Have Per Capita Incomes Stopped Converging in Missouri Counties?

Bruce Domazlicky*

ABSTRACT. Regional convergence of per capita incomes and per capita earnings in Missouri is studied for the period, 1980-2007, as well as for selected subperiods. Convergence as measured by the coefficient of variation in per capita income and per capita earnings has been modest at best from 1980 to 2007 in Missouri counties. The evidence indicates that conditional β-convergence has likely ceased in Missouri counties since 2000, and perhaps earlier. This is true whether per capital income or per capita earnings is used as the measure of regional welfare. (O47, R11)

I. Introduction

Neoclassical growth theory suggests that there should be a tendency for per capita incomes in regions to converge over time. Variations in regional returns to capital and labor will be unequal to the extent that capital-labor ratios differ between regions. For example, in regions where capital is relatively abundant in comparison to labor, returns to capital will be relatively lower and returns to labor relatively higher. These regional differences in relative returns will give rise to factor flows in response to the variations in returns, which will ultimately lead to the equalization of labor productivity among regions. The implication is that incomes will rise in low income regions relative to incomes in high income regions, leading to convergence in per capita incomes. This is a straightforward application of Solow's neoclassical growth model (Solow 1956) to a regional setting. Borts and Stein, 1964, were among the first to make such an application.

Richardson, 1969, notes that there are at least three senses of regional equilibrium: 1) regions converge to the same growth rate; 2) spatial equilibrium such that there is no incentive for factors to move between regions, which implies that factor returns have equalized, and 3) the convergence of regional per capita incomes. It is the third sense of regional equilibrium that has been most frequently studied during the past 15-20 years by regional researchers.

*Southeast Missouri State University. E-mail: bdomazlicky@semo.edu.

Barro and Sala-i-Martin, 1991, looked at convergence for U.S. states. They considered both σ-convergence and β-convergence. The former looks at the coefficient of variation (cv) of per capita incomes among regions at different points in time. If the coefficient is declining over time, then this is evidence of σ-convergence. Sala-i-Martin, 1996, points out that a necessary condition for the existence of σ-convergence is the existence of β-convergence. The latter type of convergence considers the initial starting period and looks at which regions are growing fastest (slowest); if the regions with lower (higher) per capita incomes are growing fastest (slowest), this is taken as evidence that β-convergence exists.

This approach is not without its critics. Quah, 1996, for example, points out that what is important for convergence is not how a region performs with respect to its own history, but how well it performs relative to other regions. Other researchers dismiss the notion that convergence should be expected at all. Martin and Sunley, 1998, sum up this objection thusly, "… there are no necessary reasons why regional growth and incomes should converge, even in the long run. To the contrary, regional *divergence* is likely" (1998, p. 201, emphasis original). And further, "Economies of scale and agglomeration lead to the cumulative concentration of capital, labor, and output in certain regions at the expense of others: uneven regional development is self-enforcing rather than self-correcting." (Martin and Sunley, 1998, p. 201) Myrdal, 1957, was among the first to note that underdeveloped regions will not necessarily catch up to their richer and faster growing counterparts.

The evidence from the various convergence studies is somewhat mixed, though most generally find that convergence has been occurring. In their study of U.S. states, Barro and Sala-i-Martin, 1991, find that per capita incomes among states are converging at the relatively slow rate of about 2% per year. Carlino and Mills, 1996, study state per capita earnings over a long period, 1929-88. They conclude that most of the convergence in state per capita earnings occurred by 1946, with only slow convergence after that year, with actual divergence during the period 1978-88. Garafalo and Yamarik, 2002, using a Solow growth model, find that regional productivity convergence occurred among the states during the period 1977-1996, at a rate of about 2% per year, similar to what Barro and Sala-i-Martin estimated, though using a somewhat different approach. Garafalo and Yamarik go on to state: "Regardless of economic development strategies, productivity levels among states will

converge in the long run….The clear policy implication is that attempts to attract capital and labor to a state will have only transitory effects." (2002, p. 321)

Tsionas (2000 and 2001) is notable for finding a lack of evidence of convergence in real per capita incomes among states. Using a cointegration model, he finds "…strong evidence against the hypothesis that real per capita regional incomes in the U.S. have converged over the period 1929-97." (2001, p. 694)

Most studies of convergence have considered either countries or regions within a country (such as U.S. states). Studies of convergence among subregions of a country are somewhat rarer. Rapino, et. al., 2006, look at counties in New England. They consider both σ-convergence and β-convergence and find that per capita incomes and per capita earnings are both converging among counties in New England. Their approach is similar to Rey and Montouri, 1999, and is the approach that is adopted for this paper. This is discussed in greater detail in the next section.

It is likely that the tendency toward convergence in per capita incomes will be stronger in a state than, for example, between states or between countries. While Johnson, et. al., 2006, provide evidence that the dampening effects of distance have weakened, distance remains an important barrier to the transmission of knowledge and information across space. Therefore, it is to be expected that investors and potential migrants would have greater knowledge about opportunities within a state such as Missouri than about other regions of the country. The resulting flows of capital and labor between the counties of a state can be expected to lead to convergence of per capita incomes much faster and with a greater expectation than, for example, between states of a nation. As will be shown below, this is exactly what we find (as did Rapino, et. al.).

II. Measuring Regional Convergence

The measurement of β-convergence involves the use of an econometric model in which the growth rate of a region's per capita personal income over some period is regressed against its per capita income at the beginning of the period. Since personal income includes transfer payments, which can affect convergence, it is sometimes advantageous to consider per capita earnings rather than income. Both will be considered in this paper.

Let Y be real per capita personal income and t be the initial period. Then the average change in per capita income over some period, T, can be written as:

$$R = (Y_{t+T}/Y_t)/T \quad (1)$$

Absolute β-convergence can then be measured using a simple linear model in logs:

$$\ln R = \sigma + \beta \ln Y_t + \varepsilon \quad (2)$$

where ε is the error term and is normally distributed with a mean of zero. If $\beta < 0$, absolute convergence is said to be occurring. Absolute β-convergence implies that the only difference between regions is in their capital endowments. This clearly is a very restrictive condition since we would expect regions to differ in other ways. Therefore, it seems appropriate to control for these differences between regions by including a vector of control variables, X, in our model.

$$\ln R = \sigma + \beta \ln Y_t + \gamma X + \varepsilon \quad (3)$$

If β is less than 0, then conditional convergence is occurring. With conditional convergence, we no longer necessarily expect per capita incomes to equalize as regions approach a steady state.

The use of a model such as (3) in a spatial setting raises the prospect of spatial dependence in the error terms. It is likely that a region's growth rate will be, to some extent, dependent upon the growth rates of region to which it is adjacent. This can lead to spatially dependent error terms, which violates the basic assumption of least squares regression that error terms are independent. Least-squares estimates of coefficients will still be unbiased, but they will not be efficient and tests of significance will be unreliable. (See Anselin, 1999)

The approach to spatial dependence is to extend equation (3) by decomposing the error term into two parts. The first part δ is the spatial pattern and the second part, μ, is the random error term, which is independently and identically distributed. The equation for conditional β-convergence can now be amended to become:

$$\ln R = \sigma + \beta \ln Y_t + \gamma X + \delta + \mu \quad (4)$$

The spatial pattern is usually defined by a (0,1) matrix, W, that depicts the connectivities between the regions (counties in our model). For example, in the present study, there are 114 Missouri counties plus the independent city of St. Louis. Therefore, the spatial matrix, W, is a 115 x 115 matrix with zeros along the diagonal. A spatial error model as defined in (4) is used in this paper. When absolute convergence is measured, the error term in equation (2) is also modified as in (4) to allow for spatial dependence. Maximum likelihood estimation is necessary for models such as equation (4) (Anselin, 1999). Rey and Montouri, 1999, provide a complete discussion and explanation of the approach in a regional model.

III. Empirical Results

The regions of interest are the 114 Missouri counties and the independent city of St. Louis. The time period is from 1980 to 2007. Three subperiods are considered, 1980-90, 1990-2000, 2000-07. Basic statistics for per capita income and per capita earnings (all monetary figures are in 2000 constant dollars) are given in Table 1. Both variables are from the Bureau of Economic Analysis website (http://www.bea.gov).

TABLE 1–Per Capita Earnings and Income, Summary Statistics

Per Capita Earnings

Year	Mean	Std. Dev.	Minimum	Maximum	CV
1980	8,418	2597.1	3,633	16,873	0.3085
1990	9,781	2811.3	4,964	21,484	0.2874
2000	12,808	3614.3	6,478	26,660	0.2822
2007	13,657	3766.8	6,147	27,187	0.2758

Per Capita Income

Year	Mean	Std. Dev.	Minimum	Maximum	CV
1980	13,543	2435.0	9,049	22,611	0.1798
1990	16,410	2905.7	11,676	31,835	0.1771
2000	21,168	3741.7	13,912	39,991	0.1768
2007	22,154	3876.1	15,472	43,157	0.1750

Table 1 also includes the coefficient of variation (CV) for the two variables at 10 year intervals. For both per capita income and for per capita earnings, the CV declines throughout the period, which is indicative of σ-convergence. This is in stark contrast to what Rapino, et. al., found for New England where the coefficient of variation for per capita income and for per capita earnings increased substantially from 1970 to 2000. In the case of the earnings variable, the CV increased from 0.174 (1970) to 0.299 (2000), while for the income variable, it increased from 0.173 (1970) to 0.239 (2000). The declines in the CV of the earnings and income variable in Missouri offer some support for the continuation of convergence from 1980 to 2007, but for both variables the declines are small, giving an indication that the forces for convergence have not been very strong. It will be useful to also consider β-convergence for additional evidence of trends toward the convergence of per capita income and per capita earnings.

Table 2 presents the summary statistics for the annualized growth rates for real per capita income and real per capita earnings.

TABLE 2–Growth Rate of Per Capita Income and Per Capita Earnings, Summary Statistics

Per Capita Income

Period	Mean	Std. Dev.	Maximum	Minimum	Moran's l
1980-2007	0.0241	0.0074	0.0491	0.0126	**0.115**
1980-1990	0.0218	0.0110	0.0703	-0.0003	**0.131**
1990-2000	0.0292	0.0087	0.0769	0.0094	-0.002
2000-2007	0.0069	0.0077	0.0442	-0.0080	**0.119**

Per Capita Earnings

Period	Mean	Std. Dev.	Maximum	Minimum	Moran's l
1980-2007	0.0250	0.0144	0.0906	0.0069	**0.129**
1980-1990	0.0188	0.0208	0.1376	-0.0175	**0.134**
1990-2000	0.0318	0.0168	0.1471	0.0086	**0.062**
2000-2007	0.0099	0.0103	0.0605	-0.0107	**0.069**

Note: Moran's l in bold indicates a p-value of 0.10 or better.

For the entire period, 1980-2007, growth in real per capita income averaged about 2.4% per year while per real per capita earnings averaged 2.5% per year. Growth rates for subperiods are also given. The highest average growth rates were in the subperiod 1990-2000, while the lowest growth rates were in the most recent subperiod, 2000-2007. The last column in Table 2 gives the value of Moran's I, the spatial autocorrelation coefficient. Moran's I is positive and significant in 7 of the 8 periods reported, indicating the presence of spatial autocorrelation. The existence of spatial dependence in the sample periods indicates that the use of the spatial error model as described in the preceding section is appropriate.

Table 3 presents the results of the absolute β-convergence model (equation (2)).

TABLE 3–Estimated Parameters and Log-likelihood Statistics, Absolute β-convergence

	Per Capita Earnings				Per Capita Income			
Period	1980-2007	1980-1990	1990-2000	2000-2007	1980-2007	1980-1990	1990-2000	2000-2007
Intercept	**-0.0377**	-0.0152	**-1.2803**	**-1.5518**	**-0.1216**	-0.0208	**-1.3663**	**-1.1740**
Convergence Parameter	**-0.3041**	**-0.2331**	**-0.0806**	-0.0351	**-0.2802**	**-0.2171**	**-0.0699**	**-0.0735**
Autoregressive Parameter	**0.0866**	**0.1229**	0.0027	-0.0003	**0.0300**	**0.1102**	0.0007	-0.0010
Likelihood	46.657	77.867	96.074	152.692	99.374	132.003	153.689	184.076

(Coefficient estimates in bold are significant at the 10% level or better.)

The convergence parameter, β, has the anticipated negative sign for the entire period, 1980-2007, and for the three subperiods. It is also statistically significant in all periods, except for the period 2000-07 for per capita earnings. The rate at which convergence took place during the period varied considerably. For the entire period, the rate of convergence of per capita income was 28% per year, which is substantially higher than the 2% rate found for U.S. states by Barro and Sala-i-Martin, 1991. However, the rate of convergence in Missouri falls from about 22% per year in the 1980-90 subperiod to about 7% per year in the last two subperiods. As indicated in Section I, it seems likely that convergence, if it occurs, would proceed at a faster pace in a smaller region such as for

counties in state as compared to states within a nation or even between countries. At the state level, residents and owners of capital are likely to be more aware of and responsive to differences in wages and returns between counties. It is also much easier, typically, for an individual to move across a county line or for owners of capital to invest in nearby locations than it is for them to move to or invest in another state.

The next step is to consider conditional β-convergence by controlling for regional differences that may preclude equalization of per capita earnings or income. Following Rapino, et. al., 2006, six factors were considered: 1) regional structure, 2) population size, 3) education, 4) transportation, 5) housing costs, and 6) amenities. Bernard and Jones, 1996, indicate that regional structure can affect regional convergence. Three variables were included to control for a region's structure: the percent of a region's employment in agriculture (Farming), manufacturing (Manufacturing), and tertiary (Tertiary). Data on the government sector were excluded to avoid multicollinearity problems that arise when all sectors in the economy were included. Manufacturing jobs are typically among the highest-paying in a region and it would be expected that regions with a higher share of manufacturing employment would experience more growth in income and earnings. Agricultural employment would be expected to retard income and earnings growth. It is unclear *a priori* how the tertiary and government sectors will affect income and earnings growth. County population (Population) is included to account for agglomeration economies that can spur economic growth. The education level of a county is measured by the percent of the population 25 years of age or older that has a bachelor's degree (Education). A higher level of educational attainment is expected to lead to faster income and earnings growth. Following Rapino, et. al., variations in housing prices are considered as one of the major factors in cost of living differences between regions and can, therefore, affect migration and wage rates. However, it was found that housing prices and the level of per capita income (or earnings) in the initial year of a period are highly correlated. The correlation of coefficient between housing prices and per capita income ranged from 0.58 (2000) to 0.69 (1980), making it difficult to disentangle the effects of the two variables on the growth of per capita income in the subsequent decade. The correlation between per capita earnings and housing prices also was very high (0.67 in 2000 and 0.76 in 1980). Since we are concerned with the convergence parameter and because the housing variable was not significant in any of the regressions, the housing variable was dropped from the analysis.

Transportation access is crucial to the growth and development of a region. A simple measure of transportation access was used in the model; a dummy variable is included that is equal to one if there is interstate highway access in the county and zero, otherwise (Highways). Data on state-owned highways by county was available from the Missouri Department of Transportation for 2000. Both variables are included in separate regressions for growth in per capita income for 2000-2007. The dummy highway variable was significant in explaining the growth rate of per capita income; however, the highway miles variable did not achieve significance in explaining the growth rate of either dependent variable and is not reported here. To reduce clutter, only the equation including the highway dummy variable is reported in Table 4. The final control variable is amenities (Amenities), which are a type of nonpecuniary income to county residents. Where amenities make a county a more desirable place to locate, there could be some partial offset to incomes as a result. Amenities are measured by the use of the McGrannahan index, 1999. All control variables, except for the amenities variable, are taken from the U.S. Census Bureau website (http://www.census.gov) and are measured in the first year of the period (or subperiod).

The estimated parameters from the conditional β-convergence model are given in Table 4. The convergence parameter, β, has the anticipated sign in all regressions except for per capita earnings in the period, 2000-07. Further, β is not significant in either the per capita earnings or per capita income model in the subperiod, 2000-07, or for the earnings model in 1990-2000. However, for the 1990-2000 model for income, none of the control variables is significant, which may cast some doubt on the veracity of the results. For the earnings model in that subperiod, only the sector variable for agriculture is significant.

The conditional β-convergence model for per capita earnings indicates that convergence has mostly ceased among Missouri counties since at least 2000, and perhaps earlier. For per capita income, the evidence is that convergence is still occurring. However, the speed of convergence has also declined for each variable. The rate of convergence in the earnings model was over 40% per year in the subperiod, 1980-90, and 37% per year for per capita income for the same period. By 1990-2000, the rate of convergence in incomes had slowed to about 12%, and by 2000-07, convergence of incomes slowed to 8%. A similar story can be told with per capita earnings, though the evidence seems to indicate that convergence of earnings stopped in the 1990's.

TABLE 4–Estimated Parameters and log-likelihood Statistics,
Conditional β-convergence Models

	Per Capita Earnings				Per Capita Income			
Period	1980-2007	1980-1990	1990-2000	2000-2007	1980-2007	1980-1990	1990-2000	2000-2007
Intercept	0.6594	**1.1003**	**-1.8068**	**-1.6599**	**1.6767**	**1.0709**	**-1.1239**	**-0.9979**
Convergence Parameter (β)	**-0.4194**	**-0.4259**	-0.0648	0.0179	**-0.5806**	**-0.3701**	**-0.1179**	**-0.0815**
Sector								
Farming	0.0038	0.0023	**0.5769**	**-0.2656**	-0.0000	0.0018	0.1916	**-0.2464**
Manufacturing	-0.0035	.0009	0.0500	**-0.3766**	-0.0025	0.0007	0.0535	**-0.2214**
Tertiary	0.0002	0.0003	0.2552	-0.4021	-0.0001	0.0013	0.0866	**-0.2870**
Control								
Population	0.0197	0.0290	0.0195	-0.0129	0.0235	0.0146	0.0096	0.0052
Education	**0.0111**	**0.0148**	0.0001	-0.0010	**0.0055**	**0.0100**	0.0014	-0.0011
Highways	**0.0955**	**0.0746**	0.0083	0.0194	**0.0550**	**0.0270**	0.0133	**0.0196**
Amenities	-0.0103	0.0010	-0.0130	0.0042	**0.0284**	0.0045	0.0090	**0.0157**
Autoregressive Parameter	-0.0057	-0.0046	-0.0006	0.0001	-0.0007	-0.0037	-0.0005	-0.0008
Likelihood	57.197	92.164	101.262	168.833	112.582	145.973	155.465	195.949

IV. Conclusion

The evidence presented here points to an end to the convergence of per capita earnings among Missouri counties since 1990. The rate of convergence of per capita income slowed considerably from the 1980's to the initial decade of the 21st Century. Per capita income growth since 2000 was seen to be responsive to sector composition, highways and amenities. This indicates that one strategy for increasing the growth of lagging regions might center on improving transportation access. Another strategy might focus on the inherent advantages of the region and making them better known. Some areas of the Ozarks region (the Branson area and Lake of the Ozarks), for example, have become popular tourist destinations. Some other Ozark areas (primarily south central Missouri counties) that are less populated might be well-situated to also becoming tourist or retirement destinations, given their natural amenities. While a region is unable to control its level or quality of natural amenities, it can take steps to develop and promote the advantages that it possesses. As cities continue to become more crowded, access to open space and recreation increases the attractiveness of counties that perhaps are less populated but have wilderness-type experiences available.

In a result that is not necessarily expected, education is of importance to income and earnings growth only in the subperiod 1980-90. This may be due to the fact that education levels have been steadily improving in Missouri counties, and there has been a great deal of catch-up in counties that were once far behind the rest of the state in educational attainment. Many counties have a long way to go before they reach equality with counties in the rest of the state; but the evidence indicates that this is no longer a significant hindrance to the economic development of most regions in Missouri.

The fact that earnings ceased converging a decade before income is perhaps not surprising. It would be expected that government transfer payments would tend to promote convergence as low income regions receive more payments (relative to their income levels) than do high income regions.

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