071	(0.1030)	
$\Delta ACLP_{j,t}$	-0.0025	(0.0560)	*
$SMEDI_{j,t}$	-0.0005	(0.0000)	***
$HHI_{j,t-1}$	0.0126	(0.4020)	
constant term	-0.0076	(0.0170)	**
Observations	5,432		
wald test χ^2	2,338.71	***	
Test of parameter constancy χ^2	5,013.45	***	

Notes:
1. Estimated as a Random Coefficients Model. See Swany(1970).
2. Figures in parentheses are p-value.. "***", "**" and "*" denote statistical significance at the 1%, 5% and 10% levels, respectively
3. Test of parameter constancy is a test for parameter homogeneity. The null hypothesis corresponds to homogeneous parameters across regional financial institutions, which follows the χ^2 distribution with K(n-1) degrees of freedom. K is the number of explanatoryvariables and n is the number of samples.