Intra-national and International PPP between cities of Japan and South Korea: Empirical evidence using panel unit root and panel cointegration tests[1]

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Abstract

In this paper, we investigate whether long-run absolute purchasing power parity (PPP) holds between cities of Japan and South Korea using nonstationary panel data analysis. Our samples comprise fourteen disaggregated monthly consumer price indices from fourteen Japanese and six South Korean cities from 1977 to 2002. First, by using the panel unit root tests developed by Levin, Liu and Chu (2002), Im, Pesaran and Shin (2003), and Choi (2001), we consider the stationarity of the intra-national real exchange rate. Next, we apply Pedroni's (2004) panel cointegration tests to verify the cointegrating relationship between the South Korean Won-Japanese Yen nominal exchange rate and relative consumer prices. The results clearly confirm that the real exchange rate in the two countries was nonstationary for all goods although there were some differences in the types of tests conducted and the significance levels of these tests. Also, we infer that there exists a long-term equilibrium relationship between the nominal exchange rate and relative prices in cities of the two countries.

Keywords: purchasing power parity, real exchange rate, nominal exchange rate, relative prices, panel unit root, panel cointegration.

JEL Classification: E31; F31; F41

1 Introduction

Over the past several decades, a considerable number of studies have been conducted on purchasing power parity (PPP)[1]. Further, due to the development of nonstationary time series analysis techniques, primary focus of empirical studies concerning PPP has shifted toward verifying whether deviations from PPP or the real exchange rate are stationary or whether there exists a cointegrating relationship between the nominal exchange rate and relative prices. In many cases, researchers utilized the Dickey-Fuller (1979) or Augmented Dickey-Fuller (ADF) test as the unit root test. However, as pointed out by Campbell and Perron (1991) and others, univariate unit root tests such as the ADF test have relatively low power to reject the null hypothesis when it is, in fact, false.

To compensate for this drawback, researchers have recently adapted two approaches. The first is to simultaneously monitor a number of currencies and the second is to observe long-horizon data sets. In other words, by increasing the number of countries (N) or the length of time series (T), they have attempted to increase the power of statistical inference. However, this gives rise to another problem: the fact that long time series encompass priods in which nominal exchange rates regimes shifted from floating to fixed and back again. Recently, there has been an increase in the amount of research that utilizes panel data sets ($N \times T$) in a form of integration of these components. The earliest application of panel methods for testing PPP was Hakkio (1984), which used monthly panel data sets.

Recent literatures on PPP using panel data sets include Pedroni (1995) (1997) (2001) (2004), Oh (1996), Wu (1996), Coakley and Fuertes (1997), Papell (1997) (2002), O'Connell (1998), Groen and Kleibergen (1999), Canzoneri, Cumby and Diba (1999), Groen (2000), Azali, Habibullah and Baharumshah (2001), Choi (2001), and Basher and Mohsin (2003). These studies represent the analysis of the PPP at the international level, using samples of industrialized countries.

At the same time, there exist literatures that aim to test the PPP at the intra-national level. For example, refer to Parsley and Wei (1996), Jenkins (1997), Culver and Papell (1999), Nenna (2001), Levin, Lin and Chu (2002), Cecchett, Mark and Sonora (2002), Chen and Devereux (2003), Esaka (2003), Carrion-i-Silvestre et al. (2004), and Chaudhuri and Sheen (2004). In fact, there is a wide consensus that the PPP hypothesis should be most easily satisfied at the intra-national level than when it is analyzed at the international level. The reasones for this include greater market integration and the

[1] Comprehensive surveys include Froot and Rogoff (1995) and Rogoff (1996).

absence of both trade barriers (tariffs and quotas) and exchange rate volatility. Although there exist transportation costs that prevent arbitrage, they are presumably smaller within than between countries. Since these figures are collected by the same statistical institution and the basket of goods is more homogeneous, price indices within a country are expected to be more homogeneous than price indices between countries.

In particular, Azali, Habibullah and Baharumshah (2001) applied the panel unit root tests developed by Im, Pesaran and Shin (1997) and the panel cointegration tests proposed by Pedroni (1995) (1997) to examine long-run absolute PPP for seven Asian developing countries. Also, Esaka (2003) utilized the concepts of Im, Pesaran and Shin (1997) and Maddla and Wu (1999) to test whether long-run absolute PPP holds between major Japanese cities using disaggregated consumer price data. Chaudhuri and Sheen (2004) investigated PPP across major Australian cities and found that according to the panel unit root test, intra-national PPP cannot be rejected.

In this paper, we apply the framework of these panel cointegration analyes to verify whether PPP holds between major cities of Japan and South Korea. As a verification methodology for PPP, this study investigates time series properties of real exchange rates between cites within each country and long-run time series relationships between Korean Won-Japanese Yen nominal exchange rate and relative consumer prices between pairs of cities from Japan and South Korea. We use the panel unit root test developed by Im, Pesaran and Shin (2003), Fisher-ADF and Fisher-PP tests to consider the stationarrity of real exchange rate, and Pedroni (2004) to examine cointegrating relationship between nominal exchange rate and relative prices.

This paper is structured as follows. Section 2 reconsiders the approach to PPP by using panel data sets. Section 3 introduces the tools of empirical analysis used in this paper. We perform empirical analysis and compare our results to those obtained for other countries in Section 4. Finally, Section 5 presents a conclusion for the paper and proposes directions for future research.

2 Reexamination of PPP from the viewpoint of Panel Data

According to Hallwood and MacDonald (2000), the doctrine of PPP underlies most modern literatures pertaining to balance of payments and exchange rate determination. In general, there are two versions of the theory of PPP: absolute PPP and relative PPP. Absolute PPP suggests that the long-run equilibrium-level exchange rate should be equal to the ratio of the domestic price level to the foreign price level. Thus, this relationship can be expressed as follows:

$$S_t = \frac{\sum_{i=0}^{n} a^i P_t^i}{\sum_{i=0}^{n} a^i P_t^{i*}}, \tag{1}$$

where S, P^i, and P^{i*} denote the exchange rate, domestic price level of good i, and foreign price level of good i, respectively; the subscript t represents time; and the α terms denote the weights[2]. Based on regression, this relationship between nominal exchange rates and price ratios in the log form can be written as

$$s_t = \alpha_t + \beta_t p_t + \gamma_t p_t^* + \epsilon_t \tag{2}$$

In addition, the real exchange rate can be expressed as follows:

$$Q_t = \frac{S_t \sum_{i=0}^{n} a^i P_t^{i*}}{\sum_{i=0}^{n} a^i P_t^i}, \tag{3}$$

where Q denotes the real exchange rate. If we express (3) using natral logarithms, we obtain

$$q_t^i = s_t^i + p_t^{i*} - p_t^i. \tag{4}$$

Under PPP, the (log) real exchange rate is constant (specifically, $q = 0$). In this case, let $p_{j,t}^i$ denote the log of price level of in city j at period t; $p_{k,t}^i$, the log of price level in city k; and $s_{jk,t}^i$, the log of the nominal exchange rate that relates the currencies of two cities $j, k = 1, \ldots, N, j \neq k$. Therefore, the real exchange rate between cities j and k, $q_{jk,t}^i$, is generally expressed as (4).

$$q_{jk,t}^i = s_{jk,t}^i + p_{j,t}^i - p_{k,t}^i \tag{5}$$

If city j and city k belong to different countries, $s_{jk,t}^i$ is considered the normal nominal exchange rate; however, if they are in the same country and share a common currency, the effect of the nominal exchange rate in (4) disappears. Thus, the real exchange rate within a country is given by

$$q_{jk,t}^i = p_{j,t}^i - p_{k,t}^i. \tag{6}$$

[2] In (1), it is assumed that α is constant in each country's price level.

In other words, we find it informative to study and compare the distributions of three types of log of exchange rates: $q^i_{jk,t}$ over all city-pairs within Japan; $q^i_{jk,t}$, over all city-pairs within South Korea; and $q^i_{jk,t}$, over all city-pairs where city j is in Japan and city k is in South Korea.

3 Nonstationary Panels[3]

In order to test the PPP hypothesis between cities of Japan and South Korea, we apply the panel data unit root test.

3.1 Panel unit root tests

3.1.1 Levin, Liu and Chu (2002)

Levin, Liu and Chu(2002) proposed to test the null hypothesis of $H_0 : \delta = 0$ against the alternative hypothesis of $H_1 : \delta < 0$ using

$$\Delta q_{i,t} = \alpha_{mi} d_{mt} + \delta q_{i,t-1} + \sum_{k=1}^{p} \gamma_k \Delta q_{i,t-k} + \epsilon_{i,t}, \tag{7}$$

where d_{mt} denotes the deterministic components, and $\epsilon_{i,t}$ is assumed to be independently distributed across i and t, with $i = 1, \ldots, N$ and $t = 1, \ldots, T$. Once the normalised bias and the pseudo t-ratio that corresponds with the pooled OLS estimation of δ in (7) are appropriately normalised, convergence to a standard normal limit distribution is observed as $N \to \infty$, $T \to \infty$ such that $\sqrt{N}/T \to 0$.

3.1.2 Im, Pesaran and Shin (2003)

The test in Im, Pesaran and Shin (2003) is based on the estimation of (7), but replacing δ with δ_i. The null hypothesis is given by $H_0 : \delta_i = 0 \ \forall i$, whereas the alternative hypothesis is $H_1 : \delta_i < 0$, $i = 1, \cdots, N_1$; $\delta_i = 0, i = N_1 + 1, \cdots, N$. Therefore, the null is rejected if there is a subset (N_1) of stationary individuals. The first test that they propose is the standardised group-mean Lagrange Multiplier (LM) bar test statistic

$$\Psi_{\overline{LM}} = \frac{\sqrt{N}\left[\overline{LM} - N^{-1}\sum_{i=1}^{N} E\left(LM_i\right)\right]}{\sqrt{N^{-1}\sum_{i=1}^{N} Var\left(LM_i\right)}}, \tag{8}$$

[3]This section is based on Banerjee (1999), Baltagi (2001) Ch.12, and EViews 5 User's Guide Ch.17.

with $\overline{LM} = N^{-1} \sum_{i=1}^{N} LM_i$, where LM_i denotes the individual LM tests for testing $\delta_i = 0$ in (7), and $E(LM_i)$ and $Var(LM_i)$ are obtained by Monte Carlo simulation.

The second test is the standardised goup-mean t bar test statistic $\Psi_{\bar{t}}$, with an expression similar to (8), but replacing $\overline{LM}$ and LM_i by $\bar{t}$ and t_i, respectively.

We define $\bar{t} = N^{-1} \sum_{i=1}^{N} t_i$, where t_i denotes the individual pseudo t-ratio for testing $\delta_i = 0$ in (7), and $E(t_i)$ and $Var(t_i)$ are obtained using Monte Carlo simulation. In Im, Pesaran and Shin (2003), as $N \to \infty$, $T \to \infty$, and $N/T \to k$, the limiting distribution of both test statistics is standard normal.

3.1.3 Fisher-ADF and Fisher-PP tests

An alternative approach to panel unit root tests uses Fisher's (1932) results to derive tests that combine the p-values from individual unit root tests.This notion was proposed by Maddala and Wu (1999) and Choi (2001).

If we define π_i as the p-value from any individual unit root test for cross-section i, then under the null of unit root for all N cross-sections, we have the asymptotic result

$$-2 \sum_{i=1}^{N} log\left(\pi_i\right) \to \chi^2_{2N}. \tag{9}$$

In addition, Choi (2001) demonstrates that

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}\left(\pi_i\right) \to N\left(0, 1\right), \tag{10}$$

where Φ^{-1} is the inverse of the standard normal cumulative distribution function.

3.2 Panel cointegration

In this paper, we use two types of heterogeneous panel cointegration tests developed by Pedroni (1995) (1997) (2004), which allow different individual effects across N or cross-sectional interdependency. As argued by Pedroni (1995) (1997) (2004), this method will take into account the off-diagonal terms in the residual long-run covariance and the effects of spurious regression in a heterogeneous panel. The first type of test includes the panel rho (ρ), panel non-parametric (pp), and panel parametric (adf) statistics. The panel non-parametric statistic is similar to the Phillips and Perron (1988) test, and the panel parametric statistic is analogous to the single-equation

ADF-test.The second type of test proposed by Pedroni (1995) (1997) (2004) is comparable to the group mean panel tests of Im, Pesaran and Shin (2003). Pedroni (1995) (1997) (2004) argued that both types of tests are appropriate for testing the null of cointegration in bivariate panel models with heterogeneous dynamics, fixed effects, and heterogeneous cointegrating slope of coefficients. These tests have been used to investigate the absolute PPP hypothesis. Following Pedroni (1995) (1997) (2004), the heterogeneous panel and the heterogeneous group mean panel of rho(ρ) and the parametric (adf) and non-parametric (pp) statistics are caluculated as follows:

Panel ρ-statistic

$$Z_\rho = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{2} \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i} \left(\hat{e}_{it-1} - \Delta \hat{e}_{it} - \hat{\lambda}_i \right) \tag{11}$$

Panel parametric adf-statistic

$$Z_t = \left(\hat{S}^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{*2} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{*} \Delta \hat{e}_{it}^{*} \tag{12}$$

Panel non-parametric pp-statistic

$$Z_{pp} = \left(\hat{\sigma}^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{it-1}^{2} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{e}_{it-1} \Delta \hat{e}_{it} - \hat{\lambda}_i \right) \tag{13}$$

Group ρ-statistic

$$\tilde{Z}_\rho = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{e}_{it-1}^{2} \right)^{-1} \sum_{t=1}^{T} \left(\hat{e}_{it-1} \Delta \hat{e}_{it} - \hat{\lambda}_i \right) \tag{14}$$

Group parametric adf-statistic

$$\tilde{Z}_t = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{S}_i^{-2} \hat{e}_{it-1}^{*2} \right)^{-1/2} \sum_{t=1}^{T} \hat{e}_{it-1}^{*} \Delta \hat{e}_{it}^{*} \tag{15}$$

Group non-parametric pp-statistic

$$\tilde{Z}_{pp} = \sum_{i=1}^{N} \left(\hat{\sigma}^2 \sum_{t=1}^{T} \hat{e}_{it-1}^{2} \right)^{-1/2} \sum_{t=1}^{T} \left(\hat{e}_{it-1} \Delta \hat{e}_{it} - \hat{\lambda}_i \right). \tag{16}$$

Here, $\hat{\sigma}^2$ is the pooled long-run variance of the non-parametric model given by $1/N \sum_{i=1}^{N} \hat{L}_{11i}^{-2} \hat{\sigma}_i^2$; $\hat{\lambda}_i = 1/2 \left(\hat{\sigma}_i^2 - \hat{S}_i^2 \right)$, where $\hat{L}_i$ is used to adjust for autocorrelation in the panel parametric model, $\hat{\sigma}_i^2$ and $\hat{S}_i^2$ are the long-run and contemporaneous variances, respectively, for country i and $\hat{S}^2$ are obtained from individual ADF tests of $e_{it} = \rho_i e_{it-1} + \nu_{it}$. S^{*2} is the individual contemporaneous variance of the parametric model; $\hat{e}_{it}$ the estimated residual from the parametric cointegration in (2), while $\hat{e}_{it}^*$ the estimated residual from the parametric model; $\hat{L}_{11i}$ the estimated log-run covariance matrix for $\Delta\hat{e}_{it}$; L_i is the i th component of the lower-triangular Cholesky decomposition of matrix Ω_i for $\Delta\hat{e}_{it}$, with the appropriate lag length determined by the Newey-West method.

4 Empirical Analysis

4.1 Data and Descriptive Statistics

We use consumer price data from fourteen Japanese cities (Sapporo, Sendai, Saitama, Tokyo, Chiba, Kawasaki, Yokohama, Nagoya, Kyoto, Osaka, Kobe, Hiroshima, Kitakyushu, and Fukuoka) and six Korean cities (Seoul, Busan, Daegu, Daejeon, Gwangju, and Incheon) for fourteen monthly disaggregated consumer price indices. The data for Japan is obtained from *the Annual Report on the Consumer Price Index* published by the Statistics Bureau of Ministry of Internal Affairs and Communications and data for South Korea is obtained from *the Annual Report on the Consumer Price Index* published by the National Statistical Office[4]. The data covers the period from April 1977 to December 2002.

The goods[5] used for price comparison comprise general (1), cereals (2), meat(3), dairy products and eggs (4), fruits (5), cakes and candies (6), beverages (7), alcoholic beverages (8), clothes (9), fuel, light, and water charges (10), mecial care (11), transportation and communication (12), education (13), and housing (14)[6].

We select one benchmark city each from Japan and one from South Korea. The benchmark cities selected are Tokyo and Seoul, the capital cities of the respective countries.

We calculate the relative price from the time series data of the benchmark city and the city that is the object of comparison by each goods group and adopt the logarithm value as a sample. Table 1 and 2 present the descriptive statistics of the data used in this study. A positive value in the tables indicates that prices in the subject city are higher than those in the benchmark

[4] Both countries' consumer price indices for the year 2000 are 100.

[5] The classification of goods is identical to the classification of CPI.

[6] Numbers in parentheses correspond to the notations used in tables.

city. In contrast, a negative value indicates that prices in the benchmark city are higher.

From Table 1, we observe that the Japanese cities where, on an average, prices are lower than Tokyo are Sapporo, Sendai, Saitama, and Kawasaki; however, some differences exist. across goods groups. At the same time, it is evident from from Table 2 that prices in all subject cities in South Korea are, on an average, higher than those in Seoul.

4.2 Empirical Results

4.2.1 Panel unit root

Table 3 presents the results of the standard ADF unit root test for individual relative prices of goods groups as well as the results of Levin, Liu and Chu (2002), Im, Pesaran and Shin (2003), Fisher-ADF and Fisher-PP tests for the panel unit root test. In column 1 and 2, we report the estimated results from the level of the series, and in column 3 and 4, the estimated results from the first difference of the series are reported. Also, in column 1 and 3, we adopt the model with only a constant term, and in column 2 and 4, the model with both a constant term and a time trend term is adopted[7]. In the section presenting the result of the Fisher-ADF test and Fisher-PP tests, the upper rows present the Fisher-χ^2 statistics and the lower rows present Choi's (2001) Z statistics. Hereafter, we report the results of unit root tests of individual goods groups.

1. General CPI

In a univariate unit root test, when testing by using the data of the significance level when applying the model with only a constant term, the null hypothesis of unit root test can be rejected for only one city at 10 percent significance level among the 13 Japanese cities and one city at 5 percent significance level and one at 10 percent significance level among the five South Korean cities. When the trend term is included, the hypothesis cannot be rejected among Japanese cities, but can be rejected only for one city among all South Korean cities at 10 percent level. However, when testing based on first differenced data, the null hypotheis can be for rejected in all cities at different significance levels with the exception of two cities in Japan when the model with both the constant and the trend terms is applied.

Results of panel unit root tests are described as follows. According to the LLC (2002) test, the null hypothesis of having a common unit root process

[7]According to Papell (1997), the model with a time trend term is not consistent with long-term PPP. However, similar to Esaka (2003), we estimate the model with a time trend term in this paper.

cannot be rejected for Japan; however, it can be rejected in South Korea at 5 percent significance level, assuming the constant and trend term model. From the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected for Japan at 1 percent significance level if testing is based on first differenced data and can be rejected for South Korea at all significance levels; however, the significant level of the test when using differenced data is higher thant when using original data. The two types of Fisher's panel unit root tests produce different results of estimation. First, when applying the Fisher ADF test, the null hypothesis of individual unit root process can be rejected at 1 percent significance level in Japanese cities' panel data from both χ^2 estimated value and Choi's (2001) Z statistics when using differenced data. With regard to South Korea, when the level of the series is used, the null hypothesis can be rejected at 10 percent significance level with the χ^2 estimated value and at 5 percent significance level with Choi's (2001) Z statistics when only using the constant term model specification as well as at 10 percent significance level with Choi's (2001) Z statistics. When using differenced data, both statistics indicate that the null hypothesis can be rejected at 1 percent significance level. Second, applying the Fisher-PP test to Japanese cities' panel data, the null hypothesis can be rejected when using original data and the model with only a constant term model from the viewpoint of χ^2 statistics and when using differenced data, the null hypothesis can be rejected for both formulations and both statistics.

2. Cereals

In a univariate unit root test, we can reject the null hypothesis of the unit root test for only one city at 10 percent significance level among 13 Japanese cities and one city at 5 percent significance level and one city at 10 percent significance level among five South Korean cities when testing by using the level of the series and applying the model with only the constant term. Further, when the trend term is included, we can reject the null hypothesis for two Japanese cities at 5 percent significance level as well as one city at 5 percent significance level and two cities at 10 percent significance level among South Korean cities. However, when testing based on the first differenced data, we can reject the null hypotheis for 12 Japanese cities and all South Korean cities at different significance levels, with the exception of Kitakyushu in Japan.

Next, we report the results of panel unit root tests. First, we cannot reject the null hypothesis of common unit root process in both Japan and South Korea by using the LLC (2002) test. Second, from the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected on the basis of original data of Japan at both 10 and 5 percent significance levels. If testing is based on first differenced data, we can reject the null hypothesis in both Japan and South Korea at all significance levels. Third, we report different results for the two types of Fisher's panel unit root tests. Applying the Fisher ADF test, the null hypothesis of individual unit root process cannot be rejected for Japan when using the level of data but can be rejected at 1 percent significance level when using the differenced data. With regard to South Korea, when using the level of the series, we can reject the null hypothesis at 10 percent significance level with χ^2 estimated value and at 5 percent significance level with Choi's (2001) Z statistics when applying the model with both the constant and trend terms. Using differenced data, both statistics indicate that the null hypothesis can be rejected at 1 percent significance level. Fourth, the applying Fisher-PP test to the level of the data of Japanese cities, we cannot reject the null hypothesis but can reject it while using demeaned data at 1 percent significance level for both specifications. In the case of South Korea, we can reject the null hypothesis for all specifications and all estimated values.

3. Meat

In ADF, which is an individual unit root test, we can reject the null hypothesis of the unit root test for only one city at 10 percent significance level when applying to the model with only a constant term model and at 5 percent significance level when applying the model with constant term ant trend terms among 13 Japanese cities but cannot reject it for South Korea's level data. When testing based on first differenced data and applying the constant term model, we can reject the null hypotheis of the unit root test for eight cities at 1 percent significance level, two cities at 5 percent significance level, one city at 10 percent significance level, and cannot reject it for two cities in Japan in addition to rejecting it for all South Korean cities at 1 percent significance level. With these data and with the constant and trend term model, we can reject it in six cities at 1 percent significance level, two cities at 5 percent significance level, one city at 10 percent significance level, and cannot reject in four cities in Japan, in addition to rejecting it for all South Korean cities at 1 percent significance level.

We now focus on the results of panal unit root tests. First, we cannot reject the null hypothesis of common unit root process in either Japan or South Korea from level panel data; however, we can reject it in Japan when applying the constant and trend term model at 10 percent significance level as well as in South Korea with both specifications at 5 percent significance level by using the first differenced data by the LLC (2002) test. Second, from the IPS (2003) test, the null hypothesis of having individual unit root process cannot be rejected based on original data in Japan, but can be rejected with the constant and trend term model at 10 percent significance level in South Korea. Based on first differenced data, we can reject the null hypothesis at

1 percent significance level for both countries and both models. Third, we report the different results of the two types of Fisher's panel unit root tests. Applying the Fisher-ADF test, the null hypothesis of individual unit root process can be rejected for South Korea with the constant and trend term model and at Choi's (2001) Z statistics based on original data and can be rejected in both countries from first differenced data at 1 percent siginificance level in case of both values. Fourth, applying the Fisher-PP test to the level of the panel data of Japanese cities, we can reject the null hypothesis only based on the first differenced data. As far as South Korea is concerned, it can be rejected based on original data applying the only constant term model at 10 percent significance level; however, based on demeaned data, the null hypothesis can be rejected at 1 percent significance level for both specifications.

4. Dairy products and eggs

On one hand, results of the individual unit root tests indicate that the null hypothesis cannot be rejected in all cities with the constant term only model but can be rejected in four cities at 1 percent significance level, six cities at 5 percent significance level, and two cities at 10 percent significance level in Japan with the constant and trend term model using the level of the data in Japan. Applying the ADF-test and using the differenced data, we show that the null hypothesis can be rejected for all cities and every specification in Japan. On the other hand, results of the ADF-test indicate that the null hypothesis can be rejected for two cities at 10 pecent significance level with each formulation based on the level of the data in South Korea; however, based on the differenced data, it can be rejected for all cities at respective siginificance levels for all specifications.

Findings of the LLC (2002) test indicate that we can reject the null hypothesis only from the Japan's first differenced data at 1 percent significance level; however, the findings of IPS (2003) test indicate that we can reject the null hypothesis for Japan at 1 percent significance level with the constant and trend term model based on the level of the data and with both formulataions using the demeaned data; in South Korea, we can reject the null hypothesis based on the level and differenced data at respective significance levels. Also, from the outcomes of the Fisher-ADF test, the null hypothesis can be rejected for Japan at 1 percent significance level with the constant and trend term model by using the level of data and with both models by using the differenced data in Choi's (2001) Z statistics and the χ^2 estimates; however, the null hypothesis in South Korea can be rejected for models with any specifications.In addition, results of the Fisher-PP test indicate that the null hypothesis can be rejected for Japan at 1 percent significance level with the constant and trend term model using the level of data and with both models by using the differenced data; however, we can reject the null hypothesis for South Korea based on all datas and models.

5. Fruits

In a univariate unit root test, when testing by using the level of data of Japan, the null hypothesis of the unit root test can be rejected for only one city at 10 percent significance level with the only constant term model; however, when testing by using the differenced data of the cities, it can be rejected for all cities with the only constant term model and 12 out of 13 cities with the constant and trend term model. When testing by using the level of the South Korean data, the null hypothesis cannot be rejected, but when testing using the differenced data, it can be rejected for all cities at 1 percent significance level with both model specifications.

Results of the panel unit root tests are described as follows. According to the LLC (2002) test, the null hypothesis of having a common unit root process cannot be rejected in both Japan and South Korea. From the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected only based on the first differenced data in both Japan and South Korea. The two types of Fisher's panel unit root tests produce different results of estimation. First, applying the Fisher-ADF test, the null hypothesis of individual unit root process cannot be rejected based on the original data, but based on the differenced data, it can be rejected with all statistical values at 1 percent significance level in both Japan and South Korea. Second, applying the Fisher-PP test to the panel data of Japanese cities, the null hypothesis can be rejected when using the original data with the only constant term model but it can be rejected based on the differenced data at both statistics. Applying the Fisher-PP test to South Korea's panel data, the null hypothesis cannot be rejected based on the level of data, but it can be rejecetd based on first differenced data.

6. Cakes and candies

In ADF, which is an individual unit root test, we cannot reject the null hypothesis of the unit root test except for only one city at 10 percent significance level based on the level of data of Japan. However, based on the differenced data of Japan, the null hypothesis can be rejected for 12 out of 13 cities with the only constant model and with the constant and trend term model. These results are analogous to the results obtained by using the data for South Korea. Based on the differenced data, the null hypothesis can be rejected for all South Korean cities with the only constant term model and four out of five cities with the constant and trend term model.

We now focus on the results of panal unit root tests. First, by the LLC (2002) test, we cannot reject the null hypothesis of common unit root process in the panel data for Japan, but can reject it in the difference panel data sets of South Korea at 5 percent significance level with both model specifications. Second, from the IPS (2003) test, the null hypothesis of having individual unit root process cannot be rejected based on the original data, but can be rejected for Japan at 1 percent significance level with either model. With South Korea's panel data sets, the null hypothesis can be rejected based on the original data with the constant and trend term model at 5 percent significance levell and at 1 percent significance level with both formulations based on the differenced data. Also, we report similar results for the two types of Fisher's panel unit root tests. The results of both tests indicate that the null hypothesis cannot be rejected based on the original data, but it can be rejected based on the differenced data at 1 percent significance level at two different statistics.

7. Beverages

On one hand, the results of an ADF test indicate that the null hypothesis can be rejected for three cities in Japan at 10 percent significance level with the only constant model by using the original data, but cannot be rejected with the constant and trend term model. By using the differenced data, it can be rejected for all cities at each significance level with both model specifications. On the other hand, in South Korea, the results of individual unit root tests indicate that the null hypothesis can be rejected in two out of five cities with both model specifications by using the level of the data. By using the differenced data, it can be rejected for all cities with both models.

Findings of the LLC (2002) test indicate that we can reject the null hypothesis only based on the first differenced data of both countries; however, the IPS (2003) test produces different results. The null hypothesis can be rejected at 10 percent significance level in Japan by using the level of the data with the only constant model and at 1 percent significance level with both models by using the first differenced data. In the case of South Korea, the null hypothesis can be rejected for all model specifications at respective significance levels. Further, from the outcomes of the Fisher-ADF test, the null hypothesis in Japan can be rejected at 1 percent significance level with both models by using only the first differenced data.The null hypothesis in South Korea can be rejected in all specifications. In addition, the results of the Fisher-PP test indicate that the null hypothesis in Japan can be rejected at 1 percent significance level by using only demeaned data, but we can reject the null hypothesis in South Korea at Choi's (2001) Z statistics and χ^2 estimates with three specifications.

8. Alcoholic beverages

In a univariate unit root test, when testing by using the level of the data of Japan, the null hypothesis of the unit root test can be rejected for only one city at 10 percent significance level with the only constant term model;

however, when testing by using the differenced data, the null hypothesis can be rejected in 12 out of 13 cities with the only constant term model and 10 out of 13 cities with the constant and trend term model. When testing by using the level of the data of South Korea, the null hypothesis can be rejected for only one city at 5 percent significance level, but when testing by using the differenced data, it can be rejected for all cities at 1 percent significance level with both specifications.

The results of panel unit root tests are stated as follows. According to the LLC (2002) test, the null hypothesis of having a common unit root process cannot be rejected in both the level of the data of Japan and South Korea, but can be rejected for the only first differenced data of South Korea at 10 percent significance level. From the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected only based on the first differenced data in both Japan and South Korea at 1 percent significanse level. The two types of Fisher's panel unit root tests produce similar results of estimation. The results of the Fisher-ADF test and the Fisher-PP test indicate that the null hypothesis can be rejected based on the first differenced data in Japan and South Korea at 1 percent significance level at both statistics.

9. Clothes

In a univariate ADF unit root test, we can reject the null hypothesis of the unit root test for two cities at 10 percent significance level and one city at 5 percent significance level among 13 Japanese cities and for four out of five South Korean cities by using the level of the data with the only constant term model. Also, for the model with the trend term, we can reject the hypothesis for only one Japanese city at 5 percent significance level and for two South Korean cities. On the other hand, when testing based on the first differenced data, we can reject the null hypotheis for 12 Japanese cities with both models. In South Korea, the null hypothesis can be rejected for all cities with both model specifications at respective significance levels.

Next, we report the results of panel unit root tests. First, we cannot reject the null hypothesis of common unit root process in Japan, but can reject it when applying the LLC (2002) test using the level of the data and the differenced data with the constant and trend term model in South Korea. Second, from the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected based on the first differenced data in Japan at 1 percent significance level. If testing is based on South Korea's data, we can reject it in all specifications at 1 pecent significance level with the two models and at 5 percent signivicance level in one city. Third, we report the results of the two types of Fisher's panel unit root tests. Applying the Fisher-ADF test, the null hypothesis of individual unit root process cannot be rejected in Japan based on the level of the data, but can be rejected at 1 percent significance level based on the differenced data of all statistics. With regard to South Korea, we can reject the null hypothesis in all specifications in both Choi's (2001) Z statistics and the χ^2 estimated value. Fourth, applying the Fisher-PP test to the level of the data of Japanese cities, we cannot reject the null hypothesis but can reject it when using the demeaned data at 1 percent significance level with both model specifications. In the case of South Korea, we can reject the null hypothesis based on the level of the data with the only constant term model at two statistics and based on the first differenced data with both models at 1 percent significance level.

10. Fuel, light, and water charges

In the ADF test,an individual unit root test, we can reject the null hypothesis of the unit root test for two cities at 5 percent significance level with the only constant term model and for only one city at 5 percent significance level with the constant and trend term model among 13 cities of Japan based on the level of the data, but cannot reject it in case of the level of the data of South Korea. When based on the first differenced data and with the only constant term model, we can reject the null hypotheis of the unit root test for 12 cities at 1 percent significance level and one city at 5 percent significance level in Japan, as well as four out of five South Korean cities. When using this data with the constant and trend term model, we can reject the null hypothesis for 11 cities at 1 percent significance leve and one city at 5 percent significance level in Japan and all cities at respective significance level in South Korea.

We now proceed to the results of panal unit root tests. First, we can reject the null hypothesis of common unit root process at 1 percent significance level in Japan only based on the first differenced data and at 5 percent significance level in South Korea only based on the level of the data with the only constant model by the LLC (2002) test. Second, from the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected only based on the first differenced data at 1 percent significance level for both Japan and South Korea. Third, we report marginally different results of the two types of Fisher's panel unit root tests. Applying the Fisher-ADF test, the null hypothesis of individual unit root process can be rejected only based on the first differenced data in both Japan and South Korea with both specifications. Applying the Fisher-PP test to the panel data of Japanese cities, we can reject the null hypothesis only based on the first differenced data. As far as South Korea is concerned, it can be rejected based on the original data with the only constant term model at 10 percent significance level at only Choi's (2001) Z statistics and based on the demeaned data with all specifications at 1 percent significance level.

11. Medical care

On one hand, the results of the individual unit root test indicate that the null hypothesis can be rejected for one city at 1 percent significance level, two cities at 5 percent significance level, and one city at 10 percent significance level with the only constant model and for three cities at 1 percent significance level, one city at 10 percent significance level with the constant and trend term model based on the level of the data of Japan. Based on the first differenced data of Japan, the null hypothesis can be rejected for 10 cities at 1 percent significance level and three cities at 5 percent significance level with the only constant model and for seven cities at 1 percent significance level, four cities at 5 percent significance level, and two cities at 10 percent significance level with the constant and trend term model. Based on the level of the data of South Korea, the results of the ADF test indicate that in case of the level of data, the null hypotheis can be rejected for one city at 1 percent significance level, one city at 5 percent significance level, and one city at 10 percent significance level with the only constant model and two cities at 1 percent significance level and one city at 5 percent significance level with the constant and trend term model. In case of the first differenced model, the null hypothesis can be rejecetd for all cities with both specifications.

On the other hand, findings of the LLC (2002) test indicate that we can reject the null hypothesis based on the level of the data of Japan with the constant and trend term model and based on the first differenced data with both models and at 1 percent singnificance level only based on the first differenced data with both specifications in the case of South Korea. On the other hand, the findings of of IPS (2003) test indicate the same results for both countries. The null hypothesis can be rejected based on both data and for all specifications in Japan and South Korea. Also, from the outcomes of the Fisher-ADF test, the null hypothesis can be rejected for Japan for all specifications except when testing based on the level of data with the constant model at the χ^2 estimated value. In South Korea, it can be rejected at 1 percent significance level in all models and statistics. In addition, results of Fisher-PP test indicate the same results as the Fisher-ADF test. The null hypothesis can be rejected for Japan for all specifications except when testing based on the level of the data with the constant model at the χ^2 estimated value. In South Korea, it can be rejected at 1 percent significance level for all models and statistics

12. Transportation and communication

In a univariate unit root test, we can reject the null hypothesis of the unit root test for only one city at 1 percent significance level and in one city at 5 percent significance level among 13 cities of Japan and cannot reject it for South Korea when testing by using the level of the data with the only constant term model. By including the trend term, we can reject the hypothesis for one city at 5 percent level and two cities at 10 percent significance level among Japanese cities and cannot reject it for South Korean cities similar to the case of the only constant term model. However, when testing based on the first differenced data, we can reject the null hypotheis for all cities in Japan with both models. In case of South Korean cities, the null hypothesis can be rejected for all cities with the only constant term model and three among five cities with the constant and trend term model.

Next, we report the results of panel unit root tests. First, we can reject the null hypothesis of common unit root process at 1 percent significanse level only for Japan's first differenced data and at 1 percent significance level with the constant and trend term model for the level of the data of South Korea by the LLC (2002) test. Second, on the basis of the results of IPS (2003) test, the null hypothesis of having individual unit root process can be rejected based on both classes of data and both specifications in the case of Japan, but with both models when only using the first differenced data of South Korea. Third, we report different results for the two types of Fisher's panel unit root tests. Applying the Fisher-ADF test, the null hypothesis of individual unit root process can be rejected based on the level of data of Japan with the only constant term model at Choi's (2001) Z statistics, with the constant and trend term model at the χ^2 estimated value, and can be rejected based on the first differenced data with both models. With regard to South Korea, we can reject the null hypothesis at 1 percent significance level only based on the first differenced panel data with both statistics. Fourth, applying the Fisher-PP test to the level of panel data of Japanese cities, we can reject the null hypothesis with the only constant term model at both statistics and with the constant and trend term model at the χ^2 estimated value. In the case of South Korea, we can reject the null hypothesis for all specifications and all estimated values only when using the first differenced data.

13. Education

In a univariate unit root test, when testing by using the level of data of Japan, the null hypothesis of having unit root can be rejected for only one city at 1 percent significance level and one city at 10 percent significance level with the only constant term model and for three cities at 5 percent significance level and two cities at 10 percent significance level with the constant and trend term model; however, when using Japan's differenced data, it can be rejected in 11 among 13 cities with only constant term model and in six among 13 cities with constant and trend term model. When testing using South Korea's level data, the null hypothesis can be rejected in only one city at 10 percent significance level with the only constant model and in two cities with the constant and trend term model, but by using the differenced data, it can be rejected in all cities at 1 percent significance level with both specifications.

Results of panel unit root tests are stated as follows. According to the LLC (2002) test, the null hypothesis of having common unit root process can be rejected for the level of data of Japan. With regard to South Korea data, the null hypothesis can be rejected at 1 percent significance level with the only constant model based on the level of the data and at 10 percent significance level with the constant and trend term model based on the first differenced data. From the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected with the constant and trend term model based on the level of the data and with both models based on the first differenced data in the case of Japan. The same is largely true with regard to the resutlts of the IPS (2003) test in South Korea. Also, the Fisher-ADF test produces similar results of estimation for both countries. The null hypothesis can be rejected with the constant and trend term model when using the level of the data and with both specifications when using the first differenced data. However, the results of the Fisher-PP test indicate different outcomes. In case of Japan's panel data, the null hypothesis can be rejected based on the level of the data with the only constant model at Choi's (2001) Z statistics and based on the demeaned data with both specifications. For South Korea, it can be rejected based on only the first differenced data at 1 percent siginificance level.

14. Housing

In a univariate ADF unit root test, we can reject the null hypothesis of the unit root test for only one city at 10 percent significance level among 13 Japanese cities and cannot reject it for South Korea when using the level of the data with the only constant term model. Also, when the trend term is included, we can reject the hypothesis for only one city at 1 percent significance level among Japanese cities and at 1 percent significance level for two South Korean cities. In the case, when based on the first differenced data, we can reject the null hypotheis for 12 cities with the only constant term model and for eight cities with the constant and trend term model in the case of Japan. In South Korea, the null hypothesis can be rejected for all cities with the only constant model and four cities with the constant and trend term model at respective significance levels.

Next, we report the results of panel unit root tests. First, we cannot reject the null hypothesis of common unit root process in Japan, but can reject it when using the level of the data and the differenced data with the constant and trend term model in South Korea by LLC (2002) test. Second, from the IPS (2003) test, the null hypothesis of having individual unit root process can be rejected only based on the level of the data in Japan at 1 percent significance level with the constant model and 5 percent significance level with the constant and trend term model. When testing based on the data of South Korea, we can reject it only based on the first differenced data at 10 percent significance level with the only constant model and 5 percent significance level with the constant and trend term model.

Third, we report the results of the two types of Fisher's panel unit root tests. Applying the Fisher-ADF test, the null hypothesis of individual unit root process cannot be rejected in Japan based on the first differended data at 1 percent significance level with all specifications. With regard to South Korea, we can reject the null hypothesis at 1 percent significance level with both statistics in the constant and trend term model based on the level of the data and at 1 percent significance level with both statistics in the both models.

Fourth, applying the Fisher-PP test to the level of panel data of Japanese cities, we can reject the null hypothesis at Choi's (2001) Z statistics with the only constant model at 1 percent significance level and when using the demeaned data, at 1 percent significance level with both specifications. In South Korea, we can reject the null hypothesis based on the level of the data with the constant and trend term model at the χ^2 estimated value and based on the first differenced data with both models at 1 percent significance level.

4.2.2 Panel cointegration

Table 4 reports the results of the individual ADF unit root test as a preparation for the cointegration test. In this analysis, we use General CPI as price data fot the cities of either country because we want to gain an understanding of the transition of aggregate prices in the cities.

In a univariate ADF unit root test, we can reject the null hypothesis of having unit root test for three cities at 5 percent significance level and five cities at 10 percent significance level among the 14 Japanese cities and cannot reject it for South Korea by using the level of the data according with the only constant term model. Also, if the trend term is included, we cannot reject the hypothesis for both countries. When testing based on the first differenced data, we can reject the null hypotheis for six cities at 5 percent significance level and three cities at 10 percent significance level with the only constant term model and for all cities with the constant and trend term model in Japan. In South Korea, the null hypothesis can be rejected for all cities with the only constant model and two cities with the constant and trend term model at respective significance levels. For a nominal exchange rate between the Japanese Yen and South Korean Won, the null hypotheis cannot be rejected based on the level of the data but can be rejected at

1 percent significance level with both models based on the first differenced data.

Table 5 reports the results of Johansen and Juselius's (1990) maximum lilelihood cointegration test for individual city pairs. We implement the max-eigenvalue test and the trace test and investigate whether there exist cointegrating relationships between relative prices in the cities of each country and nominal exchange rate. The results indicate that there exists a cointegrating relationship in all city combinations because the null hypotheis that there exists no cointegrating vector that is rejected at 5 percent significance level.

Summary results for the panel cointegrating regression are presented in Table 6[8]. As identified above, the panel / group-ρ test and the panel / group-PP test process the autocorrelation to non-parametric similar to the Phillips and Perron (1988) test and the panel / group-ADF test is processed to parametric. While conducting this panel cointegration test, the null hypothesis is the same in all tests, which states that there exists no cointegrating relationship among all city combinations. However, the alternative hypotheses of "panel" and "group" differ. In the case of "panel," the alternative hypothesis is that there exists a cointegration between relative prices and the nominal exchange rate among all pairs of cities pairs and to the same extent in all city combinations. On the contrary, in the case of "group," the alternate hypothesis is that there exists a cointegraion among all pairs of city, but the extent of cointegration varies from one pair of city to another.

In this panel cointegration analysis, we confirm that there exists a cointegration relationship except as indicated by the group-ρ statistics. This result implies that PPP almost always holds in the long run for Japanese and South Korean cities in the context of international perspective, over the estimation period.

5 Conclusion

This paper empirically examines the theory of purchasing power parity using several panel unit root tests and panel cointegration methods for Japanese and South Korean cities. The results of the panel unit root tests indicate that the relative prices within the two countries are nonstationary. Further, based on the panel cointegration analysis, we find that there is a tendency for price indices and nominal exchange rates in each city of the two countries to adjust toward equilibrium in the long-run.

[8] We use RATS's PANCOINT.PRG written by P. Pedroni as the panel cointegration test. This program is downloadable from ESTIMA's Homepage (http://www.estima.com). Also, refer to Enders (1996).

Recently, a conference on Free Trade Agreement (FTA) is in session between Japan and South Korea. The influence on the prices in each city and the nominal exchange rate once the FTA is agreed upon is proposed as a research topic for the future.

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Table 1
Descriptive Statistics : Japanese cities (1)

Sapporo

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	-0.0224	-0.0596	-0.0308	-0.0845	-0.0434	0.0042	-0.0113	-0.0122	-0.0002	-0.0224	0.0147	-0.0212	0.0704	-0.1017
Median	-0.0037	-0.0844	-0.0037	-0.0632	-0.0203	0.0037	-0.0120	-0.0106	0.0036	-0.0165	0.0192	-0.0229	0.0768	-0.0849
Maximum	0.0106	0.0674	0.0379	0.0277	0.1317	0.0482	0.0322	0.0287	0.1062	0.0679	0.0425	0.0169	0.1568	0.0100
Minimum	-0.0797	-0.1028	-0.1367	-0.2492	-0.2182	-0.0415	-0.0619	-0.0350	-0.0694	-0.1314	-0.0247	-0.0618	-0.0233	-0.2832
Std.Dev	0.0290	0.0421	0.0579	0.0789	0.0648	0.0173	0.0155	0.0156	0.0312	0.0452	0.0163	0.0211	0.0605	0.0938
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Sendai

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	-0.0056	-0.0174	0.0058	-0.0823	0.0060	-0.0314	0.0196	0.0226	-0.0435	0.0354	-0.0386	-0.0368	0.0747	0.0082
Median	-0.0024	-0.0278	0.0036	-0.0874	0.0026	-0.0351	0.0114	0.0258	-0.0311	0.0281	-0.0515	-0.0479	0.1023	0.0048
Maximum	0.0116	0.0475	0.0598	0.0670	0.0789	0.0290	0.1133	0.0380	0.0553	0.1298	0.0098	0.0042	0.1553	0.0603
Minimum	-0.0393	-0.0575	-0.0697	-0.2471	-0.0964	-0.0656	-0.0601	-0.0077	-0.1376	-0.0349	-0.0734	-0.0671	-0.0137	-0.0595
Std.Dev	0.0133	0.0277	0.0350	0.0855	0.0302	0.0223	0.0402	0.0112	0.0486	0.0465	0.0251	0.0245	0.0599	0.0338
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Saitama

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0019	-0.0261	0.0136	-0.0095	-0.0971	-0.0563	0.0313	0.0399	0.0980	0.0245	-0.0074	-0.0061	-0.0119	0.0040
Median	0.0020	-0.0311	0.0010	-0.0038	-0.0496	-0.0671	0.0297	0.0481	0.0798	0.0153	-0.0058	-0.0083	-0.0049	0.0058
Maximum	0.0140	0.0386	0.1138	0.0770	0.0272	0.0513	0.0886	0.0625	0.2827	0.0697	0.0101	0.0169	0.0369	0.0368
Minimum	-0.0154	-0.0808	-0.0360	-0.1207	-0.2771	-0.1491	-0.0159	-0.0045	-0.0429	-0.0213	-0.0349	-0.0375	-0.1139	-0.0335
Std.Dev	0.0055	0.0231	0.0406	0.0513	0.1043	0.0486	0.0275	0.0235	0.1029	0.0265	0.0105	0.0115	0.0350	0.0130
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Chiba

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0030	-0.0625	0.0294	0.0287	-0.0035	-0.0327	0.0476	-0.0236	0.0696	0.0056	-0.0193	-0.0176	0.0298	0.0202
Median	0.0052	-0.0776	0.0268	0.0290	-0.0039	-0.0427	0.0556	-0.0267	0.0683	0.0049	-0.0218	-0.0202	0.0298	0.0187
Maximum	0.0203	0.0407	0.1052	0.1364	0.0797	0.0733	0.0879	0.0123	0.1458	0.0504	0.0243	0.0120	0.0765	0.0782
Minimum	-0.0203	-0.1231	-0.0592	-0.0975	-0.1093	-0.0760	-0.0263	-0.0325	-0.0204	-0.0606	-0.0610	-0.0460	-0.0146	-0.0258
Std.Dev	0.0111	0.0433	0.0477	0.0554	0.0371	0.0315	0.0302	0.0095	0.0468	0.0254	0.0207	0.0171	0.0281	0.0284
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Kawasaki

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	-0.0011	-0.0485	0.0068	-0.0623	-0.0267	-0.1061	0.0127	0.0176	-0.0170	0.0335	-0.0125	0.0018	0.0062	0.0356
Median	-0.0018	-0.0700	0.0038	-0.0398	-0.0283	-0.1262	0.0135	0.0207	-0.0080	0.0301	-0.0094	0.0009	-0.0047	0.0039
Maximum	0.0206	0.0255	0.0852	0.0417	0.0485	0.0115	0.0478	0.0313	0.1332	0.0778	0.0010	0.0273	0.0836	0.1467
Minimum	-0.0143	-0.0807	-0.0704	-0.2111	-0.0809	-0.1780	-0.0322	-0.0093	-0.0989	-0.0092	-0.0662	-0.0167	-0.0330	-0.0389
Std.Dev	0.0076	0.0360	0.0426	0.0659	0.0282	0.0515	0.0174	0.0101	0.0427	0.0244	0.0136	0.0093	0.0296	0.0619
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Yokohama

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	-0.0051	0.0137	0.0179	-0.0240	-0.0335	0.0957	0.0038	-0.0068	0.0280	0.0096	0.0014	0.0087	0.0188	-0.0130
Median	-0.0046	0.0196	0.0182	-0.0026	-0.0250	-0.0886	0.0001	-0.0081	0.0241	0.0096	0.0038	0.0090	0.0074	-0.0112
Maximum	0.0060	0.0306	0.0600	0.0722	0.0415	0.0220	0.0575	0.0164	0.0948	0.0458	0.0226	0.0278	0.0922	0.0154
Minimum	-0.0166	-0.0380	-0.0385	-0.1644	-0.1076	-0.1315	-0.0396	-0.0141	-0.0516	-0.0454	-0.0340	-0.0046	-0.0281	-0.0370
Std.Dev	0.0059	0.0152	0.0233	0.0636	0.0349	0.0373	0.0191	0.0047	0.0268	0.0259	0.0133	0.0069	0.0306	0.0132
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Table 1
Descriptive Statistics : Japanese cities (2)

Nagoya

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	-0.0047	-0.0188	-0.0044	-0.0429	-0.0343	-0.0273	0.0131	-0.0010	0.0059	-0.0178	0.0178	-0.0153	0.0266	0.1658
Median	-0.0010	-0.0234	-0.0022	-0.0290	-0.0453	-0.0260	0.0137	-0.0029	0.0065	-0.0082	0.0221	-0.0167	0.0214	0.1552
Maximum	0.0062	0.0361	0.0407	0.0520	0.1357	0.0225	0.0383	0.0193	0.0785	0.0320	0.0478	0.0058	0.0768	0.4130
Minimum	-0.0369	-0.0418	-0.0713	-0.2041	-0.1814	-0.0858	-0.0403	-0.0199	-0.0823	-0.1254	-0.0054	-0.0468	-0.0343	-0.0496
Std.Dev	0.0090	0.0164	0.0344	0.0650	0.0532	0.0303	0.0123	0.0106	0.0380	0.0312	0.0125	0.0128	0.0309	0.1270
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Kyoto

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0158	-0.0130	-0.0386	-0.0344	0.0402	0.0091	0.0111	0.0042	0.0621	0.0105	-0.0192	-0.0048	0.0448	0.1080
Median	0.0200	-0.0153	-0.0515	-0.0221	0.0470	0.0052	0.0142	-0.0005	0.0660	0.0080	-0.0248	-0.0009	0.0154	0.1134
Maximum	0.0334	0.0279	0.0491	0.0472	0.0857	0.0460	0.0417	0.0317	0.1878	0.0648	0.0037	0.0104	0.1173	0.2380
Minimum	-0.0133	-0.0476	-0.0774	-0.1588	-0.0857	-0.0243	-0.0459	-0.0262	-0.0346	-0.0592	-0.0366	-0.0539	-0.0078	-0.0482
Std.Dev	0.0124	0.0124	0.0342	0.0542	0.0311	0.0189	0.0202	0.0161	0.0586	0.0322	0.0125	0.0122	0.0455	0.0725
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Osaka

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0207	0.0115	0.0414	0.0031	0.0327	-0.0549	0.0277	-0.0061	0.0559	-0.0157	-0.0157	0.0024	0.0381	0.1784
Median	0.0273	0.0136	0.0447	0.0113	0.0397	-0.0672	0.0317	-0.0112	0.0592	-0.0211	-0.0211	0.0021	0.0442	0.1696
Maximum	0.0373	0.0335	0.0857	0.0837	0.0968	0.0439	0.0653	0.0186	0.1357	0.0208	0.0208	0.0160	0.0887	0.5213
Minimum	-0.0102	-0.0270	-0.0543	-0.1277	-0.0642	-0.1054	-0.0240	-0.0301	-0.0426	-0.0375	-0.0375	-0.0138	-0.0137	-0.0534
Std.Dev	0.0150	0.0113	0.0277	0.0534	0.0378	0.0385	0.0207	0.0159	0.0532	0.0170	0.0170	0.0043	0.0333	0.1475
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Kobe

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	-0.0004	-0.0269	-0.0038	-0.0452	-0.0589	0.0227	0.0232	-0.0063	0.0410	-0.0030	-0.0192	-0.0059	0.0695	0.0231
Median	0.0003	-0.0295	-0.0003	-0.0304	-0.0562	0.0222	0.0236	-0.0026	0.0370	-0.0068	-0.0248	-0.0052	0.0456	0.0204
Maximum	0.0253	0.0200	0.0585	0.0492	0.0178	0.0682	0.0535	0.0447	0.1373	0.0566	0.0037	0.0062	0.1883	0.1093
Minimum	-0.0262	-0.0627	-0.0432	-0.1863	-0.1765	-0.0334	-0.0053	-0.0244	-0.0488	-0.0450	-0.0366	-0.0217	-0.0137	-0.0479
Std.Dev	0.0130	0.0204	0.0227	0.0642	0.0455	0.0218	0.0137	0.0140	0.0490	0.0211	0.0125	0.0065	0.0643	0.0392
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Hiroshima

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	-0.0138	-0.0072	0.0285	-0.0413	0.0054	-0.1061	0.0342	-0.0138	0.1532	0.0221	-0.0177	-0.0107	0.0563	-0.0059
Median	-0.0105	-0.0085	0.0230	-0.0322	0.0079	-0.1262	0.0355	-0.0152	0.1723	0.0167	-0.0198	-0.0098	0.0576	-0.0074
Maximum	0.0095	0.0268	0.0963	0.0636	0.0643	0.0115	0.0784	0.0288	0.2469	0.0712	0.0214	0.0169	0.1406	0.0491
Minimum	-0.0539	-0.0275	-0.0362	-0.1734	-0.0703	-0.1780	-0.0464	-0.0298	-0.0183	-0.0474	-0.0519	-0.0363	-0.0745	-0.1035
Std.Dev	0.0157	0.0143	0.0335	0.0572	0.0330	0.0515	0.0246	0.0135	0.0731	0.0257	0.0157	0.0150	0.0509	0.0265
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Fukuoka

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0026	0.0017	0.0682	-0.0453	0.0049	-0.0404	0.0320	0.0368	0.0310	0.0241	-0.0128	-0.0155	0.0293	-0.0046
Median	0.0033	0.0017	0.0706	-0.0156	0.0156	-0.0470	0.0272	0.0353	0.0321	0.0138	-0.0172	-0.0197	0.0354	-0.0031
Maximum	0.0186	0.0745	0.1326	0.0503	0.0962	0.0821	0.1126	0.1318	0.1201	0.0787	0.0573	0.0128	0.0770	0.0614
Minimum	-0.0210	-0.0584	-0.0103	-0.2035	-0.1109	-0.0951	-0.0360	-0.0021	-0.0420	-0.0273	-0.0694	-0.0420	-0.0761	-0.0716
Std.Dev	0.0113	0.0301	0.0364	0.0651	0.0407	0.0384	0.0303	0.0212	0.0425	0.0292	0.0256	0.0154	0.0369	0.0362
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Kitakyushu

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0062	-0.0153	0.0298	-0.0268	-0.0051	-0.0312	0.0237	0.0232	0.0539	-0.0143	0.0029	-0.0053	0.0108	0.0357
Median	0.0095	-0.0163	0.0354	-0.0100	-0.0041	-0.0377	0.0194	0.0308	0.0575	-0.0140	0.0004	-0.0052	0.0142	0.0300
Maximum	0.0297	0.0866	0.1063	0.0656	0.0930	0.0721	0.0977	0.0409	0.1260	0.0329	0.0419	0.0181	0.0707	0.1072
Minimum	-0.0277	-0.0636	-0.0504	-0.1805	-0.1334	-0.0891	-0.0260	-0.0337	-0.0308	-0.0547	-0.0316	-0.0360	-0.1224	-0.0151
Std.Dev	0.0172	0.0349	0.0416	0.0568	0.0316	0.0336	0.0277	0.0184	0.0411	0.0252	0.0158	0.0124	0.0454	0.0362
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Table 2
Descriptive Statistics : South Korean cities

Busan

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0232	-0.0167	0.0835	0.0604	0.1543	-0.0823	0.0023	0.0334	0.0006	0.0266	-0.0263	0.0430	0.0588	-0.0471
Median	0.0326	-0.0161	0.1117	0.0597	0.1795	-0.0776	0.0004	0.0202	-0.0002	0.0063	0.0165	0.0639	0.0602	-0.0247
Maximum	0.0472	0.0167	0.2476	0.1487	0.3261	0.0185	0.1355	0.1201	0.0567	0.1913	0.1439	0.0983	0.1547	0.0942
Minimum	-0.0181	-0.0545	-0.0784	-0.0079	-0.1076	-0.2034	-0.0578	-0.0304	-0.0655	-0.0464	-0.2208	-0.0382	-0.0096	-0.1642
Std.Dev	0.0179	0.0181	0.0860	0.0405	0.1165	0.0688	0.0331	0.0358	0.0219	0.0578	0.2093	0.0442	0.0435	0.0591
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Incheon

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0061	-0.0627	0.0290	0.0183	0.2135	0.0519	0.0154	-0.0011	0.0592	-0.0096	-0.0182	-0.1140	0.0770	-0.0454
Median	0.0065	-0.0685	0.0213	0.0178	0.2490	0.0537	0.0129	0.0005	0.0322	-0.0158	-0.0026	-0.1476	0.0725	-0.0261
Maximum	0.0311	0.0076	0.1412	0.1164	0.4721	0.1730	0.0651	0.0773	0.2455	0.0455	0.1353	0.0031	0.1656	0.1123
Minimum	-0.0326	-0.1186	-0.0726	-0.0236	-0.0560	-0.0115	-0.0208	-0.0738	-0.0226	-0.0432	-0.1156	-0.1903	-0.0018	-0.1299
Std.Dev	0.0119	0.0326	0.0445	0.0198	0.1491	0.0465	0.0173	0.0333	0.0759	0.0241	0.2078	0.0642	0.0514	0.0600
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Gwangju

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0172	0.0337	-0.0138	-0.0056	0.2450	-0.0469	-0.0438	0.0965	0.0371	-0.0401	-0.0012	-0.0495	0.0632	-0.0279
Median	0.0222	0.0372	-0.0139	-0.0030	0.2610	-0.0508	-0.0456	0.1014	0.0158	-0.0415	0.0231	-0.0456	0.0664	-0.0264
Maximum	0.0494	0.0824	0.1869	0.0591	0.5037	0.0274	0.0464	0.1680	0.1938	0.0321	0.1612	0.0080	0.1907	0.1286
Minimum	-0.0203	-0.0080	-0.2071	-0.0833	-0.1057	-0.1482	-0.1365	-0.0064	-0.0106	-0.1177	-0.1331	-0.1162	-0.0167	-0.1255
Std.Dev	0.0166	0.0238	0.0721	0.0297	0.1596	0.0364	0.0446	0.0472	0.0557	0.0440	0.2083	0.0326	0.0486	0.0400
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Daegu

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0083	-0.0133	0.0766	0.0605	0.0408	-0.0251	-0.0235	0.0612	0.1036	0.0224	-0.0685	-0.0562	0.0604	-0.0500
Median	0.0085	-0.0129	0.0648	0.0614	0.0402	-0.0120	-0.0182	0.0786	0.0616	0.0076	-0.0127	-0.0667	0.0631	-0.0464
Maximum	0.0353	0.0134	0.2891	0.1600	0.2831	0.0388	0.0215	0.1724	0.3335	0.1180	0.1392	0.0089	0.1344	0.0761
Minimum	-0.0159	-0.0492	-0.1435	-0.0128	-0.1014	-0.0987	-0.0829	-0.0494	-0.0136	-0.0518	-0.2409	-0.0978	-0.0004	-0.1577
Std.Dev	0.0143	0.0132	0.1038	0.0449	0.0787	0.0350	0.0287	0.0666	0.1113	0.0548	0.2037	0.0319	0.0340	0.0549
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Daejeon

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean	0.0265	-0.0010	0.0192	0.0220	0.1661	0.0035	-0.0333	0.0559	0.1334	0.0080	-0.0121	-0.0570	0.0953	-0.0573
Median	0.0358	-0.0001	0.0402	0.0243	0.1881	0.0014	-0.0402	0.0695	0.1237	0.0064	0.0142	-0.0660	0.1008	-0.0172
Maximum	0.0676	0.0174	0.1914	0.0690	0.4074	0.0952	0.0183	0.1351	0.4057	0.0556	0.1413	0.0021	0.2041	0.0789
Minimum	-0.0072	-0.0334	-0.2092	-0.0525	-0.1407	-0.0609	-0.1221	-0.0337	-0.0114	-0.0491	-0.0906	-0.1153	-0.0019	-0.6512
Std.Dev	0.0229	0.0113	0.0859	0.0240	0.1513	0.0317	0.0348	0.0463	0.1226	0.0288	0.2050	0.0345	0.0611	0.1262
Observations	309	309	309	309	309	309	309	309	309	309	309	309	309	309

Table 3-1
Individual and panel unit root tests for relative prices : General CPI

Individual unit root test - standard ADF test		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	-0.9472	(15)	[0.7722]	-1.5743	(15)	[0.8009]	-3.2803	(14)	[0.0167]**	-3.2627	(14)	[0.0746]*
	Sendai	-1.6571	(12)	[0.4521]	-0.6326	(12)	[0.9760]	-4.4156	(11)	[0.0003]***	-4.7589	(11)	[0.0007]***
	Saitama	-1.7044	(15)	[0.4280]	-2.1101	(15)	[0.5376]	-2.8182	(14)	[0.0569]*	-2.2631	(15)	[0.4523]
	Chiba	-1.3089	(14)	[0.6262]	-0.7155	(14)	[0.9704]	-3.8463	(13)	[0.0028]***	-4.0226	(13)	[0.0090]***
	Kawasaki	-2.6497	(14)	[0.0843]*	-2.4830	(14)	[0.3364]	-3.7834	(13)	[0.0035]***	-3.8893	(13)	[0.0136]**
	Yokohama	-2.2984	(14)	[0.1732]	-3.0783	(15)	[0.1134]	-3.5506	(13)	[0.0074]***	-3.5586	(13)	[0.0352]**
	Nagoya	-2.2061	(13)	[0.2046]	-1.0237	(13)	[0.9380]	-4.4324	(13)	[0.0003]***	-5.1880	(12)	[0.0001]***
	Kyoto	0.3652	(15)	[0.9812]	-1.5553	(14)	[0.8081]	-3.6282	(14)	[0.0058]***	-4.7002	(13)	[0.0008]***
	Osaka	0.6021	(14)	[0.9896]	-2.2531	(14)	[0.4579]	-4.3726	(13)	[0.0004]***	-4.5995	(13)	[0.0012]***
	Kobe	-1.1061	(15)	[0.7142]	-1.7736	(15)	[0.7153]	-2.8483	(14)	[0.0529]*	-2.8006	(14)	[0.1983]
	Hiroshima	-1.2475	(15)	[0.6544]	-0.5382	(15)	[0.9813]	-4.1384	(14)	[0.0010]***	-4.2784	(14)	[0.0039]***
	Fukuoka	-1.1996	(14)	[0.6755]	-1.8101	(15)	[0.7466]	-4.3023	(13)	[0.0005]***	-4.2782	(13)	[0.0039]***
	Kitakyushu	-1.0101	(14)	[0.7504]	-1.7057	(14)	[0.6976]	-3.5653	(13)	[0.0070]***	-3.4880	(13)	[0.0425]**
South Korea													
	Busan	-1.6993	(15)	[0.4306]	-2.6573	(15)	[0.2554]	-3.7574	(14)	[0.0038]***	-3.8975	(14)	[0.0133]**
	Incheon	-2.9095	(15)	[0.0454]**	-2.8491	(15)	[0.1810]	-4.2927	(14)	[0.0006]***	-4.3094	(14)	[0.0035]***
	Gwangju	-2.7650	(15)	[0.0646]*	-3.2897	(15)	[0.0699]*	-4.2451	(14)	[0.0007]***	-4.3245	(14)	[0.0033]***
	Daegu	-1.5629	(15)	[0.5003]	-1.7379	(15)	[0.7320]	-3.9494	(14)	[0.0019]***	-3.9485	(14)	[0.0114]**
	Daejeon	-1.9773	(15)	[0.2969]	-2.6955	(15)	[0.2393]	-3.4298	(14)	[0.0107]**	-3.4951	(14)	[0.0417]**
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	0.0561		[0.5224]	0.4527		[0.6746]	-1.2436		[0.1068]	-0.9198		[0.1788]
	South Korea	-0.7584		[0.2241]	-2.0844		[0.0186]**	0.7494		[0.7732]	1.4592		[0.9277]
Panel unit root test - Im, Pesaran and Shin (2003) test													
	Japan	0.7852		[0.7838]	1.9958		[0.9770]	-9.2162		[0.0000]***	-8.1132		[0.0000]***
	South Korea	-1.7969		[0.0362]**	-1.5241		[0.0637]*	-6.1287		[0.0000]***	-5.2095		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	19.3044		[0.8233]	12.4549		[0.9883]	149.5810		[0.0000]***	123.9060		[0.0000]***
		1.1394		[0.8727]	2.5816		[0.9951]	-9.6383		[0.0000]***	-8.0279		[0.0000]***
	South Korea	17.1601		[0.0709]*	14.9524		[0.1338]	62.3757		[0.0000]***	46.7029		[0.0000]***
		-1.7510		[0.0400]**	-1.4020		[0.0805]*	-6.41056		[0.0000]***	-5.2067		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	35.7629		[0.0961]*	18.0932		[0.8724]	1212.5900		[0.0000]***	1279.8300		[0.0000]***
		-0.8180		[0.2067]	1.7590		[0.9607]	-33.5692		[0.0000]***	-34.5362		[0.0000]***
	South Korea	12.6160		[0.2459]	8.5280		[0.5774]	553.8980		[0.0000]***	570.0420		[0.0000]***
		-1.1405		[0.1270]	-0.0412		[0.4836]	-22.8276		[0.0000]***	-23.1718		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-2

Individual and panel unit root tests for relative prices : Cereals

Individual unit root test - standard ADF test		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	0.6499	(15)	[0.9909]	-1.9245	(15)	[0.6391]	-3.4403	(15)	[0.0104]**	-4.3094	(14)	[0.0035]***
	Sendai	-1.2596	(15)	[0.6489]	-2.9607	(15)	[0.1453]	-3.0676	(14)	[0.0301]**	-3.1942	(14)	[0.0876]*
	Saitama	-1.0815	(15)	[0.7238]	-1.7824	(15)	[0.7110]	-4.6675	(14)	[0.0001]***	-5.0157	(14)	[0.0002]***
	Chiba	0.1654	(14)	[0.9700]	-2.3105	(14)	[0.4265]	-4.6014	(13)	[0.0002]***	-4.7575	(13)	[0.0007]***
	Kawasaki	-0.8996	(15)	[0.7876]	-2.0772	(15)	[0.5559]	-3.8876	(14)	[0.0024]***	-3.8978	(14)	[0.0133]**
	Yokohama	-1.5371	(15)	[0.5135]	-2.2103	(15)	[0.4816]	-4.8771	(13)	[0.0001]***	-4.9600	(13)	[0.0003]***
	Nagoya	1.5390	(13)	[0.9994]	-0.6932	(13)	[0.9720]	-4.0468	(12)	[0.0014]***	-4.6672	(12)	[0.0009]***
	Kyoto	-1.3171	(15)	[0.6223]	-1.9640	(15)	[0.6180]	-3.8536	(14)	[0.0027]***	-4.0285	(14)	[0.0088]***
	Osaka	-2.7514	(15)	[0.0667]*	-3.5816	(15)	[0.0331]**	-5.1373	(14)	[0.0000]***	-5.1565	(14)	[0.0001]***
	Kobe	0.3691	(15)	[0.9814]	-3.0859	(15)	[0.1116]	-3.4089	(15)	[0.0114]**	-3.7555	(15)	[0.0203]**
	Hiroshima	-1.2206	(15)	[0.6663]	-3.1335	(15)	[0.1005]	-3.5957	(14)	[0.0064]***	-4.0301	(14)	[0.0088]***
	Fukuoka	-0.6251	(14)	[0.8616]	-3.6611	(15)	[0.0266]**	-3.9013	(13)	[0.0023]***	-4.0030	(13)	[0.0096]***
	Kitakyushu	1.4462	(14)	[0.9992]	-1.8093	(15)	[0.6980]	-2.3317	(13)	[0.1627]	-2.9125	(13)	[0.1600]
South Korea													
	Busan	-3.0934	(15)	[0.0281]**	-3.2531	(15)	[0.0763]*	-4.2064	(14)	[0.0008]***	-4.2074	(14)	[0.0049]***
	Incheon	-0.6260	(15)	[0.8613]	-1.1679	(15)	[0.9143]	-3.8970	(14)	[0.0023]***	-3.9197	(14)	[0.0124]**
	Gwangju	-1.2509	(15)	[0.6528]	-3.4998	(15)	[0.0412]**	-4.6196	(14)	[0.0002]***	-4.7405	(14)	[0.0007]***
	Daegu	-2.1176	(15)	[0.2380]	-3.3992	(15)	[0.0534]*	-3.3454	(15)	[0.0138]**	-3.3329	(15)	[0.0630]*
	Daejeon	-2.6207	(15)	[0.0899]*	-2.9493	(15)	[0.1487]	-4.6473	(14)	[0.0001]***	-4.6379	(14)	[0.0011]***
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	6.0816		[1.0000]	1.1342		[0.8716]	2.1759		[0.9852]	2.1732		[0.9851]
	South Korea	2.0436		[0.9795]	1.6342		[0.9489]	1.8574		[0.9684]	2.8754		[0.9980]
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	3.8042		[0.9999]	-1.3723		[0.0850]*	-9.7790		[0.0000]***	-9.3329		[0.0000]***
	South Korea	-1.2009		[0.1149]	-2.0921		[0.0182]**	-6.6435		[0.0000]***	-5.6812		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	10.9143		[0.9958]	34.5695		[0.1213]	165.7190		[0.0000]***	144.4180		[0.0000]***
		4.1175		[1.0000]	-1.0465		[0.1477]	-10.1849		[0.0000]***	-9.2541		[0.0000]***
	South Korea	15.9829		[0.1001]	21.3752		[0.0186]*	71.0603		[0.0000]***	53.1239		[0.0000]***
		-1.1108		[0.1333]	-1.9921		[0.0232]**	-6.9471		[0.0000]***	-5.6426		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	13.7673		[0.9759]	21.1522		[0.7341]	1413.0100		[0.0000]***	1461.9500		[0.0000]***
		3.7012		[0.9999]	0.9760		[0.8355]	-36.3875		[0.0000]***	-37.0461		[0.0000]***
	South Korea	19.5850		[0.0334]**	17.4022		[0.0659]*	571.0100		[0.0000]***	590.9980		[0.0000]***
		-1.5615		[0.0592]*	-1.5255		[0.0636]*	-23.1984		[0.0000]***	-23.6218		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-3
Individual and panel unit root tests for relative prices : Meat

Individual unit root test - standard ADF test	Level						Difference					
	Constant			Constant + trend			Constant			Constant + trend		
Japan												
Sapporo	-1.5520	(13)	[0.5059]	-1.4114	(13)	[0.8560]	-4.1556	(12)	[0.0009]***	-4.2670	(12)	[0.0040]***
Sendai	-1.4766	(14)	[0.5443]	-1.6910	(14)	[0.7531]	-4.0814	(13)	[0.0012]***	-4.0770	(13)	[0.0076]***
Saitama	-1.6050	(14)	[0.4788]	-2.0975	(15)	[0.5446]	-4.1841	(13)	[0.0008]***	-4.1768	(13)	[0.0054]***
Chiba	-1.6528	(14)	[0.4543]	-1.4896	(14)	[0.8313]	-4.0629	(13)	[0.0013]***	-4.1203	(13)	[0.0066]***
Kawasaki	-1.6376	(15)	[0.4620]	-1.6530	(15)	[0.7694]	-2.6658	(14)	[0.0813]*	-2.6647	(14)	[0.2523]
Yokohama	-0.7795	(15)	[0.8230]	-0.6764	(15)	[0.9732]	-3.0544	(14)	[0.0312]**	-3.1811	(14)	[0.0902]*
Nagoya	-1.4708	(14)	[0.5472]	-2.1546	(15)	[0.5127]	-4.0933	(13)	[0.0012]***	-4.0630	(13)	[0.0079]***
Kyoto	-0.0847	(14)	[0.9487]	-1.2237	(14)	[0.9032]	-4.4801	(13)	[0.0003]***	-5.4409	(12)	[0.0000]***
Osaka	-1.4872	(14)	[0.5389]	-1.6317	(14)	[0.7783]	-3.8227	(13)	[0.0030]***	-3.9145	(13)	[0.0126]**
Kobe	-2.7936	(15)	[0.0604]*	-3.7856	(15)	[0.0186]**	-2.5641	(14)	[0.1017]	-2.7465	(14)	[0.2188]
Hiroshima	-1.3989	(15)	[0.5830]	-2.0024	(15)	[0.5972]	-2.5329	(14)	[0.1087]	-2.4516	(14)	[0.3522]
Fukuoka	-2.1976	(14)	[0.2077]	-2.4493	(14)	[0.3533]	-3.6540	(13)	[0.0053]***	-3.7247	(13)	[0.0222]**
Kitakyushu	-2.0039	(15)	[0.2852]	-2.4374	(15)	[0.3594]	-3.0984	(14)	[0.0278]**	-3.0956	(14)	[0.1093]
South Korea												
Busan	-0.9691	(13)	[0.7648]	-2.3420	(14)	[0.4095]	-4.8174	(12)	[0.0001]***	-4.8018	(12)	[0.0006]***
Incheon	-1.6510	(15)	[0.4552]	-2.5894	(15)	[0.2856]	-4.6098	(14)	[0.0002]***	-4.6670	(14)	[0.0009]***
Gwangju	-1.5234	(14)	[0.5205]	-2.7861	(15)	[0.2036]	-4.5306	(13)	[0.0002]***	-4.4752	(13)	[0.0019]***
Daegu	-1.4199	(14)	[0.5726]	-3.1155	(15)	[0.1046]	-4.3228	(13)	[0.0005]***	-4.3039	(13)	[0.0035]***
Daejeon	-1.3905	(14)	[0.5871]	-2.5421	(15)	[0.3076]	-4.2773	(13)	[0.0006]***	-4.2275	(13)	[0.0046]***
Panel unit root test - Levin, Liu and Chu (2002) test												
Japan	-0.9352		[0.1748]	-0.7013		[0.2416]	-1.0025		[0.1580]	-1.3025		[0.0964]*
South Korea	0.6423		[0.7397]	-0.0351		[0.4860]	-2.0318		[0.0211]**	-2.3057		[0.0106]**
Panel unit root tests - Im, Pesaran ans Shin (2003) test												
Japan	-0.3718		[0.3550]	0.8269		[0.7958]	-8.4397		[0.0000]***	-7.0409		[0.0000]***
South Korea	0.1612		[0.5640]	-1.6036		[0.0544]*	-7.5544		[0.0000]***	-6.5757		[0.0000]***
Panel unit root test - Fisher-ADF test												
Japan	22.4581		[0.6634]	18.2124		[0.8679]	135.0940		[0.0000]***	104.8130		[0.0000]***
	-0.0239		[0.4905]	1.3891		[0.9176]	-8.8185		[0.0000]***	-6.9669		[0.0000]***
South Korea	5.5964		[0.8480]	14.3485		[0.1577]	83.8079		[0.0000]***	63.4437		[0.0000]***
	0.4758		[0.6829]	-1.5127		[0.0652]*	-7.8225		[0.0000]***	-6.5073		[0.0000]***
Panel unit root test - Fisher-PP test												
Japan	16.6984		[0.9179]	12.2727		[0.9895]	1266.2100		[0.0000]***	1286.4100		[0.0000]***
	0.9023		[0.8166]	2.1272		[0.9833]	-34.3765		[0.0000]***	-34.6616		[0.0000]***
South Korea	14.9159		[0.1352]	10.4939		[0.3983]	476.4710		[0.0000]***	480.1150		[0.0000]***
	-1.5478		[0.0608]*	-0.7151		[0.2373]	-21.0703		[0.0000]***	-21.1522		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-4
Individual and panel unit root tests for relative prices : Dairy products and eggs

Individual unit root test - standard ADF test	Level						Difference					
	Constant			Constant + trend			Constant			Constant + trend		
Japan												
Sapporo	-0.9731	(14)	[0.7634]	-3.8265	(15)	[0.0165]**	-4.4592	(13)	[0.0003]***	-4.4502	(13)	[0.0021]***
Sendai	-0.3577	(14)	[0.9129]	-4.8155	(15)	[0.0005]***	-4.7171	(13)	[0.0001]***	-4.7497	(13)	[0.0007]***
Saitama	-1.7014	(14)	[0.4295]	-3.7627	(15)	[0.0199]**	-4.9131	(13)	[0.0000]***	-4.9166	(13)	[0.0004]***
Chiba	-1.9592	(14)	[0.3050]	-1.9611	(14)	[0.6196]	-4.6265	(12)	[0.0001]***	-4.6514	(12)	[0.0010]***
Kawasaki	-1.0190	(14)	[0.7472]	-4.3891	(15)	[0.0026]***	-5.3091	(12)	[0.0000]***	-5.3038	(12)	[0.0001]***
Yokohama	-1.0863	(13)	[0.7220]	-3.9047	(15)	[0.0130]**	-4.8617	(12)	[0.0001]***	-4.8571	(12)	[0.0005]***
Nagoya	-1.3573	(14)	[0.6032]	-3.6143	(15)	[0.0303]**	-4.3775	(13)	[0.0004]***	-4.3810	(13)	[0.0027]***
Kyoto	-1.3888	(14)	[0.5880]	-3.6421	(15)	[0.0280]**	-4.4567	(13)	[0.0003]***	-4.4488	(13)	[0.0021]***
Osaka	-1.9016	(14)	[0.3314]	-3.2458	(14)	[0.0777]*	-4.9624	(12)	[0.0000]***	-4.9509	(12)	[0.0003]***
Kobe	-1.5489	(14)	[0.5075]	-4.0207	(15)	[0.0091]***	-4.6026	(13)	[0.0002]***	-4.5939	(13)	[0.0012]***
Hiroshima	-1.5366	(13)	[0.5138]	-4.7478	(15)	[0.0007]***	-5.0239	(12)	[0.0000]***	-5.0140	(12)	[0.0002]***
Fukuoka	-1.6178	(14)	[0.4722]	-3.5387	(15)	[0.0372]**	-4.4245	(13)	[0.0003]***	-4.4178	(13)	[0.0024]***
Kitakyushu	-1.6313	(14)	[0.4653]	-3.3744	(15)	[0.0568]*	-4.4821	(13)	[0.0003]***	-4.4799	(13)	[0.0019]***
South Korea												
Busan	-1.5043	(15)	[0.5303]	-3.1988	(15)	[0.0866]*	-4.2841	(14)	[0.0006]***	-4.2791	(14)	[0.0039]***
Incheon	-2.5937	(15)	[0.0954]*	-2.7421	(15)	[0.2205]	-5.3091	(13)	[0.0000]***	-5.3156	(13)	[0.0001]***
Gwangju	-2.7291	(15)	[0.0703]*	-2.4450	(15)	[0.3555]	-3.3099	(14)	[0.0153]**	-3.4242	(14)	[0.0501]*
Daegu	-2.0772	(4)	[0.2542]	-3.3426	(5)	[0.0614]*	-3.9908	(11)	[0.0017]***	-4.0018	(11)	[0.0096]***
Daejeon	-2.4251	(15)	[0.1357]	-2.5427	(15)	[0.3074]	-4.8993	(13)	[0.0000]***	-4.8948	(13)	[0.0004]***
Panel unit root test - Levin, Liu and Chu (2002) test												
Japan	1.2877		[0.9011]	0.9517		[0.8294]	-4.7645		[0.0000]***	-5.3739		[0.0000]***
South Korea	-0.1825		[0.4276]	0.7742		[0.7806]	-0.8904		[0.1866]	-1.0123		[0.1557]
Panel unit root test - Im, Pesaran ans Shin (2003) test												
Japan	0.2604		[0.6027]	-7.3526		[0.0000]***	-12.9680		[0.0000]***	-11.5445		[0.0000]***
South Korea	-1.9945		[0.0230]**	-2.0775		[0.0189]**	-7.1763		[0.0000]***	-6.2698		[0.0000]***
Panel unit root test - Fisher-ADF test												
Japan	16.0229		[0.9356]	108.1830		[0.0000]***	239.2740		[0.0000]***	186.0970		[0.0000]***
	0.7177		[0.7635]	-7.2973		[0.0000]***	-13.3664		[0.0000]***	-11.3610		[0.0000]***
South Korea	18.0126		[0.0548]*	17.9228		[0.0563]*	79.6676		[0.0000]***	61.3518		[0.0000]***
	-1.9978		[0.0229]**	-2.0343		[0.0210]**	-7.4191		[0.0000]***	-6.1864		[0.0000]***
Panel unit root test - Fisher-PP test												
Japan	19.6193		[0.8092]	44.3945		[0.0137]**	1399.5400		[0.0000]***	1427.3300		[0.0000]***
	0.0255		[0.5102]	-3.0956		[0.0010]***	-36.2637		[0.0000]***	-36.6402		[0.0000]***
South Korea	27.7770		[0.0020]***	19.3425		[0.0361]**	490.0430		[0.0000]***	499.5990		[0.0000]***
	-2.6001		[0.0047]***	-1.7047		[0.0441]**	-21.3220		[0.0000]***	-21.5264		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-5

Individual and panel unit root tests for relative prices : Fruits

Individual unit root test - standard ADF test													
	Level						Difference						
	Constant			Constant + trend			Constant			Constant + trend			
Japan													
Sapporo	-1.4899	(14)	[0.5376]	-1.2694	(14)	[0.8931]	-4.9967	(13)	[0.0000]***	-5.1036	(13)	[0.0002]***	
Sendai	-2.4588	(14)	[0.1268]	-2.8162	(14)	[0.1926]	-4.5838	(13)	[0.0002]***	-4.5036	(13)	[0.0017]***	
Saitama	-1.8442	(15)	[0.3587]	-0.7549	(15)	[0.9673]	-3.6384	(14)	[0.0056]***	-3.9981	(14)	[0.0097]***	
Chiba	-2.7675	(15)	[0.0642]*	-2.6784	(15)	[0.2464]	-4.3797	(14)	[0.0004]***	-4.4560	(14)	[0.0021]***	
Kawasaki	-1.3949	(14)	[0.5850]	-1.9047	(14)	[0.6495]	-5.1006	(13)	[0.0000]***	-5.1230	(13)	[0.0002]***	
Yokohama	-2.1946	(14)	[0.2088]	-1.8637	(14)	[0.6708]	-3.8659	(13)	[0.0026]***	-4.0127	(13)	[0.0093]***	
Nagoya	-0.6008	(14)	[0.8670]	-3.0615	(15)	[0.1177]	-4.5869	(13)	[0.0002]***	-4.5402	(13)	[0.0015]***	
Kyoto	-1.9220	(14)	[0.3219]	-2.8749	(13)	[0.1722]	-4.6010	(13)	[0.0002]***	-5.6559	(12)	[0.0000]***	
Osaka	-1.5699	(12)	[0.4968]	-3.1115	(13)	[0.1055]	-4.9405	(11)	[0.0000]***	-5.0701	(11)	[0.0002]***	
Kobe	-1.6315	(15)	[0.4652]	-1.3383	(15)	[0.8763]	-2.6019	(14)	[0.0937]*	-2.8172	(14)	[0.1922]	
Hiroshima	-2.2928	(15)	[0.1750]	-1.4520	(14)	[0.8436]	-4.4740	(13)	[0.0003]***	-4.8049	(13)	[0.0006]***	
Fukuoka	-2.2257	(15)	[0.1977]	-2.0980	(15)	[0.5443]	-4.3680	(14)	[0.0004]***	-4.4425	(14)	[0.0022]***	
Kitakyushu	-0.6345	(14)	[0.8594]	-0.7530	(15)	[0.9675]	-6.5133	(13)	[0.0000]***	-6.6129	(13)	[0.0000]***	
South Korea													
Busan	-1.3660	(15)	[0.5990]	-2.4387	(15)	[0.3588]	-4.1027	(14)	[0.0011]***	-4.0885	(14)	[0.0073]***	
Incheon	-1.2071	(15)	[0.6722]	-2.0731	(15)	[0.5582]	-4.0685	(14)	[0.0013]***	-4.0604	(14)	[0.0080]***	
Gwangju	-0.4886	(14)	[0.8901]	-1.5004	(15)	[0.8276]	-4.8335	(13)	[0.0001]***	-5.0234	(13)	[0.0002]***	
Daegu	-2.1954	(15)	[0.2085]	-2.7934	(15)	[0.2009]	-4.2539	(14)	[0.0006]***	-4.2216	(14)	[0.0047]***	
Daejeon	-1.1922	(15)	[0.6787]	-2.2297	(15)	[0.4708]	-4.0062	(14)	[0.0016]***	-3.9981	(14)	[0.0097]***	
Panel unit root test - Levin, Liu and Chu (2002) test													
Japan	0.5853		[0.7208]	6.4219		[1.0000]	-0.5597		[0.2878]	-1.1707		[0.1209]	
South Korea	0.8057		[0.7898]	0.8217		[0.7944]	-0.1529		[0.4392]	0.2631		[0.6038]	
Panel unit root tests - Im, Pesaran ans Shin (2003) test													
Japan	-1.2570		[0.1044]	0.3956		[0.6538]	-12.1812		[0.0000]***	-11.5194		[0.0000]***	
South Korea	0.4108		[0.6594]	-0.3253		[0.3725]	-6.9150		[0.0000]***	-5.9837		[0.0000]***	
Panel unit root test - Fisher-ADF test													
Japan	29.6308		[0.2832]	22.2326		[0.6759]	225.2650		[0.0000]***	193.6280		[0.0000]***	
	-1.0200		[0.1539]	0.8589		[0.8048]	-12.5216		[0.0000]***	-11.2439		[0.0000]***	
South Korea	5.9628		[0.8184]	8.3108		[0.5985]	73.9125		[0.0000]***	56.2524		[0.0000]***	
	0.7049		[0.7596]	-0.0814		[0.4676]	-7.1932		[0.0000]***	-5.9437		[0.0000]***	
Panel unit root test - Fisher-PP test													
Japan	49.2462		[0.0039]***	30.2855		[0.2560]	1395.3600		[0.0000]***	1440.6500		[0.0000]***	
	-3.3220		[0.0004]***	-0.6964		[0.2431]	-36.1932		[0.0000]***	-36.8053		[0.0000]***	
South Korea	10.6771		[0.3832]	9.9021		[0.4491]	556.2350		[0.0000]***	571.4860		[0.0000]***	
	-0.1562		[0.4379]	-0.2702		[0.3935]	-22.8753		[0.0000]***	-23.1989		[0.0000]***	

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-6

Individual and panel unit root tests for relative prices : Cakes and candies

Individual unit root test - standard ADF test

		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	-2.9014	(15)	[0.0464]	-2.4894	(14)	[0.3333]	-5.3101	(13)	[0.0000]***	-5.6682	(13)	[0.0000]***
	Sendai	-0.2684	(14)	[0.9263]	-1.7565	(14)	[0.7233]	-4.9073	(13)	[0.0000]***	-5.2230	(13)	[0.0001]***
	Saitama	0.3673	(14)	[0.9813]	-3.1475	(14)	[0.0974]*	-4.4437	(13)	[0.0003]***	-4.7166	(13)	[0.0008]***
	Chiba	-1.7942	(15)	[0.3831]	-2.2498	(15)	[0.4597]	-4.5829	(13)	[0.0002]***	-4.6775	(13)	[0.0009]***
	Kawasaki	-1.3259	(15)	[0.6182]	-2.4449	(15)	[0.3556]	-3.3329	(14)	[0.0143]**	-3.2927	(14)	[0.0695]*
	Yokohama	-2.1352	(15)	[0.2311]	-2.3369	(15)	[0.4122]	-3.1122	(13)	[0.0267]**	-3.0389	(13)	[0.1235]
	Nagoya	-2.2970	(15)	[0.1737]	-1.8211	(14)	[0.6922]	-4.5031	(13)	[0.0002]***	-4.6797	(13)	[0.0009]***
	Kyoto	-1.6058	(15)	[0.4784]	-0.8134	(15)	[0.9622]	-4.0473	(14)	[0.0014]***	-4.3308	(14)	[0.0032]***
	Osaka	-0.2240	(15)	[0.9323]	-1.7141	(15)	[0.7428]	-3.5811	(14)	[0.0067]***	-3.6891	(14)	[0.0245]**
	Kobe	-2.2220	(15)	[0.1990]	-1.7465	(15)	[0.7280]	-4.2556	(14)	[0.0006]***	-4.3956	(14)	[0.0026]***
	Hiroshima	0.0451	(15)	[0.9609]	-2.8158	(15)	[0.1927]	-2.9833	(14)	[0.0376]**	-3.5183	(14)	[0.0392]**
	Fukuoka	1.5649	(14)	[0.9995]	1.1577	(14)	[0.9999]	-2.9576	(14)	[0.0402]**	-4.3755	(13)	[0.0028]***
	Kitakyushu	1.2856	(14)	[0.9986]	1.0504	(14)	[0.9999]	-2.2134	(14)	[0.2020]	-3.3767	(13)	[0.0565]*
South Korea													
	Busan	-0.4058	(13)	[0.9050]	-3.0539	(13)	[0.1196]	-5.0830	(12)	[0.0000]***	-5.0974	(12)	[0.0002]***
	Incheon	-2.1207	(15)	[0.2368]	-3.0032	(15)	[0.1331]	-4.1020	(14)	[0.0011]***	-4.0894	(14)	[0.0073]***
	Gwangju	-1.8805	(13)	[0.3413]	-2.6034	(13)	[0.2792]	-4.4602	(12)	[0.0003]***	-4.6142	(12)	[0.0012]***
	Daegu	-2.2473	(15)	[0.1902]	-2.2416	(15)	[0.4643]	-3.1040	(14)	[0.0273]**	-3.0828	(14)	[0.1124]
	Daejeon	-2.4502	(15)	[0.1290]	-3.3071	(15)	[0.0671]*	-4.8760	(13)	[0.0001]***	-4.8537	(13)	[0.0005]***
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	4.5712		[1.0000]	3.3608		[0.9996]	0.4014		[0.6559]	-0.0110		[0.4956]
	South Korea	0.5310		[0.7023]	0.2729		[0.6075]	-1.7127		[0.0434]**	-1.9185		[0.0275]**
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	2.2745		[0.9885]	2.0385		[0.9792]	-9.5991		[0.0000]***	-9.4327		[0.0000]***
	South Korea	-0.9022		[0.1835]	-2.0594		[0.0197]**	-7.0933		[0.0000]***	-6.1724		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	20.5729		[0.7637]	18.2341		[0.8671]	163.6640		[0.0000]***	147.5630		[0.0000]***
		2.4364		[0.9926]	2.3564		[0.9908]	-9.9612		[0.0000]***	-9.3106		[0.0000]***
	South Korea	12.6464		[0.2441]	17.7719		[0.0589]	78.4373		[0.0000]***	60.5037		[0.0000]***
		-0.8155		[0.2074]	-1.9955		[0.0230]	-7.3372		[0.0000]***	-6.0845		[0.0000]***
Panel unit root tests - Fisher-PP test													
	Japan	14.5750		[0.9646]	12.6613		[0.9868]	1391.5300		[0.0000]***	1442.7400		[0.0000]***
		3.7515		[0.9999]	3.1920		[0.9993]	-36.1279		[0.0000]***	-36.8220		[0.0000]***
	South Korea	10.1929		[0.4237]	10.9547		[0.3611]	541.4440		[0.0000]***	551.6040		[0.0000]***
		-0.4524		[0.3255]	-0.6686		[0.2519]	-22.5532		[0.0000]***	-22.7709		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-7
Individual and panel unit root tests for relative prices : Beverages

Individual unit root test - standard ADF test		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	-2.6000	(14)	[0.0941]*	-2.9661	(14)	[0.1437]	-4.8416	(13)	[0.0001]***	-4.8392	(13)	[0.0005]***
	Sendai	-2.8574	(13)	[0.0517]*	-2.7518	(13)	[0.2167]	-5.2090	(11)	[0.0000]***	-5.3189	(11)	[0.0001]***
	Saitama	-1.9018	(15)	[0.3313]	-2.6841	(15)	[0.2440]	-3.9455	(15)	[0.0020]***	-3.9712	(15)	[0.0106]**
	Chiba	-0.0464	(15)	[0.9526]	0.1883	(15)	[0.9979]	-2.9163	(15)	[0.0447]**	-4.8741	(14)	[0.0004]***
	Kawasaki	-1.6738	(15)	[0.4436]	-1.0456	(15)	[0.9348]	-4.4280	(14)	[0.0003]***	-4.6418	(14)	[0.0010]***
	Yokohama	-2.5474	(14)	[0.1054]	-2.1831	(14)	[0.4968]	-5.3319	(13)	[0.0000]***	-5.5035	(13)	[0.0000]***
	Nagoya	-2.7805	(15)	[0.0623]*	-2.5607	(15)	[0.2988]	-4.3530	(13)	[0.0004]***	-4.5071	(13)	[0.0017]***
	Kyoto	-1.6075	(15)	[0.4775]	-1.7893	(14)	[0.7077]	-2.9842	(14)	[0.0376]**	-3.9169	(13)	[0.0125]**
	Osaka	-0.5343	(14)	[0.8811]	-3.0376	(14)	[0.1238]	-4.2091	(13)	[0.0008]***	-5.1085	(12)	[0.0002]***
	Kobe	-2.1206	(15)	[0.2368]	-2.0356	(15)	[0.5790]	-3.6536	(14)	[0.0053]***	-3.6932	(14)	[0.0243]**
	Hiroshima	-1.2306	(13)	[0.6620]	-2.8457	(13)	[0.1822]	-4.5570	(12)	[0.0002]***	-4.6111	(12)	[0.0012]***
	Fukuoka	-1.5091	(12)	[0.5278]	-2.3206	(12)	[0.4210]	-5.9119	(11)	[0.0000]***	-5.9075	(11)	[0.0000]***
	Kitakyushu	-2.0833	(15)	[0.2517]	-1.9906	(15)	[0.6037]	-3.3503	(14)	[0.0136]**	-3.4561	(14)	[0.0462]**
South Korea													
	Busan	-2.7232	(15)	[0.0713]*	-3.7730	(15)	[0.0193]**	-4.8835	(13)	[0.0000]***	-4.8722	(13)	[0.0004]***
	Incheon	-3.2916	(15)	[0.0161]**	-3.1905	(15)	[0.0883]*	-5.3302	(14)	[0.0000]***	-5.3539	(14)	[0.0001]***
	Gwangju	-2.1819	(14)	[0.2134]	-2.3014	(14)	[0.4314]	-4.0843	(13)	[0.0012]***	-4.6614	(13)	[0.0010]***
	Daegu	-2.2620	(14)	[0.1852]	-2.3947	(14)	[0.3815]	-3.9004	(13)	[0.0023]***	-3.9271	(13)	[0.0121]**
	Daejeon	-1.2754	(12)	[0.6417]	-2.5184	(13)	[0.3190]	-6.2839	(11)	[0.0000]***	-6.2851	(11)	[0.0000]***
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	0.2525		[0.5997]	1.1434		[0.8736]	-2.7610		[0.0029]***	-4.0715		[0.0000]***
	South Korea	-0.5535		[0.2900]	-1.0556		[0.1456]	-1.8860		[0.0296]**	-2.1924		[0.0142]**
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	-1.3998		[0.0808]*	-0.2977		[0.3830]	-11.2737		[0.0000]***	-11.2510		[0.0000]***
	South Korea	-2.2024		[0.0138]**	-2.0423		[0.0206]**	-8.5060		[0.0000]***	-8.0095		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	34.1110		[0.1323]	25.8219		[0.4729]	202.7480		[0.0000]***	184.6330		[0.0000]***
		-1.2243		[0.1104]	0.0124		[0.5050]	-11.6343		[0.0000]***	-11.0346		[0.0000]***
	South Korea	20.8833		[0.0219]**	18.6448		[0.0450]**	102.4170		[0.0000]***	86.3181		[0.0000]***
		-2.2067		[0.0137]**	-1.9520		[0.0255]**	-8.6758		[0.0000]***	-7.7784		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	32.5676		[0.1750]	25.8158		[0.4733]	1360.5200		[0.0000]***	1408.5800		[0.0000]***
		-1.0115		[0.1559]	-0.2367		[0.4065]	-35.6990		[0.0000]***	-36.3517		[0.0000]***
	South Korea	18.8328		[0.0424]**	15.1040		[0.1283]	499.1560		[0.0000]***	505.8190		[0.0000]***
		-2.0244		[0.0215]**	-1.0487		[0.1472]	-21.5856		[0.0000]***	-21.7281		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-8

Individual and panel unit root tests for relative prices : Alcoholic beverages

Individual unit root test - standard ADF test												
	Level						Difference					
	Constant			Constant + trend			Constant			Constant + trend		
Japan												
Sapporo	-1.8196	(14)	[0.3706]	-1.7752	(14)	[0.7145]	-4.1254	(12)	[0.0010]***	-4.1198	(12)	[0.0066]***
Sendai	-2.0211	(15)	[0.2777]	-2.2990	(15)	[0.4327]	-2.7428	(14)	[0.0681]*	-3.2627	(13)	[0.0746]*
Saitama	-0.9688	(14)	[0.7649]	-1.9970	(14)	[0.6002]	-2.6819	(13)	[0.0784]*	-2.4162	(13)	[0.3703]
Chiba	-1.0462	(15)	[0.7372]	-1.7066	(15)	[0.7462]	-4.0452	(14)	[0.0014]***	-4.1096	(14)	[0.0068]***
Kawasaki	-0.2733	(15)	[0.9256]	-0.8649	(15)	[0.9572]	-2.3869	(14)	[0.1463]	-2.8231	(14)	[0.1901]
Yokohama	-1.6555	(15)	[0.4529]	-2.1043	(15)	[0.5408]	-3.9199	(14)	[0.0022]***	-4.0071	(14)	[0.0095]***
Nagoya	-1.3529	(15)	[0.6053]	-0.9889	(15)	[0.9427]	-3.7041	(14)	[0.0045]***	-3.8066	(14)	[0.0175]**
Kyoto	-1.0260	(14)	[0.7447]	-0.4510	(14)	[0.9853]	-3.6208	(13)	[0.0059]***	-3.9131	(13)	[0.0127]**
Osaka	-1.4784	(15)	[0.5434]	-1.0424	(15)	[0.9353]	-3.5415	(14)	[0.0076]***	-4.1306	(13)	[0.0063]***
Kobe	-1.2754	(14)	[0.6417]	-2.2246	(15)	[0.4737]	-4.5121	(13)	[0.0002]***	-4.5068	(13)	[0.0017]***
Hiroshima	-0.8162	(14)	[0.8127]	-2.6427	(15)	[0.2617]	-4.5922	(13)	[0.0002]***	-4.5877	(13)	[0.0013]***
Fukuoka	-2.7268	(6)	[0.0706]*	-1.9234	(6)	[0.6398]	3.0143	(4)	[1.0000]**	2.5021	(4)	[1.0000]
Kitakyushu	-1.6228	(13)	[0.4697]	-2.6704	(13)	[0.2498]	-3.3531	(12)	[0.0135]**	-3.3553	(12)	[0.0596]*
South Korea												
Busan	-2.0970	(15)	[0.2461]	-3.3826	(15)	[0.0557]*	-4.7273	(13)	[0.0001]***	-4.7162	(13)	[0.0008]***
Incheon	-3.2169	(15)	[0.0200]**	-2.9109	(15)	[0.1605]	-4.2533	(13)	[0.0006]***	-4.4937	(13)	[0.0018]***
Gwangju	-1.1099	(15)	[0.7127]	-1.8832	(15)	[0.6607]	-3.7752	(14)	[0.0035]***	-3.7416	(14)	[0.0211]**
Daegu	-0.8252	(14)	[0.8101]	-2.2808	(14)	[0.4427]	-4.4614	(13)	[0.0003]***	-4.4930	(13)	[0.0018]***
Daejeon	-0.3592	(14)	[0.9127]	-1.7226	(14)	[0.7390]	-4.6133	(13)	[0.0002]***	-4.6562	(13)	[0.0010]***
Panel unit root test - Levin, Liu and Chu (2002) test												
Japan	0.6970		[0.7571]	1.8127		[0.9651]	4.9558		[1.0000]	6.1321		[1.0000]
South Korea	0.6702		[0.7486]	-0.1020		[0.4594]	-1.4320		[0.0761]*	-1.3237		[0.0928]*
Panel unit root test - Im, Pesaran ans Shin (2003) test												
Japan	0.2655		[0.6047]	1.5193		[0.9356]	-6.5293		[0.0000]***	-5.2120		[0.0000]***
South Korea	-0.1622		[0.4356]	-0.9507		[0.1709]	-7.1948		[0.0000]***	-6.3709		[0.0000]***
Panel unit root test - Fisher-ADF test												
Japan	18.3595		[0.8623]	13.3956		[0.9801]	127.0710		[0.0000]***	98.4995		[0.0000]***
	0.6934		[0.7560]	2.0483		[0.9797]	-6.9472		[0.0000]***	-5.2649		[0.0000]***
South Korea	11.9097		[0.2911]	12.4986		[0.2531]	78.3781		[0.0000]***	61.1190		[0.0000]***
	0.0253		[0.5101]	-0.7486		[0.2270]	-7.4668		[0.0000]***	-6.3086		[0.0000]***
Panel unit root test - Fisher-PP test												
Japan	8.1702		[0.9997]	8.4447		[0.9995]	1206.4300		[0.0000]***	1238.9600		[0.0000]***
	3.2872		[0.9995]	4.3547		[1.0000]	-31.9481		[0.0000]***	-32.3968		[0.0000]***
South Korea	7.2649		[0.7002]	10.2164		[0.4217]	540.8270		[0.0000]***	556.2800		[0.0000]***
	0.6775		[0.7510]	-0.5069		[0.3061]	-22.5469		[0.0000]***	-22.8840		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-9
Individual and panel unit root tests for relative prices : Clothes

Individual unit root test - standard ADF test	Level						Difference					
	Constant			Constant + trend			Constant			Constant + trend		
Japan												
Sapporo	-2.8628	(15)	[0.0510]*	-2.8629	(15)	[0.1763]	-3.4882	(14)	[0.0090]***	-3.4930	(14)	[0.0419]**
Sendai	-2.4153	(14)	[0.1384]	-2.3786	(14)	[0.3900]	-5.5492	(12)	[0.0000]***	-5.5551	(12)	[0.0000]***
Saitama	-1.7251	(15)	[0.4176]	-0.3720	(15)	[0.9882]	-4.6479	(14)	[0.0001]***	-4.8054	(14)	[0.0006]***
Chiba	-1.0262	(14)	[0.7446]	-3.1338	(15)	[0.1004]	-4.7910	(13)	[0.0001]***	-4.7620	(13)	[0.0007]***
Kawasaki	-1.1083	(14)	[0.7134]	-3.5889	(15)	[0.0324]**	-4.8245	(13)	[0.0001]***	-4.8183	(13)	[0.0005]***
Yokohama	-2.6972	(15)	[0.0757]*	-3.0129	(15)	[0.1304]	-5.5846	(13)	[0.0000]***	-5.5918	(13)	[0.0000]***
Nagoya	-1.8377	(14)	[0.3618]	-2.4613	(14)	[0.3473]	-4.5564	(13)	[0.0002]***	-5.4118	(12)	[0.0000]***
Kyoto	-0.5951	(13)	[0.8683]	-2.9367	(14)	[0.1525]	-4.6373	(12)	[0.0001]***	-4.6711	(12)	[0.0009]***
Osaka	-0.5019	(14)	[0.8875]	-2.1116	(14)	[0.5368]	-5.1028	(13)	[0.0000]***	-5.1003	(13)	[0.0002]***
Kobe	-1.4419	(15)	[0.5617]	-1.1818	(15)	[0.9116]	-2.2082	(15)	[0.2039]	-2.2337	(15)	[0.4686]
Hiroshima	-0.1290	(15)	[0.9439]	-1.5020	(15)	[0.8271]	-4.5345	(14)	[0.0002]***	-4.6710	(14)	[0.0009]***
Fukuoka	-2.9809	(15)	[0.0379]**	-3.0867	(15)	[0.1114]	-3.9516	(14)	[0.0019]***	-4.1037	(14)	[0.0069]***
Kitakyushu	-1.9147	(15)	[0.3253]	-1.8977	(15)	[0.6532]	-3.7695	(14)	[0.0036]***	-3.7791	(14)	[0.0189]**
South Korea												
Busan	-2.4059	(15)	[0.1410]	-2.1349	(15)	[0.5237]	-4.3593	(14)	[0.0004]***	-4.5012	(14)	[0.0018]***
Incheon	-3.3485	(4)	[0.0136]**	-3.2905	(5)	[0.0698]*	-3.2869	(3)	[0.0163]**	-3.8815	(3)	[0.0139]**
Gwangju	-3.8472	(14)	[0.0028]***	-3.5843	(15)	[0.0328]**	-3.6134	(13)	[0.0060]***	-4.0676	(13)	[0.0078]***
Daegu	-2.9917	(14)	[0.0368]**	-2.0536	(14)	[0.5690]	-3.2659	(13)	[0.0174]**	-4.3918	(12)	[0.0026]***
Daejeon	-3.2032	(14)	[0.0208]**	-2.8317	(14)	[0.1871]	-3.7380	(13)	[0.0040]***	-4.4701	(13)	[0.0020]***
Panel unit root test - Levin, Liu and Chu (2002) test												
Japan	0.8873		[0.8125]	3.2789		[0.9995]	-0.6889		[0.2455]	-0.9360		[0.1746]
South Korea	-6.6887		[0.0000]***	-4.8811		[0.0000]***	-0.8565		[0.1959]	-2.0353		[0.0209]**
Panel unit root test - Im, Pesaran ans Shin (2003) test												
Japan	-0.7077		[0.2396]	-1.1463		[0.1258]	-11.8730		[0.0000]***	-10.7927		[0.0000]***
South Korea	-4.2161		[0.0000]***	-1.8710		[0.0307]**	-5.4414		[0.0000]***	-5.9420		[0.0000]***
Panel unit root test - Fisher-ADF test												
Japan	30.6970		[0.2397]	33.8332		[0.1393]	219.3930		[0.0000]***	179.0400		[0.0000]***
	-0.4583		[0.3234]	-0.8471		[0.1985]	-12.2611		[0.0000]***	-10.5476		[0.0000]***
South Korea	38.6316		[0.0000]***	17.9312		[0.0561]*	53.1118		[0.0000]***	55.3134		[0.0000]***
	-4.4199		[0.0000]***	-1.7770		[0.0378]**	-5.6990		[0.0000]***	-5.9098		[0.0000]***
Panel unit root test - Fisher-PP test												
Japan	26.1024		[0.4575]	29.6405		[0.2828]	1436.1000		[0.0000]***	1476.4200		[0.0000]***
	-0.2352		[0.4070]	-1.1128		[0.1329]	-36.7597		[0.0000]***	-37.2977		[0.0000]***
South Korea	31.3004		[0.0005]***	5.0769		[0.8860]	467.5450		[0.0000]***	494.6360		[0.0000]***
	-3.7403		[0.0001]***	1.0679		[0.8572]	-20.7918		[0.0000]***	-21.4434		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-10

Individual and panel unit root tests for relative prices : Fuel, light and water charges

Individual unit root test - standard ADF test

		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	-1.9831	(15)	[0.2943]	-2.7010	(15)	[0.2370]	-3.8836	(13)	[0.0025]***	-3.8783	(13)	[0.0141]**
	Sendai	-1.0607	(14)	[0.7318]	-0.9211	(14)	[0.9511]	-3.5161	(13)	[0.0082]***	-4.1984	(13)	[0.0051]***
	Saitama	-1.6333	(14)	[0.4642]	-2.5548	(14)	[0.3016]	-4.9925	(12)	[0.0000]***	-5.1222	(12)	[0.0002]***
	Chiba	-2.9076	(13)	[0.0456]**	-2.6179	(13)	[0.2727]	-5.0937	(12)	[0.0000]***	-5.3840	(12)	[0.0000]***
	Kawasaki	-1.0378	(14)	[0.7403]	-1.6920	(14)	[0.7527]	-4.8050	(13)	[0.0001]***	-4.9596	(13)	[0.0003]***
	Yokohama	-1.6595	(14)	[0.4509]	-1.4442	(14)	[0.8460]	-4.5907	(13)	[0.0002]***	-4.8500	(13)	[0.0005]***
	Nagoya	-3.4182	(4)	[0.0111]**	-3.4724	(4)	[0.0442]**	-5.6446	(3)	[0.0000]***	-5.6731	(2)	[0.0000]***
	Kyoto	-1.3396	(15)	[0.6117]	-2.3254	(15)	[0.4184]	-3.9079	(14)	[0.0023]***	-4.6332	(14)	[0.0011]***
	Osaka	-1.9575	(14)	[0.3058]	-2.3288	(13)	[0.4166]	-5.6355	(12)	[0.0000]***	-6.1858	(12)	[0.0000]***
	Kobe	-2.4587	(13)	[0.1268]	-2.5944	(13)	[0.2833]	-5.1271	(12)	[0.0000]***	-5.2645	(12)	[0.0001]***
	Hiroshima	-0.5433	(13)	[0.8792]	-1.9733	(13)	[0.6131]	-5.5065	(12)	[0.0000]***	-5.7172	(12)	[0.0000]***
	Fukuoka	-0.9408	(15)	[0.7743]	-2.5055	(15)	[0.3253]	-4.7259	(14)	[0.0001]***	-4.6916	(14)	[0.0009]***
	Kitakyushu	-1.8748	(15)	[0.3440]	-1.9297	(15)	[0.6364]	-3.0457	(15)	[0.0320]**	-3.0510	(15)	[0.1203]
South Korea													
	Busan	-2.0132	(15)	[0.2811]	-1.2764	(15)	[0.8915]	-3.6169	(15)	[0.0060]***	-3.6580	(15)	[0.0268]**
	Incheon	-1.6125	(15)	[0.4749]	-2.2529	(15)	[0.4580]	-3.2786	(15)	[0.0168]**	-3.5192	(15)	[0.0391]**
	Gwangju	-1.6851	(15)	[0.4378]	-1.0727	(15)	[0.9306]	-3.1062	(15)	[0.0272]**	-4.0736	(15)	[0.0076]***
	Daegu	-2.0683	(15)	[0.2578]	-0.1971	(15)	[0.9929]	-2.3935	(15)	[0.1445]	-3.2694	(15)	[0.0735]*
	Daejeon	-2.0244	(15)	[0.2763]	-1.2794	(15)	[0.8908]	-3.6151	(15)	[0.0060]***	-3.9005	(15)	[0.0132]**
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	0.1441		[0.5573]	-0.1703		[0.4324]	-4.7504		[0.0000]***	-6.5172		[0.0000]***
	South Korea	-1.6864		[0.0459]**	2.5935		[0.9952]	6.1187		[1.0000]	9.5953		[1.0000]
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	-1.1826		[0.1185]	-0.6349		[0.2628]	-12.7576		[0.0000]***	-12.3725		[0.0000]***
	South Korea	-1.0500		[0.1469]	2.3829		[0.9914]	-4.3168		[0.0000]***	-4.3603		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	32.3681		[0.1812]	25.2616		[0.5042]	239.1340		[0.0000]***	211.8700		[0.0000]***
		-0.9185		[0.1792]	-0.2754		[0.3915]	-13.0776		[0.0000]***	-12.0265		[0.0000]***
	South Korea	10.9622		[0.3605]	2.1808		[0.9948]	39.7259		[0.0000]***	37.3493		[0.0000]***
		-0.9135		[0.1805]	2.8138		[0.9976]	-4.5327		[0.0000]***	-4.3773		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	22.6179		[0.6545]	17.7123		[0.8860]	1366.9500		[0.0000]***	1398.0500		[0.0000]***
		-0.3691		[0.3560]	0.9382		[0.8259]	-35.6964		[0.0000]***	-36.0829		[0.0000]***
	South Korea	15.7483		[0.1071]	5.1458		[0.8812]	592.1270		[0.0000]***	617.8430		[0.0000]***
		-1.3831		[0.0833]*	1.5574		[0.9403]	-23.6484		[0.0000]***	-24.1815		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-11

Individual and panel unit root tests for relative prices : Medical care

Individual unit root test - standard ADF test		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	-0.8101	(15)	[0.8144]	-3.2093	(15)	[0.0846]*	-3.4613	(14)	[0.0097]***	-3.5890	(14)	[0.0324]**
	Sendai	0.7579	(14)	[0.9932]	-1.1522	(14)	[0.9172]	-3.9604	(13)	[0.0019]***	-4.2452	(13)	[0.0043]***
	Saitama	-2.9099	(15)	[0.0454]**	-2.5025	(15)	[0.3268]	-5.0748	(13)	[0.0000]***	-5.2228	(13)	[0.0001]***
	Chiba	-0.8250	(13)	[0.8102]	-2.9333	(14)	[0.1535]	-5.6004	(12)	[0.0000]***	-5.5914	(12)	[0.0000]***
	Kawasaki	-5.0669	(15)	[0.0000]***	-5.0598	(15)	[0.0002]***	-3.4272	(14)	[0.0108]**	-3.6183	(14)	[0.0299]**
	Yokohama	-2.8764	(15)	[0.0493]**	-4.0440	(14)	[0.0084]***	-3.9411	(14)	[0.0020]***	-5.3432	(13)	[0.0001]***
	Nagoya	-2.5285	(14)	[0.1097]	-5.1969	(15)	[0.0001]***	-3.4815	(13)	[0.0091]***	-3.3646	(13)	[0.0582]*
	Kyoto	-2.2286	(15)	[0.1966]	-2.5561	(15)	[0.3010]	-3.4696	(14)	[0.0095]***	-3.4790	(14)	[0.0435]**
	Osaka	-2.2224	(15)	[0.1988]	-2.3043	(15)	[0.4299]	-3.3234	(14)	[0.0147]**	-3.3138	(14)	[0.0660]*
	Kobe	-0.2300	(14)	[0.9315]	-1.9870	(14)	[0.6056]	-4.4177	(13)	[0.0003]***	-5.1052	(12)	[0.0002]***
	Hiroshima	-2.8347	(15)	[0.0547]*	-2.9396	(15)	[0.1516]	-3.4464	(13)	[0.0102]**	-3.4998	(13)	[0.0412]**
	Fukuoka	0.4074	(14)	[0.9830]	-2.5354	(15)	[0.3109]	-4.6227	(13)	[0.0001]***	-4.7569	(13)	[0.0007]***
	Kitakyushu	-1.8531	(15)	[0.3544]	-2.4286	(15)	[0.3640]	-4.6108	(13)	[0.0002]***	-4.6572	(13)	[0.0010]***
South Korea													
	Busan	-4.1585	(14)	[0.0009]***	-3.5314	(13)	[0.0379]**	-5.4597	(13)	[0.0000]***	-7.0712	(12)	[0.0000]***
	Incheon	-2.5740	(13)	[0.0995]*	-4.2871	(13)	[0.0037]***	-5.7153	(12)	[0.0000]***	-5.8645	(12)	[0.0000]***
	Gwangju	-3.2418	(14)	[0.0186]**	-4.8640	(14)	[0.0004]***	-6.8527	(12)	[0.0000]***	-6.9690	(12)	[0.0000]***
	Daegu	-2.4627	(13)	[0.1258]	-1.9224	(13)	[0.6403]	-7.5077	(12)	[0.0000]***	-7.6849	(12)	[0.0000]***
	Daejeon	-2.3049	(15)	[0.1711]	-2.5561	(15)	[0.3010]	-6.1422	(13)	[0.0000]***	-6.2156	(13)	[0.0000]***
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	1.4034		[0.9197]	-2.3382		[0.0097]***	-1.5308		[0.0629]*	-2.2288		[0.0129]**
	South Korea	-1.2458		[0.1064]	-0.9741		[0.1650]	-4.7705		[0.0000]***	-7.1833		[0.0000]***
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	-1.3162		[0.0940]*	-3.9660		[0.0000]***	-10.3985		[0.0000]***	-9.7051		[0.0000]***
	South Korea	-3.6896		[0.0001]***	-3.6721		[0.0001]***	-12.0639		[0.0000]***	-12.7658		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	53.4427		[0.0012]***	69.3582		[0.0000]***	178.6430		[0.0000]***	154.1130		[0.0000]***
		-1.2425		[0.1070]	-3.7201		[0.0001]***	-10.8033		[0.0000]***	-9.5594		[0.0000]***
	South Korea	34.2536		[0.0002]***	36.4733		[0.0001]***	169.8500		[0.0000]***	168.7020		[0.0000]***
		-3.8372		[0.0001]***	-3.5504		[0.0002]***	-11.8846		[0.0000]***	-11.8547		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	36.3864		[0.0848]*	41.1985		[0.0296]**	1336.2400		[0.0000]***	1373.7700		[0.0000]***
		-0.3019		[0.3814]	-1.5204		[0.0642]*	-35.3554		[0.0000]***	-35.8695		[0.0000]***
	South Korea	24.3844		[0.0066]***	16.3729		[0.0894]***	547.4960		[0.0000]***	560.0880		[0.0000]***
		-2.8830		[0.0020]***	-1.85237		[0.0320]***	-22.6901		[0.0000]***	-22.9609		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-12
Individual and panel unit root tests for relative prices : Transportation and communication

Individual unit root test - standard ADF test		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	-1.0405	(15)	[0.7393]	-2.8796	(15)	[0.1707]	-3.8236	(14)	[0.0030]***	-3.9028	(14)	[0.0131]**
	Sendai	-0.2793	(14)	[0.9248]	-2.1737	(14)	[0.5020]	-4.2150	(13)	[0.0007]***	-4.5386	(13)	[0.0015]***
	Saitama	-1.1396	(14)	[0.7007]	-1.9443	(14)	[0.6286]	-5.5146	(13)	[0.0000]***	-5.4893	(13)	[0.0000]***
	Chiba	-0.8818	(14)	[0.7932]	-1.7123	(14)	[0.7437]	-3.8293	(13)	[0.0030]***	-3.8676	(13)	[0.0145]**
	Kawasaki	-2.0867	(15)	[0.2503]	-2.0176	(15)	[0.5888]	-4.5495	(14)	[0.0002]***	-4.5411	(14)	[0.0015]***
	Yokohama	-3.4602	(15)	[0.0098]***	-3.1950	(15)	[0.0874]*	-4.6142	(13)	[0.0002]***	-4.7881	(13)	[0.0006]***
	Nagoya	-1.4493	(14)	[0.5580]	-2.4776	(15)	[0.3391]	-5.0648	(13)	[0.0000]***	-5.0643	(13)	[0.0002]***
	Kyoto	-2.2807	(13)	[0.1790]	-2.5059	(13)	[0.3251]	-4.6226	(12)	[0.0001]***	-4.5826	(12)	[0.0013]***
	Osaka	-3.3841	(15)	[0.0123]**	-3.3168	(15)	[0.0655]*	-5.8353	(13)	[0.0000]***	-5.9026	(13)	[0.0000]***
	Kobe	-1.9787	(14)	[0.2963]	-1.6440	(14)	[0.7732]	-5.5682	(13)	[0.0000]***	-5.6882	(13)	[0.0000]***
	Hiroshima	-2.2071	(15)	[0.2043]	-2.1624	(15)	[0.5083]	-3.4457	(14)	[0.0102]**	-3.8494	(14)	[0.0154]**
	Fukuoka	-1.1733	(13)	[0.6867]	-3.0484	(14)	[0.1210]	-5.5194	(12)	[0.0000]***	-5.5109	(12)	[0.0000]***
	Kitakyushu	-2.1089	(13)	[0.2414]	-3.5251	(14)	[0.0385]**	-6.2147	(11)	[0.0000]***	-5.5136	(12)	[0.0000]***
South Korea													
	Busan	-1.6286	(5)	[0.4667]	-2.9737	(5)	[0.1414]	-2.8253	(3)	[0.0559]*	-2.8192	(3)	[0.1915]
	Incheon	0.0370	(15)	[0.9602]	-2.0636	(15)	[0.5634]	-2.7014	(14)	[0.0749]*	-2.9938	(14)	[0.1357]
	Gwangju	-0.4840	(14)	[0.8909]	-2.2242	(14)	[0.4739]	-3.8068	(13)	[0.0032]***	-4.6052	(12)	[0.0012]***
	Daegu	-0.1107	(14)	[0.9459]	-1.8906	(14)	[0.6569]	-3.8838	(13)	[0.0024]***	-4.0405	(13)	[0.0085]***
	Daejeon	-0.2504	(14)	[0.9288]	-2.2236	(14)	[0.4742]	-3.6859	(13)	[0.0048]***	-3.8664	(13)	[0.0146]**
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	1.0368		[0.8501]	0.1039		[0.5414]	-3.6867		[0.0001]***	-4.0376		[0.0000]***
	South Korea	0.7838		[0.7834]	-3.6971		[0.0001]***	-0.9839		[0.1626]	-1.0363		[0.1500]
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	-1.3929		[0.0818]*	-1.8497		[0.0322]**	-13.4588		[0.0000]***	-12.2304		[0.0000]***
	South Korea	2.4247		[0.9923]	-0.4879		[0.3128]	-4.7640		[0.0000]***	-4.2988		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	36.5736		[0.0816]*	34.8346		[0.1153]	258.7990		[0.0000]***	206.8110		[0.0000]***
		-1.1604		[0.1229]	-1.5649		[0.0588]*	-13.7550		[0.0000]***	-11.9368		[0.0000]***
	South Korea	2.0953		[0.9956]	8.8860		[0.5430]	45.1613		[0.0000]***	38.7476		[0.0000]***
		2.6718		[0.9962]	-0.2864		[0.3873]	-4.9925		[0.0000]***	-4.2828		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	47.0347		[0.0070]***	33.3369		[0.1525]	1347.9900		[0.0000]***	1375.0600		[0.0000]***
		-2.2971		[0.0108]**	-1.3119		[0.0948]*	-35.5327		[0.0000]***	-35.9014		[0.0000]***
	South Korea	0.9229		[0.9999]	4.9610		[0.8938]	449.3970		[0.0000]***	466.3870		[0.0000]***
		3.8032		[0.9999]	0.8299		[0.7967]	-20.2929		[0.0000]***	-20.6373		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-13

Individual and panel unit root tests for relative prices : Education

		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Individual unit root test - standard ADF test													
Japan													
	Sapporo	-0.7689	(15)	[0.8258]	-2.4645	(15)	[0.3457]	-2.8022	(14)	[0.0591]*	-3.1787	(13)	[0.0907]*
	Sendai	-0.6786	(15)	[0.8490]	-2.2317	(15)	[0.4697]	-3.1311	(14)	[0.0254]**	-3.0306	(14)	[0.1257]
	Saitama	-4.0011	(15)	[0.0016]***	-3.5539	(15)	[0.0357]**	-2.8387	(14)	[0.0541]*	-4.0645	(13)	[0.0079]***
	Chiba	-1.7093	(15)	[0.4255]	-3.2567	(15)	[0.0757]*	-2.6222	(14)	[0.0896]*	-2.8030	(14)	[0.1974]
	Kawasaki	-1.9642	(14)	[0.3027]	-2.0479	(14)	[0.5722]	-3.4214	(12)	[0.0110]**	-3.4986	(12)	[0.0413]**
	Yokohama	-1.6977	(15)	[0.4314]	-1.8598	(15)	[0.6727]	-3.5905	(14)	[0.0065]***	-3.5227	(14)	[0.0388]**
	Nagoya	-2.6054	(15)	[0.0930]*	-3.6890	(15)	[0.0245]**	-2.4835	(14)	[0.1205]	-2.8207	(14)	[0.1910]
	Kyoto	-1.1175	(15)	[0.7097]	-2.0382	(15)	[0.5776]	-3.0941	(14)	[0.0281]**	-3.1046	(14)	[0.1071]
	Osaka	-0.6970	(13)	[0.8445]	-1.9114	(14)	[0.6460]	-3.7446	(12)	[0.0039]***	-3.7496	(12)	[0.0206]**
	Kobe	-1.4414	(15)	[0.5620]	-1.7487	(15)	[0.7270]	-3.2301	(14)	[0.0193]**	-2.9796	(15)	[0.1397]
	Hiroshima	-0.8768	(15)	[0.7947]	-3.4062	(14)	[0.0525]**	-3.2980	(14)	[0.0158]**	-3.4345	(14)	[0.0488]**
	Fukuoka	-2.4825	(14)	[0.1208]	-3.1947	(14)	[0.0875]*	-2.5681	(13)	[0.1008]	-2.5924	(13)	[0.2842]
	Kitakyushu	-1.9429	(15)	[0.3123]	-1.6236	(15)	[0.7816]	-2.9348	(14)	[0.0426]**	-3.1011	(14)	[0.1079]
South Korea													
	Busan	-1.3828	(14)	[0.5909]	-3.0106	(15)	[0.1311]	-5.0294	(13)	[0.0000]***	-5.0354	(13)	[0.0002]***
	Incheon	-1.5214	(15)	[0.5215]	-2.5872	(15)	[0.2866]	-4.1676	(14)	[0.0009]***	-4.2281	(14)	[0.0046]***
	Gwangju	-2.8566	(14)	[0.0518]*	-3.3571	(15)	[0.0593]*	-4.8154	(13)	[0.0001]***	-5.0096	(13)	[0.0002]***
	Daegu	-2.0951	(14)	[0.2469]	-3.2573	(15)	[0.0756]*	-4.4550	(13)	[0.0003]***	-4.4954	(13)	[0.0018]***
	Daejeon	-1.8929	(14)	[0.3355]	-2.9046	(15)	[0.1625]	-3.8135	(13)	[0.0031]***	-4.0322	(13)	[0.0087]***
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	-2.9903		[0.0014]***	-7.9222		[0.0000]***	-0.9130		[0.1806]	0.0081		[0.5032]
	South Korea	-2.9000		[0.0019]***	0.2152		[0.5852]	-1.0151		[0.1550]	-1.4795		[0.0695]*
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	-0.9369		[0.1744]	-1.9931		[0.0231]**	-6.3881		[0.0000]***	-4.9934		[0.0000]***
	South Korea	-1.2208		[0.1111]	-2.5552		[0.0053]***	-7.4175		[0.0000]***	-6.7534		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	33.2809		[0.1541]	38.6600		[0.0525]*	92.3012		[0.0000]***	67.2420		[0.0000]***
		-0.6350		[0.2627]	-1.6852		[0.0460]**	-6.7106		[0.0000]***	-4.9794		[0.0000]***
	South Korea	13.2565		[0.2097]	21.0119		[0.0210]**	82.2260		[0.0000]***	66.3962		[0.0000]***
		-1.0969		[0.1363]	-2.5334		[0.0056]***	-7.6775		[0.0000]***	-6.6631		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	31.2709		[0.2183]	40.5386		[0.0345]**	1159.3700		[0.0000]***	1242.4000		[0.0000]***
		0.0647		[0.5258]	-1.1432		[0.1265]	-32.7658		[0.0000]***	-34.0234		[0.0000]***
	South Korea	5.4750		[0.8573]	9.6748		[0.4695]	535.0990		[0.0000]***	545.1600		[0.0000]***
		0.5548		[0.7105]	-0.5212		[0.3011]	-22.4130		[0.0000]***	-22.6309		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 3-14
Individual and panel unit root tests for relative prices : Housing

Individual unit root test - standard ADF test		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan													
	Sapporo	-1.6429	(4)	[0.4594]	-1.1516	(5)	[0.9173]	-3.0300	(3)	[0.0333]**	-3.6657	(11)	[0.0262]**
	Sendai	-1.2744	(15)	[0.6422]	-0.5869	(15)	[0.9787]	-3.5958	(14)	[0.0064]***	-4.7493	(13)	[0.0007]***
	Saitama	-1.9795	(15)	[0.2959]	-1.5685	(15)	[0.8032]	-3.0550	(14)	[0.0312]**	-3.2967	(14)	[0.0688]*
	Chiba	-2.5324	(13)	[0.1088]	-2.5203	(13)	[0.3181]	-4.5671	(12)	[0.0002]***	-4.5630	(12)	[0.0014]***
	Kawasaki	-1.2893	(15)	[0.6353]	-1.7057	(15)	[0.7466]	-2.8149	(14)	[0.0574]*	-2.8335	(14)	[0.1864]
	Yokohama	-2.8087	(15)	[0.0582]*	-2.9779	(15)	[0.1402]	-4.0624	(14)	[0.0013]***	-4.1496	(14)	[0.0060]***
	Nagoya	-1.1657	(15)	[0.6899]	-2.4061	(15)	[0.3756]	-3.7984	(14)	[0.0033]***	-3.8882	(14)	[0.0137]**
	Kyoto	-0.3185	(14)	[0.9190]	-2.7630	(15)	[0.2124]	-3.3689	(13)	[0.0129]**	-3.3970	(13)	[0.0537]*
	Osaka	-1.7342	(15)	[0.4130]	-4.8251	(15)	[0.0005]***	-2.2011	(15)	[0.2064]	-2.1067	(15)	[0.5395]
	Kobe	-1.7059	(15)	[0.4273]	-2.1422	(15)	[0.5196]	-2.6744	(13)	[0.0797]*	-2.8625	(13)	[0.1764]
	Hiroshima	-1.6928	(14)	[0.4339]	-1.4384	(14)	[0.8478]	-3.7442	(13)	[0.0039]***	-3.7340	(13)	[0.0216]**
	Fukuoka	-1.7324	(15)	[0.4139]	-1.6659	(15)	[0.7639]	-2.7966	(14)	[0.0599]*	-2.8404	(14)	[0.1840]
	Kitakyushu	-2.4529	(15)	[0.1283]	-2.5848	(15)	[0.2876]	-2.7287	(14)	[0.0704]*	-2.6797	(14)	[0.2459]
South Korea													
	Busan	-0.1455	(4)	[0.9420]	-3.1232	(5)	[0.1028]	-3.4514	(3)	[0.0100]**	-3.5161	(3)	[0.0394]**
	Incheon	-2.2369	(5)	[0.1938]	-4.1273	(5)	[0.0064]***	-2.9599	(3)	[0.0399]**	-2.9909	(3)	[0.1365]
	Gwangju	0.4737	(14)	[0.9856]	-1.1566	(15)	[0.9164]	-3.1039	(13)	[0.0273]**	-3.2924	(13)	[0.0695]*
	Daegu	-0.1710	(13)	[0.9390]	-1.5777	(14)	[0.7997]	-3.4334	(12)	[0.0106]**	-3.5065	(12)	[0.0405]**
	Daejeon	-2.4986	(15)	[0.1168]	-4.0242	(15)	[0.0090]***	-5.3071	(14)	[0.0000]***	-5.2985	(14)	[0.0001]***
Panel unit root test - Levin, Liu and Chu (2002) test													
	Japan	-2.7034		[0.0034]***	-2.1279		[0.0167]**	0.1166		[0.5464]	0.7523		[0.7741]
	South Korea	1.7830		[0.9627]	-0.8286		[0.2037]	-1.5083		[0.0657]*	-1.7858		[0.0371]**
Panel unit root test - Im, Pesaran ans Shin (2003) test													
	Japan	-1.0335		[0.1507]	-0.3889		[0.3487]	-7.2115		[0.0000]***	-5.9711		[0.0000]***
	South Korea	1.3884		[0.9175]	-1.9170		[0.0276]**	-5.4482		[0.0000]***	-4.4443		[0.0000]***
Panel unit root test - Fisher-ADF test													
	Japan	27.8293		[0.3669]	32.3366		[0.1822]	110.4060		[0.0000]***	86.9440		[0.0000]***
		-0.7651		[0.2221]	0.0600		[0.5239]	-7.5429		[0.0000]***	-5.9005		[0.0000]***
	South Korea	7.8509		[0.6434]	24.7082		[0.0059]***	55.5470		[0.0000]***	41.2966		[0.0000]***
		1.4530		[0.9269]	-1.7449		[0.0405]**	-5.6495		[0.0000]***	-4.4197		[0.0000]***
Panel unit root test - Fisher-PP test													
	Japan	46.4215		[0.0082]***	28.1274		[0.3522]	1130.4800		[0.0000]***	1190.9100		[0.0000]***
		-1.2034		[0.1144]	2.3814		[0.9914]	-32.1866		[0.0000]***	-33.1360		[0.0000]***
	South Korea	11.6450		[0.3095]	27.8739		[0.0019]***	414.4980		[0.0000]***	426.0750		[0.0000]***
		1.0016		[0.8417]	-0.8865		[0.1877]	-19.1811		[0.0000]***	-19.5536		[0.0000]***

1. The numbers in parrentheses denote lag length and those in brackets are P-values. The lag length is chosen on the basis of the Akaike's Information Criteria (AIC). First, we specify maximum lag order (k) in autoregression. Next, we select apporopriate lag order according to the AIC. In this paper, the standard by Schwert (1989) suggested in Hayashi (2000) is applied to the decision of maximum lag order. Schwert 's (1989) rule is stated as follows: $k_{max} = int(12(T/100)^{1/4})$; where T is the number of sample. 2. *, **, *** are significant at the 10, 5, 1 percent significance level respectively.

Table 4

Individual unit root test for Cointegration test - ADF

		Level						Difference					
		Constant			Constant + trend			Constant			Constant + trend		
Japan	Sapporo	-2.9998	(12)	[0.0360]**	-1.3866	(12)	[0.8632]	-2.9423	(12)	[0.0418]**	-4.1693	(11)	[0.0056]***
	Sendai	-2.3263	(4)	[0.1643]	-0.9111	(4)	[0.9523]	-3.1133	(4)	[0.0266]**	-3.9300	(3)	[0.0120]**
	Saitama	-2.4034	(13)	[0.1416]	-0.1465	(13)	[0.9939]	-2.8419	(12)	[0.0537]*	-3.8471	(12)	[0.0154]**
	Tokyo	-2.6884	(12)	[0.0772]*	-0.1589	(12)	[0.9937]	-2.5595	(12)	[0.1027]	-4.0932	(11)	[0.0071]***
	Chiba	-2.7449	(12)	[0.0677]*	-0.7075	(12)	[0.9710]	-2.5645	(12)	[0.1016]	-3.8990	(11)	[0.0132]**
	Kawasaki	-2.7232	(13)	[0.0712]*	-0.5346	(12)	[0.9815]	-2.5416	(12)	[0.1067]	-4.2344	(11)	[0.0045]***
	Yokohama	-2.4824	(12)	[0.1208]	-0.6273	(12)	[0.9764]	-2.4883	(4)	[0.1193]	-3.7416	(11)	[0.0211]**
	Nagoya	-2.9323	(12)	[0.0428]**	-0.4691	(12)	[0.9845]	-2.9779	(12)	[0.0381]**	-4.4725	(11)	[0.0019]***
	Kyoto	-2.2746	(4)	[0.1809]	-0.4257	(4)	[0.9863]	-2.9058	(4)	[0.0458]**	-3.8542	(3)	[0.0151]**
	Osaka	-2.7353	(12)	[0.0692]*	0.0168	(12)	[0.9963]	-2.7328	(4)	[0.0697]*	-4.2852	(11)	[0.0038]***
	Kobe	-2.4586	(13)	[0.1268]	-0.3319	(13)	[0.9895]	-2.4632	(13)	[0.1256]	-3.7292	(12)	[0.0218]**
	Hiroshima	-3.0409	(13)	[0.0323]**	-0.7463	(13)	[0.9680]	-2.8044	(13)	[0.0588]*	-4.3854	(12)	[0.0026]***
	Kitakyushu	-2.2872	(4)	[0.1768]	-0.6126	(4)	[0.9773]	-3.0180	(4)	[0.0343]**	-4.2768	(11)	[0.0039]***
	Fukuoka	-2.6870	(13)	[0.0774]*	-0.6036	(13)	[0.9778]	-2.9704	(12)	[0.0389]**	-4.0255	(12)	[0.0089]***
South Korea	Seoul	-0.5514	(14)	[0.8776]	-2.7059	(15)	[0.2350]	-3.4797	(13)	[0.0092]***	-3.4646	(13)	[0.0451]**
	Incheon	-0.8083	(15)	[0.8150]	-2.5378	(15)	[0.3097]	-3.2434	(13)	[0.0185]**	-2.9187	(14)	[0.1580]
	Gwangju	-0.7649	(15)	[0.8270]	-2.3377	(15)	[0.4118]	-3.0687	(14)	[0.0300]**	-3.0405	(14)	[0.1230]
	Daegu	-0.8670	(15)	[0.7978]	-2.4741	(15)	[0.3409]	-3.0395	(14)	[0.0324]**	-3.0357	(14)	[0.1242]
	Busan	-0.4740	(14)	[0.8929]	-2.3029	(15)	[0.4306]	-3.3265	(13)	[0.0145]**	-3.2790	(13)	[0.0717]*
	Daejeon	-0.6648	(15)	[0.8524]	-2.1800	(15)	[0.4986]	-2.9591	(14)	[0.0400]**	-2.9205	(14)	[0.1574]
Nominal Exchange Rate		-2.4174	(14)	[0.1378]	-1.9227	(14)	[0.6401]	-7.1624	(15)	[0.0000]***	-7.4563	(15)	[0.0000]***

Table 5
Individual Cointegration tests

Individual Cointegration test - Johansen and Juselius(1990)								
			Null Hypothesis					
			λ-max			Trace		
			$r=0$		$r \leq 1$	$r=0$		$r \leq 1$
City pairs	Sapporo	Seoul	58.7707	**	8.2981	67.0689	**	8.2981
	Sapporo	Incheon	51.1091	**	8.1335	59.2426	**	8.1335
	Sapporo	Gwangju	41.0637	**	8.0497	49.1134	**	8.0497
	Sapporo	Daegu	47.5999	**	8.0663	55.6662	**	8.0663
	Sapporo	Busan	52.2396	**	7.8764	60.1160	**	7.8764
	Sapporo	Daejeon	45.0985	**	8.1756	53.2741	**	8.1756
	Sendai	Seoul	61.9445	**	7.7957	69.7402	**	7.7957
	Sendai	Incheon	53.9510	**	7.7063	61.6573	**	7.7063
	Sendai	Gwangju	44.5125	**	7.4639	51.9764	**	7.4639
	Sendai	Daegu	50.2434	**	7.4409	57.6843	**	7.4409
	Sendai	Busan	53.7272	**	7.3226	61.0498	**	7.3226
	Sendai	Daejeon	47.2383	**	7.9345	55.1728	**	7.9345
	Saitama	Seoul	62.1902	**	7.8641	70.0543	**	7.8641
	Saitama	Incheon	55.3858	**	7.8148	63.2006	**	7.8148
	Saitama	Gwangju	46.8264	**	7.6731	54.4995	**	7.6731
	Saitama	Daegu	52.5781	**	7.5497	60.1278	**	7.5497
	Saitama	Busan	55.9864	**	7.3363	63.3228	**	7.3363
	Saitama	Daejeon	49.1832	**	7.8986	57.0818	**	7.8986
	Tokyo	Seoul	62.5215	**	7.7748	70.2963	**	7.7748
	Tokyo	Incheon	56.0715	**	7.7531	63.8246	**	7.7531
	Tokyo	Gwangju	47.5048	**	7.5693	55.0741	**	7.5693
	Tokyo	Daegu	51.9156	**	7.4656	59.3811	**	7.4656
	Tokyo	Busan	55.7720	**	7.2541	63.0261	**	7.2541
	Tokyo	Daejeon	48.9226	**	7.8601	56.7827	**	7.8601
	Chiba	Seoul	60.7811	**	7.9814	68.7624	**	7.9814
	Chiba	Incheon	53.1201	**	7.8591	60.9792	**	7.8591
	Chiba	Gwangju	42.5853	**	7.4803	50.0656	**	7.4803
	Chiba	Daegu	51.1935	**	7.6939	58.8875	**	7.6939
	Chiba	Busan	54.4956	**	7.5605	62.0561	**	7.5605
	Chiba	Daejeon	46.7567	**	8.0513	54.8080	**	8.0513
	Kawasaki	Seoul	60.0079	**	7.5232	67.5310	**	7.5232
	Kawasaki	Incheon	52.8250	**	7.6243	60.4493	**	7.6243
	Kawasaki	Gwangju	45.2157	**	7.5330	52.7487	**	7.5330
	Kawasaki	Daegu	48.2705	**	7.3314	55.6020	**	7.3314
	Kawasaki	Busan	51.6162	**	7.0668	58.6830	**	7.0668
	Kawasaki	Daejeon	45.1140	**	7.7085	52.8225	**	7.7085
	Yokohama	Seoul	61.6433	**	7.9042	69.5475	**	7.9042
	Yokohama	Incheon	54.7419	**	7.7998	62.5417	**	7.7998
	Yokohama	Gwangju	43.6004	**	7.5924	51.1928	**	7.5924
	Yokohama	Daegu	51.8682	**	7.6603	59.5285	**	7.6603
	Yokohama	Busan	56.5996	**	7.4825	64.0821	**	7.4825
	Yokohama	Daejeon	47.9694	**	7.9361	55.9055	**	7.9361
	Nagoya	Seoul	60.3737	**	8.1216	68.4953	**	8.1216
	Nagoya	Incheon	52.5854	**	7.7506	60.3359	**	7.7506
	Nagoya	Gwangju	42.9123	**	7.5720	50.4843	**	7.5720
	Nagoya	Daegu	49.1159	**	7.5745	56.6903	**	7.5745
	Nagoya	Busan	52.7351	**	7.4226	60.1577	**	7.4226
	Nagoya	Daejeon	45.7598	**	7.8846	53.6444	**	7.8846
	Kyoto	Seoul	60.2633	**	7.6434	67.9067	**	7.6434
	Kyoto	Incheon	53.7369	**	7.6127	61.3496	**	7.6127
	Kyoto	Gwangju	45.8993	**	7.4358	53.3351	**	7.4358
	Kyoto	Daegu	49.2645	**	7.3001	56.5646	**	7.3001
	Kyoto	Busan	52.1835	**	7.1013	59.2847	**	7.1013
	Kyoto	Daejeon	45.7351	**	7.7805	53.5156	**	7.7805
	Osaka	Seoul	60.5783	**	8.0156	68.5939	**	8.0156
	Osaka	Incheon	54.1669	**	7.8718	62.0387	**	7.8718
	Osaka	Gwangju	44.8694	**	7.7067	52.5761	**	7.7067
	Osaka	Daegu	51.0966	**	7.6899	58.7864	**	7.6899
	Osaka	Busan	55.0946	**	7.4630	62.5575	**	7.4630
	Osaka	Daejeon	47.3005	**	7.9543	55.2548	**	7.9543
	Kobe	Seoul	61.8142	**	8.0804	69.8946	**	8.0804
	Kobe	Incheon	54.8124	**	8.2363	63.0487	**	8.2363
	Kobe	Gwangju	45.0257	**	8.0018	53.0275	**	8.0018
	Kobe	Daegu	50.9273	**	7.8411	58.7684	**	7.8411
	Kobe	Busan	55.2211	**	7.7797	63.0008	**	7.7797
	Kobe	Daejeon	48.1555	**	8.4637	56.6192	**	8.4637
	Hiroshima	Seoul	57.4765	**	8.0418	65.5183	**	8.0418
	Hiroshima	Incheon	49.2893	**	7.6291	56.9184	**	7.6291
	Hiroshima	Gwangju	40.4950	**	7.6375	48.1325	**	7.6375
	Hiroshima	Daegu	46.4804	**	7.5579	54.0383	**	7.5579
	Hiroshima	Busan	50.0081	**	7.3921	57.4003	**	7.3921
	Hiroshima	Daejeon	42.4350	**	7.7212	50.1562	**	7.7212
	Kitakyushu	Seoul	59.6390	**	8.1980	67.8371	**	8.1980
	Kitakyushu	Incheon	51.0235	**	8.4586	59.4820	**	8.4586
	Kitakyushu	Gwangju	42.1344	**	8.1903	50.3247	**	8.1903
	Kitakyushu	Daegu	49.1370	**	8.1266	57.2636	**	8.1266
	Kitakyushu	Busan	52.6900	**	8.0273	60.7173	**	8.0273
	Kitakyushu	Daejeon	44.4931	**	8.6764	53.1695	**	8.6764
	Fukuoka	Seoul	57.5953	**	8.1522	65.7475	**	8.1522
	Fukuoka	Incheon	49.7318	**	8.3349	58.0667	**	8.3349
	Fukuoka	Gwangju	41.9129	**	8.2237	50.1367	**	8.2237
	Fukuoka	Daegu	47.1758	**	8.0094	55.1851	**	8.0094
	Fukuoka	Busan	50.7305	**	7.8504	58.5809	**	7.8504
	Fukuoka	Daejeon	42.5431	**	8.3613	50.9044	**	8.3613