Economic Activity of Korea by Region

- Judged by Coincident Index of Economic Activity -

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Abstract

In this paper, coincident indices of economic activity are computed in 5 major regions of Korea. State-space model and Kalman filter are employed. Based on the calculated coincident indices, we can conclude that economic activity in all regions went through recovering trend from the second quarter of 2009. By the way, the phase of recovery showed somewhat difference among regions.

Economic activity of the provinces(the whole country excluding Seoul) fluctuated more sharply than that of the whole country. Looking at the state of economic activity in each major region, we noted that the Daejeon-Chungcheong region led recovery trend while the Daegu-Gyeongbuk region remained comparatively subdued. Difference of economic activity movements among regions came mostly from recovering speed of the manufacturing industry.

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** Contents in this paper is an opinion of author, not the official view of the Bank of Korea.

Ⅰ. Introduction

Although Korean economy went through slowdown due to the global finance crisis, it has shown a strong-based recovery trend since the second quarter of 2009. But it is well possible that the phase of recovery may differ owing to variations in the industrial structure of particular regions. The purpose of this paper is to compute coincident index of economy activity in 5 major regions of Korea. By drawing up regional coincident indices, the state of regional economic activity can be grasped and its characteristics would be revealed.

The rest of the paper is organised as follows. In section Ⅱ, we explain the model, which is employed to calculate coincident index of economic activity. In section Ⅲ, we compute coincident indices and grasp respective characteristics in each region. And we summarize result and draw implications in section Ⅳ.

Ⅱ. Employed model

In this paper, we use dynamic single variable model in Stock · Watson(1991). This model is based on the notion that each macroeconomic variable is comprised of unobserved common factor C_t, and unique factor μ_t. And it extracts common factor by maximum likelihood method, applying State-space model and Kalman filter.

1. State-space model, and Kalman filter[1)]

State-space model is a useful tool for expressing dynamic system which involves unobserved variables. The model makes it convenient to extract unobserved variables. It consists of two equations : a measurement equation and a transition equation.

Measurement equation : It describes the relation between observed variables and unobserved variables.

$$y_t = x_t \bullet \beta_t + \epsilon_t, \qquad \epsilon_t \sim i.i.d\ N(0, R) \tag{1}$$

where y_t is a N×1 vector of observed variables at time t,

β_t is a m×1 vector of unobserved variables,

x_t is a N×m matrix of coefficients, which connects m unobserved variables with n observed variables,

ϵ_t is a N×1 vector, which means measurement error of observed variables, normal distribution of 0 mean and covariance matrix R.

Transition equation(sometimes called state equation) : It describes the dynamics of unobserved variables.

$$\beta_t = F_t \bullet \beta_{t-1} + v_t, \qquad v_t \sim i.i.d\ N(0, Q) \tag{2}$$

where F_t is a m×m matrix, which means transition process of unobserved variables,

v_t is a m×1 vector, normal distribution of 0 mean and covariance matrix Q.

1) To write this part, we made reference to Kim · Nelson(1999).

Kalman filter is a method, which estimates State-space model. It is a recursive procedure that calculates optimal estimator of unobserved variables at time t, based on the available information at time t. It carries out 2 steps - prediction and correction - repeatedly.

Prediction : At the beginning of time t, the model calculates optimal estimator of unobserved variable β_t, based on all the available information up to time t-1. And $y_{t|t-1}$ is computed, applying equation (1).

$$\beta_{t|t-1} = F \cdot \beta_{t-1|t-1} \tag{3}$$

$$P_{t|t-1} = F \cdot P_{t-1|t-1} \cdot F' + Q \tag{4}$$

$$\eta_{t|t-1} = y_t - y_{t|t-1} = y_t - x_t \cdot \beta_{t|t-1} \tag{5}$$

$$f_{t|t-1} = x_t \cdot P_{t|t-1} \cdot x_t' + R \tag{6}$$

where $\beta_{t|t-1}$ is an estimator of β_t, based on the information up to time t-1,

$P_{t|t-1}$ is a covariance matrix of β_t, based on the information up to time t-1,

$\eta_{t|t-1}$ is a prediction error,

$f_{t|t-1}$ is a conditional variance of the prediction error.

Correction : At the end of time t, the model corrects estimator of unobserved variable β_t, applying prediction error $\eta_{t|t-1}$. y_t is observed at the end of time t.

$$\beta_{t|t} = \beta_{t|t-1} + K_t \cdot \eta_{t|t-1} \tag{7}$$

$$P_{t|t} = P_{t|t-1} - K_t \cdot x_t \cdot P_{t|t-1} \tag{8}$$

where $\beta_{t|t}$ is an estimator, based on the information up to time t,

$P_{t|t}$ is a covariance matrix of β_t, based on the information up to time t,

$K_t = P_{t|t-1} \cdot x_t' \cdot f_{t|t-1}^{-1}$ is a Kalman gain, which determines weight assigned to new information about β_t contained in the prediction error.

We can draw estimator of unobserved variables and parameters, combining Kalman filter and maximum likelihood method. At first, initial values of parameters are set, and likelihood function is calculated. Next, we gain optimal estimator of parameters, using maximum likelihood method. Finally, optimal estimator of unobserved variables are computed, applying Kalman filter to the estimator of parameters.

2. Selecting indicators

Statistics Korea(the national statistical office of Korea) uses 8 indicators to compute coincident index of economic activity.[2] Among those, we use 3 indicators - manufacturing production index(MPI), amount of real import(RI), employees on nonagricultural payrolls(ENP) - that are made by regions. And consumption of electricity by the service sector(CES) is added, which represents service industry. We use data from 2000:1 - 2009:12.

All indicators are seasonally adjusted, and then converted to 3-month moving average. Unit root tests for each series suggest that one cannot reject the null hypothesis of a unit root, with 5% level of significance. The result is organized in Table 1.

<Table 1>

The result of unit root tests(t-statistics)[3]

Region \ Indicator	MPI(Y_1)	RI(Y_2)	CES(Y_3)	ENP(Y_4)
The whole country	-0.428	-1.183	-1.698	-1.256
Provinces	-0.058	-1.335	-2.059	-0.847
Inchon-Gyeonggi	-0.306	-0.353	-2.433	0.282
Busan-Ulsan-Gyeongnam	-0.532	-1.364	-2.263	-2.446
Daejeon-Chungcheong	1.262	-1.491	-2.827	-2.093
Gwangju-Jeolla	-0.080	-1.271	-1.827	-3.066
Daegu-Gyeongbuk	-1.180	-0.620	-2.687	-2.507

After converting all observed variables(Y_i) to logarithm, we get the first difference, and consider dynamic factor model below.[4]

2) Statistics Korea computes weighted sum of rate of increase - compared to the last month - by each indicators to draw coincident index of economic activity.

3) Y_1, Y_2, Y_3 : ADF with intercept (5% critical value = -3.488)
Y_4 : ADF with intercept and trend (5% critical value = -4.040)

4) We reflected characteristic of employment indicator - lagging to economy activity - in equation (10)

$$\Delta y_{i,t} = \gamma_i \Delta c_t + e_{i,t}, \quad i = 1, 2, 3 \tag{9}$$

$$\Delta y_{4t} = \gamma_{40} \Delta c_t + \gamma_{41} \Delta c_{t-1} + \gamma_{42} \Delta c_{t-2} + \gamma_{43} \Delta c_{t-3} + e_{4t} \tag{10}$$

$$\Delta c_t = \phi_1 \Delta c_{t-1} + \phi_2 \Delta c_{t-2} + w_t, \quad w_t \sim i.i.d\, N(0, 1) \tag{11}$$

$$e_{i,t} = \psi_{i1} e_{i,t-1} + \psi_{i2} e_{i,t-2} + \epsilon_{i,t}, \quad \epsilon_{i,t} \sim i.i.d\, N(0, \sigma_i^2), \quad i = 1, 2, 3, 4 \tag{12}$$

where $\Delta y_{i,t} = \Delta Y_{i,t} - \Delta \overline{Y_i}$, and $\Delta c_t = \Delta C_t - \delta$, δ is an average of ΔC_t

After estimating parameters by maximum likelihood method, we can calculate $\Delta c_{t|t}$, applying Kalman filter to the estimated parameters. And we can also draw $C_{t|t}$, coincident index of economic activity at time t, using equation (13).

$$C_{t|t} = C_{t|t-1} + \Delta c_{t|t} + \delta \tag{13}$$

One can refer to Kim · Nelson(1999) to calculate δ.

Ⅲ. Computing coincident index of economic activity by regions

As figure 1, administrative district of Korea can be divided into 7 regions. Among those, gross value added(GVA) of Gangwon and Jeju region are much smaller than other regions. Therefore, we would focus on the other 5 major regions.

<Figure 1>

Administrative district of Korea

Source : Yonhap-News, Korea

<Table 2>

GVA of each region(2008)

	GVA (a trillion won)	Relative Weight (%)
The whole country	927.5	
Provinces	704.4	100.0
Inchon-Gyeonggi	223.8	31.8
Busan-Ulsan-Gyeongnam	161.4	22.9
Daejeon-Chungcheong	100.0	14.2
Gwangju-Jeolla	92.2	13.1
Daegu-Gyeongbuk	94.5	13.4
Gangwon	24.2	3.4
Jeju	8.3	1.2

Source : Statistics Korea (Table 2 ~ Table 7)

1. Provinces(the whole country excluding Seoul)

Influenced by the global financial crisis, coincident index of economic activity(Cyclical component) in the provinces showed sharp decrease from November 2008, and pointed the lowest record 91.0 in February 2009. But it continued rising and pointed 102.3 in December 2009. When coincident index of economic activity corresponds to long-term trend, its cyclical component points 100. So it makes sense that coincident index assures strong recovery trend of economic activity in the provinces.

Compared to the whole country, economic activity in the provinces went through sharp fluctuation. It was mainly caused by the fact that weight of manufacturing in the provinces is larger than that of the whole country. Manufacturing business underwent such a heavy slump owing to the global financial crisis. But it has continued rapid upward trend since March 2009, and also led recovery of economic activity.

<Table 3>

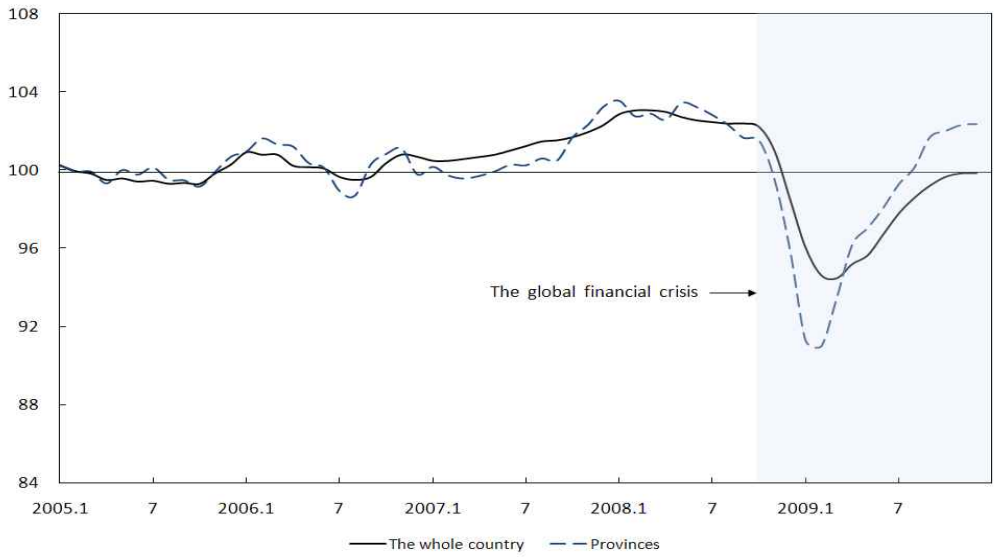
Industrial structure in the provinces(2008)

(unit : %)

	Manufacturing	Construction	Service	Others[5]	Sum
Provinces	35.1	8.0	51.1	5.8	100.0
Seoul	4.6	4.4	90.0	1.0	100.0
The whole country	27.8	7.1	60.5	4.7	100.0

<Figure 2>

Coincident index of economic activity in the provinces(Cyclical component)



5) Agriculture, forestry and fishery, Mining industry, Electricity, gas and water supply industry

2. Inchon-Gyeonggi region

Coincident index of economic activity(Cyclical component) in the Inchon-Gyeonggi region pointed the lowest record 91.1 in January 2009. However, it reached 101.7 in December 2009. In figure 3, we can find similarity pattern of cyclical component between the Inchon-Gyeonggi region and the provinces. It came mostly from analogy of the industrial structure. Inversely, now that GVA in the Inchon-Gyeonggi region is the largest among 5 major regions, we can also conclude that the region exerted large influence on the industrial structure and economic activity of the province.

<Table 4>

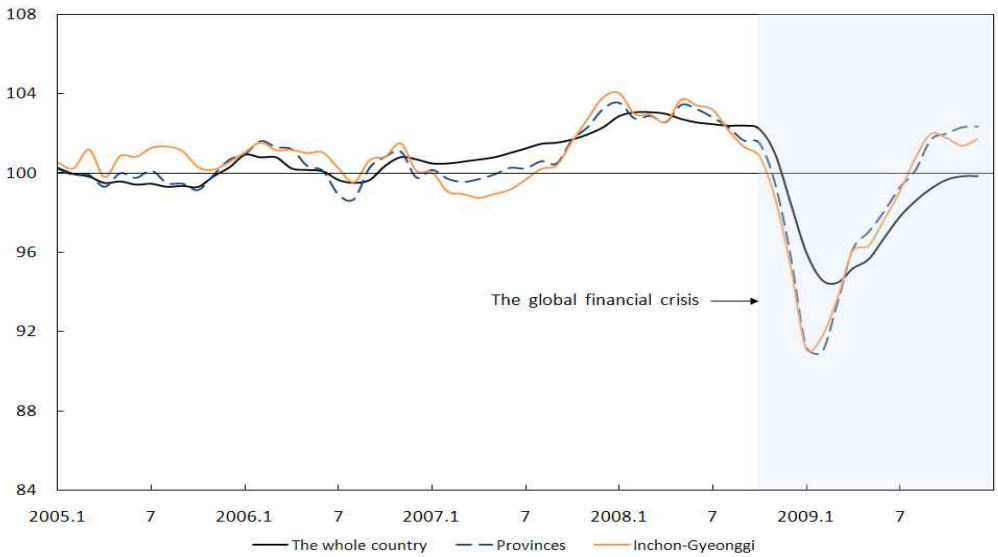
Industrial structure in the Inchon-Gyeonggi region(2008)

(unit : %)

	Manufacturing	Construction	Service	Others	Sum
Inchon-Gyeonggi	32.2	8.5	56.1	3.2	100.0
Provinces	35.1	8.0	51.1	5.8	100.0

<Figure 3>

Coincident index of economic activity in the Inchon-Gyeonggi region (Cyclical component)



3. Busan-Ulsan-Gyeongnam region

Coincident index of economic activity(Cyclical component) in the Busan-Ulsan-Gyeongnam region pointed the lowest record 94.0 in February 2009. It is similar to the lowest record in the whole country(March 2009, 94.5). Although weight of manufacturing in the region is the largest among 5 major regions, the region went through weak slump relatively. It came from high weight of the shipbuilding industry, which continued growth in the first half of 2009, because the amount of orders received was sufficient. However, it showed slowdown in the second half of 2009, as the amount of new order declined. Eventually, cyclical component of coincident index has continued decreasing since September 2009.

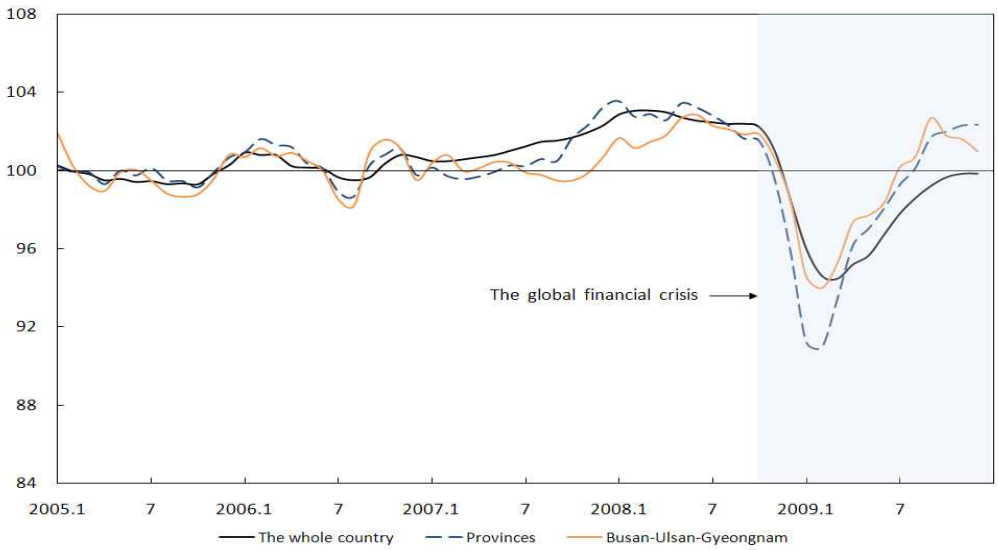
<Table 5>

Weight of shipbuilding industry in the manufacturing(2008)

The whole country	5.9%
Provinces	6.1%
Inchon-Gyeonggi	0.0%
Busan-Ulsan-Gyeongnam	20.9%
Daejeon-Chungcheong	0.0%
Gwangju-Jeolla	5.2%
Daegu-Gyeongbuk	0.2%

<Figure 4>

Coincident index of economic activity in the Busan-Ulsan-Gyeongnam region (Cyclical component)



4. Daejeon-Chungcheong region

Coincident index of economic activity(Cyclical component) in the Daejeon-Chungcheong region pointed the lowest record 90.6 in January 2009. However, it showed really sharp increase and pointed 105.1 in December 2009. As figure 5, the region led overall recovery trend in Korea since the second quarter of 2009. Weight of IT industry in the manufacturing is the largest in the Daejeon-Chungcheong region. It mainly contributed the fastest speed of recovery in the region. As demand in China increased, exports of LCD sector showed large growth. Also, production in semiconductor field increased thanks to the launch of smart-phone and Windows 7.

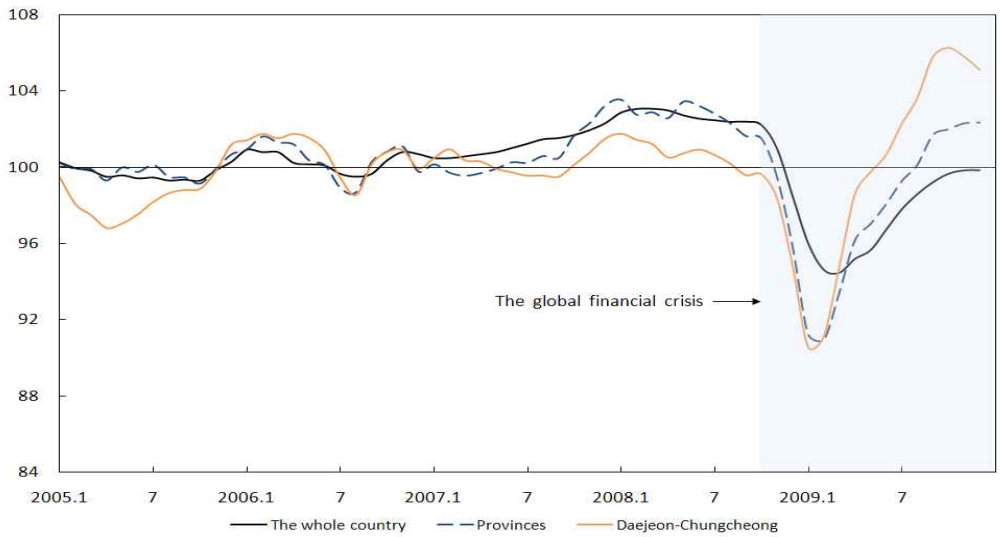
<Table 6>

Weight of IT industry[6] in the manufacturing(2008)

The whole country	11.9%
Provinces	12.1%
Inchon-Gyeonggi	19.8%
Busan-Ulsan-Gyeongnam	1.4%
Daejeon-Chungcheong	24.2%
Gwangju-Jeolla	2.3%
Daegu-Gyeongbuk	9.9%

<Figure 5>

Coincident index of economic activity in the Daejeon-Chungcheong region (Cyclical component)



6) Manufacturing semiconductor and electronic component

5. Gwangju-Jeolla region

Coincident index of economic activity(Cyclical component) in the Gwangju-Jeolla region pointed the lowest record 87.2 in February 2009. It is the lowest level among 5 major regions. Similar to other regions, manufacturing mostly brought about the decline of economic activity in the Gwangju-Jeolla region. However, after the third quarter of 2009, demand of the petrochemistry sector increased, influenced by expanding domestic demand in China. Output in the car industry went up, as both domestic demand and export showed sharp increase.[7] As a result, cyclical component of coincident index in the Gwangju-Jeolla region mounted up considerably from September 2009, and pointed 105.3 in December 2009.

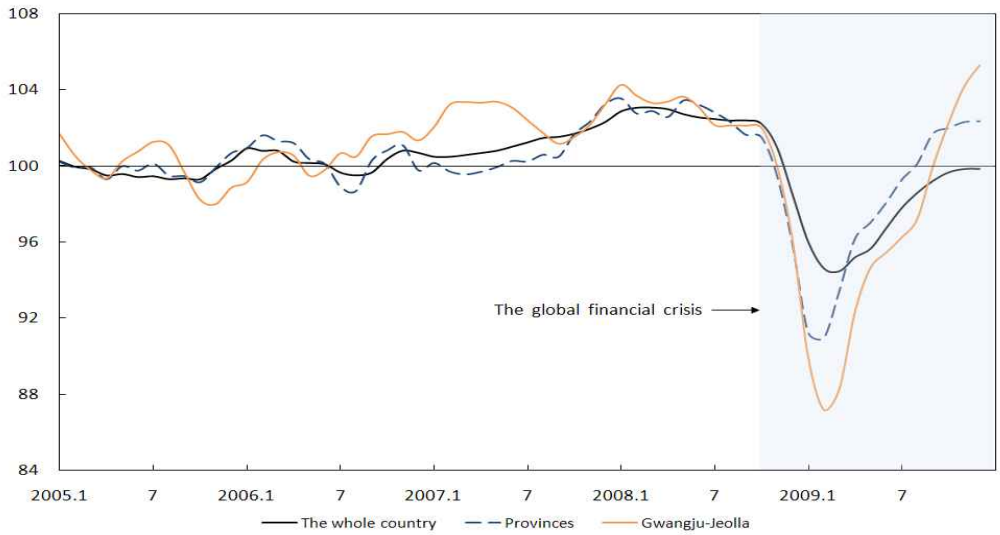
<Table 7>

Weight of the Petrochemistry industry compared to manufacturing(2008)

The whole country	4.6%
Provinces	4.8%
Inchon-Gyeonggi	0.8%
Busan-Ulsan-Gyeongnam	9.3%
Daejeon-Chungcheong	2.9%
Gwangju-Jeolla	14.5%
Daegu-Gyeongbuk	0.1%

<Figure 6>

Coincident index of economic activity in the Gwangju-Jeolla region(Cyclical component)



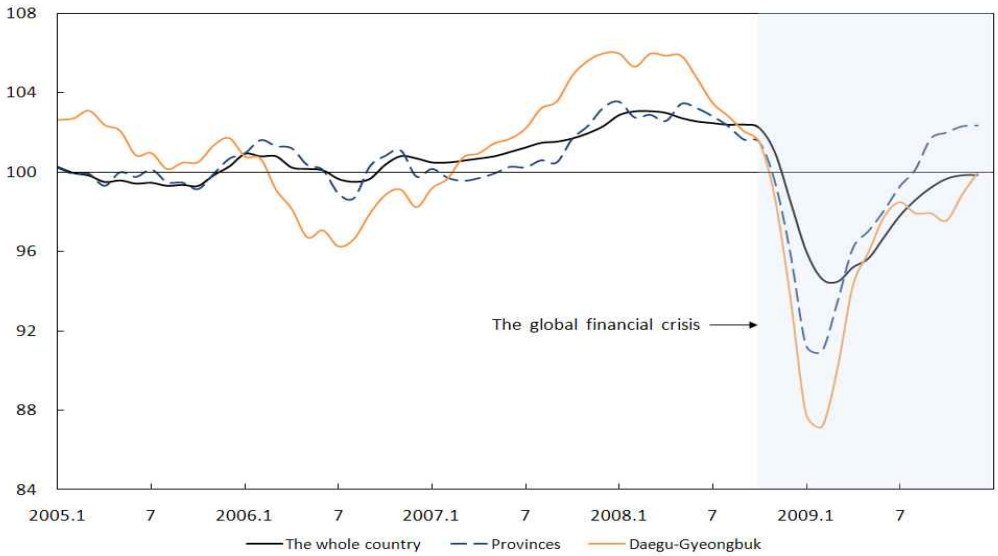
7) To stimulate economy, government of Korea gave the tax favor to those who purchased motor vehicle in 2009.

6. Daegu-Gyeongbuk region

Coincident index of economic activity(Cyclical component) in the Daegu-Gyeongbuk region pointed the lowest record 87.2 in February 2009. Its pattern was considerably similar to that of the Gwangju-Jeolla region to July 2009. While Gwangju-Jeolla region showed rapid increase since September 2009, Daegu-Gyeongbuk region went through tardy recovery phase. It was attributable to relatively slow pace of growth in the manufacturing production. It was another reason that the amount of import in the end of 2009 couldn't reach the level before the global financial crisis.

<Figure 7>

Coincident index of economic activity in the Daegu-Gyeongbuk region
(Cyclical component)



Ⅳ. Summary and Implications

In this paper, we computed coincident index of economic activity, applying State-space model and Kalman filter. Based on cyclical components of calculated indices, we found out that economy activity in Korea showed rapid recovery trend overall. However, we also discovered the difference of recovery phases among regions.

At first, coincident index of economic activity(Cyclical component) in the provinces(the whole country excluding Seoul) fluctuated sharply, compared to that of the whole country. It mostly came from relatively high weight of manufacturing sector, which was largely influenced by the global financial crisis. The Inchon-Gyeonggi region went similar business fluctuation to the provinces, due to the similarity of industrial structure. In the Busan-Ulsan-Gyeongnam region, economy showed relatively fine figure in the first quarter of 2009, caused by upswing in the shipbuilding industry. Though, it went through poor phase in the second half of 2009. Index of the Daejeon-Chungcheong region rapidly rised, centering on the IT industry. And the region led overall recovery trend in Korea. Economic activities in the Gwangju-Jeolla and Daegu-Gyeongbuk region showed really poor figure in the first quarter of 2009, influenced most largely by the global financial crisis. While the Gwangju-Jeolla region went quick recovery thanks to favorable turn in the petrochemistry and car industry, the Daegu-Gyeongbuk region showed such a dull phase.

Like this, movement of economic activity showed different figure, following industrial structure of each region. Especially, we found out that manufacturing sector led overall conditions of economic activity, during the period of occurrence and recovery of the global financial crisis. But industrial structure of Korea may go through change, like increasing weight of service industry. In this paper, we used consumption of electricity by the service sector as a indicator of service industry, attributable to the shortage of available statistics. But the indicator doesn't seem to represent an output or condition of service industry. Therefore, it is necessary to organize statistics that can represent overall condition of service industry by region.

- Reference -

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