An examination of convergence hypothesis for EU-15 countries

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ABSTRACT

In this paper we investigate whether EU-15 countries experience convergence in per capita GDP levels with respect to the EU-15 average over the period 1950–2015. Nonlinear and nonlinear-asymmetric unit root tests as well as structural break Lagrange Multiplier (LM) unit root tests are employed. When nonlinear and nonlinear-asymmetric unit root tests are employed, five countries exhibit long-run or deterministic convergence with the EU-15 average. However, when endogenous structural break LM unit root tests are employed, nine countries exhibit stochastic convergence. Test results indicate that real per capita income levels of 11 EU countries converge towards the EU-15 average.

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1. Introduction

There is a growing empirical literature on convergence literature.[1] Conceptually, two kind of convergence can be discerned, namely β-convergence and σ-convergence (Barro & Sala-i-Martin, 1991). According to Barro and Sala-i-Martin (1991) and Sala-i-Martin (1996), β-convergence occurs if poor economies tend to grow faster than rich ones, such that poor countries "catch up" to the rich ones through time in terms of the real per capita GDP levels, and σ-convergence occurs if cross-sectional dispersion of real per capita GDP levels of a group of economies tends to decrease over time. Further, Barro and Sala-i-Martin (1991) and Sala-i-Martin (1996) point out that β-convergence is a necessary condition for the existence of σ-convergence, such that causality runs from β-convergence to σ-convergence.

A number of studies have taken a time-series approach to assess the convergence hypothesis on a country-by-country basis. Time-series studies typically use unit-root tests to assess convergence hypothesis and many of them have used various concepts of convergence which are briefly discussed below.

Bernard and Durlauf (1995) use the following definition to test for the convergence: countries i, and j converge if the long-run forecasts of the log of per capita income for both countries are equal at fixed time t,

$$\underset{k \to \infty}{Lim} E\left(y_{i,t+k} - y_{j,t+k}\big|I_t\right) = 0 \tag{1}$$

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[1] Convergence hypothesis infer from the Solow Growth Model which assumes diminishing marginal productivity of capital. Under this assumption, regardless of initial endowments, per capita output for countries with identical technologies must equalize.

where I_t represents the information set available in time t. Hence, Bernard and Durlauf (1995) introduced the concept of *absolute convergence* involving the difference of per capita GDP series of two countries to be level stationary process with zero-mean. Further, Oxley and Greasley (1995) have used the notion of *catching-up* for trend stationarity of the log of relative per capita income series, and the notion of *long-run convergence* meaning level stationarity of the income difference series. Also, Li and Papell (1999) introduced the concept of *deterministic convergence* meaning level stationarity of the log of relative per capita income series. On the other hand, Carlino and Mills (1993) suggested alternative definition of convergence, named as *stochastic convergence*, meaning trend stationarity of the log of relative per capita income series. In addition, they introduced the concept of β-*convergence* which involves the point estimates of the intercept and trend coefficients in trend function to be significant with opposite signs. According to Carlino and Mills (1993), stochastic convergence is a necessary, but not sufficient, condition for per capita income convergence between two respective countries. They argue that the two conditions must be met for the actual convergence to hold. [2] Upon the acceptance of stochastic convergence, several other possibilities are noted in Tomljanovich and Vogelsang (2002); Nieswiadomy and Strazicich (2004) and Dawson and Sen (2007) in addition to the β-convergence suggested by Carlino and Mills (1993). These authors state that, if neither the intercept nor the trend is significant, absolute convergence is occurring. Also, if intercept and trend coefficients are both statistically significant with the same sign, divergence is occurring. Further, Dawson and Sen (2007) state that if an intercept is significantly different from zero and a trend that is not, conditional convergence is occurring, that is a country has already converged to its steady-state level.

Loewy and Papell (1996) and Li and Papell (1999) employ ADF-type unit root test with endogenously determined break for convergence hypothesis, whereas Strazicich, Lee, and Day (2004), and Dawson and Strazicich (2010) employ two-break Lagrange Multiplier (LM) unit root test in their convergence analyses. Their unit root tests are generally supportive of stochastic convergence mentioned in Carlino and Mills (1993). Dawson and Sen (2007) consider ADF-type unit root test with endogenously determined simultaneous breaks in the intercept and slope of the trend function (called the "Mixed Model") and tests convergence hypothesis of 29 countries over the period 1900–2001. They find evidence of stochastic convergence in 21 countries and β-convergence in 16 countries of the 29 countries. Ayala, Cunado, and Gil-Alana (2013) employ two-break LM unit root test to test β-convergence of per capita incomes for 17 Latin American countries relative to that of the US.

Chong, Hinich, Liew, and Lim (2008) use modified version of Kapetanios, Shin, and Snell (2003) nonlinear unit root test that includes linear and non-linear trend terms to test for catching-up and the long-run convergence mentioned in Oxley and Greasley (1995). On the other hand, King and Ramlogan-Dobson (2011) employ modified version of Chortareas et al. (2002) nonlinear unit root test that includes endogenously determined structural breaks to test for stochastic convergence and β-convergence.

Chapsa, Katrakilidis, and Tabakis (2015) examine the catch-up process of the EU-15 countries towards the Netherlands by using unit root tests with and without structural breaks over the period 1950–2010. Using Carlino and Mills methodology, they find evidence of a catch-up process towards the Netherlands for 11 out of 14 countries.

A common test for stochastic convergence involves testing for a unit root in the log of relative per capita income series. The evidence against the unit-root null hypothesis is consistent with the stochastic convergence, whereas failure to reject the unit root null hypothesis is the evidence of divergence. As noted above, stochastic convergence is a necessary but not sufficient condition for conditional convergence. After performing unit root tests on the log of relative series, we identify those countries that reject the unit root null hypothesis at least at the 10% level of significance. These series can be described as stationary time series. In the second step, using the information contained in various unit root tests, we perform OLS regressions for those stationary time series to test for β-convergence.

In this paper we investigate whether EU-15 countries, which first joined the European Union, experience convergence in per capita GDP levels with respect to the EU-15 average. As mentioned by Brada, Kutan, and Zhou (2005), in the convergence literature of EU countries, Germany is traditionally used as the benchmark of EU policy and macroeconomic performance. The choice of Germany is based on the credibility of the policies of the Bundesbank and further it is the largest economy in the EU. However, Germany experienced considerable monetary and real turbulence in the early and mid-1990s due to the difficulties encountered in the reunification of the country (Brada et al., 2005). As such, we use the average real per capita income level of EU-15 countries as a benchmark for convergence. To the best of our knowledge, this is the first study to investigate the convergence hypothesis of EU-15 countries with respect to the EU-15 average using new nonlinear and nonlinear-asymmetric unit root tests.

The paper is structured as follows. Section 2 describes econometric methodology, Section 3 discusses the empirical results and Section 4 concludes the study.

2. Testing methodology

Linear unit root tests cannot capture nonlinearities and structural changes in the data if the true data generating process is nonlinear or if the size of the change in the level or in the slope of the trend is relatively high. To take into account nonlinear

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[2] More specifically, in the context of the neoclassical growth model, two general notions of convergence are "absolute" and "conditional" convergence. Absolute convergence implies that per capita incomes across countries are approaching the same steady-state level regardless of their initial income level, whereas conditional convergence implies that per capita incomes converge to country-specific "steady states" or "compensating differentials" given differences in saving rates, population growth rates and technologies. Except absolute convergence, all the convergence definitions mentioned above refers to the conditional convergence.