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Full Length Research Paper

Analysis of regional disparities and wage convergence in Alabama

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This paper examines the degree to which real wages have converged in Alabama over the last thirty-seven years. The increase in government transfers, improvement in information technology and possibly, other government assistance programs would suggest that, wages in spatially dispersed counties within nation-state should become similar over time. However, the interrelation between business cycles, migration, employment structure and changes in per capita earnings over time reduces this possibility. To test the convergence hypothesis, comparable county-level real wage data are obtained from the U.S. Bureau of Economic Analysis and analyzed using cross-section and time series techniques. Particularly, two hypotheses are tested: (1) whether real wages in poor economies (rural counties) are catching up with real wages in rich economies (urban counties), and (2) whether adjacency to urban areas has an effect on the transition from low wages to high wages for rural workers in Alabama. The results differ across the different measurement techniques, but in general, the findings do not confirm the convergence hypothesis within the different sub-periods, but rather patterns of fluctuating coherence. Similarly, the proximity hypothesis is rejected suggesting that, rural workers residing in counties that are contiguous to urban areas have not benefited from the potential spillover effect.

Key words: Real wages, convergence, divergence, unit root tests, time series, cross-section analysis.

INTRODUCTION

Research on the distribution of income and wage earnings in the United States has expanded substantially during the last several years (Feenstra, 2000; Bernard et al., 2006; Yellen, 2006; Autor et al., 2008; Krugman, 2008; Ebeinstein et al., 2009). In part, this reflects the perception that inequality of earnings has been increasing, leading among other results to a large growth of workers with low and very low wage earnings. Earlier studies explained rising income and earning inequality as a result of technological change, which favors skilled workers, a falling minimum wage, and geographical variations (Holzer, 1996; McCall, 2000; Dadre and Ginther, 2001; Schmitt, 2003; Autor et al., 2008). It has also been noted, based on the assumption of diminishing returns to capital, that regions with low capital-labor ratios will have higher marginal products of capital, that will enable these regions to grow faster (Barro and Sala-i-Martin, 1991; Carlino and Mills, 1996; Maza and Villaverde, 2006; Paas and Schlitte, 2008). This implies that high-wage regions will post slow growth, while poorer regions will show strong growth in wages—previous studies however, do not consistently find convergence (Bernard and Durlauf, 1995; Tavernier and Temel, 1997). On the other hand, tests of the convergence hypothesis have for the most part considered convergence in GDP per capita (Miller and Upadhyay, 2002; Wagner and Hlouskova, 2002; Kosfeld et al., 2006; Colavecchio et al., 2005). However, the mechanism of convergence should relate equally to factor shares, for example, real wages (Oxley and Greasley, 1997; Borjas, 2000).

In this paper, we consider to what extent convergence exists between Alabama's rural and urban counties using real wage data. Given the potential economic benefits from decades-long infusions of government funding to build rural physical infrastructure (e.g., highways, water

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and sanitation facilities), the steady increase in higher paying industrial jobs in the automobile industry, capital accumulations, and human capital development, it is interesting to test whether Alabama's rural counties have posted strong growth in real wages over the past 37 years. The paper serves several purposes. Firstly, it examines the comparative growth of real wages across rural and urban counties, in one of the most rural states in the United States. Secondly, wage earnings and/or income are identified in literature as key variable(s) in explaining how individuals form their needs to create life satisfaction (Easterlin, 2001; Luttmer, 2004). Therefore, investigating the disparities in wage earnings across rural and urban regions is tantamount to examining the regional differences in satisfaction with quality of life. Lastly, the paper reinvestigates the apparent contradiction between the convergence results obtained in earlier studies (Barro and Sala-i-Martin, 1991; McCall, 2000; Gyawali et al., 2008) and the pessimistic view that prevailed in the early 1980s (Baumol, 1986; Garnick, 1990). While an analysis of this nature could be indeterminate, its results may serve to motivate a more detailed analysis for understanding rural-urban disparities in a developed country, the United States.

The remaining part of the paper is organized as follows: the concept of convergence is presented subsequently, followed by a description of the study area and the data set. The techniques used to test for convergence, followed by the empirical results are provided, as well as the result discussion and conclusions of the paper.

The concept of convergence

The concept of convergence has been a central issue around which economic growth literature has evolved. The question is, whether or not the income levels of poorer countries are converging to those of richer countries. Although, there is only one type of convergence in theoretical models, the empirical literature distinguishes two distinct, though related, concepts of convergence[1]. As Paas and Schlitte (2008) have noted, the first concept focuses on the dispersion or spread of incomes, and is used to answer the question of whether the distribution of per capita income among countries is becoming narrower over time. The second concept focuses on the mobility or the change in position, of individual economies within the distribution and is used to answer the question of whether poorer economies are catching up with richer economies. They argue that mobility is more important than dispersion; that is, the size of differences in incomes at any particular time is less important than the ability of poor economies to catch up with rich economies. Low mobility means it will take a long time to reduce the gap between the poorest and the richest economies, whereas high mobility means that individual economies quickly move up (and down) within the income distribution. According to McGrattan and Schmitz (1998), one way of looking at the mobility of economies is to compare the growth rates of the lowest-income economies and the growth rates of the highest-income economies; convergence is occurring if the economies with below-average initial income are growing relatively faster.

In empirical research, the analysis of wage convergence has much in common with the literature on income convergence (Borjas, 2000; Gyawali et al., 2008). In this case, neo-classical theory predicts that inter-regional wages should converge (Cherry and Tsournos, 2000), but as numerous studies have shown, wage disparities continue to persist across regions (Hatton and Williamson, 1991; Williamson, 1995; Simpson, 1995; Sicsic, 1995). More specifically, as market integration progresses, wage gaps and wage dispersion across regions should decline, although absolute wage equalization is rarely observable. In other words, if labor markets are perfectly integrated, the only difference observable between real wages in two locations must be due to the cost of moving from one location to another, and other observable and unobservable characteristics (such as education, infrastructure, migration, cost of living, government policies, etc.) that potentially can influence regional inequalities and uneven spatial development. This paper revisits this issue using county-level data for one of the most rural states in the United States, Alabama. The objective here is to empirically test the convergence hypothesis by examining whether real wages in poor economies (rural counties) are catching up with real wages in rich economies (urban counties).

A number of studies (Mills and Hazarika, 2001; Mills, 2001; Porter et al., 2004) have also explored the impact of proximity to an urban region on the performance of rural regions. Mills (2001), for example, analyzes whether a rural community's adjacency to a metropolitan area has an effect on transition from unemployment to employment by rural workers. This issue is revisited by examining whether adjacency to urban areas has an effect on the transition from low wages to high wages for rural workers in Alabama[2].

Characteristics of the study region and data sample

Alabama is one of the 50 states that make up the United States of America (U.S.). It was chosen for this study

[1] A third type of convergence, called stochastic convergence, focuses on the time-series properties of the distribution of per capita income (Carlino and Mills, 1996).

[2] The definition of rural and urban areas used in this paper is based on the U.S. Economic Research Services' (ERS) Rural-Urban Continuum codes, commonly known as the Beale codes (ERS, 2003). The Beale codes divided the 3,141 counties in the United States into urban and rural designations, and further refine county types by their urban population and adjacency to urban areas. Based on this definition, 39 of the 67 Alabama counties are designated as rural counties.

Table 1. Alabama median hourly wages, 2001 to 2008.

	2001	2002	2003	2004	2005	2006	2007	2008	Change 01-08 (%)
U.S.	$15.63	$15.76	$15.95	$15.95	$15.75	$15.82	$15.68	$15.74	0.70
South	$14.66	$14.74	$14.88	$14.91	$14.65	$14.92	$14.93	$14.93	1.80
Alabama	$14.28	$14.61	$15.03	$14.42	$15.00	$14.35	$13.82	$14.25	-0.20

Source: Economic policy institute analysis of current population survey data

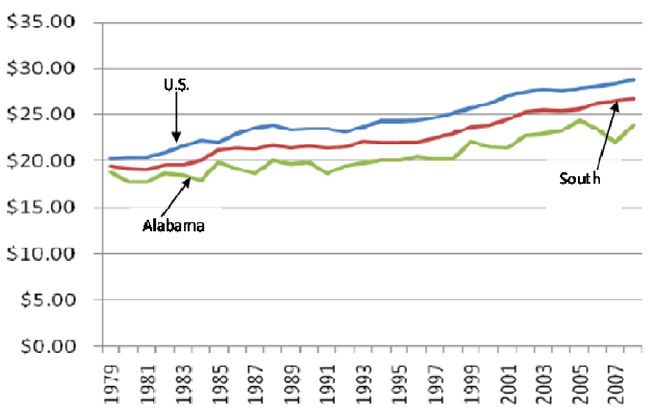

Figure 1. Alabama wage disparity between 90th and 10th percentiles, 1979 to 2008. Source: Economic policy institute analysis of current population survey data.

because it represents one of the classic examples of the nation's most rural states and economic restructuring across the U.S. has affected Alabama in ways that are significantly different from the experiences of other regions of the U.S. Notably, Alabama's economy continues to lag behind national averages on most economic measures. High rates of poverty (17%), a declining per capita income, low rates of labour force participation, and population loss are the general features (EPI, 2008; ACS, 2009; The State of working Alabama, 2009). Patterns of in- and out-migration have played an unusually large and significant role historically in perpetuating poverty and spatial inequality in earnings. For many decades, Alabama's "best and brightest" have fled rural and poverty-stricken areas for the region's burgeoning urban employment centers and beyond. Alabama's welfare poor have often remained anchored in place, a stasis that has reinforced geographic disparities and muted any potential economic benefits from decades-long infusions of government funding to build the region's physical infrastructure (e.g., highways, water and sanitation facilities) and to cultivate its human resources.

Alabama has one of the highest unemployment rates (10.9%) in the U.S., with many rural counties experiencing unemployment rates above 20%, without counting the underemployed and discouraged workers (ADIR, 2009). Similarly, the decline in the number of taxpayers has resulted in inadequate tax revenues (not to mention the ongoing economic turmoil) to maintain public services. While tax revenues are at a decline, the costs of running local governments have increased, forcing many localities to cut back on public services and these declines in local services have made rural Alabama less attractive for new businesses and industries. According to a report by "the State of Working Alabama", median hourly wages for Alabama workers also have flat-lined in the last decade. Even after a 3.1% increase in 2008, the state's median wages were no higher than they were in 2001 (Table 1).

In 2008, Alabama's median wages were 9.5% below those for U.S. workers as a whole and 4.6% behind the southern regional average. Furthermore, Alabama had the 10th lowest median wages in the nation (The State of Working Alabama, 2009), a trend that is likely to continue for decades to come. One side effect of the state's comparatively low wages is that, Alabama sees a lower disparity between its highest and lowest wage percentiles than the entire region and the nation. The hourly wage gap between workers in the state's 90th percentile and its 10th percentile last year was $23.85. For the South, the gap was $26.73, and for the nation, it was $28.73 (The State of Working Alabama, 2009). The wage disparity between the 90th percentile and the 10th percentile has grown substantially since 1979, though at a lower rate than in the region and nation as a whole. Alabama's gap has increased 27.1% since 1979, compared to 37.5% growth for the South and a jump of 41.8% for the United States (Figure 1). In the last decade, however, this disparity has increased more in Alabama than it has regionally or nationally. Since 2001, this gap has grown by 11.4% in Alabama, compared to 9.1% in the South and 6.2% in the United States.

To examine the effects of decades-long infusions of government funding on reducing the historical disparities in wage earnings between Alabama's rural and urban counties, real wage data for the sixty-seven Alabama counties was assembled. The county-level data, covering the period 1969 to 2008, were drawn from the Regional

Economic Information System (REIS, 2006) and the Bureau of Economic Analysis (BEA, 2009). The data was organized into four types of geographic classifications: urban, rural, adjacent and non-adjacent counties[3]. These classifications are based on the ranking of the sixty-seven Alabama counties on the rural-urban continuum codes[4]. Counties encompassing metropolitan statistical areas are classified as urban, whereas rural counties are those encompassing non-metropolitan statistical areas. The rural counties that are contiguous to metropolitan areas are classified as adjacent; and counties not contiguous to metropolitan areas are classified asnonadjacent[5]. In the remainder of this paper, the terms rural adjacent and rural non-adjacent are shortened to adjacent and non-adjacent, respectively.

METHODS AND RESULTS

Various economists have attempted to empirically examine wage convergence using different econometric techniques (Cherry and Tsournos, 2000; Dadre and Ginther, 2001). In this paper, three tests are utilized: (1) dynamic correlation analysis to study the short-run responses, (2) unconditional or sigma convergence test, to determine the presence, or otherwise, of σ-convergence and (3) cointegration analysis to measure the long-run relationship between Alabama's urban and rural real wages. Each of these techniques is discussed in turn followed by the estimated results[6].

Dynamic correlation analysis

The first concept of convergence examined is dynamic correlation analysis. The computation of simple correlation coefficients within different sub-periods of a total sample period can be employed to study the dynamics of the linkages between variables separated by space (Bukenya and Labys, 2005). However, since correlation analysis is static rather than dynamic, it is also important to examine cross-correlations with a lag structure between the variables of interest. To accomplish this, simple correlation coefficients (r_i^2) within different sub-periods of the total sample (1969 to 2008) are calculated. Following Bukenya and Labys (2005), the estimated r_i^2 coefficients are used to estimate the dynamic correlation indexes,

C_{ij} and C_{it}, as:

[3] Three sets of samples are employed. That is, the first set contains all Alabama's rural and urban counties, the second and third sets exclude rural counties that are adjacent and not adjacent, respectively, to urban counties.

[4] The rural-urban continuum code is based on a classification scheme developed by the U.S. Department of Agriculture (ERS, 2003). For the purposes of this analysis, counties ranked 0-3 on the continuum code (counties encompassing metropolitan statistical areas) were classified as urban; and 4-9 as rural. Among the rural counties, those ranked 4, 6, or 8 (counties contiguous to metropolitan areas) were classified as adjacent; and those ranked 5, 7, or 9 (counties not contiguous to metropolitan areas) were classified as non-adjacent (ERS, 2003).

[5] Based on these definitions and the 2000 U.S. Census, the 67 Alabama counties can be grouped into 28 urban counties, 39 rural counties, and 31 adjacent and 8 non-adjacent counties. Note also that, county classifications differ from one census to another.

[6] The analyses were performed using EViews 3.1 software (EViews, 1998).

$$C_{ij} = \frac{r_{12}^2 + r_{13}^2 + r_{14}^2 + ... + r_{67}^2}{n_{c_2}} \quad (1)$$

$$C_{it} = \frac{C_{ij}}{C_{11}} \quad (2)$$

Where i = 1, 2, …, 67; j = t = 1, 2, …, 8; and C11 is the Cij for the first sub-period. Here, i represent a county; j and t represents sub-periods in each case. In the above equations, a coefficient of C equal to one is interpreted as a perfect transmission of wage shock, while a coefficient of zero represents a short-run invariance to changes in wages elsewhere. Since the short-run effect is in principle unrestricted, a value of C_{it} greater than unity, for example, suggests an over-reaction to changes in wages in the current period. The estimated dynamic correlation indexes (C_{ij} and C_{it}) are reported in Table 2, and the graphical representations of the C_{it} indexes are depicted in Figure 2. The discussion of the results focuses on the Cit index, which takes into consideration the initial conditions (levels) of real wages at the beginning of the study period.

As depicted in Table 2 and Figure 2, the computed dynamic correlation indexes are all positive suggesting that, real wage earnings across Alabama's regions move in the same direction. The estimated Cit coefficients beyond the initial sub-period suggest an under-reaction to wage shocks across all the sub-periods for urban and rural counties (from here on Model I), and perfect transmissions of wage shocks during the 1975 to 1979 sub-periods for urban and adjacent counties and urban and non-adjacent counties (from here on Models II and III, respectively), after which a prolonged under–reaction to changes in wages is observed over the last six sub-periods for all Models. For Models I and II, the lowest Cit index values (0.84 and 0.75, respectively) were registered during the 2005 to 2008 sub-period while the next lowest values (0.86 for both) appeared during the 1995 to 1999 sub-period. For Model II, the lowest Cit index value (0.84) was registered during the 1995 to 1999 sub-period while the next lowest values (0.86) appeared during the 2005 to 2008 sub-period. For all models, the estimated Cit coefficient for the entire 37-year period is unity (Table 2), suggesting a perfect transmission of wage shocks over the studied period. Overall, the dynamic correlation results do not support the convergence hypothesis, but rather a pattern of fluctuating coherence across sub-periods.

Sigma convergence analysis

The second concept of convergence (unconditional convergence) describes how the wage dispersion among regions evolves over time. The unconditional convergence of real wage among regions can be measured empirically in several ways. It can be measured by the standard deviation, variation, or coefficient of variation (Williamson, 1995; Vojinovich et al., 2009). In this paper, the coefficient of variation (CV) of real wages was used[7]. This method of estimating unconditional convergence leads to what previous studies have called Sigma convergence (Williamson, 1995; Sala-i-Martin, 1996; Vojinovich et al., 2009). Ideally, Sigma convergence takes places when differences in real wage levels between regional economies decrease over time (Williamson, 1995; Barro and Sala-i-Martin, 1995, p. 31).

To test whether or not Sigma convergence has taken place, Vojinovich et al. (2009) suggested using the estimation of the trend

[7] The coefficient of variation is the standard deviation divided by the mean for a year.

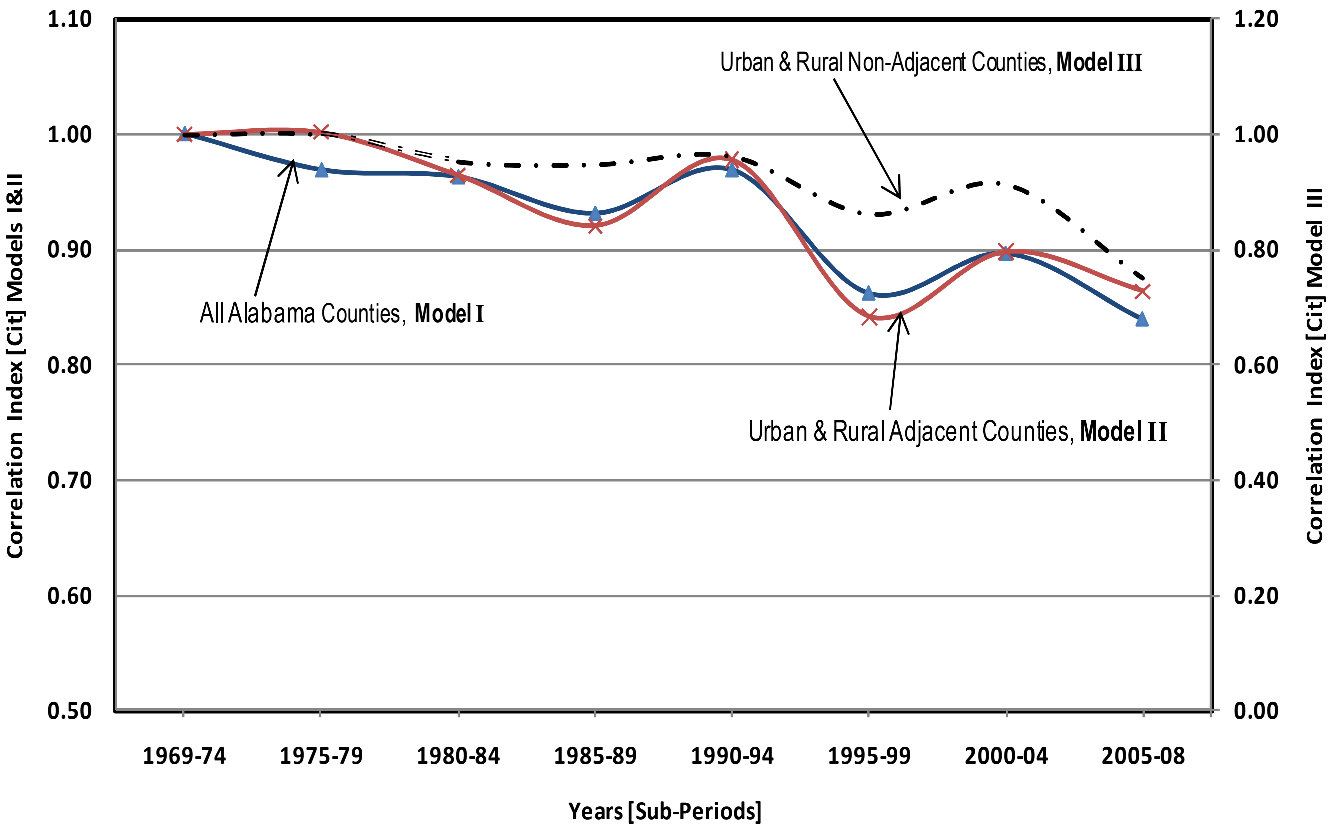

Figure 2. Estimated Dynamic Correlation Indexes for Alabama Counties.

Table 2. Estimated dynamic correlation indexes for Alabama.

Sub-periods	Model I Alabama		Model II Urban and rural adjacent		Model III Urban and rural non-adjacent	
	Cij	Cit	Cij	Cit	Cij	Cit
1969-1974	0.99	1.00	2.02	1.00	0.99	1.00
1975-1979	0.96	0.97	2.03	1.00	0.99	1.00
1980-1984	0.95	0.96	1.95	0.96	0.94	0.95
1985-1989	0.92	0.93	1.86	0.92	0.94	0.95
1990-1994	0.96	0.97	1.98	0.98	0.95	0.96
1995-1999	0.85	0.86	1.70	0.84	0.85	0.86
2000-1904	0.88	0.90	1.82	0.90	0.90	0.91
2005-1908	0.83	0.84	1.75	0.86	0.74	0.75
1969-2008	0.99	1.00	2.03	1.00	0.99	1.00

line of the dispersion in real wage levels among the concerned economies as: $CV(w_t) = \beta_0 + \beta_1 t + \varepsilon_t$. In the present context, w_t represent average real wage, t is time with a span from 1969 to 2008, and ε_t is the error term. The dependent variable is the coefficient of variation of real wage levels across Alabama counties, while the independent variable is time. If the estimated parameter "β_1" is negative, then, Sigma convergence exists (Vojinovich et al., 2009). The estimated CV parameters for Alabama's rural and urban regions are presented in Table 3. The table also reports the respective values for the estimated mean and standard deviation, based on the discussion above. Figure 3 supplements Table 3, by plotting the dynamics of CV estimates and the respective trend line for the period 1969 to 2008. The results in Figure 3 and the data presented in Table 3 suggest that, real wages across Alabama's urban and rural counties portray signs of Sigma convergence, over the studied period. Particularly, over the whole period, wage convergence resulting in a fall of the CV by 27% from 0.222 in 1969 to 0.162 in 2008 was observed.

Furthermore, the negative slope of the trend line in Figure 3

Table 3. Estimated Sigma Convergence in real wages for Alabama, 1969 to 2008.

Year	Mean	St. dev.	CV	Year	Mean	St. dev.	CV
1969	4202.537	934.006	0.222	1989	16569.701	3025.463	0.183
1970	4497.791	981.658	0.218	1990	17343.403	3280.974	0.189
1971	4828.284	1060.316	0.220	1991	18041.239	3424.293	0.190
1972	5189.716	1116.085	0.215	1992	18923.149	3618.495	0.191
1973	5636.522	1171.384	0.208	1993	19412.746	3555.985	0.183
1974	6190.940	1259.221	0.203	1994	20223.134	3551.851	0.176
1975	6677.821	1387.761	0.208	1995	20864.493	3672.951	0.176
1976	7413.328	1465.138	0.198	1996	21557.328	3702.198	0.172
1977	8015.269	1639.298	0.205	1997	22376.776	3784.130	0.169
1978	8856.552	1670.551	0.189	1998	23103.806	4029.919	0.174
1979	9695.970	1818.759	0.188	1999	24049.642	3970.837	0.165
1980	10571.746	1963.432	0.186	2000	24806.687	4040.505	0.163
1981	11449.090	2156.927	0.188	2001	25543.060	4078.339	0.160
1982	12139.522	2277.961	0.188	2002	26228.284	4237.722	0.162
1983	12819.836	2422.250	0.189	2003	27238.418	4545.219	0.167
1984	13568.701	2566.708	0.189	2004	28171.358	4595.496	0.163
1985	14348.627	2767.888	0.193	2005	29173.582	4774.038	0.164
1986	15044.970	2816.621	0.187	2006	30393.448	4997.892	0.164
1987	15540.582	2906.737	0.187	2007	31490.821	5052.931	0.160
1988	16078.582	3070.435	0.191	2008	32477.507	5274.828	0.162

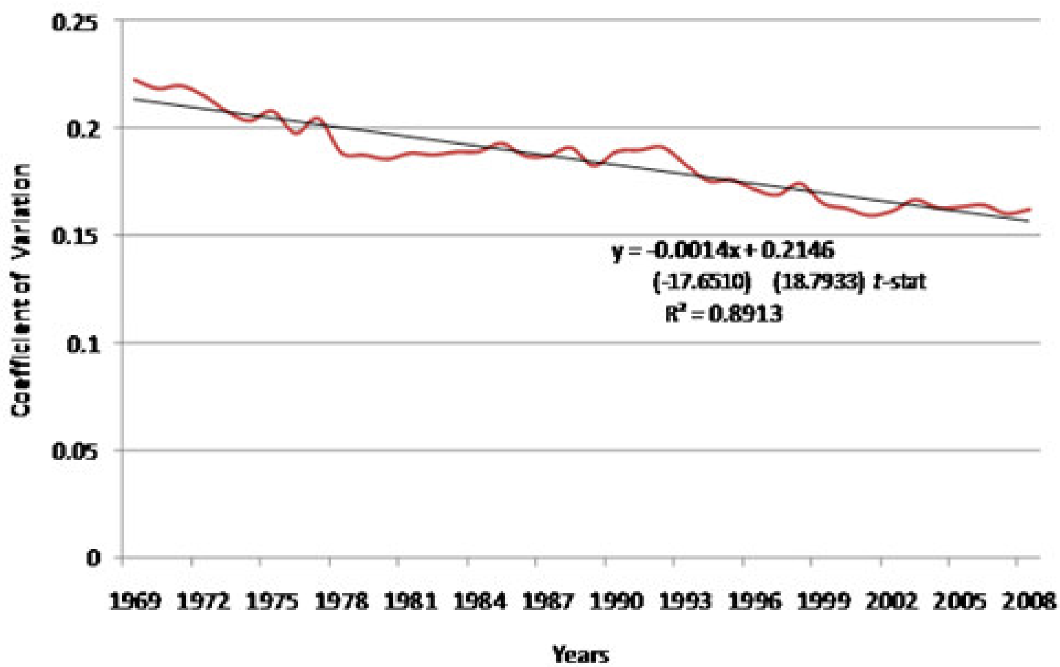

Figure 3. Estimated sigma convergence of average real wages in Alabama, 1969-2008.

reveals that, real wage disparities between Alabama's rural and urban counties have declined over time. The trend line regression results show good statistical properties, which further support the presence of Sigma convergence over the studied period. Particularly, the high R-squared (89%) of the trend line regression, suggests that, the time variable explains roughly 89% of the observed decline in real wage disparities between rural and urban counties. The estimated slope and intercept parameters are also

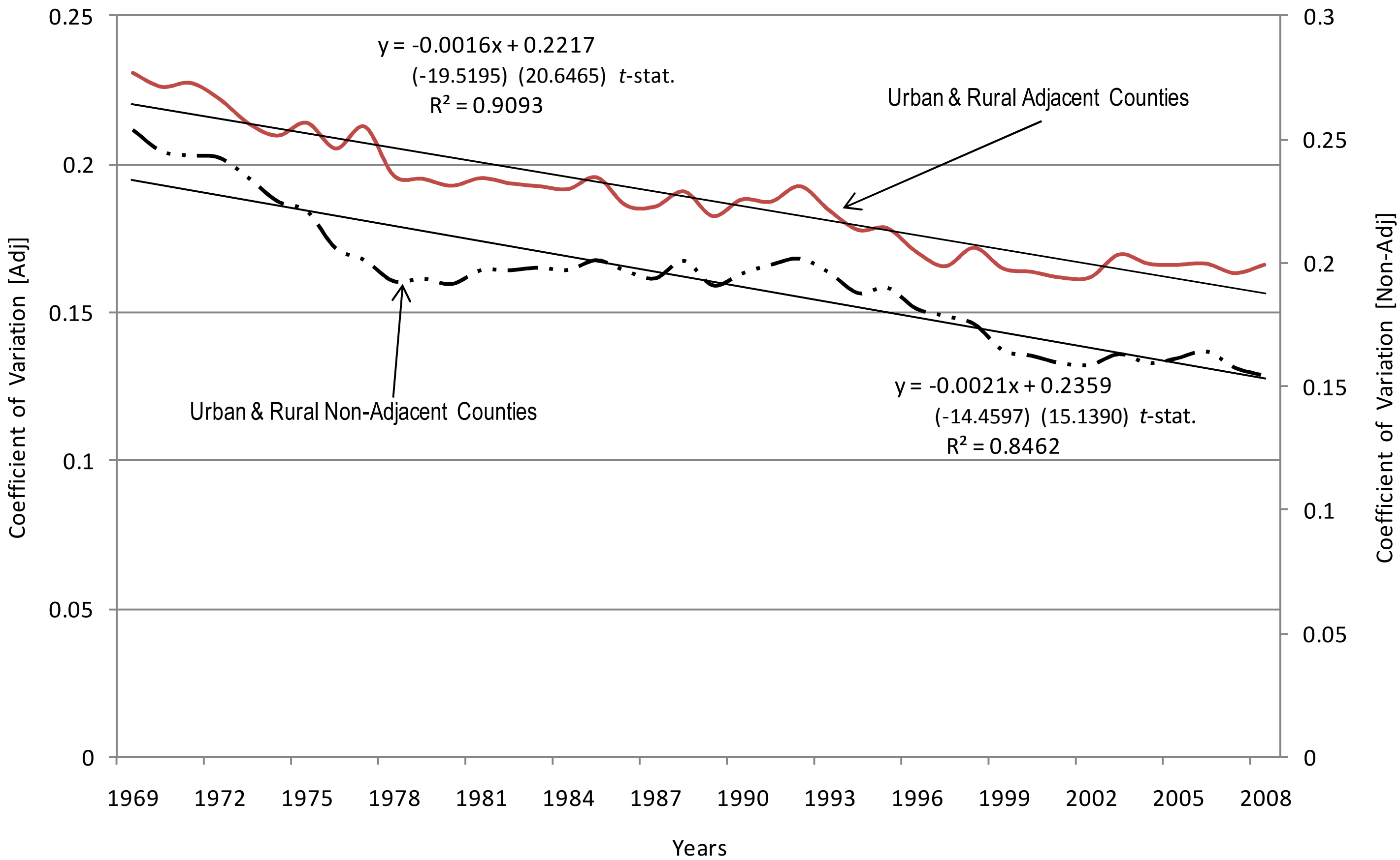

Figure 4. Estimated sigma convergence of average real wages in Alabama's urban, rural adjacent, and non-adjacent counties, 1969-2008.

statistically significant at p<0.01 level. Another interesting observation from the trend line in Figure 3 is that, although the estimated CV parameters for real wage data, support the presence of Sigma convergence over the entire sample (1969 to 2008), the observed Sigma convergence is not linear. In some periods, particularly 1989 through 1992 (which includes a recession) there are signs of Sigma divergence. These results are in line with the previous findings reported under dynamic correlation analysis, which revealed tendencies of under-reaction to changes in real wages across sub-periods and a perfect transmission of wage shocks over the entire period, 1969 to 2008.

The possible explanations for the observed trends, especially during the 1980s, are factors such as exogenous shocks (such as the oil price shocks) and national and international business cycle conditions (such as recession/depression). Wage instabilities have been largely intertwined with swings in international business cycles. The crucial phase occurred when OPEC sharply increased crude oil prices from $3 per barrel in 1973, then to $12 in 1974, and finally to $40 in 1978. By 1980, however, higher oil prices had induced greater oil supplies and hence lower oil prices. Other commodity prices followed downwards, and in 1980 to 1982, the world economy slipped into a recession that was at its worse since the 1930's; and then, the 1990 to 1991 recession. Such strong business cycle interactions, could well have caused the observed wage instabilities.

To examine whether adjacency to urban areas has an effect on transition from low wages to high wages for rural workers in Alabama, we separated the data into two sets of samples: the first set excludes rural counties that are adjacent to urban counties (Model II) and the second set excludes rural counties that are not adjacent to urban counties (Model III). Figure 4 present plots of estimated CV for Models II and III over the period 1969 to 2008. The results in the figure not only show evidence of real wage instability within the sub-periods, but also across the defined regions. For instance, under the adjacent counties (Model II), the results are very similar to the previous rural-urban results. Over the entire period (1969 to 2008), real wage convergence resulting in the fall of the CV by 28% from 0.231 in 1969 to 0.166 in 2008 was observed.

Furthermore, the estimated trend line regression, show good statistical properties with a higher R-squared value (91%) compared to the rural-urban model. Similarly, the estimated slope and intercept parameters are highly significant (at p<0.01), providing further support of Sigma convergence in real wages between urban and adjacent counties. Turning to the non-adjacent counties (Model III), the observed rate of Sigma convergence in real wages over the whole period was greater compared to the urban-adjacent regression (Model II), with the fall of the CV by 39% from 0.254 in 1969 to 0.154 in 2008. In comparison, adjacent counties have shown greater dispersion than non-adjacent counties according to Figure 4, which depicts the two curves for rural adjacent counties above the rural non-adjacent ones. The chart also presents evidence of a prolonged regional convergence among non-adjacent counties almost throughout the 1970s, after which patterns of fluctuations set in starting in the early 1980s. These results imply that, first, real wages in Alabama's remote (rural non-adjacent) counties have grown faster over the 37-year period than real wages in urban counties. Second, real wages in Alabama's remote

Table 4. Unit root tests for average real wages for Alabama regions.

	Intercept and time-trend		Intercept no time-trend	
	Level series	First difference	Level series	First difference
Rural counties	-0.555	-3.722*	2.181	-2.839
Urban counties	-0.502	-4.217*	2.496	-3.480*
Adjacent counties	-0.287	-3.701*	2.189	-2.825
Non-adjacent counties	-2.758	-4.728*	1.855	-4.102*

* Represents significance at the 5% level or higher.

counties have grown faster over the 37-year period than real wages in the not so rural (adjacent) counties.

We have used the CV as the measurement of convergence. However, if the data are not stationary, the usefulness of the CV as an indicator of convergence may be called into question. As quoted in Brandl (1996), previous studies (Enders, 1995; Kennedy, 1993) have noted that, there are several differences between stationary and non-stationary time series data. They contend that, if the series is non-stationary then a shock in one period may dramatically lower (or rise) the standard deviation, in that period and many others. In a following period, another shock may send the data in the opposite direction. Thus, if the data is non-stationary, when the CV has fallen over a period, one is not certain what this means (Brandl, 1996). It is important, therefore, to determine if the data is stationary and for that we turn to cointegration analysis.

Cointegration analysis

A growing body of empirical literature has used cointegration techniques in measuring equilibrium relationships between variables. Previous applications to wages include Gunay et al. (2005), Ghali (1999), Wakeford (2004), Gunay et al. (2005), Mora et al. (2005), Bardadym and Emmenegger (2007), and Bildirici and Alp (2008). Since only nonstationary series can be subject to cointegration analysis, the first step is to confirm that the variables are nonstationary and integrated of the same order. To this end, several different tests are available. In the present context, the Dickey-Fuller and Augmented Dickey-Fuller tests were employed and estimated in EViews (1998) using the following regression:

$$\Delta w_t = a + gw_{t-1} + \sum_{i=1}^{k} b_i \Delta w_{t-i} + e_t \qquad (3)$$

The lag length k is chosen to generate a white noise error term et. To determine whether wt is nonstationary, the null hypothesis of nonstationarity is evaluated by testing whether g = 0, against the alternative of stationarity g < 0. Following stationarity tests, cointegration tests are conducted using the Bernard and Darlauf (1995) method. Since this methodology has been extensively discussed in the literature, brief descriptions are presented here.

The Bernard and Durlauf (1995) approach defines long-run convergence between regions i and j if the long-term forecasts of the price variable for both regions are equal at a fixed time t:

$$\lim_{k\to\infty} E\left(p_{i,1+k} - p_{j,t+k} \middle| \xi_t\right) = 0 \qquad (4)$$

where ξ_t stands for the information available at time t. This definition is satisfied if $p_{i,1+k} - p_{j,t+k}$ is a mean, zero-stationary process. In the current analysis, this implies that in order for real wages in counties i and j to converge, the two series must be cointegrated with cointegrating vector [1, -1]. In addition, if the variables are trend-stationary, then the definitions imply that the trends for each region must be the same. Bentzen (2003) employs this approach by estimating a cointegrating equation of the form:

$$\Delta\left(p_{i,t} - \bar{p}_t\right) = \alpha + \beta_t + \mu\left(p_{i,t-1}\right) + \text{lagsof}\,\Delta\left(p_{i,t} - \bar{p}_t\right) + \varepsilon_t \qquad (5)$$

Following Bentzen (2003), Equation 5 is estimated where the test relies on a Dickey-Fuller type of test for a unit root in the difference of the (log) values of real wages, with t indicating a time trend. In the presence of a unit root, average real wages in rural and urban counties will be driven by separate stochastic trends and, hence, diverge over time. On the other hand, the absence of a unit root in Equation 5 would imply that, the intercept term and the deterministic trend parameter may be insignificant and thus indicate long-run convergence. Finally, when the deterministic trend parameter differs significantly from zero, a catching-up process is likely to take place, assuming that the initial values of real wages differ in levels.

To perform cointegration analysis, unit root tests are first conducted using the Augmented Dickey-Fuller (ADF) method (Dickey and Fuller, 1979; 1981). Whether or not to include the linear trend in conducting unit root tests is still contentious. For instance, McCoskey and Selden (1998) indicated that, the ADF regressions should not include any linear trend, because the intercept itself already acts as a trend and power is lost in the case of a limited sample. To the contrary, Hansen and King (1996) argued that the time trend is evident and must be included, to apply the ADF test in its general form. In this paper, unit root tests are performed using equations that incorporate a constant with and without a trend. The non-rejection of the null hypothesis for the unit root indicates that, the series is characterized by a random walk representation (Dickey and Fuller, 1979; Davidson and MacKinnon, 1993).

The findings suggest that, the null hypothesis of a random walk in the series of levels (actual values), when a time trend is included, cannot be rejected in all series (Table 4). Critical values at the 5% level of significance require t-statistics in excess of 3.53 in absolute value for rejection of the null hypothesis (Fuller, 1976, p. 373); here the estimated t-statistics are below 3.53 in absolute values. On the other hand, the null hypothesis of a random walk in the first differences is rejected for all series. That is, the ADF t-statistics on the first difference series when a time trend is included are all in excess of 3.53 in absolute value. These findings suggest that the first differences of all series are stationary. Under the no time-trend specification, an approximate 5% critical value of –2.94 is used and the null hypothesis of a random walk in the level series is not rejected since the test statistics are not greater than the critical values for all series. On the contrary, however, the null hypothesis of a random walk in the first difference series is rejected for urban counties and for non-adjacent counties, but not reject for rural counties and for the adjacent county series. Thus, the first

Table 5. Catching-up hypothesis: Urban versus rural Alabama (Model I).

Rural and urban counties	ADF test	$\hat{\alpha}$		R2	D-W stat.*
1969-1979	-1.369618	0.005082	-0.000694	0.83	1.55
		0.003736	0.000544		
1980-1989	-2.911036	0.000831	-0.000206	0.64	2.38
		0.001507	0.000285		
1990-1999	-3.015105	0.000860	-0.00008	0.69	2.16
		0.001914	0.000363		
2000-2008	-2.601405	-0.000801	0.000190	0.82	1.73
		0.001857	0.000382		
1969-2008	-5.994483*	0.000224	-0.00006	0.68	2.07
		0.000947	0.00004		
Urban and rural counties	**ADF test**	$\hat{\alpha}$	$\hat{\beta}$	**R2**	**D-W stat**
1969-1979	-1.365668	-0.005048	0.000692	0.83	1.55
		0.003728	0.000542		
1980-1989	-2.927745	-0.00909	0.000225	0.64	2.19
		0.001482	0.000281		
1990-1999	-3.110268	-0.000968	0.000114	0.69	2.17
		0.001740	0.000327		
2000-2008	-2.611309	0.000626	-0.000148	0.81	1.73
		0.001884	0.000390		
1969-2008	-6.013429*	-0.000219	0.000061	0.68	2.08
		0.000926	0.000039		

*The estimated D-W statistics are ranging from 1.55 to 2.38, indicating no autocorrelation problems.

differences of urban and non-adjacent rural county series under the no time-trend specification are stationary while the series for rural and adjacent county series are non-stationary.

On the basis of the above unit root tests, cointegration analysis is conducted to test for long-run relationship in the real wage series. The analysis employs Equation 5, estimated using the stationary series, with an intercept and a time trend. Following Bentzen (2003), cointegration tests are conducted which provides estimation of the relationship between the group average series for rural counties and group average series for urban counties (rural-urban) and vice versa (Model I). In addition, the proximity hypothesis is tested by estimating the group average series for urban counties and group average series for adjacent counties (urban-adjacent) and vice versa (Model II); and the group average series for urban counties and group average series for non-adjacent counties (urban-nonadjacent) and vice versa (Model III). The results are reported in Tables 5 and 6[8].

First, among rural-urban regions (Table 5), the unit root hypothesis is not rejected in all sub-periods, implying that, the group average real wage series in Alabama's rural and urban counties are driven by separate stochastic trends within the sub-periods and hence, diverge within the ten-year time periods. Similarly, the unit root hypothesis is not rejected for urban-rural regions; implying the absence of long-run relationship between rural-urban and urban-rural average, real wage series within the different sub-periods. On the contrary, the unit root hypothesis is rejected for both rural-urban and urban-rural regions over the entire study period, 1969 to 2008; and the intercept terms are not statistically different from zero, indicating that differences in average real wages between Alabama's rural and urban counties vanished over time, as the time trend is most likely zero. These results reveal the presence of a long-run relationship between rural-Urban and Urban-rural average real wage series, over the entire period studied. The general conclusion here is evidence of divergence within the different sub-periods and the presence of a long-run relationship over the 37-year period.

The results for the proximity phenomenon (Models II and III) are somewhat similar to the rural-urban findings (Model I). As shown in Table 6, we fail to reject the unit root hypothesis for both urban-adjacent and urban-non-adjacent series for all sub-periods, with the exception of the 1980 to 1989 sub-periods, under the urban-nonadjacent category. This implies that, the group averages of urban and adjacent (non-adjacent) counties are driven by separate stochastic trends, and hence, diverged over time. As previously, the unit root hypothesis is rejected for both urban-adjacent and Urban-Nonadjacent counties for the entire study period, 1969 to 2008; and the intercept terms for the entire period are not statistically different from zero, indicating that differences in average real wages between urban and adjacent (non-adjacent) counties vanished over time as the time trend is most likely zero. These results imply the presence of a long-run relationship between urban-adjacent and urban-non-adjacent average real wage series over the entire period and within the 1980 to 1989 sub-period under the Urban-Non-adjacent category.

Thus, the general conclusion here is that, while there is no strong evidence that proximity to urban areas influences the transition from low wages to high wages in the short-run (10 years), there is statistically significant evidence suggesting that, in the long-run (37 years), proximity to urbanized areas has an effect on transition from low to high wage for rural workers in Alabama.

[8] The number of rural and urban counties has changed across different census periods, so the data are organized into ten-year sub-periods that closely reflect the ten-year U.S. Census periods.

Table 6. Catching-up hypothesis: Urban versus adjacent and non-adjacent Alabama Counties.

Urban and adjacent Counties Model II	ADF test	$\hat{\alpha}$	$\hat{\beta}$	R2	D-W stat.*
1969-1979	-2.443	-0.0110	0.0016	0.84	1.44
		0.0060	0.0009		
1980-1989	-2.340	0.0022	0.0000	0.52	1.91
		0.0044	0.0008		
1990-1999	-2.083	-0.0009	-0.0008	0.78	2.01
		0.0035	0.0009		
2000-2008	-1.978	0.0025	-0.0007	0.66	2.12
		0.0041	0.0009		
1969-2008	-4.219**	0.0002	0.0000	0.47	2.06
		0.00040	0.00002		
Urban and non-adjacent counties Model III	**ADF test**	$\hat{\alpha}$	$\hat{\beta}$	**R2**	**D-W stat**
1969-1979	-0.545	-0.0134	0.0015	0.97	1.80
		0.0302	0.0042		
1980-1989	-3.628*	0.0038	-0.0005	0.76	2.18
		0.0065	0.0012		
1990-1999	-2.102	-0.0035	0.0001	0.46	2.22
		0.0093	0.0018		
2000-2008	-2.147	0.0075	0.0001	0.68	1.99
		0.0092	0.0016		
1969-2008	-4.165*	-0.0008	0.0001	0.47	2.06
		0.0014	0.0001		

*The estimated D-W statistics are ranging from 1.55 to 2.38, indicating no autocorrelation problems.

Table 7. Alabama labor market indicators.

Years	1990	1991	1992
CV of wages	0.189	0.190	0.191
Unemployment rate	6.9	7.2	7.4
Proportion of farm employment	31.2	31.5	31.5
Rural population	30.8	30.6	30.5

Source: REIS, 2006.

DISCUSSION AND CONCLUSION

The focus of this paper was the widening wage gap between Alabama's rural and urban counties. The paper draws on the neo-classical theory which states that if wage earnings are higher in urban regions, labor will migrate from rural to urban regions. As a result, labor will become more scarce in the rural region and abundant in the urban region, triggering an upward and downward movement of wage earnings in rural and urban regions, respectively. To test this theory, two overriding objectives were delineated to examine the disparities in real wages across Alabama's urban and rural counties; and to examine whether a rural county's adjacency to urban areas has an effect on transition from low to high wages for rural workers. The analysis employed county-level data from 1969 through 2008, which were analyzed using both cross-section and time series-techniques, which included dynamic correlation analysis to study the short-run responses; coefficient of variation to determine the presence or otherwise, of sigma convergence and cointegration test, to study the long-run relationships.

The dynamic correlation results did not support the convergence hypothesis, but rather a pattern of fluctuating coherence. Similarly, while Sigma convergence results revealed signs of convergence over the 37-year period, the observed Sigma convergence in non-linear over time. In several periods, particularly 1989 to 1992, which includes a recession[9], there were signs of Sigma divergence in real wages. One interesting observation is that, the estimated CV during the periods of Sigma divergence, reveals correlation patterns with some other indicators of Alabama's labor market dynamics (Table 7). Particularly, the rate of unemployment and the proportion of the working population employed in the farm sector follow the same pattern as the estimated CV of real wages.

There was also evidence (based on the CV estimates) to suggest that, adjacency to urban areas has no effect on the transition from low wages to high wages for rural

[9] The period corresponds with the 1990-91 recession, which is perhaps the most regionally distinct of the three most recent recessions.

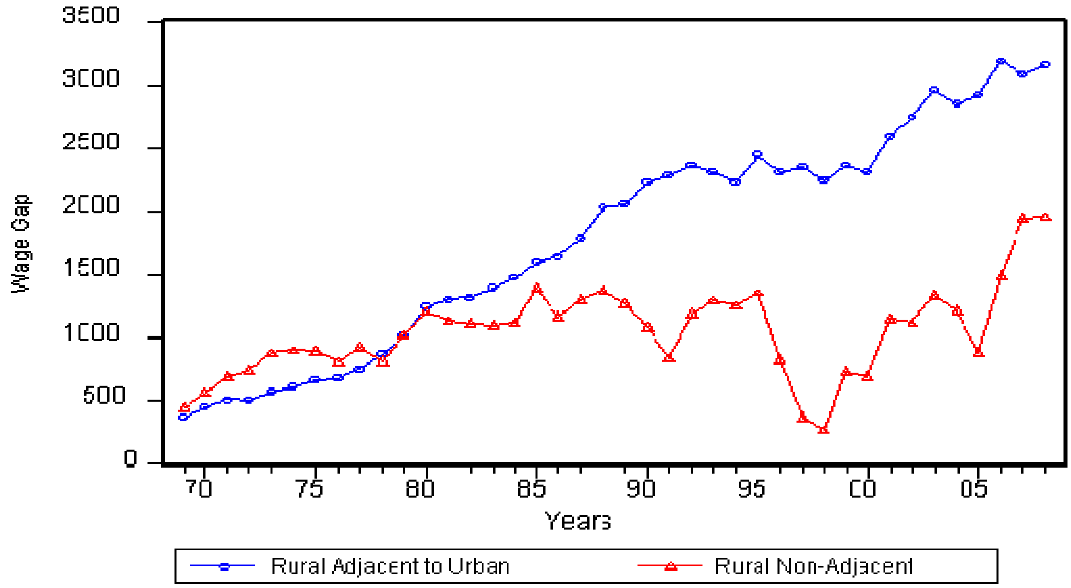

Figure 5. Estimated real wage differences: Adjacent versus non-adjacent counties, 1969-2008.

workers in Alabama. This finding is supported further by the data in Figure 5, which offers a more nuanced representation, contrasting wage disparities between urban and adjacent (versus non-adjacent) counties in Alabama. The figure plots estimates of the differences in average real wages between Alabama's urban counties and adjacent (non-adjacent) rural counties.

The observed trends suggest that compared to adjacent counties, real wage disparities were greater in non-adjacent counties up until 1977, after which the wage gap equalized in both regions for a while (1978 to 1980). Starting in 1981 through 2008, the roles were reversed and average real wage disparities grew faster in adjacent counties compared to non-adjacent counties. This reversal in trends was sparked off by the 1980 to 1982 recession, which as noted before, was one of the worst since the 1930s. Lastly, time series (stationarity test) results are also ambivalent, suggesting evidence of divergence within the different sub-periods and the presence of a long-run relationship over the 37-year period. The observed weak relationship between cross-section and time-series results is not unexpected. For time-series analysis, it has been documented in the literature (Baffes and Ajwad, 1998; Hamilton, 1994; Bukenya and Labys, 2000) that conventional stationarity tests exhibit low power and may give misleading results, regarding the true degree of cointegration.

Overall, while disparities in real wages across Alabama regions have declined over time, the findings do not confirm the convergence hypothesis within the different sub-periods, but rather patterns of fluctuating coherence. Similarly, the proximity hypothesis is rejected suggesting that rural workers residing in counties that are contiguous to urban areas have not benefited from the potential spillover effect. Numerous theories have been proposed to explain why some regions achieve significantly higher growth rates than others, with particular emphasis on the role of initial conditions, the potential for innovation and knowledge spillovers, human capital endowments, capital labor ratio, the composition of economic activity and structural changes among others (Porter, 1990; Glaeser et al., 1992; Barro and Sala-i-Martin, 1995; Venables, 1996; Henderson, 1997; Fujita et al., 1999). In closing this discussion, further research is needed on wage disparities and convergence, using different variables such as gender, race, education, and other demographics, that may influence the presence or lack of convergence. Such work can combine up-to-date time-series and cross-section data, to shed more light on interregional wages in Alabama. Further research is also necessary to look at the effects due to the recent economic downturn.

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