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Ambient Returns: Creative Capital's Contribution to Local Manufacturing Competitiveness

Timothy R. Wojan and David A. McGranahan

This paper addresses the possibility that competitive rural manufacturing is increasingly driven by quality-of-life factors required to attract highly skilled and creative workers. Recent findings that highly creative workers are drawn to amenity-rich rural areas provide the empirical leverage for testing anecdotal claims that these areas tend to contain small manufacturing bases that are more reliant on innovation. This contrasts with the cost advantage rationale of traditional rural manufacturing, an advantage that is eroding with increased globalization. The analysis provides the first empirical evidence that the start of entrepreneurial manufacturing plants and the adoption of advanced technologies and management practices are strongly associated with the local employment share in highly creative occupations.

Key Words: amenities, competitiveness, entrepreneurship, product cycle, rural manufacturing

The potential role of quality-of-life factors in promoting rural development has gained attention as the traditional cost advantages of rural production are eroded by globalization (Salvesan and Renski 2002). Amenity-based rural development has been conceived mainly as the valorization of these collective goods by attracting tourists, retirees, or second-home owners (OECD 1999, McGranahan 1999, Deller et al. 2001, Pezzini and Wojan 2002). However, places providing an opportunity for enriched personal lives may attract highly skilled workers willing to trade wages for quality of life in the middle of their productive lives. This possibility frames a rural variant of Richard Florida's (2002) creative capital thesis that development is increasingly driven by the novel combination of knowledge and ideas, and that certain types of workers specialize in this task, making the retention and attraction of these workers critical to new economic development strategies. McGranahan and Wojan (2007) provide evidence that rural places with higher shares of workers in creative occupations in 1990 generally had faster employment growth over the decade, and that these creative workers were attracted by natural amenities, along with other attributes.

The extension of this rural creative capital thesis to competitive, knowledge-intensive manufacturing is highly tenuous. Although Florida (2002) argues that creative processes are important inputs to all economic activities, his case study and focus group work does not examine manufacturing activities. Yet, even if the location preferences of workers of creative occupations in urban manufacturing were found to be similar to other creative workers, very thin markets for such workers might deter rural location. The argument can be made that competitive manufacturing is much less footloose than the services Florida examines, as it is dependent on a far wider set of inputs than the ideas of its workers. If these other critical inputs to competitive manufacturing tend to be absent where amenities are plentiful, then the possible creative capital link between amenities and competitive rural manufacturing disappears.

To investigate whether the posited creative capital link between amenities and competitive manufacturing exists in rural areas, we draw on a unique data set, the 1996 ERS Rural Manufacturing Survey, which contains detailed information

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on the establishment, ownership structure, and adoption of advanced technologies and management practices for over 2,500 nonmetropolitan establishments (Gale et al. 1999). This information is combined with contextual information from the respective county where the plant is located related to the size of the creative class, the quality of natural amenities, settlement size, educational attainment of the workforce, and factors that have been associated with rural manufacturing location and manufacturing innovation. Results from the analysis provide empirical evidence for the posited creative capital link: both the start of entrepreneurial manufacturing plants and the adoption of advanced technologies and management practices in rural areas are strongly associated with the share of the local workforce employed in highly creative occupations after controlling for other county characteristics.

The discussion begins with a review of the literature examining linkages between creative capital, competitive manufacturing, and amenities. We provide a number of suggestive anecdotes on the possible link between competitive manufacturing and amenities to establish the value of empirical testing. Given our research interest in examining manufacturing start-ups, we also address parallels between Florida's creative capital thesis and theories of entrepreneurship, and identify important distinctions. The limitations of our data for examining all manufacturing start-ups are addressed in the formulation of explicit testable hypotheses and the specification of an econometric model. The paper concludes with a discussion of the policy implications for rural development strategies suggested by our findings.

Linkages Between Creative Capital, Amenities, and Competitive Manufacturing

This paper's central hypothesis is that the strong association between creative capital and amenities, and the strong posited association between creative capital and competitive manufacturing, produces a link between amenities and competitive manufacturing. In this section we define the meaning of these terms as used in the paper and review empirical and conceptual work that has examined the linkages between these constructs.

Creative Capital and Amenities

For Florida, the "distinguishing feature of the Creative Class" is that "its members engage in work whose function is to 'create meaningful new forms'" (2002, p. 68). He identifies members by occupation, according to the creativity typically entailed. The hypothesis that creative activity drives economic development can thus be empirically tested, as can the hypothesis that individuals engaged in these processes act on particular residential preferences.

McGranahan and Wojan (2007) identify two problems of construct validity with Florida's creative class measure, problems exacerbated in rural areas. First, Florida uses generally creative summary occupations that include a number of detailed occupations requiring little creativity. Second, Florida includes health care professionals and schoolteachers, engaged primarily in processes of economic reproduction, not economic development. Not only are these occupations ubiquitous in providing essential services, they also make up a relatively large share of the creative class in declining rural communities. Their inclusion makes it more difficult to isolate the true contribution of creative workers to economic development. Differences between the original Florida measure and the one used in the current analysis are documented in Table 1.

The detailed description of the creative class in Table 1 allows us to note some important distinctions between entrepreneurship and the creative class. These distinctions are important for understanding our conjectures on why a significant presence of the creative class facilitates competitive manufacturing. Entrepreneurs—who are often represented in occupational data as managers—are a subset of the creative class who clearly perform the central function of creating "meaningful new forms" (Florida 2002, p. 68) Yet, other functions related to initiative, delegation, and leadership required of entrepreneurship might not be necessary in many other creative class occupations. A compelling distinction coming from theories of entrepreneurship is that entrepreneurs must be generalists (Lazear 2004), whereas many in the creative class are better characterized as specialists. Our conjecture is that manufacturing entrepreneurs dependent on the specialist knowledge embodied in nonproduction manufacturing

Table 1. Florida's (2002) Original Creative Class Occupations and a Recast Creative Class, Excluding Economic Reproduction Occupations and Occupations Requiring Little Creativity

STF4 Occupation Title	Florida	Recast	Excluded from Recast
Management Occupations	*Summary*		
Top executives	×	×	
Advertising, marketing, promotions, public relations, and sales managers	×	×	
Financial managers	×	×	
Operations specialties managers, except financial managers	×	×	
Farmers and farm managers	×		×
Other management occupations, except farmers and farm managers	×	×	
Business and Financial Operations Occupations	*Summary*	×	
Business operations specialists	×	×	
Accountants and auditors	×	×	
Other financial specialists	×	×	
Computer and Mathematical Occupations	*Summary*	*Summary*	
Architecture and Engineering Occupations	*Summary*	*Summary*	
Architects, surveyors, and cartographers	×	×	
Engineers	×	×	
Drafters, engineering, and mapping technicians	×	×	
Life, Physical, and Social Science Occupations	*Summary*		
Life and physical scientists	×	×	
Social scientists and related workers	×	×	
Life, physical, and social science technicians	×		×
Legal Occupations	*Summary*		
Lawyers	×	×	
Judges, magistrates, and other judicial workers	×		×
Legal support workers	×		×
Education, Training, and Library Occupations	*Summary*		
Post-secondary teachers	×	×	
Teachers: primary, secondary, and special education	×		×
Teachers: preschool, kindergarten, elementary, and middle school	×		×
Teachers: secondary school	×		×
Teachers: special education	×		×
Librarians, curators, and archivists	×	×	
Other teachers, instructors, education, training, and library occupations	×		×
Arts, Design, Entertainment, Sports, and Media Occupations	*Summary*	*Summary*	
Health Care Practitioners and Technical Occupations	*Summary*		
Physicians and surgeons	×		×
Registered nurses	×		×
Therapists	×		×
Other health diagnosing and treating practitioners and technical occupations	×		×
Health technologists and technicians	×		×
High-End Sales—Part of Sales Occupation Summary Category			
Sales representatives, services, wholesale and manufacturing	×	×	
Other sales and related occupations, including supervisors	×	×	

Source: McGranahan and Wojan (2007).

occupations will favor amenity-rich rural areas capable of attracting such workers (see also Dahl 2004).

McGranahan and Wojan (2007) identify a strong association between employment growth and both the initial level and growth of the creative class for the 1990–2000 period using their modified creative class measure. The analysis also identifies those county characteristics associated with the attraction of the creative class workers. The majority of variables characterized as amenities, either natural or man-made, were strongly associated with growth of the creative class. Landscape variables, including mountain topography and the share of land in forests, were positively associated with growth, while the share of land in cropland was negatively associated with growth. The number of days of January sun was another natural amenity that attracted creative workers. As for man-made amenities, the positive association with population density suggests that the availability of various consumer services is an important requirement. However, the negative association with density squared suggests that rural creative workers are not seeking out highly urbanized environments. The empirical evidence also supports Florida's claim that the creative class values opportunities for an active lifestyle: both the proportion employed in recreation and the number of sporting goods or bicycle shop employees per 1,000 residents were also associated with growth of the creative class.

The rural creative class is highly concentrated in the Mountain West, reflecting this strong association with amenities. However, rural creative class magnets are more dispersed than counties with the highest level of natural amenities. Figure 1 demonstrates this diffusion, showing every state with a nonmetro county to contain at least one county ranked in the top quarter in share of workers in the creative class. Within states, there appears to be an affinity to those locales that are amenity-rich, if not always spectacularly so. For example, areas such as the Smoky Mountain region in North Carolina, the Upper Peninsula of Michigan, Northern Wisconsin, and the Texas Hill Country all contain contiguous groups of counties in this upper quartile. Thus, while the top 5 percent of counties contain elite nonmetro Valhallas such as Aspen (Pitkin County, Colorado) and Jackson Hole (Teton County, Wyoming), or contain relatively large college towns, many counties in the top quarter are best characterized by a moderate level of amenities that increase the quality of life but, by themselves, may fail to comprise a compelling tourist attraction.

The econometric analysis is highly suggestive of a sorting of creative workers based on quality-of-life criteria that Florida identifies using qualitative methods for the urban creative class. Concentrations of creative class workers emerge as a behavioral outcome of this sorting process, for which amenities are a critical input. As such, the share of workers in the creative class should provide a much more reliable indicator of development potential than that provided by amenities directly. High natural amenity areas having very limited accessibility will fail to support various quality-of-life criteria. In other instances, the natural amenity input may be so highly valued that its capitalization in land values displaces other economic activities. We now discuss the conceptual justification for positing the co-location of creative capital and competitive manufacturing.

Creative Capital and Competitive Manufacturing

Despite claims that the creative revolution is also transforming manufacturing, Florida identifies cities with a large share of employment in production occupations as being deficient in creative class workers and, by extension, lacking the urban amenities that attract these workers (Florida 2002, p. 240). Our analysis of competitive manufacturing suggests that the critical phenomena between the creative class and manufacturing are happening at the margin where new manufacturing establishments are created, or are transformed to bolster their long-term survival.

The creative transformation in manufacturing is regarded in some respects as a renewal of the creative process of highly skilled craft workers in an earlier epoch of industrialization (see Piore and Sabel 1984). The new "creative factories" emphasize continuous improvement and the delegation of responsibility for quality and problem-solving to all workers in a plant. This contrasts with the waning Fordist model that "delegated creativity to the man at the top and denied it to the rank and file" (Florida 2002, p. 66). The implication is that similar qualities required for the

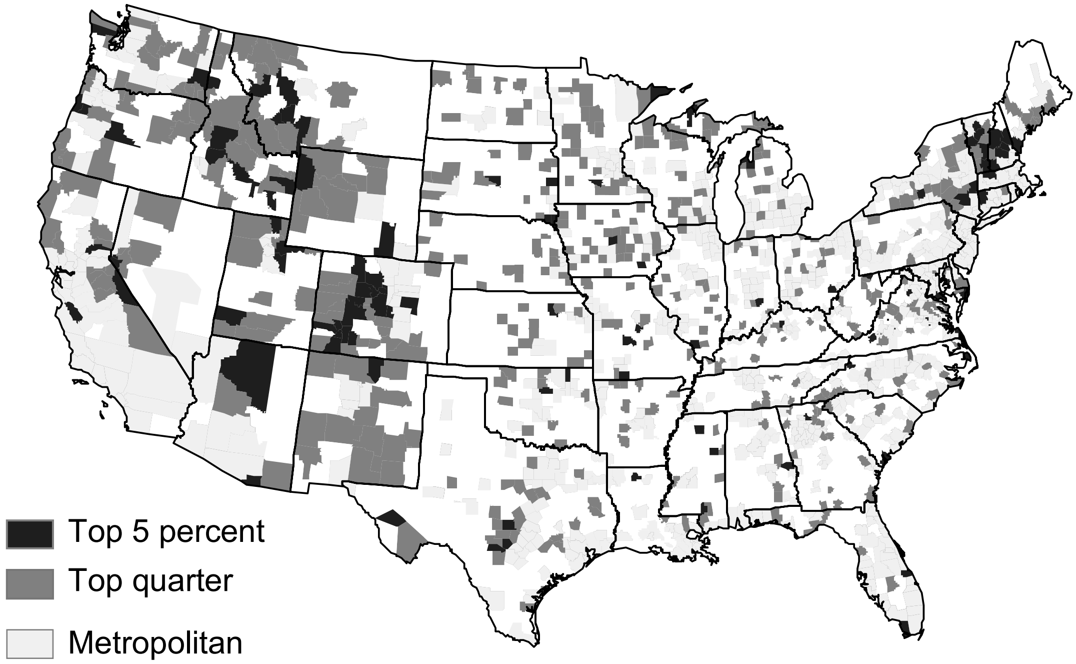

Figure 1. Creative Class (Recast) Share in Nonmetropolitan Counties, 2000

management of creative class workers would also apply to the management of creative production workers, in direct contradiction to the Fordist interest in work control (see also Doeringer, Evans-Klock, and Terkla 2004).

The greater importance of product differentiation, in concert with labor-saving production technologies, is also increasing the share of professional nonproduction workers in manufacturing. These workers—engineers, designers, marketing professionals—are included in the creative class as their work is highly creative and so presumably have residential preferences similar to their colleagues in nonmanufacturing industries. Rural branch plant industrialization may be unaffected by this shift if the majority of these professional functions take place at headquarters or in R&D facilities. In contrast, unit plants may favor locations with attractive quality-of-life attributes, given their need to recruit professional workers. If a link between amenities and competitive manufacturing mediated through the creative class does exist, we would expect this association to be much stronger for unit plants than for branch plants.

Lee, Florida, and Acs (2004) provide evidence that some urban attributes that appeal to creative class workers are also associated with faster rates of new manufacturing firm formation. Their "creativity index" was related to both manufacturing and service industry start-ups. In contrast, the population proportion with a college degree had a negative relationship with manufacturing start-ups and a positive relationship with service industry start-ups. The focus on manufacturing start-ups arguably differentiates highly adaptable firms from more established plants that may or may not follow practices associated with the "creative factory." Entry of new firms in this context is not only "an (imperfect) mechanism for getting prices right in markets, it is a mechanism for getting product and process specifications right" (Geroski 1995, p. 437; see also Fritsch and Mueller 2004)—changes needed to adapt to new pressures coming from the increasing competitiveness of low-cost offshore producers. The conclusion is that creative class occupations in manufacturing exhibit the same locational preferences as other creative class workers. The following analysis will test whether the positive creative capital impacts on manufacturing start-ups extend to the rural context.

Long-established manufacturing plants may also adapt to these new competitive pressures through the adoption of advanced technologies and management practices. These technologies and strategies may increase the competence, competitiveness, and performance of manufacturing plants, or these innovations may merely bolster command-and-control strategies (e.g., Shaiken, Hertzenberg, and Kuhn 1986). A definitive answer is dependent on how the innovation is implemented, but empirical evidence suggests that all are common fixtures in high-performance factories (Appelbaum et al. 2000, Doeringer, Evans-Klock, and Terkla 2004, Doms, Dunne, and Troske 1997). In addition, establishments adopting these practices had greater demand for skill upgrading of production workers (Gale, Wojan, and Olmsted 2002). Our hypothesis is that plants adopting these practices are more prevalent in counties that also attract the creative class. See box for a list of technologies and management practices used to construct our count index [see also Doms, Dunne, and Troske (1997) and Baldwin, Diverty, and Sabourin (1995)].

Evidence of Amenities Attracting Competitive Manufacturing

The most tenuous linkage is that between amenities and competitive manufacturing in rural areas. Granger and Blomquist (1999) found that, in urban areas, amenities as measured by a quality-of-life index mattered most for labor-intensive industries in which payroll was a high percentage of value-added. More generally, studies have found that amenities are most likely to factor into location decisions for high-technology and highly skilled activities (Salvesan and Renski 2002, Gottlieb 1994). However, these literature reviews concerned mainly with the locational preferences of "new economy" firms caution that rural areas may lack critical inputs: "The bundle of agglomeration benefits offered by large metro areas is likely to outweigh the singular quality-of-life benefits of smaller places for most firms" (Salvesan and Renski 2002, p. 19).

Survey research by Halstead and Deller (1997) suggests that amenities and quality of life have a strong influence on the location decisions of small rural manufacturing plants in northern New England and Wisconsin. The location decision for these small firms was dominated by the residential preferences of the business owner. While this result helps explain the existence of manufacturing in amenity-rich areas, it does not address the potential competitive advantages of these areas. In particular, the findings from Halstead and Deller do not contradict Salvesan and Renski's conjecture that rural quality of life may fail to outweigh rural disadvantages for most competitive manufacturers.

We offer several examples of where the linkage between amenities and competitive manufacturing has been directly observed or where the linkage is strongly suggested. Since "existence proves possibility" (Isserman 2000, p. 132), the anecdotes provide assurance that empirical testing as to whether this linkage applies generally in rural areas is worthwhile.

Wojan (1996) provides direct evidence of this linkage in interviews with owner-managers of manufacturing plants in northern Wisconsin. Several owners cited growing frustration with the weekend commute from Chicago or the Twin Cities to their vacation home as the principal motivation for relocating their manufacturing operation from the city to a rural recreational playground. In another example, a hometown entrepreneur returned to establish a high-tech manufacturing firm after obtaining an advanced degree

TECHNOLOGIES

- Computer-aided design (CAD)
- CAD linked to computer-aided machining (CAD/CAM)
- Numerically or computer-controlled machines (NC/CNC)
- Programmable controllers (PC)
- Local area computer network (LAN)
- Fax machines
- Modems
- Satellite communications
- Computer linkages to other companies
- Other (self-identified)

MANAGEMENT PRACTICES

- Self-directed or self-managed work teams
- Job rotation
- Employee problem-solving groups or quality circles (PSG/QC)
- Statistical process control (SPC)
- Total quality management (TQM)

Source: Gale et al. (1999).

in engineering. In both instances, familiarity with the area convinced these entrepreneurs that the quality-of-life attributes would be sufficient to attract professional staff from Chicago or the Twin Cities. In addition, the strong interest of locals to stay in their community ensured the availability of a committed and stable production workforce that was becoming increasingly difficul to secure in the city.

An examination of amenity-driven development in Europe is suggestive of the sorting process for competitive manufacturing in rural areas examined here (OECD 2002). A matching algorithm to find NUTS 3[1] regions that were structurally similar to Siena, Italy—using rudimentary characteristics such as population density, proximity to large urban centers, and employment shares in agriculture, manufacturing, and services—identified two seemingly coincidental factors. As with Siena, several of the matched regions had developed reputations for producing world-class wines, a high-value activity that would preserve a low population density through the maintenance of vineyards despite urban proximity. The other common feature was a specialization in various high-tech sectors such as pharmaceuticals in Siena, multimedia in Vienne, France, high-tech contract manufacturing in Rieti, Italy, and expertise in plastics, imagery, and mechanical engineering in Saone-et-Loire, France.

The fact that some high-amenity areas have demonstrated success in attracting or developing competitive manufacturing is enough to consider extending amenity development strategies far beyond tourism. The likelihood that these strategies will meet with success is addressed next.

Constructing Empirical Tests

The manufacturing data for this study are from the 1996 telephone survey of 3,900 manufacturers carried out for the Economic Research Service by the Washington State University Social and Economic Sciences Research Center. The estimated response rate for the survey was 68 percent. The survey over-sampled nonmetropolitan establishments ($N = 2{,}841$), large establishments, and establishments in the nonmetropolitan West Census region. Establishments with fewer than 10 employees were not surveyed, as the adoption of advanced technologies was a major motivation for the study and many of these technologies are not relevant for very small manufacturers. For the present study, the sample was weighted to reflect the nonmetropolitan establishment population in 1994, keeping the same sample *N*.

We analyze two dependent variables reflecting entrepreneurial activity. The first and most direct is whether the establishment was new since 1992, a direct question on the survey. Our expectation is that establishments are more likely to be new where creative capital is high.[2] This measure is similar to that used in Lee, Florida, and Acs (2004), although, due to the nature of our data, we use establishments rather than locations as units of analysis.

Censoring establishments with fewer than 10 employees is problematic if the concern is to model location choices of all rural manufacturing entrepreneurs. Establishments with fewer than 10 employees comprise the majority of all manufacturing establishments and the huge preponderance of recent manufacturing start-ups. However, not all entrepreneurial events in manufacturing are necessarily germane to the hypothesis being tested. Both "lifestyle manufacturing entrepreneurs" (McMahon 2001) and micro-manufacturers that subcontract to larger local firms will have no need to recruit manufacturing professionals. In contrast, the location decisions of new start-ups that are growth-oriented will be influenced by the eventual ability to recruit highly skilled staff. Although arbitrary, the 10-employee size threshold is a reasonable cut-off for excluding many manufacturers that are not growth-oriented, while missing only some aspiring growth-oriented firms.

The other dependent variable relates to manufacturing technologies and practices. We are asking, in essence, whether creative capital is related not only to the formation of new growth-oriented manufacturing establishments but also to the way

[1] Nomenclature of Territorial Units for Statistics (NUTS) is the geocode standard for identifying administrative divisions in the European Union. NUTS 3 is the smallest regional division made up of local administrative units such as districts and municipalities. NUTS 3 divisions correspond with provinces in Italy and départements in France.

[2] We assume that a high ratio of new to old plants reflects a high rate of start-ups. However, it would be possible to find a high proportion of new plants in situations where existing plants have closed at a very high rate. It is difficult to imagine that this would not be a highly exceptional case.

manufacturing is carried out, with the expectation that plants in localities high in creative capital are likely to use more advanced production and management methods. The measure takes on the value of 1 if the establishment falls in the top quarter in the count of advanced production technologies, management practices, and information technologies included in the survey, 0 otherwise.[3] The advanced-technologies scale is relevant across detailed industries, with high-scoring establishments found in almost all 3-digit SIC industries.

We include three other establishment characteristics in the analysis: its employment size (ln), whether it is self-directed or a branch of a larger firm, and its 2-digit SIC code, expressed as a set of dummy variables. Previous research with this same data set indicated that large, branch plants were likely to have adopted more advanced technologies than their smaller, locally owned counterparts (Gale 1997, McGranahan 2002). In the adoption equation, we also include an indicator of whether the plant was established in the three years preceding the survey, with the expectation that new plants will be high adopters (Geroski 1995, Fritsch and Mueller 2004).

However, our interest in plant branch status and size is more than as simple control measures. If areas high in creative capital generate and attract entrepreneurial activity rather than simply attract new plants, then creative capital should be more highly related to the formation of new self-directed plants than to the location of new branch plants. Moreover, branch plants are likely to adopt new methods and technologies as a part of a firm-level strategy rather than an establishment-level strategy. Thus, branch plants should be less affected by location than self-directed plants in advanced technology adoption.

We expect that several local area measures will be related to both entrepreneurship and creative capital. Foremost are indicators of human capital: the proportion of young adults (age 25–44) in the county with at least a college degree and the proportion of young adults in the local labor market with at least a high school degree. The former was included as higher education has been associated both with entrepreneurship and creative capital. Area rates of high school completion have been related to technology adoption (Gale 1997).

In addition, we include the percentage of 18- to 25-year-olds enrolled in college to differentiate counties with substantial college towns from counties lacking a significant college population. Colleges are not prevalent in nonmetropolitan counties, and their presence could facilitate entrepreneurship. College and university faculty are considered to be members of the creative class by definition.

Urban access, whether through adjacency to a metropolitan area or through county urbanization, as measured by population density and the presence of a city of 10,000–50,000 residents reflects access to resources that might enhance entrepreneurship. The creative class as a proportion of all employment is likely to be higher in more urban locations because of the greater availability of services.

The proportion of county jobs in manufacturing may enhance entrepreneurship, creating a more fertile seedbed for start-ups in the manufacturing sector (Fritsch 1992). We expect it to be negatively associated with creative capital, however, given that manufacturing enterprises are relatively large and, in rural areas at least, not major employers of professional workers.

In rural areas, the creative class is drawn to areas high in natural amenities (McGranahan and Wojan 2007), and manufacturing entrepreneurs and manufacturing professionals might be as well. We included McGranahan's (1999) natural amenity scale, which combines 4 climate measures [average January temperature and days of sun, average July humidity (coded negatively), and temperate summer], varied topography, and surface water as a percentage of county area. The scale does not otherwise measure landscape, so we also included the proportion of county land in forest as an additional measure.

We also include controls for more traditional phenomena related to manufacturing location and technology adoption (see Granger and Blomquist 1999, Roper 2001, Lambert, McNamara, and Garrett 2006). These variables relate to local demand, agglomeration and localization, market access, and labor cost. We control for potential differences in final demand for manufactured goods by including the weighted median household income of counties within an establishment's

[3] Since the scale of technology use is based on a set of items, the actual cut-off included a slightly larger fraction than a quarter.

labor market area.[4] Predicted manufacturing employment growth in an establishment's labor market area between 1991 and 1993, computed as the industrial mix component from a standard shift-share decomposition, is used to proxy changes in intermediate demand.

We include two variables to control for differing hypotheses regarding the importance of localization and agglomeration. The clustering of firms in the same 2-digit SIC industry is captured by a modified Herfindahl index, defined by the number of establishments divided by the Herfindahl employment concentration of the industry in the county (see Wojan and Lackey 2000). The value of this variable explodes with the increase of similarly sized establishments in an industry, capturing effects associated with a Marshallian industrial district. Previous analysis also found that the diversity of industries in a rural place increased the probability of adopting advanced technologies and practices (McGranahan 2002). This is represented by the log of the number of unique 3-digit SIC industries in the county and captures the cross-fertilization across industries first posited in Jane Jacobs' theories of urban development.

The importance of market accessibility to the location of competitive manufacturing is assessed by including the presence of an interstate highway and the presence of a commercial airport in the county. We include manufacturing wages in the county in the relevant preceding period (first quarter of 1993) to assess the importance of labor cost factors in the location of competitive manufacturing.

The four Census regions were represented by dummy variables to take account of broad regional variation that might not be reflected in the other independent measures. Finally, the advanced technology use analyses include dummy variables for 2-digit SIC industries.

Despite our assumption that the local context has some impact on the decisions at the establishment level, we are unable to control for spatial lags or spatial errors that may condition the data. While one might assume that adoption rates are conditioned by adoption rates of neighboring establishments, these data are not available. We do control for potential spillover effects in the independent variables related to market demand, but otherwise assume an aspatial specification that is typical when using microdata.

Results

Table 2 summarizes establishment characteristics from the survey for branch plants, self-directed plants, and, for comparison purposes, metropolitan plants. Branch plants accounted for nearly a third of all nonmetropolitan establishments and about half of employment. In general, they are more significant in nonmetropolitan areas than in metropolitan areas.

New plants were relatively scarce in the survey—only 5 percent of the total nonmetropolitan sample had not been in operation in 1992. The numbers undoubtedly would have been higher if establishments with fewer than 10 employees had not been excluded from the sample. Moreover, while the sample was drawn in 1995, there may have been some lag between the start of a plant and its appearance in the sampling frame. While the proportion of new branch plants was twice that of the proportion of new self-directed plants, there were more new self-directed plants, reflecting their greater number.

Branch plants were also more likely to use advanced technologies than self-directed plants. The proportion of branch plants in the top quarter in advanced technology use was nearly twice as high. In part, this reflects the larger size of the branch plants. In general, the adoption of advanced technologies may have involved scale economies at both the plant and firm level.

Among the counties with manufacturers in the sample, the mean proportion of employment in the creative class was 13 percent in nonmetropolitan counties, much lower than the 21 percent in metropolitan counties. Nevertheless, there was a considerable range across nonmetropolitan counties, with a top decile (19 percent) that was twice the bottom decile (9 percent).

An OLS regression of creative capital on the control measures for all nonmetropolitan counties containing at least one plant in the ERS Manufacturing Survey shows a strong relationship between creative capital and human capital (Table

[4] Labor market areas were constructed from journey-to-work data from the 1990 Census using a hierarchical cluster method to combine counties with large intercounty flows (Tolbert and Sizer 1996). As labor market sheds, these labor market areas provide the most compelling functional area constructed from administrative boundaries.

Table 2. Survey Establishment Characteristics

	Nonmetropolitan			
	Plant type			
Characteristics	Branch	Self-directed[a]	Total	Metropolitan[b]
No. of establishments	818	2,002	2,820	1,041
Proportion branch (%)			29.0	17.2
Total employment	158,254	162,193	320,446	144,253
Average size	193	81	114	139
New in last 3 years				
N	60	78	138	
%	7.3	3.9	4.9	3.5
ISO 9000 registered (%)	12.9	4.9	7.2	6.7
Top quarter in advanced technology use (%)	41.3	22.4	27.9	31.2

[a] A fifth of these establishments are headquarters for multi-establishment firms.
[b] Metropolitan establishments were sampled at a substantially lower rate.

3). The beta coefficient for the proportion of young adults with at least a college degree is 0.66, even with the high school completion measure for the local labor market area in the analysis as well.

Consistent with the markedly higher creative capital levels in metropolitan counties compared with nonmetropolitan counties, creative capital is also strongly associated with density and city size within nonmetropolitan areas. However, counties adjacent to metropolitan areas have slightly lower levels of creative capital than other nonmetropolitan counties. Areas high in creative capital are not simply high-end suburbs. In general, nonmetropolitan counties specializing in manufacturing have less creative capital than other nonmetropolitan counties, a reflection perhaps of the occupational structure of rural manufacturing.

Consistent with McGranahan and Wojan's (2007) argument that in rural contexts, creative capital is drawn to attractive environments, both the natural amenities scale and the forest measures are associated with creative capital.

The picture that emerges is that nonmetropolitan counties high in creative capital are relatively urban counties, very high in human capital. This creative capital does not derive particularly from the presence of universities or proximity to major urban areas, however, but is related to industry structure and attractiveness of the county as a place to live.

The likelihood that a nonmetropolitan manufacturing establishment was new was significantly higher in counties high in creative capital in 1990 than in other counties (Table 4). Human capital itself was not associated with the generation of new plants, however. In fact, county college completion has a net negative effect, which is what Lee, Florida, and Acs (2004) found in their study of new metropolitan manufacturing firms. When the sample is split into branch and self-directed plants, it is apparent that creative capital is relevant only for the latter. New branch plants are not particularly drawn to areas high in creative capital. However, the coefficient for creative capital is exceptionally strong in the case of autonomous plants.

Creative capital is also related to the likelihood of being a high adopter of advanced technologies (Table 5). As in the case of new plant formation, creative capital is associated only with advanced technology use among self-directed plants.[5] For branch plants, the coefficient is actually slightly negative. Plants established within 3 years of the

[5] We found a very similar result of the creative class share being associated with a higher probability that a plant was registered to the ISO 9000 quality assurance standards, maintained by the International Organization for Standardization. The advantage of this measure is that the event is confirmed by an accredited third party in contrast to the self-reporting of technology and management practices in the adoption measure analyzed here. There is also case study evidence to suggest that the standards facilitate the contributions from a more autonomous workforce to continual improvement, consistent with the objectives of the "creative factory" (Wojan 2001).

Table 3. Regression of Creative Capital on Other County and Area Characteristics—Nonmetropolitan Counties with Manufacturers in ERS Data Set

	B	Std. Error	Beta	t	Sig.
Household income (LMA)	**0.0159**	**0.0035**	**0.080**	**4.4974**	**0.0000**
Manufacturing jobs county (%)	**-0.0006**	**0.0001**	**-0.181**	**-10.84**	**0.0000**
Manufacturing wage	**1.7E-06**	**3.7E-07**	**0.071**	**4.5901**	**0.0000**
Modified Herfendahl index (2-digit)	1.5E-06	1.2E-05	0.002	0.1192	0.9051
Manufacturing diversity	**0.0077**	**0.0013**	**0.133**	**6.0856**	**0.0000**
Expected manufacturing growth (1,000s) (LMA)	-1.5E-07	2.6E-07	-0.008	-0.5742	0.5659
Workforce education (ages 25–44, 1990)					
H.S. diploma (local labor market)	3.1E-05	0.0001	0.007	0.2951	0.7680
College completed (county)	**0.0039**	**0.0001**	**0.664**	**31.6392**	**0.0000**
Educational institution (county)					
Population 18–25 enrolled in college	-5.9E-06	4.2E-05	-0.003	-0.1406	0.8882
Settlement, 1990					
Adjacent to metropolitan area	**-0.0047**	**0.0010**	**-0.068**	**-4.5679**	**0.0000**
Center with 10,000+ residents	**0.0032**	**0.0013**	**0.043**	**2.4761**	**0.0134**
Population density (ln)	**0.0062**	**0.0009**	**0.164**	**6.7454**	**0.0000**
Commercial airport (county)	0.0003	0.0021	0.002	0.1609	0.8722
Interstate highway in county	0.0009	0.0010	0.013	0.9327	0.3512
Natural amenities					
Natural amenity scale	**0.0023**	**0.0003**	**0.147**	**6.8793**	**0.0000**
Land in forest (%)	**0.0021**	**0.0004**	**0.085**	**4.9746**	**0.0000**
Region					
Northeast	**-0.0065**	**0.0022**	**-0.047**	**-2.9683**	**0.0031**
South	-2.0E-05	0.0016	-2.9E-04	-0.0127	0.9899
West	0.0032	0.0026	0.030	1.2455	0.2132
Constant	-0.1301	0.0334		-3.8986	0.0001
R^2	0.796				
N = 1194					

survey were also more likely to be high adopters of advanced technologies, suggesting that new firm formation is one mechanism for manufacturing modernization (Geroski 1995, Fritsch and Mueller 2004).

Aside from the association with creative capital (and plant size), there is surprisingly little bearing that local area characteristics appear to have on advanced technology use. As noted above, previous research has found that local labor market education levels are associated with new technology adoption, but that is not the case here. For all plants, local labor market completion rates are associated with adoption, but when the sample is split, the relationships are not strong enough for statistical significance. Part of the explanation may lie in the fact that creative capital is itself associated with local education levels and that it is creative capital that is key, not local workforce characteristics.

In all, the results are striking evidence for the association between creative capital and manufacturing entrepreneurship, where that entrepreneurship is measured by new plant formation and advanced technology use. The data are not clear on whether the association between creative capital and entrepreneurship is simply associational, in that manufacturing entrepreneurs are attracted to

Table 4. Logistic Regression of New Establishment in Past Three Years on Creative Capital and Other Measures

	All Establishments			Branch Establishments			Self-Directed Establishments		
Independent variables	B	Wald	Sig.	B	Wald	Sig.	B	Wald	Sig.
Plant characteristics									
Branch plant	0.6227	10.86	0.001						
2-digit SIC dummy variables	---	---	---	---	---	---	---	---	---
Local area characteristics									
Creative capital, 1990 (county)	10.3004	2.83	0.092	-5.6403	0.30	0.581	**19.6630**	**5.91**	**0.015**
Industrial context									
Household income (LMA)	-0.6406	0.69	0.405	0.5074	0.18	0.673	-1.4430	1.90	0.168
Manufacturing jobs, county (%)	0.0065	0.33	0.567	-0.0146	0.57	0.449	**0.0259**	**3.25**	**0.072**
Manufacturing wage	-0.0001	0.92	0.337	**-0.0003**	**3.18**	**0.075**	0.0000	0.07	0.786
Modified Herfendahl index (2-digit)	-0.0002	0.01	0.918	-0.0010	0.05	0.820	-0.0005	0.10	0.748
Manufacturing diversity	-0.0387	0.02	0.884	0.3123	0.47	0.491	-0.1206	0.13	0.720
Expected manufacturing growth (1,000s) (LMA)	0.0001	1.84	0.175	0.0000	0.00	0.991	**0.0001**	**3.13**	**0.077**
Education completed, ages 25–44									
High school (LMA)	0.0074	0.11	0.735	-0.0143	0.18	0.671	0.0217	0.55	0.460
College (county)	-0.0533	1.90	0.168	0.0205	0.10	0.751	**-0.0938**	**3.57**	**0.059**
Educational institution (county)									
Population 18–25 enrolled in college	0.0011	0.01	0.906	-0.0107	0.45	0.500	0.0074	0.42	0.518
Settlement and location									
Adjacent to metropolitan area	-0.1055	0.25	0.616	0.1767	0.26	0.610	-0.3772	1.79	0.181
Center with 10,000+ residents	-0.1817	0.49	0.486	0.0769	0.03	0.855	-0.2399	0.47	0.495
Population density (ln)	0.2100	1.03	0.311	0.1038	0.09	0.766	0.2328	0.76	0.383
Commercial airport (county)	-0.3269	0.48	0.487	-0.2288	0.13	0.718	-0.5382	0.54	0.464
Interstate highway in county	0.1777	0.84	0.359	0.3910	1.73	0.189	-0.0424	0.03	0.874
Amenities									
Natural amenity scale	-0.0802	1.19	0.275	-0.0145	0.02	0.900	-0.1117	1.26	0.262
Land in forest (%)	-0.0917	0.96	0.328	0.0750	0.23	0.635	**-0.2160**	**3.12**	**0.077**
Region									
Northeast	**-1.2472**	**3.22**	**0.073**	**-2.2364**	**3.29**	**0.070**	-0.6353	0.54	0.461
South	**0.7061**	**4.53**	**0.033**	0.0221	0.00	0.964	**1.2278**	**6.68**	**0.010**
West	0.6177	1.14	0.285	0.0228	0.00	0.981	1.0857	2.06	0.152
Midwest (omitted)									
Constant	0.4664	0.00	0.949	-24.37	0.00	0.996	6.7175	0.45	0.503
R2 (Nagelkerke)	0.09			0.11			0.14		
N	2781			806			1975		

Table 5. Logistic Regression of High Use of Advanced Technology on Creative Capital and Other Measures

	All Establishments			Branch Establishments			Self-Directed Establishments		
Plant characteristics	B	Wald	Sig.	B	Wald	Sig.	B	Wald	Sig.
Branch plant	**0.4372**	**14.65**	**0.000**						
Employment size (ln)	**0.7922**	**252.89**	**0.000**	**0.7321**	**73.60**	**0.000**	**0.8779**	**182.24**	**0.000**
New establishment in past 3 years	**0.8699**	**17.62**	**0.000**	**0.9630**	**10.11**	**0.001**	**0.8319**	**7.74**	**0.005**
2-digit SIC dummy variables	---	---	---	---	---	---	---	---	---
Local area characteristics									
Creative capital, 1990 (county)	**6.6188**	**3.83**	**0.050**	-1.1270	0.04	0.850	**10.2294**	**5.90**	**0.015**
Industrial context									
Household income (LMA)	-0.2930	0.48	0.487	-0.1503	0.04	0.833	-0.6580	1.46	0.226
Manufacturing jobs, county (%)	-0.0080	1.34	0.248	0.0039	0.12	0.733	-0.0131	2.06	0.152
Manufacturing wage	0.0000	1.15	0.284	0.0001	2.51	0.113	0.0000	0.04	0.847
Modified Herfendahl index (2-digit)	0.0000	0.00	0.977	**-0.0045**	**2.73**	**0.099**	0.0007	0.61	0.433
Manufacturing diversity	0.0403	0.08	0.783	-0.0220	0.01	0.931	0.0365	0.04	0.844
Expected manufacturing growth (1,000s) (LMA)	0.0000	1.42	0.233	0.0001	2.40	0.121	0.0000	0.00	1.000
Education completed, ages 25–44									
High school (LMA)	**0.0221**	**3.03**	**0.082**	0.0224	1.13	0.287	0.0204	1.53	0.215
College (county)	-0.0205	1.05	0.305	0.0076	0.04	0.832	-0.0361	2.14	0.143
Educational institution (county)									
Population 18–25 enrolled in college	-0.0060	1.56	0.212	-0.0014	0.03	0.869	-0.0082	1.78	0.183
Settlement and location									
Adjacent to metropolitan area	0.0215	0.03	0.857	-0.0048	0.00	0.981	0.0365	0.06	0.812
Center with 10,000+ residents	-0.0913	0.42	0.519	0.2011	0.69	0.407	-0.1852	1.07	0.301
Population density (ln)	-0.1538	2.02	0.155	-0.0668	0.12	0.733	-0.1813	1.81	0.179
Commercial airport (county)	0.2739	1.75	0.186	**0.7058**	**3.59**	**0.058**	-0.0242	0.01	0.929
Interstate highway in county	**0.1811**	**2.87**	**0.090**	**0.3206**	**3.18**	**0.075**	0.1735	1.59	0.208
Amenities									
Natural amenity scale	-0.0301	0.56	0.453	-0.0305	0.20	0.656	-0.0234	0.21	0.647
Land in forest (%)	**0.0907**	**3.05**	**0.081**	0.0750	0.69	0.405	0.1083	2.71	0.100
Region									
Northeast	0.0185	0.01	0.930	-0.5867	2.17	0.141	0.2358	0.87	0.350
South	-0.0930	0.25	0.617	-0.1956	0.41	0.519	-0.1442	0.35	0.556
West	0.2818	0.89	0.347	0.4443	0.68	0.410	0.2267	0.37	0.545
Midwest (omitted)									
Constant	-4.1643	1.06	0.303	-4.5899	0.46	0.498	-1.0231	0.04	0.846
R2 (Nagelkerke)	0.28			0.26			0.27		
N	2625			768			1857		

areas high in creative capital, or causal, in that location in a county high in creative capital generates new plant formation and leads to adoption of advanced technologies.

Policy Implications

Our empirical findings support the hypothesis of an association between amenities and competitive manufacturing, mediated through relatively high employment shares of the local creative class. Although the actual mechanisms producing this association are unknown, the results are consistent with anecdotal accounts of manufacturing entrepreneurs whose desire to locate in amenity-rich rural areas was feasible owing to the ability to recruit talented professional staff. Previous work finding an association between amenities and the creative class apparently extends to creative workers in the manufacturing sector. In fact, the share of creative capital in the labor force is the only county characteristic consistently associated with proxies for competitive manufacturing in self-directed plants examined here.

Notwithstanding this strong empirical support, we anticipate considerable resistance to the idea of amenity-driven industrial development. Much less contentious is confirmation from the analysis that amenities as a regional asset have much broader application than tourism development. The conventional approach to amenity-driven development has certainly stressed tourism, but not to the exclusion of other economic activities. The examination of both small, export-oriented producer services companies (Beyers and Lindahl 1996) and of concentrations of producer services firms (Goe 2002) in rural areas has emphasized the importance of recreational and quality-of-life attributes. Although the literature is somewhat skeptical of rural areas' ability to attract "new economy" firms though amenities and the possibility of a high quality of life (see Salvesan and Renski 2002), our findings are encouraging.

An amenity-driven strategy that extends beyond tourism should develop those collective goods that increase the quality of life of current and potential future residents (see also Gottlieb 1994). The interconnectivity of the community with the outside world will be a general concern among any creative class migrants and should also be a top priority. Such a strategy could also tap the availability of committed, long-term workers required of successful ventures—a potentially large underutilized resource. Communities stressing quality education, with an emphasis on problem-solving and interpersonal communication required in the creative workplace (Murnane and Levy 1996), will have a huge advantage in attracting talent relative to other amenity-rich areas able to supply only low-skill, low-wage workers.

However, envisioning the feasibility of attracting knowledge-intensive manufacturing activities to rural areas may be short-circuited by an abiding faith in the product cycle theory of industrial development. Product cycle theory asserts that innovative manufacturing requires an urban environment. The serious conceptual problems identified with the product cycle theory (Taylor 1986, Scott and Storper 1987, Dosi, Pavitt, and Soete 1990, pp. 132–133) suggest that its continued appeal is premised on its apparent empirical robustness (Barkley 1988, Barkley, Dahlgren, and Smith 1988, Barkley and Keith 1991, Glasmeier 1991, Miller 1989). Our results suggest that this robustness may be an artifact of the types of data used to test the theory. Aggregate county-level data will tend to confirm the hypothesis that plants relocate to rural areas to secure unskilled labor. This is because processes that conform to the theory will be given more weight in any analysis using employment as a metric, as branch plant relocations will tend to be quite large. In contrast, establishment-level data can identify innovative practices within rural plants, given a capability of examining manufacturing processes explicitly. Tests of the theory using aggregative data will simply fail to exhibit the innovative activity of smaller firms because their employment is buried in an aggregate composed mainly of traditional branch plants. In this instance, the product cycle hypothesis is confirmed despite being invalid for a significant, policy-relevant subgroup. Accordingly, the implications from product cycle theory that are confirmed by observed patterns of branch plant industrialization are not necessarily applicable to the logic of self-directed plant location identified here.

The evidence presented here, derived from the relevant subgroup, helps to portray the product cycle as an ideal type—a mode of industrial development that may characterize the development of a particular industry at some time or place but does not prescribe an inevitable development path for urban and rural places. Clearly, the logic of branch plant location is not driven by the quality-of-life attributes valued by the creative class (Table 4). The fact that no county-level variables in the new branch plant equation are statistically significant reinforces the conclusion that different sets of factors not considered here may play a role in branch plant location decisions. In addition, the present analysis does not address the location decisions of manufacturing entrepreneurs in very small plants who have no need to recruit nonproduction manufacturing professionals.

By identifying the co-location of competitive manufacturing and creative capital and a strong negative association between creative capital and manufacturing employment, the analysis provides empirical evidence of a presumed trade-off between the rate of employment growth and its skill composition. Indeed, the prescription from the product cycle cautions that rural areas should be especially wary of industries that utilize large amounts of labor, as they are likely to provide poor jobs. The evidence provided here points to a clear alternative path for some rural communities but one that involves a trade-off of slower growth in employment for a developmentally superior labor force composition.[6]

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[6] This perspective has been addressed in the literature but has received little attention from researchers of rural development. In a piece outlining a framework to examine the relationship between human resource development and industrial development, Smith (1989, p. 21) writes: "[T]here may be important trade-offs between large complements of indiscriminately recruited jobs and smaller ones that have, if the hypothesis is correct, longer range possibilities for breaking the vicious cycle of low levels and qualities of education, severe underutilization and low productivity of labor, low skill demanding employers, and re-enforcement of the low standards of investment in human capital."

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