The Journal of
Regional
Analysis
& Policy

Regular Article, JRAP 37(2): 80-89.

Convergence of Relative State-level Per Capita Incomes in the United States Revisited

Panos Fousekis
University of Macedonia - Greece

Abstract. In this paper convergence in per capita incomes (personal and disposable) in US states over 1929-2005 is revisited using the notion of relative stochastic convergence and stationarity tests for panel data. According to the results, although the dispersion of per capita income became stationary by the early 1960s a large proportion of states have not converged to the national average. The presence of diverging states indicates that a long-run (steady-state) distribution in relative incomes has not yet been attained, something which contrasts sharply with the findings of earlier empirical studies on the topic.

1. Introduction

Whether poor regions or countries eventually catch-up with rich ones and how long this might take are important issues not only for policy makers but for economists as well since they relate to the validity of competing growth theories. An implication of the Neoclassical Growth Model (Solow, 1956) is that the concavity of the production function will offset differences in the initial conditions resulting, thus, in spatial convergence of income. The New Growth theorists (e.g. Romer, 1986; Lucas, 1988), challenge the above implication and argue that increasing returns to scale is a fundamental growth factor that can create a non-diminishing relationship between initial conditions and income over arbitrarily long horizons.[1]

Despite the different views, most economists accept that if convergence is plausible at all, it is surely more likely to occur across regions *within* a country since in that case the flow of production factors is easier and the regions are subject to similar policy and technological constraints (e.g. Barro et al., 1991; Button and Pentecost, 1993; Kane, 2001). The US states constitute an example of highly integrated economies. It is not accidental, therefore, that convergence in per capita income (or earnings) in the US states and Census regions has been the focus of a large number of empirical studies (e.g. Barro et al., 1991; Eberts and Schweitzer, 1994; Izraeli and Murphy, 1997; Coughlin and Mandelbaum, 1998; Johnson, 2000; Webber et al., 2005). All studies appear to confirm that convergence (decrease in inequality) of personal per capita incomes has been a persistent fact within the US states and regions until the late 1970s; in the 1980s inequality increased, while in the most recent years it has showed no apparent trend.

The interruption of a long-run converging trend was somewhat puzzling for researchers. A commonly offered explanation (which, in turn, is based on the absence of any trend in inequality since 1990) has been that the process of convergence has stopped because the relative per capita incomes of the US states have attained their long-run equilibrium (steady-state) values. An implication of that explanation is a stable cross-section distribution of relative per capita incomes, meaning a cross-section distribution in which the relative positions (the per capita income ratios) of any two states remain constant over time.

To assess the validity of the above explanation, Sherwood-Call (1996) estimated a number of growth-initial income regressions for state personal per capita incomes over the period 1972-92. In most cases, the coefficient of the initial income (speed of catching-up)

[1] For details about the assumptions, the implications, and the shortcomings of competing growth theories see Azariades and Drazen (1990), Romer (1994), Sala-i-Martin (1996), and Islam (2003). For alternative notions of convergence (e.g. β-convergence, conditional β-convergence, σ-convergence, stochastic convergence, club convergence) and their relationships see Barro et al. (1991), Quah (1993), Friedman (1994), Bernard and Durlauf (1996), Hobjin and Franses (2000), and Nahar and Inder (2002).

was not statistically significant. The author interpreted the absence of catching-up effects as evidence that state incomes came close to their long-run equilibrium values sometime in the 1970s. The growth-initial income regressions, however, have been severely criticized for being uninformative about convergence or divergence (e.g. Friedman, 1994; Quah, 1993, 1996, 1997). Moreover, for the problem at hand, a researcher needs to know not what happened to the "average/representative" state but whether there is a (common to all states) period of time in which the relative per capita income of every individual state attained its steady-state value.

For Carlino and Mills (1996), convergence requires that a state with relative per capita income above (below) its respective equilibrium value will grow more slowly (faster) than the nation. For the empirical implementation of that idea, they regressed relative personal per capita income in each state on a linear deterministic trend. Opposite signs of the regression constant and the coefficient of the trend variable were taken as evidence of convergence. Allowing for a break in the deterministic linear trend in 1946, Carlino and Mills (1996) concluded that convergence in US states was achieved by the end of World War II.

The conceptual framework in the work of Carlino and Mills (1996) has theoretical merit. Its empirical implementation, however, poses two important problems. First, the constant in their regressions cannot be identified with a steady-state value. As a result, there is no guarantee that the constant and the coefficient of the trend variable will be negatively related. Second, if a dependent variable contains a stochastic trend its regression on a linear deterministic trend would be a spurious one (inconsistent parameter estimates and invalid standard inference procedures) (Granger and Newbold, 1974; Enders, 1995). A preliminary analysis of the relative state personal per capita income series (dependent variables) by Carlino and Mills (1996) showed that a large proportion of them (40 percent) indeed contained stochastic trends. This fact alone creates serious questions about the empirical results of that study.

Kane (2001), examined convergence in relative per capita earnings for the 8 Bureau of Economic Analysis (BEA) regions over the period 1929-98 using the approach by Carlino and Mills (1996). According to his results, three regions (Great Lakes, Plains, and Far West) had not converged to their steady state values by the last year of the sample.

In this paper the issue of whether the relative per capita incomes in the US states have attained their long-run equilibrium values is revisited using recently developed conceptual tools in convergence research (the notion of asymptotically relative stochastic convergence) and more advanced econometric methods (stationarity tests for panel data). The analysis, which considers both the personal well as the disposable per capita income utilizes data up to 2005 taking, thus, into account the most recent trends in inequality.[2] In what follows, section 2 contains the conceptual framework and section 3 the econometric methodology. Section 4 presents the empirical results, while section 5 offers conclusions.

2. Conceptual Framework

The most commonly used measure of inequality in convergence analysis is the standard deviation of natural logarithms, denoted by σ (e.g. Barro et al., 1991; Bernard and Jones, 1996a and 1996b). The stability of σ over time at a non-zero value has been often interpreted as evidence of *relative* convergence which is consistent with a constant, but generally different from 1, ratio of per capita incomes between any two economic entities (countries, regions, or states) in a given cross-section (e.g. Sherwood-Call, 1996). Constancy of ratios results in a cross-section distribution in which the relative position of each entity remains unchanged. In the extreme case, σ may assume a zero value suggesting *absolute/perfect* convergence which is consistent with equalization of per capita incomes across all economic entities.

The standard deviation of natural logarithms is a member of a class of inequality measures which are homogeneous of degree zero in individual incomes. Other members are the Coefficient of Variation, the Theil's Entropy Measure, and the Gini Coefficient (Sen, 1997). Consider now a cross-section of M economic entities with individual per capita income levels y_m, m= 1, 2, …., M and write a measure of inequality at period t as $I_t = I_t(y_{1t}, y_{2t}, \dots, y_{mt}, \dots, y_{Mt})$. Under homogeneity of degree zero, it holds that

$$I_t = I_t(y_{1t}, y_{2t}, \dots, \dots y_{mt}, \dots, y_{Mt}) = I_t(y_{1t}/y_{mt},\ y_{2t}/y_{mt}, \dots, 1, \dots, y_{Mt}/y_{mt}) = I_t(y_{1t}/y_{nt},\ y_{2t}/y_{nt}, \dots, y_{mt}/y_{nt}, \dots, y_{Mt}/y_{nt}) \quad (1)$$

[2] Personal and disposable income are just two possible indicators of well-being. Consumption expenditure is another indicator which is considered to be more appropriate by a number of researchers because utility is derived from consumption of goods and services rather than the receipt of income (e.g. Johnson et al., 2005). Both the life-cycle as well as the permanent income hypothesis imply that individuals "smooth" spending. Therefore, convergence in consumption levels is more likely to occur than convergence in income levels. The present work focuses on incomes because state-level consumption data of the required length for empirical analysis are not available.

where y_{nt} stands for the cross-section average. From (1) it is obvious that if the ratios between all individual income levels (or equivalently those between the individual levels and the cross-section average) remain constant over time, I_t will remain constant as well. That means, stability of ratios is a sufficient condition for a constant I_t. It is not, however, a necessary condition since I_t may remain constant in the presence of changing ratios.[3] Therefore, the stability of I_t over time should not be interpreted as evidence of relative convergence.

Nevertheless, the analysis of the evolution of I_t could still provide useful information when the question is whether the relative per capital incomes have attained their steady-state values. The reason is that (by the rules of Mathematical Logic) if I_t changes over time, then certain of the ratios will not remain constant something which is not consistent with a long-run equilibrium situation.[4] Therefore, in searching for a steady-state distribution one should concentrate on time periods in which I_t has remained stable.

The discussion that far has abstracted from the fact that the ratios are stochastic processes which are subject to random shocks. To take this into account we adopt the *stochastic convergence approach* (Bernard and Durlauf, 1996; Hobijn and Franses, 2000) according to which there is *asymptotically relative convergence* of y_{mt} to y_{nt} if

$$\lim_{k\to\infty} E(\frac{y_{mt+k}}{y_{nt+k}}) = c_m \qquad (2)$$

where E is the expectation operator and $c_m \neq 1$ is a constant.[5] In words, *asymptotically relative convergence* requires the ratio y_{mt} to y_{nt} be stationary (it contains neither a deterministic nor a stochastic trend). The long-run equilibrium (steady-state) cross-section distribution of ratios is the one in which every entity attains its compensating differential (with a zero-mean error), implying that (2) holds for all m= 1, 2, …., M. The steady-state distribution replicates itself overtime in such a way that the ratio of each entity's per capita income to the cross-section average and to that of any other entity remains (on average) constant.[6] Given that at the long-run equilibrium random shocks to ratios have only temporary effects, a homogenous of degree zero inequality measure will be stationary (it will fluctuate with a zero-mean error around its minimum value).[7]

3. Econometric Methodology

To assess the stationarity of a single series (here, σ_t and individual y_{mt}/y_{nt} , m= 1, 2, …., M ratios) we use the KPSS test (Kwiatkowski et al., 1992). Under the null, the series is assumed to be stationary around a constant (it contains neither deterministic not stochastic trends).[8] The KPSS test statistic (*LM*) is calculated as

$$LM = \frac{\sum_{t=1}^{T} S_t^2}{T^2 f_o} \qquad (3)$$

where S_t is the partial sum of residuals of the OLS regression of the series on a constant only, T is the number of time periods considered, and f_0 is an estimator of the residual spectrum at frequency zero.[9] Re-

[3] This can be shown with a simple counterexample. Suppose that there are only two economic entities (1 and 2) with individual income levels at t y_{1t} and y_{2t} $(y_{1t} \neq y_{2t})$, respectively. Suppose also that at $t+1$ the entities switch incomes so that $y_{1t+1} = y_{2t}$ and $y_{2t+1} = y_{1t}$. Although the ratio of incomes in t+1 is the inverse of that in t (that, means the relative positions of the entities are switched) the value of the inequality measure remains the same in both periods. This is hardly surprising since a single moment (like an inequality measure) cannot reflect all information contained in an evolving cross-section distribution.

[4] This of course means that a constant over time I_t is a necessary but not a sufficient condition for constant ratios.

[5] In the works of Carlino and Mills (1996) and Kane (2001) $c_m - 1$ is referred to as *equilibrium or compensating differential* arising from the unique characteristics of each region (i.e. amenities, industry mix, population traits, etc).

[6] The same characterization of a long-run equilibrium distribution in ratios appears in the work on Fingleton and Lopez-Bazo (2003) on productivity dynamics in the EU manufacturing. Obviously, if $\lim_{k\to\infty} E(\frac{y_{it+k}}{y_{nt+k}}) = c_i$ and $\lim_{k\to\infty} E(\frac{y_{jt+k}}{y_{nt+k}}) = c_j$, then $\lim_{k\to\infty} E(\frac{y_{it+k}}{y_{jt+k}}) = \frac{c_i}{c_j} = c_{ij}$.

[7] When c_m =1 for all m, there is *asymptotically perfect/absolute convergence*. Here, it does not make sense to consider absolute convergence since despite the decrease in the σ measure over much of the 20th century, differences in state per capita incomes are still considerable (for example, in 2005 the richest state (Connecticut) had almost two times the per capita personal income of the poorest state (Mississippi)).

[8] Carlino and Mills (1996) also subjected the relative per capita income series to stationarity (ADF) tests. They allowed, however, for the presence of deterministic linear trends. Their choice looks quite strange since in p. 600 they write that for convergence the equilibrium differential should be time-invariant and it is well known that both the deterministic and stochastic trends induce non-stationarity (e.g.Enders, 1995).

[9] Denoting the residuals of the above regression as $\hat{u}_s$, $S_t = \sum_{s=1}^{t} \hat{u}_s$; f_0 is obtained using a kernel-based sum-of- covariances as $f_0 = \sum_{j=-(T-1)}^{T-1} \hat{\gamma}(j) K(j/l)$, where l is a bandwidth parameter, K is a ker-

jection of the null hypothesis implies that the series contains a deterministic or a stochastic trend (or both).

To assess stationarity of multiple series (here, y_{mt}/y_{nt} , m= 1, 2, …., M) we use the Hadri test (Hadri, 2000). [10] Under the null, all series are assumed to be stationary around series-specific constants. Like the KPSS, the Hadri test is based on the residuals from the individual OLS regressions of y_{mt}/y_{nt} , m= 1, 2, …., M on a constant only. The relevant test statistic, LM_p is calculated as

$$LM_p = \frac{1}{M}(\sum_{m=1}^{M}(\sum_t S_{mt}^2)/T^2)/f_{mo}) \quad (4)$$

where S_{mt} and f_{m0} are, respectively, the partial sum of residuals and the estimator of the residual spectrum at frequency zero from the of the *m-th* regression.[11] Hadri (2000) shows that

$$Z = \frac{\sqrt{M}(LM_p - \xi)}{\zeta} \to N(0,1) \quad (5)$$

where ξ = 1/6 and ζ = 1/45. Rejection of the null implies that there is at least one non- stationary series in the panel something which is not consistent with a steady-state cross-section distribution in ratios.

4. The Empirical Results

4.1. The Personal Per Capita Income Series

The data for the empirical analysis come form the US BEA and cover 48 contiguous states over 1929-2005; y_{mt} is the state personal per capita income and y_{nt} is the national average, both in current values.[12] The stationarity of a homogenous of degree zero inequality measure is a necessary condition for a long-run equilibrium cross-section distribution in ratios. Guided by this relationship, we conduct the search for a steady-state distribution in two steps. In the first, we determine all sub-periods of the total 1929-2005 period in which the inequality measure (here σ) is stationary using the KPSS test. In the second, within those sub-periods (if any) we assess the stationarity of the relative personal per capital income series using the Hadri test.[13] To implement the first step we adopt a recursive procedure. We start from the total period and we proceed by considering successively shorter (by one year) and more recent sub-periods. In particular, we apply the KPSS test to 52 sub-periods in total (1929-2005, 1930-2005, … , 1979-2005, 1980-2005). [14]

Figure 1 presents the σ measure, while Figure 2 shows empirical value of the *LM* statistic (denoted by KPSS) for each sub-period along with the 5 percent critical value (denoted by CR). The inequality measure exhibits a clear downward trend until 1979; for the period 1980-1988 the trend is reversed, while in the most recent years σ fluctuates around levels similar to those in the early 1970s. The KPSS also shows a downward trend which is consistent with the fact that

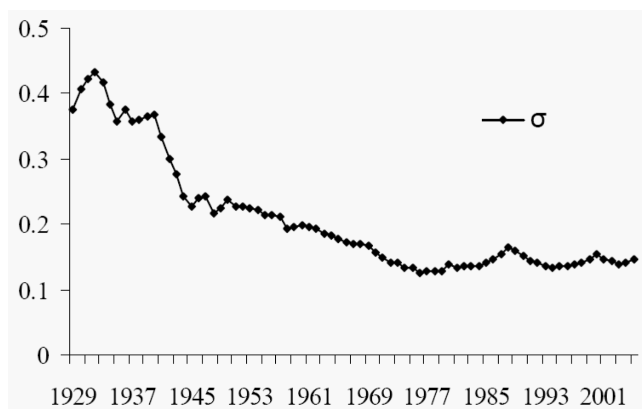

Figure 1. The Evolution of the Inequality Index for Personal Per Capita Income (1929-2005)

---

nel function, and $\hat{\gamma}(j)$ is the *j-th* sample autocovariance of the residuals. Critical values for the *LM* statistic are available in Kwiatkowski et al. (1992). The bandwidth parameter has been selected optimally following Newey and West (1994).

[10] The panel unit root tests are far more powerful when compared to the single-series ones and their power increases with the number of cross-sections. Other panel unit root tests (e.g. the IPS by Im et al. (2003), the Fisher ADF and PP by Maddala and Wu (1999), the Choi test by Choi (2001)) are available in the literature. In those tests the null hypothesis is that *all* series are non-stationary and the alternative that there is at least one stationary series. This setting of the null and the alternative is not very helpful for the present study since the objective here is to determine whether there is a time period in which *all* relative per capita income series are stationary.

[11] This form of LM_p allows for heteroscedasticity across m.

[12] Ideally, y_{mt} and y_{nt} should be converted into real values. State-specific price indexes, however, are not available. At the same time, deflating both series with the national consumer price index serves no purpose since the variables of interest are already in relative (to the nation) terms. Current values were used in Carlino and Mills (1996), Johnson (2000), and Kane (2001). Regional consumer price indexes (South, West, Northeast, and Midwest) are available for the period 1967-2005. The indexes have correlation coefficients above 0.998 and, more importantly, their growth rates per annum are very similar ranging from 0.0455 to 0.0476. These suggest that the impact on the empirical results from using ratios of nominal rather than ratios of real values will be practically negligible.

[13] All tests have been carried out in the E-views 5.1 program.

[14] No tests have been conducted for sub-periods with less than 25observations (1981-2005, 1982-2005, etc.) to preserve a reasonable level of confidence in the empirical results.

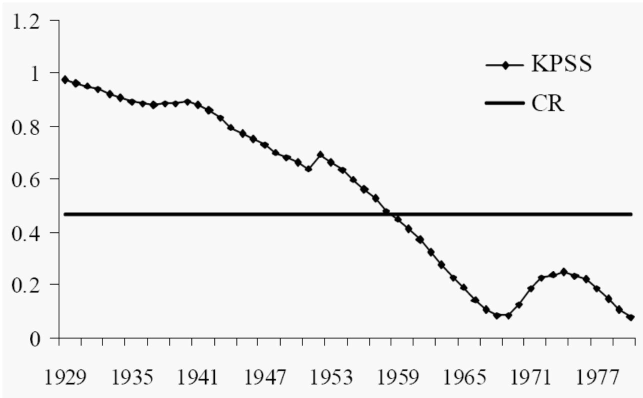

Figure 2. Personal Per Capita Income. Empirical Value (KPSS) and 5 Percent Critical Value (CR) of the Stationarity Test on the σ Measure of Inequality (the starting year for each sub-period appears in the horizontal axis)

the inequality levels become progressively similar as we consider more recent years. The empirical value lies above the 5 percent critical value for the sub-periods 1929-2005, 1930-2005, … , 1958-2005 implying non-stationarity of *σ*. For all remaining sub-periods, however, the assumption of stationarity cannot be rejected. These results suggest that the search for a steady-state distribution in ratios should be confined to the 22 most recent sub-periods (1959-2005, 1960-2005, …, 1979-2005, 1980-2005).

Figure 3 presents the empirical value of the LM_p statistic (denoted by HADRI) for each sub-period along with the 5 percent critical value (denoted by CR). The empirical value decreases with time but lies well above the theoretical value for every sub-period considered implying that there is no sub-period in which all relative personal per capita income series became stationary (or equivalently, there is no sub-period in which a steady-state cross-section distribution in ratios was attained). The results here contrast sharply with those obtained by Carlino and Mills (1996) and Sherwood-Cal (1996). Prior to the end of 1950s even the necessary condition for a long-run equilibrium (stationarity of *σ*) had not been achieved. Therefore, the suggestion by Carlino and Mills (1996) that by the end of World War II the cross-section distribution of relative incomes has stabilized lacks support by the real world data. The conclusion by Sherwood-Cal (1996) that the long-run equilibrium has been attained in the early 1970s is also unfounded something which signifies that evidence from a single moment of the cross-section distribution or from the "average/representative" behavior could be quite misleading.

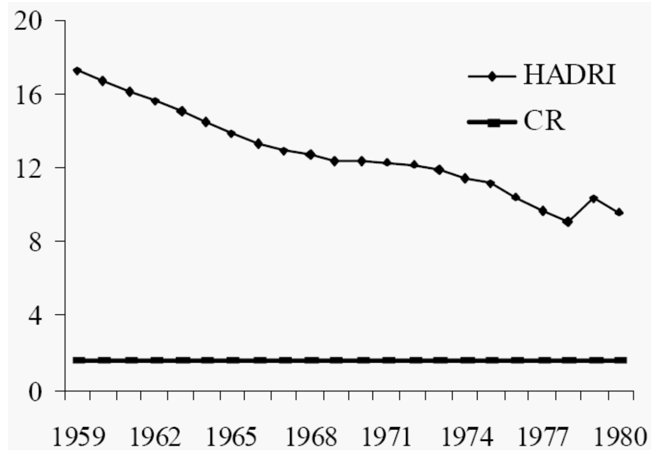

Figure 3. Relative Personal Per Capita Income. Empirical Value (HADRI) and 5 Percent Critical Value (CR) of the Panel Stationarity Test (the starting year for each sub-period appears in the horizontal axis)

From equation (4) it is obvious that the LM_p is the average of the individual *LM* statistics. As such, its empirical value may be driven by few strongly non-stationary series (outliers) (e.g. Taylor and Sarno, 1998; Leon-Ledesman, 2002). To assess whether this is the case with relative personal per capita income in the US states we plot (in Figure 4) the number of non-stationary series (denoted by NNS and based on individual stationarity tests) in each sub-period. The NNS

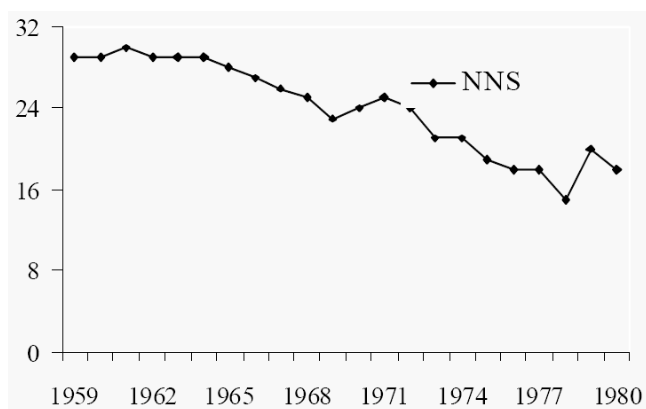

Figure 4. Relative Personal Per Capita Income. The Number of Non-Stationary Series (the starting year for each sub-period appears in the horizontal axis)

series declines from around 29 in the earlier sub-periods to around 18 in the most recent ones something which is in line with the evolution of the empirical value of the LM_p statistic. Nevertheless, it is not just a few non-stationary series which are responsible for the rejection of the null in the panel test. In fact, the proportion of non- stationary series ranges from 31 percent in the sub-period 1978-2005 to 62 percent in the sub-period 1961-2005.

Table 1 presents information on the non-stationarity of individual series by sub-period. There are 12 states (AL, CA, CT, GA, MA, MN, NJ, NC, OH, SC, TN, VT) the relative personal per capita income of which are in all sub-periods non-stationary and 11 states (ID, LA, NM, NY, ND, PA, TX, WA, WI, WV, WY) the relative personal per capita income of which are in all sub-periods stationary. In line with the overall downward trend in the inequality measure and the empirical values of the LM and the LM_p statistic, there is a number states with non-stationary ratios in the early sub-periods which turned to stationary in the most recent sub-periods (e.g. AR, CO, DE, IN, MI, MO, and UT), but very few states (notably, AZ and KS) for which happened the opposite. Overall it appears that once a state achieves a stable position relative to the national average it is very likely that it will retain its position in future periods.

Table 1. Relative Personal Per Capita Income. Non-Stationarity of Individual Series by Sub-period

State	Sub-periods of Non-Stationarity	State	Sub-periods of Non-Stationarity
AL	all sub-periods	NE	1980-2005
AR	1959-2005 to 1967-2005	NM	0 sub-periods
AZ	1967-2005 to 1980-2005	NY	0 sub-periods
CA	all sub-periods	NV	1959-2005 to 1979-2005
CO	1959-2005 to 1968-2005	ND	0 sub-periods
CT	all sub-periods	NH	1959-2005 to 1977-2005
DE	1959-2005 to 1965-2005	NJ	all sub-periods
FL	1979-2005, 1980-2005	NC	all sub-periods
GA	all sub-periods	OH	all sub-periods
ID	0 sub-periods	OK	1979-2005
IL	1959-2005 to 1970-2005, 1972-2005	OR	1959-2005 to 1960-2005
IN	1959-2005 to 1966-2005	PA	0 sub-periods
IA	1961-2005 to 1966-2005, 1971-2005 to 1974-2005	RI	1971-2005 to 1974-2005
KY	1959-2005 to 1968-2005, 1980-2005	SC	all sub-periods
KS	1970-2005 to 1980-2005	SD	1979-2005 to 1980-2005
LA	0 sub-periods	TN	all sub-periods
ME	1959-2005 to 1979-2005	TX	0 sub-periods
MD	1959-2005 to 1971-2005	UT	1959-2005 to 1964-2005
MA	all sub-periods	VT	all sub-periods
MI	1959-2005 to 1971-2005	VA	1959-2005 to 1977- 2005
MN	all sub-periods	WA	0 sub-periods
MS	1959-2005 to 1971-2005, 1979-2005 to 1980-2005	WI	0 sub-periods
MO	1959-2005 to 1972-2005	WV	0 sub-periods
MT	1959-2005 to 1975-2005	WY	0 sub-periods

The work of Kane (2001) on relative per capita earnings suggested the presence a regional dimension in convergence. Nevertheless, aggregation of state variables to regional ones may mask important differences between states in the same BEA region. For example, in Mideast the relative personal per capita incomes of NY and PA are stationary in all sub-periods, that of NJ is non-stationary in all sub-periods, while the ratios for DE and MD are non-stationary only for the early sub-periods. Similar results hold for all 8 BEA regions.

4.2. The Disposable Per Capita Income Series

Data on disposable per capita income by state are available only for the period 1948-2005. The difference between personal and disposable income consists of taxes and transfer payments. The income tax system in the USA is progressive and Welfare programs transfer income to the poor with the objective of reducing inequality in consumption across individuals. The interest here is whether the government intervention in the form of taxes and transfers has influenced the stochastic properties of income ratios and the evolution of the relative positions of states in the cross-section distribution. We note that no other study so far has considered convergence in disposable per capita income.

Figure 5 presents the σ measure and Figure 6 the empirical value of the *LM* statistic (denoted by KPSS) for each sub-period (1948-2005, 1949-2005, …, to 1980-2005) along with the 5 percent critical value (denoted by CR). The σ measure for disposable income evolves in a way which is very similar to that for personal income. It tends, however, to have a slightly lower value (for example in 2005 the σ measure for personal income is 0.145 and for disposable income is 0.128). The *LM* test cannot reject stationarity for all 1961-2005 to 1980-2005 sub-periods.

Figure 7 presents the empirical value of the LM_p statistic (denoted by HADRI)) along with the 5 percent critical value (denoted by CR). The LM_p test strongly rejects stationarity everywhere. The values of the LM_p statistic for disposable and for personal income (calculated for the same sub-period) are very close to each other. Figure 8 presents the number of non-stationary series (denoted by NNS). With the exception of sub-periods 1961-2005, 1973-2005, and 1974-2005, the number of non-stationary series for disposable income is slightly higher than that for personal income. Table 2 presents information on the non- stationarity of individual series by sub-period. There have been 14 states (AL, CA, GA, ME, MA, MN, NH, NJ, NC, OH, SC, TN, VT, VA) the relative disposable per capita incomes of which are in all sub-periods non-stationary and 11 states (DE, ID, LA, NM, ND, OK, PA, WA, WI, WV, WY) the relative disposable per capita income of which are in all sub-periods stationary. Also, there are several series which turned to stationary in the most recent sub-periods (e.g. AR, CO, IN, MI, MO, UT) but very few (e.g. AZ) for which happened the opposite. Overall, it appears that although taxes and transfers may affect the relative position of individuals they have a marginal impact on the stochastic properties of income ratios and the evolution of the relative positions of states over time.

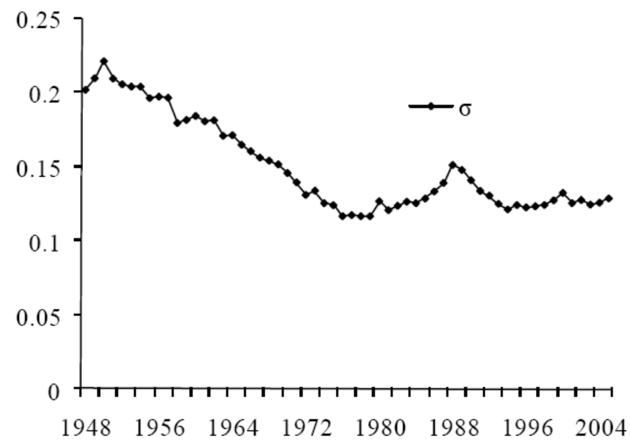

Figure 5. The Evolution of the Inequality Index for Disposable Per Capita Income (1948-2005)

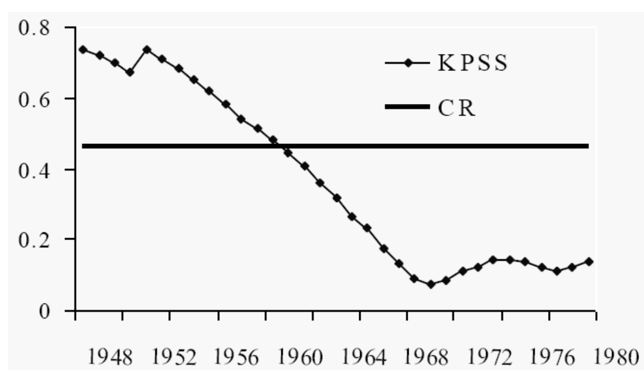

Figure 6. Disposable Per Capita Income. Empirical Value (KPSS) and 5 Percent Critical Value (CR) of the Stationarity Test on the σ Measure of Inequality (the starting year for each sub-period appears in the horizontal axis)

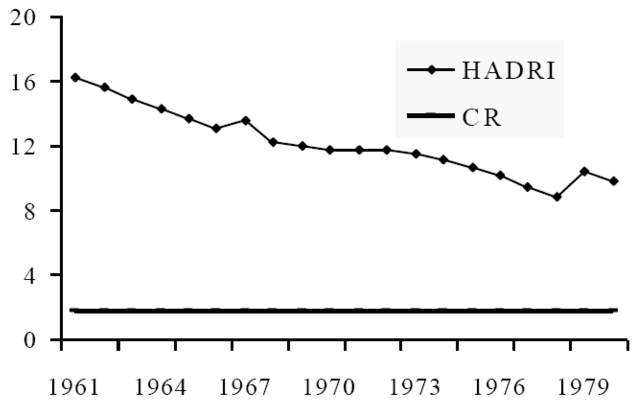

Figure 7. Relative Disposable Per Capita Income. Empirical Value (HADRI) and 5 Percent Critical Value (CR) of the Panel Stationarity Test (the starting year for each sub-period appears in the horizontal axis)

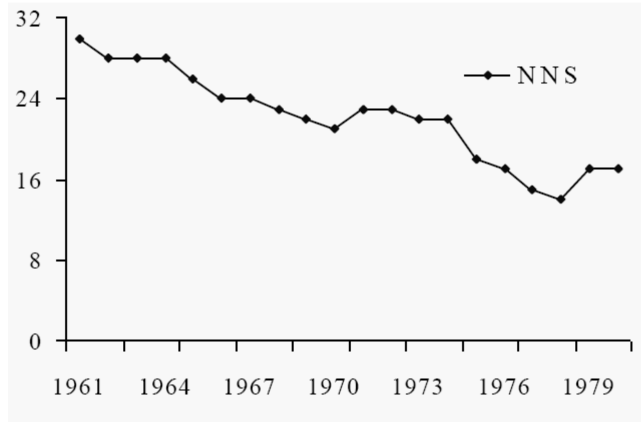

Figure 8. Relative Disposable Per Capita Income. The Number of Non-Stationary Series (the starting year for each sub-period appears in the horizontal axis)

Table 2. Relative Disposable Per Capita Income. Non-Stationarity of Individual Series by Sub-period

State	Sub-periods of Non-Stationarity	State	Sub-periods of Non-Stationarity
AL	All sub-periods	NE	1980-2005
AR	1961-2005 to 1967-2005	NM	0 sub-periods
AZ	1967-2005 to 1980-2005	NY	1980-2005
CA	All sub-periods	NV	1961-2005 to 1977-2005
CO	1961-2005 to 1968-2005	ND	0 sub-periods
CT	1961-2005 to 1976-2005	NH	all sub-periods
DE	0 sub-periods	NJ	all sub-periods
FL	1980-2005	NC	all sub-periods
GA	All sub-periods	OH	all sub-periods
ID	0 sub-periods	OK	0 sub-periods
IL	1961-2005 to 1969-2005, 1971-2005, 1973-2005	OR	1961-2005
IN	1961-2005 to 1964-2005	PA	0 sub-periods
IA	1961-2005 to 1965-2005	RI	1970-2005 to 1974-2005
KY	1961-2005 to 1967-2005, 1980-2005	SC	all sub-periods
KS	1970-2005 to 1975-2005	SD	1979-2005 to 1980-2005
LA	0 sub-periods	TN	all sub-periods
ME	all sub-periods	TX	1961-2005
MD	1961-2005 to 1974-2005	UT	1961-2005 to 1964-2005
MA	all sub-periods	VT	all sub-periods
MI	1961-2005 to 1969-2005	VA	all sub-periods
MN	all sub-periods	WA	0 sub-periods
MS	1961-2005 to 1974-2005, 1979-2005 to 1980-2005	WI	0 sub-periods
MO	1961-2005 to 1965-2005	WV	0 sub-periods
MT	1961-2005 to 1974-2005, 1980-2005	WY	0 sub-periods

5. Conclusions

The causes and the implications of the interruption of a long-run downward trend in economic disparities among the US states is an issue which has attracted the interest of both economists and policy makers. A number of empirical studies have suggested that the observed stability of standard inequality measures is just a reflection of the fact that the process of convergence has stopped because the relative per capita incomes of US states have attained their long-run equilibrium (steady-state) values.

In this paper relative convergence of state per capita incomes is revisited using recently developed conceptual tools (asymptotically relative stochastic convergence) and more advanced econometric techniques (stationarity tests for panel data). According to the empirical results, the inequality of per capita income (personal and disposable) became free of deterministic or stochastic trends by the early 1960s. This development, however, has not been accompanied with stationarity of all relative state per capita (personal and disposable) income series. Indeed, although the number of converging states has almost doubled in the last 40 years, there are 12 series for personal per capita income and 14 series for disposable per capita income which were not stationary for every subperiod considered. The presence of diverging states is certainly not consistent with a long-run equilibrium cross-section distribution in ratios. In this respect, the results of the present paper appear to contrast sharply with those reported in earlier empirical works on the topic.

The US states is an example of highly integrated economies and, thus, they may act as a benchmark model to speculate on potential developments at the global level as countries around the world move towards further integration. Given that 25 percent of states (for personal income) and 29 percent of states (for disposable income) diverge persistently from the national average, one may conclude that even relative convergence (not to mention perfect/absolute one) can be quite difficult. Further research is certainly needed to identify characteristics (e.g. industry mix, workings of the state institutions) driving the convergence phenomenon. Hopefully, the present work will provoke greater interest in that direction.

References

Barro, R., X. Sala-i-Martin, O. Blanchard, and R. Hall. 1991. Convergence across states and regions. *Brooking Papers on Economic Activity* 1:107-82.

Bernard, A. and C. Jones. 1996a. Productivity across industries and countries: Time series theory and evidence. *Review of Economics and Statistics* 78: 135-46.

Bernard, A. and C. Jones. 1996b. Comparing apples to oranges: Productivity convergence and measurement across industries and countries. *American Economic Review* 86:1216-38.

Bernard, A. and S. Durlauf. 1996. Interpreting tests of convergence hypothesis. *Journal of Econometrics* 71:161-73.

Button, K. and E. Pentecost. 1993. Regional service sector convergence. *Regional Studies* 27:623-36.

Carlino, G. and L. Mills. 1996. Convergence and the US states: A time-series analysis. *Journal of Regional Science* 36:597-616.

Coughlin, C. and T. Mandelbaum. 1988. Why have state per capita incomes diverged recently? Federal Reserve Bank of St Louis *Economic Review* September/October, pp. 24-36.

Choi, C-Y. 2001. Unit root for panel data. *Journal of International Money and Finance* 20:249-72.

Eberts, R. and M. Schweitzer. 1994. Regional wage convergence and divergences: Adjusting wages for cost of living differences. Federal Reserve Bank of Cleveland *Economic Review* Q2, pp. 26-37.

Enders, W. 1995. *Applied Econometric Time Series.* John Wiley: N. York.

Fingleton, B., and E. Lopez-Bazo. 2003. Explaining the distribution of manufacturing productivity in the EU regions. In: Fingleton, B. (ed) *European Regional Growth.* Springer Verlag: London.

Friedman, M. 1994. Do old fallacies ever die? *Journal of Economic Literature* 30:2129-32.

Granger, C. and P. Newbold. 1974. Spurious regressions in econometrics. *Journal of Econometrics* 2:111-20.

Hadri, K. 2000. Testing for stationarity in heterogeneous panels data. *Econometrics Journal* 3:148-61.

Hobjin, B. and P. Franses. 2000. Asymptotically perfect and relative convergence in productivity. *Journal of Applied Econometrics* 15:59-81.

Im, K., M. Pesaran, M. and Y. Shin. 2003. Testing for unit roots in heterogeneous panels. *Journal of Econometrics* 115:53-74.

Islam, N. 2003. What wave we learned from the convergence debate? *Journal of Economic Surveys* 17:309-62.

Izraeli, O. and K. Murphy. 1997. Convergence in state nominal and real per capita income. *Public Finance Review* 25: 555-576.

Johnson, P. 2000. A non parametric analysis of income convergence across the US states. *Economic Letters* 69:219-23.

Johnson, D., T. Smeeding, and B. Boyle Torrey. 2005. Economic inequality through the prisms of income and consumption. *Monthly Review*, April pp. 11-24.

Kane, R. 2001. Investigating convergence of the US regions: A time-series analysis. *The Journal of Regional Analysis and Policy* 31:1-22.

Kwiatkowski, D., P. Phillips, P. Schmidt, and Y. Shin. 1992. Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics* 54:179-78.

Leon-Ledesman, M. 2002. Unemployment hysteresis in the US and the EU. *Bulletin of Economic Research* 54:99-105.

Lucas, R. 1988. On the mechanics of development planning. *Journal of Monetary Economics* 22:3042.

Maddala, S. and S. Wu. 1999. A comparative study of unit root tests with panel data, and a new simple test. *Oxford Bulletin of Economics and Statistics* 61:631-52.

Nahar, S. and B. Inder. 2002. Testing convergence in economic growth for OECD countries. *Applied Economics* 34:2011-22.

Newey, K. and D. West. 1994. Automatic lag selection in covariance matrix estimation. *Review of Economic Studies* 61:631-53.

Quah, D. 1993. Empirical cross-section dynamics in economic growth. *European Economic Review* 37:426-34.

Quah, D. 1996. Convergence empirics across economies with (some) capital mobility. *Journal of Economic Growth* 1:95-124.

Quah, D. 1997. Empirics for growth and distribution: stratification, polarization, and convergence clubs. *Journal of Economic Growth* 2:27-59.

Romer, P. 1986. Increasing returns and long-run growth. *Journal of Political Economy* 98:71-102.

Romer, P. 1994. Origins of economic growth. *Journal of Economic Perspectives* 8:3-22.

Sala-i-Martin, X. 1996. Regional cohesion: Evidence and theories of regional growth and convergence. *European Economic Review* 40:1325-52.

Sen, A. 1997. *On Economic Inequality*. Clarendon Paperbacks: Oxford.

Sherwood-Call, C. 1996. The 1980's divergence of state per capita incomes: What does it tell us? Federal Reserve Bank of San Francisco. *Economic Review* 1:14-25.

Solow, R. 1956. A contribution to the theory of economic growth. *Quarterly journal of Economics* LXX: 65-94.

Taylor, P. and L. Sarno. 1998. The behavior of real exchange rates during the Post-Bretton Woods Period. *Journal of International Economics* 281-312.

Weber, D., P. White, and D. Allen. 2005. Income convergence across US states: An analysis using measures of concordance and discordance. *Journal of Regional Science* 45: 565-89.