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Long-run analysis on convergence of Japanese local price levels: A pairwise approach

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ABSTRACT

This paper investigates the convergence of local price levels within Japan, using long-run data spanning six decades and based on a pairwise approach. The analysis investigates convergence of all binary combinations of local price levels, rather than choosing a particular city as reference. The results indicate that the null hypothesis of no convergence is rejected, but also that a substantial portion of local price levels fail to converge within Japan. Convergence is limited to some extent. The extent does not substantially change over periods. The results also show that the likelihood of convergence is influenced by population growth rates and the distance between areas. With differing population growth rates and a large distance between locations, convergence between areas is unlikely.

1. Introduction

This paper investigates the convergence of Japanese local price levels. It aims to examine the integration of Japanese local economies and explore factors hampering the integration. The analysis uses a long run series of data spanning six decades, and is based on the pairwise approach. The null hypothesis of no convergence among Japanese local price levels is found to be rejected, but convergence is limited to a certain extent. Many pairs of local price levels fail to converge. This main claim is, additionally, examined by non-parametric tests. What limits the integration? The results indicate that convergence between a pair of cities depends on the difference in population growth rates and also on the geographical distance between them. When the population growth rates are differing and two cities are located distantly, convergence of local price levels is unlikely. However, the relation between the likelihood of convergence and these factors has been becoming weak in recent years.

There have been many studies of convergence of domestic local price levels in a single country, following seminal papers by Parsley and Wei (1996) and Cecchetti et al. (2002). These studies cover various countries including Japan. Previous studies of the convergence of Japanese local price levels use data spanning only a few decades.[1] The present paper uses data spanning six decades; the regional difference index of consumer prices of 46 prefecture capitals whose start is in the early 1950s. This makes long-run analysis possible, revealing changes of relations among economic variables over time.

The paper is based on the pairwise approach, following Pesaran (2007) and Pesaran et al. (2009), which directly evaluates the proportion of converging relative price levels, rather than using a panel unit root test. Pesaran (2007) and Pesaran et al. (2009) are not studies of convergence of local price levels within a single country, but their methodology is readily applicable to studies on the convergence of local price levels within a single country. The pairwise approach used in this paper investigates the convergence of all binary combinations of local price levels, rather than choosing a certain city as reference. Unit root tests are executed on all binary combination of investigated cities.

When the relative price level between two areas follows a stationary process, it is interpreted as convergence of the two local price levels in the literature. Hence, investigation of the convergence involves a unit root test in most studies. Previous studies have mostly used panel unit root tests.[2] A panel unit root test is regarded as more powerful in rejecting the null hypothesis of unit root than traditional univariate unit root tests, such as the Augmented Dickey–Fuller (ADF) test. However, the use of a panel unit root test involves in the following problems. First, rejection of the null hypothesis does not imply that converging relative price levels are dominant among relative price levels. The null hypothesis used in panel unit root tests is typically that all series in the panel contain a unit root. Rejection of the null hypothesis would then imply that at least one stationary series exists. This procedure does not provide information on whether the majority of the series are stationary.[3] Second, panel unit root tests use a single price level as the base of all investigated relative price levels, so results depend on choice of the base.[4] Third, panel unit root tests do not investigate the

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[1] Following are studies on the convergence of local price levels within Japan: Esaka (2003), Nagayasu and Inakura (2009), Nagayasu (2011), and Ikeno (2014). The statement applies to all of them.

[2] For example, Esaka (2003) and Nagayasu and Inakura (2009) use panel unit root tests to investigate Japanese local price levels. Cecchetti et al. (2002) is the seminal paper using panel unit root tests in this field.

[3] Breuer et al. (2001) and Sonora (2009) also point out this problem of interpretation of rejecting the null hypothesis in panel unit root tests.

[4] See Chmelrova and Nath (2010).

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relation between two regional price levels, none of which is chosen as the base. For example, consider a set of three cities. If City A is chosen as the base, the relation between Cities A and B is analyzed and, also, that between Cities A and C is analyzed. But the relation between Cities B and C is not analyzed. Pesaran et al. (2009) and Pesaran (2012) set out problems with the use of panel unit root tests in detail.

In this paper, the convergence of local price levels within Japan is investigated by two steps in the framework of the pairwise approach. The proportions of stationary relative price levels are first estimated by pairwise unit root tests. Then, using bootstrapping, it is investigated whether those proportions differ statistically from the value expected under the null hypothesis of no convergence.[5] Results from these analyses indicate limited convergence of Japanese local price levels. This main claim is, additionally, examined by a non-parametric method developed in Phillips and Sul (2007). Results indicate that the main claim from the pairwise approach still holds when the non-parametric method is used in place of the pairwise approach.

This paper explores what factors affect the likelihood of the convergence. It is important to understand conditions under which local price levels converge (or not) within a single country. If local markets are integrated with each other, then the local price levels should converge. So, understanding the conditions implies understanding what promotes or hampers integration of domestic local economies. If transaction cost, typified by transportation cost, prevents integration and is correlated with the geographical distance, then a long distance between areas hampers convergence. Differences in fundamental conditions of local economies, such as income, retail system, and population, also may influence convergence. Population growth often affects housing rent. With the Balassa–Samuelson effect, an increase in income is expected to be positively correlated with price levels.[6] Difference in these factors between areas may hamper convergence of price levels.

This paper uses a Probit model to examine conditions for the convergence. Results indicate that geographical distances between areas affect the likelihood of convergence of local price levels. They also indicate that differences in population growth rates affect the likelihood of the convergence. However, the relation between the likelihood of convergence and these factors has become weak in recent years.

This paper is organized as follows. Sections 2 and 3 explain the methodology and the data used in this paper. Section 4 discusses results from unit root tests, based on the pairwise approach. Section 5 discusses results from bootstrapping analysis, with the aim of statistical evaluation of the results from the pairwise unit root tests. Section 6 discusses non-parametric tests of convergence and their results. Section 7 discusses conditions characterizing the convergence, using a Probit model. Section 8 presents conclusions.

2. Methodology

Tests based on the pairwise approach evaluate the proportion of converging relative price levels in all relative price levels among the cities investigated. Let $P_{i,t}$ denote the consumer price level in city i at period t, and $P_{b,t}$ denote the national common base of the consumer price level at period t. The relative price level in city i on the national common base is defined logarithmically as

$$p_{i,t} \equiv \ln\left(P_{i,t}/P_{b,t}\right) \qquad t = 1, \cdots, T. \tag{1}$$

Then, the relative price level in cities i and j at period t in log is equal to

$$\begin{aligned} p_{ij,t} &= \ln\left(P_{i,t}/P_{j,t}\right) \\ &= \ln\left(P_{i,t}/P_{b,t}\right) - \ln\left(P_{j,t}/P_{b,t}\right) \\ &= p_{i,t} - p_{j,t} \qquad\qquad t = 1, \cdots, T. \end{aligned} \tag{2}$$

If p_{ij} does not follow a stationary process, the purchasing power in cities i and j can divert indefinitely. If p_{ij} follows a stationary process then the local consumer price level in city i relative to the local consumer price level in city j moves around a certain long-term level, which implies a relative Purchasing Power Parity (PPP). It is interpreted as convergence of the price levels in the two areas.

Let N denote the number of cities investigated. The number of all possible pairs of cities is then equal to $N(N-1)/2$. This paper executes univariate unit root tests, so as to examine stationarity, on the relative price levels of all possible pairs. What Pesaran (2007) theoretically demonstrates is presented here as follows:

Consider the fraction of the $N(N-1)/2$ pairs for which the null hypothesis of unit root is rejected at a given significance level, α. This fraction is denoted as

$$Z_{NT} = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} Z_{ij,T} \tag{3}$$

where $Z_{ij,T} = 1$ if the null hypothesis of unit root of p_{ij} is rejected at the significance level α, and $Z_{ij,T} = 0$ otherwise. Then, under the null hypothesis that all p_{ij} s are nonstationary, the fraction Z_{NT} converges to α as N and T jointly tend to infinity, while the underlying individual unit root tests are not cross-sectionally independent. It is important that cross-sectional independence is not assumed. Cross-sectional independence should not be assumed in an analysis of local price levels within a single country. Correlations of local price levels should not be assumed away. The null hypothesis here means that there is no convergence among the cities investigated. This paper follows Pesaran's methodology, and calculates and examines the fractions, Z_{NT}.

The following univariate unit root tests are used to calculate Z_{NT}; the ADF test, the weighted symmetric ADF (ADF–WS) test developed in Park and Fuller (1995), the generalized least-square detrending (ADF–GLS) test developed by Elliott et al. (1996), and the nonlinear unit root test (KSS test) developed by Kapetanios et al. (2003).[7] The ADF–WS and ADF–GLS tests are regarded as more powerful to reject the null hypothesis of unit root than the ADF test. Elliott et al. (1996) argue that the ADF–GLS test is more powerful in rejecting the null hypothesis than the ADF test. Pesaran et al. (2009) claim that the ADF–WS test performs better than the ADF–GLS test in rejecting the null hypothesis of unit root. The KSS test considers a nonlinear price adjustment, and uses a nonlinear exponential smooth transition autoregressive process. As the null hypothesis it takes no adjustment, implying a nonstationary process, and the alternative hypothesis is nonlinear adjustment, implying a globally stationary process. The number of lag terms in the equation used for these unit root tests is determined by the Akaike Information Criteria (AIC). Considering the convergence of the relative price levels as the relative PPP, a constant term is included, but no trend term.

To investigate whether the fraction Z_{NT} is statistically different from α, this work undertakes bootstrapping, following Pesaran et al. (2009), rather than analytical derivation of the statistical distribution of the fraction Z_{NT}. The analytical derivation is intractable due to the fact that $Z_{ij,T}$s are not independent. Bootstrapped samples are generated for the relative price level on the national common base, i.e., $p_{i,t}$, of each city,

[5] Yazgan and Yilmazkuday (2011) analyze convergence of the US local price levels by the pairwise approach and calculate proportions of stationary relative price levels, but they do not examine whether the proportions are statistically different from the value expected under the null hypothesis of no convergence.

[6] Bahmani-Oskooee and Nasir (2005) provide an extensive survey of the Balassa–Samuelson Effect.

[7] Execution of the ADF–WS test in the present work is based on formulation by Pesaran (2007).