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Understanding regional growth dynamics in Japan: Panel co-integration approach utilizing the PANIC method

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ABSTRACT

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This study proposes a panel co-integration approach using the PANIC method for understanding the regional growth dynamics using non-stationary panel data, and applies it to Japanese prefectures. This approach enables us to analyze both long-run equilibrium growth path and short-run dynamics across the regions. Specifically, we find that there is one common source of growth to which prefectures attach different weights, that the per capita real income of follower-prefectures will catch up to that of leader-prefectures, and that temporal fluctuations of the catch-up process elicited by Barro type regression qualitatively corresponds to short-run dynamics across prefectures by the PANIC method.*J. Japanese Int. Economies* **40** (2016) 17–30. Research Institute for Economics and Business Administration, Kobe University, 2–1, Rokkodai, Nada, Kobe, 657–8501, Japan; Faculty of Economics, Konan University, 8–9–1 Okamoto, Higashinada, Kobe, 658–8501, Japan; Faculty of Economics, Okayama Shoka University, 2–10–1 Tsushima, Kyomachi, Kitaku, Okayama, 700–8601, Japan.

1. Introduction

In this study we develop a method for analyzing the convergence problem and apply it to regional economies in Japan. This paper focuses on β-convergence, a concept that is extensively developed and widely used.[1] β-convergence means that poor economies tend to grow faster than rich economies or, in terms of growth theory, that the presence of long-run balanced growth paths are parallel across economies.[2]

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[1] For an overview of literature on convergence, including empirical papers using the panel data approach, see Durlauf et al. (2005).

[2] In the neoclassic growth theory, if each country has access to the same aggregate production functions (decreasing returns to production factors), the steady-state is independent of an economy's initial capital, labor stocks, and initial income. Long-run differences in output reflect differences in the determinants of accumulation, not differences in the technology used. Therefore, poor economies grow faster than rich ones, and the poor will eventually catch up with the rich. This type of convergence is called "absolute convergence". Even if one relaxes the assumption that countries have access to the same production functions, convergence in growth rates can still occur so long as each country's production function is concave in capital per efficiency unit of labor and each country experiences the same rate of labor-augmenting technological change. In such a case, although gap between poor and rich economies shrinks over time, it does not completely vanish in the steady states. This type of convergence is called "conditional convergence".

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'Barro regression', a cross-sectional regression of the long-term per capita income growth rate on initial per capita income, is the first method to investigate β-convergence. It requires data only at the two remote time points needed for testing the convergence hypothesis derived from the Solow model and seeks empirical evidence of a negative correlation between the initial per capita income and its growth rate (Barro, 1991).

Many cross-sectional regression studies, including Barro and Sala i Martin (1992a); Barro and Sala-i-Martin (1992b), argue that follower-economies catch up to leader-economies at the annual rate of about 2% in the context of absolute or conditional convergence. Barro regression has the advantage of being parsimonious, but this advantage is at the same time a problem: it disposes of numerous data between the two remote time points and tells us nothing about the dynamic process of the growth. Another problem is that a negative correlation is a necessary condition for the convergence, so that convergence is not warranted even if a negative correlation is found in Barro regressions.

Bernard and Durlauf (1995)'s Definition 2.1 and Evans and Karras (1996) provide a test for absolute and conditional convergence hypotheses using a unit root test on panel data (hereinafter, the Evans and Karras type test). Their idea is that two economies will converge if the difference in per capita income between the two economies is stationary. This condition neatly matches the definition of convergence. In addition, they argue that the panel unit root test has greater statistical merit for increasing the efficiency of estimations than cross-sectional regressions.

However, when we examine whether there are common components affecting per capita incomes that differ in magnitude across economies, the above convergence definition becomes ambiguous. There exists the possibility that the economies have access to heterogeneous technology and, thus, nonparallel long-run balanced growth paths may emerge. We can generalize the panel unit root test to allow that per capita incomes of economies co-integrate with common components with different long-run weights. In other words, the panel unit root approach is a special case of co-integration. This approach was proposed by Bernard and Durlauf (1995), and enables us to examine the short-run dynamic behavior of deviations from long-run equilibrium paths.

In this paper, we follow the co-integration approach since it is the most comprehensive method today. Then, we face the problem of which statistical tool to use. The well known Johansen (1995) test, which is employed by Bernard and Durlauf (1995), seems a good candidate since it reports the co-integration rank and co-integration vectors as well as information on short-run dynamics from error correction terms. Suppose, however, that we want to analyze long-run equilibrium growth among 50 countries. Even in the lucky occasion that annual data for 50 years are available, the degree of freedom is not adequate to estimate a Johansen model.[3] Thus, we need to develop a statistical tool that allows us to follow the co-integration approach.

This paper achieves this goal by adopting the 'Panel Analysis of Nonstationarity in Idiosyncratic and Common Components (PANIC)' method developed by Bai and Ng (2004).[4] Its idea is to estimate common factors of per capita incomes of the economies before estimating the co-integration relation between per capita income and the factors.[5]

We apply the method to panel data from 46 Japanese prefectures from 1955 to 1999. As shown in Section 2, the income gap among prefectures in Japan has been evidently decreasing in a long-run perspective over the entire sample period, suggesting that the Japanese economy serves as a good exercise for the convergence problem. On the other hand, as discussed in Subsection 4.5, the rate of change in the income gap between leader and follower prefectures has been fluctuating over the same period. We analyze the regional income dynamics underlying these findings.

Several novel features of our analysis set this study apart from the existing literature. First, we explore the long-run equilibrium growth across Japanese prefectures. Literature using panel data has not reached consensus on income convergence across them.[6] While panel unit root tests have generally accepted the no convergence null (e.g., Kawagoe, 1999), tests based on the dynamic panel regression approach, an extension of the Barro regression to the panel case, show that Japanese prefectures are converging at a rate faster than 2% annually (e.g., Shioji, 2001).[7] This paper provides a clear picture of the long-run per capita income of Japanese prefectures.

Second, we analyze short-run dynamics by looking at the deviation from equilibrium paths. In analyses of both long-run equilibrium and short-run dynamics, we examine cross-prefectural properties to highlight the reality.

The remainder of the paper is structured as follows. Section 2 explains how to construct real per capita income data of the prefectures and conduct preliminary analyses. In Section 3, the Evans and Karras type convergence hypothesis is tested using panel unit root tests. In Section 4, we develop a framework for the co-integration approach adopting the PANIC method and empirically examine long-run and short-run dynamics of prefectural per capita income. Concluding remarks are given in the final section.

[3] Bernard and Durlauf (1995) carried out a Johansen test with annual data from 1900 to 1987 for 15 countries, assuming that the lag-length is two.

[4] Pesaran (2007) propose a pairwise approach to testing for co-integration for all possible pairs of output gaps across economies. This method may be an alternative to the method adopted in this paper. His approach is applicable when the number of the economies is large relative to the time dimension of the panel.

[5] Westerlund et al. (2010), analyze Chinese economies using a similar method.

[6] Current studies on convergence for countries around the world have not reached consensus either. See Islam (1995, 1998), Lee et al. (1997, 1998), and Evans and Karras (1996) for pro and Bernard and Durlauf (1995) and Quah (1996) for con.

[7] Some empirical studies, such as Islam (1995, 1998); Lee et al. (1997, 1998); Shioji (2001), basically regress panel data regarding per capita income over its lagged value. We call this type of analysis the dynamic panel regression approach. A problem of this approach is argued in Shibamoto and Tsutsui (2014).