Three Essays in Regional Economics

DISSERTATION

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Abstract

In the United States, the economic recession and the ongoing economic restructuring have led researchers and policy makers to revisit their assumptions about the drivers of economic growth. My research seeks to understand the drivers of economic growth in two regions of the United States that have suffered the most during the recent period – Appalachia and the Great Lakes Region.

Appalachia is a predominantly rural region with a long history of high poverty and economic isolation. Because this region has low levels of human capital and the other resources that are typically associated with economic growth, in Chapter 1, I consider whether entrepreneurs can contribute to growth in that region. Using proprietor and small business shares as proxies for entrepreneurship and self-employment, and employing instrumental variables (IVs) and other approaches to control for endogeneity, I find that self-employment is positively associated with employment and income growth. This suggests that building entrepreneurial capacity may be one of the few economic development strategies with positive payoffs in the Appalachian region.

The Great Lakes region is comprised of eight states which border the Great Lakes and which historically benefited economically from this proximity. The eastern portion of the Great Lakes region is the heart of the nation's rust belt. With the decline of manufacturing and the ongoing economic restructuring, this region's economy has suffered. Policymakers are interested in whether there are economic development opportunities associated with access to the Great Lakes and their natural and recreational

amenities and if and how environmental and industrial disamenities might affect this potential.

In Chapter 2, I look at county-level population and employment growth in the Great Lakes region, drawing on the Tiebout (1956) notion that "people vote with their feet" and reside in places with particular bundles of economic and site-specific public goods and amenities, which may include urban, natural, and environmental amenities (or disamenities). I find little evidence that lake amenities are associated with overall population and employment growth in the region. However, consistent with natural amenities being normal or superior goods, I find that individuals with higher human capital are more likely to migrate toward counties located on one of the Great Lakes.

By using county-level data I may not be able to distinguish between those households that live directly on or within a short distance of one of the Great Lakes and those that live within a coastal county but farther from the lake. Thus, in Chapter 3, I use individual housing transactions for Northeast Ohio to examine more closely the value of lake amenities. This analysis will use the Rosen (1976) hedonic framework in which, within a labor market, housing prices can be used to uncover the values associated amenities and disamenities. Using a unique dataset that includes detailed geographically defined amenities and disamenities, I find that there is strong value from being immediately next to Lake Erie, but little evidence of additional willingness to pay by households in this region for other lake-related amenities.

In loving memory of my mother, Jean Joyner Stephens.

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Chapter 1: Do Entrepreneurs Matter for Economic Growth in Appalachia?

I. Introduction

Programs to support entrepreneurship are increasingly a core part of local economic development strategies in the United States. A wealth of research has suggested 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 forthcoming; Deller and McConnon 2009; Glaeser, Kerr, Ponzetto 2010; Glaeser 2007; Karlsson, Stough, and Johansson 2009; Loveridge and Nizalov 2007; Robbins et al. 2000; Shrestha, Goetz, and Rupasingha 2007). In particular, this research stream has linked entrepreneurship with endogenous growth.

Much of the previous research, however, has focused on the role of entrepreneurship in urban areas and some work even suggests that entrepreneurship may have larger marginal effects on economic growth in metropolitan areas (Shrestha, Goetz, and Rupasingha 2007). Other research has found that, for some regions, entrepreneurship is inversely linked to job creation (Mueller et al. 2008). Despite these findings, since rural, remote, and lagging regions in general may lack agglomeration economies and other features conducive to overall growth, building entrepreneurial communities may be the most practical policy option to help stimulate endogenous growth in these areas. Indeed, while there is evidence that rural economic growth is associated with proximity to urban areas (Partridge et al. 2008) and the presence of natural amenities (Deller et al.

2001; Partridge and Rickman, 2003), counties cannot create natural amenities or move closer to urban clusters, but they can support business development.

Many U.S. rural and remote regions face increasing economic hardships due to the restructuring of their traditional natural resource industries through the implementation of labor-saving technologies. These economic problems have been exacerbated by negative spillovers from lost natural resource jobs into the construction, retail, and services sectors (Black et al. 2005) and by increased global competition from low-wage developing countries that has wiped out the traditional (wage and land) cost advantages possessed by rural U.S. manufacturers. Rural areas are further disadvantaged in attracting large firms because of constraints on workforce availability or infrastructure and transportation cost disadvantages due to remoteness. Arguably, no other U.S. region has suffered longer from a lagging economy than the Appalachian mountain region. This is despite ongoing efforts to revitalize the region over more than four decades—including efforts to attract large outside firms through "smokestack chasing" and tax incentives.

Because there are many reasons to expect that new business development will support local growth, economic developers are increasingly turning to efforts to generate entrepreneurial communities in order to support growth in lagging regions (Goetz et al. forthcoming; Shrestha, Goetz, and Rupasingha 2007; Loveridge and Nizalov 2007; Deller and McConnon 2009). Additional benefits such as locally-owned businesses being more likely to purchase local inputs and less prone to relocation due to the owners' ties to the region, may magnify their positive impact on the region's economy.

A web of local businesses would also provide a diversified economic base that is less reliant on the whims of a few large, dominant firms. Large firms are more likely to be run by management located outside of the region and the profits from those companies are unlikely to be reinvested locally. For Appalachia, support for local-based entrepreneurs also provides hope for breaking the region's dependence on export-based industries, whose large employers facilitated the creation of a segmented and imperfectly competitive labor market that has been highly affected by downsizing and labor-saving productivity growth (Weiler 2001).

While policymakers assume entrepreneurship can advance growth in lagging communities, the challenge facing researchers is that it is not easily measured. Entrepreneurship is often associated with innovative, creative individuals who start new enterprises, yet researchers are forced to rely on measures of self-employment or business size to proxy for entrepreneurship (e.g., Shrestha, Goetz, and Rupasingha 2009; Loveridge and Nizalov 2007; Deller and McConnon 2009; Glaeser et al. 1992; Glaeser 2007). Regardless of the perfect definition, most programs striving to enhance entrepreneurship are aimed at raising the share of the workforce that is comprised of proprietors owning their own businesses (with or without employees). Thus, using the self-employment share (or share of small businesses) reflects how the entrepreneurship programs work in practice. However, all researchers acknowledge that the self-employed and small businesses may not always be innovative or creative in developing new products or in developing new markets (e.g., Lichtenstein and Lyons 2006). Many of these are in business more out of necessity (e.g., Acs 2006; Acs et al. 2009; Low et al. 2005). In a depressed setting such as Appalachia, this consideration could be especially problematic, suggesting that growth may even be inversely associated with these proxies (Mueller et al. 2008). In lagging regions, small business formation and self-employment may be emblematic of a weak economy rather than an engine of growth that can lift the region to prosperity.

Further complicating matters is that there could be tremendous heterogeneity in how entrepreneurship affects local economic activity (Deller forthcoming). As previously indicated, remote regions appear to be disadvantaged relative to urban centers in how entrepreneurial conditions affect growth. In rural settings, entrepreneurial activities may be more effective in increasing growth near urban centers or near places that are endowed with amenities that may be complementary to local growth. Likewise, institutional and policy differences would introduce further heterogeneity. In Appalachia, the influence of the Appalachian Regional Commission (ARC) is particularly noteworthy because it has invested in projects to leverage entrepreneurial economies through its Entrepreneurship Initiative (EI) (RUPRI et al., 2008). Yet, there is some evidence that ARC entrepreneurial activities have had very little impact on entrepreneurship in the region (Goetz and Rupasingha 2009).

Therefore, given the importance of understanding when and how entrepreneurship affects economic conditions in Appalachia, and remote and lagging regions in general, we use county-level data to test the effect of self-employment and small businesses on economic growth in Appalachia. A variety of economic indicators are considered including employment growth, per-capita income growth, and the change in poverty rates. We further assess whether access to urban areas and proximity to natural amenities are intervening variables in this process. In appraising different environments, we take advantage of the quasi natural experiment created by the designation of the ARC compared to neighboring Appalachian counties that are not part of the commission's domain. Finally, great care is taken to account for endogeneity and spatial spillovers (i.e. dependence).

Our empirical results suggest that despite the strong barriers to growth in Appalachia, increases in self-employment are positively associated with employment and per-capita income growth. However, we find very little evidence that the share of small businesses contributes to economic growth. We also find little evidence that self-employment or small business intensity affect poverty rates. As expected, self-employment appears to have its strongest positive effects near metropolitan areas and in places with high natural amenities. Finally, while there is only weak evidence that self-employment is more important in ARC counties versus the entire Appalachian region, we find evidence that the ARC has had some positive effects in other ways.

In what follows, we first describe the ARC region followed by a section that details the previous literature and our theoretical framework. Next, we describe our empirical model and data; followed by the empirical results. The final section presents some concluding thoughts and a discussion about policy.

II. The Appalachian Region

The Appalachian region follows the Appalachian Mountains and foothills from southern New York to northern Mississippi (see **Figure 1**). Historically, its economy has been dependent on the boom and bust cycles of the extraction of its natural resources, and many of the region's counties have been among the poorest in the nation. In 1965, Congress established the Appalachian Regional Commission (ARC) "to address the persistent poverty and growing economic despair of the Appalachian Region."[1] The ARC originally included 360 counties in 11 states, though today it has been expanded to 420

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[1]The background source is the ARC Website, www.arc.gov. Downloaded on July 20, 2010.

counties in parts of 13 states and includes roughly 25 million residents. The region is characterized by rugged mountain terrain whose inaccessibility is matched by its beauty—two features that will play a role in our empirical analysis. The region is rural – with only 30 percent of its counties considered part of a metropolitan area. Since 1965, the ARC region has made great strides in fighting poverty. But while some parts of the region have become more economically diversified, others, especially the more remote portions of the region, still require basic infrastructure such as roads and water and sewer systems, and nearly 20 percent of ARC counties remain economically distressed.

The ARC's efforts to fight poverty initially focused on attracting larger manufacturers and profitably extracting the region's natural resources (Whisnant 1994). Later efforts turned to diversification of the economy such as through development of the tourism and recreation industries. Throughout it all, developing the Appalachian road system has been a key priority, one that has achieved some success (Munro 1969; Rephann and Isserman 1994; Isserman and Rephann 1995).[2]

Appalachian economic development leaders have increasingly placed greater emphasis on entrepreneurship, resulting in numerous initiatives by federal agencies, states, local governments, universities, non-profits, and others to encourage self-employment and new business development. This effort gained momentum in 1997 with the ARC's launch of the Entrepreneurship Initiative (EI), a "ten-year initiative to invest in projects designed to build entrepreneurial economies across the Region" (Appalachian

[2]Building better highways to remote areas have *a priori* ambiguous effects because while highways increase access to urban markets for rural customers and commuters, they also allow urban firms greater access to remote markets allowing them to take advantage of economies of scale—i.e., a Krugman New Economic Geography argument (Partridge, 2010; Puga, 1999). Thus, remoteness may provide "distance protection" for remote small businesses from urban competitors.

Regional Commission). Other initiatives to support entrepreneurship in the region include the federal New Markets Initiative, which was enacted in 2000 to promote access to equity financing for start-up firms in underserved areas nationwide. One of the first venture capital firms created through the New Markets initiative, Adena Ventures, served part of the Appalachian region. In 2005, the Kellogg Foundation also funded two small projects that impacted Appalachia through its Rural Entrepreneurship Development Systems grant program (W.K. Kellogg Foundation). However, the few evaluation efforts yield mixed evidence about whether these initiatives have increased regional entrepreneurial development.[3] Even if they have been successful, it is still unclear whether increasing regional entrepreneurial development will actually result in long-term growth in lagging regions. Thus, we believe that an analysis of the *underlying motivation* of these policies is both timely and necessary—i.e., does greater 'entrepreneurship' increase growth in lagging regions and support the use of initiatives such as ARC's EI program?

III. Literature Review

Classical regional development theory typically focuses on the role of exports as a source of regional economic growth. Historically, this led many communities—especially rural communities—to focus on recruiting large export-oriented businesses as a means of

[3]According to the report prepared by RUPRI et al. (2008) for the ARC, during the 1997-2005 period, ARC directly invested $43 million in entrepreneurial initiatives and leveraged an additional $73 million in private investments. These investments are purported to have created 1,787 businesses and served 8,242 existing businesses. Direct job creation totaled 9,156 and 3,022 jobs were retained, all at an average public cost of $579 to $3,994 per job. However, ARC's investment is very modest, annually representing under $0.25 per capita. The reported direct job creation accounts for significantly less than one percent of the region's jobs. In fact, analysis by Goetz and Rupasingha (2009) found that in the 1990 to 2000 period, the region continued to lag behind the nation in proprietor formation.

generating economic growth. Yet, in recent work, Kilkenny and Partridge (2009) found that for rural areas, export employment is "neither necessary nor sufficient for rural development." Their results show that, in many rural areas, export-based employment (such as mining, manufacturing, or agriculture) has been associated with lower levels of growth. One key reason for their finding is that traditional export industries have experienced significant labor-saving technological changes resulting in major employment effects for small rural communities. "Over reliance" on export industries is consistent with Appalachia's persistent low growth rates and with the findings of Weiler (2001) that regional specialization in export-based industries has led to chronic high levels of unemployment due to its highly-segmented labor markets.

Acs and Kallas (2008) further contend that traditional supply-side theories of economic development based on having a "competitive pool of inputs" to attract new investment would be ineffective in a region with a poorly-educated workforce, like Appalachia. Indeed, global competition from developing countries further reduces the ability of remote regions in North America to compete on their historic advantages of low land and labor costs. For example, Polèse and Shearmur (2006) found that for remote regions of Canada (with similar natural resource-dependent economies to Appalachia), traditional economic policies are not effective and new approaches are needed to promote long-term economic sustainability in the face of declining populations. Their more recent work (Shearmur and Polèse 2007) focuses on the important role that local factors can play in influencing local growth.

Since traditional approaches appear to be of less use in promoting economic growth in the Appalachian region and other remote regions, we turn to research related to the effects of entrepreneurship, self-employment, and small businesses – because these factors may be highly localized and can possibly be affected by government policy.[4]

Theoretical work by Fritsch and Mueller (2004) explored the effects of new business creation – the direct effect of creating jobs; the displacement effect, where new businesses take jobs away from existing businesses; and the induced or indirect effects, where new businesses accelerate structural change, create new markets or products, induce other firms to become more competitive, and contribute to the economic growth of a region. The direct and indirect effects should increase employment. For example, a positive factor for entrepreneurial-driven growth is that the self-employed and small businesses may purchase more inputs locally and may be less prone than multinational corporations to leave for greener pastures (i.e. for cheaper labor, lower taxes, or other economic development incentives). However, the displacement effects should lower employment. If the positive effects outweigh the negative effects, there should be net economic growth in a region. As Mueller et al. (2008) found in their analysis of start-ups in Great Britain, whether or not the creation of new businesses leads to economic growth depends on the characteristics of a region such as the type of incumbent new businesses and the business climate in the region. In addition, because the indirect effects may take some time to develop, the full effects from new business development may only be realized over the longer term. Yet, not all new businesses are entrepreneurial and not all entrepreneurial businesses are new, thus it is not clear whether only focusing on *new* businesses would provide a good measure of the effect of entrepreneurs on growth.

Numerous other studies have documented the direct effects from small businesses – e.g., the job creation ability of small businesses (Robbins et al. 2000; Barth et al. 2008).

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[4] In the literature and theoretical overview, we use new businesses, small business, entrepreneur, and self-employed interchangeably as they were used by the original authors. More on this point in Section V.A.

According to a 2004 study by the Kauffman foundation, "over the last decade, small firms have provided 60–80% of the net new jobs in the economy," (U.S. Small Business Administration 2004). However, as Shane (2009) points out, small businesses also are prone to "destroy" more jobs due to layoffs and closure. Again, the distinction must be made between small businesses and entrepreneurs.

Audretsch (2002) found that spillover effects from entrepreneurship and innovation can have positive impacts on both business formation and economic growth. Spillovers arise when knowledge created by one business "spills over" into the immediate geographic region. Audretsch contends that urban areas are best suited to benefit from these effects, which is not surprising as spillovers are generally associated with urban agglomeration effects (Puga 2010), though Monchuk et al. (2009) found innovative firms in certain industries can thrive in remote regions. However, using UK data, Faggian and McCann (2009) find little support that small firms promote regional innovation, suggesting that there is no clear *a priori* prediction regarding the effect of small firms. This raises an important question about the correlation between entrepreneurship and the size of firms.

Several researchers have attempted to explain how entrepreneurship can affect economic growth by explicitly introducing entrepreneurs into traditional endogenous growth models in the spirit of Romer (1986, 1990) and building from Aghion and Howitt (1992). Recent studies tend to model technological advance as a process of entrepreneurial innovation; including Audretsch and Keilbach (2004; 2007), Braunerhjelm et al. (2010), and Greis and Naudé (2010). Braunerhjelm et al. (2010) introduce the notion of a Schumpeterian (Schumpeter, 1942) or innovative entrepreneur into their model of endogenous growth. In their model, the entrepreneur converts general knowledge into "economically useful" knowledge as a means of generating growth. Thus, regional disparities in economic growth depend on the differences in the intensity of entrepreneurial capital (Roberts and Setterfield, 2010). Audretsch and Keilbach (2004; 2007) expand the pool of competitive inputs in traditional endogenous growth models to include entrepreneurial capital, which they define as a region's capacity to support new start-ups. They find that entrepreneurship capital is strongly correlated with economic growth and, like Shearmur and Polèse (2007), they find evidence of localized growth.

A number of other papers have tested the theoretical models relating entrepreneurship to growth. Using self-employment as a measure of entrepreneurship, Shrestha, Goetz, and Rupasingha (2007) examined the economic growth of U.S. regions in the five-year period after new proprietorships were formed. They found that increases in the number of proprietors were positively associated with net job growth in a region. The strongest evidence of this effect was found in metropolitan counties, which had an additional 0.1 percent increase in jobs over rural areas (Shrestha, Goetz, and Rupasingha 2007). They also found clusters of high job growth rates in certain geographic areas of the country, further evidence of spillover effects and consistent with work by Porter (1998). However, Feser et al. (2008) found no link between clustering and job growth in Appalachia. In a similar study of Sweden, Fölster (2000) found that self-employment had a positive impact on overall employment growth.

Deller and McConnon (2009) examined the association between microenterprises (one to four employees) and regional economic growth (population, employment, and per capita income) using state-level data. Their results suggest that a greater share of microenterprises is positively associated with economic growth, especially in the service sector. Deller (forthcoming) further concludes that there is significant spatial heterogeneity in the effect of microenterprises on growth, suggesting that "blanket statements about how small businesses influence growth can be misleading." Indeed, such heterogeneity underlies our analysis below.

Acs's (2006) notion of necessity entrepreneurship is particularly relevant for Appalachia. Specifically, he found that entrepreneurship due to individuals having no other options for work, or "necessity entrepreneurship," has no effect on economic growth. Given the long-term decline of employment in the Appalachian region's traditional industries, if 'entrepreneurship' is associated with a lack of alternative prospects, we would expect to find little relationship between self-employment and economic growth (similarly for recent formations of small businesses). In fact, Low, Henderson, and Weiler (2005) found that rural areas may be more entrepreneurial because of a lack of opportunity. Conversely, if a region has high rates of "opportunity entrepreneurship," where individuals choose to take advantage of business opportunities, then Acs's (2006) findings suggest a stronger link to economic growth. However, given the rural nature of the region, we may be less likely to see positive agglomeration spillover effects from (opportunity) entrepreneurs and less positive growth related to clustering, suggesting smaller positive effects on the local economy.

IV. Theoretical Framework

Recent theoretical work introduces entrepreneurship to traditional endogenous growth models in the spirit of Romer (1986; 1990). We focus on the model developed by Braunerhjelm et al. (2010) (other recent examples include Greis and Naudé 2010; Audretsch and Keilbach 2004; 2007). In this model, "entrepreneurship" (*E)* influences the rate at which general knowledge is converted into economically-relevant knowledge

(Arrow 1962). Thus, *E* reflects an aggregate measure of entrepreneurial capital in the region. A region's growth then depends on the distribution of entrepreneurial capital and regional policy, institutions, and infrastructure.

We do not reproduce a full theoretical model here. Rather, we sketch a general model that draws on these new endogenous growth models and standard spatial equilibrium analysis to illustrate how "small regional economies" can be affected by entrepreneurial capacity (e.g. Ferguson et al. 2007; Partridge et al. 2009a, 2009b). We then discuss why we may or may not see a relationship between our measures of entrepreneurship and growth in Appalachia. In a spatial equilibrium approach, households (individuals) choose the location that maximizes their utility and firms choose the location that maximizes their profits. In the long run, interregional utility and profits are equalized and households move to locations offering the greatest utility and firms relocate or expand in locations offering the greatest profit (Roback 1982).

In our approach, individuals choose between becoming an entrepreneur or remaining an employee based on the relative expected payoff between the two alternatives. The expected payoff for an entrepreneur depends on individual entrepreneurial ability (*e*), and regional factors that influence the probability of success, such as reduced regulatory burdens. Individuals thus maximize their utility based on *e*, wages for employees (*W)*, and the proportion of time they are expected to be employed *p*, owing to unemployment resulting from market conditions and ability levels affected by average education (*ED*) and age (*AGE*). Individuals consume a traded good *C* and a non-traded good *H* (presumably housing) that costs r_i^H. Utility is also related to location-specific attributes such as the natural amenity stock (*S*), local population (*POP*), and other location factors (X). Population affects the availability of urban consumer amenities and the ability of employees to find good labor market matches. Individuals choose the "career" (entrepreneur or worker) and location that maximizes their utility.

Firms maximize profits based on cost of labor, determined by the supply of labor and the wage rate (*W*), the non-traded land cost (r_i^C), population (*POP*), and the location-specific attributes (*X*) which affect regional prices, productivity, and costs. Population can influence firm productivity and wages because of increased agglomeration economies and improved labor matching. The region's entrepreneurial capital, represented by the number of entrepreneurs in the economy (*E*), can increase profits through indirect or induced effects that improve productivity. While capital is an important component of profit maximization, because capital (*K)* is perfectly mobile, its return will be equalized across locations and thus capital input is assumed optimized and omitted from the problem (Roback 1982). The regional factors in *X* are described below in the empirical analysis while the total labor and entrepreneurial capital available in region *i* are directly related to the number of households in the region, which in turn is directly related to the maximization of individual utility. In spatial equilibrium, firms move to or expand in the location that maximizes their profits.

The model suggests that growth of the regional economy *g* is a function of the entrepreneurship rate (*E)* and the various other control variables that affect the utility of households and the profit of firms in the region, which can be represented by the following reduced form function:[5]

(1) $$g_i = f(E_i, POP_i, ED_i, AGE_i, S_i, X_i)$$

While Schumpeterian entrepreneurs are expected to be positively related to

[5]While unemployment rates, wages, and land prices are structural determinants, since they are endogenous, they are omitted from the reduced form model, Equation (1).

economic growth, the endogenous growth theory does not provide as clear of an answer about whether entrepreneurs are drivers of growth in a poor, rural region like Appalachia. If the region possesses a disproportionate share of entrepreneurs of necessity (Acs 2006), they may not serve the same function and may not contribute to growth. One reason is that entrepreneurs of necessity may not induce the same indirect or induced effects that improve competition and productivity in a region and thus lead to net positive growth (Fritsch and Mueller 2004). There may also be underlying regional factors that prevent lagging regions from being able to capitalize on entrepreneurial talent – such as infrastructure, capital, or regional or state policies. Thus we explore the relationship between entrepreneurship and growth in Appalachia using an empirical model developed below.

V. The Empirical Model and Data

A. Measuring Entrepreneurship with Self-Employment and Small Business Intensity

Before turning to our empirical model, we first need to explain the data we use to measure entrepreneurship. Entrepreneurs are generally thought of as some combination of risk-taking, innovative or creative individuals who start their own businesses. Yet, these attributes are hard to measure at a regional level (Deller and McConnon 2009). Namely, available data only identifies numbers of self-employed and how many businesses are in various size classifications. Typically, "small" businesses are measured based on size, but what is a small business—e.g., less than 5 employees or under 500 as defined by the U.S. Small Business Administration (SBA)?

The self-employed and proprietors are those that own their businesses which may or may not have any employees. These businesses may be part-time consulting businesses for a multiple jobholder, a former factory worker working as a handyman, or an innovative owner of a bio-tech start-up. The latter is more often thought to be an opportunity entrepreneur, but successful innovation may occur among all three (product and process varieties). At least in the initial period after new businesses are formed, entrepreneurs would, for the most part, be a subset of the self-employed. If this entrepreneurial share of self-employment is fixed across regions, then aside from scaling the regression coefficient, empirical models would produce reasonable estimates of the role of entrepreneurs. This pattern underlies why self-employment in a county should provide clues about the relative contribution of entrepreneurs, which is why a significant share of the literature relies on it as a proxy (e.g., Goetz and Rupasingha 2009; Van Praag and Versloot 2007 provide a discussion).

A potential problem lies in that the regional share of opportunity entrepreneurs among the self-employed could vary. For example, forward-looking entrepreneurs may be less inclined to start businesses in depressed regions, raising the relative share of necessity entrepreneurs, and these entrepreneurs may not have strong positive spillovers on the local economy. Yet, a careful instrumental variable (IV) approach could account for the long-term persistent factors that are correlated with present economic outcomes and the share of the self-employed that are opportunity entrepreneurs—though again caution needs to be used in interpreting the results.

Thus, we follow many others in the literature and use the share of total employment that is self-employed as one of our key proxies for entrepreneurship. We focus on nonfarm proprietors, because farm proprietors depend on the availability of land, and we want to focus on the type of proprietor that can be more easily influenced by policy. The U.S. Bureau of Economic Analysis (BEA) data we incorporate includes both sole proprietorships and others that are owners of non-limited partnerships, providing a full accounting of the self-employed. To the extent that this measure includes both innovative entrepreneurs and those who start businesses out of necessity, the resulting empirical results will *understate* the positive effects of entrepreneurship, though IV approaches should minimize this effect.

While there is no clear link between size and innovativeness, since most new businesses start out as "small", we also investigate whether there is a connection between microenterprises and regional growth. Thus, we examine whether having a greater intensity of small businesses increases local economic growth. Yet, these effects would be offset by displacement effects where new (or small) businesses reduce employment from existing businesses. For example, encouraging a new Mexican restaurant to form may cause an existing Mexican restaurant to close, producing no net impact on employment. Our measure of small businesses is the approximate share of total employment working in businesses with one to four employees, based on Census Business Patterns Data and the method used by Loveridge and Nizalov (2007). Following the work by Deller and McConnon (2009), Deller (forthcoming), and Glaeser (2007), we try other "small business thresholds" above four employees, but the results are similar.

B. Empirical Model—Sample and Dependent Variables

Our sample includes one observation for each of the 420 counties in the federally-designated ARC region and the 134 counties that are not in the federally-designated region, but share a geographic border with the region. **Figure 1** has a map that shows the Appalachian study region, with the ARC portion clearly denoted. The immediately surrounding counties are included in order to test whether the relationship between entrepreneurs and economic growth is different in the ARC-designated counties than in the greater Appalachian region. The surrounding counties share many similarities (geography, culture, economic etc.) with those in the ARC region, though there are some differences. Because they share many of the same features as the ARC counties, the non-ARC counties provide somewhat of a natural experiment of how the ARC designation affects outcomes. Henceforth, when we refer to "ARC counties" we mean the 420 counties in the federally-designated ARC region; we refer to the remaining Appalachian counties as "other" or "non-ARC" counties.

We consider two main county economic outcomes that are possibly affected by entrepreneurship. The first is employment growth. The theoretical model suggests that greater entrepreneurship should improve productivity, attracting more firms and increasing employment (though with some caveats). Specifically, we use the 1990-2006 percent change in county-level total employment using data from the U.S. Bureau of Economic Analysis (BEA). To assess whether the ARC region and non-ARC portion of Appalachia are comparable regions (i.e., so that the non-ARC counties are akin to a control group), we note that over the 16-year study period, the average county-level job growth for the ARC sub-sample was 32%, compared to the national job growth rate of 27.6%. For non-ARC counties, job growth was about 33% over the period, illustrating the close similarities between the two regions.

The second economic outcome measure is per-capita income growth, which is closely associated with regional value-added (output) and any net transfers that the region receives. The theoretical model suggests that entrepreneurship increases productivity, which would increase wages and profits, raising per-capita income. Specifically, we use the 1990-2006 percent change in county-level per capita income based on U.S. BEA data.

Per capita income increased 88% in both the ARC and non-ARC regions, compared to 89% for the nation as a whole. Overall, given our proxies for entrepreneurship, we especially expect the self-employment share to be positively linked to both economic outcomes.

Further analysis will assess how entrepreneurship affects the lower-tail of the income distribution via its association with the poverty rate. Specifically, we use the percent change in the county-level poverty rate from 1989 to 2006 based on U.S. Census Bureau data.

C. Base Empirical Model and Explanatory Variables

The empirical analysis regresses the 1990-2006 change in economic outcomes (1989-2006 change in poverty rate) on the initial 1990 economic conditions. We use explanatory variables measured in 1990 to minimize potential endogeneity bias in the parameter estimates, though we will also employ instrumental variable approaches. Because of unforeseeable changes to the U.S. economy between 1990 and 2006 with two recessions, the longest economic expansion on record in the 1990s, three Middle East wars, the internet boom of the late 1990s and early 2000s, September 11th, and unforeseen advances in technology and policy, it is unlikely that an entrepreneur in 1990 could have accurately predicted national 1990-2006 economic growth, let alone conditions for a given Appalachian county. Thus, we believe the explanatory variables can be treated as pre-determined (and thus account for factors associated with the county fixed effects). In particular, by using this long time frame, we minimize any bias that could occur when businesses are formed in expectation of a county's economic conditions for the next 16 years. However, our assumption of pre-determination is assessed in the sensitivity analysis section using IV approaches.

Therefore, to understand how entrepreneurs affect economic growth in the Appalachian region, we consider the following reduced form empirical model:

(2) $y_j = \beta_0 + \beta_1 \times E_j + \beta_2 \times ARC_j + \beta_3 \times Dist.to\ Metro_j + \beta_4 \times S_j + \beta_5 \times Z_j + \beta_6 \times State\ FE_j + \varepsilon_j$ where y_j represents the change in employment, per-capita income, and the poverty rate. The other explanatory variables are described below. A summary of all of the variables used in this analysis is available in **Table 1**.

As our first proxy for entrepreneurship (E_j), we use a measure of the self-employed – the 1990 county share of total employment that is nonfarm proprietors. Nonfarm proprietors are 17% of total employment in the ARC counties and 15% in non-ARC counties. By comparison, the average national share is 14%. **Figure 2** contains a map showing the self-employment intensity in the counties in the region. While the overall aggregate statistics suggest little variation in self-employment rates between the ARC region and the non-ARC region (and the U.S. as a whole), Figure 2 clearly shows that there is tremendous heterogeneity in the study region with some locations having self-employment shares under 10%, while others are over 21%. With that kind of variation, we expect that if self-employment is associated with economic outcomes, this association would reveal itself in the Appalachian region.

Following Shrestha et al. (2007), we also test whether our results are robust to using the 1980–1990 percent change in total employment that is due to changes in nonfarm proprietor employment—this reflects the *growth* in proprietor employment.[6] To

[6] Like Shrestha et al. (2007), we use the Labor Market (LM) approach that normalizes the growth in proprietorships by the total number of initial workers (rather than the stock of initial proprietors). This

test the link between small businesses and growth, we use the approximate share of total employment working in small businesses with one to four employees.[7]

To control for the effect of ARC-designation, we include a dummy variable that indicates whether a county is in the ARC region (ARC_j). The ARC effect is *a priori* unclear. While ARC policies may be effective in leveraging federal and other resources to stimulate growth, the ARC focuses its efforts on the communities most in distress (i.e., a "worst first" policy) which may mean it is squandering its resources in communities with little hope of generating positive economic outcomes. Given the ARC's policy emphasis on entrepreneurship, we then test whether proprietors make more or less of a difference in generating economic growth in a county that is part of the ARC region by interacting the ARC indicator with the share of proprietors.

As noted above, the degree of opportunity versus necessity entrepreneurship likely affects how self-employment influences the results. While there is no clear variable that captures this phenomenon, we believe that opportunity entrepreneurs likely have higher income levels than necessity entrepreneurs—holding all else constant. To consider whether this factor influences how entrepreneurship/self-employment affects economic outcomes, we estimate models that include 1990 proprietor income per proprietor, using BEA data, and also the interaction between this measure and the ARC dummy to examine whether there as a differential ARC effect.

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approach is preferred because otherwise the growth rate is inflated on a small initial stock of proprietors (Shrestha et al., 2007).

[7] We calculate the share using the approach by Loveridge and Nisalov (2007) where the number of businesses in each size category is weighted by the smallest number of employees in that category. All categories are then totaled and the approximate number of employees in businesses with one to four employees is divided by the approximate total number of employees. This allows us to get a better idea of the impact of small businesses on the economy, instead of overweighting the impact of a business with one to four employees versus one with 500 or more.

As one of the ***X*** variables in the theoretical model (Equation 1), urban proximity is a key determinant of rural firm location and economic prosperity. To account for urban influence (*Dist. to 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 (following Partridge et al. 2008; 2009a; 2009b). The average ARC county is 52.9 km from the nearest MSA, while the other counties that surround the federally-designated region are, on average, 39.8 km away from the nearest MSA. As shown in Table 1, the incremental distances to cities of over 250,000 and 500,000 people are also higher for the ARC counties, further illustrating their economic isolation.

We also expect that the influence of entrepreneurship is affected by economic remoteness. For example, closer access to cities creates new markets for rural firms and it improves their access to inputs in larger cities. However, closer proximity to cities also allows urban-centered businesses better access to the rural community's markets, and the resulting growth shadows could hurt rural businesses (Puga 1999; Partridge et al. 2009b). Thus, the overall effect is an empirical question. To test the intervening effect of distance, some models include interactions of the distance to the nearest metro variable with the share of proprietors, which would have a negative coefficient if distance/remoteness weakens the positive effects of entrepreneurship/self-employment.

Natural amenities are highly positively related to economic growth in rural areas (Deller et al. 2001). We control for natural amenities (S_j) with each county's natural amenity score using the Natural Amenities Scale from the USDA Economic Research

Service.[8] The ARC counties have a significantly higher natural amenity score (0.17) than the non-ARC counties (-0.42), meaning they have more natural amenities. We expect that places with more amenities are more conducive to growth and thus we expect that entrepreneurship/self-employment may be more able to influence growth in high amenity locales. To consider this effect, we interact the amenity score with the self-employment share to assess whether a greater self-employed share in high amenity areas is more strongly related to growth.

To capture other determinants of economic growth in the region, we include a number of additional control variables (Z_j) that reflects POP, ED, AGE, and other ***X*** variables in Equation 1:

- Education. Two education variables to account for labor force quality using data from the 1990 Census: (i) the Share of College Graduates is the percentage of those age 25 and older with a college degree (bachelor's and above) and (ii) the Share of High School Graduates is the percentage of individuals age 25 and older with a high school diploma (but no additional education).
- Industry Concentration. The 1990 share of manufacturing, government, and farm employment (using data from the BEA).
- Average Age. From the 1990 Census, the average age of the population captures factors related to the net-migration of younger workers and retirees.
- Population. Population is associated with agglomeration economies (and congestion), urban amenities, and thicker labor markets for job matching. We use the natural log

[8] "The natural amenities scale is a measure of the physical characteristics of a county area that enhance the location as a place to live. The scale is constructed by combining six measures of climate, topography, and water area. These measures are warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area." Source: www.ers.usda.gov/Data/NaturalAmenities/

(Ln) of the population (from 1990 Census data) in the model.

- Topography Score. Appalachian terrain can be steep, which has historically been a barrier to development because there is less level ground suitable for construction of buildings and there are fewer good roads. Partridge et al. (2008) found that mountainous regions in the eastern United States are even less likely to benefit from steep topography in terms of amenities than those in the West, where there is more open space. Using the 1-21 Topography Scale, we control for this effect.[9] ARC counties have an average score of 15.3, which indicates the terrain is "open high hills" and "open low mountains." The average score of non-ARC counties is 9.5 indicating terrain of "plains with hills."
- 1950–1960 Change in Population (deviation from the mean using U.S. Census Bureau data). This measure accounts for historic factors that predate the formation of the ARC (akin to controlling for fixed effects) that may underlie whether a county is persistently growing faster or slower than average—e.g., good government, an active business community, etc. The ARC counties, as expected, had population changes from 1950 to 1960 below the mean, while the surrounding counties had populations that were growing faster than the mean, which was a reason for the formation of the ARC.

We also include state dummy variables ($State_j$) for each of the thirteen Appalachian states (Georgia is the omitted category). These state-specific factors could include the influence of state government policies such as taxes, or other factors common to a given

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[9] 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 are able to distinguish the influence of topography separately from other natural amenities.

state's counties—e.g., Georgia and North Carolina counties are growing relatively rapidly compared to New York and Pennsylvania.

Finally, we correct for heteroskedasticity and use sensitivity analysis to test for spatial dependence.

Despite our attempts to control for the factors that determine economic growth, there is still the possibility that endogeneity could affect the results for our entrepreneurship proxies. Thus, we create four possible exogenous instrumental variables to assess whether our OLS results are biased. First, we use the deep lag of the share of non-farm proprietors in a county in 1969 as an instrument for our 1990 measure. Second, we use the 1969-1979 change in non-farm proprietor employment as a share of total employment. This variable is an instrument for the corresponding 1980-1990 measure. Third, we use the deep lag 1974 share of employment in firms with one to four employees, using County Business Patterns Data. This instrument is for the small business share. Fourth is the 1960 population per square mile in a county, using data from the 1962 County Data Book from the U.S. Census Bureau.[10] This measure reflects historic agglomeration factors (or lack thereof) that would have had a long-term impact on the formation of existing self-employment and small business.

VI. Estimation and Results

Tables 2 through 5 contain our empirical results. Since we believe that self-employment is a better measure of entrepreneurship than those based purely on firm size,

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[10] U.S. Census Bureau, 1962 County Data Book, U.S. Department of Commerce. Retrieved from Inter-University Consortium for Political and Social Research, www.icpsr.umich.edu. Accessed 25 March 2010.

we use the share of proprietors in 1990 as our core indicator of entrepreneurship (Tables 2 – 4). We then compare these results to similar models using the 1980–1990 change in share of non-farm proprietor employment and the approximate 1990 share of total employment in businesses with one to four employees (Table 5). Overall, we find that both the 1990 share of proprietors and the 1980-1990 change in share of proprietors are significantly associated with employment growth and per capita income growth. But we find no statistical correlation between the share of small businesses and growth. Since we also find that none of our entrepreneurship variables are statistically correlated with changes in poverty rates, we only briefly consider those results.

Because the entrepreneurship variables are potentially endogenous and may be correlated with some unobserved aspect of economic growth, we initially estimate each model using our IV approaches. We follow the method developed by Angrist (Angrist and Pischke 2009) for testing the strength of instruments in models where we use two instruments. The F-statistics for the weak instrument test, shown in Tables 2, 4, and 5, are between 18 and 390, giving us confidence that we have strong instruments. For each model, 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 the OLS results. In other cases, we report both the OLS and IV results.

In **Table 2**, we consistently find a strong relationship between self-employment and employment growth. First, Model 1 is a parsimonious model that includes only state fixed effects and the ARC dummy variable. Model 2 adds the distance variables. Model

3 is our core model that also includes the natural amenity variable and the other control variables. In all cases, we find that the results are robust to the inclusion of additional variables, suggesting that multicollinearity is not driving the results.

In Model 3, a one percentage point increase in the 1990 share of proprietors is associated with a more than four percentage point increase in 1990-2006 employment growth in the Appalachian region. This result suggests that entrepreneurship is positively linked to subsequent growth and, because opportunity entrepreneurship is confounded with necessity entrepreneurship in the self-employment measure, the result would likely be stronger for opportunity entrepreneurship if measured in isolation.[11]

The ARC indicator coefficient is positive, but statistically insignificant. On one hand, this could be viewed as a success because the ARC region faces so many barriers to growth that keeping up with neighboring Appalachian counties is a success. However, it may also indicate that after nearly a half century of existence, the ARC is not delivering on its promise to improve economic prospects in the region (perhaps this is due to its "worst first" emphasis on helping distressed counties that have few growth prospects). Further research is needed to assess that question.

Regarding the other results, as expected, distance to a metropolitan area has a negative association with job growth, while natural amenities have a positive association. The topography score, on the other hand, is negatively associated with employment

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[11] We note that the ARC's Entrepreneurial Initiative (EI) and other programs to promote entrepreneurship in the region were generally implemented after 1997, well after we measure our key independent variables in 1990. While footnote 3 noted that these policies were small, ARC's modest efforts usually focus on distressed counties which likely have less entrepreneurship (i.e. "worst-first" assistance). To the extent that these policies produced meaningful changes in entrepreneurship in these counties, this would negatively bias our entrepreneurship coefficients because low entrepreneurial counties (based on 1990 shares) would then have faster growth. Though this would strengthen our results, as we have already noted, the evaluation of these ARC programs found modest effects at most, suggesting little practical impact on our results.

growth, suggesting that rugged terrain makes places harder to develop. This is also consistent with Partridge et al. (2008) and suggests the natural amenities that are important in Appalachia may be different than in places like the Mountain West. Given the measures in the natural amenities score, this may mean access to lakes and rivers, low summer humidity, and warm winters are more important in Appalachia, which is consistent with the large scale development near lakes on the edges of southern Appalachia—e.g., places near Lake Lure, North Carolina. Finally, we find, as suggested by Kilkenny and Partridge (2009), that a large presence of manufacturing is negatively associated with job growth.

We next add the interaction variables between proprietor share and the ARC dummy variable (Model 4) and the distance to the closest metro area (Model 5). In Model 4, the coefficients on the self-employment share and its interaction with the ARC indicator are both positive and are jointly statistically significant. However, the two coefficients are individually statistically insignificant. Thus, we have some weak evidence that the proprietor share has an additional positive relationship with employment growth in ARC counties, which tentatively suggests that ARC may be on the right track in stressing programs to encourage entrepreneurial activities. However, we caution that while this suggests the benefits *may* be higher in the ARC region, we have not considered the costs of entrepreneurial development—i.e., how much is being spent to get these benefits. On a wide-scale basis, it may be more costly to identify and support successful entrepreneurial talent in the ARC region, making it less cost effective to support ARC entrepreneurs. At the same time, we recognize that, given the lack of economic development alternatives for the region, it still may make sense to support entrepreneurship development.

In Model 5, the specification tests suggest that endogeneity may be more problematic, so we focus on the IV version. The self-employment share and its interaction with distance to the nearest MSA are both individually and jointly statistically significant. The distance interaction coefficient is negative, suggesting that the positive relationship between job growth and self-employment attenuates with greater distance from a metropolitan area. Combining the two coefficients, the marginal effect of having a higher share of proprietors turns negative at just over 40 kilometers from a metropolitan area. One possibility for this result is that opportunity entrepreneurs may have more options in locations closer to metropolitan areas, while in more remote areas, there are more necessity entrepreneurs with fewer alternative options. Nonetheless, these results suggest that programs aimed at entrepreneurship development may have their limits in very remote locations and this warrants further study.

In **Table 3**, we provide further evidence of the relationship between proprietors and employment growth. We conduct a number of tests for spatial dependence for either a spatial lag of the dependent variable or spatial autocorrelation (results not shown). We tried several spatial weight matrices including distance and inverse distance weights and nearest five and eight neighbors. In all cases, the tests reject the presence of standard spatial dependence.

To assess whether there are spillovers for the *explanatory* variables, we also estimate a model which includes as regressors the explanatory variables interacted with a normalized inverse distance spatial weighting matrix (within 250 km), **W**. In particular, we are interested in whether the self-employment share in nearby counties spills over to influence the county of interest ($\mathbf{W} \times SE$). The spatial lag of self-employment share is statistically insignificant with a t-statistic of -1.09, suggesting few spatial spillovers from nearby clusters of "entrepreneurship," while the main self-employment coefficient remains statistically significant. Likewise, the spatial lags for the other explanatory variables are statistically insignificant (not shown, but the results are available on request). Thus, we conclude that the rugged terrain of Appalachian limits the geographical reach of these economic spillovers.

In an attempt to appraise the specific roles of necessity versus opportunity entrepreneurship, we also estimate two models in which we use 1990 county-level data on proprietor income per proprietor as a measure of the value of proprietor wages. While there is no perfect measure of opportunity versus necessity entrepreneurship, at some stage it seems reasonable to expect opportunity entrepreneurs to earn higher incomes than those who start businesses out of necessity, and thus we would expect a greater positive association between (*initial* 1990) average income per proprietor and 1990-2006 economic growth. Indeed, the results are consistent with our notion of opportunity entrepreneurs having a larger influence, as income per proprietor is positively associated with employment growth, while the main self-employment share coefficient remains positive and statistically significant.

We next interact the income-per-proprietor variable with the ARC indicator to determine if there is any difference in the ARC region. In this case, while the income-per-proprietor coefficients are positive and jointly statistically significant, only the coefficient on the interaction is individually statistically significant. This suggests that higher-income entrepreneurs have a greater positive influence on employment growth in the ARC region than in its neighbors, which indicates that efforts to promote entrepreneurial communities may be sensible in the ARC region, assuming the costs of developing opportunity entrepreneurs are manageable.

To examine whether high-amenity locales have more entrepreneurial opportunities, we interact the share of proprietors with the natural amenity score and find that the resulting parameter estimate for the amenity interaction variable is positive and statistically significant. This suggests that proprietors have a greater positive influence in regions with more natural amenities, which is consistent with Deller et al.'s (2001) contention that amenities may be a very important factor for growth, but that amenities alone, without manmade interventions, will not generate growth (e.g., a mountain without the investment in a ski resort has a smaller impact).

Next, we consider per capita income growth as a measure of economic growth. In **Table 4**, our results point to a strong positive relationship between proprietor share and per-capita income growth. Based on the results from Model 3 (our base model), a one percentage point increase in the share of proprietors is associated with a 0.65 percentage point increase in per capita income growth. However, all else equal, the ARC region had lower per capita income growth, (weakly) suggesting that the ARC may not have been successful in supporting high wages or high income growth—though we again caution that historic factors may underlie this result.

In Model 4, the coefficients on the share of proprietors and the interaction between the proprietor share and the ARC dummy are jointly significant, but the ARC interaction coefficient is negative and insignificant on its own. Thus, there is weak evidence that proprietors have a smaller positive effect on income growth in the ARC region and that one reason for lagging income growth in the ARC counties may be the underperformance of the self-employed and their businesses. One possible explanation is that while there is evidence that opportunity entrepreneurship plays a greater positive role in the ARC region, entrepreneurs (self-employed) in the region may be disproportionately of the necessity type.

Model 5 includes the interaction variable between the share of proprietors and the distance to metro areas. The distance interaction and the share of proprietors are again jointly statistically significant, though the distance interaction is individually insignificant. Moreover, the extremely small negative coefficient on the distance interaction variable (-0.006) suggests that there is virtually no economically-meaningful difference in the effect of proprietors on per capita income growth in more remote areas versus urban areas.

In **Table 5**, we examine whether the positive relationship between entrepreneurship and economic growth is robust to alternative measures of entrepreneurship. When we use the 1980-1990 Labor Market (LM) change in share of proprietors, we find strong evidence that a change in the number of proprietors is positively associated with subsequent employment and per capita income growth. In contrast, when we use the 1990 share of employment in businesses with one to four employees, we observe no statistical relationship with either employment or per capita income growth. Tests using other measures of small business concentration produce similar results (results not shown), suggesting there is no statistical relationship between small business concentration and economic growth in the study region.

We also estimated models using the change in the 1989-2006 poverty rate as the dependent variable (results not shown). We find that none of our measures of entrepreneurship have a statistical effect on poverty reduction. Thus, while entrepreneurship as measured by self-employment is positively associated with average income and jobs, it does not seem to have any additional effects at the lower end of the income distribution. However, we do observe a negative association between being in the ARC region and the poverty rate, suggesting ARC may be having success in meeting a core mission of poverty reduction.

VII. Conclusion

Theoretical models do not provide us with clear guidance on whether entrepreneurship is associated with economic growth in poor, rural regions like Appalachia. If new business creation is due to individuals having no other options for work, or "necessity entrepreneurship," it may have little relationship with economic growth (Acs 2006). If, however, the region has high rates of "opportunity entrepreneurship," then entrepreneurs should have a greater positive association with economic growth (Acs 2006). Prior work has found that the effects of entrepreneurship on economic growth are stronger in metropolitan areas and that they are enhanced by spillover effects, suggesting that such programs may be less effective in remote rural locations—especially in areas that lack innovative capacity.

We find evidence that the self-employed contribute to net economic growth in the broad Appalachian region. Thus, even in remote rural regions, self-employment and the associated entrepreneurial capacity are positively linked to growth. Yet, we find no statistical linkage between the number of small businesses and growth, suggesting that the type of business is more important than size.

Looking specifically at the ARC region, we find that the region has more self-employment than its immediate neighbors and that there is, at best, weak evidence that the contribution of the self-employed to employment growth in ARC counties is greater than in its immediate neighboring counties. Given the historical barriers to growth in the

ARC region, we believe it is suggestive that entrepreneurship is potentially an effective engine of growth *even* in lagging regions. Thus, entrepreneurial programs targeted at the distressed ARC region may be sensible, though we would have to weigh the costs of implementing entrepreneurial strategies to determine the final answer.

In contrast, a greater proprietor share in ARC counties is associated with lower levels of per capita income growth. It is not immediately clear whether this is due a greater share of necessity entrepreneurs in the ARC region than in its neighbors. Preliminary analysis, using a measure of income per proprietor interacted with the ARC indicator variable, provides statistical evidence that income per proprietor has a larger positive effect on employment growth in the ARC region. We took this as providing some evidence that opportunity entrepreneurs have a more positive influence on growth in the ARC region. Thus, this is consistent with the need to make sure policies to support entrepreneurs are aimed at creating opportunity entrepreneurs, or better supporting opportunity entrepreneurs, even in historically distressed areas like the ARC region—though again this needs to be weighed against the costs of any policies or programs. In addition, better data on entrepreneurs are needed in order to assess fully what types of businesses are being formed and whether we are truly seeing opportunity entrepreneurship.

Finally, we find that natural amenities and close proximity to urban areas strengthen the positive association between the self-employment share and economic growth. Thus, as expected, other factors that affect a business's ability to be competitive are likely to further enhance the effect of entrepreneurs.

Unlike the presence of natural amenities and proximity to urban areas, which are factors that a county cannot control, new business formations and the expansion of existing businesses are possibly endogenous and can be influenced by policies. These results suggest that programs that support entrepreneurship and new business development may support economic growth, even in areas that are generally lagging and more remote—i.e., even in regions that are not known for innovative capacity.

This study does not address what types of entrepreneurship policies would be best for the region. Goetz and Rupasingha (2009) found that the region lags behind the nation in proprietor formations. At the same time, however, the region has fewer business deaths and higher rates of startup survivals than the national average (Acs and Kallas 2008), which has contributed to the relatively higher levels of nonfarm proprietors in the region. However, further weakening the Appalachian region's ability to compete is its low educational attainment, which may inhibit labor productivity and reduce the number of opportunity entrepreneurs. Thus, while our results are mainly positive, further research is needed to understand what policies and programs are best for supporting the types of entrepreneurs that will contribute to sustainable, long-term growth in Appalachia and perhaps in other lagging regions.

	ARC Counties				Non-ARC Counties			
Variables	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Growth Variables								
% Change in County-Level Total Employment, 1990 to 2006	0.32	0.89	-0.73	15.55	0.33	0.51	-0.16	4.60
% Change in County-Level Per-Capita Income, 1990 to 2006	0.88	0.16	0.37	1.51	0.88	0.18	0.54	1.50
% Change in County-Level Poverty Rate, 1989 to 2006	-0.03	0.18	-0.56	0.72	0.03	0.22	-0.39	0.62
Explanatory Variables								
Share of Proprietors, 1990[1]	0.17	0.05	0.07	0.38	0.15	0.04	0.07	0.28
Labor Market (LM) Change in Share of Proprietors, 1980 to 1990	0.06	0.06	-0.08	0.42	0.05	0.05	-0.06	0.24
Weighted Share of Small Businesses with one to four employees, 1990	0.07	0.03	0.02	0.46	0.06	0.03	0.03	0.20
Distance to nearest Metro (km)	52.89	31.69	0.00	163.09	39.84	29.62	0.00	148.51
Incremental distance to a metro > 250,000 pop.	22.73	30.88	0.00	124.05	16.86	30.07	0.00	154.70
Incremental distance to a metro > 500,000 pop.	38.40	50.63	0.00	208.20	23.06	41.05	0.00	186.19
Incremental distance to a metro > 1,500,000 pop.	97.96	98.14	0.00	394.25	144.26	125.73	0.00	394.33
Natural Amenity Score	0.17	1.19	-3.72	3.55	-0.42	1.16	-3.22	1.78
Share of College Graduates, 1990	0.10	0.05	0.04	0.42	0.14	0.07	0.05	0.37
Share of High School Graduates, 1990	0.35	0.07	0.19	0.53	0.33	0.05	0.20	0.45
Share of Farm Employment, 1990	0.08	0.08	0.00	0.56	0.07	0.07	0.00	0.35
Share of Government Employment, 1990	0.15	0.05	0.08	0.41	0.15	0.06	0.06	0.47
Share of Manufacturing Employment, 1990	0.21	0.11	0.01	0.54	0.22	0.09	0.05	0.46
Average Age, 1990	36.31	1.96	30.27	43.08	35.34	1.76	30.64	38.55
Natural Log of 1990 Population	10.31	0.96	7.66	14.11	10.88	1.20	8.69	14.09
Topography Score	15.25	5.05	2.00	20.00	9.49	5.44	1.00	20.00
Change in Population, 1950 to 1960, deviation from the mean	-0.03	0.14	-0.30	0.90	0.09	0.24	-0.29	1.41

Continued

Table 1. Descriptive Statistics, Appalachian Region

Table 1. Continued

Available Instruments								
Share of Proprietors, 1969	0.13	0.04	0.06	0.33	0.12	0.03	0.04	0.21
Labor Market (LM) Change in Share of Proprietors, 1969 to 1979	0.04	0.05	-0.07	0.51	0.04	0.04	-0.02	0.26
Weighted Share of Small Businesses with one to four employees, 1974	0.09	0.05	0.03	0.78	0.08	0.03	0.03	0.17
Population/Square Mile, 1960	86.61	140.04	8	2231	192.70	409.72	13	3735
Total Number of Counties:	554							
Total Number of ARC Counties:	420							

[1] All proprietor variables include non-farm proprietors only.

	Model 1	Model 2	Model 3	Model 4	Model 5	
	OLS	OLS	OLS	OLS	OLS	IV
Explanatory Variables						
Share of Proprietors, 1990[1]	*****4.675**	*****4.908**	****4.650**	**2.699**	***9.133**	*****13.198**
	3.28	*3.08*	*2.42*	*1.38*	*1.65*	*3.11*
Proprietors * ARC				2.405		
				1.20		
Proprietors * Distance to nearest Metro					-0.094	**-0.328
					-1.24	*-2.37*
ARC	-0.062	0.028	0.146	-0.215	0.150	0.198
	-1.03	*0.38*	*1.14*	*-0.80*	*1.14*	*1.31*
Distance to nearest Metro (km)		***-0.005	**-0.005	**-0.005	0.009	**0.043
		-2.85	*-2.15*	*-2.1*	*1.14*	*2.31*
Incremental distance to a metro > 250,000 pop.		***-0.003	**-0.003	**-0.002	**-0.003	**-0.006
		-3.07	*-2.46*	*-2.4*	*-2.46*	*-2.51*
Incremental distance to a metro > 500,000 pop.		-0.001	-0.001	-0.001	-0.001	**-0.003
		-1.23	*-1.23*	*-1.3*	*-1.49*	*-2.45*
Incremental distance to a metro > 1,500,000 pop.		0.000	0.001	0.001	0.001	0.000
		0.56	*0.73*	*0.72*	*0.68*	*0.23*
Natural Amenity Score			***0.129	***0.126	***0.100	0.023
			3.22	*3.19*	*2.97*	*0.51*
Share of College Graduates, 1990			0.255	0.275	0.317	0.135
			0.37	*0.38*	*0.42*	*0.17*
Share of High School Graduates, 1990			-1.719	-1.707	-2.161	-2.057
			-1.28	*-1.25*	*-1.3*	*-1.5*
Share of Farm Employment, 1990			-2.101	-2.140	-2.005	-1.512
			-1.55	*-1.52*	*-1.56*	*-1.34*
Share of Government Employment, 1990			0.414	0.269	0.740	0.570
			0.37	*0.25*	*0.54*	*0.54*
Share of Manufacturing Employment, 1990			**-0.995	**-0.987	**-0.936	**-2.194
			-2.5	*-2.46*	*-2.27*	*-2.13*
Average Age, 1990			0.024	0.023	0.040	-0.067
			0.34	*0.32*	*0.49*	*0.85*
Natural Log of 1990 Population			*-0.204	*-0.208	*-0.177	-0.230
			-1.76	*-1.72*	*-1.73*	*-1.64*
Topography Score			*-0.048	*-0.047	**-0.042	-0.022
			-2.01	*-1.95*	*-2.11*	*-1.5*
Change in Population, 1950 to 1960, dev. from the mean			0.265	0.270	0.278	0.556
			0.95	*0.93*	*0.94*	*1.3*
State Fixed Effects	Y	Y	Y	Y	Y	Y
Adjusted R^2	0.134	0.151	0.220	0.221	0.237	0.028
Joint F-test for Proprietors & Proprietors * ARC				***2.82**		
Joint F-test for Proprietors & Proprietors * Distance to nearest Metro					*****5.27**	*****5.26**
Instruments Used for 2SLS:						
Share of Proprietors, 1969	?	?	?	?	?	
Population/Square Mile, 1960				?	?	
First Stage F-test of Instruments	388.81	372.13	195.91	22.49	18.24	
Endogeneity test of regressors:	2.10	1.90	2.35	3.52	5.80	
Probability > Chi-Square Statistic	0.15	0.17	0.13	0.17	0.06	

[1] All proprietor variables include non-farm proprietors only.

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Values in *italics* are the heteroskedasticity-adjusted t-statistics.

Table 2. County-Level Employment Growth, Appalachian Region, 1990 to 2006 The Impact of the Share of Proprietors, 1990

	With Spatial Weighting Matrix[2]	With Income per Proprietor	With Income per Proprietor and Interaction with ARC	With Amenity Interaction
Explanatory Variables				
Share of Proprietors, 1990[1]	******4.433***	******5.729***	******5.677***	*****4.424***
	2.59	*2.67*	*2.74*	*2.3*
Proprietors * Weighting Matrix[2]	-1376.11			
	-1.09			
Income per Proprietor		****0.086**	0.023	
		2.24	*1.36*	
Income per Proprietor * ARC			****0.075**	
			2.16	
Proprietors * Amenity				*****1.289**
				2.89
ARC	0.447	0.127	**-0.932	0.143
	0.24	*1.23*	*-2.24*	*1.10*
Natural Amenity Score	***0.145	***0.125	***0.124	-0.097
	3.54	*3.39*	*3.47*	*-1.27*
State Fixed Effects	Y	Y	Y	Y
Interaction between other variables and spatial weights[2]	Y			
Other Control Variables[3]	Y	Y	Y	Y
Adjusted R^2	0.310	0.369	0.387	0.228
Joint F-test for Inc/Proprietor and Inc/Proprietor*ARC			***2.65**	
Joint F-test for Proprietor and Proprietor*Amenity				*****4.77**

[1] All proprietor variables include non-farm proprietors only.

[2] Uses the normalized inverse distance spatial weighting matrix (250 km).

[3] Also controls for distance to metro areas, shares of college and high school graduates, shares of farm, government, and manufacturing employment, average age, population, topography score, and the change in population from 1950 to 1960.
*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.
Values in *italics* are the heteroskedasticity-adjusted t-statistics.

Table 3. County-Level Employment Growth, Appalachian Region, 1990 to 2006

Testing Alternative Specifications Using Share of Proprietors, 1990
(All models estimated using OLS)

	Model 3 OLS	Model 4 OLS	Model 5 OLS
Explanatory Variables			
Share of Proprietors, 1990[1]	*****0.635**	****1.028**	*****0.907**
	3.27	*2.57*	*2.7*
Proprietors * ARC		-0.486	
		-1.18	
Proprietors * Distance to nearest Metro			-0.006
			-1
ARC	***-0.053	0.020	***-0.053
	-3.08	*0.31*	*-3.07*
Distance to nearest Metro (km)	*0.001	*0.001	0.001
	1.87	*1.93*	*1.55*
State Fixed Effects	Y	Y	Y
Other Control Variables[3]	Y	Y	Y
Adjusted R^2	0.241	0.243	0.241
Joint F-test for Proprietors & Proprietors * ARC		*****5.53**	
Joint F-test for Proprietors & Proprietors * Distance to nearest Metro			*****5.49**
Instruments Used for 2SLS:			
Share of Proprietors, 1969	?	?	?
Population/Square Mile, 1960		?	?
First Stage F-test of Instruments	118.38	22.49	18.24
Endogeneity test of regressors:	0.82	4.38	3.94
Probability > Chi-Square Statistic	0.36	0.11	0.14

[1] All proprietor variables include non-farm proprietors only.

[2] Also controls for incremental distances to bigger metro areas, natural amenity scores, the shares of college and high school graduates, the shares of farm, government, and manufacturing employment, average age, population, topography score, and the change in population from 1950 to 1960.

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Values in *italics* are the heteroskedasticity-adjusted t-statistics.

Table 4. County-Level Per Capita Income Growth, Appalachian Region, 1990 to 2006

The Impact of the Share of Proprietors, 1990

	County-Level Employment Growth, 1990 to 2006			Per Capita Income Growth, 1990 to 2006	
	OLS	IV	OLS	OLS	OLS
Explanatory Variables					
LM Change in Share of Proprietors[1], 1980 to 1990	***2.909**	*****6.277**		****0.382**	
	3.65	*4.30*		*2.39*	
Weighted % of Businesses with less than 5 employees, 1990			**-2.361**		**0.142**
			0.316		*0.39*
ARC	0.151	0.127	0.168	***-0.052	***-0.049
	1.09	*0.91*	*1.19*	*-3.02*	*-2.77*
Distance to nearest Metro (km)	*-0.005	-0.004	**-0.006	*0.000	0.000
	-1.99	*-1.61*	*-2.24*	*1.69*	*1.29*
Incremental distance to a metro > 250,000 pop.	*-0.003	*-0.002	**-0.004	0.000	0.000
	-2.85	*-1.75*	*-3.33*	*-0.12*	*-0.44*
Incremental distance to a metro > 500,000 pop.	-0.001	0.000	***-0.002	0.000	0.000
	-1.61	*-0.34*	*-2.83*	*-0.97*	*-1.36*
Incremental distance to a metro > 1,500,000 pop.	0.001	0.001	0.000	0.000	0.000
	0.75	*0.92*	*0.53*	*-0.97*	*-1.07*
Natural Amenity Score	*0.111	**0.093	***0.128	0.006	0.008
	2.78	*2.22*	*3.04*	*0.68*	*0.87*
Share of College Graduates, 1990	-0.197	-0.462	0.040	**-0.357	**-0.328
	-0.32	*-0.72*	*0.06*	*-2.3*	*-2.01*
Share of High School Graduates, 1990	-1.445	*-2.046	-0.816	**-0.492	**-0.430
	-1.25	*-1.66*	-0.73	*-2.42*	*-2.03*
Share of Farm Employment, 1990	-2.151	*-2.404	-1.476	-0.089	-0.088
	-1.6	*-1.75*	*-1.44*	*-0.69*	*-0.61*
Share of Government Employment, 1990	0.398	1.123	-0.130	**0.400	*0.312
	0.41	*1.02*	*-0.13*	*2.57*	*1.91*
Share of Manufacturing Employment, 1990	*-1.454	-0.910	***-2.216	***-0.292	***-0.336
	-2.69	*-1.59*	*-2.75*	*-3.4*	*-3.50*
Average Age, 1990	0.046	0.083	0.015	-0.001	-0.005
	0.65	*1.1*	*0.22*	*-0.2*	*-1.15*
Natural Log of 1990 Population	**-0.272	-0.207	**-0.352	-0.019	*-0.025
	-1.8	*-1.39*	*-2.00*	*-1.42*	*-1.74*
Topography Score	**-0.045	**-0.047	*-0.042	0.000	0.000
	-1.94	*-2*	*-1.87*	*-0.24*	*-0.16*
Change in Population, 1950 to 1960, dev. from the	0.307	0.168	0.444	-0.060	-0.046
	0.94	*0.52*	*1.23*	*-1.06*	*-0.77*
State Fixed Effects	Y	Y	Y	Y	Y
Adjusted R^2	0.203	0.172	0.184	0.233	0.223
Instruments Used for 2SLS:					
LM Change in Share of Proprietors, 1969 to 1979[1]	?			?	
Weighted % of Businesses with less than 5 employees, 1974			?		?
First Stage F-test of Instruments	52.75		19.91	52.75	19.91
Endogeneity test of regressors:	7.69		2.34	0.50	2.54
Probability > Chi-Square Statistic	0.01		0.13	0.48	0.11

[1]Labor Market Change in Proprietors, includes non-farm proprietors only.

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Values in *italics* are the heteroskedasticity-adjusted t-statistics.

Table 5. Other Measures of Entrepreneurship and their Impact on Appalachian Regional Growth

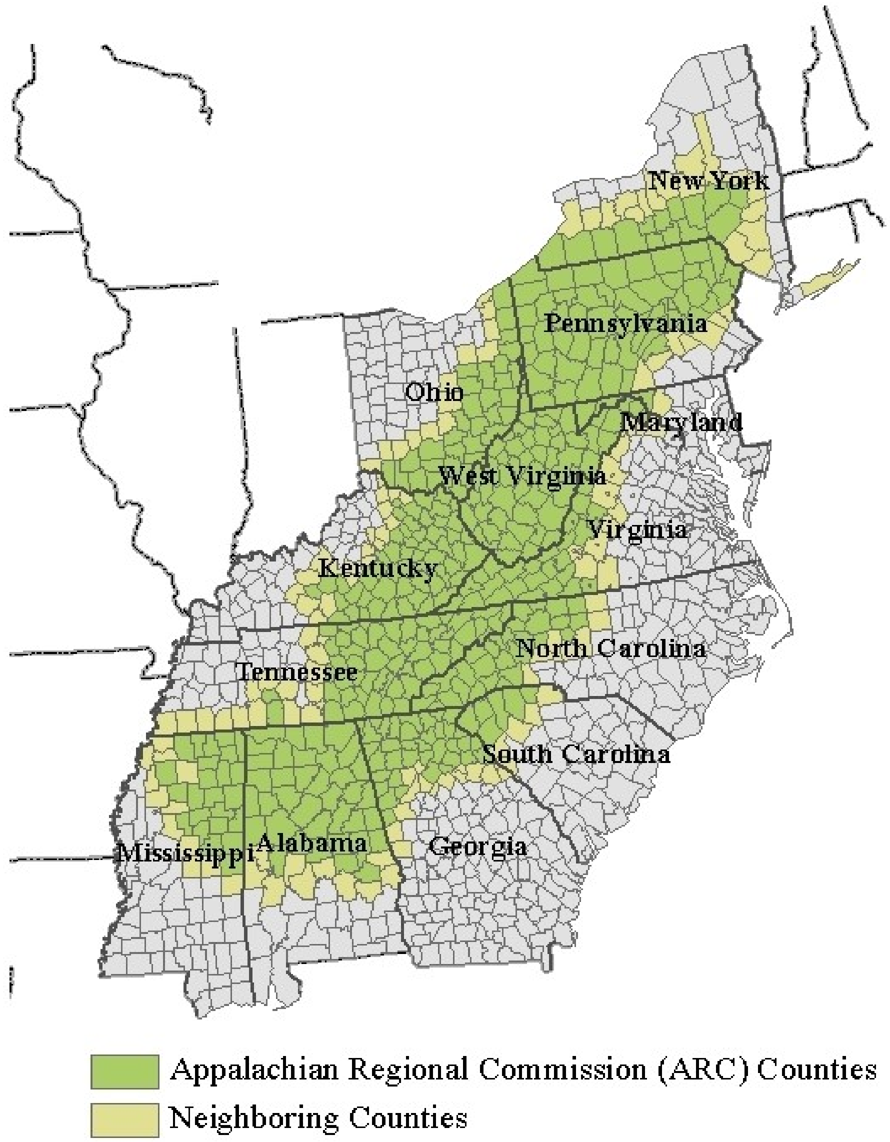

Figure 1. Counties in the Appalachian Region

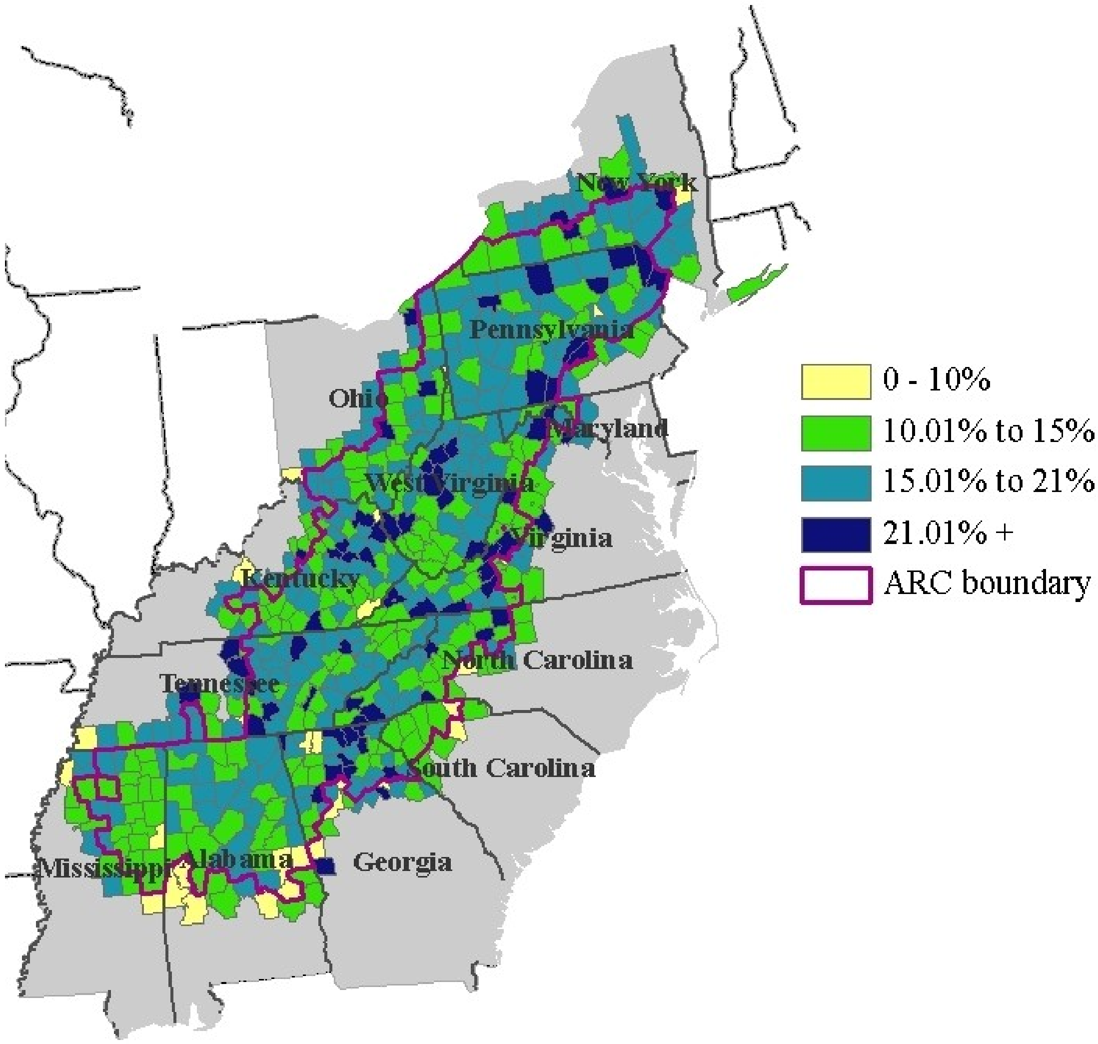

Figure 2. Share of County Self-Employment in the Appalachian Region, 1990

Chapter 2: The Role of Lake Amenities and Environmental Disamenities in Great Lakes Regional Growth

I. Introduction

Regional migration and growth are increasingly associated with high-quality *in situ* natural amenities. The Great Lakes, with their abundant fresh water and natural amenities, would seem to provide the foundation for this type of economic growth. Indeed, some places around the western Great Lakes are prime examples of amenity-led growth (e.g., Door County, Wisconsin, Cook County, Minnesota, and Western Michigan, along the Lower Peninsula). For the overall region, the role that the Great Lakes play in regional growth is less clear. With the current economic recession and ongoing economic restructuring that is eroding the region's economy, especially in the former rust belt cities of the eastern Great Lakes region, finding new ways to capitalize on the region's assets and generate growth is paramount. Policymakers are interested in whether the Great Lakes are quality of life (QOL) enhancing assets that can attract households and support regional economic growth.

Underlying the QOL research is the Tiebout (1956) theoretical notion that people "vote with their feet" and sort to reside in places with particular bundles of economic and site-specific public goods and amenities. Since amenities are normal or superior goods, rising incomes and technological advances in the United States have contributed to a footloose population that increasingly moves to areas with higher *levels* of natural amenities (Graves, 1976;1980; Rappaport, 2001; 2004; Rappaport and Sachs, 2003; McGranahan, 2008; Deller et al., 2001) and urban amenities (Glaeser, 1999; Glaeser and Maré, 2001; Florida, 2002a; 2002b). Work by Banzhaf and Walsh (2008) provides evidence of the negative effects from nearby environmental degradation.

In considering the potential for Tiebout-style sorting in response to Great Lakes amenities, this research thus hypothesizes that people who favor Great Lakes natural amenities will self-sort to live close to the water (all else constant). However, if there is also nearby environmental degradation in the form of existing industry or abandoned industrial sites, individuals will choose to locate elsewhere. The question is do households value the lake amenities and can the region chart a new economic future that is based on the lakes as *in situ* natural resources rather than one based on industrialization and extraction? Additionally, can all parts of the region benefit from amenity-driven growth or is there an east-west divide when it comes to the region?

This paper seeks to examine these questions within a spatial equilibrium framework in which movements by households and firms are due to differences in regional utilities and costs. Specifically, I examine whether proximity to lake amenities is associated with population and employment growth. I separately control for whether a county is located on the coast of one of the Great Lakes and the distance to the nearest Great Lake; these measures will help tease out whether positive lake amenity effects spillover into the region. Since amenities are also normal or superior goods, I test whether lake amenities have additional attraction value for individuals with high levels of human capital, building on the work by Moretti (2004) and Roback (1988) that suggests that high-skilled workers may be more likely to make migration decisions based on QOL.

My unique dataset includes measures of industrial disamenities that allow me to control for any offsetting effects they might have on growth.

While a growing body of literature has demonstrated the positive effects of natural amenities, this is one of the only studies to focus specifically on the Great Lakes region. Much of the previous research has focused on the natural amenities of the mountain west or the South. And, given the spatial heterogeneity of amenity effects (Partridge et al., 2008), national studies are not always instructive in explaining how amenities affect growth in specific regions. Additionally, while there is anecdotal evidence of an east-west divide in the region, with the Western Great Lakes doing better economically and also benefiting from amenity-driven growth, there has been little empirical examination of this difference. This research will examine these differences. One explanation for an east-west divide is that the industrial legacy effects are more prevalent in the east, which is defined as those areas closer to Lakes Erie, Huron, and Ontario. As shown in **Table 6**, eastern counties are closer to Superfund sites, have more power plants, and have more water and air pollution than those in the west (closer to Lakes Michigan and Superior). As evidence of an east-west divide, eastern counties have lagged their western counterparts in population growth since 1990, although the averages mask the tremendous heterogeneity in population growth in the region as shown in **Figure 3**. Additionally, **Table 6** shows that after 2000 the advantage of western counties seems to have largely disappeared.

Finally, this paper uses a unique dataset that includes geographically-defined variables related to natural amenities and environmental disamenities. While there is a plethora of research in the environmental literature that looks at the effect of individual environmental disamenities on regional growth or local housing values, this is one of the first attempts to use detailed pollution and other environmental data to assess how environmental degradation can offset the benefits to regional growth from natural amenities.

The results reveal that, consistent with a story that high-skilled workers should be more attracted to places with higher levels of amenities, coastal areas in the region are positively associated with increases in shares of college graduates. However, there is no statistical difference in this effect for places in the eastern part of the region versus the west.

At the same time, there is only weak evidence that lake amenities are associated with overall population or employment growth. And after 2000, overall population and employment growth declined. Since proximity to the lakes was associated with rising rents in the 1990s, this suggests increasing household value and/or firm productivity from lake amenities. The overall decline in firm and household migration after 2000 could also be due to the value of amenities being capitalized into rents and wages; providing little reason for additional movement after 2000. Another possible explanation is that the economic downturn of the 2000s may have reduced demand for access to lake amenities because they are normal, superior, or even luxury goods. Finally, there is evidence that the environmental quality in the lakes worsened after the late 1990s and this could explain a devaluing of the lake amenity post-2000.

Based on these results, I cautiously conclude that Great Lakes communities may be able to leverage their proximity to lake amenities to support economic growth, especially in terms of attracting individuals with high levels of human capital who are most likely to make migration decisions based on QOL measures. However, additional analysis is needed to identify which policies would be most effective for specific portions of the region and to assess the costs of such efforts. Additionally, if the more recent deterioration of lake water quality in the region becomes widely known, it could act as a disamenity and thus repel those households most likely to consider migrating to the region.

The remainder of this paper is organized into the following sections: Section II provides an overview of the relevant literature; Section III outlines the theoretical framework used for estimation; Section IV presents the empirical specifications; Section V discusses the unique dataset used in this analysis; Section VI discusses the key results; and, lastly, Section VII summarizes and concludes.

II. Motivation and Literature Review

Underlying the research on amenities and economic growth is the Tiebout (1956) theoretical notion that people "vote with their feet" and sort to reside in places with particular bundles of economic and site-specific public goods and amenities, which may include urban, environmental, or natural amenities. A wealth of previous empirical work has demonstrated the link between population growth and natural amenities (Graves, 1976; 1980; Rappaport, 2001; 2004; Rappaport and Sachs, 2003; McGranahan, 2001; McGranahan, 2008; Deller et al, 2001, among others) and urban amenities (Glaeser, 1999; Glaeser and Maré, 2001; Florida, 2002a; 2002b). While most of the recent work has focused on national studies or the mountain West or South, some of the earliest investigations into the relationship between natural amenities and growth were for Lakes Michigan and Superior (Wehrwein and Johnson, 1943). Partridge et al. (2008) looked at the population growth differential between areas with high and low levels of natural amenities and found that metropolitan areas with amenities at the level of Detroit grew

150% less than areas with amenities at the level of Orlando, and for rural areas the corresponding differential was 70%. However, Partridge et al. (2011) found evidence that amenities may have become less important to migration and population change since 2000. In a test of their formal theoretical model of the Tiebout hypothesis, Banzaf and Walsh (2008) found that environmental degradation associated with toxic releases is associated with decreases in population and income, supporting that idea that people sort away from environmental disamenities. If lake-based amenities can attract households, this literature suggests that environmental degradation could cause them to locate elsewhere.

Differences in regional utilities and profits will provide incentives for households and firms to move between regions. QOL-enhancing amenities will attract households; productivity-enhancing amenities will attract firms. In the long run, in equilibrium, the value of amenities and disamenities will be capitalized into the prices of land and labor, which will reflect the implicit prices of amenities or disamenities (Roback, 1982). Roback's (1982) seminal work has been the basis for a number of papers that have constructed QOL indices based on values of urban and natural amenities, including Blomquist et al., (1988); Gabriel and Rosenthal (2004); Chen and Rosenthal (2008); Shapiro (2006); and Albouy (2008). However, this research generally focuses on creating national rankings of metropolitan areas or states on a variety of QOL measures. Cities and states in the Great Lakes region also tend to rank relatively low in these studies, although this may be due to the overweighting of urban amenities in these measures. In another application of Roback's model, Clark and Nieves (1994) demonstrate the negative effects of proximity to environmental disamenities.

These papers rely on the assumption that the U.S. has reached a long-run spatial equilibrium in which households and firm have no incentive to make further relocations. More realistically, ongoing household and firm movements are expected due to productivity and QOL differences which may be affected by amenities. Additionally, mobility costs will not likely allow a pure spatial equilibrium to hold in the face of ongoing economic shocks (Greenwood et al., 1991; Rappaport, 2004; and Graves and Mueser, 1993). There is also evidence from Gabriel and Rosenthal (2004) that the factors that are QOL enhancing may not be the same as those that are productivity enhancing and cause firms to migrate. In fact, Jeppesen et al. (2002) found that areas with more pollution may be more conducive to certain types of economic growth because they may have looser environmental regulations and may be more attractive to manufacturing and other similar types of industries. Similarly, places close to the lake may be QOL enhancing but may have no effect on productivity.

Both QOL effects and productivity effects will determine if households will choose to "vote with their feet," since the utility that individuals get from a particular location also depends on the productivity generating wages they receive in that location (Tiebout, 1956; Rosen, 1979; Roback, 1982; Rappaport and Sachs, 2003). Since firms can also choose to "vote with their feet," the relative benefits they receive in terms of productivity, wages, and capital costs will affect where they choose to locate. Even if the population is moving toward areas with higher levels of QOL, this may not correspond with associated employment growth. Perhaps it is retirees who are moving to these high QOL areas; Gabriel and Rosenthal (2004) find that places that are productivity enhancing are not the places where retirees are moving. However, Monchuk and Miranowski (2007) find evidence that natural amenities are associated with employment growth in the

Midwest; so perhaps, as hypothesized, they are chasing the workers who are moving to be near these amenities. However, *a priori* this effect is unknown, and in their analysis of U.S. nonmetropolitan counties, Partridge et al. (2008) found tremendous spatial variation in the effect of amenities on employment growth.

In this type of model, amenities could thus lead to population growth as households move into a region to be near QOL-enhancing amenities and firms relocate to seek these workers, thus raising employment. These movements could lead to higher land rents, which are reflected in higher housing prices. At the same time, a greater supply of labor, relative to the number of jobs, would cause average wages to fall, and thus high-amenity places are often associated with lower wages. For example, high-amenity regions may be areas that can be converted into recreation or retirement destinations which may have a lot of low-paying hospitality-oriented jobs.

However, an offsetting factor is that because amenities are normal or superior goods, higher-skilled workers, a proxy for higher income people, may be attracted to high-amenity areas. In fact, Kerr (2011) found that amenities are even likely luxury goods; further emphasizing that QOL may be most important to those with higher incomes. In this case, amenities can lead to new firms entering the region who demand high-skilled labor, and thus bid up the wages (Deller et al., 2001; Partridge and Rickman, 2003b; Kim et al., 2005). With increasing numbers of high-skilled workers and the firms that hire them, there may be knowledge spillovers and other productivity benefits that can increase wages (Rosenthal and Strange, 2001; 2003). These effects can help transform high-amenity regions into economically diverse regions that include higher-paying, higher-skilled jobs.

This explanation is supported by theoretical models from Roback (1988) and Moretti (2004) which include two types of workers. If amenities are normal or superior goods, then workers with higher incomes or higher education may be more attracted to places with more amenities. In Moretti's (2004) specification, only those with high levels of human capital value amenities. The spatial equilibrium in this model suggests that high amenity areas will have a larger share of workers with high levels of human capital, which can be proxied by those with high levels of education, such as college graduates.

As a complementary measure of human capital, Florida introduced the concept of creative skills, measured by the number of workers in creative occupations (2002 a,b).[12] Florida 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. Consistent with creative workers being more attracted to amenities, McGranahan and Wojan (2007) find that rural U.S. counties with a large share of creative workers and high levels of natural amenities had higher employment growth. However, Dorfman et al. (2011) found that for high-tech employment, natural amenities only matter for a small subset of firms that hire high-human capital workers in U.S. counties in micropolitan areas, but not for metropolitan or rural areas. In my dataset (explained in Section V), the shares of college graduates and those in the creative class

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[12] The 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.)

are highly overlapping with a correlation of 0.94, suggesting that the share of college graduates is a good proxy for those with high-human capital.

Access to amenities could also contribute to population and job growth over a wide geographic area. For example, Schmidt and Courant (2006) show that certain amenities, such as national monuments, can influence economic outcomes for hundreds of kilometers. Other papers have examined the geographical reach of site-specific attributes including access to cities, public goods, and natural amenities (Ferguson et al., 2008; Partridge et al., 2008; and Irwin, 2002). Thus, the influence of the Great Lakes may not only be on the immediately adjacent counties but also on counties that are "near" the lakes as people move to be close enough to the lakes to enjoy them in their leisure time.

III. Theoretical Framework

My empirical analysis is based on a two-equation spatial equilibrium framework (from Roback, 1982; Partridge et al., 2010; and Jeanty et al., 2010) in which firms maximize profits and households maximize utility. In this model, the representative household chooses amounts of a composite traded good (Y), land (L^h), and site-specific characteristics (s) to maximize utility subject to a budget constraint:

$$\max U_i \left(Y_i, L_i^h \middle| s_i\right) \qquad s.t.\, w_i = Y_i + r_i L_i^h, \tag{1}$$

where wage and rental payments are w and r and the price of the composite good is normalized to 1. The s vector includes all regional characteristics that make regions heterogeneous, including natural and urban amenities and environmental disamenities.

In spatial equilibrium, because households can sort to the location with the highest utility, wages and rents will adjust so that the indirect utility is the same in all regions, and is equal to $\bar{V}$, otherwise, some households would move.

$$\bar{V} = V_i(\mathrm{w_i}, \mathrm{r_i} \,|\mathrm{s_i}) \tag{2}$$

The representative firm produces Y using a constant-returns-to-scale production function $Y_i = f\left(L_i^f, \mathrm{N_i}\middle|\mathrm{s_i}\right)$ where N is the number of workers. Here the area characteristics act as profit shifters. For example, a higher share of college graduates may raise the productivity of the firm.

Again, under the assumption of perfect mobility, in spatial equilibrium, wages and rents will adjust so that unit costs are equalized across regions, and are equal to 1. I utilize the unit cost function because of the constant returns to scale assumption.

$$\mathrm{C}_i(\mathrm{w_i}, \mathrm{r_i} \,|\mathrm{s_i}) = 1 \tag{3}$$

Given a partial adjustment process, in the long run, spatial equilibrium is reached when utility and cost differentials are eliminated across all regions. In equilibrium, because the value of amenities is capitalized into wages and rents, Roback (1982) and others have shown that regional differences in wages and rents can be used to value location-specific attributes. However, Rappaport (2004) shows that spatial equilibrium is the long-run steady state of a growth model and that migration toward equilibrium (i.e. being out of the steady state) can be persistent where even small frictions to labor and capital mobility, productivity, or QOL can draw this adjustment process out for decades.

The literature has long highlighted the U.S.'s long history of migration toward equilibrium (Graves and Mueser, 1993; Rappaport, 2007; Greenwood et al. 1991; and Partridge et al. 2011).

Thus, I assume there will be ongoing movements toward equilibrium. Since regional utility and cost differentials are the main drivers of firm and household relocations across regions, the movement of households μ_i and the movement of firms η_i are functions of these differentials:

$$\mu_i = f\{[\bar{V} - V_i(\mathrm{w_i}, \mathrm{r_i} \,|\mathrm{s_i})]\theta_i\} \tag{4}$$

$$\eta_i = f\{[\mathrm{C}_i(\mathrm{w_i}, \mathrm{r_i} \,|\mathrm{s_i}) - 1]\tau_i\} \tag{5}$$

Where θ_i reflects frictions to household movement, such as moving costs and imperfect information and τ_i is an adjustment factor related to firm movement, such as barriers to entry.

The model can be expanded to include two types of workers in the spirit of Roback (1988) and Moretti (2004), high-human capital workers and low human-capital workers. In that case, there would be two household migration equations with each type responding to different long-run spatial equilibrium utility levels.

In Chapter 3, I will assume that housing prices are in equilibrium and that the value of amenities can be uncovered by looking at housing prices within a single labor market (Rosen, 1979). This contrasts with my assumption here that there are small frictions to household and firm mobility that result in ongoing movements toward equilibrium. Both approaches represent simplifications of reality. Rappaport (2004) and Greenwood et al.(1991) both provide evidence of ongoing movements of households and firms. However, Rappaport (2004) also demonstrates that wages and rents adjust much more quickly to a new steady state equilibrium than do populations. The two approaches focus on different aspects of the housing market and both are consistent with an equilibrium-based framework in which the housing market adjusts to a long run spatial equilibrium.

IV. Empirical Specifications

Following Roback (1982) and a host of other empirical papers that have subsequently used the Roback model (e.g., Partridge et al. (2010), and Jeanty et al. (2010)), I consider how population and employment changes are affected by natural amenities, especially access to the Great Lakes, and environmental disamenities (equations (6) and (7), below). Population changes are affected by migration of households, related to equations (4). While I am interested in assessing movement of households or migration due to utility differentials, Faggian et al. (2011) and Partridge et al. (2011) find that population change is a good proxy for household migration and reveals the representative household's assessment of where his/her well-being is improved. Employment changes are determined in the labor market by both the movement of households and firms, both equations (4) and (5) above. Household movements affect labor supply and firm movements affect labor demand; and together they jointly determine the level of employment in a region.

To better understand who is moving, and assuming amenities are normal or superior (or luxury) goods, I also investigate whether higher-educated individuals or those with higher levels of human capital are choosing to locate near high-amenity locations in the region. Specifically, I look at the change in the share of college graduates in the region as demonstrated in equation (8). This allows me to test Moretti's (2004) and Roback's (1988) extension of the original Roback (1982) model.

For each county *i* in state *s*, the reduced form estimation equations are:

$$\Delta POP_{\mathrm{is}} = \alpha^{\mathrm{P}} + \beta_1^{\mathrm{P}}\mathrm{AMENITY}_{\mathrm{is}} + \beta_2^{\mathrm{P}}\mathrm{X}_{\mathrm{is}}^{\mathrm{P}} + \sigma_{\mathrm{s}}^{\mathrm{P}} + \varepsilon_{\mathrm{is}}^{\mathrm{P}} \quad (6)$$

$$\Delta EMP_{\mathrm{is}} = \alpha^{\mathrm{E}} + \beta_1^{\mathrm{E}}\mathrm{AMENITY}_{\mathrm{is}} + \beta_2^{\mathrm{E}}\mathrm{X}_{\mathrm{is}}^{\mathrm{E}} + \sigma_{\mathrm{s}}^{\mathrm{E}} + \varepsilon_{\mathrm{is}}^{\mathrm{E}} \quad (7)$$

$$\Delta COLLGRAD_{\mathrm{is}} = \alpha^{\mathrm{C}} + \beta_1^{\mathrm{C}}\mathrm{AMENITY}_{\mathrm{is}} + \beta_2^{\mathrm{C}}\mathrm{X}_{\mathrm{is}}^{\mathrm{C}} + \sigma_{\mathrm{s}}^{\mathrm{C}} + \varepsilon_{\mathrm{is}}^{\mathrm{C}} \quad (8)$$

AMENITY includes the natural amenities and industrial disamenities, X is a vector of control variables (described in Section V), σ's are state fixed effects that account for common state-specific factors such as regulatory regime and tax structure, and the ε's are error terms. State fixed effects will control for any specific state policies that might lead to higher or lower growth rates. As explained below, I examine changes in both the 1990s and from 2000 to 2007.[13] I specifically choose to cut off my analysis in 2007 in order to avoid including the most recent recession in my analysis. I consider the two decades separately because other research has found some evidence that in recent years the effect of amenities may be changing (Partridge et al., 2011). To minimize endogeneity, I use beginning period values for the explanatory variables contained in X; i.e. for 1990 to 2000, I use 1990 explanatory variables, and for 2000 to 2007, I use explanatory variables from 2000.

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[13] After 2000, college graduate data is only available for all counties from the American Community Survey 5-year Estimates. Thus, my final college graduate share is an average from 2005 to 2009, rather than from 2007.

These models allow me to test whether lake amenities are positively associated with changes in population, employment, and the share of the population with high-human capital in the Great Lakes region. They also provide a means of testing whether there is an offsetting impact from pollution and industrial disamenities and whether there are differences in the eastern versus the western parts of the region, through the use of an East dummy variable, as explained in Section V. As seen in Table 6, eastern counties have experienced slower population growth, are closer to Superfund sites, have more power plants, and have more water and air pollution than those in the west.

Given that population and employment growth declined after 2000, and because of evidence that the effect of amenities may be changing (Partridge et al., 2011), I am also interested in whether there was a change in preference for lake amenities or a change in productivity associated with being closer to one of the lakes. Thus, I consider the change in the value of the amenity from the 1990s to the post-2000 time period by using a differencing approach. This approach involves subtracting the change in the measures of growth for population, employment, and college graduates from the change in that same measure in the post-2000 period. This method allows me to difference out the county-level fixed effects and minimize omitted variable bias. The time-invariant amenity measures are assumed to have different values in each time period, and the state fixed effects and the east dummy variable (explained below) are eliminated from the estimation equation. The resulting equations also combine the constants and error terms into common terms. The new vector Z includes the time-varying amenity and disamenity measures and the variables previously contained in X in equations 6, 7, and 8. The reduced form estimation equation is as follows, where Y is population, employment, or college graduates:

$$\Delta Y_{is00} - \Delta Y_{is90} = \alpha^{Y} + (\beta^{Y}_{1,00} - \beta^{Y}_{1,90})\text{AMENITY}_{is} + \beta^{Y}_{2,00} Z^{Y}_{is00} - \beta^{Y}_{2,90} Z^{Y}_{is90} + \varepsilon^{Y}_{is}$$
$$= \alpha^{Y} + \Delta\beta^{Y}_{1}\text{AMENITY}_{is} + \beta^{Y}_{2,00}\Delta Z^{Y}_{is} + \Delta\beta^{Y}_{2} Z^{Y}_{is90} + \varepsilon^{Y}_{is} \quad (9)$$

For all models (6, 7, 8, and 9), I adjust for both standard heteroskedasticity and any within economic cluster correlation by clustering the standard errors based on the Bureau of Economic Analysis economic areas. Primo et al. (2007) have shown that not properly accounting for this correlation can lead researchers to overstate the statistical significance of coefficient estimates. However, I also test the results against those using robust standard errors and they were similar (results not shown).

I also consider the possibility of general spatial error correlation, spatial correlation of the dependent variables, and spatial spillovers of the explanatory variables and test all models using Moran's I and LM Error and LM Lag tests (results not shown). Overall, I find the results to be qualitatively similar to those shown in Tables 2 through 7.

Finally, sensitivity analysis will test if the results are robust to the model specifications.

V. Data

I have constructed a unique dataset that consists of observations for the counties in the eight states in the Great Lakes region of the United States – Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. Counties within 100 miles of the Atlantic Ocean (from New York and Pennsylvania) are excluded from this sample. As discussed in further detail below, data are collected from a variety of sources, including the U.S. Census, the Bureau of Economic Analysis (BEA), the

Department of Housing and Urban Development (HUD), the Environmental Protection Agency (EPA), the Department of Energy (DOE), the U.S. Geological Service (USGS), USDA-Economic Research Service (USDA-ERS), and others. ArcGIS is also used to construct a number of specialized variables using data from these sources. This dataset allows me to control both for access to lake amenities and the intervening effects of industrial disamenities while also controlling for other factors that would be expected to explain growth in the region. **Table 6** shows the full list of variables and some descriptive statistics.

Dependent Variables

The analysis uses the following dependent variables:

1) Percent change in population, 1990 to 2000 and 2000 to 2007[14], using data from the BEA (Equation 6).
2) Percent change in employment, 1990 to 2000 and 2000 to 2007, using data from the BEA (Equation 7).
3) Percent change in college graduate share, 1990 to 2000 and 2000 to 2007, using data from the U.S. Census (Equation 8).[15]
4) Difference in Growth Rates = [Percent change in population, employment, or college-share growth, 2000-2007] – [Percent change in population, employment, or college-share growth, 1990-2000]; (Equation 9).

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[14] I end my analysis in 2007 in order to pick up long-term trends and to avoid cyclical effects of the recession.

[15] As noted previously, after 2000, college graduate data are only available for all counties from the American Community Survey 5-year Estimates. Thus, my final college graduate share is an average from 2005 to 2009, rather than from 2007.

Explanatory Variables

The AMENITY variables can be grouped into two categories – natural amenities and industrial disamenities. Natural Amenities include measures related to the Great Lakes and other natural amenities that may important to households. The value of the Great Lakes is measured by 1) distance to the nearest Great Lake in kilometers and 2) a coastal measure that indicates whether or not a county is located on the coast of a Great Lake. Other natural amenities included in the model are measures of relative values of January temperature, July temperature, and topography. I also include a measure of interior water area that does not include the water area in the Great Lakes. Additionally, I have a measure of the percent of the county that is in forest cover. All natural amenity data are time-invariant and are from USDA/ERS, USGS, or constructed using ArcGIS.[16]

Industrial disamenities data include number of power plants, constructed using data from DOE's Energy Information Administration (EIA); and from the EPA, distance to the nearest Superfund site and measures of total air and water pollution (in pounds) released in the county (measures of industrialization) using Toxic Release Inventory (TRI) data. Because of high levels of multicollinearity among the disamenity measures, I create disamenity indices for both 1990 and 2000, which are comprised of the sum of the z-scores for the four disamenity measures in each year. This approach is similar to the approach used by McGranahan (1999) to construct his well-known index of natural amenities. This allows me to assess the offsetting impact of disamenities in the models

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[16] All measures using ArcGIS are from the population weighted centroids of counties.

while avoiding the multicollinearity that arises when the measures are included individually.

I follow the literature in proxying for the other forces that influence household and firm migration such as demographic composition of a region, industry composition, and urban proximity and amenities (Deller et al., 2001; Glaeser et al., 1995; Partridge et al. 2008; 2009). Conditioning on other factors that affect household and firm migration is important to ensuring that the results are not affected by omitted variable bias. All time-varying explanatory variables are from the initial time period in order to avoid issues of endogeneity. Alternative model specifications are considered to test the robustness of the results.

Variables in the X vector of the various specifications:

- Because the attractiveness of a region is affected by access to urban amenities or urban agglomeration that may increase productivity, I control for urban proximity and urban agglomeration through the use of a dummy variable for counties in metropolitan areas; measures of distance (in kilometers) to the nearest metropolitan area and incremental distances to metro areas with 250,000, 500,000, and 2.5 million people (based on the 2000 Census), which are generated using ArcGIS; and population density, which is measured in 1990 and 2000, using data from the U.S. Census.[17] By controlling for proximity to cities of various sizes, I am controlling for whether a community is near a small metropolitan area like Springfield, Illinois, with about 200,000 people, or a large one like Chicago, with over

[17] Measures are based on distance from the population weighted centroid of each county to the population weighted centroid of the metropolitan area.

9 million people, and which provides access to the full range of urban amenities and services for businesses.

- The educational attainment of the population can increase the attractiveness of a region to firms due to productivity benefits. Additionally, many endogenous growth theories are based on a pool of competitive human capital skills to generate growth. However, for some areas with limited employment prospects, a higher initial share of educated individuals may actually be inversely related to growth. Finally, college graduates may be attracted to areas with higher levels of amenities. Work by Partridge et al. (2008) found that the relationship between college graduate share and growth was generally negative in non-metropolitan counties in the Midwest; but that there is tremendous heterogeneity in the relationship between college graduates and growth. From the U.S. Census, for 1990 and 2000, I include measures of educational attainment in the county, including percent of population 25 and older with only high school diplomas (or the equivalent), those with some college, and college graduates, which includes those with bachelors, graduate, professional, and doctorate degrees.
- Other demographic measures from the U.S. Census available for both 1990 and 2000 include racial composition, gender composition, age composition, and percent of the population that is married. As shown in much of the migration literature, the demographic composition of a region can affect its relative attractiveness to both people and firms. For example, young, single men would be more attracted to a place with a

higher percentage of young, unmarried women. Similarly, firms would be more attracted to a place with working age people of both genders. Since people tend to be attracted to places with similar types of people (especially in terms of race), racial composition can make a difference in terms of migration. However, because the young may be inclined to move to faster growing places (Partridge et al., 2011), directly controlling for age can raise endogeneity issues, thus I also test models without the age variables, but the results are similar.

- To control for initial economic conditions, I include the initial percent of the population over 16 that is employed, which is a measure of the efficiency of the local labor market, and data on industrial composition. From BEA and EMSI[18] county-level industry employment data, I construct shares of county employment in various industries in 1990 and 2000. Specifically, I include initial percent of total employment in manufacturing, agriculture, and government; and percent of wage and salary employment in leisure companies (NAICS Sectors 71 and 72). These employment shares control for economic opportunities and the industrial mix. By including the share of leisure employment, I am controlling for whether there is a high level of employment in industries that would be associated with a tourist destination.

[18] EMSI 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. (2011) for more details of EMSI's employment estimating procedures.

- The share of 1970 manufacturing employment, from the BEA, controls for historic industrial legacy effects that may be preventing a county from taking advantage of lake-related amenity development. Industrial legacy effects include both abandoned factories and other abandoned industrial sites which are not fully accounted for in the disamenity index and a dependence on an industry composition of declining industries; both of which would be expected to contribute to lower growth.
- The east-west effect is proxied by a dummy variable, East, that is equal to 1 if the nearest Great Lake is Erie, Huron, or Ontario. I also interact the east variable with distance to the nearest great lake and the coastal variable to test whether there is a difference in the effect of lake amenities in the eastern versus the western portions of the Great Lakes region.

Since I am interested in the Great Lakes as drivers of growth, ideally I would have good data on water quality. However, as noted by Gyourko et al. (1997), since water quality is monitored at the state level and the standards vary from state to state, consistent measures of water quality for the entire region are unavailable.

To avoid direct endogeneity, the explanatory variables measure beginning of period effects. For example, if the dependent variable measures a change from 1990 to 2000, the explanatory variables are from 1990.

VI. Results and Discussion

Because of multicollinearity concerns, I first estimated several parsimonious models that only include the amenities and disamenity index, and combinations of the state fixed effects, the East indicator dummy variable, and measures of urban proximity, to assess if there were any relationships between the variables of interest – proximity to amenities and disamenities and the "east" variables – and my measures of growth. I then added demographic and industrial control variables as well as measures of spatial spillovers and other economic controls. When state fixed effects are included in the models, there is additional evidence of multicollinearity and I report estimates that both include and exclude these controls.

Additionally, including both the initial and changes in the explanatory variables when estimating changes in population, employment, and collage graduate share growth between the decades [equation (9)] introduces high levels of multicollinearity into the models. Thus, I report only the models which include the beginning (1990) levels of time-varying explanatory variables in the results, which also minimizes endogeneity. However, doing so does not change the key results.

Population Changes

As shown in **Table 7**, overall proximity to the Great Lakes does not seem to be a major driver of population growth. However, in the 1990s, coastal counties experienced roughly 4% lower population growth than the rest of the region. This result holds up as I move from Model 1, which includes only controls for urban and natural amenities and disamenities, through Model 5, which includes a full set of demographic and industrial controls plus state fixed effects. At the same time, however, there is a slightly positive relationship between being closer to one of the Great Lakes and population growth, roughly 0.2% for every 10 kilometers from one of the lakes. Since the population-weighted centroid of the average coastal county is 10 kilometers from a Great Lake, the average coastal county in the region has -3.8% lower population growth than other counties in the region. One possibility for the apparently conflicting results of the lake variables is that higher rents right on the lakes may be discouraging people from wanting to live in coastal counties, but that people are interested in being close enough to the lakes to enjoy their recreational and other benefits. People may also just generally be interested in being able to access the lakes for recreational purposes, but may not care whether or not they live on the lake, consistent with a story that natural amenities can have significant distance effects. There is also the possibility that disamenities that are located directly on one of the lakes, like power plants, may be keeping people from wanting to live directly on the lake. Since I am using county-level data and the distances are based on population-weighted centroids of the counties, it also may be that I am not able to distinguish between those households that live exactly on the coast of one of the Great Lakes, or within a short distance of a lake, and those that live within a coastal county but farther from the lake.

Overall, eastern counties had lower total population growth in the 1990s. However, eastern coastal counties had slightly higher population growth than other counties in the eastern part of the region. At the same time, for counties in the eastern part of the region, there is a small positive relationship between being farther away from one of the Great Lakes and population growth. The net result is that, in the 1990s, it appears that the eastern part of the region saw almost no population growth due to lake amenities. An alternative explanation is that because regression provides the average effect that it may be masking the positive gains of a few key coastal counties.

Table 8 shows that after 2000 the correlation between proximity to one of the Great Lakes and population growth weakens considerably. Again, these results are robust to the inclusion of additional explanatory variables, as I move from Model 1 to

Model 5. As expected from the lack of statistical difference between average eastern and western population growth in that decade (see **Table 6**), all else equal, both parts of the region experience similar levels of growth and the negative association between being in the east and total population change is smaller. This is also consistent with evidence that amenity-driven migration is declining in recent years. Nevertheless, coastal counties (in the entire region) continue to be negatively associated with population growth. And, as shown in Model 4, after 2000, eastern coastal counties continue to see higher population growth (1%) than other counties in the eastern part of the region.

Looking closely at whether there is an offsetting effect of proximity to industrial and environmental disamenities, I see that, in both decades, there is some evidence of a negative disamenity effect with higher levels of the disamenity index associated with statistically significant lower population growth. However, once I control for the industrial mix in Model 3 in Tables 7 and 8, the statistical significance disappears. Since there is also the possibility that disamenities could be highly correlated with employment opportunities, I replace the disamenity measure for 2000 with the measure for 1990 in the post-2000 models (results not shown). The results are qualitatively similar to those using the 2000 disamenity index and thus I conclude that the measure is not endogenous.

Employment Changes

Next I consider employment changes. Overall, there is only a weak, negative relationship between proximity to the Great Lakes and employment growth.

In the 1990s, as **Table 9** shows, being on the coast of one of the Great Lakes was weakly associated with lower employment growth. This is consistent with the lower population growth observed in those counties. Again, as expected, I also find that, overall, being in the east was associated with lower 1990s employment growth. However, unlike with population growth, eastern coastal counties are not doing better than other eastern counties when it comes to employment growth, and this result is robust from Model 1 to Model 4 as I add explanatory variables. Additionally, in Model 4, I observe a (weak) additional negative relationship between being in the east and closer to one of the Great Lakes and employment growth.

After 2000, as **Table 10** illustrates, for the broader region there appears to be no statistically significant relationship between proximity to the Great Lakes and employment growth. And consistent with the lack of statistical difference between average eastern and western employment growth in that decade (see **Table 6**), all else equal, both parts of the region experience similar levels of growth.

I also look at whether there is a relationship between disamenities and employment growth. In the 1990s, the disamenity index appears to be weakly negatively associated with employment growth. This suggests that employment growth in the region is probably not due to gains from manufacturing and other businesses which might find proximity to power plants and other sources of pollution to be attractive or productivity enhancing. I see further evidence of this when I look at the positive and statistically significant coefficient on the share of wage and salary leisure employment in the 1990s employment change equation.[19] However, after 2000, the statistically significant correlation between share of initial leisure employment and overall employment growth disappears and there is now a positive and statistically significant relationship between the level of disamenities and employment growth. This suggests

[19] While not shown, the coefficient on the share of wage and salary leisure employment in Table 9, Model 3 is 0.784 and is statistically significant at the 99% level.

that jobs are being created in different types of industries after 2000 or that the water quality of the lakes may be deteriorating.

College Graduate Share Growth

To explore whether those with high levels of human capital are more likely to be attracted to high levels of amenities, I consider the growth in the share of college graduates. As **Table 11** illustrates, in both decades, coastal counties were associated with higher levels of growth of college graduates, which is consistent with the theoretical models of Roback (1988) and Moretti (2004). Additionally, the statistically significant relationship between percent water and the growth in the share of college graduates provides further evidence that college graduates are attracted to natural amenities. For the 1990s, however, away from the coastal counties, being farther from one of the lakes is statistically significant and positively associated with higher growth in college graduates. This suggests that there is a split among college graduates. Some relocate to areas immediately adjacent to one of the lakes and others locate where access to the Great Lakes is not a factor. For example, recreational amenities may draw college graduates and those in creative occupations to places like Traverse City, Michigan. However, the availability of jobs is likely the main driver in relocations to places like Columbus, Ohio, where proximity to Lake Erie, which is more than 100 miles away, is not likely a factor.

In exploring whether there is a difference between the east and west, I found somewhat surprising results. In the 1990s, there is no statistically significant difference between the east and west in terms of growth of college graduates. But after 2000, the eastern counties actually seem to be doing better, overall, in terms of increasing their share of college graduates. And, in both decades, the eastern coastal counties appear to enjoy the same boost (or even more of one) in terms of attracting college graduates as their counterparts in the west. This is surprising given that, compared to their western counterparts, eastern coastal counties have higher levels of disamenities which might be expected to offset the positive attraction of natural amenities.

Differences between the 1990s and 2000s

In **Table 12**, I also explore whether the attraction value of lake amenities is changing between the 1990s and the post-2000 period by looking at the difference across decades. This also allows me to difference out the unobservable fixed effects [see Equation (9)].

There is a positive change in the association between distance to the nearest Great Lake and population growth from the 1990s to the 2000s, suggesting that the value of being closer to the lake declined after 2000, which is consistent with the results in Table 8. One explanation is that if amenities are normal or superior goods, then the sluggish economy post-2000 may have reduced the demand for lake-based amenities. Another possible reason is that the environmental quality of the lakes worsened after the late 1990s and this may explain the reversal of migration patterns post-2000.

I also difference across decades to see if there is a change in the value of proximity to the Great Lakes relative to employment growth between the 1990s and the post-2000. As shown in Table 12, there is evidence of a weak increasing coastal effect on employment growth across the decades suggesting that perhaps there is an increasing productivity benefit from being on the coast.

Finally, I consider the difference in growth in college graduate shares across decades. Again, this allows me to difference out the fixed effects and assess whether the value of proximity to the lakes in terms of increasing college graduate share is changing across decades. The positive and statistically significant coefficient for the coastal variable suggests that amenity-based migration for the college graduate population is becoming more important post-2000. And, other natural amenities, as evidenced by the positive and statistically significant coefficient on non-Great Lakes water, also appear to be increasing in value to college graduates. This contrasts with the negative change related to lake amenities I observe for the total population, but is consistent with the positive change for total employment. This is evidence that the total population changes, which are averages across the entire population, mask the heterogeneity in the effect of being closer to one of the lakes or on the coast. It is also consistent with a story that, after 2000, only the highly skilled were able to live near the lakes, possibly due to increasing housing prices. Additionally, these results suggest that perhaps it is the increase in high skilled workers in coastal counties that is driving the productivity improvements that have led to increases in employment. However, I caution that the low explanatory value of these models, as evidenced by the small values of the adjusted R-squared, suggests more analysis may be needed.

VII. Conclusion and Future Research

With the economic recession and ongoing economic restructuring, there is interest in the Great Lakes region in whether the lakes themselves can be drivers of growth. There is an increased sense of urgency in finding new ways to generate growth, especially for the former Rustbelt cities and the entire eastern part of the region, which has experienced a decline in population since the 1970s.

To assess whether the Great Lakes are associated with growth in the region, I examine changes in population, employment, and share of college graduates. Given the access to fresh water and recreational opportunities that the Great Lakes offer, I try to answer whether the region could reinvent itself with amenity-driven growth. Or, will the industrial legacies of the rust belt create a repulsion effect that overwhelms the attraction of QOL-enhancing amenities? The evidence is mixed.

There is evidence that being in a coastal county is associated with growth at the high-end of the human capital spectrum, as seen by the relationship with growth in the share of college graduates. This is consistent with work by Moretti (2004) and Roback (1988) that suggests that amenities are more important to those with higher incomes or higher human capital and by Kerr (2011) that shows that amenities are luxury goods. Additionally, eastern coastal counties, with their industrial legacy, seem to be doing just as well as their western counterparts in terms of increasing shares of college graduates, and this trend continues past 2000. It appears that amenity-based migration by those with higher levels of education is happening throughout the region and has not died off after 2000.

At the same time, overall population changes do not appear to be driven by a strong amenity effect. In the 1990s there is some evidence that people may be interested in locating close enough to one of the lakes to enjoy their recreational benefits but not necessarily on one of the lakes. This is consistent with studies that show proximity benefits from natural amenities. It may also be that other factors such as housing prices affect exactly where they choose to live, and that higher rents near the lake may lead them to choose to be close enough to enjoy the benefits of the lakes, but just far enough away where they do not have to pay the amenity premium in their housing costs. But, between the 1990s and the 2000s, the relationship between proximity to the lakes and population growth declines. This could be that since positive amenities are normal or superior goods, the housing crisis and the two recessions of the 2000s have made households, in general, less concerned with amenities and disamenities. Alternatively, it could be due to the decline in environmental quality of the lakes starting in the 1990s has made the lakes less attractive since 2000.

One possibility for the relatively weak results for overall migration is that that by using county-level data I am not able to distinguish between those households that live directly on or within a short distance of one of the Great Lakes and those that live within a coastal county but farther from the lake. Thus, in future work I will use micro-level data at the household level to try to distinguish true coastal households from those who simply live "near" one of the lakes.

At first glance, it also appears that the Great Lakes do not seem to play much of a role in overall employment changes, with almost no discernable relationship between proximity to the lakes and employment changes after 2000. However, when I look at whether the value of proximity to the lakes is changing between the decades, I see evidence that being on the coast is becoming more important to employment growth. Perhaps this is due to the increasing numbers of college graduates who are moving into the coastal counties thus creating productivity benefits for employers.

Overall, there is a dramatic decrease since 2000 in both population and employment growth. This drop could be due to the capitalization of amenity benefits into wages and rents that may have brought the region into approximate spatial equilibrium, reducing any reason for households or firms to move. In other words, there may simply be fewer disequilibrium adjustments toward equilibrium in terms of population and employment changes after 2000. For example, rising housing costs may be offsetting amenity benefits for the broader population. And, if this means that only the higher-skilled, higher-income workers and households can afford to live near the lakes, this could have important distributional or welfare effects not explored in this paper.

At the same time, a policy focused on attracting high-skilled workers could have tremendous benefits for the region in terms of transforming it into one that is economically diverse and includes higher-paying, higher-skilled jobs. Previous work has shown that as high-skilled labor enters a market this can also attract new firms entering the region who demand this high-skilled labor. Through knowledge spillovers and productivity increases as well as bidding between firms, wages can increase (Deller et al., 2001; Partridge and Rickman, 2003b; Kim et al., 2005; Rosenthal and Strange, 2001; 2003). However, this strategy could also crowd out lower-skilled, lower-income workers from areas near the lakes.

There also could be tremendous heterogeneity in terms of the ability of specific communities to implement an economic development strategy focused on attracting high-skilled workers with lake amenities. It may be that a combination of both access to amenities and jobs in specific industries are important to attracting high-skilled workers; thus it would be interesting to investigate which types of jobs the college graduates are taking. Future work should also consider other measures of growth, such as the change in the share of self-employment or employment in specific industries or occupations.

Additionally, the real and perceived quality of amenities varies throughout the region and changes over time. For example, there is evidence that many would-be tourists think of Lake Erie as dirty (Ohio Sea Grant, 2005) while there are positive perceptions of the water quality in Lake Superior. Even when environmental restoration improves water quality, changes in perceptions may take time. As the same time, water quality has declined for many parts of the region in recent years and this may or may not be known to potential in-migrants.

Overall, this research suggests that for those counties and sub-regions close to the Great Lakes there may be economic benefits to preserving or restoring the quality of the lakes as a QOL-enhancing amenity. Additional research can help identify which economic development strategies would work best for specific counties or sub-regions.

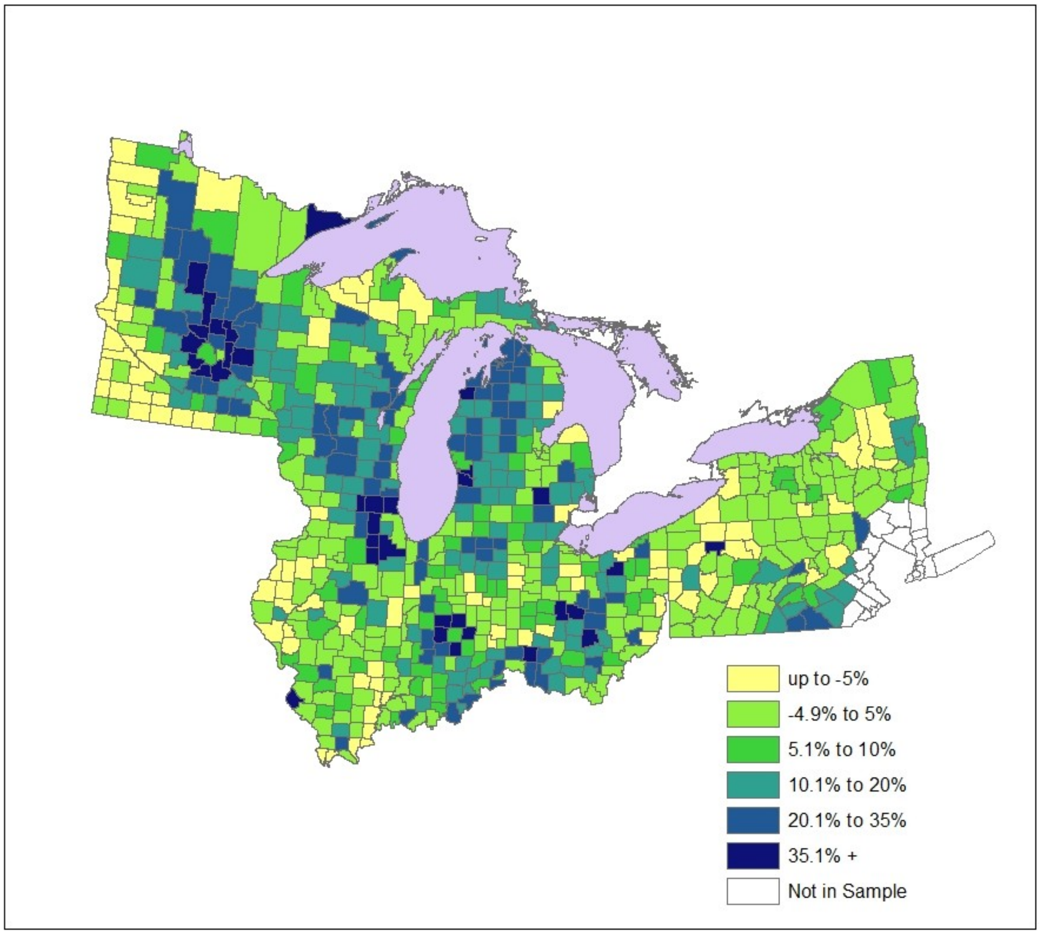

Figure 3. Great Lakes Region, County-Level Population Change, 1990 to 2007

	Eastern Great Lakes Counties (n=244)		Western Great Lakes Counties (n=384)		Difference between East and West?
	Mean	Std. Dev.	Mean	Std. Dev.	T-Statistic
Growth Variables: 1990 to 2000					
% Change in County-Level Population	5.56	8.43	8.56	10.93	3.65 ***
% Change in County-Level Employment	16.65	15.77	21.83	17.43	3.77 ***
% Change in County-Level Share of College Graduates	23.19	11.49	26.95	13.19	3.65 ***
Growth Variables: 2000 to 2007					
% Change in County-Level Population	0.67	5.91	1.59	8.40	1.48
% Change in County-Level Employment	2.46	10.84	1.97	10.79	-0.56
% Change in County-Level Share of College Graduates[1]	16.01	12.34	17.30	24.87	0.75

	Eastern Great Lakes		Western Great Lakes		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Levels of Growth Variables						
Population, 1990	130,038	232,730	73,594	281,350	95,524	264,769
Population, 2000	134,368	233,992	80,807	298,300	101,618	276,147
Employment, 1990	68,655	138,619	41,420	175,403	52,002	162,533
Employment, 2000	76,987	151,941	49,241	191,841	60,021	177,796
% College Graduates, 1990	13.05	5.77	13.00	5.40	16.22	6.72
% College Graduates, 2000	15.96	6.86	16.39	6.62	13.02	5.54
Explanatory Variables (1990)						
Distance to Nearest Great Lake	136.94	93.68	199.56	134.05	175.23	123.74
Percent Forest Area	42.60	25.15	26.82	25.84	32.95	26.69
Topography Score	0.14	1.02	-0.53	0.61	-0.27	0.86
January Temperature - Z score	-0.57	0.32	-1.00	0.69	-0.83	0.62
July Temperature - Z score	0.47	0.39	-0.17	0.59	0.08	0.61
Percent water (not including Great Lakes)	-0.21	0.46	-0.01	0.69	-0.08	-0.62
Distance to the nearest Superfund site	30.59	22.07	43.05	32.74	38.83	29.53
Number of power plants	1.52	3.07	0.85	1.49	1.03	2.20
total water emissions (tons)	38,805	223,023	27,469	273,389	32322	258697
total air emissions (tons)	1,277,166	2,170,466	832,704	2,443,207	997886	2366926
Disamenity Index	0.02	2.14	-0.04	2.18	-0.02	-2.17
Distance to Nearest Metro	43.36	32.74	68.34	54.34	58.64	48.66
Incremental Distance to Metro > 250,000	20.13	30.72	40.88	56.21	32.82	48.97
Incremental Distance to Metro > 500,000	14.84	26.86	40.63	57.77	30.61	49.76
Incremental Distance to Metro > 2.5 million	67.18	85.18	17.22	35.72	36.63	64.69
% College Graduates	13.05	5.77	13.00	5.40	13.02	5.54
% some college	19.93	4.66	22.60	3.65	21.56	4.27
% High School graduates	40.76	5.91	38.89	4.84	39.62	5.35
% white	95.86	5.13	96.23	5.29	96.08	5.22
% married	61.24	4.32	62.59	4.52	62.07	4.49
% population female	51.15	1.13	50.83	1.25	50.95	1.22
population density	228.29	408.91	139.72	427.51	174.13	422.27
% population under 18	25.20	2.27	25.66	2.26	25.48	2.27
% population over 65	13.61	2.65	14.88	3.36	14.39	3.16
% Population over 16 that is employed	55.62	6.24	57.77	6.75	56.94	6.64
% Manufacturing Employment 1970	27.08	10.47	19.06	11.72	22.18	11.90
Percent of Nonfarm Proprietors Employment	16.39	4.19	17.36	4.56	16.98	4.44
Percent Wage and Salary Workers, Leisure	8.33	3.34	8.88	4.48	8.66	4.08
Percent Wage and Salary Workers, Manufacturing	24.02	10.69	20.45	11.37	21.84	11.24
Percent Wage and Salary Workers, Government	19.12	7.39	20.79	8.09	20.14	7.86
Percent Wage and Salary Workers, Agriculture	1.61	1.55	3.20	2.75	2.58	2.48

1 The share of college graduates in 2007 is actually theAmerican Community Survey 5-year estimate from 2005-2009.

Table 6. The Great Lakes Region, Descriptive Statistics

	Model 1	Model 2	Model 3	Model 4	Model 5
Distance to Nearest Great Lake	-0.021 *(0.007)* ***	-0.029 *(0.007)* ***	-0.023 *(0.005)* ***	-0.019 *(0.005)* ***	-0.021 *(0.006)* ***
Great Lakes Coastal County	-4.077 *(1.382)* ***	-5.140 *(1.878)* ***	-3.734 *(1.448)* **	-4.103 *(1.373)* ***	-3.989 *(1.499)* **
Percent Forest Area	0.060 *(0.039)*	0.045 *(0.040)*	0.006 *(0.025)*	0.002 *(0.023)*	0.006 *(0.027)*
Topography Score	-0.664 *(0.887)*	-0.890 *(0.911)*	-0.049 *(0.539)*	0.073 *(0.536)*	0.400 *(0.540)*
January Temperature - Z score	-1.528 *(0.984)*	-1.309 *(0.981)*	-1.402 *(1.101)*	-1.295 *(1.148)*	-1.410 *(1.731)*
July Temperature - Z score	1.158 *(1.562)*	1.029 *(1.511)*	0.058 *(1.004)*	0.083 *(1.114)*	0.674 *(1.022)*
Percent water (not including Great Lakes)	2.005 *(0.904)* **	2.098 *(0.909)* **	1.185 *(0.620)* *	1.315 *(0.606)* *	1.341 *(0.584)* **
Disamenity Index	-0.599 *(0.188)* ***	-0.590 *(0.192)* ***	-0.154 *(0.133)*	-0.054 *(0.126)*	-0.027 *(0.118)*
Distance to Nearest Metro	0.006 *(0.019)*	0.015 *(0.019)*	0.017 *(0.011)*	0.002 *(0.011)*	0.004 *(0.011)*
Incremental Distance to Metro > 250,000	-0.051 *(0.015)* ***	-0.046 *(0.015)* ***	-0.031 *(0.008)* ***	-0.035 *(0.008)* ***	-0.031 *(0.008)* ***
Incremental Distance to Metro > 500,000	-0.058 *(0.010)* ***	-0.056 *(0.010)* ***	-0.042 *(0.008)* ***	-0.042 *(0.008)* ***	-0.044 *(0.008)* ***
Incremental Distance to Metro > 2.5 million	-0.034 *(0.010)* ***	-0.028 *(0.010)* ***	-0.023 *(0.006)* ***	-0.023 *(0.007)* ***	0.002 *(0.009)*
Located within a Metro Area	5.528 *(1.383)* ***	5.486 *(1.367)* ***	3.355 *(0.880)* ***	3.118 *(0.668)* ***	3.166 *(0.746)* ***
East Control	-6.110 *(1.599)* ***	-10.589 *(2.394)* ***	-9.557 *(1.615)* ***	-8.984 *(1.691)* ***	-6.059 *(1.468)* ***
East x Distance to Nearest Great Lake		0.030 *(0.013)* **	0.028 *(0.008)* ***	0.028 *(0.007)* ***	0.030 *(0.007)* ***
East x Coastal		3.084 *(2.378)*	3.892 *(1.698)* **	3.864 *(1.761)* **	3.529 *(1.702)* **
Other Controls?					
Demographic (a)	N	N	Y	Y	Y
Industry	N	N	Y	Y	Y
State Fixed Effects	N	N	N	N	Y
Other Economic Controls	N	N	N	Y	Y
Adjusted R^2	0.295	0.306	0.574	0.591	0.601
Highest VIF	4.94	6.44	7.99	8.14	17.11
Number of observations (n)	628	628	628	624	624

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic (a) includes 1990 variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes 1990 % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Other Economic Controls include 1970 manufacturing employment share and spatially-lagged 1990 employment share variables.

Table 7. Population Change in the Great Lakes Region, 1990 to 2000

	Model 1	Model 2	Model 3	Model 4	Model 5
Distance to Nearest Great Lake	-0.011 (0.007)	-0.016 (0.008) *	-0.009 (0.007)	-0.010 (0.006)	-0.006 (0.006)
Great Lakes Coastal County	-2.588 (1.382) *	-3.219 (2.013)	-2.389 (1.372) *	-2.531 (1.459) *	-1.566 (1.260)
Percent Forest Area	0.021 (0.021)	0.011 (0.021)	0.023 (0.016)	0.022 (0.018)	0.015 (0.017)
Topography Score	0.385 (0.487)	0.223 (0.484)	0.249 (0.354)	0.137 (0.331)	-0.004 (0.309)
January Temperature - Z score	-1.982 (0.680) ***	-1.835 (0.678) ***	-1.006 (0.524) *	-1.146 (0.402) ***	-3.322 (0.947) ***
July Temperature - Z score	-1.148 (1.091)	-1.251 (0.982)	-0.949 (0.665)	-1.008 (0.594) *	-0.794 (0.537)
Percent water (not including Great Lakes)	0.442 (0.639)	0.507 (0.632)	0.166 (0.564)	0.152 (0.555)	0.239 (0.534)
Disamenity Index	-0.288 (0.133) **	-0.268 (0.141) *	-0.073 (0.076)	-0.102 (0.063)	-0.112 (0.076)
Distance to Nearest Metro	-0.015 (0.015)	-0.010 (0.016)	-0.007 (0.009)	-0.001 (0.013)	-0.008 (0.012)
Incremental Distance to Metro > 250,000	-0.044 (0.009) ***	-0.041 (0.009) ***	-0.023 (0.005) ***	-0.019 (0.006) ***	-0.022 (0.006) ***
Incremental Distance to Metro > 500,000	-0.038 (0.005) ***	-0.037 (0.005) ***	-0.025 (0.005) ***	-0.024 (0.005) ***	-0.028 (0.006) ***
Incremental Distance to Metro > 2.5 million	-0.021 (0.006) ***	-0.017 (0.006) **	-0.017 (0.004) ***	-0.017 (0.005) ***	-0.015 (0.006) **
Located within a Metro Area	5.432 (1.405) ***	5.395 (1.404) ***	2.468 (0.810) ***	1.993 (0.607) ***	1.756 (0.659) **
East Control	-2.592 (0.985) **	-5.544 (1.776) ***	-3.949 (1.665) **	-4.268 (1.805) **	-4.314 (1.540) ***
East x Distance to Nearest Great Lake		0.020 (0.008) **	0.018 (0.009) **	0.017 (0.008) **	0.013 (0.007) *
East x Coastal		1.849 (2.110)	3.278 (1.334) **	3.552 (1.596) **	3.029 (1.439) **
Other Controls?					
Demographic (a)	N	N	Y	Y	Y
Industry	N	N	Y	Y	Y
State Fixed Effects	N	N	N	N	Y
Other Economic Controls	N	N	N	Y	Y
Adjusted R^2	0.288	0.297	0.566	0.575	0.586
Highest VIF	4.88	6.51	9.02	9.4	17.85
Number of observations (n)	628	628	628	624	624

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic (a) includes 2000 variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes 2000 % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Other Economic Controls include 1970 manufacturing employment share and spatially-lagged 2000 employment share variables.

Table 8. Population Change in the Great Lakes region, 2000 to 2007

	Model 1			Model 2			Model 3			Model 4		
Distance to Nearest Great Lake	-0.012	*(0.013)*		-0.020	*(0.013)*		-0.012	*(0.012)*		-0.004	*(0.010)*	
Great Lakes Coastal County	-4.460	*(1.805)*	**	[illegible].401	*(2.089)*	**	-3.273	*(1.987)*		-2.953	*(1.577)*	*
Percent Forest Area	0.132	*(0.068)*	*	0.117	*(0.070)*		0.036	*(0.055)*		0.067	*(0.054)*	
Topography Score	-1.691	*(1.477)*		-2.068	*(1.523)*		-1.079	*(1.098)*		-1.241	*(1.018)*	
January Temperature - Z score	-2.949	*(1.451)*	**	-2.723	*(1.456)*	*	-1.477	*(2.044)*		-1.703	*(1.931)*	
July Temperature - Z score	1.952	*(2.672)*		1.506	*(2.689)*		0.682	*(2.221)*		1.144	*(1.917)*	
Percent water (not including Great Lakes)	3.128	*(1.388)*	**	3.217	*(1.418)*	**	1.358	*(0.937)*		1.700	*(0.781)*	**
Disamenity Index	-1.116	*(0.312)*	***	-1.101	*(0.316)*	***	-0.393	*(0.208)*	*	-0.271	*(0.207)*	
Distance to Nearest Metro	0.027	*(0.024)*		0.035	*(0.024)*		0.020	*(0.018)*		-0.005	*(0.019)*	
Incremental Distance to Metro > 250,000	-0.055	*(0.018)*	***	-0.050	*(0.016)*	***	-0.032	*(0.013)*	**	-0.046	*(0.012)*	***
Incremental Distance to Metro > 500,000	-0.073	*(0.016)*	***	-0.072	*(0.014)*	***	-0.051	*(0.016)*	***	-0.060	*(0.013)*	***
Incremental Distance to Metro > 2.5 million	-0.061	*(0.016)*	***	-0.054	*(0.014)*	***	-0.045	*(0.011)*	***	-0.053	*(0.011)*	***
Located within a Metro Area	7.581	*(1.723)*	***	7.461	*(1.739)*	***	4.436	*(1.602)*	***	4.249	*(1.252)*	***
East Control	-6.753	*(2.834)*	**	-10.865	*(3.567)*	***	-9.205	*(2.595)*	***	-7.750	*(2.333)*	***
East x Distance to Nearest Great Lake				0.031	*(0.029)*		0.033	*(0.020)*		0.032	*(0.018)*	*
East x Coastal				0.679	*(3.192)*		2.040	*(2.464)*		1.730	*(2.260)*	
Other Controls?												
Demographic (a)	N			N			Y			Y		
Industry	N			N			Y			Y		
State Fixed Effects	N			N			N			N		
Other Economic Controls	N			N			N			Y		
Adjusted R^2	0.188			0.192			0.432			0.439		
Highest VIF	4.94			6.44			7.99			8.14		
Number of observations (n)	628			628			628			624		

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic (a) includes 1990 variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes 1990 % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Other Economic Controls include 1970 manufacturing employment share and spatially-lagged 1990 employment share

Table 9. Employment Change in the Great Lakes region, 1990 to 2000

	Model 1			Model 2			Model 3			Model 4		
Distance to Nearest Great Lake	-0.001	*(0.008)*		-0.007	*(0.008)*		-0.004	*(0.008)*		-0.005	*(0.007)*	
Great Lakes Coastal County	-2.000	*(1.406)*		-1.397	*(1.990)*		0.462	*(1.285)*		0.588	*(1.318)*	
Percent Forest Area	0.021	*(0.025)*		0.012	*(0.028)*		0.009	*(0.028)*		0.013	*(0.029)*	
Topography Score	1.742	*(0.638)*	***	1.398	*(0.574)*	**	0.921	*(0.583)*		0.860	*(0.658)*	
January Temperature - Z score	-4.684	*(0.759)*	***	-4.519	*(0.693)*	***	-3.212	*(0.787)*	***	-3.157	*(0.778)*	***
July Temperature - Z score	0.047	*(1.586)*		-0.421	*(1.576)*		-0.319	*(1.374)*		-0.342	*(1.355)*	
Percent water (not including Great Lakes)	1.301	*(0.848)*		1.367	*(0.820)*		0.649	*(0.583)*		0.695	*(0.560)*	
Disamenity Index	0.050	*(0.165)*		0.083	*(0.179)*		0.382	*(0.134)*	***	0.335	*(0.122)*	***
Distance to Nearest Metro	-0.023	*(0.012)*	*	-0.018	*(0.013)*		-0.019	*(0.009)*	**	-0.006	*(0.011)*	
Incremental Distance to Metro > 250,000	-0.048	*(0.010)*	***	-0.044	*(0.010)*	***	-0.025	*(0.009)*	***	-0.020	*(0.009)*	**
Incremental Distance to Metro > 500,000	-0.042	*(0.007)*	***	-0.042	*(0.008)*	***	-0.031	*(0.007)*	***	-0.028	*(0.008)*	***
Incremental Distance to Metro > 2.5 million	-0.014	*(0.007)*	*	-0.009	*(0.008)*		-0.009	*(0.008)*		-0.009	*(0.009)*	
Located within a Metro Area	6.139	*(1.511)*	***	6.013	*(1.552)*	***	3.225	*(0.875)*	***	2.819	*(0.916)*	***
East Control	-1.869	*(1.296)*		-4.591	*(2.250)*	**	-2.426	*(2.499)*		-3.424	*(2.396)*	
East x Distance to Nearest Great Lake				0.022	*(0.012)*	*	0.019	*(0.012)*		0.021	*(0.012)*	*
East x Coastal				-0.781	*(2.433)*		0.780	*(1.738)*		1.320	*(1.660)*	
Other Controls?												
Demographic (a)	N			N			Y			Y		
Industry	N			N			Y			Y		
State Fixed Effects	N			N			N			N		
Other Economic Controls	N			N			N			Y		
Adjusted R^2	0.176			0.184			0.424			0.433		
Highest VIF	4.88			6.51			9.02			9.4		
Number of observations (n)	628			628			628			624		

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic (a) includes 2000 variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes 2000 % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Other Economic Controls include 1970 manufacturing employment share and spatially-lagged 2000 employment share variables.

Table 10. Employment Change in the Great Lakes region, 2000 to 2007

	1990 to 2000			2000 to 2007[1]		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Distance to Nearest Great Lake	0.020 *(0.007)* ***	0.019 *(0.007)* **	0.018 *(0.007)* **	0.0227 *(0.015)*	0.0279 *(0.017)*	0.0231 *(0.019)*
Great Lakes Coastal County	4.172 *(1.412)* ***	4.814 *(1.730)* ***	5.517 *(2.006)* ***	4.5014 *(1.750)* **	5.2169 *(2.822)* *	6.1433 *(2.942)* **
Percent Forest Area	0.011 *(0.033)*	0.009 *(0.033)*	0.034 *(0.028)*	-0.0236 *(0.056)*	-0.0135 *(0.059)*	-0.0548 *(0.070)*
Topography Score	0.886 *(0.714)*	0.754 *(0.783)*	1.102 *(0.687)*	-1.1688 *(1.395)*	-1.0135 *(1.424)*	-0.2539 *(1.437)*
January Temperature - Z score	-2.449 *(1.105)* **	-2.416 *(1.075)* **	-0.753 *(1.593)*	4.2974 *(1.953)* **	4.1484 *(1.953)* **	2.7660 *(2.055)*
July Temperature - Z score	1.604 *(1.241)*	1.369 *(1.285)*	1.865 *(1.066)* *	-1.3420 *(2.761)*	-1.2582 *(2.743)*	-1.0847 *(2.759)*
Percent water (not including Great Lakes)	2.283 *(0.722)* ***	2.292 *(0.724)* ***	2.206 *(0.953)* **	2.7078 *(1.323)* **	2.6415 *(1.316)* *	2.8362 *(1.468)* *
Disamenity Index	-0.351 *(0.155)* **	-0.346 *(0.155)* **	-0.034 *(0.196)*	0.5664 *(0.415)*	0.5465 *(0.416)*	0.7135 *(0.473)*
Distance to Nearest Metro	0.014 *(0.017)*	0.015 *(0.017)*	0.018 *(0.017)*	0.0231 *(0.028)*	0.0176 *(0.027)*	0.0057 *(0.025)*
Incremental Distance to Metro > 250,000	-0.029 *(0.011)* **	-0.028 *(0.010)* ***	-0.018 *(0.012)*	-0.0009 *(0.013)*	-0.0039 *(0.013)*	-0.0178 *(0.014)*
Incremental Distance to Metro > 500,000	-0.015 *(0.013)*	-0.015 *(0.012)*	-0.012 *(0.012)*	0.0365 *(0.022)*	0.0354 *(0.022)*	0.0283 *(0.023)*
Incremental Distance to Metro > 2.5 million	-0.034 *(0.010)* ***	-0.032 *(0.009)* ***	-0.031 *(0.008)* ***	0.0111 *(0.010)*	0.0074 *(0.010)*	0.0110 *(0.014)*
Located within a Metro Area	4.735 *(1.192)* ***	4.677 *(1.203)* ***	7.510 *(1.406)* ***	-6.0471 *(2.273)* **	-6.0151 *(2.241)* ***	-0.0634 *(1.796)*
East Control	-2.523 *(1.434)* *	-2.831 *(2.655)*	-0.073 *(2.760)*	2.6094 *(1.741)*	5.6396 *(2.788)* **	6.8737 *(3.395)* *
East x Distance to Nearest Great Lake		0.005 *(0.018)*	-0.005 *(0.016)*		-0.0199 *(0.013)*	-0.0286 *(0.018)*
East x Coastal		-1.276 *(2.751)*	-3.864 *(3.273)*		-2.0398 *(3.254)*	-6.0573 *(3.698)*
Other Controls?						
Demographic	N	N	Y	N	N	Y
Industry	N	N	Y	N	N	Y
State Fixed Effects	N	N	N	N	N	N
Adjusted R^2	0.092	0.089	0.216	0.047	0.045	0.074
Highest VIF	4.94	6.44	7.99	4.88	6.51	9.02
Number of observations (n)	628	628	628	628	628	628

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic includes 1990 variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes 1990 % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

[1] The share of college graduates in 2007 is actually theAmerican Community Survey 5-year estimate from 2005-2009.

Table 11. Changes in Shares of College Graduates in the Great Lakes Region

	Population Change	Employment Change	Change in Share of College Graduates
Distance to Nearest Great Lake	0.011 *(0.005)* **	0.014 *(0.014)*	0.015 *(0.015)*
Great Lakes Coastal County	1.185 *(0.992)*	3.453 *(1.984)* *	3.683 *(1.881)* *
Percent Forest Area	-0.023 *(0.022)*	-0.075 *(0.068)*	-0.078 *(0.073)*
Topography Score	0.790 *(0.404)* *	2.822 *(1.307)* **	-0.284 *(1.608)*
January Temperature - Z score	-0.490 *(0.702)*	-1.874 *(1.708)*	4.025 *(1.761)* **
July Temperature - Z score	-0.430 *(0.916)*	-0.001 *(3.178)*	0.588 *(2.519)*
Percent water (not including Great Lakes)	-0.890 *(0.527)* *	-0.317 *(1.105)*	3.048 *(1.211)* **
Distance to Nearest Metro	-0.024 *(0.010)* **	-0.041 *(0.024)* *	0.007 *(0.022)*
Incremental Distance to Metro > 250,000	0.001 *(0.008)*	0.001 *(0.014)*	-0.016 *(0.015)*
Incremental Distance to Metro > 500,000	0.010 *(0.006)*	0.018 *(0.018)*	0.028 *(0.024)*
Incremental Distance to Metro > 2.5 million	0.012 *(0.006)* *	0.045 *(0.014)* ***	0.016 *(0.012)*
Located within a Metro Area	0.088 *(0.705)*	-0.647 *(1.886)*	-1.496 *(1.908)*
Other Controls?			
Demographic	Y	Y	Y
Industry	Y	Y	Y
Adjusted R^2	0.300	0.189	0.062
Highest VIF	5.08	5.08	5.08
Number of observations (n)	628	628	628

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

[a] Difference between Population, Employment, and College Graduate Share growth from 2000 to 2007 and 1990 to 2000

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic includes 1990 variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes 1990 % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Table 12. Differences between the 2000s and the 1990s[a] in how Amenities and Disamenities Affect Growth

Chapter 3: How Housing Values in Northeast Ohio are affected by Access to Lake Amenities and Industrialization

I. Introduction

Lake Erie has long been the driving force behind economic development in the Greater Cleveland, Ohio, region; from the early settlements on the shore of the Lake, to the growth of ports to transport goods from the markets of the East Coast to the Mississippi River and the West, to the growth of the automobile and other manufacturing businesses. The presence of high quality housing along the shoreline, along with the presence of public and private beaches and marinas, also suggests that people in the region value the Lake beyond its role in creating employment. In recent years, as global competition and economic restructuring have put pressure on the industrial sectors that led to the growth of this region, there is a renewed interest in exploring the role of the Lake in attracting households who are value the lake amenities. Policymakers seek to understand how and if people value Lake Erie in order to determine whether economic development policies focused on the Lake make sense.

In advanced economies, such as the United States, there is evidence that people increasingly value quality of life (QOL) and are willing to pay for access to natural amenities (McGranahan 2008; Rappaport 2004, 2007; Partridge and Ali, 2008). One approach to assessing the value of natural amenities involves use of the hedonic pricing framework. This method can provide insight into how access to amenities is capitalized into housing prices, and has been used to value such amenities as open space (Smith, Poulos, and Kim, 2002; Irwin, 2002) and lake amenities (Lansford and Jones, 1995; Nelson, 2010).

A complicating factor is that there is pollution and environmental degradation near Lake Erie as a result of proximity to Lake Erie being one of the drivers behind the industrialization of the Cleveland area. In other contexts, there is evidence that housing values are negatively affected by proximity to environmental disamenities such as power plants, superfund sites, and air pollution (Davis, 2011; Hite et al., 2001; Smith and Huang, 1995).

This research thus considers the potential for QOL-oriented Lake Erie development in Greater Cleveland. We hypothesize that, if households value access to Lake Erie, they will be willing to pay a higher housing price, all else equal. We also will test whether industrialization has made it less desirable to live close to Lake Erie, offsetting any positive aesthetic or recreational benefits, and reducing housing prices. Using residential sales transactions data from the Greater Cleveland region, we use a hedonic price model to measure the marginal willingness to pay for proximity to Lake Erie and its recreational amenities. We also consider the potentially negative value of being closer to industrialized sites or pollution. Our unique dataset includes over 300,000 housing transactions from 1990 to 2006 as well as detailed geographically-located data on industrial disamenities and industrial emissions, as well as natural and related built amenities, such as parks and Lake Erie and its beaches and marinas. To control for unobserved characteristics, we also include both time and spatial fixed effects.

This research provides insight into the value of lake amenities in a highly-industrialized, developed, and distressed region. Much of the previous literature that has valued lake amenities has focused on resort communities along the coasts and in the South. Thus, *a priori*, it was unclear whether and how much households in this region value lake amenities. Additionally, we consider the different types of lake amenities – including lake views as well as access to boat ramps and beaches. And, we look at the role of industrialization and abandoned facilities. This research provides some initial insight to policymakers in the region of the value of lake-related amenities.

We find strong evidence that, consistent with other studies which have found that access to lake views and being very close to water is valuable to households, immediate proximity to Lake Erie increases housing values. However, there appears to be little additional willingness to pay for lake access or for recreational or other lake amenities.

There is also evidence that households do notice industrialization and that it is reflected in a price decrease for houses near manufacturing facilities. However, the negative effect on price of being close to air pollution or Superfund sites is much lower, suggesting that households are more likely to notice smokestacks than pollution.

In what follows, we first detail the previous literature and our theoretical framework. Next, we describe our empirical model and data; followed by the empirical results. The final section presents some concluding thoughts and a discussion about implications and future research.

II. Theoretical Framework and Previous Literature

The hedonic pricing framework using housing transactions in a single housing market to value non-market amenities such as natural amenities or pollution and other environmental disamenities has a long history dating back to Rosen (1974).

By focusing on a single market (such as a metropolitan area), the assumption is that wages are held constant in a region and that housing prices can be used to uncover the variation in value associated with natural amenities and industrial and environmental disamenities. Consumers maximize utility by their choice of a house (Rosen, 1974; Palmquist, 2005; Taylor, 2003).

The price of a house is determined by preferences of buyers and sellers in the market. In Chapter 2, we assumed that small frictions to household and firm mobility would result in ongoing household and firm movements toward equilibrium. In contrast, here, we assume that housing prices are at equilibrium and that the value of amenities is fully capitalized. While both are probably simplifications of reality, as noted in Rappaport (2004), wages and rents do adjust much more quickly to a new steady state equilibrium than do populations. Thus the two approaches, which are based on assumptions of ongoing migrations of households and (approximate) equilibrium prices of households, are both consistent with an equilibrium-based framework in which the housing market adjusts to a long run spatial equilibrium. Additionally, Greenwood et al. (1991) demonstrated that even if a region is out of equilibrium, errors from using the differences in prices to estimate the value of quality of life are relatively minor.

Even though we are dealing with the equilibrium in a single housing market, houses are differentiated products and there will be no single price because the quality and characteristics of houses vary. Differences include property characteristics such as number of rooms, age, and square feet, and neighborhood characteristics like access to urban and natural amenities. Thus, the price will depend on consumers' preferences for these different characteristics. Assuming that in the short-term the supply of housing is fixed then we can ignore the effect on prices of the cost of new construction of houses (Palmquist, 2005).

Following Rosen (1974), the price P of housing is a function P(z), where z = (z_1, . . . , z_n) are the *n* characteristics of a house. Consumers can decide whether or not to purchase a house at a given price, but they cannot affect the underlying equilibrium prices and thus are price takers. Consumers are assumed to purchase one house and utility is maximized over the purchase of the house and a composite good (all other goods), $U = (x, z_1, \ldots, z_n)$. The income of the consumer is y and the price of all other goods is set equal to one, thus the budget constraint is $y = x + P(z)$.

The consumer will choose the optimal level of each z_i and x to maximize utility. From the first two first-order conditions of utility maximization:

$$U_{z_i} = \partial U/\partial z_i = \lambda \partial P(z)/\partial z_i = \lambda p_i \quad (1)$$

$$U_x = \partial U/\partial x = \lambda \quad (2)$$

Thus, the marginal rate of substitution between a characteristic of a house and the composite good is equal to the marginal price of the characteristic at the equilibrium:

$$U_{z_i}/U_x = \partial P(z)/\partial z_i = p_i \tag{3}$$

We are really interested in knowing how much an individual would be willing to pay for a house with alternative sets of z characteristics. Rosen (1974) shows that we can model a bid function where $\theta = \theta(y, z, u)$ is the amount an individual would be willing to pay for a house with specific attributes z, such that the bid function shows how a consumer's bid would vary with different attributes, holding utility and income constant:

$$U(y - \theta, z) \equiv u \tag{4}$$

This can be expanded to model the decision for each individual *j* with attributes α (such as income).

$$U_j = (y_j - \theta_j, z, \alpha_j) \equiv u_j \tag{5}$$

By maximizing utility, and ignoring differences in individual attributes, we can solve for the marginal bid function $\partial\theta/\partial z_i$ for each attribute in the z vector.

$$\partial\theta/\partial z_i = \theta_{z_i} = U_{z_i}/U_x \tag{6}$$

Combining this with Equation (3) we find that the marginal bid or the marginal willingness to pay (MWTP) for a housing characteristic is equal to its equilibrium marginal price.

$$\theta_{z_i} = U_{z_i}/U_x = p_i \qquad (7)$$

The (first-stage) hedonic price function, P(z), is the envelope of all bid functions and represents the equilibrium price schedule between buyers and sellers in the market. Thus it can be used to get insight into the marginal value that consumers' place on housing attributes. Again, this means that the marginal price of an attribute is equal to the marginal willingness to pay for that attribute.

The hedonic pricing framework has been used quite extensively with housing prices to consider the MWTP for various amenities (both natural and urban amenities) as well as environmental attributes and disamenities such as pollution.

In an early application of the hedonic method to look at access to lake amenities, Brown and Pollakowski (1977) found that property values decrease with distance from the lake. Feather et al. (1992) examined the relationship between water amenities and housing prices in Orange County, Florida, and saw evidence that the land value of lakefront property is greater than property away from a lake, and that the effect of being close to a lake diminishes with distance.

A number of other papers have also found a link between either access to lake amenities or proximity to a lake and housing values, including Lansford and Jones, (1995a;b) and Nelson (2010). Lansford and Jones found that adjacency to the lake is the strongest effect and that the lake effect dies off quickly. White and Leefers (2007) looked at a rural housing market in Michigan and found that the only natural amenity that affected housing values in their study area was proximity to the major lake.

Looking specifically at the Northeast Ohio Lake Erie lakefront, Bond et al (2002) found some evidence of a willingness to pay a premium to live in housing that has a view of the Lake. However, they also qualify their results by noting that they fail to control for a number of important factors including access to recreational amenities and proximity to urban amenities and downtown Cleveland.

Among other natural amenities that may affect housing prices are open space and parklands. A number of previous studies have looked at the effect of open space on housing prices, including Smith, Poulos, and Kim, 2002; Irwin, 2002, among others. Poudval et al. (2000) found that access to larger urban parks was associated with increased house values. In their study of urban areas in Finland, Tyrväinen and Miettinen (2000) found that proximity to forests increases housing sales prices, and there is a premium for being within view of those forests. Other studies have shown that the benefits from certain natural amenities (including national monuments and other public open space) extend a significant distance beyond their boundaries (examples include Schmidt and Courant, 2006; Irwin, 2002).

Finally, other previous studies have examined the effect of natural amenities and access to recreational opportunities on rental housing in resort areas and provided evidence that proximity to recreation is positively linked to rental rates (e.g. Nelson, 2010).

In the environmental economics literature, the hedonic price method has been used to quantify the negative effects of pollution and proximity to hazardous waste sites and other environmental disamenities. Many studies have provided evidence that housing values are negatively affected by proximity to environmental disamenities such as power plants, Superfund and other hazardous waste sites, and air pollution (Examples include: Davis, 2011; Ihlanfeltd and Taylor, 2004; Hite et al., 2001; Smith and Huang, 1995; Kiel and McClain, 1995; Chattopadhyay, 1999; Beron et al., 2001). In another study focused on Ohio, Brasington and Hite (2005) looked at proximity to what they call "hazards" or sites that have been identified as possible brownfields or future Superfund sites. They found that proximity to such hazards is negatively correlated with housing prices.

Smith and Huang (1995) looked at 25 years of hedonic analysis considering a link between housing prices and air quality and found that, in general, there is a positive relationship. However, a related study by Boyle and Kiel (2001) found that the values on air quality are generally statistically insignificant. They suggest that it could be that air quality variables are correlated with both included and omitted variables. This study also provides evidence that studies which included multiple environmental variables tended to have higher significance, perhaps due to fewer omitted variables, although they suggest that further research is needed.

Looking at the relationship between toxic releases as measured by the U.S. Environmental Protection Agency (EPA) Toxic Release Inventory (TRI), Fonseca and Noonan (2006) saw almost no statistical relationship between proximity to the nearest toxic release and housing price. However, they suggest that future work may want to consider the amount of the releases, not just what is closest.

McConnell (1990) found that there may be multiple drivers of the price of houses close to the water. These factors include the view, the recreational opportunities, and environmental benefits, if the air quality is better close to the water, or environmental disamenities, if there is industrialization or more pollution near the water.

In other research, there is evidence that proximity to certain businesses or the presence of congestion may be associated with changes in housing prices. For example, that proximity to industrial businesses is negatively correlated with housing prices (Franklin and Waddell, 2003). Perhaps it is that people are more likely to be concerned with smokestacks rather than with air quality or pollution, which they may not be able to observe (unless it is coming out of the previously mentioned smokestacks). Timmins and Murdoch (2007) found that congestion was important when considering the willingness to pay for access to recreational amenities. And, hedonic methods have uncovered a link between the effects of traffic congestion and housing prices (Wilhelmsson, 2000; and Davis, 2004).

Despite its usefulness, there are a number of well-known limitations of the hedonic price model. Messer et al. (2006) noted that hedonic models do not take into account individual household characteristics and thus do not allow estimates of marginal willingness to pay to vary across household types. In addition, the hedonic price function does not account for the movement of households or sorting that may take place due to changes in the level of an amenity or disamenity. Since the hedonic price function represents the equilibrium price schedule, when considering policy scenarios that model non-marginal changes in environmental quality or public good provisions, the results may no longer be accurate. Such non-marginal changes could affect both supply and demand and thus lead to a new equilibrium.

Several methods have been used to uncover the demand for an attribute. For example, estimating hedonic functions for multiple markets has been a strategy to recovering demand functions for specific attributes. And more recently, sorting models have used locational choice modeling to back out demand functions for specific attributes (Bayer et al., 2005; Bayer et al., 2007; Bayer and Timmins, 2007; Klaiber and Phaneuf, 2009; 2010; and Kuminoff, 2009).

III. Data

This research focuses on six counties in the Greater Cleveland (Ohio) region, Ashtabula, Cuyahoga, Geauga, Lake, Lorain, and Medina Counties. A map of the study area is shown in **Figure 4.** This area includes the Cleveland Metropolitan Statistical Area (MSA) and the adjacent Ashtabula Micropolitan Area which, together, form a single labor and, by assumption, a regional housing market. Thus housing prices in this region can be used to uncover the marginal value of non-traded amenities and disamenities. The market is likely comprised of several overlapping local markets. However, since they are all part of a single greater metropolitan area, with connections by major roads and lack of physical features that would separate the areas, we expect significant overlap in these markets and believe the housing market is best modeled as a single regional market. This is consistent with the work by Irwin (1995) in looking at the housing market in Maryland.

Housing Transactions

We have sales data for single-family houses from the six county region from 1990 to 2006. These data had originally been cleaned to purge it of non-owner occupied transactions. That revised dataset contained 468,706 transactions and was compiled from data provided by the Center for Urban and Regional Analysis (CURA) at The Ohio State University and purchased from Corelogic Data Services.

Key to conducting this analysis is the ability to match the transactions to parcel shapefiles obtained from the six counties. This allows an accurate mapping of the sales data to locations using ArcGIS, rather than relying on geocoding of addresses. This increases the accuracy of our calculations of spatially-defined variables such as distance to lake amenities and environmental disamenities (as explained below). Cleaning of the data to delete those without accurate parcel numbers reduced the dataset to 420,989 transactions.

The housing transactions data consist of housing characteristics, such as lot size, building size, number of rooms, number of bedrooms, number of bathrooms, year built, basement information, and fireplace information, and information about the sale, including date, sale price, mortgage price, and owner information. In order to estimate a hedonic price model, we need accurate information on these characteristics for all transactions in the sample. Thus, we eliminate transactions with missing or zero values for the relevant variables in the estimation. In addition, outliers are removed. We use approximately the 1st and 99th percentile as the limits of the bounds of those transactions we retain, as suggested in Klaiber (2008). Thus the final dataset contains transactions whose characteristics are in the following bounds:

- $10,000 <= sale price <= $1,750,000
- 0.05 <= lot acres <= 15
- 600 <= building square footage <= 4500
- 1 <= total number of bathrooms <= 6
- 1 <= number of bedrooms <= 8
- Age of house <= 130 years
- Ratio of bathrooms/total rooms <= 0.6
- Sale Price/square feet <= $400

These cleaning steps reduce the number of transactions to 329,342.

The number of square feet in each house is scaled by dividing by 100, so that our models include measures of hundreds of square feet.

In our estimation models we use the sale price of the house and the following housing characteristics, which are likely to be predictors of house attractiveness: controls for the size of the house and the land: lot acres and hundreds of square feet in the building; and controls for quality and house amenities: total number of bathrooms, age of the house, whether the house has a garage, and whether the house has a fireplace (generally a sign of higher quality). The use of these characteristics is consistent with other hedonic studies and, based on the available data, provides the best set of controls for heterogeneous housing characteristics.

Amenities and Disamenities

Since we are interested in proximity to Lake Erie, we use ArcGIS to measure the distance between each parcel in our transactions data and the closest point on the Lake. We then construct a dummy variable that indicates whether or not the house is within 100 meters of the Lake, this will help pick up those houses that are adjacent to or have a view of Lake Erie.

Data on recreational amenities on Lake Erie, including beaches and boat ramps, were obtained from the Ohio Department of Natural Resources. We measured the distance from each parcel in our transactions data to the nearest Lake Erie beach and boat ramp.[20] We combine the distance to beach and boat ramp into a single variable, distance to nearest boat ramp or beach, due to the high collinearity between the two distance measures (0.986). We also construct dummy variables indicating whether or not a house is within 250 meters of a boat or beach, i.e. within close walking distance of these amenities. The number of parking spaces at the closest boat ramp is also included in the data and is interacted with the dummy variable that indicates if a boat ramp is within 250 meters, to get a measure of the number of parking spaces near a house. This will measure congestion related to the boat facilities.

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[20] Because of available data, all distance measures here are straightline distances, not driving distances. Given the extensive road network in this highly urbanized region, straightline distances should approximate driving distances. However, we recognize that there could be some differences not controlled for here.

Additional data on public parks and recreational lands were provided by Ohio Ducks Unlimited. We include the number of park acres (in tens of acres) within 1000 meters of the parcel as a control for other natural amenities in the neighborhood of a house.

We recognize that the recreational amenities could be endogenous. However, most of the public recreational infrastructure in the region was constructed before 1990, minimizing endogeneity. Unfortunately, detailed data on the actual construction date for each facility was not available.

To control for proximity to urban amenities and business opportunities, we include a measure of the distance to downtown Cleveland. Downtown Cleveland contains or is near many of the urban amenities in the region including the sports stadiums for the major professional sports teams, as well as museums and restaurants. Additionally, classical urban growth theory would suggest that housing prices are (negatively) correlated with distance to downtown Cleveland, assuming that workers are generally commuting there (Alonso, 1967; Muth, 1961; Mills,1964).

Data on businesses, by location, in the region are available by three-digit and six-digit NAICS code, by year. These data are used to measure the number of manufacturing businesses, defined as businesses with NAICS code 31, 32, or 33, within 1000 meters of each parcel. Since these manufacturing businesses could be heterogeneous in terms of building size and structure, we also tested several other specifications and found similar results. We hypothesize that households are more likely to notice ugly buildings or "smokestacks," thus the presence of a manufacturing facility in close proximity to a house will be likely to be associated with lower housing prices. To control for endogeneity, we use one-year lagged values of the numbers of businesses; for example, for a transaction in the year 2000, we use the number of nearby manufacturing businesses in 1999.

To control for local industrial disamenities, we use U.S. EPA toxic release inventory (TRI) data on aggregate toxic air releases, by company, by year. We then use ArcGIS to measures the distance between each parcel in our transactions data to the releasing companies. To avoid counting small releases that may not be obvious to households we only consider companies whose annual air toxic releases total over 1000 pounds. We then aggregate the toxic releases within 1000 meters of a parcel to into a measure in tens of thousands of pounds, and create a measure of the amount of toxic releases over 5000 pounds per year. We tested the use of other cut-offs, but the results were similar. For the TRI data, we also lag the values by one year. Because our TRI data is only available starting in 1991, this means we are only able to estimate the model using transactions from 1992 to 2006 when the measures of air pollution are included in the model.[21]

To control for proximity to abandoned hazardous industrial sites, we measure the distance to the nearest Superfund site in a particular year, using data from the U.S. EPA. Then, we created a dummy variable that indicates whether or not the parcel is located within 1000 meters of a Superfund site and include that measure in our models.

IV. Empirical Specification

Based on the theory, a general first-stage hedonic model is:

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[21] We recognize that the lag of one year may not fully account for the potential endogeneity of our emissions and business variables. However, due to data availability, further lags would have required us to drop many of the observations in our dataset.

$$P(z) = f(A, H, \varepsilon) \quad (8)$$

where A are the amenities and disamenities, H are housing characteristics, and ε is an error term.

Unfortunately, the theory does not provide clear guidance as to the correct functional form of the hedonic price model. However, as Rosen (1974) and Coulson (2012) point out there are some theoretical constraints. Linear pricing is only possible when competition can lead to division of a previously bundled product. However, this assumption is unrealistic in the housing market, where a bedroom cannot be sold separately from the rest of the house. Thus, for housing prices, researchers generally assume there is some sort of nonlinearity.

Palmquist (2005) and Kuminoff et al. (2010) point out that since a full range of every possible housing attribute and community characteristic is unlikely to be available, it is important to pick a functional form that is less sensitive to omitted variable bias and this is especially important when working with spatially delineated amenities and environmental disamenities which are likely to be correlated with unobserved neighborhood characteristics, such as we have here (Kuminoff et al., 2010). Using simulation, Kuminoff et al. (2010) found that the use of spatial fixed effects, and at least a somewhat flexible form, was the most robust in the face of omitted variable bias.

One common functional form that addresses the nonlinearity is the semilog or log-linear specification, where X now includes all of the explanatory variables A and H from Equation (8) above:

$$\ln(P_i) = \beta_0 + \sum_j \beta_j X_{ij} + \varepsilon_i \quad (9)$$

In our estimation, following the guidance from Kuminoff et al. (2010) we will make this even more of a flexible functional form by including census tract (spatial) fixed effects which will account for any potential omitted neighborhood characteristics that might affect housing values. These unobservable characteristics include school quality, access to urban amenities, crime, etc. We will also test our results by using block group fixed effects to see if there are other unobservable characteristics not being accounted for by the census tract controls. However, we caution that the number of observations in a block group may introduce other biases.

We will also account for time trends in the data by 1) using a series of times trends (time fixed effects), and 2) testing whether splitting the sample into multiple groups based on housing market dynamics is necessary. The time fixed effects will also control for omitted variables that are specific to one year or several years. We will test whether the data can be pooled by looking at the difference between the sum of square errors (SSE) between the unpooled and pooled regressions as proposed by Ohta and Griliches (1975). If the SSE increases by more than 10% when moving from the unpooled to the pooled regression, then the test rejects the aggregation of the data over time.

Our final estimation equation is as follows:

$$\ln(P_i) = \beta_0 + \textstyle\sum_{h1} \beta_{h1} H_{ih1} + \sum_{h2} \beta_{h2} H_{ih2} + \sum_{h3} \beta_{h3} (H_{ih2})^2 + \sum_a \beta_a A_{ia} +$$
$$\beta cCi+\beta sc(Ci)2+ Ti+Si+\varepsilon i \qquad (10)$$

In this functional form specification, the vector of housing characteristics is split into two vectors, H_1 and H_2, due to the inclusion of quadratic terms of some of the variables. We will also test whether dropping the quadratic terms changes the results. H_1 contains the total number of bathrooms and the dummy variables indicating if there is a garage or fireplace. H_2 consists of age, hundreds of square feet in the building, and lot acres. The housing characteristics in H_2 enter the equation both linearly and as quadratic terms. The distance to downtown Cleveland is split from the rest of the original amenity vector and its square is also included in the estimation equation. The rest of the natural amenities and industrial disamenities are included in the final vector, A. T and S are the time (sales year) and census tract (spatial) fixed effects, respectively. A summary of some of the variables is included in **Table 13.**

When estimating the models, we will test the sensitivity of our results to the inclusion of specific amenity and disamenity variables. We will also correct for heteroskedasticity by using robust standard errors.

Calculating MWTP

Finally, with the results from the hedonic estimations, we will estimate MWTP for the various amenities and disamenities. Since, from Equation (7), we know that MWTP for a housing characteristic is equal to its marginal price, we can calculate the MWTP for our amenities and disamenities as follows.

Assuming that the amenity enters into the estimation equation linearly, for a continuous variable, X_j:

$$MWTP_j = \partial P/\partial X_j = \beta_j P \tag{10}$$

For dummy variables (or variables equal to zero or one), the calculation is a bit different. Now, the coefficient is the approximate percent change in the price when the characteristic is present (equal to one). The exact calculation for dummy variable D_j with coefficient β_j is:

$$\%\text{ Change in Price} = \left(e^{\beta_j} - 1\right) * 100, \text{ when } D_j > 1 \tag{11}$$

For all MWTP measures, since there is no single price in our sample, we will estimate the MWTP values for every housing transaction and then present the average MWTP results as the mean of the entire sample.

V. Results and Discussion

To test whether the results could be pooled across the decades, models were run for the 1990s and the 2000s separately, and then the data were pooled. Using the method outlined in Ohta and Griliches (1975), the standard error of the regression (SEE) of the pooled, full model was compared to that of the separate, unpooled models (results not shown). Since the SEE did not increase by more than 10%, the test indicates that use of pooled regression of the data from all of the years is appropriate.

The regression results are presented in **Table 14**. Models 1, 2, and 3 are estimated on the full sample of years (1990 to 2006), but exclude the TRI air emissions control variable. Models 4 and 5 include the TRI emissions variable, TRI air releases within 1000 meters (in 10,000s of pounds); however, as explained in the Data section, this requires us to estimate the model using only the data from 1992 to 2006. Models 1 and 4 include year fixed effects only, while Models 2, 3, and 5 include both year and census tract fixed effects. Any difference between the results for the models with year fixed effects only and those which also include the census tract fixed effects would suggest that perhaps there are unobservable factors associated with house price that are correlated with those control variables and that are being captured by the spatial (census tract) fixed effects. Alternatively, it could be that the census tract fixed effects are absorbing the identification of these control variables.

In all models, the core housing characteristics are statistically significant and of the expected signs. The number of bathrooms, the presence of a garage or fireplace, the building size and the lot size all are associated with an increase in the price of the house. Also, as shown by the squared terms for building size and lot acres, the residential housing price is increasing at a decreasing rate in terms of the size of the house and the size of the lot. Additionally, as expected, older houses, on average, have lower prices. However, whether or not the results suggest that house price is decreasing at a decreasing or increasing rate relative to age depends upon whether or not we include the census tract fixed effects in our model. Without the tract fixed effects, it appears that price is decreasing at an increasing rate relative to age. However, with the tract fixed effects, the coefficient on the quadratic term is positive, thus suggesting that the price of houses is decreasing at a decreasing rate, which is what we would have expected *a priori*. Thus, it appears that there are omitted variables in Models 1 and 4 which the census tract fixed effects are capturing. This is consistent with work by Kuminoff et al. (2010) which concluded that spatial fixed effects can be important to minimizing omitted variable bias.

From this point forward, for purposes of discussion of amenities and disamenities, we focus on the models which control for those potential omitted variables with the census tract fixed effects, Models 2, 3, and 5. However, we will note when there is a change in sign between the two types of models.

Focusing on the lake amenities, we find strong evidence that being on or very close to Lake Erie (within 100 meters) is associated with a positive and statistically significant price increase, and this is consistent across all models. However, there does not seem to be any additional benefit to being close to a beach or boat access point. Once the spatial fixed effects are included in the model, both variables are consistently statistically insignificant. One explanation we explored is whether this result is due to high collinearity between the three variables; however, tests of correlation and collinearity rejected this.

Interestingly, however, in Model 3, we find that the number of parking spots at boat access points within 250 meters of a house is associated with a price increase. Since the number of parking spaces could be seen as a measure of congestion, which would likely make it less desirable (all else equal) to have a house nearby, it is likely that there are additional amenities associated with boat ramps with lots of parking spaces that are not controlled for by our model. Perhaps instead, boat ramps with lots of parking spaces are also nicer boat ramps.

Away from those homes immediately located on Lake Erie, our results suggest there is a premium on housing prices from being farther from Lake Erie as demonstrated by the positive and statistically significant coefficient on the distance to boat or beach access variable in Models 2 and 5, and on the distance to Lake Erie variable in Model 3, once we control for spatial fixed effects. Again, there is a sign change between the time fixed effects models and those that also include the spatial fixed effects. This could be a problem with the spatial fixed effects masking or absorbing the relationship between the Lake and housing prices. Or, the negative relationship between proximity and price may be evidence that people like living in the Greater Cleveland area because they can access Lake Erie when they want to enjoy its recreational and other benefits but that, unless they live directly on the Lake, they are not willing to pay to be close.

One hypothesis is that its industrialization may be reducing the attractiveness of portions of the region. We also propose that proximity to the physical plants or smokestacks will deter home buyers. Consistent with these hypotheses, we find evidence that proximity to manufacturing businesses is negatively related to housing prices, and statistically significant. Sensitivity analysis found that there is an additional negative impact on prices for manufacturing facilities near Lake Erie (see Table 15) suggesting that industrialization near the Lake could drive down prices more than similar industrialization farther from the Lake.

The industrial legacy has also left abandoned hazardous waste sites, including Superfund sites, and those manufacturing businesses and other industrial sites that create air pollution that is tracked by the TRI. However, we observe only a weak relationship between proximity to a Superfund site and home price, and that statistical significance disappears when we add the toxic air release data. And, the coefficient on nearby TRI air releases is very small, although it is negative and statistically significant.

As predicted by the urban bid rent model, housing prices are decreasing (at a decreasing rate) with the distance to downtown Cleveland. Again, this is a factor where the inclusion of the spatial fixed effects resulted in a change in the sign of the coefficient.

We also considered whether proximity to open space in the form of recreational parks is associated with higher housing prices. We find that proximity to larger parks is positively and statistically significantly related to housing prices, consistent with other studies which have looked at a variety of open space types. Interestingly, however, this is one of those variables where the sign changed between the time fixed effects only and the full models. Again, however, since the full model has the expected sign, we take this as evidence that the census tract fixed effects are important to reducing omitted variable bias in our models.

Sensitivity Analysis

To test the robustness of our results, we considered alternate specifications. We tested eliminating the quadratic terms, including additional explanatory variables, and using block group spatial fixed effects instead of census tract spatial fixed effects.

Eliminating the quadratic terms had almost no effect (results not shown). This is perhaps not surprising given that the coefficients on the quadratic terms in our original models were virtually zero.

To measure the next row of houses beyond those closest to the Lake, we added a variable that indicates if a house is within 100 meters and 250 meters of the Lake. As shown in **Table 15**, there is a positive and statistically relationship between price and that variable. This suggests that the Lake effects may extend at least a few blocks beyond the Lake. Addition of this variable also had almost no effect on the core measure of immediate proximity to the Lake.

On inspection of the housing along the Lake, it appears that much of the high-end private development is in areas with cliffs rather than beach access. To test for this, we considered a measure of elevation using Digital Elevation Model (DEM) data in ArcGIS for those houses within 100 meters of the Lake in Models 3 and 6 in Table 15. The relationship was negative, but almost zero. This may be evidence that, within a tract, elevation doesn't matter.

Finally, we tested whether using a finer level of spatial fixed effects changed our results by using Census block group fixed effects rather than those based on Census tracts. Models 4, 5, and 6 in Table 15 include those results. With the exception of the distance to Lake Erie variable, the other measures of amenities and disamenities, including the strong effect of being within 250 meters of Lake Erie and the negative effect of being close to industrial businesses, stay virtually the same when we switch to the block group spatial fixed effects. However, the sign on the distance to Lake Erie variable switches signs, and now it appears to be more valuable to be closer to the Lake. While spatial fixed effects can address omitted variables, they can also absorb the explanatory value of other included variables. Without spatial fixed effects, our results suggest that it is more valuable to be closer to Lake Erie; with the census tract fixed effects, it seemed that it was more valuable to be farther away; and, with block group fixed effects, it appears that it is better to be closer. Our seemingly contradictory results may be explained by the fact that there is little variation, on average, within a census tract or block group in terms of distance to Lake Erie. Or, it could be indicative that using spatial fixed effects at the block group level appropriately controls for omitted variables.

Value of Amenities and Disamenities

As explained in the Empirical Specification section, we use the estimates from the first-stage hedonic price model, to estimate the marginal willingness to pay to for the amenities and disamenities. **Table 16** contains the mean MWTP based on the estimation results contained in Table 14.

Of all the amenities and disamenities, households appear to be willing to pay the most to be within view of or within 100 meters of Lake Erie. We estimate that the MWTP for this benefit is close to $50,000. It could be that this value is picking up characteristics of the lakefront homes that are not included in our model, given that houses on the water may be more luxurious, have Lake Erie piers, private beaches or foundations[22]. However,

[22] Looking at Google Maps, we saw that houses near Lake Erie seem very different than those only a short distance away.

discussions with local leaders confirmed that similar houses do sell for more simply by being on the Lake and they found our estimate of MWTP to be reasonable.

However, away from direct Lake proximity, people are actually willing to pay to live farther from the Lake, about $1400 per kilometer, perhaps because they only value lake views or perhaps because only a subset of people value the Lake. As mentioned previously, one of the shortcomings of the hedonic price method is that it fails to account for heterogeneity in preferences across household types.

Since the coefficients on proximity to boat ramps and beaches are statistically insignificant, we ignore their marginal value. Interestingly, however, while there seems to be no value to closeness to a boat ramp, *per se*, people appear to put a marginal value on being close to boat access points with lots of parking spots, with an average MWTP of about $394. As discussed above, this may be evidence that there are still omitted variables that are correlated with boat ramps with lots of parking spaces that are not controlled for by our model; including perhaps that boat ramps with parking have other unobserved amenities.

Finally, Table 16 shows that there is a negative willingness to pay for industrial disamenities. Each new manufacturing business within 1000 meters of a house reduces its value to households by about $1300. Similarly, proximity to TRI air releases and Superfund sites have some negative price effects (although they are small and when combined, the Superfund effect is statistically insignificant).

VI. Conclusion and Future Work

Policymakers and other leaders in the Ohio Lake Erie region are interested in whether economic development policies that are focused on Lake Erie will contribute to economic growth in the region. Specifically they are interested in knowing if and how much households value access to Lake Erie and its views and recreational opportunities and the value associated with improvements in environmental quality or increased recreational opportunities.

One way to assess the value that consumers place on non-traded public goods like natural amenities is to uncover their implicit value using the hedonic price method. Since houses are traded on a competitive market, their prices are determined by consumers' willingness to pay for specific attributes of those houses included those public goods.

Results from this analysis suggest that households do value being on or close to Lake Erie, at least if they are close enough to have a view or be virtually next to the Lake. Beyond that, it is not clear what value households in the region place on Lake Erie. With the census tract fixed effects, there appears to be a negative price effect the farther a house is from the Lake, this could also be that other unobserved factors, such as demographics, which are correlated with distance to the Lake that contribute to housing prices away from the Lake. We see further evidence of this when the coefficient of the distance to the Lake variable switches signs when block group fixed effects are added. Or, the spatial fixed effects might be simply absorbing the effects of distance to the Lake and in future work we will explore this further. At the same time, perhaps away from those houses in close proximity to Lake Erie, the Lake has little to no effect on people's willingness to pay.

Consistent with our hypothesis that industrial disamenities may play a role in repelling households, we find evidence that people's willingness to pay decreases with the concentration of nearby manufacturing facilities. However, the effect is much smaller when we consider air pollution levels. This may be due to the fact that households are able to see the smokestacks or industrial sites but may not necessarily notice pollution otherwise.

While there appears to be some evidence of the value of Lake Erie and negative value of environmental disamenities, we believe that these results also suggest several ways to expand on this analysis in future research. In future work, we plan to conduct auxiliary analyses to further test the robustness of our results. We will look more closely at the use of the spatial (census tract and block group) fixed effects. It could be that the spatial fixed effects are actually absorbing the effect of the important variables in our model like distance to Lake Erie and distance to downtown Cleveland, thus making it difficult to interpret our results. We will consider splitting the region into several housing submarkets to test whether the pooling of the housing market for the entire region is justified. We will also interact some of our key amenity variables with time fixed effects to see if the value of these amenities is changing over time. This may provide us additional insight into the preferences of households for amenities as the average effect in our pooled regression may be masking heterogeneity over time and space.

More analysis is also needed to examine the lake effects. For example, it would be interesting to look at whether the results are affected by the variation in water quality in the Lake, both over time and space, as suggested by the work by Ara (2007).

More importantly, we believe that there is a need to assess whether individual households have heterogeneous preferences over lake amenities that are not fully explored with a hedonic analysis. As seen in Chapter 2, there is evidence that income or education may be an important determinant of household demand for residential location vis-à-vis proximity to the Great Lakes. Future work could use the results from this hedonic analysis to set up a structural discrete choice model that will allow preferences for amenities to vary by households attributes such as income. An additional advantage of using a structural discrete choice model is that it will allow us model the welfare effects from policies that have non-marginal effects on regional amenities in which households may sort due to the changes and the underlying demand function could change. For example, we could model whether there is a welfare effect from building a new marina on the Lake.

While it appears that immediate proximity to Lake Erie is valued by households, as the results here show, further clarification is needed about how and whether a focus on Lake Erie as a quality of life enhancing amenity is a policy worth pursuing.

Figure 4. Map of the six-county region, Northeast Ohio

	Obs	Mean	Std. Dev.	Min	Max
ln (Price)	329,342	11.64	0.56	9.21	14.38
Price	329,342	133,349	83,455	10,000	1750000
Price/Sq Foot	329,342	78	28	3	400
Bathrooms	329,342	1.61	0.69	1	6
Hundreds of square feet	329,342	16.73	6.64	6	45
Lot acres	329,342	0.44	0.85	0.05	15
House Age	329,342	43.97	27.43	0	130
Km to Downtown Cleveland	329,342	24.38	16.85	0.86	107.22
Km to Lake Erie	329,342	8.49	8.31	0.00	51.69
Km to Nearest Beach or Boat Ramp	329,342	10.17	8.94	0.03	55.54
Number of Parking Spots at Nearest Boat Ramp	329,342	26.93	44.87	0	150
# of Sales within 100 meters of Lake Erie	3,009				
# of Sales within 250 meters of a Boat Ramp or Beach	830				
# of Sales within 1000 meters of a Superfund site	378				
# of Sales within 1000 meters of 1 or more Manufacturing Business	260,079				
# of Sales withn 1000 meters of TRI air pollution	27,410				

*Note: When 303,907 transactions from 1992 to 2006 are included, descriptives are virtually identical.

Table 13. Descriptive Statistics, Northeast Ohio Housing Transactions

Dependent Variable: Ln(Price) **Explanatory Variables:**	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Number of Bathrooms	0.142***	0.0919***	0.0919***	0.141***	0.0911***
	(0.00148)	(0.00129)	(0.00129)	(0.00153)	(0.00134)
Garage? (0/1)	0.130***	0.0674***	0.0673***	0.127***	0.0653***
	(0.00200)	(0.00198)	(0.00198)	(0.00210)	(0.00205)
Fireplace? (0/1)	0.0816***	0.0273***	0.0271***	0.0878***	0.0318***
	(0.00164)	(0.00141)	(0.00141)	(0.00165)	(0.00142)
Building size (100s of square feet)	0.0443***	0.0290***	0.0290***	0.0431***	0.0283***
	(0.000427)	(0.000391)	(0.000391)	(0.000442)	(0.000403)
Building size, squared	-0.000223***	-8.95e-05***	-8.97e-05***	-0.000206***	-7.75e-05***
	(9.80e-06)	(9.21e-06)	(9.20e-06)	(1.01e-05)	(9.48e-06)
Lot acres	0.107***	0.0836***	0.0830***	0.107***	0.0841***
	(0.00243)	(0.00238)	(0.00238)	(0.00253)	(0.00249)
Lot acres, squared	-0.00973***	-0.00598***	-0.00592***	-0.00973***	-0.00605***
	(0.000387)	(0.000322)	(0.000321)	(0.000402)	(0.000337)
Building age	-0.000996***	-0.00689***	-0.00687***	-0.000859***	-0.00673***
	(9.04e-05)	(9.88e-05)	(9.88e-05)	(9.33e-05)	(0.000103)
Building age, squared	-3.39e-05***	3.17e-05***	3.15e-05***	-3.42e-05***	3.04e-05***
	(8.60e-07)	(8.86e-07)	(8.86e-07)	(8.81e-07)	(9.18e-07)
Distance to Downtown Cleveland (km)	0.00686***	-0.00556***	-0.00365***	0.00663***	-0.00537***
	(0.000147)	(0.000850)	(0.000748)	(0.000150)	(0.000882)
Distance to Downtown Cleveland, squared	-0.000120***	-3.38e-05***	-4.81e-05***	-0.000116***	-3.06e-05**
	(1.67e-06)	(1.20e-05)	(1.18e-05)	(1.70e-06)	(1.23e-05)
Lake Erie within 100 meters (0/1)	0.234***	0.237***	0.242***	0.239***	0.241***
	(0.00805)	(0.00777)	(0.00778)	(0.00828)	(0.00803)
Beach within 250 meters (0/1)	0.0311*	0.0157	0.0117	0.0252	0.0107
	(0.0187)	(0.0159)	(0.0159)	(0.0198)	(0.0168)
Boat Access within 250 meters (0/1)	0.0641**	0.00914	-0.0314	0.0957***	0.0254
	(0.0272)	(0.0232)	(0.0254)	(0.0286)	(0.0244)

Table 14. Northeast Ohio Hedonic Regression Results

Continued.

Table 14. Continued.

Distance to nearest Boat Access or Beach (km)	-0.000574***	0.0108***		-0.000490***	0.0106***
	(7.94e-05)	(0.000551)		(8.21e-05)	(0.000574)
Acreage of Parks within 1000 meters (tens of acres)	-0.00156***	0.000518***	0.000513***	-0.00151***	0.000526***
	(0.000163)	(0.000141)	(0.000141)	(0.000171)	(0.000147)
Number of Manufacturing businesses within 1000 meters	-0.0172***	-0.00976***	-0.00963***	-0.0164***	-0.00938***
	(0.000571)	(0.000606)	(0.000605)	(0.000595)	(0.000631)
Superfund site within 1000 meters (0/1)	-0.158***	-0.0352*	-0.0360*	-0.112***	-0.00721
	(0.0185)	(0.0193)	(0.0193)	(0.0211)	(0.0205)
Number of Parking Spots at nearby Boat Access (within 250 m)			0.00296***		
			(0.000727)		
Distance to Lake Erie (km)			0.0101***		
			(0.000427)		
TRI air releases within 1000 meters (in 10,000s of pounds)				-0.000977***	-0.000444***
				(8.05e-05)	(5.96e-05)
Constant	10.89***	11.52***	11.52***	10.90***	11.52***
	(0.00800)	(0.0118)	(0.0117)	(0.00817)	(0.0121)
Year Fixed Effects?	Y	Y	Y	Y	Y
Census Tract Fixed Effects?	N	Y	Y	N	Y
Observations	329,342	329,342	329,342	303,907	303,907
years included:	1990-2006	1990-2006	1990-2006	1992-2006	1992-2006
R-squared	0.693	0.791	0.791	0.686	0.785
Adjusted R-squared	0.693	0.790	0.790	0.686	0.785

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Dependent Variable: Ln(Price) **Explanatory Variables:**	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Number of Bathrooms	0.0909***	0.0908***	0.0908***	0.0846***	0.0843***	0.0843***
	(0.00134)	(0.00134)	(0.00134)	(0.00134)	(0.00134)	(0.00134)
Garage? (0/1)	0.0652***	0.0653***	0.0653***	0.0617***	0.0615***	0.0615***
	(0.00205)	(0.00205)	(0.00205)	(0.00203)	(0.00203)	(0.00203)
Fireplace? (0/1)	0.0313***	0.0313***	0.0313***	0.0285***	0.0284***	0.0284***
	(0.00142)	(0.00142)	(0.00142)	(0.00141)	(0.00141)	(0.00141)
Building size (100s of square feet)	0.0282***	0.0282***	0.0282***	0.0265***	0.0265***	0.0265***
	(0.000403)	(0.000403)	(0.000403)	(0.000412)	(0.000411)	(0.000411)
Building size, squared	-7.80e-05***	-7.84e-05***	-7.85e-05***	-6.27e-05***	-6.29e-05***	-6.29e-05***
	(9.47e-06)	(9.47e-06)	(9.47e-06)	(9.68e-06)	(9.68e-06)	(9.68e-06)
Lot acres	0.0836***	0.0837***	0.0837***	0.0790***	0.0790***	0.0790***
	(0.00249)	(0.00249)	(0.00249)	(0.00257)	(0.00257)	(0.00257)
Lot acres, squared	-0.00599***	-0.00600***	-0.00600***	-0.00529***	-0.00528***	-0.00528***
	(0.000337)	(0.000337)	(0.000337)	(0.000333)	(0.000333)	(0.000333)
Building age	-0.00672***	-0.00674***	-0.00674***	-0.00700***	-0.00702***	-0.00702***
	(0.000103)	(0.000103)	(0.000103)	(0.000108)	(0.000108)	(0.000108)
Building age, squared	3.03e-05***	3.03e-05***	3.04e-05***	3.34e-05***	3.35e-05***	3.35e-05***
	(9.18e-07)	(9.18e-07)	(9.18e-07)	(9.65e-07)	(9.65e-07)	(9.65e-07)
Distance to Downtown Cleveland (km)	-0.00367***	-0.00369***	-0.00368***	0.0513***	0.0511***	0.0511***
	(0.000774)	(0.000774)	(0.000774)	(0.00132)	(0.00132)	(0.00132)
Distance to Downtown Cleveland, squared	-4.44e-05***	-4.37e-05***	-4.38e-05***	-0.000556***	-0.000560***	-0.000560***
	(1.21e-05)	(1.21e-05)	(1.21e-05)	(2.09e-05)	(2.09e-05)	(2.09e-05)
Lake Erie within 100 meters (0/1)	0.256***	0.299***	0.331***	0.200***	0.221***	0.235***
	(0.00811)	(0.0124)	(0.0192)	(0.00869)	(0.00899)	(0.0169)
Lake Erie between 100 and 250 meters away (0/1)	0.0403***	0.0397***	0.0397***		0.0498***	0.0499***
	(0.00449)	(0.00450)	(0.00450)		(0.00497)	(0.00498)
Elevation if along the Coast (DEM)			-5.87e-05**			-2.60e-05
			(2.87e-05)			(2.83e-05)
Beach within 250 meters (0/1)	-0.00797	-0.00829	-0.00768	0.0112	-0.00471	-0.00460
	(0.0168)	(0.0168)	(0.0168)	(0.0182)	(0.0180)	(0.0180)

Table 15. Additional Analysis of NE Ohio Housing Prices

Continued.

Table 15. Continued.

Boat Access within 250 meters (0/1)	-0.0252	-0.0211	-0.0206	0.0747***	0.0325	0.0325
	(0.0268)	(0.0273)	(0.0272)	(0.0232)	(0.0254)	(0.0254)
Distance to Lake Erie (km)	0.0103***	0.0103***	0.0103***	-0.0227***	-0.0222***	-0.0222***
	(0.000447)	(0.000447)	(0.000447)	(0.000564)	(0.000561)	(0.000561)
Number of Parking Spots at nearby Boat Access (within 250 m)	0.00287***	0.00273***	0.00275***		0.00231***	0.00232***
	(0.000740)	(0.000748)	(0.000747)		(0.000736)	(0.000736)
Acreage of Parks within 1000 meters (tens of acres)	0.000535***	0.000534***	0.000534***	0.000647***	0.000686***	0.000687***
	(0.000147)	(0.000147)	(0.000147)	(0.000174)	(0.000174)	(0.000174)
Number of Manufacturing businesses within 1000 meters	-0.00888***	-0.00854***	-0.00851***	-0.00570***	-0.00534***	-0.00534***
	(0.000632)	(0.000632)	(0.000632)	(0.000716)	(0.000718)	(0.000718)
TRI air releases within 1000 meters (in 10,000s of pounds)	-0.000435***	-0.000444***	-0.000444***	-0.000357***	-0.000352***	-0.000352***
	(5.96e-05)	(5.99e-05)	(5.99e-05)	(6.39e-05)	(6.41e-05)	(6.41e-05)
Superfund site within 1000 meters (0/1)	-0.00779	-0.00730	-0.00726	-0.00597	-0.00477	-0.00475
	(0.0205)	(0.0205)	(0.0205)	(0.0213)	(0.0213)	(0.0213)
Number of Manufacturing businesses within 1000 meters if on the Coast		-0.0332***	-0.0349***			
		(0.00674)	(0.00674)			
Constant	11.52***	11.52***	11.52***	11.25***	11.25***	11.25***
	(0.0121)	(0.0121)	(0.0121)	(0.0157)	(0.0157)	(0.0157)
Year Fixed Effects?						
Census Tract Fixed Effects?	Y	Y	Y	N	N	N
Block Group Fixed Effects?	N	N	N	Y	Y	Y
Observations	303,907	303,907	303,907	303,907	303,907	303,907
years included:	1992-2006	1992-2006	1992-2006	1992-2006	1992-2006	1992-2006
R-squared	0.786	0.786	0.786	0.792	0.792	0.792
Adjusted R-squared	0.785	0.785	0.785	0.790	0.791	0.791

Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Variable	MWTP ($) Model (2)	MWTP ($) Model (3)	MWTP ($) Model (5)
Distance to nearest Boat Access or Beach (km)	1,433.73		1,443.23
Distance to Lake Erie (km)		1348.32	
Acreage of Parks within 1000 meters (tens of acres)	69.05	68.44	71.66
Number of Manufacturing businesses within 1000 meters	-1,301.91	-1284.25	-1,279.10
Lake Erie within 100 meters (0/1)	48,500.67	49510.03	50,880.47
Beach within 250 meters (0/1)	*2314.91**	*1719.25**	*1607.78**
Boat Access within 250 meters (0/1)	*1547.71**	**-5218.18**	*4484.51**
Superfund site within 1000 meters (0/1)	-2,327.77	-2380.22	*-498.61**
Number of Parking Spots at nearby Boat Access (within 250 m)		394.15	
TRI air releases within 1000 meters (in 10,000s of pounds)			-60.46
Number of observations in dataset	329,342		303,907

**Indicates parameter is not statistically significant.*

Table 16. Estimates of MWTP for Amenities and Disamenities in Northeast Ohio

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