Economic Integration and the Appalachian Experience in the Rust Belt–Sun Belt Transition

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Economic Integration and the Appalachian Experience in the Rust Belt-Sun Belt Transition

By Autumn C. James and Ryan D. James

For a number of decades, Appalachia has been a region that has lacked the growth and development that neighboring regions have experienced. Interestingly, in the past thirty years, as investment relocated during the Rust Belt-Sun Belt Transition, evidence of Appalachian integration into the national economy has begun to emerge. This inclusion, however, is generally confined to Northern and Southern Appalachia, and is not fully understood. To explore the nature of this integration, this paper uses geographic visualization and a two-way ANOVA on capital, labor, and technology measures. Results indicate that Appalachian counties continued to lag in these neoclassical factors of growth when compared to non-Appalachian, Rust Belt, or Sun Belt counties, though the Appalachian lag effect lessened over time.

Introduction

Historically, Appalachia has been physically, socially, and economically dissimilar from the remainder of the United States (Moore 2005; Raitz and Ulack 1984). It is often characterized by high poverty and unemployment rates, low per capita income, and poor educational attainment, placing it in contrast to other, more centrally important, regional economies (Bradshaw 1992). With this contrast, Appalachia has typically been framed in a core-periphery relationship with the rest of the nation (Moore 1994, 2005). In this role, Appalachia supplies raw materials and low-cost labor to more integrated regions, while its development lags. Necessary development factors remain stunted due to lack of capital inflow (Santopietro 2002) and an underdeveloped infrastructure (Hansen 1966; Moore 1994; Ghirmay 2014). Compounding these problems is a dependency on economic decisions made in core economies. These challenges are well known, and numerous development programs, notably the Appalachian Development Highway System

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(ADHS) and the Appalachian Regional Commission's (ARC) growth centers, have attempted to raise these levels to jump-start Appalachian progress (Isserman 1996; Moore 1994).

The impact of these programs has been difficult to assess (Isserman 1996; Hicks 2014). Boundary problems may be a potential cause of this difficulty, as the underlying heterogeneity of Appalachia has led to inconsistent definitions (Raitz and Ulack 1984), causing confusion in discussions of the region (Cooper, Knotts, and Elders 2011). As Appalachian definitions can be drawn around economic, cultural, or physiographic lines (Raitz and Ulack 1984), it is difficult to assess the impact of a specific policy if the study area is ambiguous. Appalachian Regional Commission definitions offer some remedy, as they are broadly based. Yet, the influence of cultural identity on local economic development in the region, coupled with the known problems along ARC boundaries, leads even these bounds to be questioned (Strickland 1999; Weaver and Holtkamp 2016). Compounding the boundary problem, Northern and Southern Appalachia overlap with the Rust Belt and Sun Belt vernacular regions (Tabb 1984). Rust Belt decline, rapid Sun Belt growth, and a spatially similar process in Appalachia (Moore 1994) present an interesting regional overlap problem suggesting Appalachia may have been subject to multiple regional growth processes. Regional boundary and definition problems are known to influence spatial development patterns (Friedman 1966), yet no studies on this have been undertaken for Appalachia.

A second explanation may come from economic development theory. There is evidence of multiple economic processes occurring simultaneously in Appalachia. While Appalachia has traditionally been understood in a core-periphery framework (Meyer 1983; Moore 1994), this framework has been far from uniform. Moore (1994) noted three different Appalachian peripheries through 1990. Northern Appalachia was characterized by higher levels of income and industrialization coupled with slow growth, Southern Appalachia experienced rapid growth in income and industrialization, while Central Appalachia remained mired in sustained poverty and underdevelopment. This spatial pattern of growth mirrors the larger neoclassically driven Rust Belt-Sun Belt Transition of the late twentieth century (Bishop, Formby, and Thistle 1992; James 2010). Evidence suggests that by 2010, Northern and Southern Appalachia began integration into the national neoclassical economy and were subject to neoclassical processes, while Central Appalachian integration remained incomplete (Ghirmay 2014; Gebremariam, Gebremedhin, and Schaeffer 2011; James and James 2015). If the Appalachian economy began neoclassical integration over the last twenty years, an uneven impact of development policy would not be unexpected. This argument is relatively unexplored, as James and

James (2015) are the only authors to argue for integration of Northern and Southern Appalachia into the neoclassical economy. Ghirmay (2014) and James and James (2015) find Central Appalachian integration incomplete. Gebremariam, Gebremedhin, and Schaeffer (2011) find support of neoclassical processes within Appalachia, but do not address integration. How the theorized integration process occurred is unexplored in any of these papers. With evidence pointing toward Northern and Southern Appalachian integration, and the potential for a regionalized growth process in Appalachia, additional work examining the integration process is warranted.

To more fully explore the nature of this integration, this paper extends the work of James and James (2015) to an earlier time period, 1970–2000, to more closely examine the Appalachian experience in the Rust Belt-Sun Belt Transition. The neoclassical model is deconstructed into measures of capital, labor, and income, and those factors are examined in Rust Belt and Sun Belt states that overlap Appalachia. This analysis will answer the following research questions: (1) Are there differences in the factors behind neoclassical growth between Appalachian and non-Appalachian counties in the Rust Belt and Sun Belt regions?; (2) Did those differences diminish over time, if present?; and (3) To what extent did Appalachian counties mirror the changes in capital, labor, and income endowment in non-Appalachian counties as the Rust Belt-Sun Belt Transition occurred? These questions will address the research objective of assessing the participation of Northern and Southern Appalachia in the Rust Belt-Sun Belt Transition. In turn, this provides a depiction of the mechanics of Northern and Southern Appalachian integration into the national economy proposed by James and James (2015).

Background

Neoclassical Growth and the Rust Belt-Sun Belt Transition

There are a number of regional growth theories, each with its own unique interpretation, emphasis, and drawbacks. For example, Economic Base Theory explains local growth processes, but fails to generate a unified picture of growth (Malizia and Feser 1999). While Economic Base remains popular (Tiebout 1962), the response to that deficiency helped develop the exogenous Solow-Swan (broadly, neoclassical) model, a prominent approach in development research for decades (Solow 1956, 1994; Swan 1956; Romer 1994). In exogenous growth theory, growth is a function of local endowments and utilization of capital, labor, and an external technological component (Solow 1956; Swan 1956). With assumed diminishing returns to capital, constant returns to scale, ubiquitous access to technology, marginal decisions of firms, and barrier-free flows of capital and labor, cross-regional flows of capital and income are expected. This produces a convergence of

regional incomes and productivity (Barro and Sala-i-Martin 1992; Baumol 1986).

Traditionally, capital describes structures and machinery available for use in production (Barro and Sala-i-Martin 2004; Malizia and Feser 1999). With diminishing returns, the most productive units are used first. Therefore, the potential for greatest returns are in capital-poor locations. Capital endowment can be measured through per capita gross domestic product (GDP) or per capita personal income (PCPI), as high levels are the result of capital availability and utilization. As such, regions of high wages are regions of large capital endowment and utilization (Barro and Sala-i-Martin 2004). Capital can be extended to public capital, such as highways, and human capital aspects, such as labor skills (Barro and Sala-i-Martin 1992, 2004; Mankiw, Romer, and Weil 1992; Shioji 2001). When human capital benefits are included, exogenous growth becomes endogenous growth (also neoclassical).

In endogenous growth, the role of labor becomes more complicated. In exogenous models, labor availability and growth are key concerns. Similar to capital, labor is necessary for economic activity, and has diminishing returns in exogenous models (Barro and Sala-i-Martin 2004). In endogenous approaches, human capital links capital and labor (Lucas 1988; Pack 1994; Romer 1986, 1994, 1996). While labor availability remains important, labor skills are what drive productive capacity. With a concentration of skilled labor, according to Romer (1986) and Lucas (1988), new ideas and technologies are generated that are more easily adopted in the host economy. The production function of the innovating region then gets reset before others, allowing for sustained growth and avoidance of top-down convergence. While high wages are associated with skilled labor, they are also correlated with physical capital, and thus a poor measure of labor skills. Rather, education level has been argued to better capture labor skills (Mathur 1999).

In exogenous models, technology is assumed ubiquitous, while the endogenous model assumes unequal access and diffusion (Malizia and Feser 1999). Regional connectivity is central to diffusion, which allows for capital and technology to flow freely. This assumption has not historically been met, as transportation access has been unequal, even in developed regions. Further, regional connectivity is a known factor in site selection processes (Hayter 1997). With unequal connectivity, only connected regions would be viable to receive investment. This led to many policies aimed at "opening up" isolated regions, such as the Appalachian Development Highway System (Wood 2001).

The neoclassical framework can explain the capital relocation in the United States known as the Rust Belt-Sun Belt Transition. In the nineteenth century through the mid-twentieth century, capital, labor, and wealth were

centered around the Great Lakes and Ohio River, a region with demand for raw materials to supply large metalworking and engineering industries (Krugman 1991). The growth of these industries led to product diversification and branch plants producing standardized products for growing regional markets (Moriarty 1991). As Rust Belt capital aged, industries began to relocate to places of greater productivity and efficiency (Michimi and Berentsen 2008). Increases in import competition, communication, and manufacturing technology led to the restructuring of investment away from colder climates with inflexible, expensive workforces (Crandall 1986; Essletzbichler 2004). Concentration was placed on geographic diversification allowing for regional differences in function to provide maximum returns on capital, a largely neoclassical result (Moriarty 1991).

Southern and western locations became attractive due to lower taxes, wages, energy costs, non-union work environments, and an increased connectivity, allowing them to receive investment (Crandall 1986; Florida 1996; Michimi and Berentsen 2008). The Civil Rights Movement further opened the region while northern cities experienced increased racial tension (High 1997). Southern locations received relocating capital, a large influx of workers, and retirees, thus expanding demand for non-basic production (Michimi and Berentsen 2008; Suarez-Villa 2002). The end result was a relocation of low-skill industries chasing low wages coupled with semi-skilled labor serving growing markets (Tabb 1984).

A classic example of this process comes from the automobile industry. In the early twentieth century, it concentrated around the Great Lakes for automobile and component part production (Rubenstein 1992). This location offered advantages through a concentration of labor, access to raw materials, physical infrastructure, and market proximity (Rubenstein 1988), minimizing the standard concern of transportation costs (Hayter 1997). Costs were further minimized though vertical integration and Fordist-style production (Rubenstein 2001). However, in conjunction with the southern migration of population, and the development of Just-in-Time production, Rust Belt cost advantages diminished (Rubenstein 1988, 2001). These changes led to a concentration of plants in Appalachian Alabama, Tennessee, Georgia, and South Carolina, and a presence in Appalachian Ohio and Pennsylvania (Rubenstein 2010). This follows Park and Wheeler (1983), who noted the attractiveness of Appalachian northern Georgia for branch plants supplying the growing Atlanta market, due to semi-skilled labor force, market proximity, and low wages. In fact, the poverty of Appalachia has been presented as a comparative advantage, as low competition in hiring minimizes labor costs (Galston and Baehler 1995).

This economic change began in Rust Belt states, stretching between the Appalachian Mountains and the Mississippi River north of the Ohio River

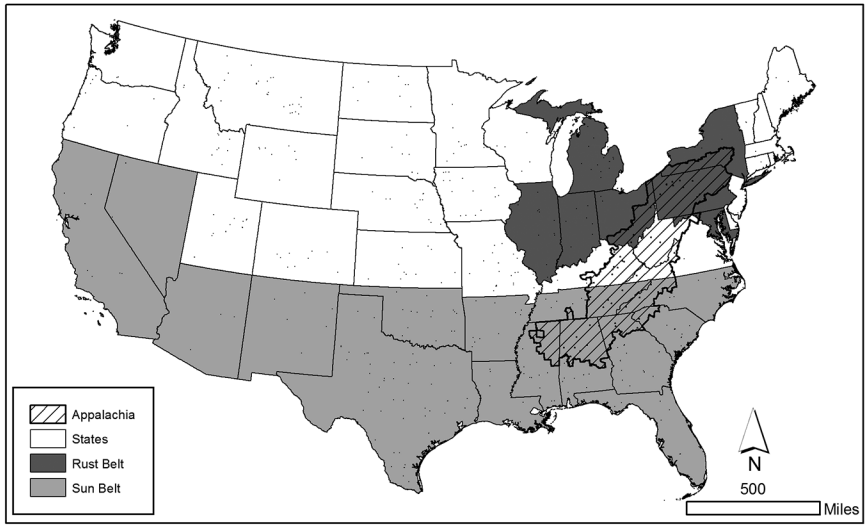
(Shortridge 1989). As a vernacular region (Zelinsky 1980), this definition draws from a shared, spontaneous image of territorial reality in ordinary people (High 1997). Similarly vernacular, the Sun Belt includes North Carolina, South Carolina, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas, as well as New Mexico, Arizona, California and Nevada (Browning and Gesler 1979). Both regions overlap Appalachia. Appalachia shared many economic characteristics with the South (low physical and human capital, low wages, low connectivity) (Moore 1994), yet northern capital sidestepped Central Appalachia for the more distant Sun Belt, and Southern Appalachia. This would be suggestive of Appalachian exclusion, or at least incomplete participation, in the larger neoclassically driven relocation.

Appalachian Growth

As defined by the ARC, Appalachia (fig. 1) extends from southern New York to northern Mississippi, including portions of Tennessee, West Virginia, North Carolina, Pennsylvania, Kentucky, South Carolina, Ohio, Virginia, Georgia, Alabama, and Maryland. Within these thirteen states, there are 420 counties, which range from metropolitan to rural mountain locations. Appalachian overlap with the Rust Belt and Sun Belt is noted in figure 1.

A onetime hub for mining, forestry, and agriculture, Appalachia is a contradiction, having rich natural resources, yet widespread poverty

Figure 1: The Rust Belt, Sun Belt, and Appalachia.



(Rothblatt 1971). Once one of the most self-sufficient regions of the United States, it became one of the least self-sufficient (Salstrom 1994). Since World War II, Appalachia has been isolated from much of the development that has spread throughout the United States. Isolation has been theorized to have created a lagging region, where both urban and rural Appalachia lag behind their non-Appalachian counterparts (Moore 2005). Although some Appalachian urban economies have made gains, rural areas have generally not (Glasmeier and Farrigan 2003). Given dependence on primary sector activities, coupled with its noted lag, Appalachian growth has typically been explored through a core-periphery framework (Moore 1994), where Appalachia is a dependent region, serving as a resource supplier and subject to external economic decisions (Friedmann 1966).

As postulated by Friedmann (1966), core-periphery development occurs in three stages, leading to sustained uneven development. In Stage One, urban core economies grow and diverge from rural peripheries. The peripheries supply resources and labor that are utilized for higher-value production in the urban core. In Stage Two, peripheral economies grow as demand for their resources in the core economies grows. Here, a convergence occurs, though peripheral dependence on core demand and decisions remains. Stage Three is one of divergence and sustained uneven development. As core economies become increasingly knowledge- and service-oriented, they become tied to other core economies, and demand for the peripheral supplied resources shrinks. Peripheral economies then diverge from core economies, leading to uneven development. As this stage continues, peripheral economies face many challenges. Primary industries are increasingly marginal nationally, so an extractive base is increasingly less viable (Galston and Baehler 1995). Additionally, the lack of existing capital in these locations and leakages due to outside ownership make growth without policy intervention quite difficult (Galston and Baehler 1995; Power 1996).

Connecting this model to Appalachia is not unreasonable. With its resource endowment and image of the eastern Kentucky coal economy defining the region (Moore 1991), this connection becomes easier. Yet, the extractive economy comprises only a part of a complex Appalachian economy (Newman 1972), and therefore this theory requires nuance in interpretation and application (Moore 1994; James and James 2015). For example, the boom-and-bust structure of the mining industry has failed to provide sustained growth to the region (Santopietro 2002). Further, this peripheral experience is not uniform, as Moore's three peripheries (1994, 2005) describe an industrialized and comparatively wealthy Northern Appalachia, persistently lagging Central Appalachia, and rapidly growing Southern Appalachia. Conversely, James and James (2015) found this to be suggestive of neoclassical growth, as it follows the spatial pattern of investment change

that dominated the latter twentieth century. Though stopping short of tying this to the Rust Belt-Sun Belt Transition, other authors describe a national convergence process that places Northern Appalachia in a northern (Rust Belt overlapping) convergence club (Lim 2016) and Southern Appalachia in a southern convergence club (Sun Belt overlapping) (James 2010; Lim 2016) during similar time periods. Placement in these convergence clubs indicates similarity in economic structure to larger Rust Belt and Sun Belt regions, suggesting integration earlier than James and James (2015) found.

Even with this suggested integration, the process has not been smooth. Billings and Tickamyer (1993) describe Northern Appalachia engaged in Rust Belt manufacturing processes, Southern Appalachia developing and following New South patterns, and Central Appalachia remaining on the periphery, even when compared to non-Appalachian counties in the same states. Following New South patterns, rural Southern Appalachia lags when compared to its urban counterparts (Billings and Tickamyer 1993). This reinforces Whisnant's (1980) argument that Appalachian development problems stemmed from the singular purpose in integrative connections made. Historically, this meant integration as a peripheral resource supplier. As Northern and Southern Appalachia continued integration, they became low-cost manufacturing centers (ARC 2010); while a neoclassically driven process, it reinforces the Appalachian power disparity. That Appalachia attracted firms due to its labor market advantages of poverty and poorly developed human capital supports this idea (Billings and Tickamyer 1993; Galston and Baehler 1995). This power disparity allows Appalachia to be considered a domestic colony (Billings and Tickamyer 1993). Here, the region is thoroughly dominated economically and politically by outside sources through absentee property ownership and unbalanced tax, investment, and political structures (Billings and Tickamyer 1993). These factors reinforce the peripheral role by instilling feelings of powerlessness among Appalachian populations (Gaventa 1980).

Evidence of economic integration outside of Central Appalachia should not be surprising, as overcoming isolation, developing human and physical capital, economic diversification, and removing economic dependence drove Appalachian development policy (Higgins and Savoie 1997). The ARC was established in 1965 to help guide development and integration efforts. It was created as a partnership between the federal and thirteen state governments to improve Appalachian conditions (Rothblatt 1971; Pollard 2003). Most funds authorized for the ARC were allocated to highway construction to alleviate the inaccessibility that has prevented development activity, as connectivity is central to labor and capital accessibility (Hansen 1966). It was the goal of the ADHS to open up areas with developmental potential that have been hindered due to lack of access (Munro 1969), concentrate

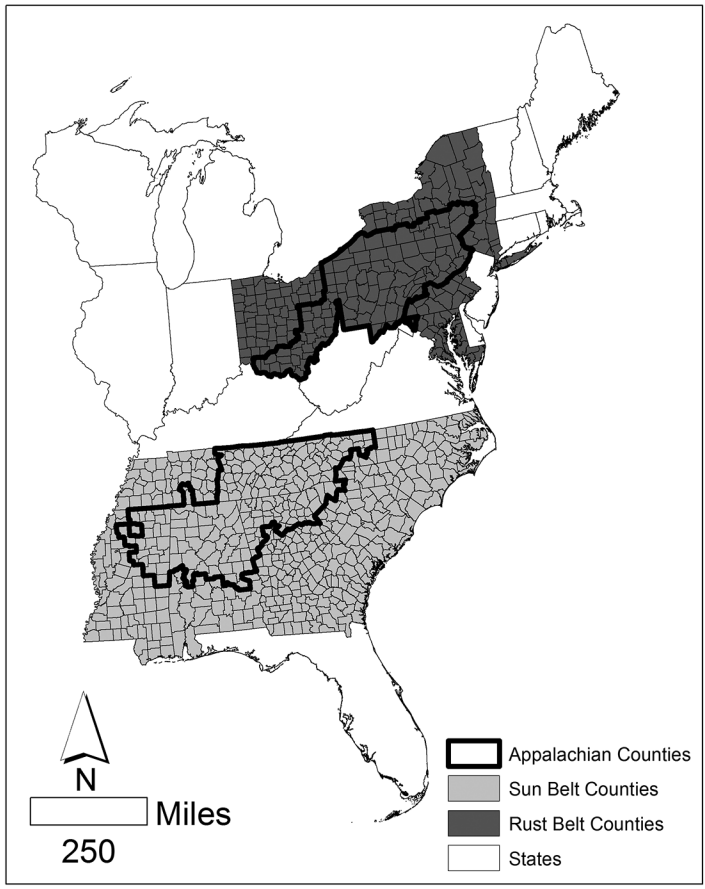
investment in areas where there is significant potential for future growth and high returns to investment to improve regional accessibility (Britt 1971), and remove the locational disadvantages of rural economies (Galston and Baehler 1995).

Taken together, there is evidence of multiple economic growth processes occurring in the United States. A neoclassically driven movement of capital and investment from northern Rust Belt locations to southern Sun Belt locations to maximize returns is well known. At the same time, there is evidence of a long-standing peripheral relationship between Appalachia and the larger neoclassical economy. These economic and regional processes are not as neat as described; there is regional overlap, and evidence of these processes occurring simultaneously in overlapping regions. In what follows, this paper utilizes a two-way analysis of variance (ANOVA) to classify Rust Belt, Sun Belt, and Appalachian counties as either overlapping (Rust Belt Appalachian, Sun Belt Appalachian) or non-overlapping (non-Appalachian Rust Belt, non-Appalachian Sun Belt), and to analyze the difference of means and regional interaction across each classification in three key factors of growth. If the difference of means between Appalachian and non-Appalachian counties decreased, a reduction in peripheral forces in these overlapping counties and a greater degree of integration into the national neoclassical economy are suggested.

Methods

To assess the manner of Appalachian integration into the national, neoclassical economy, the following research questions are answered: (1) Are there differences in the factors behind neoclassical growth between Appalachian and non-Appalachian counties in the Rust Belt and Sun Belt regions?; (2) Did those differences diminish over time, if present?; and (3) To what extent did Appalachian counties mirror the changes in capital, labor, and income endowment in non-Appalachian counties as the Rust Belt-Sun Belt Transition occurred? Data are examined from Appalachian (current definition), Rust Belt, and Sun Belt counties (see fig. 1). Specifically, this paper examines overlapping and non-overlapping Appalachian and Sun Belt counties housed in the states of North Carolina, South Carolina, Georgia, Tennessee, Alabama, Mississippi, Ohio, Maryland, New York, and Pennsylvania (fig. 2). A total of 790 counties are categorized as Appalachian Rust Belt (101 counties), Appalachian Sun Belt (185 counties), non-Appalachian Rust Belt (140 counties) or non-Appalachian Sun Belt (364 counties). This excludes Central Appalachia, historically the least integrated region of Appalachia (Moore 1994; Raitz and Ulack 1984). This exclusion is purposeful for two reasons. First, this paper examines Appalachian integration, and the evidence of Central Appalachia integration is either mixed (James and

Figure 2: Study area.



James 2015) or pointing toward a lack of integration (Ghirmay 2014). Secondly, since this paper examines the performance of Appalachian counties as compared to non-Appalachian counties during the Rust Belt-Sun Belt Transition, only states that had regional overlap were included.

County-level data were collected for 1970 and 2000. These years were chosen to overlap works of Moore (1994) and James and James (2015). Moore (1994) found evidence of core-periphery processes, while James and James (2015) found evidence of neoclassical processes and integration. This study period will provide a picture of the internal dynamics of the process studied previously. Secondly, by overlapping the study period with the Rust Belt-Sun Belt Transition, the influence of this process on Appalachian growth

can be examined. Data related to capital, measured via per capita earnings (wages and supplements), and labor, measured by educational attainment, were gathered from the Bureau of Economic Analysis (BEA) and the National Historic Geographic Information System (NHGIS), respectively. Connectivity data (a form of physical capital), measured through centroid connectivity to completed highways, were obtained from the US Census Bureau. Earnings data were deflated to 1970 constant dollars through use of the Consumer Price Index. Earnings were selected over the traditional PCPI, since James and Campbell (forthcoming) and Rapino, Spaulding, and Hanink (2005) note that earned income is most directly responsible for the convergence and neoclassically driven spatial changes of investment. James and Campbell (forthcoming) further note the growth in importance of earnings in Appalachian development, with unearned income generating unstable impacts.

Once collected, each variable is mapped to explore regional differences. The two-way ANOVA compares means when a grouping variable has subgroups, and will test for regional differences and interaction effects. Here, counties are classified by Appalachian membership, and Rust Belt-Sun Belt membership. This analysis will then allow for a comparison of means across county classification.

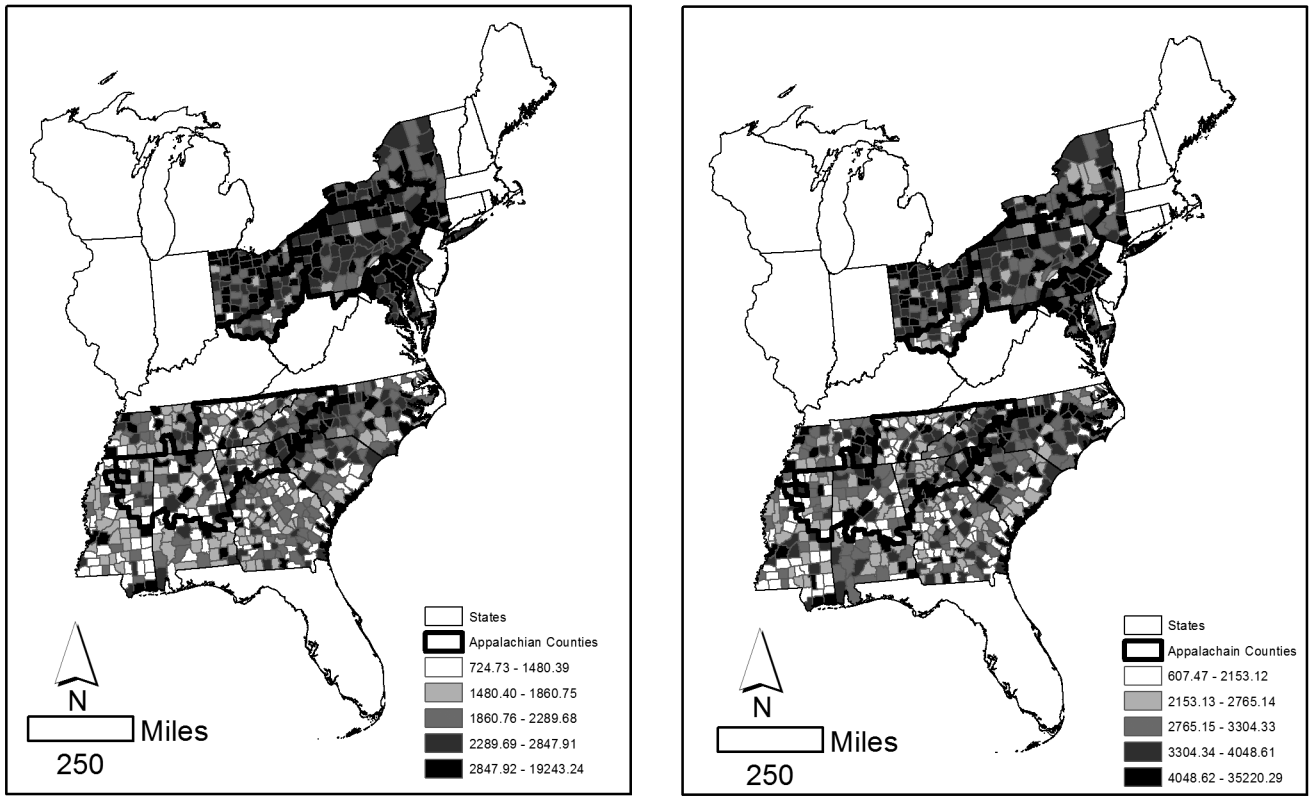
These analyses will provide answers to the research questions. For Question 1, the answers will come from the ANOVA and will be visualized through the mapping for both time periods. Answers to Questions 2 and 3 will come from a comparison of ANOVA results across variables and time.

Results and Discussion

Mapped Results

In figure 3, 1970 and 2000 per capita earnings are mapped, with few conclusions readily apparent. First, there was overall growth in earnings, as noted by the increased values for each classification from 1970 to 2000 (save a slight decrease in the overall minimum value). In 1970, however, there was a noted difference between Rust Belt and Sun Belt earnings indicated by the concentration of the top quintiles in Rust Belt counties. Appalachian differences were more muted. While the top quintile is noticeably more present in non-Appalachian Rust Belt than in Appalachian Rust Belt counties, both Rust Belt categories maintained a noticeable lead on the Sun Belt. While lagging, non-Appalachian Sun Belt counties have a larger presence of the top quintile compared to their Appalachian counterparts, with middle and lower quintiles well represented in both. This inspection would suggest that county-level earnings were separated more by Rust Belt-Sun Belt differences than by Appalachian classification in 1970. By extension, this may suggest that neoclassical effects of capital concentration

Figure 3: 1970 and 2000 per capita earnings.

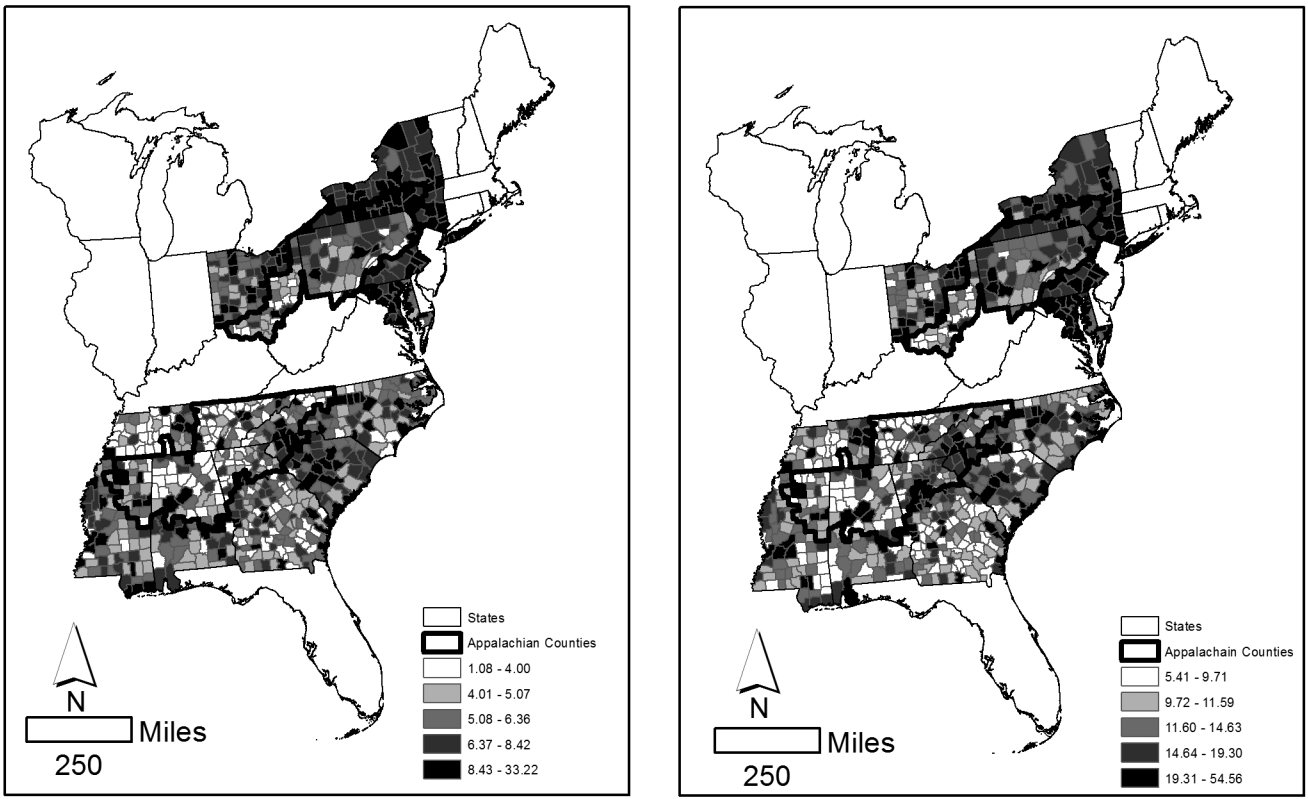


and flows were more powerful than Appalachian peripheral effects, even in 1970. By 2000, Rust Belt-Sun Belt differences were present, though less stark as dominance of the top quintile was reduced. While Appalachian counties grew, comparatively few reached the highest earnings category. Worth noting is the bottom-up effect in Appalachian Sun Belt counties, which make up a smaller portion of the lowest quintile than in 1970. While these patterns would reflect gains in productive output and available capital in Appalachia, they have not fully placed the overlapping Appalachian regions on par with their non-Appalachian counterparts. This suggests Rust Belt top-down convergence was harder in Rust Belt Appalachia, and the Sun Belt bottom-up convergence had a lower ceiling in Sun Belt Appalachia. While Rust Belt and Sun Belt Appalachia were integrated enough to participate in the Rust Belt-Sun Belt Transition, an incomplete integration kept Appalachian economies from being competitive at the highest levels.

Figure 4 displays 1970 and 2000 educational attainment. Similar to earnings, there was an across-region improvement in educational attainment noted by scale increases. Attainment levels in 1970 indicated a Rust Belt and Sun Belt difference, with a concentration of the largest quintile in the Rust Belt. The theorized Appalachian effect is also noted, as in the Rust Belt, the lowest levels of attainment are in the Appalachian counties, a region that also displayed few counties in the highest quintile. In the 1970 Sun Belt, a strong concentration of the lowest quintile in the Appalachian Sun Belt, coupled with few top quintiles reinforces the Appalachian lag. It appears that there were neoclassical Rust Belt-Sun Belt and Appalachian periphery effects influencing human capital distributions in 1970. The integration noted in 1970 earnings is missing in 1970 human capital. This may suggest that 1970 Appalachian earnings were driven by low-skill sectors, reinforcing the peripheral role, or an incomplete integration.

Educational attainment in 2000 increased in all regions, though regionalization remained. While the Rust Belt top quintile concentration diminished, the Sun Belt presence in the quintile was largely urban, such as the Charlotte, North Carolina, or Atlanta, Georgia, functional regions. In 2000 Sun Belt Appalachia, there was a noticeable bottom-up convergence, as counties that were previously in the lowest quintile moved into the middle quintiles. The mere presence of high-attainment counties in Appalachia, coupled with the large number of middle and above quintiles in Appalachia suggests integration. But, comparative scarcity of top quintile counties in Appalachia reinforces the incomplete integration. Appalachian counties were competitive with human capital offerings to rural Sun Belt locations, but not to urban Rust Belt or Sun Belt locations. For example, the agglomeration of human capital in New York City offers the potential for sustained endogenous growth (Romer 1986; James and Moeller 2013). Without these

Figure 4: 1970 and 2000 percentage of populations with a bachelor's degree or higher.



concentrations, the potential for sustained growth to high levels in Appalachia may be stunted, reflecting incomplete integration. Also, the Sun Belt educational convergence was weaker than with earnings. This suggests a more nuanced integration than earnings, albeit a neoclassical one. Since relocating capital seeks to maximize returns, the initial movement is akin to the filtering down associated with the spatial dimensions of the Product Life Cycle (James and Moeller 2013). Here, mature, low-skill industries relocate first, and drive initial development. Accumulated wealth from that investment, such as dividends, interest, and rent (or, in this case, educational attainment) follow, though temporally lagged (James and Campbell, forthcoming). The implication is that the convergence—and, in turn, the integration process—for both Appalachia and the Sun Belt is incomplete.

Distances of county centroids to the nearest interstate highway are mapped for 1970 and 2000 in figure 5. Across both time periods, there is a distinct Rust Belt-Sun Belt difference. Large portions of the Sun Belt were comparatively isolated in both 1970 and 2000, indicated by the concentration of the 61–150 km classification there. Comparatively, few Rust Belt counties were more than 45 km from a highway in 1970 or 2000. The coastal Sun Belt, southern Georgia, and Black Belt counties are particularly poorly connected. Appalachian connectivity is largely consistent with the Rust Belt and Sun Belt counterparts, though poor connectivity remains in southern Ohio, north-central Pennsylvania, and Appalachian Alabama and Mississippi. While this may suggest ADHS success, it is worth noting that the most isolated subregion of Appalachia (Central) is excluded.

Taken together, the mapped variables present an interesting regional analysis. Per capita earnings, human capital, and connectivity all reflect consistently strong Rust Belt-Sun Belt regionalization, while Appalachian regionalization varies across variables. These results would suggest that (1) differences in earnings and human capital availability remain between Appalachian and non-Appalachian counties in the Rust Belt and Sun Belt, while connectivity appears consistent across regions; (2) those differences appear to have diminished over time, suggesting an increasing integration of these Appalachian counties in the Rust Belt-Sun Belt Transition; and (3) the changes in earnings and human capital in these Appalachian counties mirrored the changes in the larger Rust Belt and Sun Belt, though a lower upper limit to earnings and human capital development is noted for Appalachia. The two-way ANOVA will provide more conclusive answers to the research questions of this paper. In all ANOVA analyses, there is one degree of freedom.

For 1970 per capita earnings (table 1), *F*-statistics indicate that Appalachian earnings are different from non-Appalachian county earnings, as are Rust Belt and Sun Belt earnings. When compared to the 1970 earnings map,

Figure 5: 1970 and 2000 distance (km) from county centroid to interstate highway.

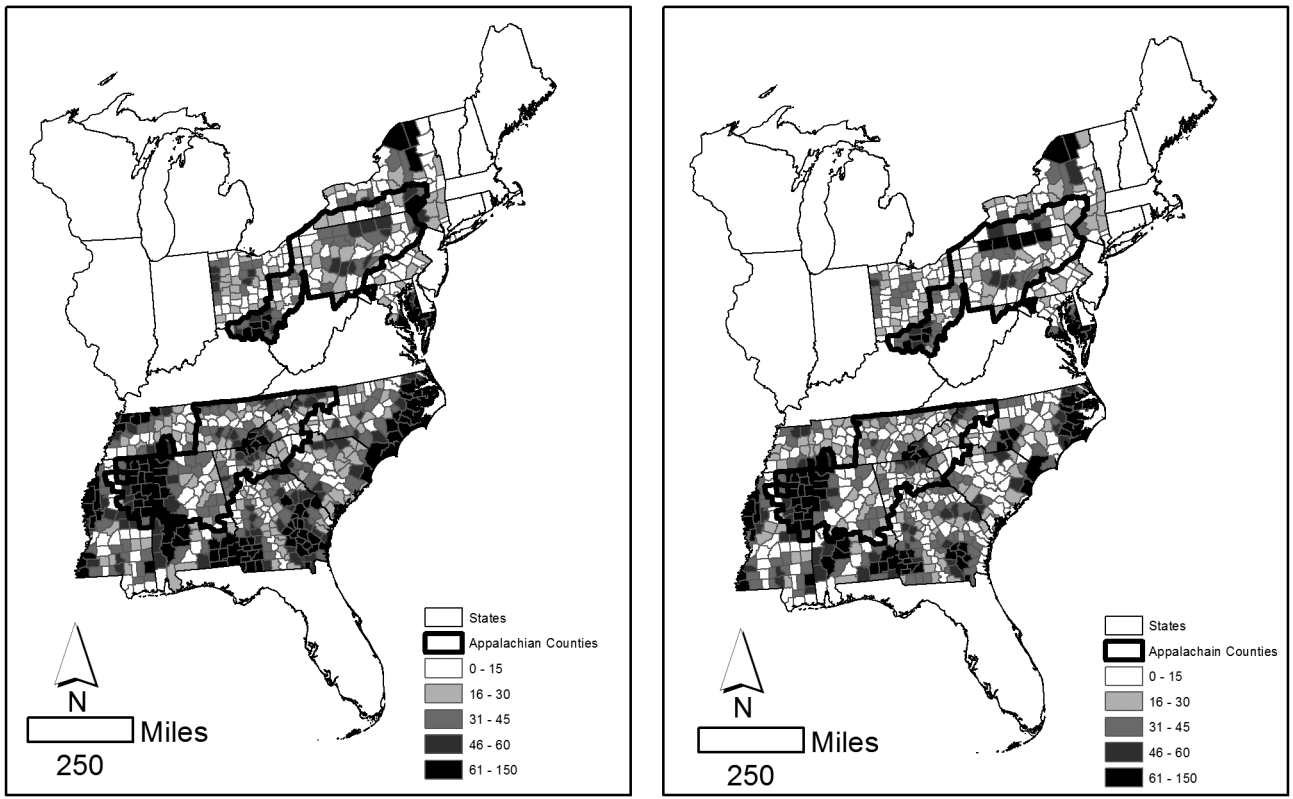


Table 1: 1970 and 2000 per capita earnings ANOVA

	1970			2000		
Earnings	Sum of Squares	Mean Square	*F*-Statistic	Sum of Squares	Mean Square	*F*-Statistic
Rust Belt–Sun Belt	100874200	100874200	103.8*	95422920	95422920	30.02*
Appalachian	14008550	14008550	14.41*	60988220	60988220	19.19*
Interaction	4614836	4614836	4.75*	32544700	32544700	10.24*
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
Rust Belt Non-Appalachian	3001.05	2811.2	1590.93	4321.89	3716.94	3016.58
Rust Belt Appalachian	2533.5	2562.45	629.68	3249.31	3249.06	965.31
Sun Belt Non-Appalachian	2033.42	1859.08	872.99	3093.83	2865.99	1570.76
Sun Belt Appalachian	1906.86	1757.65	721.37	2926.78	2712.6	1153.18

* Significant at 0.05 level.

both Rust Belt classifications outperform their Sun Belt counterparts. Means and medians reinforce that finding, with the Rust Belt leading in both. The *F*-statistics further indicate that differences in earnings between Rust Belt and Sun Belt counties in 1970 were of a greater magnitude than Appalachian and non-Appalachian differences. In 1970, earnings were separated more by Rust Belt-Sun Belt factors than by Appalachian factors. Compounding these regional effects is a significant interaction term. With significant interaction effects, the interpretation of Rust Belt high earnings in figure 3 becomes more nuanced. In Appalachian Rust Belt counties, the Rust Belt advantage is somewhat tempered by Appalachian effects. Appalachian presence did not fully undo Rust Belt effects, as Appalachian Rust Belt counties outperformed both Sun Belt categories. But overall, Appalachian counties lagged behind their non-Appalachian counterparts.

For 2000 earnings, *F*-statistics indicate significant differences based on Rust Belt-Sun Belt and Appalachian classifications. The earnings maps and means show both Rust Belt classifications outperforming their Sun Belt counterparts. Although Rust Belt counties have higher levels of earnings than those of Sun Belt counties, the earnings gap in Sun Belt counties decreased over the study period, and growth across all counties should be noted. Broadly, the Rust Belt-Sun Belt difference continues to be the dominant force, as the *F*-statistic for that regionalization remains the largest.

Surprisingly, the *F*-statistic for Appalachian effects and the interaction term increased. This is an interesting result, suggesting there to be a negative Appalachian effect on growth, reinforcing continued peripheral processes. However, the data may suggest an alternate explanation. When means and standard deviations are compared across regions, a trend emerges. Appalachian earnings have smaller standard deviations than do non-Appalachian earnings, indicating greater dispersion of earnings in non-Appalachian counties than in Appalachian counties. This is exemplified with Rust Belt Appalachia at $965.31, non-Appalachian Rust Belt at $3,016.58, Sun Belt Appalachia at $1,153.18, and non-Appalachian Sun Belt at $1,570.76. Contextualized with the mapped analysis, this makes sense, as the non-Appalachian regions housed more counties and agglomerations in the highest category than did the Appalachian regions. The *F*-statistic, coupled with means and standard deviations, supports this, as the agglomerations of high-earning counties would influence the dispersion of the data, and regional means. This point is furthered when medians are compared to means, as all medians are smaller than means, which reflects the influence of the high-earning counties.

For the 1970 Percentage of Population with a Bachelor's Degree (table 2), there are significant *F*-statistics for both Rust Belt-Sun Belt and Appalachian

Table 2: 1970 and 2000 percentage of population with a bachelor's degree ANOVA

	1970			2000		
Pct Bachelor's Degree	Sum of Squares	Mean Square	*F*-Statistic	Sum of Squares	Mean Square	*F*-Statistic
Rust Belt–Sun Belt	662.6472	662.6472	56.85*	2102.468	2102.468	40.69*
Appalachian	494.4617	494.4617	42.42*	2062.51	2062.51	39.91*
Interaction	99.03242	99.03242	8.5*	1168.878	1168.878	22.62*
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
Rust Belt Non-Appalachian	9.06	7.94	4.15	20.73	18.38	8.86
Rust Belt Appalachian	6.51	5.77	3.61	14.41	13.39	5.89
Sun Belt Non-Appalachian	6.23	5.43	3.29	14.37	11.78	7.23
Sun Belt Appalachian	5.25	4.54	2.87	13.48	11.29	6.28

* Significant at 0.05 level.

effects. In other words, there was a regionalization in human capital in 1970. The means and medians reinforce this supposition, as the top performing Rust Belt non-Appalachian category had a mean of 9.06 and a median of 7.94, which dwarfs the lagging Sun Belt Appalachian categorical mean of 5.23 and median of 5.4. When contextualized with mapped data, and supplemented by the means and standard deviations, this spatially uneven distribution in human capital becomes clearer. Rust Belt counties substantially outperformed Sun Belt counties, and non-Appalachian counties substantially outperformed Appalachian counties. These factors compound with the significant interaction term.

By 2000, these differences in human capital persisted, as *F*-statistics indicated all regionalizations remaining significant. While all regions reflected substantial gains in educational attainment, the significant regional effects remain. On the surface, this would again be suggestive of a lack of integration, though more insight comes from the means and standard deviation. Here, means are largely within one standard deviation of each other, but an interesting pattern emerges when standard deviation ranges are compared. Similar to earnings, the distribution is tighter around the mean for Appalachian counties. The means are slightly larger than medians, reflecting a slight inflation from urban agglomerations in each region. When contextualized with the mapped analysis, it is not that Appalachian counties were strikingly worse-off; rather, there were simply fewer Appalachian counties in the highest categories, even though the middle range values were well represented in Appalachia. In fact, this argument could be extended to any region outside of the non-Appalachian Rust Belt, which has persistently high levels. The concentration of human capital in this region could be indicative of human capital-driven endogenous regional growth, a supposition with some theoretical and empirical support (Gottmann 1957; James and Moeller 2013). The mapped analysis and large standard deviation for the region supports this conclusion, as there are large agglomerations of both human capital and earnings around New York City and Philadelphia, two urban centers in the Megalopolis region (Gottmann 1957). When taken back to Appalachian integration, evidence points toward incomplete integration. Appalachian Rust Belt counties did not transition as successfully into the knowledge economy as did non-Appalachian Rust Belt economies, reflected in the descriptive statistics, mapped data, and agglomeration discussion. The highest quintiles remained concentrated in non-Appalachian Rust Belt counties. However, Appalachian counties are largely on par with Sun Belt, non-Appalachian counties. Rust Belt non-Appalachian effects may be strong enough to skew the Appalachian difference of means test, as the mean values in this classification are comparatively large versus their medians in both 1970 and 2000. With urban non-Appalachian economies at the center of the southern bottom-up convergence club (James 2010;

Lim 2016), an argument can be made that Appalachian human capital was competitive in that region, though Appalachia and the larger Sun Belt may lag against the endogenous economy of the Megalopolis region.

F-statistics for distance to highway in 1970 (table 3) do not indicate differences between Appalachian and non-Appalachian counties, but that Rust Belt and Sun Belt counties are different. The maps of figure 3, along with regional means, support the ANOVA results. Rust Belt counties are closer to highways than Sun Belt counties, and Appalachian classification makes no difference. In fact, the comparatively low median for non-Appalachian Rust Belt counties suggests these counties to be even more connected than the mean would suggest, as it appears to be skewed by a few poorly connected counties. These results are slightly surprising, since Appalachia has been characterized by its isolation. It is important to keep in mind that the South has also been historically characterized by its isolation. While non-Appalachian Rust Belt counties were the most connected, Appalachian Rust Belt counties received attention for highway funding and were relatively well connected, though to a lesser degree. When the interaction term is examined, there appear to be four significantly different categories. This difference is less pronounced than the Rust Belt-Sun Belt difference. This indicates that the difference between Rust Belt Appalachian counties and Rust Belt non-Appalachian counties is large enough to influence this result, even with the more marginal differences of the Sun Belt counties.

Table 3: 1970 and 2000 connectivity ANOVA

Highways	Sum of Squares	Mean Square	*F*-Statistic	Sum of Squares	Mean Square	*F*-Statistic
Rust Belt–Sun Belt	33725.79	33725.79	42.52*	10273.58	10273.58	16.99*
Appalachian	410.96	410.96	0.52	1578.56	1578.56	2.61
Interaction	3104.01	3104.01	3.91*	1328	1328	2.2
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
Rust Belt Non-Appalachian	29.47	15	23.96	27.96	15	22.63
Rust Belt Appalachian	35.5	30	20.32	34	30	21.1
Sun Belt Non-Appalachian	48.46	45	31.16	38.9	30	24.87
Sun Belt Appalachian	45.64	45	28.52	39.16	30	27.09

* Significant at 0.05 level.

The ANOVA *F*-statistics for 2000 do not indicate differences between Appalachian and non-Appalachian counties. However, Rust Belt and Sun Belt counties remain different, though to a lesser extent than in 1970. The maps in figure 4 support this conclusion. Means and medians each decreased from 1970 values. However, there is a notable decrease in the distance of Sun Belt counties by 2000. This decrease indicates a greater degree of highway investment in the Sun Belt, as should be expected given the region's growth. The lack of a significant Appalachian effect is consistent with the 1970 results. This indicates the presence of a thoughtful effort to connect Appalachia to the transportation network. This effort was of greater regional significance than the connection occurring in the Sun Belt. Given the lack of significance of the Appalachian category, the interaction test was not significant. It seems that once the Rust Belt highway density was accounted for, there was no other distinct regional effect. This presents a surprising conclusion, suggesting that while Appalachia did experience growth in earnings and educational attainment, some capital sidestepped the relatively well connected Appalachian region for less connected Sun Belt locations. This would further suggest the possibility of an incomplete integration, where both neoclassical and peripheral processes occurred.

The mapped results and the two-way ANOVA show that 1970–2000 were comparatively positive for the Rust Belt, despite the movement of manufacturing to southern locations. Results overwhelmingly show that Rust Belt counties, Appalachian or non-Appalachian, were consistently ahead in per capita earnings, human capital availability, and connectivity (public capital). However, in the case of earnings, though non-Appalachian Rust Belt counties had highest levels of earnings, the decrease in the gap between Appalachian Rust Belt, Appalachian Sun Belt, and non-Appalachian Sun Belt was quite dramatic. One explanation is that the Rust Belt was the core to the Appalachian and Sun Belt periphery in 1970, with that effect lessening by 2000. In particular, the large standard deviations for non-Appalachian economies, when contextualized with mapped analysis, suggest that while Appalachian counties were on par with non-Appalachian counties in the middle of the distribution, the upper limit for Appalachian earnings was lower than for non-Appalachian earnings. On one hand, the bottom-up convergence would represent a step forward in integration, suggesting Appalachian participation in the Rust Belt-Sun Belt Transition. On the other hand, while the bottom-up convergence helped increase the levels of earnings in Appalachia, the integration is not complete, as clusters of the highest levels of earnings were concentrated outside of the region. In other words, the regional economies that presented opportunities for the largest earnings, and the potential for endogenous growth, had yet to filter into Appalachian economies.

Percentage of persons with a bachelor's degree suggests higher levels of attainment in the Rust Belt, though overall levels increased over the thirty-year period. Nevertheless, categorically, there has been no change. Non-Appalachian Rust Belt counties continue to have the highest levels of human capital, and Appalachian Sun Belt counties remain the most challenged. An Appalachian periphery argument could be made as lower levels of education in Appalachia are reflective of labor skills needed for the peripheral processes. A neoclassical explanation can also be offered, as investment seeks to relocate to maximize marginal returns to capital and labor (Barro and Sala-i-Martin 2004). In that regard, the growth in both the Sun Belt and Appalachian economies would, in part, be influenced by the comparative attractiveness of low-wage, low-skilled labor. As a result, there would be a disincentive for these economies to exhibit the highest concentration of wages and human capital.

Proximity to completed highways showed change from 1970–2000. In 1970, mapped data indicate that Rust Belt counties were the most connected. By 2000, Appalachian Sun Belt counties made accessibility gains, while non-Appalachian Sun Belt counties remain the least connected. The ANOVA results support that conclusion. When comparing back to Appalachian earnings and growth, an interesting pattern emerges. In terms of connectivity, Appalachia does not appear to be as isolated as common perception dictates. This may be due to the implementation of ADHS programs, or that the most isolated locations of Appalachia were not a part of this study area.

These results present an interesting picture of Appalachian growth and incomplete inclusion in the Rust Belt Appalachian counties in terms of connectivity. For human capital and earnings, there is a tale of Appalachian growth and participation in the national, neoclassical economy. But, that inclusion is tempered by the lack of inclusion of Appalachian counties in the economic processes that generate the highest levels of earnings that necessitate the highest levels of human capital. While these effects are present in non-Appalachian Rust Belt counties, they are to a lesser degree in Sun Belt and Appalachian counties. These results produce the following answers to the research questions of this paper: (1) that there are differences in the neoclassical factors of growth between Appalachian and non-Appalachian counties in the Rust Belt and Sun Belt, with public physical capital being on par across regions, with a lagging of Appalachian earnings and availability of human capital; (2) that while there was a growth in earnings and human capital in Appalachia, there was still a distinct Appalachian effect when the highest levels of earnings and human capital were compared; (3) that the changes in neoclassical growth factors in Appalachia mirrored the changes in the larger Rust Belt-Sun Belt Transition, with a rapid growth of human

capital and earnings, but that growth was tempered by a cap in Appalachia on the highest levels.

Conclusion

Appalachia has long been characterized as a peripheral region, serving as a supplier of resources to growing regions while its own development remained stunted. This process was well supported by Friedmann's (1966) description of core-periphery processes, which has long served as the background for academic studies of Appalachian development and the formulation of development policy (Moore 1994; Higgins and Savoie 1997). However, recent evidence (Gebremariam et al. 2011; James and James 2015) suggests a degree of integration into the national economy through the latter part of the twentieth century. While this time frame mirrors a larger movement of capital through the United States, the Rust Belt-Sun Belt Transition, the manner of integration and role of Appalachia in the Rust Belt-Sun Belt Transition has yet to be fully explored. This paper addresses this deficiency by answering the following research questions: (1) Are there differences in the factors behind neoclassical growth between Appalachian and non-Appalachian counties in the Rust Belt and Sun Belt regions?; (2) Did those differences diminish over time, if present?; and (3) To what extent did Appalachian counties mirror the changes in capital, labor, and income endowment in non-Appalachian counties as the Rust Belt-Sun Belt Transition occurred?

Results from geographic visualization and a two-way ANOVA on neoclassical growth factors suggest there to have been rapid growth in Appalachian and Sun Belt earnings and human capital. Appalachian connectivity did not appear stunted even by 1970. These results suggest that the flows of capital and types of growth and earnings would be indicative of inclusion and integration into the national economy, and in turn, the Rust Belt-Sun Belt Transition. However, an important caveat must be placed on this proposed integration. For Appalachian counties, there was a noticeable void of large agglomeration of high levels of earnings and human capital. While the types of capital and development that would occur in a bottom-up converging region, such as Appalachia, would view high levels of earnings and development as a disincentive, it is suggestive of an incomplete inclusion.

Results from the two-way ANOVA reinforced the idea of incomplete integration. Outside of connectivity, significant regional differences remained in both earnings and human capital in 1970 and 2000. Given the large levels of agglomeration of earnings and human capital in non-Appalachian Rust Belt and Sun Belt counties, these differences are not surprising. As a difference of means test, the two-way ANOVA will be sensitive

to means calculations, and the presence of these concentrations will inflate the mean leading to significant differences. With large agglomerations, there remain regional economies that operate in a fundamentally different way than Appalachian economies.

These results offer several areas for future research. First, this paper adds additional insight on how Appalachian capital grew and integrated, where further detail can be gained through more focused local analysis. In particular, through mapping the locational changes of specific firms and surveys on the location conditions attractive to Appalachian firms, this could add further insight in the manner and sectors in which Appalachian locations are competitive for footloose capital. Second, with the noticeable "cap" on Appalachian development, an investigation into the deficiency of human capital and earnings in Appalachian economies would add more insight into this process. In particular, from a policy perspective, understanding how to develop the urban economies in Appalachia to be competitive and connected to the larger system of knowledge-based production would be important. The use of Pittsburgh as an Appalachian case study on the topic would be an interesting example. Finally, this analysis only studied Northern and Southern Appalachia. Further study on the Central Appalachian economic experience is still needed, as even in papers arguing for integration (James and James 2015), a lag in Central Appalachia is noted.

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