

Innovation, entrepreneurship and economic growth in lagging regions

Heather Stephens[†], Mark Partridge[†] and Alessandra Faggian[‡],

August 19, 2011

Abstract. We investigate what factors are linked with growth in rural, remote, and lagging regions. As governments decide how best to spend their resources to promote growth, do proprietors, entrepreneurs, creativity, advanced technology clusters, or university spillovers (or some combination of these factors) play a role in fostering growth in regions with historically low growth rates? Using county-level data, we focus on the Appalachian region of the United States and compare it to the rest of the U.S. Given its low level of human capital and high poverty rate, we examine what is driving growth in this region. Building on previous work, we find that proprietors, along with the related entrepreneurship and creativity factors, are key to increasing growth in the region. However, we find little evidence that having high concentrations of advanced technology industries, being in close proximity to research universities, or even having a highly educated population, aside from the creative class, are supportive of growth in Appalachia.

Keywords: human capital, creative class, entrepreneurship, economic growth, lagging regions

[†]AED Economics. The Ohio State University, Columbus, OH, USA. Partridge email: partridge.27@osu.edu; Stephens email: stephens.177@osu.edu

[‡]School of Geography, University Southampton, and AED Economics, The Ohio State University, email: faggian.1@osu.edu.

An earlier version of this paper was presented at the Tinbergen Institute Conference, Free University, Amsterdam, NL, on May 23-24, 2011 and the 2011 PRSCO meetings in Seoul, Korea. We thank all session participants for helpful comments.

1. Introduction

Governments expend significant resources in trying to promote economic growth in lagging regions, but in most cases with limited success. Providing policymakers with guidance about how best to target their scarce resources is hence of paramount importance. However, in order to do so, a clear understanding of what drives economic growth in these lagging regions is needed. Economic theory does not provide clear guidance when it comes to identifying growth factors in lagging regions – especially if rural and remote. Different governments in different countries have tried various strategies, but is there a ‘best’ policy to support growth in these regions?

Most growth theories are based on the notion that the ‘human factor’ is the real engine of growth. Whether it is in the form of entrepreneurial or innovative skills (Schumpeter 1911); human capital or education (Becker 1964) or creativity (Florida 2002a), the role of the skills of the workforce is undisputed. The ‘human factor’ and the exchange of knowledge – or knowledge spillovers – is also the key to the functioning of high-technology clusters (Marshall 1920; Porter 1998; Crescenzi, et al. 2007). However, as Acs and Kallas (2008) noted, it is unclear how these growth theories apply to regions which are lagging economically and have a low-skilled workforce. How can these theories be applied to regions facing many economic barriers including low population, remoteness from markets and knowledge, and weak institutional arrangements? How can endogenous ‘home-grown’ growth be produced and what are the most important factors?

Rupasingha and Goetz (forthcoming) find that there is a strong, statistically significant relationship between entrepreneurship – measured in terms of proprietors – and growth in U.S. non-metropolitan areas. Stephens and Partridge (forthcoming) found a similar result for the Appalachian region and also found evidence that the positive role of entrepreneurship in supporting growth relates to having a greater share of ‘opportunity entrepreneurs’ –i.e. highly creative and innovative individuals who identify and exploit an opportunity - as opposed to ‘necessity entrepreneurs’ – i.e. individuals who are ‘forced’ to start a business because of a lack of other employment options (Acs 2006).

Our work builds upon the Stephens and Partridge (forthcoming) contribution in two ways. First, it considers whether entrepreneurs in Appalachia are not only creating jobs for themselves but rather

generating broader economic impacts that spill over and result in more wage and salary (W&S) jobs. If, as Low et al. (2005) found, new business formation in rural areas is due to a lack of other job prospects, then there would not be substantial new W&S job creation. Secondly, in our model we test for the importance of other knowledge-based factors, i.e. (1) human capital and “creative workers,” (2) knowledge spillovers and advanced technology clusters, and (3) spillovers originating from university sources. Showing that entrepreneurship generates growth in lagging regions does not necessarily imply that investing in entrepreneurship is the optimal, first-best, strategy. Other strategies, e.g. investing in education or ‘creative’ activities, might have equal or greater economic development payoffs. Indeed, Gülümser et al. (2010) contend that in the past, creativity in rural regions has been mis-measured and its influence underestimated. The paper tests the applicability (or lack thereof) of these economic growth theories to lagging regions.¹

Our empirical results suggest that despite strong barriers to growth in Appalachia, an increase in the share of proprietors appears to be positively related to job growth beyond just proprietors hiring themselves. We find that such strategies are likely to bear more fruit than other “knowledge” strategies such as focusing on attracting highly educated workers and building advanced-technology clusters. Yet, we find a more narrowly conceived effort aimed at attracting creative-class workers may also pay positive dividends. This provides further evidence of the possibility that programs to support entrepreneurship and attract key knowledge workers may be warranted in a lagging region, like Appalachia. Yet, we caution that the costs of such efforts must also be considered in a full policy appraisal.

In what follows, we first describe the literature and theoretical underpinnings of our analysis. We then examine the Appalachian region and how it compares to the rest of the nation on a number of dimensions. Finally, we describe our model and empirical results and make some concluding remarks.

2. Literature Review

Our literature review is organized into four main sections, each considering a potential source of

¹To varying degrees, the Appalachian Regional Commission (ARC) has supported all of these strategies in promoting growth in the region (e.g., see ARC, 2010). The ARC promoted entrepreneurship in Appalachia with its Entrepreneurship Initiative (RURPI, 2008). For examples of studies that suggest entrepreneurial strategies are likely to be successful, see Loveridge and Nizalov (2007) and Deller and McConnon (2009).

growth in lagging regions, i.e., (1) entrepreneurship; (2) human capital and a creative workforce; (3) high-technology clusters; and (4) university spillovers.² We recognize that there are complementarities and overlaps among and across the four categories, but the classification adds clarity to the presentation.

2.1 Entrepreneurship

Schumpeterian theories suggest that entrepreneurial skills are paramount in transforming economies and thus increasing the number of entrepreneurs leads to economic growth (Schumpeter 1911). Consistent with this, Stephens and Partridge (forthcoming) found a link between self-employment and total job growth in Appalachia. However, their results do not distinguish between self-employment stemming out of lack of opportunities, and self-employment of the ‘Schumpeterian’ type where innovative entrepreneurs exploit some latent market opportunities. Previous work by Low et al. (2005) found that entrepreneurship, or business formation, in rural areas may be due to a lack of opportunities. As Acs (2006) suggests, this “entrepreneurship of necessity,” may not necessarily translate into long-term economic growth (or, at best, may mean lower growth than if the self employment was of the Schumpeterian ‘opportunity exploiting’ type).

New business creation has three general effects on the economy: 1) the direct effect of creating jobs, 2) the displacement effect (new businesses take jobs away from existing businesses, such as a new Mexican restaurant causing an existing Mexican restaurant to go out of business); and 3) the induced or indirect (or spillover) effects on other businesses (Fritsch and Mueller, 2004). The direct and indirect effects should increase total employment and the displacement effects should lower total employment. The indirect effects include the entrepreneurs directly hiring W&S workers or ‘multiplier’ effects caused by increases in *total* employment in other firms (including hiring of new W&S workers).

Indirect employment effects in a region are influenced by its characteristics and business climate (Audretsch 2002; Mueller et al. 2008). Spillovers can arise for many reasons including basic input-output links that are likely further magnified with locally-owned businesses spending money in the local area (Fleming and Goetz, forthcoming). Likewise, intangible spillovers can arise when knowledge created by

²We will frequently swap the terms “high technology” and “advanced technology.”

one business “spills over” into the immediate geographic region.³ Audretsch contends that urban areas are best suited to benefit from these spillover effects (also see Shrestha et al. 2007). This pattern is not surprising as spillovers are generally associated with urban agglomeration effects that include larger markets and actors being in close proximity to each other (Puga 2010). However, Monchuk et al. (2009) found that innovative firms can thrive in remote regions, suggesting that agglomeration is not the entire story. Schumpeterian (or opportunity) entrepreneurs are expected to tap into larger markets and benefit from knowledge spillovers and thus we expect that they will create more indirect jobs than necessity entrepreneurs. In examining the impacts of entrepreneurs, it is important to recognize that because the indirect effects may take time to materialize, the full effects from entrepreneurial development may only be realized over the longer term.

“Entrepreneurs of necessity” (Acs 2006) may only provide the positive direct effects from being self-employed (i.e., providing employment for themselves), minus the displacement effects. Reinforcing these weak employment generating effects is the possibility that necessity entrepreneurs may be more likely to fail, which wipes out even the jobs they created for themselves (see Shane 2009 for a related discussion). Thus, if entrepreneurs in the region are predominantly of the necessity type, or there are large displacement effects, then there is no clear link between economic growth and the share of entrepreneurs. Indeed, indirect effects of entrepreneurship may be especially small in a lagging region such as Appalachia because of the lack of Schumpeterian market opportunities or smaller local input-output linkages in this sparse, predominantly rural region.

2.2. Human Capital and Creative Workforce

For many decades, a host of researchers has also explored the link between human capital, usually measured by education, and economic growth (Becker 1964). The underlying premise is that a well-educated workforce will enhance productivity, which then drives economic growth. Likewise, greater high-skilled labor availability may attract businesses and encourage the retention and expansion of

³There is significant research suggesting a link between entrepreneurship and innovation, knowledge spillovers, and economic growth (Acs and Armington 2004; Acs et al. 2009; Audretsch and Keilbach 2004; Beaulieu and Goetz 2007; Deller 2010; Deller and McConnon 2009; Glaeser, et al. 2010; Glaeser 2007; Karlsson et al. 2009; Loveridge and Nizalov 2007; Robbins et al. 2000; Shrestha, et al. 2007).

existing firms. Baptista and Mendonça (2010) found that greater access to human capital is positively linked to more “knowledge based” start ups. In an urban setting, Glaeser et al. (1995), Simon (1998), and Florida et al. (2008) found evidence of a link between human capital and regional economic growth.

The human-capital/growth link is less clear in rural, remote, and lagging regions where the workforce may be less educated. However, Partridge et al. (2008b) found some evidence of a positive relationship between the population share with college education and local growth in U.S. nonmetropolitan counties, though they also find tremendous heterogeneity in these effects. Specifically, they found negative effects in rural areas of the eastern U.S., including in Appalachia. This suggests that human capital theories may not be applicable in this region due to the outmigration of educated workers or “brain drain” and the lack of industries that employ higher-skilled workers.

Using an alternative measure, Richard Florida has led an expanding effort to examine the role that creativity plays in driving economic success (Florida 2002a, 2002b, 2003, Florida et al. 2008). He argues that creative skills, measured by number of workers in creative occupations, are critical to economic growth and has found evidence for this in his analysis of urban areas. Florida et al. (2008) also considered creativity as a measure independent of human capital, suggesting that the two effects do not simply overlap (Comunian et al. 2009). Thus, it is not surprising that Florida et al. (2008, p. 617) concluded that “human capital and the creative class play different but complementary roles in regional development.” Their reasoning is that the creative class increases productivity and human capital increases regional income and wealth, though it is not entirely clear how this distinction arises.

Creative occupations may be able to have a larger influence in nonmetropolitan areas than metropolitan areas because the more specialized knowledge of creative workers can have a bigger marginal impact in thin nonmetropolitan labor markets—while the thicker labor markets in metropolitan areas allow generic human capital to play a stronger role. Consistent with this possibility, McGranahan and Wojan (2007) found that rural growth from 1990 to 2004 was positively associated with creative occupation employment. However, they caution that other factors (such as amenities) are also critical to understanding the effect of creative occupations on rural growth –i.e., areas with more natural amenities

may draw creative individuals out of the cities and lead to growth.⁴

Illustrating that creative workers and entrepreneurship are two different factors, the correlation between the employment share in creative class occupations and the self-employment rate is -0.11 in the Appalachian Regional Commission (ARC) region, suggesting that it may not be the creative individuals who are self-employed *in this region* (or that having more creative workers crowds out local entrepreneurship). Similarly, the correlation between self-employment and the share of college graduates in the region is -0.17. Such a negative correlation could also suggest a smaller share of Schumpeterian entrepreneurs, or that the self-employed in the ARC region are more of the mundane or necessity type.

2.3 Advanced Technology Clusters and Local Growth

Another line of research, which builds on the notion that human capital and entrepreneurship are critical for growth, suggests that “advanced technology” or innovative firms are additional growth factors (Acs et al. 2009; Hart and Acs 2011). Since these are all complimentary –e.g., human capital and entrepreneurship facilitate the formation of innovative firms – we are describing an effect beyond human capital and entrepreneurship, in which there is an added boost to growth when the region has a concentration of high-wage, high-innovation industries. Forming close institutional relationships, including labor market, knowledge, and supply-chain links, may aid in the formation of clusters that could further increase growth (Porter 1998; Porter and Stern 2001; Porter 2003). Thus, endogenous growth could be spurred due to knowledge spillovers and availability of high-skilled workers that are attracted by these clusters (for an earlier view, see Marshall 1920; Lucas 1988). Such endogenous growth is of the ‘Marshall-Arrow-Romer externalities’ type in a dynamic sense (Marshall 1920; Glaeser et al. 1992, 1995; Crescenzi et al. 2007).⁵

One means of measuring innovation is the number of patents or by research and development expenditures. Using these types of measures, there is empirical evidence that local innovation enhances growth (Bauer et al., forthcoming; Rodríguez-Pose 1999; Rodríguez-Pose and Crescenzi 2008).

⁴McGranahan et al. (2010) subsequently found that entrepreneurship is an additional factor that drives rural growth.

⁵Growth could be due to other factors such as urbanization economies where a large diverse metropolitan area with a wide range of firm and household services increases the local labor force and firm productivity. This pattern is further reinforced by close access to large input and customer markets (Glaeser et al., 1992, 1995; Puga, 2010).

Most of the previous research has focused on the advantages that core urban areas have related to innovative industries and clusters. However, Birch (2011) argues that, for lagging regions, there is the possibility that new ideas and people can be “imported” and fresh governance arrangements can be developed to support these innovations and clusters.

At the same time, however, there are those that are skeptical that having high concentrations of high-technology industries or clusters support growth (e.g., Feser, et al. 2008; Duranton et al. 2010; Partridge et al. 2008a). Supporting this pessimistic assessment are the raw employment numbers. They suggest that, while advanced-technology sectors have at times experienced phenomenal growth, their growth has slowed in recent decades. These patterns are consistent with the maturing of many advanced-technology industries.⁶ If many advanced-technology industries are maturing, a product cycle model suggests that advanced-technology firms would seek to relocate assembly jobs and other positions to low-cost peripheral regions, such as Appalachia. Indeed, besides low labor and land costs, rural Appalachian counties may have an abundance of natural amenities that may be particularly attractive for creative and university-educated workers needed to manage such facilities (McGranahan and Wojan 2007; Partridge et al. 2008b; McGranahan et al., 2010). Thus, as so-called advanced technology industries mature, they may contribute to growth in lagging regions (but not in the core).

However, it is not clear that lagging regions such as Appalachia have sufficient capacity in terms of human capital to enable advanced technology firms to thrive. Foremost, despite significantly improved road infrastructure, parts of Appalachia are too remote for many advanced-technology firms. Likewise, even factors such as improved broadband may have limited effects (Kandilov and Renkow 2010), especially since the region also suffers from lower human capital. Rodríguez-Pose and Crescenzi, (2008) suggest that “backward” regions have a difficult time in absorbing innovation due to these type of factors. In fact, Smith and Barkley (1991) found little evidence that nonmetropolitan areas are conducive to supporting high-technology firms, while Dorfman et al. (forthcoming) find that natural amenities do not compensate for other rural barriers in nonmetropolitan areas lacking a city of at least 10,000 people.

⁶Between its peak in March 2001 and August 2010, U.S. national information employment declined 27%, while overall nonfarm employment only declined by 1.8% (Partridge and Olfert, 2011). Likewise, biotechnology employment fell by about 1 percent over the period.

2.4. Universities and Economic Spillovers

There is a rich literature that examines the role of universities related to economic growth. As already indicated, universities play a key role as producers of creative and high human capital that is embodied in their graduates and their staff and that increases productivity. Others have also argued that universities can be a contributor of growth as a source of knowledge spillovers (Anselin et al. 1997).

There is some debate in the literature as to size of these university knowledge spillovers. For example, Woodward et al. (2006) found that proximity to university-led research and development only modestly increases the probability of high-technology firm start-ups, though with distance effects that spread out up to 145 miles. Varga (2000) found stronger university spillover effects when there is a critical mass of high technology firms, while Goldstein and Drucker (2006) contend that general university spillovers are greater in small to medium sized metropolitan areas. In terms of high-technology start-ups, Bania et al. (1993) found that university research facilitates greater university start-ups in some industries, but not others. Likewise, De Silva and McComb (2011) found that proximity to a research university only slightly increases the probability of high-technology start ups, but find no evidence that it affects the survival of new firms. Indeed, given the small size of these spillovers, it is not surprising that Faggian and McCann (2006, 2009) conclude that universities' most favorable influence on *local* growth is as a supplier of human capital and creative workers and less as a source of knowledge spillovers.

3. Theoretical Framework.

The theoretical basis of our analysis builds on endogenous growth theory in the spirit of Romer (1986; 1990) which has been expanded to include human capital and spillovers (Lucas 1988; Acs 2009) and entrepreneurship capital (Braunderhjelm et al. 2010; Audretsch and Keilbach 2004; 2007; Greis and Naude 2010). The model is similar to the one used in Stephens and Partridge (forthcoming) and draws on these endogenous growth theories and standard spatial equilibrium analysis to illustrate the growth of small regional economies (Chen and Partridge forthcoming; Glaeser and Gottlieb 2009). The main features of the model are that net labor supply migration into a region is a positive function of utility in region i relative to the national average level of utility:

$$(1) \Delta L_i^S = \beta_{Si}(V_i - V^{AVG} - M_i), \quad 0 \leq \beta_S \leq 1,$$

where labor migration flows are positively related to the region's relative utility level (V_i) compared to the U.S. national average (V^{AVG}). β_S is the adjustment-speed factor affected by information costs. Migration costs M_i are affected by personal and financial moving costs. Utility is a function of average wages and housing costs, employment probability, and site-specific natural amenities.

More important to our story is the change in labor demand, which is positively related to the profits for the region's representative firm relative to the national average. Specifically, labor demand changes (ΔL^D) are a function of spatial movements and net-expansions of firms (domestic and foreign). These changes are a positive function of profit differentials between the region (π_i) and the national average (π^{AVG}):

$$(2) \Delta L^D_i = \beta_D(\pi_i - \pi^{AVG}), \quad 0 \leq \beta_D \leq 1$$

where β_D is the adjustment-speed factor. Of course, profits are a function of factors that increase own prices and productivity and reduce costs.

When hiring labor, a firm sets the marginal revenue product of each factor equal to the factor's input cost. At the aggregate regional level, this is greatly affected by the representative firm's production function for output Q , which we stylistically represent with a Cobb-Douglas function to illustrate our main points. The literature review pointed to production being a function of the opportunity entrepreneurship (OE) and necessity entrepreneurship rates (NE), human capital (HC), creative class (CC), high-technology industry share (HT), access to a research university (UN), as well as low-skilled labor (L), physical capital (K), and other various control variables that shift production (α). This suggests the following production function:

$$(3) Q_i = \alpha O E^\beta N E^\gamma H C^\delta C C^\epsilon H T^\zeta U N^\eta L^\theta K^\lambda, \quad \alpha, \beta, \gamma, \delta, \epsilon, \zeta, \eta, \theta, \lambda \geq 0$$

The exponents represent the relative productivity contribution of each factor, which we assume is non-negative for now, but actually could be negative (e.g., γ could be negative depending on the effect of NE). We expect that opportunity entrepreneurship is more strongly linked to productivity than necessity entrepreneurship, suggesting that $\beta > \gamma$.

One of our key goals is to understand labor demand. Thus, the production function in equation (3) shows the role that each of these factors play in influencing labor demand by affecting productivity and

marginal revenue product for each factor. To the extent that the factors in Equation 3 have dynamic effects (e.g., MAR externalities), they would also have greater effects in increasing employment growth. Equations (1) - (3) can be combined to solve for the reduced-form change in employment:⁷

$$(4) \ g_i = f(\alpha, \mathbf{OE}_i, \mathbf{NE}_i, \mathbf{HC}_i, \mathbf{CC}_i, \mathbf{HT}_i, \mathbf{UN}_i),$$

where α is comprised of other shift factors that influence job growth. We will describe how we empirically implement this equation in Section 5.

As described below, there is no clear measure of opportunity and necessity entrepreneurs. For this, we proxy for both by using the self-employment or proprietor share (SE). The production coefficient on the SE term in equation (3) is then some weighted average of β and γ that would directly relate to the respective share of opportunity versus necessity entrepreneurs. The resulting SE production exponent then likely understates (overstates) the productivity of opportunity (necessity) entrepreneurs on local growth, which would, in turn, suggest our reduced form regression estimates in equation (4) are a weighted average of the two effects. The resulting SE regression coefficient would be a reasonable expectation of the effect of encouraging a typical person to become self-employed given that certain proportions would be necessity and opportunity entrepreneurs. Likewise, to the extent that the ratio of necessity to opportunity entrepreneurs varies across space, the coefficients reflect the average effect across space (Angrist and Pischke 2009, 2010).

4. The Appalachian Region and comparisons with surrounding counties and the rest of the U.S.

The Appalachian region is named after the mountain range that has led to its economic isolation and resulting economic deprivation. The Appalachian Regional Commission (ARC) was formed in 1965 by the federal government “to address the persistent poverty and growing economic despair of the Appalachian Region.”⁸ The ARC-designated region today includes 420 counties in parts of 13 states, stretching from northern Mississippi to southern New York. The region is largely rural, with Pittsburgh being its only major metropolitan area. The ARC designation has led to success in reducing poverty, but almost 20 percent of ARC counties remain economically distressed.

⁷Note that equation (4) is a reduced form model so that factors such as wages, housing prices, and unemployment rates are not included.

⁸The background source is the ARC Website, www.arc.gov. Downloaded on May 10, 2011.

The ARC region is *immediately adjacent* to 135 counties that are within the same states as the ARC-designated counties, but these counties generally have had better economic outcomes. However, because the surrounding region has not faced the historical barriers faced by the ARC counties, they provide a nice comparison group for some of our empirical analysis because they share the same state policies as their ARC neighbors. Most of our focus will be on the ARC sample, but we will also examine the broader sample and comparisons with the neighboring counties. A map of the ARC counties and the surrounding counties is shown in **Figure 1**.

Table 1 presents some unweighted descriptive statistics of the entire U.S., ARC-designated counties, and immediately adjacent surrounding counties. The ARC counties have higher levels of entrepreneurship (percent nonfarm proprietors or owners of small businesses) (16.6%) than the surrounding counties (14.7%), although the level is lower than the U.S. as a whole (17.2%). However, ARC counties have lower levels of human capital (percent college graduates) and creativity (percent of people in creative class occupations) than both the U.S. and the immediately surrounding counties. While knowledge or occupation is not part of a formal definition of Schumpeterian entrepreneurs, this weakly suggests that the ARC region will have a greater share of necessity entrepreneurs than the U.S. average, which reduces the expected indirect effects of greater self-employment shares.

Figure 2, Panel A, illustrates the national variation in county self-employment rates. The highest rates are found in the southern Great Plains, Northern Rocky Mountain, and Pacific Northwest regions, while the lowest rates tend to be in the historic Black belt crescent that runs from Central Mississippi, through Alabama and Georgia, and up into South Carolina. The highlighted ARC region has considerable variability as well, with higher self-employment rates in the north and lower rates in the south.

While Table 1 shows that *total* employment growth from 1990 to 2007 in both the ARC region (32.1%) and the surrounding counties (34.7%) was slightly above the national average (31.1%), while W&S employment growth in the ARC counties (20.1%) was below that in the surrounding counties (28.5%) and the national average (25.6%). Thus, even if entrepreneurs are creating jobs in the ARC region, perhaps they are only creating jobs for themselves, with few positive spillovers.

Innovation is often associated with the number of patents (Lim 2003). Using patents per 10,000

people as our proxy for innovation intensity, Table 1 shows the ARC region (0.74) and its surrounding counties (1.16) are considerably disadvantaged compared to a national average of 11. Indeed, with a relatively low share of knowledge workers in the ARC region, even absorbing other regions' innovations may be problematic. Nonetheless, consistent with a product cycle model, the share of high-technology industry jobs is actually higher in the ARC region than the national average and the Level I high-technology employment share is the same in the ARC region as in the U.S. (Level I includes the most intensive high-technology industries).⁹ Yet, the ARC region's 1990-2006 high-technology job growth greatly lagged the U.S. and the surrounding region. But, even here, note that the unweighted national average high-technology W&S job growth of 27.9% from 1990 to 2006 barely exceeded the national average of overall W&S job growth of 25.7%. This illustrates that even though the 1990s were the red-hot decade in terms of high technology, there does not seem to be evidence that those industries have been major engines of growth. Overall, these comparisons suggest that previous studies that considered the nation as a whole may not be nuanced enough to provide insights into what contributes to growth in remote, rural regions like Appalachia (Partridge et al. 2008b).

5. Empirical Model and Data

5.1 Sample and Dependent Variables

Our data consists of the 420 counties in the ARC region and the 135 counties which share a border with the federally-designated region. We first assess job creation using the percent change in *total* employment (both proprietors and W&S workers) from 1990 to 2007 using data from the U.S. Bureau of Economic Analysis (BEA). The purpose is to replicate the base findings of Stephens and Partridge (forthcoming) that examine slightly different years and use a different empirical specification. Then, because we want to know if entrepreneurs are creating jobs for others, not just for themselves, we focus on the percent change in W&S employment during the same time period, also using BEA data. Sensitivity analysis will use detailed one-digit industry level data to help assess whether there are different roles

⁹The most intensive high-tech job industries are those defined by the U.S. Department of Labor in Hecker (2005) and include the 14 industries in which technology-oriented occupations account for a proportion that is at least 5 times the average and constituted 24.7 percent or more of industry employment.

across industries. Our detailed industry level data are from the EMSI consulting firm.¹⁰ We also use the EMSI data to conduct two “shift-share” type analyses. Following Partridge and Rickman (1995), Stimson et al. (2009), and Ashcroft and et al (1991), we examine the “shift” or difference between actual and predicted levels of 1) nonfarm proprietor employment (entrepreneurship) in 2007 and 2) 1990-2007 W&S employment growth (Percent change in W&S employment).

We first calculate the shift term for W&S employment—i.e., the difference between the actual W&S employment growth rate and the growth rate predicted by industrial composition if the county’s W&S employment in each industry grew at the corresponding national rate. This “shift” factor is also known as the competitiveness growth rate. Thus, we use the 1990-2007 W&S competitiveness growth rate as a dependent variable to appraise what factors are associated with counties having higher growth rates than predicted by their industry mix.

We conclude by examining whether the county has greater than expected self-employment share using another shift-share method: we create a *Shift* term that shows whether the county has an above or below average share of self-employed workers given its industry composition. The derivation is in Appendix 1. **Figure 2**, Panel B, shows how the self-employment “shift” variable varies nationally. It shows that Central Appalachia generally has less self-employment than predicted by its industry composition, while the Great Plains region tends to have greater than expected values.

5.2 Empirical Model and Explanatory Variables

Our empirical model is as follows:

$$(5) \quad y_j = \beta_0 + \beta_1 \times Ent_j + \beta_2 \times HC_j + \beta_3 \times Creative_j + \beta_4 \times AT_j + \beta_5 \times Univ_j + \beta_6 \times Metro_j + \beta_7 \times Amenities_j + \beta_8 \times State_j + \beta_9 \times ARC_j + \beta_{10} \times X_j + \varepsilon_j$$

Where y_j are our measures of:

- Percent change in Total Employment, 1990 to 2007
- Percent change in W&S Employment, 1990 to 2007
- Percent change Industry-level W&S Employment, 1990 to 2007 (various industries)
- W&S Competitiveness Growth Rate, 1990 to 2007

¹⁰EMSI data has been used in many academic studies due to the care they take in deriving accurate employment measures even in sparsely populated counties (EMSI.com). See Dorfman et al. (forthcoming) for more details of EMSI’s employment estimating procedures.

- Self-Employment “Shift,” 2007

We use explanatory variables measured in 1990 to minimize potential endogeneity bias in the parameter estimates (a list of explanatory variables is in **Table 2**), though we also employ instrumental variable (IV) approaches. Because of a host of unforeseeable changes to the U.S. economy between 1990 and 2007, the explanatory variables are assumed to be predetermined (and thus account for factors associated with the county fixed effects). However, we test our assumption through IV estimation.

To measure the role of entrepreneurship (Ent_j), we use the 1990 percent of total employment that is nonfarm proprietors. The BEA self employment data includes nonfarm proprietors, or business owners of any employment size (though most businesses are small or micro businesses). We recognize that using nonfarm proprietors does not fully capture all dimensions of “entrepreneurship” because it does not distinguish between necessity versus Schumpeterian or innovative entrepreneurs. However, in a lagging, remote region such as Appalachia, we believe that the dimension of entrepreneurship that matters more is risk-taking, or willingness to start a business that then can employ workers. Likewise, though it may not always reflect “radical innovation,” proprietorship (ownership) also reflects the need to identify market opportunities and to engage in mundane (but important) process innovation. To the extent that there is measurement error, our estimates would be biased toward zero (which means we understate its effects). However, IV approaches should minimize any measurement error effect. Moreover, this choice is consistent with others in the literature and appears to be a better measure for the ARC region than using small businesses or other measures. To be sure, Stephens and Partridge (forthcoming) considered other entrepreneurship measures such as changes in self-employment share and percent of employment in small businesses, but they conclude that the self-employment share is the best proxy in the ARC region.¹¹

Human Capital (HC_j) is measured by the percent of the population age 25 and over using 1990 U.S. Census data and includes: (i) the percent with a college degree (bachelors and above), (ii) the percent that have some college education without a four-year degree, and (iii) the percent of high school graduates who did not attend college. Creative workforce ($Creative_j$) is proxied by the employment

¹¹Stephens and Partridge (forthcoming) found some evidence that income per proprietor is a good proxy for opportunity entrepreneurship, but we will not consider it for analysis. We expect that one reason why the proprietor or self-employment share performs better in the ARC region is that it is more rural and remote and all businesses are generally smaller.

share in creative-class occupations in 1990 based on Florida (2002a), as developed by McGranahan and Wojan (2007).¹²

Advanced technology (AT_j) is accounted for by including the share of W&S employment in Level I high-technology firms. We also tried the overall high-technology employment share, but the results were roughly unchanged. As another measure of innovation (Lim 2003), we include the 1990 number of Patents issued per 10,000 residents using U.S. Patent and Trademark Office (USPTO) data.

To account for university spillovers ($Univ_j$) beyond the impact of producing college-educated workers for the local area, we include a dummy variable that equals one if there is a Research I or Land Grant University located within 100 miles of the county. If proximity to a research university affects growth besides its influence on the share of university educated people, this variable will have a positive relationship with job growth. We tried several other variations of this measure including a measure of being within 50 miles of a research university, but all had a similar effect.

To control for agglomeration ($Metro_j$), we use measures of the distance in kilometers from the population weighted center of each county to the population center of the nearest metropolitan statistical area (MSA) and three measures of *incremental* distance to a) an MSA of over 250,000 people, b) an MSA of over 500,000 people, and c) an MSA of over 1.5 million people. Partridge et al. (2008a; 2008b) found that these measures of proximity to urban agglomeration economies are important in explaining metropolitan and nonmetropolitan growth dynamics. We also include a dummy variable indicating if the county is located within a metro area.

As noted in the literature review, many studies have found that natural amenities are positively related to economic growth in rural areas. We control for natural amenities ($Amenities_j$) with each county's natural amenity score using the Natural Amenities Scale from the USDA Economic Research Service¹³ and the 1-21 Topography Score from the U.S. Geological Survey.¹⁴ We also control for the

¹²The creative occupations include managers, scientists and engineers, art and design workers, sales representatives and supervisors and college teachers. The creative class occupations were classified using O*NET, a Bureau of Labor Statistics data set that describes the skills generally used in occupations. Creative occupations are those that involve a high level of "thinking creatively." This skill element is defined as "developing, designing, or creating new applications, ideas, relationships, systems, or products, including artistic contributions." (Source: USDA/ERS website, <http://www.ers.usda.gov/Data/CreativeClassCodes/methods.htm>, accessed March 15, 2011.)

¹³The natural amenities scale combines six measures: warm winter, winter sun, temperate summer, low summer

topography score because Partridge et al. (2008b) find that mountainous regions in the eastern United States are less likely to benefit from steep topography in terms of positive amenities than the West.

We also include state dummy variables ($State_j$) for the 13 Appalachian states (Georgia is the omitted category) to control for state-specific factors such as the influence of state government policies including taxes or other factors common to a given state's counties—e.g., North Carolina's counties are growing relatively rapidly compared to Ohio's. In the total sample that includes the surrounding counties, an ARC region dummy variable (ARC_j) is added to account for policy and other historical differences between those counties in the federally-designated region and the other nearby counties in our sample.¹⁵

We also control for other determinants of economic growth in the region (X_j), including:

- Industry Composition. Industry composition is controlled using (i) percent of total employment that is in manufacturing, agriculture, and government, using data from the BEA, and (ii) percent of W&S employment in mining, construction, professional services (NAICS Sectors 54, 55, and 56), other services (NAICS Sector 81), and retail (NAICS Sector 44-45) using EMSI data.
- Population. Population is related to agglomeration and congestion economies, urban amenities, and thicker markets for labor matching and proximity to customers and suppliers. We use the natural log (Ln) of the population (from 1990 Census data) in the model.
- Average Age of the Population. From the 1990 Census, the average age of the population.
- Racial Composition. From the 1990 Census, the percent of the population that is African-American.

In estimating our models, we correct for heteroskedasticity. We considered spatial autocorrelation and spatial autoregressive models, but Stephens and Partridge (forthcoming) show that spatial dependence plays remarkably little role in economic activity in the ARC region, most likely due to the long list of control variables and the mountainous terrain limiting transportation and economic spillovers.

Because we are especially interested in exploring the role that entrepreneurs play in supporting

humidity, topographic variation, and water area. Source: www.ers.usda.gov/Data/NaturalAmenities/.

¹⁴ The topography scale is from The National Atlas of the United States of America, U.S. Department of Interior, U.S. Geological Survey, Washington, D.C., 1970. By including this variable we distinguish the influence of topography from that of other natural amenities.

¹⁵ Between 1990 and 2008, Congress added 23 counties to the ARC region. To access whether our results are affected, we re-estimated our models using the 1990 ARC-designated boundary, finding that the results are robust.

regional growth, we use an IV approach to address possible endogeneity of the percent of nonfarm proprietors. In particular, despite our efforts to control for the factors associated with economic growth, it is possible that omitted factors affect both the initial share of self-employed and the economic-outcome dependent variables. More specifically, it is possible that self-sorting entrepreneurs initially locate in counties that they expect will undergo economic growth, positively biasing the self-employment regression coefficient. We use as our identifying instrument the deep lag of the share of nonfarm proprietors in a county in 1969.¹⁶ The F-statistics for the first-stage weak instrument test, shown in **Tables 3 and 4** are between 48 and 90, giving us confidence that we have strong instruments.

For these models, we also test for the endogeneity of the regressors using the difference between two Sargan-Hansen statistics (unlike the Durbin-Wu-Hausman Test, this test allows for heteroskedasticity). Under the null, there is no statistical evidence of endogeneity and Ordinary Least Squares (OLS) appears to be appropriate in estimating the model. Therefore, in cases where the null hypothesis cannot be rejected at the 10% level, we report only the OLS results.

6. Results

6.1 Wage and Salary Growth

Previously, Stephens and Partridge (forthcoming) found that self-employment contributes to *total* employment growth in this region. To test whether their results are robust to the different specification, we first regress the 1990-2007 percent change in total employment using the model shown in equation (5) (results not shown). Using the full sample, we find strong evidence that 1990-2007 total job growth is positively related to the 1990 self-employed share. We then limited the sample to only ARC counties and our findings remain unchanged. We conclude that their findings apply in our setting.

Because we really want to know if the self-employed are creating jobs for others (not just for themselves), we now consider the 1990-2007 percent change in W&S employment as the dependent variable. The results are reported in **Table 3**, where our focus is the ARC region. For the ARC counties, the Chi-square statistic reported at the bottom of the table suggests that the self-employment measure is

¹⁶We also tried using the predicted share of self-employment in 1990 based on the county's industry composition as an instrument (*Pred-ShSE_i* in Appendix 1), but it failed the weak instrument test and we did not use it.

endogenous, so we stress the IV results.

We find a strong, statistically significant relationship between the initial self-employment share and subsequent W&S employment growth, suggesting that entrepreneurs in the ARC region contribute to job creation. In particular, using the coefficient from the IV results for the Percent of nonfarm proprietors employment from Table 3 (2.19) and the standard deviation of the Percent of nonfarm proprietors employment in Table 1 (4.73), a one standard deviation increase in the Percent of nonfarm proprietors employment is associated with a 10.4% increase in W&S employment. Comparing this to the mean W&S growth rate in ARC counties of 20.1% illustrates that the self-employment share has a nontrivial relationship with W&S growth, even after addressing potential endogeneity and self sorting of firms.

We also find a positive relationship between W&S employment growth and the percent of people in creative class occupations, suggesting that, despite relatively lower levels of creative class workers in the region, creativity is associated with growth. Using the IV results for the ARC sample, a one standard deviation increase in the creative-class employment share is associated with 25.8% faster W&S employment growth. However, we find an inverse association between human capital as measured by the college graduate share and W&S employment growth. The negative college graduate response is consistent with either a story of general brain drain or that general college graduates are insufficiently specialized to promote growth in this lagging region, unlike the more narrowly defined creative workers.

One concern is that the creative class share is highly correlated with the university graduate share. The correlation is about 0.9 in the ARC sample, and thus, a possible concern is that multicollinearity drives our results. To assess this possibility, we experimented by first dropping the three educational attainment variables from the model (not shown). The results for the creative class were about the same. Likewise, while omitting the creative class share from the model leads to the college graduate share coefficient turning positive, it is statistically insignificant. Thus, we conclude that our findings that the creative class is more important in Appalachia are robust and they do not appear to be an artifact of multicollinearity.

We fail to find a positive statistical association between W&S employment growth and the initial share of high-technology Level I industries, being within 100 miles of a research university, or patents per

10,000 residents. This suggests that many knowledge-based economic development strategies may be inappropriate in remote, lagging regions, with the possible exception of strategies aimed at attracting workers in creative occupations.

When we examine the full sample of both ARC and the surrounding counties, there is no statistical relationship between the initial self-employment share and subsequent W&S employment growth regardless of whether we use OLS or an IV approach. This is consistent with current work by Faggian et al. (2011) that has found no statistical relationship between self-employment and local economic growth at the national level. Thus, it appears that it is the peripheral ARC counties with potentially fewer economic options in which proprietor employment has its strongest association with growth. Creativity also appears to be important for growth in the overall region, but again human capital (percent college graduates) is negatively correlated with W&S growth. We also continue to find little evidence that proximity to a research university, patents per 10,000 people, and the employment share in Level I high-technology employment are related to W&S job growth for the broader region.

We also find a strong positive association between W&S job growth and the amenity index. Our results are then consistent with McGranahan et al.'s (2010) finding that rural job growth is positively associated with entrepreneurs, creativity, and natural amenities. There is also an inverse relationship between growth and manufacturing and mining employment shares. Somewhat surprisingly (given Goetz and Debertin 1996), we find the initial agriculture employment share is positive and statistically related to W&S employment growth, though agriculture only directly accounts for about 2% of total employment.

We see some evidence that areas farther away from larger metropolitan areas experience lower W&S employment growth. However, we find only weak evidence to suggest that small local populations do not support W&S job growth. Finally, in the results for the overall region, we find that being in the ARC region is negatively associated with W&S job growth. However, this is consistent with the ARC region having less W&S growth during this time period than the adjacent counties (see Table 1).

We next assess whether there were differential effects across major one-digit industries and across high-technology firms (total and Level I). Specifically, do the entrepreneurial and knowledge variables differentially affect industry W&S growth rates? We estimated separate 1990-2007 (1990 to

2006 for the high-tech industries) *industry-level* W&S growth regressions using the same explanatory variables as in Table 3 (with and without the industry shares as controls). However, except for W&S employment growth in Level I high-tech firms, we did not detect any real strong patterns (results not shown). For Level I high-tech industries, there is some evidence that nonfarm proprietors and the creative class are positively related to W&S employment growth both in the ARC counties and the broader region. Yet, these results are not robust to the inclusion of industry shares. Overall, we conclude that in a sample of relatively remote, sparsely populated counties, industry-level growth is somewhat idiosyncratic.

6.2 Wage and Salary Competitiveness Growth Rate

To further examine Appalachian W&S job growth, in **Table 4** we use the 1990-2007 W&S competitiveness growth rate as the dependent variable (i.e., the difference between actual W&S employment growth and that which would have been predicted given a county's industrial mix). Again, we focus on the ARC-designated counties and on the IV results. What is remarkable about these results is how similar they are to the overall W&S employment growth results in Table 3. Specifically, we continue to find evidence suggesting that a greater self-employment share and a more creative workforce share is positively related to the W&S employment growth rate, while the other knowledge-related factors are not statistically significant (or an unexpected sign). The similarity between the competitiveness results and the overall W&S growth results suggests that what matters for growth is less about having a favorable industry composition, but more about having faster growth in existing industries. Thus, in terms of economic development policy, rather than focusing on the next hot industry, these results suggest that more basic efforts to raise productivity and profitability in existing industries (or retention of existing industries) may pay higher returns.¹⁷

6.3 What Explains High Self-Employment Shares

We have found consistent evidence that having a greater share of creative workers and entrepreneurs (as proxied by self-employment) is associated with increased growth. Of course, policymakers need to know what they should prioritize if they were to use these findings. First, we note

¹⁷See Partridge and Olfert (2011) for an analogous discussion. For a similar conclusion when considering net migration patterns, see Partridge and Rickman (1999).

that prior research related to attracting the creative class suggests that it is very difficult. Olfert and Partridge (2011) find that, after accounting for natural amenities and agglomeration effects, there is very little left to help explain *changes* in creative class shares. Conversely, in this case, we have found that growth is less about industry mix and more about how each industry is performing. Thus, given a local area's industry composition, we want to know what are some of the factors associated with greater self-employment shares? We do this by examining the 2007 self-employment share 'shift' or competitiveness term—i.e., after we account for the industry mix, does the county have larger or smaller self-employment than expected. These results are reported in **Table 5**.

First, because industry structure is an important factor associated with the self-employment share and industry structure is somewhat persistent, we try to decompose the portion of self employment in 1990 that is due to industry composition from that is due to have a greater than expected share self-employment—perhaps due to having characteristics that support an entrepreneurial economy. Thus, we regress the percent of nonfarm proprietors employment in 1990 on the twelve 1990 W&S industry employment shares. The regression residual is the share of 1990 Nonfarm Proprietors Employment (or entrepreneurship) that is not explained by the industry composition. We then use the residual or the “unexplained” 1990 self-employment share in our 2007 self-employment model.

For both the ARC-designated counties and the entire sample, this proxy for the share of 1990 nonfarm proprietors is associated with a higher 2007 *shift* self-employment share. Hence, there is some evidence of a virtuous cycle in which having more self-employed is associated with having even more self-employed nearly 20 years later, which could indicate a culture of entrepreneurship. Thus, we tentatively conclude that policies aimed at increasing local entrepreneurship are at least focusing on a reasonable objective because of these possible self-reinforcing features that persist (though the costs of creating entrepreneurs also need to be considered). Indeed, we find little evidence that having higher self-employment crowds out future self-employment by displacing competitors in the local economy.

Interestingly, however, a higher percentage of creative workers in 1990 are inversely related to the competitiveness self-employment measure. One possibility is that creative workers are associated with employment in larger firms or help attract larger firms that crowd out smaller firms—especially in a

lagging region such as Appalachia. Yet, while these results raise the possibility that some of the positive effects from having a larger creative workforce share in terms of W&S job growth are offset by crowding out some self-employment, we believe future research is needed to understand this effect. We also find some weak evidence that human capital (percent of college graduates) is linked to more self-employment in the ARC region. However, we find much stronger evidence that a greater share of high school graduates is positively linked to more self-employment suggesting that moderate levels of education may be sufficient to induce greater entrepreneurship in lagging or remote regions. The other “knowledge” factors such more patents, having greater shares of Level I high-technology industries, and being close to a research university are not statistically associated with having a greater shift self-employment share.

Industry composition also has some statistically significant associations with the shift in nonfarm proprietor employment share. For example, a greater 1990 agriculture employment share is positively related to the 2007 shift in *nonfarm* self-employment share, i.e. it leads to more self-employment than would have been predicted. This pattern merits further research because many farmers are proprietors who already have significant experience with managing businesses, developing business plans, obtaining financing, and understanding global commodity markets and exchange rates. Hence, this farm experience may be increasingly transferred to *nonfarm* enterprises either directly or indirectly through knowledge spillovers. Conversely, we find initial industry shares in mining, other services, and retail to be inversely associated with the shift in self-employment share. The mining result is especially interesting. It is not necessarily unexpected that a greater 1990 mining employment share is inversely related to 1990-2007 W&S employment growth given the industry-wide labor-saving technological changes that are reducing employment. Additionally, there seem to be negative spillovers from mining employment that are creating an environment that is not conducive to proprietorship/entrepreneurship. In fact, the labor downsizing in mining could have facilitated an increase in self-employment, because laid-off workers may have started new enterprises – even if just out of necessity. Thus, the negative association between initial (1990) mining employment and subsequent self-employment may be due to other factors – such as local environmental degradation due to mining that may restrict the amenity-related benefits of an area and limit the ability of laid-off workers to start recreation-oriented businesses, or possibly to a culture

associated with mining that does not support an entrepreneurial environment.

A “positive” finding is that there is very little evidence that the agglomeration variables (log population, located in a metropolitan area, distance to incrementally larger metropolitan areas) are associated with self-employment. The results suggest that concentrations of self-employment can take place in locations that are rather remote and sparsely populated—and that, unlike other economic activities, self-employment does not appear to face as many barriers in peripheral settings.

7. Conclusions

Economic development strategies that are used to promote local growth include efforts to promote entrepreneurship and “knowledge-based” approaches such as attracting knowledge workers, attracting advanced technology firms, and taking advantage of knowledge assets, such as universities. Yet, it is not clear *a priori* whether these types of strategies can be effective in lagging, peripheral regions. Entrepreneurs may want to locate elsewhere or may be predominantly of the necessity type, while knowledge strategies may be unrealistic in regions that lack the human and physical capacity to implement them.

This study examines the relative effectiveness of economic development strategies in Appalachia. This region has persistently lagged in economic growth and historically has had very high poverty rates. To assess the different strategies, we examine whether these are conducive to W&S employment growth, i.e., whether greater self-employment supports growth of *employees*, not just owners or proprietors. We also examine the W&S competitiveness growth rate, i.e., whether job growth is greater than or less than expected based on the local area’s industry composition. Our analysis corrects for endogeneity in that proprietors are likely to self sort to locate in more prosperous locations.

Our results suggest that greater self-employment is associated with a rather large increase in W&S job growth—i.e., a one standard deviation increase in the 1990 self-employment share is associated with over a 10 percentage point increase in 1990-2007 W&S employment growth. With the exception of a positive relationship with creative workers, we find very little evidence that knowledge-based factors increase W&S job growth—i.e., being close to a research university, having a greater high-technology employment share, having more patents per 10,000 residents, or having more university graduates do not

appear to be associated with higher W&S employment growth. Similarly, we found the same factors were important (or not) to having a higher competitiveness growth rate. Together, these results suggest that economic development policy in this region may be more successful if it focuses on cultivating existing industries or supporting homegrown entrepreneurs, and not worrying about whether the local area has the latest “hot” industry or worrying about an innovation agenda.

Because self-employment appears to be important to growth in this region, we also examined what explains the relatively large self-employment share by considering the “competitiveness” type self-employment share (the difference between actual and predicted self-employment share in a county, given its industry mix). We find that a greater than expected 1990 self-employment share (net of industry composition) is associated with a higher 2007 competitiveness self-employment share. One possible implication is that new self-employment does not lead to simple displacement of other local proprietors, but may actually be evidence of a culture of entrepreneurship. Again, as with the W&S analysis, we find little evidence that knowledge factors induce greater competitiveness self-employment. On a positive note, agglomeration economies also do not appear to affect competitiveness self-employment. In other words, higher levels of entrepreneurship are possible even in remote areas.

One interesting result is that - despite all of the attention that academics, policymakers, and economic development professionals have given to knowledge industries and ‘innovation’ in general - there is little evidence that, with the exception of having a greater creative class share, W&S employment growth is positively associated with knowledge factors in this lagging region. Yet, we find that greater proprietorship and the associated entrepreneurship seem to play an important role. Indeed, the results suggest that when regions lack the capacity to absorb innovation, a better strategy is using home grown approaches such as cultivating local entrepreneurship (even in a lagging region). Even so, we caution that policymakers need to consider the costs of any economic development approaches, but that supporting entrepreneurship and small business development appears to be promising. While we acknowledge that generalizing these results to regions outside of Appalachia is problematic, they do suggest that conventional strategies for economic development revolving around knowledge and innovation should not be applied in cookie cutter fashion, especially in regions that lack the capacity to benefit from them.

Appendix 1.

To derive the predicted share of self-employment, we do the following:

a) Calculate the national ratio (N) of self-employment (nonfarm proprietors employment) to W&S employment for each industry j , using national BEA data and national W&S employment data from the U.S. Bureau of Labor Statistics (BLS): $SE-WS_{Nj} = SE_{Nj} / WS_{Nj}$.

b) For each county, i , we calculate the share of W&S employment (WS) by industry:

$$ShWS_{ij} = WS_{ij} / \sum_j WS_j$$

c) For each county, i , and for each industry, j , we then multiply the national ratio of self-employment to wage and salary employment times the industry's share of wage and salary employment in the county: $X_{ij} = SE-WS_{Nj} * ShWS_{ij}$

d) The predicted number of self-employed for each county i is then the total number of wage and salary employment in that county times the sum, over all industries, of the values obtained from step c):

$$Pred-SE_i = \sum_j WS_j * \sum_j X_{ij}$$

e) The Predicted self-employment share is predicted number of self-employed divided by total employment :

$$Pred-ShSE_i = Pred-SE_i / TotalEmployment_i$$

$Pred-ShSE_i$ is the county's predicted share of self employment if all of the counties industries had their corresponding national share of self-employed workers.

f) Then, the "Shift" is the difference between the actual self-employment rate in a county and the predicted value: $Shift_i = ShSe_i - Pred-ShSE_i$.

References

- Acs, Z. J. (2006). How is Entrepreneurship Good for Economic Growth? *Innovations*, 1(1), 97-107.
- Acs, Z. J., & Armington, C. (2004). The impact of geographic differences in human capital on service firm formation rates. *Journal of Urban Economics* 56, 244-278.
- Acs, Z. J., & Kallas, K. (2008). State of Literature on Small- to Medium-Sized Enterprises and Entrepreneurship in Low-Income Communities. In G. Yago et al, ed. *Entrepreneurship in Emerging Domestic Markets* (pp. 21-45). Milken Institute.
- Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., & Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics* 32, 15–30.
- Angrist, J. D. and Pischke, J. (2009). *Mostly Harmless Economics, An Empiricist's Companion*. Princeton, NJ: Princeton University Press.
- _____. 2010. "The Credibility Revolution in Empirical Economics: How Better Research Design Is Taking the Con out of Econometrics," *Journal of Economic Perspectives* 24, 3-30.
- Anselin, Luc, Attila Varga, and Zoltan Acs. (1997). Local Geographic Spillovers between University Research and High Technology Innovations. *Journal of Urban Economics*. 42, 422-448.
- Appalachian Regional Commission (ARC) (2010). *Moving Appalachia Forward: Appalachian Regional Commission Strategic Plan, 2011–2016*. Downloaded from <http://www.arc.gov/images/newsroom/publications/sp/ARCStrategicPlan2011-2016.pdf>, May 11, 2011.
- Ashcroft, B., Love, J.H., and Malloy, E. (1991). New firm formation in the British counties with special reference to Scotland. *Regional Studies* 25, 395-409.
- Audretsch, D. B. (2002). The Dynamic Role of Small Firms: Evidence from the U.S. *Small Business Economics* 18, 13-40.
- Audretsch D. B., & Keilbach, M. (2004). Entrepreneurship capital and economic performance. *Regional Studies* 38(8), 949-959.
- Audretsch D. B., & Keilbach, M. (2007). The Localisation of Entrepreneurship Capital, Evidence from Germany. *Papers in Regional Science* 86(3), 351-365.
- Bania, N., R.W. Eberts, and M.S. Fogarty. (1993). Universities and the Startup of New Companies: Can we Generalize from Route 128 and Silicon Valley? *Review of Economics and Statistics* 75(4), 761–766.
- Baptista, Rui and Joana Mendonça (2010) Proximity to knowledge sources and the location of knowledge-based start-ups. *Annals of Regional Science*. 45, 5-29.
- Bauer, Paul, Mark E. Schweitzer, and Scott Shane (forthcoming) Knowledge Matters: The Long-Run Determinants of State Income Growth. *Journal of Regional Science*.
- Beaulieu, L., & Goetz, S. J. (2007). Creative and Entrepreneurial Economies: Are They Achievable in Rural America? Invited chapter in Ron Knutson et al. (Eds.), *Perspectives on 21st Century Agriculture, A Tribute to Walter J. Armbruster* (pp. 195-209). Ann Arbor, MI: Sheridan Books.
- Becker, G. (1964) *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. NBER; distributed by Columbia University Press (New York).
- Birch, Kean. (2011). Weakness” as “Strength” in the Scottish Life Sciences: The Institutional Grounding of Knowledge-based Commodity Chains in a Less-favoured Region. *Growth and Change*. 42, 72-97.
- Braunerhjelm, P., Acs, Z., Audretsch, D. B., & Carlsson, B. (2010). The Missing Link, Knowledge

- Diffusion and Entrepreneurship. *Small Business Economics*. 34, 105-125.
- Chen, Anping & M.D. Partridge. (Forthcoming). "When are cities engines of growth? Spread and Backwash Effects across the Chinese Urban Hierarchy." *Regional Studies*.
- Comunian, Roberta, Alessandra Faggian, and Qian Cher Li. (2010). Unrewarded careers in the creative class: The strange case of Bohemian graduates. *Papers in Regional Science* 89, 389-410
- Crescenzi, R., A. Rodriguez-Pose, & M. Storper. (2007). "The Territorial Dynamics of Innovation: A Europe–United States Comparative Analysis," *Journal of Economic Geography* 7, 673–709.
- Deller, Steven C. (2010). Spatial Variations in the Role of Microenterprises in Economic Growth. *Review of Regional Studies* 40, 71–97.
- Deller, S. C., and J. McConnon Jr. (2009). Microenterprises and Economic Growth, A Panel Study of the US States 1977 to 1997. *Applied Economic Letters* 16, 1307-1312.
- Desmet, Klaus, and Marcel Fafchamps. (2005). Changes in the Spatial Concentration of Employment across US Counties: A Sectoral Analysis 1972-2000. *Journal of Economic Geography* 5(3), 261-84.
- De Silva, Dakshina and Robert McComb. (2011). Research Universities and Regional High-Tech Firm Start-up and Exit. *Economic Inquiry* 49, 1-19.
- Dorfman, J., M.D. Partridge, and H. Galloway. (forthcoming). Are High-tech Employment and Natural Amenities Linked: Answers from a Smoothed Bayesian Spatial Model. *Spatial Economic Analysis*.
- Duranton, Gilles, Philippe Martin, Thierry Mayer, & Florian Mayneris. (2010). *The Economics of Clusters: Lessons from the French experience*. Oxford: Oxford University Press.
- Faggian, Alessandra and Philip McCann. (2006). Human Capital and Regional Knowledge Assets: a Simultaneous Equation Model. *Oxford Economic Papers* 58(3), 475-500.
- Faggian, Alessandra and Philip McCann. (2009). Human Capital, Graduate Migration and Innovation in British Regions. *Cambridge Journal of Economics* 33, 317-333.
- Faggian, A., Partridge, M.D., Malecki, E. (2011). Creating an environment for economic growth: human capital, creativity and entrepreneurship in the USA. Working Paper.
- Feser, E., H.Renski and H. Goldstein. (2008). Clusters and Economic Development Outcomes: An Analysis of the Link between Clustering and Industry Growth. *Economic Development Quarterly* 22(4), 324-344.
- Fleming, D. and S.J. Goetz. (Forthcoming). Does Local Firm Ownership Matter? *Economic Development Quarterly*.
- Florida, R. (2002a). *The rise of the creative class: And how it's transforming work, leisure, and everyday life*. New York: Basic Books.
- Florida, R. (2002b). The Economic Geography of Talent. *Annals of the Association of American Geographers*. 92(4), 743-755.
- Florida, R. (2003). Cities and the Creative Class. *City and Community* 2, 3-19.
- Florida, R., Mellander, C., and Stolark, K. (2008). Inside the black box of regional development – human capital, the creative class, and tolerance. *Journal of Economic Geography* 8, 615-649.
- Fritsch, M. & Mueller, P. (2004). Effects of New Business Formation on Regional Development over Time. *Regional Studies* 38, 961–975.
- Glaeser, E. L. (2007). Entrepreneurship and the City. Working Paper 13551, National Bureau of Economic Research (NBER), Cambridge, MA.

- Glaeser, Edward L. and Joshua D. Gottlieb. (2009). The Wealth of Cities: Agglomeration Economies and Spatial Equilibrium in the United States." NBER Working Paper #14806.
- Glaeser, E. L., Kallal, H., Scheinkman, J. A., Shleifer, A. (1992). Growth in Cities. *Journal of Political Economy* 100 (6), 1126-1152.
- Glaeser, E. L., Kerr, W. R., & Ponzetto, G. A. M. (2010). Clusters of Entrepreneurship. *Journal of Urban Economics* 67(1), 150-168.
- Glaeser, Edward L., Hedi Kallal, Jose Sheinkman, and Andre Schleifer. (1992). Growth in Cities. *Journal of Political Economy* 100, 1126-52.
- Glaeser, E.L., J.A. Sheinkman, and A. Sheifer. (1995). Economic growth in a cross-section of cities. *Journal of Monetary Economics* 35, 117-43.
- Goetz, S. J., & Rupasingha, A. (2009). Determinants of growth in non-farm proprietor densities in the US, 1990–2000. *Small Business Economics* 32, 425–438.
- Goetz, S.J. & Debertin, D.L. (1996). Rural population decline in the 1980s: Impacts of farm structure and federal farm programs. *American Journal of Agricultural Economics* 78(3), 517-529.
- Goldstein, Harvey and Joshua Drucker. (2006). The Economic Development Impacts of Universities on Regions: Do Size and Distance Matter? *Economic Development Quarterly* 20, 22-43.
- Gries, T., & Naudé, W. (2010). Entrepreneurship and structural economic transformation. *Small Business Economics* 34, 13-29.
- Gülümser, A.A. , T. Baycan-Levent, and P. Nijkamp (2010). Measuring Regional Creative Capacity: A Literature Review for Rural-Specific Approaches. *European Planning Studies* 18, 545-563.
- Hart, D. and Z.J. Acs. (2011). Immigration and High-Impact, High-Tech Entrepreneurship. Brookings Institution Issues in Technology Innovation. #6. Downloaded on May 10, 2011 at: http://www.brookings.edu/~media/Files/rc/papers/2011/02_immigration_hart_acs/02_immigration_hart_acs.pdf.
- Hecker, D. E. (2005). High technology employment: a NAICS based update. *Monthly Labor Review Online*, July 2005.
- Kandilov, Ivan T. and Mitch Renkow. (2010). Infrastructure Investment and Rural Economic Development: An Evaluation of USDA's Broadband Loan Program. *Growth and Change*. 41, 165-191.
- Karlsson, C., Stough, R., & Johansson, B. (Eds.) (2009). *Entrepreneurship and Innovations in Functional Regions*. Cheltenham, UK: Edward Elgar Publishing.
- Lim, U. (2003). The Spatial Distribution of Innovative Activity in U.S. Metropolitan Areas: Evidence from Patent Data. *Journal of Regional Analysis and Policy*. 33, 97-126.
- Loveridge, S., and D. Nizalov. (2007). Operationalizing the Entrepreneurial Pipeline Theory: An Empirical Assessment of the Optimal Size Distribution of Local Firms. *Economic Development Quarterly* 24, 244-262.
- Low, S., Henderson, J., & Weiler, S. (2005). Gauging a region's entrepreneurial potential. *Economic Review* (3rd quarter), 61-89. Kansas City, MO.: Federal Reserve Bank of Kansas City.
- Lucas, R.E., Jr. (1988). On the mechanisms of economic development. *Journal of Monetary Economics* 22, 1-42.
- Marshall, A. (1920). *Principles of economics*. London: Macmillan.
- McGranahan, D.A., and Wojan, T.R. (2007) Recasting the creative class to examine growth processes in rural and urban counties. *Regional Studies* 41, 197-216.

- McGranahan, D.A., Wojan, T.R., and Lambert, D.M. (2010). The rural growth trifecta: outdoor amenities, creative class, and entrepreneurial context. *Journal of Economic Geography* 11(3), 529-557.
- Monchuk, D. C., Brewin, D. & Partridge, M. D. (2009). Are all Innovations Created Equally? Examining the Adoption of Product and Process Innovations in the Canadian Food Processing Industry. *Canadian Journal of Agricultural Economics*, 57, 75-98.
- Mueller, P., van Stel, A., and Storey, D. J. (2008). The effects of new firm formation on regional development over time: The case of Great Britain. *Small Business Economics* 30, 59-71.
- Olfert, M. Rose and Mark D. Partridge. (2011). "Creating the Cultural Community: Ethnic Diversity vs. Agglomeration." *Spatial Economic Analysis*. 6, 25-55. DOI: 10.1080/17421772.2010.540032.
- Partridge, Mark D. and M. Rose Olfert. (2011). The Winners' Choice: Sustainable Economic Strategies for Successful 21st Century Regions. *Applied Economic Policy Perspectives*.
- Partridge, M.D., and Rickman, D.S. (1995). Differences in State Unemployment Rates: The Role of Labor and Product Market Structural Shifts. *Southern Economic Journal* 62, 89-106.
- Partridge, Mark D. and Dan S. Rickman. (1999). "A Note on the Benefits to Current Residents of State Employment Growth: Is There an Industry Mix Effect on Migration." *Journal of Regional Science* 39, 167-181.
- Partridge, M.D., D.S. Rickman, K.Ali, and M.R. Olfert. (2008a). Employment Growth in the American Urban Hierarchy: Long Live Distance. *The B.E. Journal of Macroeconomics*. 8, Article 10.
- Partridge, M. D., Rickman, D. S., Ali, K., & Olfert, M. R. (2008b). The Geographic Diversity of U.S. Nonmetropolitan Growth Dynamics: A Geographically Weighted Regression Approach. *Land Economics* 84, 241-266.
- Porter, Michael. (1998). *On Competition*. Cambridge, MA: Harvard Business School Press.
- Porter, M.E. and S.Stern. (2001). Innovation: Location Matters. *MIT Sloan Management Review* 42(4), 28-39.
- Porter, Michael E. (2003). The Economic Performance of Regions. *Regional Studies*. 37, 549-578.
- Puga, D. (2010). The magnitude and causes of agglomeration economies. *Journal of Regional Science* 50, 203-220.
- Robbins, D. K., Pantuosco, L. J., Parker, D. F., & Fuller, B. K. (2000). An Empirical Assessment of the Contribution of Small Business Employment to U.S. State Economic Performance. *Small Business Economics* 15, 293-302.
- Rodriguez-Pose, Andres. (1999). Innovation Prone and Innovation Averse Societies: Economic Performance in Europe. *Growth and Change* 30, 75-105.
- Rodriguez-Pose, Andres and Riccardo Crescenzi. (2008). Research and Development, Spillovers, Innovation Systems, and the Genesis of Regional Growth in Europe. *Regional Studies* 42(1), 51-67.
- Romer, P. (1986). Increasing Returns and Economic Growth. *American Economic Review* 94, 1002-1037.
- Romer, P. (1990). Endogenous Technical Change. *Journal of Political Economy* 98, 71-102.
- (RUPRI) Rural Policy Research Institute, EntreWorks Consulting, and RTI International. (2008). Creating an Entrepreneurial Appalachian Region: Findings and Lessons from an Evaluation of the ARC's Entrepreneurship Initiative 1997-2005. Available at: http://www.arc.gov/research/researchreportdetails.asp?REPORT_ID=72. Downloaded 23 July, 2010.
- Rupasingha, A. and S.J. Goetz. (Forthcoming). Self-Employment and Local Economic Performance: Evidence from US Counties. *Papers in Regional Science*.

- Schumpeter, J.A. (1911). *The Theory of Economic Development: An inquiry into profits, capital, credit, interest and the business cycle*. 1934 translation, Cambridge, Mass: Harvard University Press.
- Schumpeter, J.A. (1942). *Capitalism, Socialism and Democracy*. New York: Harper and Brothers.
- Shane, S. (2009). Why Encouraging More People to Become Entrepreneurs is Bad Public Policy. *Small Business Economics* 33, 141-149.
- Shrestha, S. S., Goetz, S. J., & Rupasingha, A. (2007). Proprietorship Formations and U.S. Job Growth. *The Review of Regional Studies* 37, 146-168.
- Simon, C. (1998). Human capital and metropolitan employment growth. *Journal of Urban Economics* 43, 223-43.
- Smith, Stephen M., and David L. Barkley. (1991). Local Input Linkages of Rural High-Technology Manufacturers. *Land Economics* 67, 472-483.
- Stephens, H., and Partridge, M.D. (Forthcoming). Do Entrepreneurs Enhance Economic Growth in Lagging Regions? *Growth and Change*.
- Stimson, R.J., Robson, A., and Shyy, T.-K. (2009). Modeling regional endogenous growth: an application to the non-metropolitan regions of Australia. *Annals of Regional Science* 43, 379-398.
- Varga, Attila. (2000). Local Academic Knowledge Transfers and the Concentration of Economic Activity. *Journal of Regional Science* 40, 289-309.
- Woodward, Douglas, Octavio Figueiredo, and Guimaraes Paulo. (2006). Beyond the Silicon Valley: University R&D and high-technology location. *Journal of Urban Economics*. 60, 15-32.