DRIVERS OF ECONOMIC PERFORMANCE IN MICHIGAN

natural features, green infrastructure and social/cultural amenities

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A PARTNERSHIP BETWEEN THE LAND POLICY INSTITUTE AND THE MICHIGAN NATURAL FEATURES INVENTORY

full report

MICHIGAN STATE UNIVERSITY | Extension

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About Land Policy Research

Research and analysis is supported by the Land Policy Research (LPR) Team at LPI.

This report #LPR–2011–NE–04 of the LPI New Economy Report Series is the full report from a major research partnership between the Land Policy Institute (LPI); the Office of the John A. Hannah Distinguished Professor in Land Policy in the Department of Agricultural, Food and Resource Economics; and the Michigan Natural Features Inventory; all at Michigan State University. Its aim is to provide science-based information to local, regional, state and national policy decision makers and others involved in place-based strategies for sustainable development. This work was embarked on during the tenure of Professor Adesoji Adelaja, as Director of the Land Policy Institute.

Foreword

As our state economy transitions from one built on the platform of an old industrial model to one built on the principles of the next economy, it is important for state residents and their elected representatives to better understand the range of assets that are relevant in economic development in the New Economy. One of the newly emerging and exciting paradigms is a diversified and resilient economy based on the principles of sustainability. The transition from the industrial economy to the New Economy requires greater understanding of what drives sustainable development. Based on previous studies, it appears that green infrastructure, which encompasses critical natural features, is an important economic driver. Increasingly, these natural features are not being viewed as simply inputs to industrial economic development, but as drivers of economic activity, especially in the service and knowledge driven sectors of the economy, where significant growth has been occurring. It may well be that a basic premise of the New Economy is that economic activities can revolve around sustainable management of existing green assets, and that a state strategy that focuses on optimal management of such assets can drive prosperity. A fair amount of research has been done on the ecological benefits of natural amenities, but for those of us who participate in and inform public decision makers, we need more science and evidence about the green economy, its underpinnings, its interconnections, and how it translates into economic prosperity.

In the old industrial economy, economists were able to account for the impacts and marginal productivities of traditional industrial assets of places, especially labor, capital, technology, raw materials and management. One of the unique features of the New Economy is that assets previously viewed as "intangibles" may not only be tangible today, but may play a significant role in driving economic change. Earlier proponents of this idea drew the links between amenities and property values, and amenities and people's preferences or satisfaction levels. This report gives the reader the necessary information to compare the roles of green infrastructure to other traditional economic development drivers. By showing how green infrastructure directly leads to changes in population, employment and income this report helps to illustrate how green infrastructure affects local economic growth.

We appreciate the support of the W.K. Kellogg Foundation, through the People and Land (PAL) initiative. Based on this work, we can now talk about such things as per capita income effect of wetlands per acre, the employment effects of trails, or the number of residents attracted to inland lakes. Similarly, we can now talk about the economic impacts of these natural amenities in comparison to adding one more strip mall to a community. The information provided in this report helps to set the stage for Michigan to move forward, by leveraging its place assets in sustainable ways and building future prosperity based on a green strategy.

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Preface

The Michigan Natural Features Inventory (MNFI) is a program of Michigan State University (MSU) Extension focused on providing end users with the best information available on Michigan's biological diversity. With more than 16,000 records in the natural heritage database, MNFI currently maintains the most comprehensive database available on Michigan's unique natural features. The MNFI aims for Michigan to be the leading state in providing decision makers involved in land- and water-based decisions and policies with the best information science can provide.

The Michigan State University Land Policy Institute (LPI) is a policy research institute involved in the utilization of data and informatics in policy modeling, simulation and analysis to inform policy decision makers and aid the policy development process. The Institute has implemented dozens of studies designed to discover game-changing policy ideas, especially in areas related to the green economy, the New Economy, renewable energy and asset-based economic development.

Despite several studies previously conducted by LPI on the impact of green infrastructure on key economic variables, questions continue to be raised about the nature of the green economy and the value of investments in green infrastructure. Of course, a meaningful place to focus efforts is on documenting just how natural features and green assets contribute to the economy. The partnership between LPI and MNFI in this study is a unique and exciting one, and holds great promise for Michigan. The initial result of this partnership is this report, which we deem to be the most comprehensive analysis of the economics of natural features conducted to date.

We expect that this report will provide greater understanding not only of the green economy, but also of the potential for a nature-based economic development strategy for Michigan. We also expect that this study will highlight the value and importance of the great work that the MNFI is engaged in to document the natural features of the state, and the important work of LPI in isolating the economic value of such infrastructure. After all, we know where all the bridges, roads, utilities and airports are and the roles that they play. If green infrastructure is relevant to Michigan's economic future, it is equally important that a comprehensive, accurate and up-to-date database on Michigan's natural features is in place to help local communities better understand the potential value of their natural amenities.

Michigan, with its wealth and diversity of natural resources, could benefit tremendously from an effort to complete a comprehensive natural features inventory. An accurate, up-to-date, systematic survey of Michigan's natural features would assist planners and decision makers in a large variety of land-based activities and decisions. Most importantly, because natural features are related to a wide range of economic activities, such as timber production, tourism, recreation and property transactions, they could play a significant role in Michigan's future economic recovery. One of the key elements of understanding this relationship is determining what effects, if any, various natural assets have on local economic performance in Michigan; this study provides a significant first step towards accomplishing that goal.

Executive Summary

AS THE NEW ECONOMY SLOWLY REPLACES TRADITIONAL ECONOMIC FRAMEWORKS AND BEGINS TO UNSEAT LONG HELD PARADIGMS, CLEAR PATHWAYS MUST BE EXPLORED ON HOW GREEN INFRASTRUCTURE AND AMENITIES IMPACT THE ECONOMY. DO NATURAL AMENITIES PROVIDE A COMPETITIVE ADVANTAGE TO COMMUNITIES IN MICHIGAN? WHICH COMPONENTS OF GREEN INFRASTRUCTURE DRIVE POPULATION, INCOME AND EMPLOYMENT GROWTH? WHAT ARE THE MEASURABLE IMPACTS OF SPECIFIC NATURAL AMENITIES TO LOCAL ECONOMIES, WHICH HAVE NEVER BEEN STUDIED AT SUCH A SCALE BEFORE? THIS REPORT SEEKS TO ANSWER THESE QUESTIONS.

Background

Michigan's economy has struggled since the early 2000s, evidenced by periods of population and job loss combined with an increasing unemployment rate. The latest national recession made matters worse. At 9.8% (November 2011), unemployment was the tenth-highest of any state. The near collapse of the domestic automobile industry had politicians and other leaders scrambling to find solutions on how to diversify and correct Michigan's current economic predicament. It is evident that the state needs a diversified strategy, and many expect that this strategy will be tied to the long-term sustainability of its natural features.

There is no shortage of natural amenity and green infrastructure research, and some of the pieces of the puzzle are in place. Indeed, most studies have found positive relationships between the presence of natural amenities and such things as population change and economic growth. The literature is beginning to find that amenities are important for increasing employment and income growth as well. Historically, people chased jobs. But the New Economy has created a scenario where people move to places with high endowments of amenities, and jobs follow (Vias, 1999).

As the New Economy slowly replaces traditional economic frameworks and begins to unseat long held paradigms, clear pathways must be explored on how green infrastructure and other amenities impact the economy. Do natural amenities provide a competitive advantage to communities in Michigan? Which components of green infrastructure drive population, income and employment growth? What are the measurable impacts of specific natural amenities to local economies, which have never been studied at such a scale before? This report seeks to answer these questions.

GREEN INFRASTRUCTURE*
The physical environment within and between our cities, towns and villages. It is a network of multi-functional open spaces, including formal parks, gardens, woodlands, green corridors, waterways, wetlands, forest and open countryside. It comprises all environmental resources.

**Adapted from the "Green Infrastructure Planning Guide," by C Davies, R MacFarlane, C McGloin and M Roe.*

Bridging this gap in the literature, by specifically explaining the roles of a diverse set of green infrastructure assets on place performance, is the goal of this study. Specifically, this report expands the scope of natural amenities beyond those considered in previous studies, by including specific ecological variables measured at the

local level. We examine a full range of amenities and natural features, and how they relate to the economic prosperity and performance of places. We also present a coherent economic modeling framework that allows the attribution of economic outcomes to specific green infrastructure elements.

To evaluate the influence of specific quality-of-life and amenity attributes on population, income and employment levels, a large and in-depth collection of data was necessary. Economic data are easily obtainable at the Minor Civil Division (MCD) level, which include cities, townships and villages. Data for this study is generated from various sources, including the U.S. Census Bureau, U.S. Bureau of Labor and Statistics, the Michigan Center for Geographic Information, the U.S. Geological Survey and others. When necessary, spatial data was processed from its original form, which covered Michigan or the country as a whole, and measured within Michigan communities. The data used in the study is a time series for the years 1990 and 2000, with the lion-share of the data relating to various factors within the community in 1990, and data representing shifting population, employment, and income trends from 1990 to 2000.

The categories of variables that have been theorized to impact growth include:

1. Initial Conditions and the Cost Associated with Structural Legacy;
2. Existing Gray Infrastructure Assets and Subsequent Investments;
3. Industrial Structure, including the Contributions of Key Industries;
4. Local Public Finance;

5. Local Governance and Political Structure;
6. Accumulation of Human Capital (including knowledge and creative capital, as well as knowledge infrastructure, such as universities);
7. Information Technology and Communications Technology Infrastructure (such as broadband);
8. Cultural Assets;
9. Social and Ethnic Diversity Related Assets;
10. Green Infrastructure (natural amenities); and
11. Others (such as demographic, housing market, socio-economic and educational factors).

Results

The primary focus of this study is understanding the roles of green infrastructure and natural features in economic growth. Table 1, a subset

of the overall results, highlights the significant effects of green infrastructure on changes in population, income and employment. A more detailed explanation of the quantitative methods and a comprehensive table of regression results (Table 2) can be found later in this report.

The results of this study clearly demonstrate that natural assets can be important to the economic performance of local communities in Michigan. These results are not surprising given the findings from previous natural asset studies conducted across the United States.

Of the 27 natural asset variables included in the study, 19 (70%) had a positive impact on population, income and/or employment levels, with only one variable (state environmental areas) having a negative effect. The remaining seven variables had no significant effect.
Positive effects spanned all major categories of green infrastructure included in this study: 1) basic land assets, 2) ecological land assets, 3) basic water assets, 4) ecological water assets and 5) developed land or water assets. From a cumulative effects perspective, 14 of the 27 green infrastructure variables (52%) had at least one positive cumulative impact on resident population, income and/or employment levels. Additionally, nine of the 27 variables had zero cumulative effects (or a value of less than one), leaving only four variables that had a negative cumulative effect on population, income and/or employment levels.

Of particular interest, seven of the 27 green infrastructure variables (26%) had only positive cumulative effects on both population and employment levels. These include: 1) miles of Great Lakes shoreline, 2) presence of a trout stream, 3) miles of reference or no impact streams, 4) percentage of functional sub-watersheds, 5) number of state forest campgrounds, 6) presence of identified trails, and 7) number of boat launches.

Recommendations

Much is being said nationally and internationally about green infrastructure and economic development. With its natural resources base, its alternative energy resource capacity, its huge and unique agricultural industry and the state's long-term history and prominence in preservation and conservation, Michigan may well be poised to be the leading green state in the nation. Therefore, based on these points and the results from this study, the following recommendations are offered.

Policy Recommendations

1. The results from this report do not encourage unbridled development of our natural lands or the 100% conservation of all open space. Rather, the findings point communities toward the long-term viability of their most important natural assets coupled with compatible, sustainable economic development.

2. Michigan should develop a green economy plan that incorporates ideas about how its natural resource base can be leveraged to help position its economy for long-term success, while improving the health of Michigan's natural assets and environment. The People and Land Initiative has identified Natural Resources for Recreation and Jobs as a "Pillar for Prosperity," but no definitive plan exists to reach such an objective. We recommend that the administration should direct its agencies to collaborate and deliver a plan for securing and improving Michigan's natural resources for place-base economic development, quality

of life, recreation and talent attraction. If there is a prosperity pathway through "green," Michigan should be the state that's leading the nation.

3. One of the unique observations resulting from this study is that people are attracted to both employment centers and natural assets. However, employment centers in Michigan are typically highly urbanized. Urban and suburban communities have an excellent opportunity to increase their locational competitiveness by maintaining, restoring and enhancing their unique natural assets.

Table 1: Selected Green Infrastructure Findings

Green Infrastructure-Related Factor*	Effect On		
Variable	Population	Per Capita Income	Employment
Each Additional 1% of Agriculture	6 fewer people	$18.2 more in income	–
Each Additional 1% of Forested Land	5 fewer people	$33.67 more in income	4 fewer employed people
Each Additional 1% of Sand, Rock and Clay	37 more people	–	29 fewer employed people
Presence of Important Bird Habitat	136 more people	–	89 fewer employed people
Each Additional 1% MCD Consisting of Natural Vegetation Core Area	3 more people	–	3 fewer employed people
Each Additional 10% MCD Consisting of Inland Lakes	–	$4.80 more in income	1 fewer employed person
Each Additional Mile of Great Lakes Shoreline	2 more people	–	–
Each Additional Mile of Inland Lake Shoreline	0.51 more people	–	1 fewer employed person
Presence of State Environmental Area	51 fewer people	–	–
Each Additional 1% of Wetland	–	$39.68 more in income	7 fewer employed people
Presence of a Trout Stream	35 fewer people	–	34 more employed people
Each Additional Mile of Reference/No Impact Stream	–	–	1 more employed person
Each Additional 10% of Functional Sub-Watershed	4 fewer people	–	8 more employed people
Each Additional State Forest Campground	45 fewer people	–	27 more employed people
Presence of Identified Trails	58 fewer people	–	34 more employed people
Each Additional Mile of Developed Inland Lake Frontage	2 more people	–	1 fewer employed person
Each Additional Boat Launch	9 more people	–	–
Each Additional Marina Business	103 fewer people	–	34 more employed people
Each Additional Mine	67 fewer people	$127.68 less in income	47 more employed people
Each Additional National Pollutant Discharge Elimination System (NPDES) Site	31 more people	–	22 fewer employed people
Each Additional Part 201 Contaminated Site	83 fewer people	$83.98 less in income	54 more employed people

Only statistically significant (at the $p<0.1$ level) green infrastructure variables are shown. Other socio-economic, cultural, business and demographic variables have been omitted for simplicity.

The effect on population, employment and income change from 1990-2000 must be interpreted in the context of "all else being equal," which includes those omitted variables.

* Measured at the Minor Civil Division (city, village, township) scale.

– Signifies that the variable is not significant in this model.

4. Obviously, Michigan's natural assets are diverse. This study begins to link various green asset categories to prosperity. We recommend that state agencies be tasked with developing and implementing strategies that recognize the estimated impact of various natural amenities, based on the findings of this report.

5. Planners and community and economic developers should explicitly consider the role of green infrastructure in all land use planning and economic growth activities, particularly master land use plans, and park and recreation plans.

6. In addition to green infrastructure's effect on economic growth, planners and community and economic developers should also explicitly consider the benefits that ecological services and green infrastructure provide (flood protection, pollution filtration, water storage, climate regulation, wildlife habitat, recreation opportunities, research and education, etc.), when making decisions about the future of Michigan's communities.

7. Since natural features and processes typically do not follow jurisdictional boundaries, regional or watershed planning efforts should be strongly encouraged or incentivized. Jurisdictions that collaborate with their neighboring municipalities should be rewarded with grant funding to help complete planning, design or implementation efforts.

8. Similar to the Michigan Natural Resources Trust Fund (MNRTF) requiring an updated parks and recreation plan for communities to apply for funding, the state should require that all natural features be fully addressed in all land use planning activities, particularly land use master plans, in order to receive certain types of state financial assistance.

9. Since many landscape ecosystems and ecological processes, such as hydrology, occur over large scales, the state should take the lead in developing and promoting large-scale ecosystem management efforts. These efforts should be highly integrated and inclusive of economic, social, and ecological goals and objectives.

10. The old paradigm pitting conservation against economic development will not lead the state to the desired outcome of economic prosperity. In order to fully capitalize on the results of this study, a new form of economic growth will need to be created. This new paradigm will need to implement more of an integrated approach that takes into account the triple bottom line (economic prosperity, social equity and ecological health), and shift toward a model founded upon long-term sustainability.

Outreach Recommendations

1. One of the keys to facilitating the smart conservation/restoration of green infrastructure is to increase the accessibility of natural features information to local communities and decision makers. To do this, we will need: 1) a central hub to organize the information and serve as a gateway; 2) a suite of decision support tools for different types of applications, such as utility planning, climate change adaptation and comprehensive land use plans; 3) a clearinghouse to store and share relevant data, information and knowledge; 4) technical support to assist end users and build capacity within communities; and 5) outreach and education to engage and inspire constituents across the state.

2. There should be support from the state to support additional outreach activites explaining the relationship between green infrastructure and economic growth to planners, economic development officials and other decision makers.

Funding Recommendations

1. In order to fully capitalize on a region's natural features, local communities need to know what they have, where it's located, how much they have, and what condition it is in. To accomplish this, there should be long-term financial support from the state to conduct a statewide systematic natural features inventory. This type of effort should be prioritized based on a set of logical criteria, such as the degree of threat to the resources, the amount of natural features, proximity to population centers, etc.

2. Pure Michigan ads have been successful in attracting tourists to Michigan, which translates into additional revenue for future management and consumer spending in our communities. We strongly recommend that the state maintain funding at current levels for the Pure Michigan Campaign to increase natural resource-based tourism activity.

3. Michigan is in desperate need of long-term stable funding to support natural features data management and delivery, smart conservation and restoration, applied research, technical support and outreach. A strategy needs to be deployed that engages a diverse coalition of groups who can build broad support for long-term funding and make it a reality. Successful revenue generation ideas in other states include: the percentage of sales tax, the percentage of real estate transfer tax, and bonds to provide important long-term support.

Research Recommendations

1. By conducting this analysis at the MCD scale, this study was able to uncover patterns occurring at a relatively small scale. As a follow up, a better understanding of the proximity effect of various quality-of-life and cultural assets and green infrastructure assets on community growth is needed. For example, someone may live and work in different places. Understanding the effects that nearby jurisdictions have on population, employment and income change is essential. These proximity effects could have a significant impact on the potential growth of a community.

2. Due to the fact that the vast majority of natural features are located in rural MCDs, we should conduct an analysis that distinguishes between rural and urban MCDs, or at least metropolitan and non-metropolitan MCDs. It would be very interesting to compare urban communities rich in natural features with urban communities poor in natural features. This distinction may also show significant differences in regard to quality-of-life and cultural assets.

3. From an ecological perspective, Michigan is a relatively diverse state, to which several different types of regional frameworks have been applied. Because of these regional differences, an econometric analysis of green infrastructure should be conducted based on ecological regions rather than the whole state. The addition of data from the 2010 Census would also determine, spatially, where the concentrations of wealth and growth occurred in the 2000s by MCD.

4. Zoning is decided at the local level. An inventory of zoning ordinances by MCD should be collected and the relationship

between various types of zoning ordinances, natural features and economic performance should be explored.

5. Several efforts and trends are currently underway in Michigan—such as development of wind energy in agricultural areas and a new pheasant initiative focusing on private lands by the DNR. Specific studies should be conducted on a case-study basis to determine the effective synergy between different sectors of the economy—such as agricultural wind energy and biofuels-pheasant production—in order to identify new and innovative partnerships that can enhance local economies and promote natural resource use, conservation and alternative energy production.

Conclusion

Michigan finds itself at a crossroads. For more than a decade, Michigan has been suffering from an economic crisis from which it is still trying to recover. The impacts have been devastating to state and local governments, businesses, communities and families alike. To truly move the economy forward, a new paradigm is needed based on identifying, sustaining and enhancing its strengths and assets. Despite Michigan's dependence on the automobile sector and associated manufacturing industries over the last half of the 20th century, Michigan's underlying strengths have always been its wealth of natural resources. Bordering four of the five Great Lakes, Michigan is known proudly as the Great Lakes State. The two peninsulas encompass more than 37 million acres of land, and at 19 million acres, the state contains the largest stock of forestland east of the Mississippi River. More than 38,000 miles of rivers and approximately 11,000 lakes can also be found within Michigan's borders. Its 3,200 miles of Great Lakes shoreline also boast the largest collection of freshwater dunes in the world. In moving forward, one of the biggest challenges Michigan faces is finding a way to balance desired economic growth with the long-term viability of its natural assets. Perhaps it is from the very challenge of defining, understanding and implementing long-term sustainability that new ideas and solutions will ultimately emerge for Michigan to become prosperous in the 21st century.

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Part 1: Introduction

STUDIES HAVE FOCUSED ON ESTIMATING AMENITY BENEFITS TO PEOPLE AND COMMUNITIES, WITHOUT ADDRESSING THE BROADER ISSUE OF HOW SUCH AMENITIES AFFECT THE ECONOMIC PERFORMANCE OF A PLACE. THE PATHWAYS FROM AMENITIES TO EMPLOYMENT, INCOME AND POPULATION GROWTH ARE IMPORTANT ONES TO ILLUMINATE THROUGH RESEARCH, PARTICULARLY BY FOCUSING AT THE LOCAL LEVEL.

Amenities, in general, have been defined as the various natural, built, and cultural, location-specific, non-exportable features that benefit the residents of a place (Gottlieb, 1994). Nature-based amenities represent the subset of amenities that are inherently natural. For the purpose of this report, we define nature-based amenities to include:

- Natural features, such as wetlands, grasslands, rivers, streams, lakes, forests, plants, animals and unique geologic features. These tend to be inherent to a place, and are important features of place that can naturally diminish over long periods of time or if society consumes, degrades or erodes them.
- Outdoor recreational amenities, such as parks, campgrounds, marinas, trails and canoe liveries. These represent human-based, intentional development efforts that provide access to natural features.
- Climate and weather-related amenities, which are inherent in the location of place, and can fluctuate over time.

Traditionally, many natural amenities were viewed from the perspective of their value in the production process as raw materials and input into manufacturing processes. Rural areas and regions were dependent on extractive industries for sources of employment and income. During the past 40 years, however, more places began to develop new economic opportunities around such amenity-

The emerging view of amenities in economic development stresses utilizing amenities to attract people through a strong amenity-based (green infrastructure, social/cultural opportunities, recreation, etc.) portfolio that can help drive employment, income and population growth.

based service industries as leisure, tourism, recreation and amusement (Green, 2001). With respect to effects amenities have on attracting population, retirees have been shown to have greater affinity for natural amenities, with resulting implications for economic activity (see Haas and Serow, 1993). Shumway and Otterstrom (2001), for instance, describe the transition in rural areas toward nature-based economic activity in the context of the "Old West" and "New West," where the former thrived on extractive industries and manual labor, whereas the latter relies on tourism and service-related jobs. The context within which amenities have been featured in economic development has, therefore, changed from one that was based on *production* to one that is based on *quality of life*.

The emerging view of amenities in economic development stresses utilizing amenities to attract people through a strong amenity-based (green infrastructure, social/cultural opportunities, recreation, etc.) portfolio that can help drive employment, income and population growth. However, relying on tourism and service-related jobs, instead of productive extractive industries, has created local tensions (English et al., 2000) in many places and begs the question: "Which is preferable from an economic development standpoint?" Extractive industries that typically pollute, but provide jobs and good wages, may not attract migrants (Rupasingha and Goetz, 2004) or senior citizens; or service-based jobs, which are reliant on tourism and are subject to cyclical unemployment trends based on seasonality (Stynes and Pigozzi, 1983). Such concerns, while important to local economies, deepen the debate about both the market and non-market values of amenities and green infrastructure to people and places. The bottom line is that amenities—natural, built and cultural—are increasingly being seen as potential economic development drivers.

A plethora of studies have responded to the evolving economic views of amenities. Evidence is mounting, and rapidly so, that the stock of natural amenities inherent in a place confers economic value to such a place. Since the seminal works of Krutilla (1967) and Rosen (1974, 1979) on natural amenity benefits and quality-of-life factors, a generation of research has flourished, with the intent to define and quantify natural amenities in order to better estimate the values conferred to people and their functions in attracting households (Graves and Linneman, 1979) and firms (Foster, 1977). Research has concentrated on amenity benefits and the tendency for people and companies to be attracted to natural amenities.[1] This includes local residents and tourists. The attraction of local residents to a strong base of amenities is obvious. As drivers of nature-based recreation, natural features also enhance tourism and promote spending by visitors that contributes to the local economy (English et al., 2000; Marcouiller et al., 2004; Dwyer et al., 2004; Lee et al., 1998; Zhou et al., 1997).[2]

1. Studies have shown that people benefit from natural resources indirectly through ecosystem services, such as crop pollination, carbon sequestration and pollution absorption, as well as directly through property values, physical health, spiritual growth and psychological well-being (De Groot et al., 2002); Millennium Ecosystem Assessment, 2003).
2. Kroeger (2008) goes even further. According to him, all uses of natural lands carry economic value, and these values need to be taken into account when considering the conversion of natural lands to other uses. Humans use natural resources directly in the form of consumptive and non-consumptive activities in which value can be estimated from market or non-market methods. Direct market extraction from the system, such as logging, mining, grazing and fishing, can be quantified using market values for goods, while ecosystem services, such as water quality and scenic beauty, must be quantified using non-market valuation techniques.

There is a huge gap in knowledge, however, between academics/scholars, and those at the local level who are increasingly inquisitive about the growing role of amenities. Despite the huge amount of existing literature, little is available in the form of comprehensive and systematic evidence on exactly how amenities impact growth. Local practitioners must decide how to leverage their natural—and other—amenities for creating a competitive advantage, and whether or not leveraging such strategies offers better levers than other well-understood economic development strategies. To provide meaningful information to practitioners, it must be made clear just how amenities impact an economy.

One of the reasons why this critical piece of information has not been made obvious to economic development and other local policy makers is the tendency of past studies to focus on the impact of amenities on specific elements of economic activity. For example, much of the existing ecosystem benefit research focused on the effects of specific ecosystem components on such things as visual appeal, locational preferences, property values and environmental health. More importantly, studies have focused on estimating amenity benefits to people and communities, without addressing the broader issue of how such amenities affect the economic performance of a place. The pathways from amenities to employment, income and population growth are important ones to illuminate through research, particularly by focusing at the local level.

From an economic perspective, the most obvious key pathway between amenities and local economic development is direct employment resulting from amenity-related industries, such as extractive industries, tourism (including eco-tourism), recreation, real estate construction and other real estate activities. Such activities are economically palpable because they directly employ people. For example, natural amenities enhance the potential for hunting, fishing and outdoor recreation activities (Shafer et al., 1993). The added employment opportunities that may be tied to the creation of recreation-related value are obvious links between amenities and economic performance. The higher incomes that can accrue to amenity-rich places, due to the industrial and employment impacts also suggests a positive relationship between amenities and economic development. Despite the expected positive direct relationship between amenity concentration and economic activity, evidence has also shown that rural places driven by amenity-based economies are often troubled with social class inequalities and lower wages, due to the nature of service jobs (Marcouiller, 1997), a slow response to economic transformation, poor accessibility, or other economic structural problems. All told, there is a gap in the literature on how amenities, green infrastructure and other factors affect local economies, as measured by changes in population, employment and income.

A Land Policy Institute report authored by Adelaja et al. (2009) took some innovative steps in an attempt to come up with a value for the economic impact of natural resources and other amenities. The study decomposed the dynamics of growth across U.S. counties in order to tease out the contributions of green infrastructure to the economic performance of places. The relationship between broad categories of developed green amenities, land amenities, water amenities, winter amenities and climate amenities, and measures of economic development were estimated, finding positive impacts on income and employment growth. In their subsequent analysis, they also found that change in population was directly related to a place's endowment of green

infrastructure. But by lumping together various categories of green infrastructure at the county level, analysis was constrained by the inability to evaluate the effects of specific elements of green infrastructure on local economies. That study was restricted by amenity data that was only available at the county-level. Moreover, the lack of natural features data impeded in-depth analysis that can potentially explain green infrastructure benefits not previously examined in the literature.

Bridging this gap in the literature, by specifically explaining the roles of a diverse set of green infrastructure assets on place performance, is the goal of this study. Specifically, this report expands the scope of natural amenities beyond those considered in previous studies, by including specific ecological variables measured at the local level. We examine a full range of amenities and natural features, and how they relate to the economic prosperity and performance of places. We also present a coherent economic modeling framework that allows the attribution of economic outcomes to specific green infrastructure elements.

Michigan is used as a case study, due to the combination of its vast natural resource base, the availability of data on specific natural features at the local level, and its recent history of lackluster economic performance. Michigan's faltering economy—despite its huge green infrastructure base— begs a number of questions, including those related to the marginal productivity of green infrastructure, factors that limit the benefits of being an asset-rich state, and which assets are relevant in building a more resilient and sustainable economy. The possibility of capitalizing on Michigan's wealth of natural assets is gaining some recognition among state policy makers. Another study conducted by the MSU Land Policy Institute found that Michigan ranked second to last in the amount of per capita funding for natural resource conservation in the U.S., while ranking near the top in its endowment of natural assets (Adelaja et al. 2007). However, the state's continuing budget woes combined with political and citizen unease regarding new taxes and spending programs make increasing natural resource funding challenging. Nonetheless, Michigan is endowed with natural splendor, and decades of research support the notion that these natural endowments are advantageous jobs and people magnets (Ullman, 1954; Krutilla, 1967; Graves, 1979; Graves, 1983; Knapp and Graves, 1989; Deller et al., 2001; McGranahan, 2008). Why has Michigan not been able to leverage its endowment of natural amenities more effectively? What factors are limiting Michigan's potential to emerge in the Green Economy and sustainably benefit from its endowment of natural amenities? Answering these questions is beyond the scope of this project, but it begins to lay the groundwork for future research in this area.

Michigan's economy has struggled since the early 2000s, evidenced by periods of population and job loss combined with an increasing unemployment rate. The latest national recession made matters worse. At 9.8% (November 2011), unemployment was the tenth-highest of any state.[3,4] The near collapse of the domestic automobile industry had politicians and other leaders scrambling to find solutions on how to diversify and correct Michigan's current economic predicament. It is evident that the state needs a diversified strategy, and many expect that this strategy will be tied to the long-term sustainability of its natural features. In the next chapter, we explore the literature in order to reveal evidence that green infrastructure enhancement can contribute to economic development.

3.U.S. Bureau of Labor Statistics: http://www.bls.gov/web/laus/laumstrk.htm.
4.Michigan's unemployment rate has been declining rapidly since peaking at 14.1% in Aug./Sept. 2009.

Part 2: Literature Review

AS THE NEW ECONOMY SLOWLY REPLACES TRADITIONAL ECONOMIC FRAMEWORKS AND BEGINS TO UNSEAT LONG HELD PARADIGMS, CLEAR PATHWAYS MUST BE EXPLORED ON HOW GREEN INFRASTRUCTURE AND AMENITIES IMPACT THE ECONOMY. HOW PRODUCTIVE ARE GREEN PLACES? WHICH COMPONENTS OF GREEN INFRASTRUCTURE DRIVE POPULATION, INCOME AND EMPLOYMENT GROWTH? WHAT ARE THE LOCAL IMPACTS OF VARIOUS NATURAL AMENITIES TO LOCAL ECONOMIES?

In this section, we explore further the various studies that have addressed the role of amenities in economic development, place performance and prosperity. We begin with studies that explain the changing nature of amenities, followed by studies that are definitional in the sense that they help explain the nature of amenities, in general, and natural amenities, in particular. This is followed by a review of methodological approaches and the impacts of amenities on people and firms. It further highlights recent amenity research, and concludes with a summary of what we see as emerging issues in this research space.

2.1 Understanding the Changing Roles of Amenities

Historically, economic development was seen by economists as driven by a set of traditional factors: labor supply, low wages, low taxes, access to materials, etc. Workers primarily followed job opportunities, with location and location attributes playing a more minor role. The Upper Midwest, including states in the Great Lakes Region, particularly Michigan, are examples of places whose economies thrived, based on the pecuniary benefits they offered as anchors of economic activity.

Recently, there is growing evidence that amenities are playing an increasing role in the economic development equation (Knapp and Graves, 1989; Gottlieb, 1995; Green, 2001; Deller et al., 2001). Empirical evidence suggests that natural amenities affect regional economies through measures of economic performance, such as population, income, employment and/or housing development (Kwang-Koo et al., 2005), and are becoming increasingly relevant in shaping regional economic growth (McGranahan, 1999; Deller et al., 2001; Dissart, 2007). Green infrastructure is also argued to be relevant in shaping the pattern of urban economic growth (Clark, 2003b; Florida, 2002a, Brueckner et al., 1999), attracting human capital and creating talent clusters (Lucas, 2002; Rousseau and Wachtel, 1998). Besides Clark and Hunter (1992), not much direct evidence has been presented specifically on how broader economic impacts occur as a result of various amenities.

2.2 Understanding the Characteristics of Amenities

A key study that provides typological information on amenities was conducted by Power (1996), who defined amenities as non-marketed immobile qualities of a locality that make it an attractive place to live and work by providing benefits to people through the direct consumption of specific aspects of land, natural resources and human activity (OECD, 1994). Green (2001) takes this further by identifying several important amenity characteristics, which include:

- Non-fungibility (use is restricted to a particular place),
- Irreversibility (value cannot be restored once it has been destroyed),
- High income elasticity (cost of living may be very high), and
- Non-substitutable (they are unique).

So, most amenities are fixed, although several natural amenities can be enhanced through the development of complementary green infrastructure or other recreation-based activities. For example, it has been estimated that the annual economic and environmental benefits of biodiversity in the U.S. total approximately $300 billion (Pimental et al., 1997). The U.S. spends approximately $29 billion per year on fishing, and $12 billion per year on hunting (USBC, 1995). Non-consumptive recreation, such as bird watching, going to the beach and kayaking, contributes approximately $18 billion per year in the U.S. (USDI, 1991). Wild foods, including seafood, contribute an estimated $3 billion per year to the U.S. economy (USBC, 1995; Pimental et al., 1997). Nature based tourism, which is dependent on an area's unique set of natural resources, has been experiencing rapid growth world-wide (Fuller et al., 2005). These benefits are realized, as long as there are natural or built amenities (i.e., green infrastructure) in location-specific places to accommodate such activities. Across the United States, communities are eager to be convinced that green infrastructure enhancement can, in fact, be a potent economic development strategy.[4]

Most amenities are fixed, although several natural amenities can be enhanced through the development of complementary green infrastructure or other recreation-based activities.

2.3 Understanding the Role of Amenities on Income and Employment Growth

Researchers have attempted to quantify the relationships between natural amenities and changes in income and employment. Most have found a significant positive relationship. In a widely cited study, Deller et al. (2001) conducted an analysis of 2,243 non-metropolitan U.S. counties. They used five broad-based indices of amenity and quality-of-life attributes: 1) climate, 2) land, 3) water, 4) winter recreation and 5) developed recreational infrastructure. The results of the study demonstrated that rural areas endowed with high levels of natural resource amenities and overall quality of life experienced higher overall levels of economic growth than areas with low levels of amenities. Each of the five amenity classes included in the models was positively correlated to at least one measure of growth (population, employment and income). None were negatively related to any of the measures of growth.

4.A number of cities and other communities have embarked on programs that seek to leverage green infrastructure as a key economic development policy. For example, the West Michigan Strategic Alliance Green Infrastructure Program has targeted the promotion and preservation of open space and water recharge capacity, parks, agriculture and walkable communities, as a key economic development tool and strategy. Many cities in the United States are investing in parks, waterfronts and other "green" programs (Philadelphia (PA), Chicago (IL), Portland (OR) and Boston (MA)). Organizers and activists in Detroit are exploring and implementing urban agriculture programs to improve food access, revitalize communities and get citizens involved. With a high density and very little existing green infrastructure, New York City has recently branded itself as a green city (New York City Economic Development Corp., 2010), and evidence is mounting that this strategy has resulted in increased economic activity.

Lewis et al. (2002) found that a 10% increase in public lands in seven Upper Midwest and Eastern U.S. states yielded a 1% increase in the employment growth rate. Lorah and Southwick (2003) found that rural counties in the western U.S. with protected lands grew 11.5 times faster in terms of population, 5.7 times faster in terms of employment growth and 2.75 times faster than rural counties without protected lands. Similarly, Holmes and Hecox (2004) found a significant positive correlation between wilderness areas in rural counties of the American West and growth in population, income and employment between 1970 and 2000. Lastly, Kwang-Koo et al. (2005) found that lake-related amenities in the Upper Midwest had a significant positive association with growth in the retail and service industry.

2.4 Understanding the Role of Amenities in Firm Growth and Business Attraction

Less is known about the relationship between firm location choice and amenities than household migration from an economic development standpoint, because amenities have predominantly been thought to attract residents (Gottlieb, 1995). Yet, some studies have gained insights into what firms look for when they make location decisions. A survey of firm leaders found that many desired to relocate in U.S. states in the Pacific and Sunbelt regions, illustrating that firm location choices were influenced by quality-of-life factors, such as safety, school quality and a scenic environment (Foster, 1977). Johnson and Rasker (1995) conducted a survey of 500 business owners and managers in the northern portion of the Greater Yellowstone Region to determine which variables influence business location decisions. They found that the highest ranking factor was scenic beauty, followed by quality environment, good place to raise a family, desire to live in rural setting, small town atmosphere and various other amenities related to recreation.

Similarly, Gottlieb (1994) found that there is wide agreement in the literature that groups of technical professionals can only be sustained in areas with a high quality of life and an array of amenities that appeal to a managerial elite. The same study reported amenity rankings for all firms and, more specifically, high-tech firms (Dorfman et al., 2008) across several studies that surveyed businesses making a regional location decision. Out of a total of 12 amenities, environmental quality ranked first among high-tech firms and third among all firms as drivers for location decisions. However, Gottlieb (1995) found that firms may be trying harder to avoid dis-amenities (pollution, hazardous sites) rather than simply agglomerating in amenity-rich areas. Former economic development strategies did indeed focus on attracting firms, with the belief that industry and businesses would attract population and income. More recently, however,

natural amenities have been found to drive population, which in turn has also attracted jobs and fueled income growth.

2.5 Understanding the Role of Amenities in General Population Growth

The many studies that focused on the population and migration dynamics in the western U.S. all found a correlation between various natural amenities and population growth (McGranahan, 1999; Deller et al., 2001; Shumway and Davis, 1996; Rudzitis, 1999; Vias, 1999). Rudzitis (1993) found that federally designated wilderness areas had population increases three times greater than other non-metropolitan counties in the 1960s; and in the 1980s their population increased six times the national average. Likewise, the findings of Rasker and Hansen (2000) suggested that population growth in the Greater Yellowstone area was associated with mountainous areas, extensive forests and access to protected lands. In addition, research by Nelson (1999) found that areas in the West, with high levels of natural amenities, enjoyed growing populations and income levels during the 1990s, and that much of that growth came from people with income from self-employment or investments. Additionally, Vias (1999) found that population in the Rocky Mountain West increased in areas with a high percentage of federally owned lands and high topographic variation.

Other areas in the U.S. experienced similar trends. High population increases in the 1990s occurred in counties in the Southeast having a high percentage of forested land and recreational opportunities (Nzaku and Bukenya, 2005). Other areas in the U.S. showing similar patterns include the Upper Midwest. Results by Gustafson et al. (2005) showed that environmental characteristics have some degree of influence on the spatial distribution of population and housing change in the Midwest. Variables that positively correlated with increased population and/or housing density included topographic relief, shoreline density, percent of forest, percent of wetland, ratio of forest to agriculture, degree of fragmentation, percent of forest in public ownership and percent of land in reserved status (Gustafson et al., 2005). Marcouiller et al. (1996) found that second-home homeowners were attracted to local amenities, and had positive economic impact on the local economy in Forest County, WI, which is located in the Upper Great Lakes Region.

Agricultural and manufacturing industries have exited many rural places in the past few decades, forcing such places to consider how to diversify or rebuild their economies. Tourism focused on natural amenities has been one way to do so. The debate on whether or not tourism has improved income and employment in communities relying on recreation-based tourism has been obscured by methods focusing on aggregate economic growth and not specific development indicators (Marcouiller et al., 2004). English et al. (2000) corroborate findings of Beale and Johnson (1998) by finding that counties relying on tourism have grown faster than other rural counties. Furthermore, these high-growth tourism counties are typically endowed with such amenities as beaches, lakes, forests and mountains. They also note that when these amenities are owned by public agencies, tourism is an ever-more important component of the economy. Due to the limitations of aggregate studies (Marcouiller et al., 2004), and the unknown overall impacts of tourism on employment and economic implications (Blakely

and Bradshaw, 2002), more must be understood about how local indicators affect tourism, which in turn affects overall economic growth. From an economic development perspective, Blakely and Bradshaw (2002) are quick to warn that tourism and retirement populations alone cannot totally revive rural economies, which is significant, since some places have made attracting retirees or other age groups part of an overall economic development strategy (Duncombe et al., 2000; Serow, 2003; Bennett, 1996), even if local government expenditures—particularly healthcare related— increase as a result (Glasgow, 1990). Next, we examine studies of the impacts of amenities on specific segments of the population.

2.5.1 Understanding the Relationship between Amenities and Retirees

Amenities have been shown to influence age-specific migration (Graves, 1980; Clark and Hunter, 1992; Clark et al., 1996; Judson et al., 1999; Johnson et al., 2005). Retiree and elderly migrations have been studied quite extensively. Haas and Serow (1993) found that retirees were mostly influenced by climate and scenic beauty, and were also more apt to move to places they had visited previously as tourists. Poudyal et al. (2008) showed that the percentage of forest land, as well as the presence of national parks, state parks and local parks all had a positive effect on retiree growth. Likewise, Haigood and Crompton (1998) conducted a survey of retirees in the Texas Lower Rio Grande Valley and found that recreational opportunities greatly influenced their decision to move. Attracting retirees has also become an economic development strategy, because the elderly and retiree age groups typically have higher incomes, high property wealth and demand fewer costly public services (Duncombe et al., 2000) compared to families with children (Shields et al., 2001). Overall, since around 1950, counties exhibiting high levels of recreational amenities have succeeded in attracting retirees, whereas metropolitan counties have succeeded in attracting younger residents. Those same metropolitan areas simultaneously lost population of other age groups (Johnson et al., 2005).

2.5.2 Understanding the Relationship between Amenities and Youth

Young workers are typically attracted to high-wage urban or metropolitan areas, whereas retirees—who are not as concerned with wages—are generally more focused on settling in places with higher levels of amenities than wages (Judson et al., 1999). Economic development interests have been focused on attracting young migrants and job seekers, usually through the provision of amenities, recreational opportunities, entertainment and other quality-of-life factors (Nelson, 1999). The *Rise of the Creative Class* (Florida, 2002a) symbolizes this importance. From 1970 to 1990, the percentage of college-educated couples that live in cities increased from 39% to 50%, which further emphasizes the importance of cultural and recreational opportunities in cities (Costa and Kahn, 2000).

However, Clark and Hunter (1992) and Kodrzycki (2001) generally observed that amenities have had less of an effect than labor market conditions on attracting the young. Similarly, Niedomysl and Hansen (2010) found that highly educated migrants were more likely to move based on jobs, rather than amenities. Thus, there appears to be a more tenuous association between amenities and youth migration than there is with employment opportunities.

2.6 Other Amenity Research

Since amenities represent key elements that define places, we expect that their role will depend upon the context within which they exist. Amenities affect economic activity in both urban (Florida, 2002b; Clark, 2003a) and rural areas (McGranahan and Beale, 2002; Hunter et al., 2005). Since the creative class has been identified as being a potent economic driver in metropolitan areas, targeting them by appealing to their desire for social and cultural amenities has been part of some economic development strategies. McGranahan and Wojan (2007) suggest that the creative class, which Florida (2002b) showed to typically have greater impacts on metropolitan economies, can now also cluster in rural locations, due to more effective and cheaper infrastructure for telecommunications (Beyers and Lindahl, 1996; Marcoullier et al., 2004), greater locational flexibility of employers and households (Cromartie, 1998) and better access to outdoor recreation, natural amenities and quality of life (Goe, 2002; McGranahan,1999; Deller et al., 2001). Such findings support the position that rural places endowed with amenities need not rely on extractive industries to support their economies or economic development initiatives.

There is variation in the literature on the impacts of amenities on economic growth, which can be explained by how they are organized. Earlier studies focused on rather broad categories of natural assets, such as climate (Graves, 1980), temperature (Mueser and Graves, 1990) and view or lakefront location (Benson et al., 1998). Moving forward, studies started to incorporate more detailed, but still broad categories, such as land, water, developed recreation, climate, land ownership (Cromartie, 1998, Deller et al., 2001, Holmes and Hecox, 2004, Lewis et al., 2002, Lorah and Southwick., 2003, Vias, 1999), and even socio-economic and diversity factors, and attitudes (Clark, 2003a). More recently, researchers have started to include and combine even more detailed variables, such as forests, wetlands, shoreline density, wilderness designation, topographic relief, lakes, streams and trails (Kwang-Koo et al., 2005, Gustafson, 2005). Some of the variation in results can also be explained by the different locations of the studies.

Hedonic pricing-based research continues to show the property enhancement value of various natural amenities (Benson et al., 1998; Diamond, Jr., 1980; Irwin, 2002; Sengupta and Osgood, 2003; White and Leefers, 2007), which translate into economic value. Natural features have also been shown to enhance municipal tax revenues (Fuller et al., 2005). Another pathway is the enhancement of quality of life. For example, wetlands have been shown to contribute to air and water quality, and enhance health and livability of a place (Brander et al. (2006); the higher the quality of life in an area, the greater the attraction of that area not only to people, but to economic activity. The literature supports the notion that migration and

population change are significantly influenced by natural amenities (McGranahan, 1999; Rasker and Hansen, 2000, among others). High-quality places enhance property values, by increasing the demand for property, vis-à-vis supply. High-quality places should also attract higher income people, translating into greater economic activity.

2.7 Issues to Consider in Implementing a Comprehensive Amenities Influence Study

The first issue that is important to consider in amenities influence modeling is the issue of scale and unit of measurement. Several researchers have pointed out that one of the problems with using metropolitan-level data is that some amenities are meaningless when averaged over a territory that is too large—either because they are not totally accessible from the entire area, or because such averages eliminate underlying variation (Gottlieb, 1994). They suggest that future research use municipal or census tract data rather than county level data (Gottlieb, 1994; Gustafson et al., 2005). Kwang-Koo et al. (2005) suggests that future research should identify and develop region-specific amenity measures that reflect unique regional competitive advantages, rather than simply accepting that all amenities can drive economic growth in every place. This is particularly relevant in this study of Michigan, where the amenity mix is unique and highly documented by the Land Policy Institute and the Michigan Natural Features Inventory.

Another issue relates to methodology. Kwang-Koo et al. (2005) points out that systematic and scientific measurement methods with stronger theoretical foundations would enhance our understanding of the economic effects of natural amenities. For example, if location in space (place) matters, future natural amenity econometric models need to move beyond just the presence, size or amount of natural amenities and incorporate spatial distribution, patterns and proximity (Kwang-Koo et al., 2005). Additionally, future research should address the impacts of amenity-driven economic development strategies on the amenities themselves. Unchecked, this type of development could lead to increased sprawling development patterns, which, in turn, could have a large negative impact on wildlife habitat, water and air quality, rare species populations and intact landscapes (Paskus and Hyde, 2006; Green, 2001).

Another important issue is the need to utilize a modeling approach that allows the comparison of the relevant roles of alternative amenities. Adelaja et al. (2009) take a unique approach in that they decompose growth elements into a variety of factors, including natural assets. Results from the population model show that at a larger scale (county level) amenities do have a significant impact on economic growth. This provides rationale that amenities have value to people and, therefore, can influence the growth of a community. This focus on estimating relative impacts of natural asset variables, vis-à-vis other factors, suggests the need to weigh the contributions of natural assets in order to determine whether it is a more relevant strategy than other strategies. In other words, the study begs the question: "Do natural assets provide opportunities to grow the economy by further enhancing those natural assets?" A related question is: "Which natural assets will work well in spurring economic activity and in what locations?"

Yet, another important issue is being able to tease out the relative role of amenities in influencing the components of economic development. Some amenities might attract population without increasing income and employment (e.g., government programs designed to cater to the needs of unemployed low income people). Some might attract income and employment, without affecting population (e.g., a built-out coastal community where certain amenities lead to gentrification). Some might increase employment, but lower per capita income by attracting more low-income people into the community (e.g., when an amusement park moves to town that offers service jobs). This issue becomes directly apparent from the Adelaja et al. (2009) study.

There is no shortage of natural amenity and green infrastructure research, and some of the pieces of the puzzle are in place. Indeed, most studies have found positive relationships between the presence of natural amenities and such things as population change and economic growth. The literature is beginning to find that amenities are important for increasing employment and income growth as well. Historically, people chased jobs. But the New Economy has created a scenario where people move to places with high endowments of amenities, and jobs follow (Vias, 1999).

Most studies have found positive relationships between the presence of natural amenities and such things as population change and economic growth.

As the New Economy slowly replaces traditional economic frameworks and begins to unseat long held paradigms, clear pathways must be explored on how green infrastructure and amenities impact the economy. Do natural amenities provide a competitive advantage to communities in Michigan? Which components of green infrastructure drive population, income and employment growth? What are the measurable impacts of specific natural amenities to local economies, which have never been studied at such a scale before? This report seeks to answer these questions.

Part 3: Theory and Empirical Framework

INCREASINGLY, THE LITERATURE RELATED TO THE NEW ECONOMY SUGGESTS THAT HIGH-VALUE COMPANIES FOLLOW KNOWLEDGE WORKERS, WHO THEMSELVES ARE INCREASINGLY RESPONSIVE TO AMENITY ASSETS OF LOCATIONS. THEREFORE, WE EXPECT THAT POPULATION DYNAMICS WILL HAVE AN IMPACT ON FIRM LOCATION CHOICES, WITH EMPLOYMENT AND INCOME OPPORTUNITIES ENDOGENOUS TO POPULATION, ESPECIALLY KNOWLEDGE WORKERS. THE LOCATION CHOICE THEORY ILLUSTRATES THE FRAMEWORK OF *WHY* PEOPLE MOVE. THE EMPIRICAL FRAMEWORK IN THIS SECTION ILLUSTRATES MORE FULLY WHAT AFFECTS POPULATION, INCOME AND EMPLOYMENT CHANGES AND, MORE IMPORTANTLY, TO WHAT EFFECT.

In this section, we introduce the empirical framework to guide the development of our modeling efforts. The location choice theoretical framework, which shows how households choose communities based on a utility maximizing behavior that incorporates preferences for quality of life, including amenities, is explored in more details in the Appendices. Increasingly, the literature related to the New Economy suggests that high-value companies follow knowledge workers (Florida, 2002a and 2002b), who themselves are increasingly responsive to amenity assets of locations (Clark, 2003b; Deller et al., 2008). Therefore, we expect that population dynamics will have an impact on firm location choices, with employment and income opportunities endogenous to population, especially knowledge workers. The location choice theory illustrates the framework of why people move. The empirical framework in this section illustrates more fully what affects population, income and employment changes and, more importantly, to what effect.

3.1 Place Amenities and Place Performance

How individuals (who seek jobs and generate personal income) and employers (who provide jobs, generate place income and provide personal income) make the decisions about where they locate has been illustrated in the context of amenities. In short, economic activity and people are attracted to amenities. How local economies are affected by amenities is determined, therefore, by the relative attractiveness of a place, vis-à-vis others, and the net job implications (supply and demand for jobs). The net effects on a place, therefore, accrue from the net local effects of differentials in amenities and other factors of employment, income and population. That is, whether or not amenities drive increased economic activity is really a function of the degree to which amenities create job opportunities that exceed employee attraction.

To illustrate this point, consider the case where a place offers superior amenities, vis-à-vis others. The economic outcome of such superiority can manifest itself in the form of employment growth, income growth and population growth, all of which are interrelated. For example, if amenity differentials attract new entrants, without an increase in employment, it can depress place income by increasing labor supply, vis-à-vis job demand, possibly leading to a reduction in per capita income. Similarly, a place that is attractive as a destination point for firms without adequate labor supply can result in increased wages or per-capita income, without improving employment

opportunities. To evaluate how place economies are affected by amenities, a framework that allows the observation of impacts on all three key elements of place performance is needed.

3.2 Empirical Framework

For this study, we utilize the empirical framework used by Adelaja et al. (2009) and Deller et al. (2001) to decompose place growth into its components. We particularly focus on the role of natural amenities, including green infrastructure and natural features. For a comprehensive discussion of this methodology, see the Adelaja et al. (2009) study. The empirical model employed for this study is as follows.

3.3 Hypothesized Sources of Growth

The categories of variables that have been theorized to impact growth include:

1. Initial Conditions and the Cost Associated with Structural Legacy;
2. Existing Gray Infrastructure Assets and Subsequent Investments;
3. Industrial Structure, including the Contributions of Key Industries;
4. Local Public Finance
5. Local Governance and Political Structure;
6. Accumulation of Human Capital (including knowledge and creative capital, as well as knowledge infrastructure, such as universities);
7. Information Technology and Communications Technology Infrastructure (such as broadband);
8. Cultural Assets;
9. Social and Ethnic Diversity Related Assets;
10. Green Infrastructure (natural amenities); and
11. Others (such as demographic, housing market, socio-economic and educational factors).

Unfortunately, data on many of these indicators are not often readily available, particularly at the local level, making a complete analysis at a large scale difficult. However, the influence pattern of many of the variables for which data are not available tends to be at a larger scale than the scale of reference in this report, which is the Minor Civil Division (MCD) level (city, township or village). For this research, we attempt to collect as much data on these drivers as possible, at the MCD level, in order to conduct growth analysis at the level at which many natural amenities are actually managed. Section 3.5 describes the data utilized in the following analysis.

3.4 Methodology

This section presents the regional economic growth model developed to estimate the relative contributions of alternative growth drivers and details about the nature, definition, sources and descriptive statistics related to the data utilized in this study.

A local growth modeling approach is utilized in this study to decompose the growth of communities in Michigan. Following previous work by Carlino and Mills (1987), Deller et al. (2001) and Adelaja et al. (2009), targeted growth measures are defined as population, employment and per capita income changes over time. The justification for including population growth is that people seek prosperous places and are, thus, attracted to those places. We further hypothesize that places that attract population also have a strong likelihood to attract jobs, and perhaps income (Adelaja et al., 2009, based on a previous

growth interdependence finding). Places that grow jobs are also likely to attract population, which in the context of the current economy also have a strong likelihood of translating into growth in income. This is the rationale for including population and employment as markers of growth or prosperity. Places that grow per capita income are naturally likely to be places that feature vibrant communities and job markets. They are, therefore, more likely to grow employment and population. Using the three interdependent indicators of growth (place performance), i.e., population, employment and income growth, as endogenous markers for growth and prosperity is, therefore, the ideal empirical approach.[5] One would expect that any strategy that affects one marker will likely affect other markers as well.

Growth in employment, holding other factors constant, translates into improved economic performance or "prosperity." Similarly, improved per capita income, holding other factors constant, is tantamount to prosperity. With respect to population, population growth in the absence of employment or income growth is not necessarily synonymous with prosperity. New entrants will increase labor supply and decrease the level of employment, unless new jobs are created or the new entrants generate so much more economic activity that the economy expands. More often than not, the movement of population into a place signifies, to some extent, a gap in prosperity between places. From this perspective, population growth is an equilibrating factor and movement to a destination implies greater prosperity at that destination. The challenge in this analysis is to explain how jobs, incomes and population are enhanced by factors that help explain economic prosperity, including amenities and green infrastructure.

Not only are population, income and employment interdependent, a series of other factors also impact their growth. Such things as property values, local taxes, job opportunities, poverty and crime rates, etc., may affect the degree of population change. Infrastructure development, availability of local talent, structure of the economy, financial markets, etc., may impact job growth. Similar issues may also impact income growth. Based on this premise, a general economic growth model is specified as follows:

$$
\begin{aligned}
Y^* &= f(E^*, P^*, \Omega^Y) \\
E^* &= f(Y^*, P^*, \Omega^E) \\
P^* &= f(Y^*, E^*, \Omega^P)
\end{aligned}
\tag{1}
$$

where Y^*, E^*, P^* are equilibrium levels of income, employment and population in a given place (such as a county), respectively. Ω^P, Ω^E and Ω^Y are exogenous variables that affect growth patterns, including social/cultural (SC) and green infrastructure (GI) assets. The latter includes such things as basic land (BL), basic water (BW), developed land and water assets (DLWA), and negative land and water assets (NLWA). What constitutes these assets is described more fully in section 3.5.1.2 of this report.

Past performance of a place is likely to affect future population, employment and income growth. Future growth performance is often predicated on past success. Hence, population and employment are likely to adjust to their equilibrium values based on their past values (or lag values) (Mills and Price, 1984). Likewise, income is assumed to adjust to its equilibrium value, with substantial lags. The distributed lag adjustment equations can be specified as follows:

5.Endogenous variables are those that are explained within the model in which they appear by other variables in the model. Exogenous variables are independent from other variables in the model. They are determined by factors outside of the model under study.

(2)
$$Y_t = Y_{t-1} + \lambda_y (Y^* - Y_{t-1})$$
$$E_t = E_{t-1} + \lambda_e (E^* - E_{t-1})$$
$$P_t = P_{t-1} + \lambda_p (P^* - P_{t-1})$$

where λ_y, λ_p and λ_e are coefficients for the speed-of-adjustment and take values between zero and one, and *t*–1 is one period time lag. The speed-of-adjustment value measures how fast growth happens between the previous period and the current period.

The current levels of population, employment and income can be expressed as functions of their initial level values and changes between two time periods. Using Δ to indicate the changes in each variable, Equation 3 is specified as follows:

(3)
$$\Delta Y = \lambda_y (Y^* - Y_{t-1})$$
$$\Delta E = \lambda_e (E^* - E_{t-1})$$
$$\Delta P = \lambda_p (P^* - P_{t-1})$$

In Equation 3, the equilibrium levels of population, employment and income are unobservable, while their current levels are observable. However, one does not need to directly observe the equilibrium levels for a particular place in order to estimate the equation. Using Equations 2 and 3, and assuming a linear function for each growth marker, Y^*, E^* and P^* can be substituted into their expression in Equation 3, and taking into consideration the relationship in Equation 2 and Equation 4. The result can be written as:

(4)
$$\Delta Y = \lambda_Y . f_y \{(E_{t-1} + \lambda_E \Delta E) + (P_{t-1} + \lambda_P \Delta P)\} - \lambda_Y Y_{t-1} + \sum_{i=5}^{k} \beta_i \Omega_{Y_i}^{SC} + \sum_{i=k+1}^{n} \beta_i \Omega_{Y_i}^{GI} + \sum_{i=n+1}^{m} \beta_i \Omega^{Y} + \varepsilon_i$$
$$\Delta E = \lambda_E . f_e \{(Y_{t-1} + \lambda_Y \Delta Y) + (P_{t-1} + \lambda_P \Delta P)\} - \lambda_E E_{t-1} + \sum_{i=5}^{k} \alpha_i \Omega_{E_i}^{SC} + \sum_{i=k+1}^{n} \alpha_i \Omega_{E_i}^{GI} + \sum_{i=n+1}^{m} \alpha_i \Omega^{E} + \varphi_i$$
$$\Delta P = \lambda_P . f_p \{(Y_{t-1} + \lambda_Y \Delta Y) + (E_{t-1} + \lambda_E \Delta E)\} - \lambda_p P_{t-1} + \sum_{i=5}^{k} \gamma_i \Omega_{P_i}^{SC} + \sum_{i=k+1}^{n} \gamma_i \Omega_{P_i}^{GI} + \sum_{i=n+1}^{m} \gamma_i \Omega^{P} + \psi_i$$

where $\Omega_{Y,}^{SC}$ Ω_{Y}^{GI}, Ω_{E}^{SC}, Ω_{E}^{GI}, Ω_{P}^{SC}, Ω_{P}^{GI} are exogenous social/cultural and green infrastructure variables in the population, employment and income equations. Ω^P, Ω^E and Ω^I are other exogenous variables that affect the changes in population, employment and income, and $\varepsilon_i, \phi_i, \psi_i$ are the error terms (i.e., error associated with estimating each equation). Following Deller et al. (2001), the speed-of-adjustment coefficients λ_i are embedded in the linear coefficient parameters of α, β and γ. The coefficients of the model, therefore, capture the dynamic elements of adjustment, allowing us to use the coefficients as implying causality. The linear version of the local growth decomposition econometric model is specified as follows:

(5)
$$\Delta Y = \beta_0 + \beta_1 E_{t-1} + \beta_2 P_{t-1} + \beta_3 \Delta E + \beta_4 \Delta P + \sum_{i=5}^{k} \beta_i \Omega_{Y_i}^{SC} + \sum_{i=k+1}^{n} \beta_i \Omega_{Y_i}^{GI} + \sum_{i=n+1}^{m} \beta_i \Omega^{Y} + \varepsilon_i$$
$$\Delta E = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 P_{t-1} + \alpha_3 \Delta Y + \alpha_4 \Delta P + \sum_{i=5}^{k} \alpha_i \Omega_{E_i}^{SC} + \sum_{i=k+1}^{n} \alpha_i \Omega_{E_i}^{GI} + \sum_{i=n+1}^{m} \alpha_i \Omega^{E} + \varphi_i$$
$$\Delta P = \gamma_0 + \gamma_1 Y_{t-1} + \gamma_2 E_{t-1} + \gamma_3 \Delta Y + \gamma_4 \Delta E + \sum_{i=5}^{k} \gamma_i \Omega_{P_i}^{SC} + \sum_{i=k+1}^{n} \gamma_i \Omega_{P_i}^{GI} + \sum_{i=n+1}^{m} \gamma_i \Omega^{P} + \psi_i$$

The relationship between income, employment and population changes for a place is modeled in Equation 5. It explains the relationships between determinants of growth and growth in the three growth indicators. Section 4.3 discusses the specific categories of variables utilized in this analysis. Due to the high correlation between population and population density, contrary to theoretical model specification, we used population density instead of population in the second stage of the estimations. Population of the base year, 1990, was included in the first stage of the population and income estimations, but was excluded from the first stage of the employment estimation, due to a high correlation.

3.5 Data Infrastructure, Measurement and Descriptive Statistics

3.5.1 Data Infrastructure

To evaluate the influence of specific quality-of-life and amenity attributes on population, income and employment levels, a large and in-depth collection of data was necessary. Economic data are easily obtainable at the MCD level. In many states, however, detailed data on natural amenity and social/cultural variables are difficult to obtain as they are not widely collected, making the estimation of their impact on economic growth difficult. This is particularly so at a national level and helps explain why the type of detailed analysis pursued in this study is not often performed. This study is unique in this respect.

3.5.1.1 Data Integration

Data for this study is generated from various sources, including the U.S. Census Bureau, U.S. Bureau of Labor and Statistics, the Michigan Center for Geographic Information, the U.S. Geological Survey and others. When necessary, spatial data was processed from its original form, which covered Michigan or the country as a whole, and measured within Michigan communities. The data used in the study is a time series for the years 1990 and 2000, with the lion-share of the data relating to various factors within the community in 1990, and data representing shifting population, employment, and income trends from 1990 to 2000. When creating a dataset for this analysis, ensuring that it is cross-comparable through time and at different geographies is necessary, as there are various changes in townships and cities from 1990 to 2000 within Michigan. Differences in MCD coding by data source are also accounted for. This normalized data is used within the study.

3.5.1.2 Variable and Data Definition and Sources

Building upon previous work on New Economy growth (Adelaja et al., 2009) and identification of Michigan's critical assets (Adelaja et al., 2010), and on the availability of unique natural features data at the MCD level for Michigan from the MNFI, more than 70 variables that may contribute to population movement, income level changes and shifts in levels of employment have been compiled and categorized. For a complete list of all variables utilized in estimating the changes in population, income or employment, please see Appendix 1, which provides the definition and sources of data utilized in this study. The data are organized in separate categories for simplicity.

1. *Predicted Endogenous Variables*: Data in this category include changes in population, employment and per capita income. Collectively, they measure the economic performance of an MCD. Employment refers to the number of people employed in an MCD. It does not refer to *where* they work. Per capita income is *per person* income and is not a measure of household earnings.

2. *Initial Condition Variables*: Data in this category include 1990 values of population, employment and per capita income. Growth of a community partly depends on initial levels of these identified indicators.

3. *Demographic Variables:* Data in this category include 1990 levels of population per square mile, the percentage of 25- to 34-year-olds and retiree population, the percentage of foreign born, the percentage of working class and the percentage of the population living in poverty in 1990. Such data are included to control for and measure their impact on growth.

4. *Housing Market Variables*: Data in this category include 1990 values of the percentage of owner-occupied and median home value of owner-occupied homes. Including these variables permit exploration of the relationship between the housing market and economic performance.

5. *Education Variables:* Data in this category include 1990 values of the number of college, university and other higher education institution employees (using a gravity model), the percentage of the population with an associate's degree, bachelor's degree and graduate or professional degree. Including these variables helps to understand the role of education in economic performance.

6. *Gray Infrastructure-Related Variables*: Data in this category include 1990 values of rural interstate road density, rural freeway road density, urban interstate road density and urban freeway road density. These are used to estimate the extent to which the gray infrastructure assets contribute to growth.

7. *Economic Structure Variables*: Variables in this category include 1990 levels of the percentage of total employment in manufacturing, farming, services and finance sectors. These variables represent the degree of transition to the New Economy and resulting economic performance.

8. *Other New Economy Asset Variables*: Data in this category include 1990 values of the percentage of employment in the creative class and a racial diversity index. These New Economy variables are included to test their effect on growth performance.

9. *Social and Cultural Variables*: Data in this category include the distance to an urban center; the number of eating and drinking places per capita; the number of arboreta, botanical and zoological businesses; dance studios, schools and halls; theatrical producer businesses; bands, orchestras, actors and other entertainment/entertainers; bowling center businesses; sports clubs and promoter businesses; racing tracks and racetrack businesses; physical fitness businesses; coin-operated amusement businesses; amusement park businesses;

membership sports and recreation clubs; other recreation businesses; and public golf courses in each MCD. Social and cultural assets are the things that offer access to richness of experience, culture, entertainment and recreation.

10. *Green Infrastructure Variables*: Data in this category capture different elements of green infrastructure assets. They are divided into basic land, ecological land, basic water, ecological water, developed land and water assets and negative land and water assets sub-categories.

    - *Basic Land*: Variables in this category include the percentage of land in agricultural acreage; forested land; sand, rock and clayey acreage; and shrub land acreage in each MCD, square meters of public land and square meters of private land.

    - *Ecological Land*: Variables in this category include the presence of important bird habitat, the percentage of the MCD consisting of natural vegetation core areas and the percentage of the MCD consisting of potentially high-quality patches of natural habitat.

    - *Basic Water*: Variables in this category include the percentage of acreage consisting of inland lakes, miles of river, miles of great lakes shoreline and miles of inland lake shoreline in the MCD.

    - *Ecological Water*: Variables in this category include the percentage of wetland acreage, the presence of a trout stream, the number of high-quality lakes, miles of no impact or reference streams and the percentage of the watershed that is also a functional sub-watershed in the MCD.

    - *Developed Land and Water Assets*: Variables in this category include the number of state forest campgrounds, the number of fish stocking sites, the amount of developed inland lake frontage, the number of boat launches, the number of marina businesses, the number of mines and the number of dams in each MCD.

    - *Negative Land and Water Assets*: Variables in this category include the presence of a state environmental area, the presence of a Part 201 Contaminated Site, the number of national pollutant discharge elimination system (NPDES) sites, and a count of all other pollution sites.

In addition, the capacity to drive growth in the New Economy is tied to the ability to leverage knowledge, creativity and skills. The difference in productivity of people as it relates to prosperity has to do with what mindset they start with, and how their creativity can be harnessed as a driver of growth. Richard Florida's work on the creative class shows that certain groups drive above-average value creation, and are more ready to connect to the New Economy. Such variables as the percentage of the population age 25 to 34, the percentage foreign-born population, institutional influence, the percentage of the population age 25 and older with

an associate's, bachelor's or graduate/professional degree, and the percentage of the population employed in creative class jobs, which are included in the demographic, education and other New Economy assets categories, are also considered to be "knowledge" assets, and are sub-categorized as such.

3.5.2 Measurement of Transformed Data

Data definition and sources are indicated in the Appendices. To integrate data into the economic model, various data transformations were conducted. Some data transformations were minor, such as calculating percentages and measuring changes between two time periods. Other variables, such as the Racial Diversity Index (computed using Simpson's Diversity Index and used as an indication of how racially diverse, or homogenous, a community is) and the Institutional Influence (presence of universities) variables, were calculated variables. Geographic Information System (GIS) software was also used to calculate some variables at the MCD level.

3.5.3 Descriptive Statistics of Data

The descriptive statistics of the data are available in Appendix 2. Presented are the mean, standard deviation, minimum and maximum values of all MCD's in the State of Michigan utilized in this study. There are 1,513 observations (all MCDs in Michigan for which there is complete data).

3.6 Estimation Technique

Equation 5 (section 3.4) represents a simultaneous system of equations that requires a different method of estimation than ordinary least squares (OLS). Each equation's coefficients (for population, employment and income) must be identified as a system, due to the simultaneous nature of the relationships. The two-staged-least-squares (2SLS) estimation procedure would yield unbiased and efficient estimates for the type of system that Equation 5 represents. The 2SLS procedure involves two stages. First, it utilizes an instrumental variable approach to identify endogenous variables in the system. Second, it utilizes generated instrumented endogenous variables to identify the entire system of equations.

Critical to the use of the 2SLS procedure is the identification of whether each equation's estimates can be identified separate from other equations. This is handled by including more information in each equation that is not included in other equations. The identifiably of each equation in our model was done using the *order* and *rank* conditions. The procedure for identifying *the order condition* is: $H \leq EX$, where H is the number of right-hand side endogenous variables in a given equation, and EX is the number of excluded exogenous variables from a given equation, when compared to other equations in the system. The *rank condition* is: $EMX \geq H\text{-}1$, where EMX is the number of excluded endogenous and exogenous variables in a given equation, compared to other equations in the system, and $H\text{-}1$ is the total number of endogenous variables in the system minus one. All equations in our model are identifiable and meet these conditions. We also checked for potential heteroskedasticity using the White test. Based on estimated correlation coefficients, we conclude that earlier estimates of the models exhibited some degree of multi-collinearity. These are corrected for in our modeling efforts. We use a dynamic lag-adjustment model that estimates the relationship between changes in the elements of growth and the drivers of growth.

Part 4: Drivers of Place Performance – Results

PART 4 PRESENTS RESULTS OF THE ECONOMETRIC ANALYSIS SEQUENTIALLY, FOCUSING ON THE THREE TYPES OF GROWTH (EMPLOYMENT, INCOME AND POPULATION). FOR EACH TYPE OF GROWTH, WE EXAMINE THE RELATIONSHIP TO EACH CLASS OF GROWTH DRIVERS, ESPECIALLY GREEN INFRASTRUCTURE AND NATURAL FEATURES.

In Part 3, we presented an empirical framework for examining the relationships between various amenities (green infrastructure in particular) and economic performance. By economic performance, we mean employment growth, income growth, population growth or combinations thereof. This tripartite framework for looking at performance allows one to evaluate what drives or explains various aspects of economic growth.

Part 4 presents results of the econometric analysis sequentially, focusing on the three types of growth (employment, income and population). For each category of growth, we examine the relationship to each class of growth drivers, especially green infrastructure and natural features. The coefficients of the population model are relevant in designing policies to attract, retain and recruit population, especially knowledge workers. The coefficients of the income model are useful in devising strategies to grow local prosperity via higher wages and incomes. These coefficients are particularly important in Michigan, which has experienced an erosion of its income base in recent years. The income of the state ranked 12th in the nation during 1969, and dropped to 37th by 2008 (U.S. Census Bureau, 2010a; U.S. Census Bureau, 2000). Understanding what drives income can be useful in devising policies and strategies to improve the economy and enhance the earning power of residents. The coefficients of the employment model help explain why some communities are losing employed people, while others are growing rapidly. Job creation has become the single most important policy objective for Michigan during recent years. The coefficients of the employment equation will help establish why jobs are lost or gained, and the role of amenities in that process.

The parameter estimates are reported in Table 2. The statistical significance of coefficients is indicated via asterisk. Triple asterisk (***) indicates significance at the 1% confidence level. Double asterisk (**) indicates significance at the 5% level. Single asterisk (*) indicates significance at the 10% level. For the purpose of discussion, given the nature of the analysis, we deem anything at the 10% level of significance or better to be statistically significant.

In evaluating social/cultural assets, as well as the green infrastructure assets and their roles in economic development, we present not only specific impacts on population, income and employment, but also through cumulative effects, we present their overall effects. This is in recognition of the fact that estimated coefficients do not tell the whole story, as they only show partial effects. For example, there is a direct effect of cultural assets on employment. There may also be an effect of cultural assets on population attraction, which might then enhance the effect on employment (See Figure 1, arrow A). Similarly, the concentration of cultural assets in a community might enhance income, which would then enhance employment directly (B) and indirectly through population attraction (C, then A). So, with social/cultural assets and our green infrastructure amenities, we report not only the partial effects, but the aggregate, cumulative effects of these variables.

4.1 Results

Understanding the model's estimated coefficients is critical to an accurate interpretation of results. A positive coefficient of a variable (e.g., presence of a trout stream) implies that places with that feature tend to more rapidly increase in population than a place that does not have that feature. Furthermore, a positive coefficient for a variable in the income equation suggests that an increase in that variable is associated with higher per capita incomes in an MCD. Finally, a positive coefficient for a variable in the employment equation implies that an increase in that variable is associated with a greater number of employed residents living in the community. It does not imply that the community has greater capacity to generate employment. The data used tracks employed people that live within a community, not jobs within the community. In essence, the study focuses on place assets, and how they may affect changes in population, income and employment.

It is also important to recognize that our population, income and employment change equations yield coefficients that depict the partial effects of causal factors. That is, for example, the coefficient for the number of dams in a community in the employment equation is based on the assumption that everything else is held constant, with the only difference being the change in the number of dams. In reality, however, we know that if the construction of a dam creates a lake that attracts more employed people, the influence on income will depend on whether the employed people have higher or lower incomes. If the dam attracts knowledge workers with higher incomes, the income effect would be positive. If not, the income effect could be negative.

Thus, the cumulative effects presented for social/cultural assets and green infrastructure assets allow us to investigate these compounding effects. It is important to look at this cumulative effect on growth, because it will more likely represent what a community may experience. For example, if our results indicate that there

Figure 1: Inter-Relationship between Population, Employment and Income

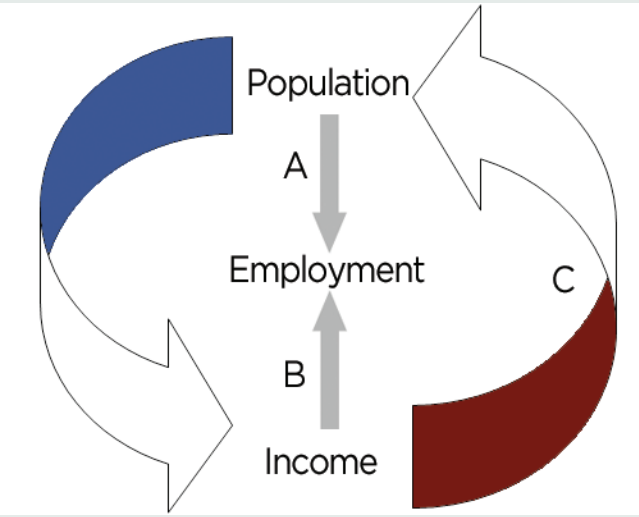

Table 2: Drivers of Population, Income and Employment Change in Michigan MCDs

Variable	Change in Population		Change in Income		Change in Employment	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Population Change: 1990–2000	-	-	-0.14	0.09	0.46***	0.01
Per Capita Income Change: 1990–2000	-0.20***	0.01	-	-	0.22***	0.02
Total Employment Change: 1990–2000	2.29***	0.01	0	0.25	-	-
Total Population in 1990	-0.06***	0	-	-	-	-
Total Employment in 1990	-	-	-	-	0.09***	0.002
Per Capita Income in 1990	-	-	-0.17**	0.07	-	-
Population per Square Mile in 1990	-0.13***	0.01	0.46***	0.17	-0.03	0.02
% of Population Age 65 and Older in 1990	1.32	1.38	32.97	20.95	-0.55	2.26
% of Population Age 25 to 34 in 1990	-39.87***	2.26	-66.62***	37.34	26.02***	3.72
% of Foreign Born in 1990	122.54***	3.80	-116.36**	54.48	-53.39***	6.40
% of Working Class Total in 1990	6.40***	1.16	31.84	24.92	-5.71***	1.90
% of Owner-Occupied	3.90***	0.45	-97.71	677.73	-117.82	72.76
Median Housing Value of all Owner-Occupied Housing Units	0.004***	0.001	0.07***	0.01	-0.01***	0.001
Institutional Influence: Universities	0.001	0.001	-0.02	0.02	0	0.002
% of Population Age 25 and Older with Associate's Degree in 1990	-6.48***	2.36	-20.32	34.82	3.01	3.85
% of Population Age 25 and Older with Bachelor's Degree in 1990	6.54***	2.02	45.14	39.32	-8.42**	3.29
% of Population Age 25 and Older with Graduate or Professional Degree	27.07***	2.28	16.31	46.58	-8.79**	3.68
Rural Interstate Road Density	0.34***	0.06	1.56***	0.84	-0.28***	0.10
Rural Freeway Road Density	0	0.08	-0.81	0.66	0.16	0.14
Urban Interstate Road Density	0.03	0.03	0.58	0.44	-0.07	0.05
Urban Freeway Road Density	0.09**	0.05	-0.09	0.43	-0.07	0.05
Southern Half of Lower Peninsula	0.35	24.27	732.50**	296.42	-87.60**	39.60
Upper Peninsula	-407.35***	23.91	-230.82	347.02	223.98***	39.05
% of People Employed Age 16 and Older: Mining	-8.09***	1.96	-19.93	27.85	7.14**	3.19
% of People Employed Age 16 and Older: Finance, Insurance, Real Estate	-2.91	2.17	-36.65	29.77	5.99*	3.55
% of People Employed Age 16 and Older: Services	-5.79***	1.08	1.83	20.51	2.23	1.76
% of People Employed Age 16 and Older: Manufacturing	-3.05***	1.12	-7.60	23.07	2.42	1.82
% of People Employed 16 and Older: Agriculture	-0.94	1.51	-24.01	20.60	3.85	2.46
Racial Diversity Index	-4.38***	0.36	-1.65	4.39	2.89***	0.59
% of Creative Class Employment in 1990	5.93***	1.47	54.11***	28.71	-7.35***	2.41
% of Poverty in 1990	-8.63***	0.94	-0.21	0.15	5.62***	1.53

* Significant at the 0.10 confidence level.
** Significant at the 0.05 confidence level.
*** Significant at the 0.01 confidence level.
– Variable not included in model.

Table 2: Drivers of Population, Income and Employment Change in Michigan MCDs (cont.)

Variable	Change in Population		Change in Income	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Distance to Urban Center (Miles)	0.002***	0	0.004***	0.002
# of Arboreta, Botanical and Zoological Businesses	67.45*	38.18	925.97**	363.39
# of Dance Studios, Schools and Halls	181.37***	8.41	50.70	86.97
# of Theatrical Producer Businesses	-199.97***	8.07	-26.64	132.54
# of Bands, Orchestras, Actors and Other Entertainment/Entertainers	177.69***	6.05	40	69.71
# of Bowling Center Businesses	205.42***	8.67	-169	103.97
# of Sports Clubs and Promoters Businesses	-218.89***	18.40	266.80	269.96
# of Racing Tracks and Racetrack Businesses	-67.54***	12.86	25.06	166
# of Physical Fitness Businesses	359.67***	8.47	109.19	108.38
# of Coin-Operated Amusement Businesses	-512.76***	15.27	-356.25**	172.53
# of Amusement Park Businesses	-271.93***	23.06	-201.10	224.30
# of Membership Sports and Recreational Clubs	96.62***	6	-0.36	73.66
# of Other Recreational Businesses (Includes Skiing)	2.82	3.90	-33.35	47.16
Eating and Drinking Places per Capita	-3,979.99*	2,154.85	-32,145.3	50,712.40
Square Meters of Public Land	144.46	177.26	744.07	2,689.33
Square Meters of Private Land	58.16	40.89	-233.57	653.76
% of Agriculture	-5.85***	0.71	18.20**	8.59
% of Forested Land	-5.28***	0.90	33.67***	9.76
% of Sand, Rock and Clay	36.64***	7.46	105.80	147.62
% of Shrubland	-15.03	24.05	201.51	385.51
Presence of Important Bird Habitat	135.98***	14.50	245.24	193.01
% MCD Consisting of Natural Vegetation Core Area	2.81***	0.49	10.61	7.07
% MCD Consisting of Potentially High-Quality Patches of Natural Habitat	-0.07	0.45	-4.26	5.83
% MCD Consisting of Inland Lakes	0.01	0.01	0.48***	0.28
Miles of River	-0.22	0.62	5.44	7.39
Miles of Great Lakes Shoreline	2.26***	0.51	-4.66	19.82
Miles of Inland Lake Shoreline	0.51*	0.30	6.72	4.10
Presence of State Environmental Area	-51.46**	25.35	478.73	513.88
% of Wetland	-0.38	1.02	39.68***	10.67
Presence of a Trout Stream	-34.52***	11.52	-209.89	135.09

Change in Employment		Total (Cumulative) Effects†		
Coeff.	Std. Err.	Population	Income	Employment
-0.002***	0	0	0.004	0
-243.44***	62.61	-223.48	925.97	-100.13
-121.66***	13.84	-97.40	0	-38.63
89.03***	13.06	4.03	0	-2.51
-130.46***	10.23	-121.23	0	-49.11
-95.82***	14.06	-14.14	0	-1.78
82.51***	30.24	-29.83	0	-17.70
49.40**	21.03	45.66	0	18.48
-219.29***	14.26	-142.80	0	-54.63
294.07***	25.13	58.40	-356.25	16.08
149.57***	37.66	70.78	0	25.08
-42.55***	9.78	-0.87	0	1.69
-21.75***	6.44	-49.83	0	-21.75
8,914.63**	3,525.24	16,446.73	0	7,092.60
-107.70	289.38	0	0	0
1.51	66.73	0	0	0
-112.56	115.87	-0.61	18.20	-0.47
-3.59**	1.48	-3.79	33.67	-1.91
-29.48**	12.20	-30.91	0	-12.71
-6.58	39.27	0	0	0
-89.02***	23.73	-68.00	0	-26.77
-2.48***	0.80	-2.87	0	-1.19
0.77	0.73	0	0	0
-0.07***	0.02	-0.02	0.48	-0.01
-1.51	1	0	0	0
-0.70	0.82	2.26	0	1.03
-1.37***	0.49	-2.62	0	-1.13
-15.41	41.35	-51.46	0	-23.56
-6.83***	1.66	-4.21	39.68	-2.01
34.28*	18.83	44.03	0	18.48

† Total (cumulative) effects are only estimated for Green Infrastructure and Social/Cultural Assets, as these are the main focus for this report.
* Significant at the 0.10 confidence level.
** Significant at the 0.05 confidence level.
*** Significant at the 0.01 confidence level.

Table 2: Drivers of Population, Income and Employment Change in Michigan MCDs (cont.)

Variable	Change in Population		Change in Income	
	Coeff.	Std. Err.	Coeff.	Std. Err.
# of High-Quality Lakes	6.03	4.37	-62.71	48.82
Miles of Reference/No Impact Streams	0.23	0.33	-5.78	3.55
% of Functional Sub-Watershed	-0.38*	0.23	-4.81	3.40
# of State Forest Campgrounds	-44.55***	9.52	-39.78	100.01
Presence of Identified Trails	-57.96***	10.38	-99.75	122.70
# of Fish Stocking Sites	0.68	1.57	-6.04	15.92
Amount of Developed Inland Lake Frontage (Miles)	1.84***	0.24	-0.69	3.09
# of Boat Launches	8.88**	4.18	-4.92	51.33
# of Marina Businesses	-103.23***	5.91	82.56	64.48
# of Dams	2.61	2.20	10.31	24.58
# of Public Golf Courses	-12.69	8.29	101.92	104.93
# of Mines	-67.49***	7.70	-127.68**	64.87
# of National Pollutant Discharge Elimination System (NPDES) Sites	31.17***	1.07	4.94	10.11
# of Part 201 Contaminated Sites	-85.39***	1.68	-83.98***	20.29
Constant	1,880.76***	138.95	2,057.10	2,133.12

is little to no impact on the population and employment estimations on income; hence, the cumulative effects for income are the same as the partial effects. On the other hand, the cumulative effects of employment on population are quite significant, and often result in a change in direction of estimated coefficients.

4.1.1 Growth Interdependence

Predicted exogenous factors help identify the three equations, but also help explain the interdependence between population growth, employment growth and income growth between 1990 and 2000. Our results are similar to those found in the *Chasing the Past or Investing in Our Future* report by Adelaja et al. (2009). In essence, these results suggest that a community that increased its number of employed people increased its population, and that a community that increased per capita income levels had slower population growth. Furthermore, places that tended to gain population and per capita income also experienced a positive change in employment from 1990 to 2000. These results partly suggest that prosperity attracts prosperity, and that growth elements are synergistic. Since income is found to be negatively associated with population change from 1990 to 2000, our interdependent growth hypothesis is found to be partially confirmed.

4.1.2 Initial Conditions

How the 1990 levels of population, employment and income of a community affect its potential for growth is important for modeling purposes. Initial condition factors are included in the analysis to help test the hypothesis that changes in 1990–2000 population, income and employment levels are influenced by 1990 levels.

Change in Employment		Total (Cumulative) Effects†		
Coeff.	Std. Err.	Population	Income	Employment
5.57	7.12	0	0	0
1.16**	0.54	2.66	0	1.16
0.81**	0.38	1.48	0	0.64
26.63*	15.54	16.47	0	6.23
33.78**	16.96	19.44	0	7.24
1.43	2.57	0	0	0
-1.35***	0.40	-1.25	0	-0.51
-0.69	6.82	8.88	0	4.06
34.12***	9.61	-25.05	0	-13.14
-1.08	3.59	0	0	0
-54.08***	13.47	-123.92	0	-54.09
46.79***	12.56	2.91	-127.68	0.39
-22.11***	1.79	-19.51	0	-7.85
53.84***	2.78	13.78	-83.98	4.55
-940.87***	226.71	N/A	N/A	N/A

† Total (cumulative) effects are only estimated for Green Infrastructure and Social/Cultural Assets, as these are the main focus for this report.
* Significant at the 0.10 confidence level.
** Significant at the 0.05 confidence level.
*** Significant at the 0.01 confidence level.

Our findings suggest that the greater the 1990 levels of population, the slower the pace of growth in population from 1990 to 2000. So, places previously known for high population exhibit a tendency to shrink their populations. Therefore, we expect new places will emerge based on the natural tendency of people to migrate away from previously populated areas, which tend to be old industrial communities. Our findings also suggest that the greater the 1990 levels of employed population, the greater the pace of employment growth from 1990 to 2000. So, places known to house a higher number of employed people will be even more successful at that in the future. Finally, our findings suggest that the greater the 1990 levels of income, the slower the pace of income growth between 1990 and 2000. This suggests that previously high-income communities, on average, will see an erosion of income over time. These findings, in general, suggest a shifting of the landscape in favor of employment hubs, to the disadvantage of past income and population hubs. The notion that employed people with escalating incomes will increasingly aggregate in certain places, over time, raises some questions about the long-term viability of communities that are fiscally stressed.

4.1.3 Demographic Factors

The demographics of an area may or may not play a role in the potential for future place performance, but identifying and understanding these impacts can help communities prepare for the future based on their current composition. Population per square mile (or population density), used as one of the proxies by which a community is urban/

suburban/rural, is found to be negatively related to population change, but positively related to income change. This may partly explain the shrinking cities phenomenon, whereby people from dense parts of metropolitan areas move to more suburban and rural locations. But, higher population density is associated with higher future per capita income, suggesting that density spurs income growth. This is consistent with the findings of Adelaja et al. (2009), and others.

A higher concentration of 25- to 34-year-olds is associated with decreased population and income and increased employment, at least for the period between 1990 and 2000. This suggests that in the case of Michigan, the argument typically made by New Economy and endogenous growth theory advocates that young people are anchors of overall economic prosperity does not hold true for population and income change during the period. This is concerning, considering that many have highlighted the importance of attracting young people in order to grow the economy.

Both the Land Policy Institute and the current administration in Michigan have promoted the concept of attracting foreign-born people in order to grow Michigan's economy. Foreign-born professionals have been shown to attract population, and increase per capita income in other studies. The results here seem to support the population attraction hypothesis, but not as it relates to higher income.

Moving on, the greater the population that is classified as working class, the greater the population growth. The fact that slower employment growth is associated with the concentration of foreign-born residents, as well as working class residents, may be due, in part, to the nature of the jobs foreign-born and working class residents are employed in, and the rate at which those jobs expand.

The percentage of the population that is in poverty was found to be negatively related to population and positively related to number of employed residents. This indicates that increased poverty drives away population, but that the more people there are in poverty, the greater likelihood of more residents having employment. This could be the result of more members of a household needing to work to survive.

4.1.4 Region of Michigan

Michigan is unique in the U.S. in the fact that it is split into two peninsulas, with limited access to surrounding states. To account for regional differences, the state is divided into three zones: the Upper Peninsula, the northern Lower Peninsula and the southern Lower Peninsula. Estimations of regional differences are done in comparison to the upper half of the Lower Peninsula. Results indicate that the southern half of the Lower Peninsula has higher income levels and lower employment levels, all else being equal, than the upper half of the Lower Peninsula. On the other hand, the Upper Peninsula has much lower population coefficient estimates and much higher employment coefficient estimates, all else equal, than the upper half of the Lower Peninsula. These findings are curious, considering that the Upper Peninsula has been generally declining in population and employment over the years. However, since these comparisons must be made to the northern Lower Peninsula, unique population and/or employment phenomena that may have occurred between 1990 and 2000 may cloud the results. Future research (discussed later) ought to denote more regions in order to better control for regional effects that cannot be explained here.

4.1.5 Housing Market

The housing market in a community can affect the perception of those interested in moving into the area and, hence, the growth potential of a community. The percentage of owner-occupied and median housing value of all owner-occupied homes are included in the analysis to investigate what effects the local housing market has on a community's growth potential. Both positively affect population growth, implying that population increases in communities with a strong and stable housing market. Not surprisingly, the higher the median housing value, the higher the per capita income of the community. Obviously, more income is needed to afford property in these places. On the other hand, employment decreases for communities with higher median housing value, which could be indicative of the types of communities with higher home values. Employment levels in communities that are fully "built out," such as many of the wealthy suburbs around Detroit, have limited ability to increase employment levels (population being held constant), as many with higher incomes are already employed and children do not work. Employment levels in prosperous communities are often stable.

4.1.6 Educational Attainment

Education is expected to play a large role in the future prosperity of communities (Adelaja et al., 2009). To investigate the role of education in growth, we examine which degrees have the greatest effect and how large of a role educational institutions play in that success. All levels of education have an effect on population growth, while only bachelor's degrees and graduate/professional degrees affect employment levels. None of the variables are found to be statistically significant in regard to changes in income levels for the communities. This finding is contrary to other studies that show a direct relationship between educational attainment and income. The explanation may be the fact that this is a Michigan-based study and the state's educational attainment is generally below average (U.S. Census Bureau, 2010b). The structure of the economy may be such that the heavy entrenchment in manufacturing provides limited opportunities for highly educated people to hold high income jobs.

While lower population levels are associated with a higher percentage of the population with an associate's degree, higher population levels are associated with increased percentages of bachelor's and graduate/professional degrees. On the other hand, employment levels are lower for communities with a higher number of bachelor's and graduate/professional degrees. This could be the result of the typical demographic profile of those with advanced degrees in Michigan, or could have to do with where more highly educated residents live, as opposed to where they actually work.

4.1.7 Gray Infrastructure

The accessibility (via transportation networks) of a community is expected to play a role in future growth and prosperity. Gray Infrastructure variables investigate, through the use of rural and urban interstate and freeway road densities, the effect of built gray infrastructure on growth. Previous work used a nationwide index to estimate the role of infrastructure in communities, and found a positive correlation with changes in population, per capita income and employment (Adelaja et al., 2009). Estimates here indicate that rural interstate road density affects changes in population, income levels and employment levels, and urban freeway road density affects population, but no other variables are significant for employment or income.

As rural interstate road density increases (i.e., more feet of road per square mile of MCD), population and income are expected to grow, while residents employed is expected to decline. Increased rural interstate road may make it easier for individuals to reside in a location and commute to other communities for work. This may be exemplified by bedroom communities, which bring in families with children (hence, larger populations) who can afford larger homes on larger lots that, in turn, may drive out more densely clustered, lower-wage-earning residents, resulting in lower employment levels. Urban freeway road density is also positively related to changes in population, and could also be a reflection of the accessibility of the community.

4.1.8 Structure of the Economy

The economic structure variables look at how the previous breakdown of economic activity drives growth. The greater the percentage of people employed in the mining, services or manufacturing sectors in the community, the lower the expected population. While the greater the percentage of the population employed in the mining and finance, insurance and real estate sectors, the greater the expected employment levels. Michigan's manufacturing sector has traditionally been a cornerstone of its economic growth. The findings here suggest that manufacturing, which defined Michigan's Old Economy, inhibits a place's population growth, perhaps by making unemployed workers look for job opportunities elsewhere.

4.1.9 Other New Economy Assets

Other New Economy assets, including racial diversity and creative class employment are also examined. Diversity is found to be negatively related to population growth and positively related to employment change. Since this analysis is done at the MCD level for Michigan, a relatively homogeneous state, these findings may be more indicative of urban-rural differences than a direct relationship between diversity and population growth. This could also be the case, because many of Michigan's shrinking cities have more diversity than the growing suburbs and townships.

A unique feature of this report is the investigation of the effects that various quality-of-life assets have on growth.

Increased creative class employment is associated with positive population change and higher per capita income. This is consistent with previous findings (Adelaja et al., 2009). However, creative class employment is associated with a lower resident employment level. This indicates that the greater the percentage of professionals employed in the creative class, the better the community's potential for future population and income growth, but not resident employment levels.

4.1.10 Social and Cultural Assets

A unique feature of this report is the investigation of the effects that various quality-of-life assets have on growth. We utilized several assets, categorized as social and cultural assets that are predicted to affect the growth of a community, and all are found to be statistically significant for either the population, income and/or employment estimations. The associations vary across assets, but for the most part, impacts on population and employment are contrary to each other. In other words, as population increases, employment decreases and vice versa in most cases.

Increased distance to an urban center is positively related to changes in population and income, and negatively related to changes in employment. In other words, *ceteris paribus*, the

closer a community is to an urban center, the greater the potential for lower population and income, but higher employment levels, although the effects are marginal.

An increase in the number of eating and drinking place per capita in an MCD is associated with lower resident population, but higher resident employment levels. This low population effect may be related to the population loss occurring in the urban cores, where people often go to work, recreate, wine and dine, but may not reside.

Population tends to increase in places with higher numbers of physical activities—such as locations that have dance studios, fitness centers, bowling centers and membership sports and recreation clubs. These types of facilities, as well as golf courses and other recreation businesses, such as skiing, are associated with lower levels of resident employment, holding population levels constant. By investigating the cumulative effects of population, income and employment, it is found that, with the exception of membership sports and recreation clubs, the overall effect on a community of the increased presence of these businesses is a lower population and a lower resident employment level.

A greater number of amusement park, coin-operated amusements, racing tracks, sports clubs/promoters and theatrical production types of businesses are negatively related to population growth, and positively related to employment growth, while a greater number of coin-operated amusement businesses negatively impact per capita income levels. The cumulative effects of these amenities, however, vary. The cumulative effects reveal that an increased number of racing tracks, coin-operated amusements, amusement parks and theatrical production types of businesses are positively associated with population change, and all, with the exception of theatrical production businesses, are positively related to increased resident employment levels. This indicates that people with jobs are attracted to areas that offer these amenities.

The number of sports clubs and promoter businesses, on the other hand, is adversely related to population levels and employment levels, when cumulative effects are accounted for. This may be reflective of the fact that a greater number of sports clubs and promoters are associated with more urbanized areas, which have been population loss places in Michigan. This may indicate that people do not like to live in proximity to these types of businesses, but perhaps like them to be located in a neighboring community, such as an urban core to which they travel to recreate.

4.2 Green Infrastructure

4.2.1 Basic Land Assets

The availability of land, by itself, does not necessarily add value to a community. Society reaps additional benefits that land offers in the form of its economic value. The enhancement of human interaction with land generates additional value, which contributes to economic performance. In other words, it is the features of land, not the land itself, that affect employment, income and population. As in the section on social and cultural assets, we report not only the partial effects, but also the cumulative, or aggregate, effects of each hypothesized causal variable.

4.2.1.1 Public and Private Lands

Public land is land owned by the federal, state, county or other local unit of government. In Michigan, the largest percentage of public land is owned by the State of Michigan and is managed

primarily for timber products. Approximately 21% of the land in Michigan is in public ownership; it is not, however, distributed evenly across the state (See Table 3 in Appendix 1). Public lands also include parks, which provide residents and visitors with easy access to a variety of outdoor recreation opportunities. Neither the percentage of public lands nor private preserves within an MCD have a significant impact on any of the economic characteristics measured in this study. Since previous studies have indicated public lands have had positive impacts on economic growth, this might suggest that Michigan has sufficient public land holdings. This might also be explained by the law of diminishing marginal returns, where an increase in public lands in a location that already has a large endowment will not attract additional population. However, given the fact that the majority of Michigan's public lands are located in the Upper Peninsula (55%), we recommend that this variable undergo additional analysis (See Table 3). We are very interested in the impact of public lands in the Lower Peninsula, particularly the southern Lower Peninsula, which contains the majority of the state's population and urban centers, but only 4% is in public ownership (See Table 3).

4.2.1.2 Agricultural Land

Agricultural land can be found throughout the state, but the vast majority is located in the southern Lower Peninsula, which has a longer growing season and is less susceptible to late spring frost. Agricultural land constitutes approximately 25% of Michigan's landscape, and agriculture is considered the second largest economic sector in the state contributing approximately $71 billion per year.[6] Areas with a higher percentage of agricultural land are associated with decreasing populations and increasing incomes. This may be explained by an increasing trend in larger farm operations over the past 30 to 40 years that, in turn, pushes out smaller farm operations, along with the families living on these smaller farms. As a result, the larger farm operations are seeing an increase in their income. Additionally, a large percentage of farm land in surrounding urban centers and suburban communities has been converted to large single-family parcels and businesses looking for cheaper land in close proximity to urban amenities in the 1990s. Cumulatively, agriculture's negative effect on population leads to a very small decrease in the level of resident employment, but income remains very positive. The strong positive effect on income demonstrates the attractiveness of farmland to higher income residents.

4.2.1.3 Forested Land

Forested land can also be found throughout the state, with the vast majority located in the Upper Peninsula. Approximately 50% of Michigan is covered by upland and lowland forest, the most dominant land cover in the state (See Table 3). Forested land is typically viewed as an attractive amenity to live near. However, areas with a higher percentage of forest land are associated with lower populations, higher resident income and lower employment levels. Findings indicate that an increase in 1% of forested land cover results in a lower resident population of more than five people, a higher per capita income of $33.69 and lower resident employment of close to four jobs. This can probably be explained by the phenomena of second-home development and retiree migration to northern Michigan, where the majority of forest lands are located. Areas with a high percentage of forestland tend to be sparsely populated by permanent residents and businesses, but they do

6. Michigan Farm Bureau, "Agricultural Education": http://www.michfb.com/education.

attract second home development for recreational purposes, as well as retirees. Retirees, whose permanent residence is located in forested regions of the state, tend to bring with them a comfortable, investment-based income, which might explain the large positive impact of forested lands on resident income levels. Cumulatively, forested lands' positive effect on resident incomes remains unchanged, and both population and resident employment levels improve, but remain slightly negative.

4.2.1.4 Sandy, Rocky and Clayey Soil Land

Sandy, rocky and clayey soil land include a variety of land uses found throughout Michigan. Included in this category are areas being cleared for some sort of future development, quarries and, to a much lesser degree, large open sand dunes and beaches along the Great Lakes. These areas, accounting for less than 0.5% of the landscape, tend to be relatively small scattered patches (See Table 3). Areas with a higher percentage of exposed sandy, rocky or clayey soil show an increase in population accompanied by lower employment levels. Every 1% of exposed sandy, rocky and clayey soil acreage in an MCD is associated with a 37-person increase in resident population. On the other hand, these soil types are associated with lower resident employment, and with 29 fewer residents employed for every 1% increase in these exposed soils. Cumulatively, the lower employment levels lead to a significant decrease in population numbers. The majority of these areas have existing or former quarry operations that tend to be located in isolated rural MCDs. Although active quarries provide jobs, the areas surrounding quarries are not considered to be desirable places to live, due to potential noise, air and water pollution associated with typical quarrying activities. Due to the measurement of this variable, it is impossible to separate the individual effects of just sand dunes.

4.2.1.5 Shrubland

Shrublands are found throughout Michigan, but are primarily located in close proximity to suburban communities. They account for approximately 10% of the landscape (See Table 3). For the purposes of this study, shrubland includes upland shrub communities, as well as old fields and grasslands. All three of these categories of land are considered to be early successional stages, or transitional lands. Over time, these areas will slowly succeed to upland forest, unless they are set back by some sort of natural or human disturbance or purposeful management regime to maintain the early successional stage. Areas with higher percentages of shrubland show no significant effect on the economic characteristics measured in this study.

4.2.2 Ecological Land Assets

In addition to the basic land composition of a community, the ecological contributions of such lands are also important, and are hypothesized to contribute positively to a community's growth potential. Such assets as important bird areas, core natural vegetation areas and high-quality patches of natural habitat go beyond simple acreage of open land and indicate concentrations of high-quality and ecologically important lands. It is important to note that the effect of an ecological asset could be positive or negative. On the one hand, these assets attract people who value the amenity benefits. On the other hand, given the various protection mechanisms that are in place—based on federal and state legislation—people may be limited to certain uses of land. This may make it difficult for them to reside close to these unique ecological assets, or engage in employment-generating activities when compared to areas without high-quality natural features.

4.2.2.1 Important Bird Areas

Important bird areas (IBAs) are identified by The Nature Conservancy based on their significance to migrating birds and nesting sites for declining bird species. These areas are distributed across the state; however, they have a high affinity with coastal areas. The presence of important bird areas is positively related to population. For every additional important bird area in a community, resident population increases by close to 136 people, suggesting that people are attracted to important bird habitats. On the other hand, the presence of IBAs is negatively related to employment. For every additional important bird area, employment declines by more than 89 jobs. It appears that people are attracted to areas that support this important habitat type, but this does not translate into jobs or higher incomes. People like to live near these relatively large intact natural landscapes, but not necessarily those people with higher incomes or positive employment status. This observation is exemplified by the movement of retirees into an area, who are unemployed. However, when the cumulative effects are investigated, the overall impacts on population and employment are negative, indicating that while people like these amenities, it does not necessarily translate into increased residents, but may lead to increased visitors to the area.

4.2.2.2 Natural Vegetation Core Areas

Natural vegetation core areas were defined by Paskus et al. (2008) based on the size of large intact natural landscapes found within each of the three major eco-regions of the state. These large intact landscapes range in size from 500 acres (the minimum threshold for the southern Lower Peninsula) to more than 100,000 acres. Given the rather large minimum size threshold needed to qualify, it is expected that natural vegetation core areas will have a negligible effect on economic growth within an MCD. The findings indicate that for every 1% increase in natural vegetation core area, resident population increases by close to three people, while employment decreases by more than two jobs. The population attraction is easily explained by people's general preference for large, natural areas. The cumulative effects, on the other hand, result in a negative impact on population and a slightly less negative impact on resident employment, as the percentage of natural vegetation core area increases. The effects however are very minor.

4.2.2.3 High-Quality Patches of Natural Habitat

High-quality patches of natural habitat have been modeled by the Michigan Natural Features Inventory based on size, shape and landscape context of discrete natural vegetation patches. Examples of a natural patch type are an upland deciduous forest or a non-forested wetland. This vegetative-based feature is modeled using digital land cover, and is not found to be statistically significant in relation to population, income or employment growth.

One of Michigan's most prized assets is its abundance of freshwater. Michigan is bordered by four of the five Great Lakes, as well as Lake St. Clair, and the St. Clair and Detroit rivers.

4.2.3 Basic Water Assets

One of Michigan's most prized assets is its abundance of freshwater. Michigan is bordered by four of the five Great Lakes, as well as Lake St. Clair, and the St. Clair and Detroit rivers. The Great Lakes state also contains more than 11,000 inland lakes, and approximately 38,000 miles of rivers and streams. Combined, the state has one of the largest freshwater systems in the world. How we utilize our water assets may have an increasing impact on our prosperity, as global demand for water continues to increase, especially as drought is predicted to pervade much of the country and the world. The impact of water amenities is expected to be positively related to population, employment and income. Results indicate positive relationships exist between population and their proximity to miles of Great Lakes shoreline, as well as miles of inland lake shoreline; a positive relationship exists between the percentage of inland lakes to income; while the percentage of inland lake acreage and miles of inland lake shoreline is significantly related to employment.

4.2.3.1 Inland Lakes Acreage

The percentage of acreage of the MCD consisting of inland lakes is positively related to income and negatively related to employment. An MCD with 10% greater inland lake acreage is associated with a larger per capital income of $4.78, and a lower resident employment level of close to 0.7 jobs. In other words, the greater the number and/or size of lakes in the MCD, higher per capita incomes and slightly lower levels of resident employment are expected. Obviously, higher-income people are attracted to high-value homes in lake communities. However, the cumulative impacts indicate that population becomes negatively related to increased lake acreage, while the effect on income does not change, and the effect on employment becomes slightly less negative. With such a relatively small effect on population and employment, the negligible results may be caused by the "crowding out" of livable space, due to less land available for development. Another theory is that many of Michigan's inland lakes were already built out in the early- to mid-1900s and, therefore, do not hold much potential for additional growth.

4.2.3.2 Miles of River

With more than 38,000 miles of rivers and streams in the state, no one is ever very far from a river in Michigan. Probably because they are so ubiquitous across the state, miles of river within a community do not have any significant effects on population, income or employment. Another explanation may be that many of Michigan's rivers are not navigable and many more are not easily accessible. A breakdown of the type and quality of rivers may show different results.

4.2.3.3 Miles of Great Lakes Shoreline

There are more than 3,200 miles of Great Lakes shoreline within Michigan's borders. Not surprisingly, miles of Great Lakes shoreline is significantly and positively related to population increases. For every 10 miles more of shoreline an MCD has, its resident population is expected to increase by 23 people. The cumulative effects on population and employment are also positive. In other words, as expected, the Great Lakes, and their adjacent shorelines, attract people, especially those who tend to have jobs.

4.2.3.4 Miles of Inland Lake Shoreline

While the percentage of inland lakes acreage represents the spatial extent of lakes in the community, miles of inland lake shoreline represents the shoreline development and/or recreational potential for the community. Results indicate that for each additional 10 miles of inland lake shoreline a community has, the community is expected to experience an increase in resident population by approximately five people, with lower resident employment levels of close to 14 people. The cumulative effects are negative for both, with a lower population of 26 people and a decrease in resident employment by about 11 jobs for every 10 additional miles of inland lake shoreline. The cumulative effect of employment negatively impacts the overall population levels of the community. While lake locations are highly desirable places to live, areas with a high number of lakes typically are located in remote isolated areas of the state. In addition, many privately owned shorelines were already developed by the mid-1900s primarily for second homes and resorts.

4.2.4 Ecological Water Assets

Ecological water assets go beyond the traditional general accounting of water amenities in a community. These assets are those which may have some environmental significance, and provide an indication of the quality of water assets available in a community. Some of the ecological water assets, such as trout streams and functional (or high quality) sub-watersheds, are found to have a significant and negative effect on population levels in a community. Trout streams, no impact streams and high-quality sub-watersheds all positively affect employment levels, and all river-related assets have a positive cumulative effect on both population and employment.

4.2.4.1 Wetland Acreage

For the purposes of this study, wetlands—located throughout Michigan—include only non-forested wetlands. Approximately 7.3% of the state consists of wetlands (See Table 3). The vast majority of wetlands are found in small isolated pockets, although there are some large wetland patches found along the Great Lakes coastal areas and places like Seney National Wildlife Refuge in the central Upper Peninsula. Areas with a higher percentage of wetlands show a significant increase in income accompanied by lower levels of employment. A 1% increase in wetland acreage is associated with a higher per capita income of $39.68. For every 1% increase in wetland acreage, there are approximately seven fewer jobs. Cumulatively, the lower levels of employment lead to a slight decrease in population. This pattern is similar to that found with sand, rock and clayey soils, forested land and agriculture. Since wetlands are more evenly distributed across the state compared to the other basic land types mentioned, the analysis

suggests that areas with a larger percentage of wetlands are attractive to households with higher income levels, particularly wealthy retirees. However, these areas also appear to possibly be too expensive for lower wage earners and too remote for larger households.

4.2.4.2 Designated Trout Stream

A designated trout stream is a fast-running, cold water, high-quality river environment, able to support environmentally sensitive fish species, such as brown and brook trout. The presence of a trout stream in an MCD is significantly related to changes in population and employment of a community. A community that has an identified trout stream is associated with a lower resident population of close to 35 people, and a higher resident employment of more than 34 jobs. The cumulative effects reveal that the total effect on population growth is an increase in population of 44 people for the presence of a trout stream, while the employment level is lower, but still positive at more than 18 jobs. The positive results of the cumulative effects of designated trout streams on population and employment appear to demonstrate the significance of high-quality water environments to recreation-based economic activity and tourism.

4.2.4.3 Potential High-Quality Lakes

High-quality lakes are expected to be more beneficial to a community than lower-quality water environments. Potential high-quality lakes were identified by Paskus et al. (2008) based on land cover and roads. Lakes are predicted to have higher water quality if they have fewer roads and less development within a given buffer zone. These types of lakes are typically very difficult to access, and are usually found on public land or within a private preserve. Based on these criteria, the authors predicted that areas with high-quality lakes should see negligible to negative economic effects. Results indicate that there is no statistically significant impact of high-quality lakes on population, income or employment. This may be due to the fact that the effect of other water features, such as miles of inland shoreline or acres of inland lakes may, in and of themselves, hold the value of the water amenity, and that its predicted water quality has a limited effect.

4.2.4.4 No Impact or Reference Streams

No impact or reference streams are those that are located in rural areas with minimal gray infrastructure. They are identified by the Institute for Fisheries Research based on a variety of criteria, including pollution inputs, impervious surfaces and land cover. An example of a reference stream is the Pere Marquette River located on the western side of the northern Lower Peninsula. Every 10 miles more of reference or no impact streams in the community is associated with an increase in resident employment of close to 12 people, while the cumulative effect is positive for both population and employment. Since these streams are essentially the highest quality streams in the state, the results demonstrate the significance of rivers with high water quality, as an attractant for residents with jobs, as opposed to rivers with degraded water quality. These results may demonstrate the significance of these relatively pristine river systems to recreational economic activity and eco-tourism.

4.2.4.5 Functional Sub-Watersheds

A functional sub-watershed is defined as a sub-watershed that has a low number of dams, stream crossings, urban land cover, pollution discharge sites, agricultural land and low-road density (Paskus et al., 2008). Functional sub-

watersheds represent areas that have a high degree of ecological integrity, and as such do not support high levels of human activity or development. The vast majority of functional sub-watersheds, as defined by Paskus et al. (2008), are located in the northern Lower Peninsula and the Upper Peninsula. A lower population of close to four people is associated with an increase of 10% in the share of an MCD that is considered a functioning sub-watershed. In other words, as the percentage of an MCD that falls within a functioning sub-watershed increases, population declines. This may be due to the lack of gray infrastructure, restricting the community's ability to support growth. However, a 10% increase in this same type of community is also associated with a higher resident employment of more than eight people, and the cumulative effects reveal that both population and employment are positively affected by a 10% increase in the functional sub-watershed, with 15 more people and six more residents employed. Similar to both designated trout streams and no impact or reference streams, these results appear to demonstrate the significance of these relatively pristine areas to recreational economic activity and eco-tourism.

4.2.5 Developed Land or Water Assets

The existence benefit of land and water assets alone may not impact the growth potential of a community. How those land and water assets are utilized and developed has the potential to create added value for a community. Most of the developed land and water assets are associated with a decrease in population, no impact on income and an increase in employment levels. Cumulatively, the majority of developed land and water assets are associated with increases in both population and employment. The results imply that the economic benefit of a natural feature can be enhanced by providing and marketing recreational accessibility.

4.2.5.1 State Forest Campgrounds

Communities with a higher number of state forest campgrounds are associated with a lower population. At the time of this study, there are 145 state forest campgrounds in Michigan. For every additional state forest campground, resident population is lower by about 45 people. This exemplifies the loss of population in predominantly rural areas in northern Michigan where state forest campgrounds are located. On the other hand, a state forest campground is associated with a higher resident employment level of close to 27 jobs. The cumulative effects result in a higher population of more than 16 people and higher resident employment of more than six jobs. This indicates that the presence of state forest campgrounds may be job attractors, and the net effect is an increase in both population and resident employment. This could be the case with tourist types of locations, where increased economic activity may result in increased employment opportunities and finally an increase in population.

4.2.5.2 Concentration of Identified Trails

There are thousands of miles of trails located throughout the state; however, most of these systems are not digitized, and many that have been are considered too minor to include. For the purposes of this study, an identified trail is defined as a major trail system documented by the Michigan Trails and Greenways Alliance and available as a digitized dataset. The value is calculated as miles of trail per square mile

for each MCD. The lack of a complete digital trail dataset needs to be addressed to provide a more accurate assessment of their effect on economic growth. The concentration of identified trails crossing through or contained in an MCD is found to be related to lower population levels of close to 58 people and higher resident employment levels of close to 34 jobs. In other words, trails appear to be features of sparsely populated areas, in general, while they attract people who are employed. The cumulative effects reveal that both population and resident employment are expected to be higher in areas with identified trails, with more than 20 additional people and seven more jobs added per trail. As with state forest campgrounds, identified trail systems may be locations that are job attractors, perhaps due to tourist and recreational types of employment and they, in turn, draw in population seeking employment.

4.2.5.3 Fish Stocking Sites

At the time of this study, there are more than 3,600 fish stocking sites tracked by the State of Michigan. The number of fish stocking sites in each MCD, which may be an indication of availability of recreational/sports fishing opportunities for local residents or tourists, is not found to be significantly related to population, income or employment levels.

4.2.5.4 Developed Inland Lake Frontage

Developed inland lake frontage represents the current stock of housing/businesses along an inland shoreline. For every mile of increased developed inland lake frontage, resident population is expected to be higher by close to two people and resident employment is expected to be lower by approximately one job. While people are attracted to areas with developed lake frontage, there are fewer employed residents, and no impact on income. This could be the result of retirees desiring to

locate to waterfront homes. The cumulative effect of a mile of increased developed inland lake frontage is a lower population of more than one person and a lower resident employment of half a job. This could indicate that while some would like to locate near or along developed lake frontage, the decline in resident employment levels leads to people to locate elsewhere to find work.

4.2.5.5 Boat Launches

Boat launches provide residents and visitors with direct water access for their watercraft to lakes and rivers throughout Michigan. At the time of the study, there are 1,325 boat launches tracked by the State. As with developed inland lake frontage, the number of boat launches in each MCD is positively related to population. For each additional boat launch in the community, resident population is expected to be higher by close to nine people. While there is no direct effect on employment from an increase in the number of boat launches, the cumulative effect is a higher resident employment level of more than four jobs. In other words, boat launches are associated with both higher populations and higher resident employment levels. As with trails and campgrounds, access to natural amenities appears to be a critical factor for attracting population and resident employment.

4.2.5.6 Marina Businesses

Marinas are businesses that provide important services to recreational boaters and charter boat companies. They are typically located in harbors at river mouths that empty into the Great Lakes, protected bays and shorelines, connecting channels and large, well-developed inland lakes. With a greater impact on population than the previously discussed developed land and water assets, the number of marina businesses in the MCD is negatively related to population changes. An additional marina in the community is associated with a lower resident population of more than 103 people. On the other hand, each additional marina is associated with an increase of resident employment of close to 34 jobs. Marinas are tourist and leisure destination points, which seem to increase local employment, but contribute very little to population growth. The cumulative effects of an additional marina in the community are associated with a lower

population of 25 people and lower resident employment levels of 13 jobs. While there may be increased employment opportunities in locations with marinas, as population declines, resident employment levels decline as well.

4.2.5.7 Dams

In 2005, there were approximately 1,635 dams located on Michigan's rivers and streams. These dams are found across the state and serve a variety of purposes from energy production to recreational development. The number of dams in a community, which could be argued to be either a developed land and water asset, or a negative land and water asset depending on the location and use, is not found to effect population, income or employment growth. This is surprising given the attention dams have received over the previous decades for their role in increasing economic development.

4.2.5.8 Mines and Mining Plants

Mines are located all across the state. Mining operations are set up to extract non-renewable resources from the surface and sub-surface, such as iron, nickel, copper, crushed stone, peat, sand and gravel, and cement. At the time of the study, there are 253 mines known to operate in Michigan. As with the number of dams, mines could be argued to be either developed land and water assets, or negative land and water assets, depending in part on the public's view and the ecological impact of the mine. In an attempt to make no value judgment on the classification of mines, they are included in the developed land and water assets. For each additional mine in the MCD, resident population is expected to be lower by more than 67 people, per capita income is expected to be lower by $127.68 and employment is expected to be higher by close to 47 people. These numbers may reflect environmental issues and concerns associated with extractive activities. Mines are often associated with pollution, and are expected not to draw people to the area, but may offer employment opportunities to those presently residing in the area. The cumulative effects show a higher population of close to three people, higher employment levels of 0.3 jobs, while per capita income remains $127.68 lower for each additional mine. These results indicate that the population and employment effects seen by a community with a mine are negligible, but income levels are lower, all else being equal. These results suggest that mines are not considered to be desirable places to reside in close proximity to, but mining activity may have a small attraction for those seeking jobs.

Pollution sites may be associated with growth of a community, when resulting from increased industrialization. How these features impact community growth is of great interest, particularly for those communities seeking to balance development and environmental conservation.

4.2.6 Negative Land and Water Features

Not all green infrastructure elements are considered to be positive contributors to a community. For example, such community features as environmental pollution sites may contribute negatively to the perception of a community. We term these "negative land and water features." At the same time, pollution sites may be associated with growth of a community, when resulting from increased industrialization. How these features impact community growth is of great interest, particularly for those communities seeking to balance development and environmental conservation.

4.2.6.1 State Environmental Areas

State Environmental Areas are places identified by the Michigan Department of Environmental Quality that contain environmentally sensitive areas along the eastern coastline of the Lower and

Upper Peninsulas. These areas tend to be very isolated, rural, and have low populations. The presence of any state environmental protection areas within an MCD is related to a lower resident population of roughly 51 people, with no effect on income or employment. However, the cumulative effects reveal that while the population effect remains the same, the cumulative effect on employment levels is a lower resident employment of close to 24 jobs. This finding is expected given the isolated location of state environmental areas, as well as the regulated aspects of these environmentally sensitive sites.

4.2.6.2 National Pollutant Discharge Elimination System (NPDES) Sites

The National Pollution Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources (e.g., pipes) that discharge pollutants into surface waters, by imposing effluent limitations to protect the environment. These sites tend to be located in highly industrialized and/or urban areas of Michigan, many of which are facing economic hardship. The number of NPDES sites is positively related to population and negatively related to employment levels. For each additional NPDES site, a MCD is expected to have a higher population of more than 31 people, but lower resident employment of more than 22 jobs. While this could suggest that people tend to locate in contaminated areas (such as more urban locations), it could also simply suggest that communities with larger populations are more likely to have more NPDES sites. The cumulative effects of NPDES sites is a lower population of close to 20 people and a lower resident employment level of close to eight jobs, indicating that people who are able to relocate are moving away from areas with higher concentrations of NPDES sites (e.g., industrial and urban areas).

4.2.6.3 Part 201 Contaminated Sites

Part 201 contaminated sites are facilities and places where there has been a significant release of hazardous substances. Part 201 of the Natural Resource Environmental Protection Act (NREPA) regulates the majority of known sites in Michigan. At the time of this study, there are more than 4,000 Part 201 contaminated sites in the state, with the vast majority located in highly industrialized areas. As expected, population and income levels are lower in communities with these types of contaminated sites. For each additional Part 201 contaminated site in a community, resident population is lower by more than 85 people, and per capita income is lower by $83.98. Resident employment, on the other hand, is higher by close to 54 jobs. This is consistent with expectations that these locations are not highly desirable places to live. Due to the employment opportunities found in industrial areas, the cumulative effect of higher employment levels is a higher population of close to 14 people. However, due to people's dislike of living in or near these types of contaminated environments, the cumulative employment effect is only higher by close to five jobs, as opposed to 54 from the direct effect (a decrease of 49). The per capita income effect remains the same—lower by $83.98. These results indicate that although people prefer not to live near these contaminated sites, the draw of employment opportunities is stronger, particularly for those with fewer options, as indicated by the lower per capita income level. There may be an equity issue, with a lower-income population being more prevalent in undesirable locations, due to the lower cost of living.

Part 5: Summary of Results

MUCH OF THE GROWING POPULATION IN SPARSELY POPULATED AREAS CAN BE ATTRIBUTED TO SPRAWL, WHICH IS DRIVEN PARTLY BY THE DESIRE FOR MORE OPEN SPACE AND LARGER LOT SIZES THAN AVAILABLE IN URBAN AND SUBURBAN SETTINGS. HENCE, POPULATION AND EMPLOYMENT MAY BE LOWER WHERE PEOPLE BUILD "ESTATES," WHILE THE AVERAGE INCOME IS HIGHER.

5.1 Basic Land Assets

Basic land assets are simple categories of open space, such as a wetland or farmland. Overall, basic land assets tend to have a cumulative effect that is negative for population and employment, but highly positive for income. This seems to demonstrate that these areas are desirable places to reside for higher-income households; however, they also tend to be more expensive places to live, ultimately leading to lower population and employment levels. Basic land assets, in general, are attractive to people with higher incomes. Much of the growing population in sparsely populated areas can be attributed to sprawl, which is driven partly by the desire for more open space and larger lot sizes than available in urban and suburban settings. Hence, population and employment may be lower where people build "estates," while the average income is higher.

5.2 Ecological Land Assets

These are assets that reflect a known or predictive ecological value that is higher than those discussed in the basic land asset section. Ecological land assets tend to be large intact landscapes located away from population centers. Based on the cumulative effects, most ecological land assets are found to be negatively related to the population and employment of a community. This may be the result of population shifts from rural areas to more suburban and urban locations, but does not negate the fact that people are attracted to open space and unique natural land features. By definition, these assets tend to be located in very rural, isolated MCDs with small populations and low economic activity.

5.3 Basic Water Assets

These are basic categories of water features, such as lakes, rivers and shorelines. Overall, the results indicate that population is generally attracted to basic water assets, but incrementally so. People may be more willing to live in a community away from the water, with access to larger lakes, as opposed to living in a community with several small lakes with complex shorelines. The small effect on population may also be explained, in part, by the amount of future growth that is possible given a very limited resource like shoreline. The results may be confounded by the fact that much of Michigan's shorelines were already developed by the mid-1900s. The results also indicate that while people may be attracted to water assets, limited employment opportunities may cause them to reside elsewhere.

5.4 Ecological Water Assets

This category focuses on water assets that reflect a known or predictive ecological value that is higher than those discussed in the basic water assets section. High-quality ecological water assets tend to be found in the northern portions of the state. The results indicate that trout streams, no impact streams and functional (high-quality) sub-watersheds all have a cumulative effect of higher population and employment levels in the community.

This result is due primarily to the direct effect of increased resident employment levels in the community, resulting in the attraction of additional residents. This may be the result of tourism-related economic development in northern portions of the state where water quality tends to be higher.

5.5 Developed Land and Water Assets

This category focuses on assets that provide access to the natural environment. Without access, it is typically difficult for residents to value the natural features of a region. This study finds that state forest campgrounds, identified trails and boat launches are all associated with higher cumulative levels of population and resident employment. This is predominantly due to the direct effect of increased resident employment resulting in increased population. People and employment are attracted to locations with these types of accessible features. On the other hand, developed inland lake frontage and marinas are associated with lower population and employment levels, when the cumulative effects are investigated. While developed inland lake frontage appears to be slightly attractive to people, the lower employment levels result in lower total population in the community.

5.6 Negative Land and Water Assets

Unlike the previous categories discussed, this category focuses on pollution-related items that carry a negative perception. Also, unlike many of the other asset categories, negative assets are typically located in Michigan's most industrialized areas. As might be expected, an increase in the number of NPDES sites is associated with a cumulative decrease in population and employment, while the number of Part 201 sites reflects a dramatic decrease in income. On the other hand, Part 201 sites are correlated with a cumulative increase in population and employment. The results appear to indicate that, while people prefer to live away from contaminated sites and facilities that discharge wastewater into adjacent rivers and streams, finding employment and a lower cost of living can be overriding factors.

Part 6: Discussion

IF MICHIGAN IS TO REVERSE ITS LOSS OF POPULATION, MORE EFFORT MUST BE MADE TO SUSTAINABLY CAPITALIZE ON GREEN INFRASTRUCTURE, IMPROVE AND PROMOTE HIGH-QUALITY ENVIRONMENTS, REDEVELOP AND REDESIGN VIBRANT URBAN PLACES TO INCLUDE RECREATIONAL OPPORTUNITIES, AND BUILD ON SOCIAL AND CULTURAL ASSETS IN LOCAL COMMUNITIES.

The results of this study clearly demonstrate that natural assets can be important to the economic performance of local communities in Michigan. These results are not surprising given the findings from previous natural asset studies across the United States. Similar to other categories of variables in the study, such as social and cultural assets, the results of the natural asset analysis are not similar across all variables. Of the 27 natural asset variables included in the study, 19 (70%) had a positive impact on population, income and/or employment levels, with only one variable (state environmental areas) having a negative effect. The remaining seven variables had no significant effect.

Positive effects spanned all major categories of green infrastructure included in this study: 1) basic land assets, 2) ecological land assets, 3) basic water assets, 4) ecological water assets and 5) developed land or water assets. From a cumulative effects perspective, 14 of the 27 green infrastructure variables (52%) had at least one positive cumulative impact on resident population, income and/or employment levels. Additionally, nine of the 27 variables had zero cumulative effects (or a value of less than one), leaving only four variables that had a negative cumulative effect on population, income and/or employment levels.

Of particular interest, seven of the 27 green infrastructure variables (26%) had only positive cumulative effects on both population and employment levels. These include: 1) miles of Great Lakes shoreline, 2) presence of a trout stream, 3) miles of reference or no impact streams, 4) percentage of functional sub-watersheds, 5) number of state forest campgrounds, 6) presence of identified trails, and 7) number of boat launches. These numbers compare favorably to the social and cultural asset variables analyzed in the study, which include four of the 15 (26%) variables showing only positive cumulative effects.

A common, but significant, characteristic of three of the seven green infrastructure variables mentioned above is high-quality river systems. Designated trout stream is a very strict designation determined by the Michigan Department of Natural Resources, based on a stream's ability to support healthy trout populations (which are highly sensitive to degraded environmental conditions). No impact or reference streams and functional sub-watersheds represent river systems with minimal human disturbance within the river itself, along the riparian zone and floodplain, as well as within the surrounding landscape that drains into the river system. Again, most of these pristine river systems are located in the northern Lower Peninsula and the Upper Peninsula. It is important to recognize that all three of these river-based variables are inherently dependent on high-quality natural environments. Another common thread for three of these variables is the importance of accessibility. Campgrounds, trails and boat launches all provide critical access to Michigan's wealth of natural lands and waters. It appears that not only does population increase in places with high-quality water resources, it also increases in places that provide a high level of access to the state's natural environments.

Overall, it is apparent that natural assets are appealing to people in Michigan who can afford to

live in close proximity to these amenities, as seen through positive income changes and/or population increases. On the other hand, natural assets are probably not enough to spur economic growth without other asset types already in place. The places that tend to have a large amount of natural assets also tend to be places that have lower employment potential, due to their more isolated locations. As seen in the results, often times, when the amenity's effect on resident employment levels is positive, the resulting cumulative effect on population levels will usually be positive, even when the amenity is not necessarily attractive to people. In other words, jobs matter, and existing employment levels will continue to play a strong role in the expected population of a community. An important take-home message, however, is that green infrastructure or natural assets can certainly enhance economic performance in existing population centers and metropolitan regions in Michigan. Based on the findings in this study, natural assets that communities should pay particular attention to for improving economic performance are: 1) Rivers and streams; 2) Recreational access (trails, campgrounds, boat launches, etc.); and 3) Great Lakes shoreline. Other natural assets that are found to be important economically from an income perspective include: 1) Wetlands; 2) Forests; 3) Agriculture; and 4) Botanical gardens.

Overall, the results underscore the importance of several ongoing initiatives that are supporting long-term sustainability. Such efforts as Smart Growth, local and community food systems, brownfield redevelopment, making communities more walkable and sustainable, addressing nature deficit disorder and restoring and cleaning the Great Lakes each, in one way or another, address sustainability and are accessible to high-quality amenities and green infrastructure. Parks and green infrastructure networks are recognized as being positive population attractors for various age groups. Sustainability and a clean environment are important for all walks of life. If Michigan is to reverse its loss of population, more effort must be made to sustainably capitalize on green infrastructure, improve and promote high-quality environments, redevelop and redesign vibrant urban places to include recreational opportunities, and build on social and cultural assets in local communities.

Lastly, there are some limitations when undertaking this type of modeling effort that must be addressed. While the model includes as many factors as possible to explain population, employment and income change, there could be other factors that have affected those changes. Statistically, those factors are captured by the error term of the regression analysis. However, this does little to assist decision-making in the policy arena. For instance, local parks are not included in the analysis, due to being highly correlated with other green infrastructure characteristics. However, campgrounds, trails and other environmental data ought to capture the nature of parks. Since parks are a recognized green strategy, other modeling efforts that focus more squarely on parks may be warranted. Additionally, we recognize that second-home ownership may affect growing populations in rural and green infrastructure areas of the state. Controlling for this factor will also be important in future modeling efforts. Furthermore, a more precise model could be estimated if we had improved data. For instance, we still do not have a digitized source of all of Michigan's trails. Finally, there may be factors outside the state that affect changes in population, income and employment. Does being located closer to say, Chicago (IL), affect change? Does being closer to Sault Ste. Marie, Ontario affect those changes? What about Wisconsin? Desirable places and their parks may, to one degree or another, affect changes in this state. Depending on the how we want to examine this, it is possible to control for these influences, as well.

Part 7: Recommendations

THE OLD PARADIGM PITTING CONSERVATION AGAINST ECONOMIC DEVELOPMENT WILL NOT LEAD THE STATE TO THE DESIRED OUTCOME OF ECONOMIC PROSPERITY. IN ORDER TO FULLY CAPITALIZE ON THE RESULTS OF THIS STUDY, A NEW FORM OF ECONOMIC GROWTH WILL NEED TO BE CREATED.

Much is being said nationally and internationally about green infrastructure and economic development. In Europe, green has been translated into more than the conservation of natural features and includes such things as the expansion of clean technology, green technology and sustainability-related products. At the national level, the Obama administration is promoting and has provided hundreds of billions of dollars targeting green infrastructure and the broader green economy. With its natural resources base, its alternative energy resource capacity, its huge and unique agricultural industry and the state's long-term history and prominence in preservation and conservation, Michigan may well be poised to be the leading green state in the nation. The following recommendations are provided based on the report's findings.

7.1 Policy

1. The results from this report do not encourage unbridled development of our natural lands or the 100% conservation of all open space. Rather, the findings point communities toward the long-term viability of their most important natural assets coupled with compatible, sustainable economic development.

2. Michigan should develop a green economy plan that incorporates ideas about how its natural resource base can be leveraged to help position its economy for long-term success, while improving the health of Michigan's natural assets and environment. The People and Land Initiative has identified Natural Resources for Recreation and Jobs as a "Pillar for Prosperity," but no definitive plan exists to reach such an objective. We recommend that the administration should direct its agencies to collaborate and deliver a plan for securing and improving Michigan's natural resources for place-base economic development, quality of life, recreation and talent attraction. If there is a prosperity pathway through "green," Michigan should be the state that's leading the nation.

Michigan should develop a green economy plan that incorporates ideas about how its natural resource base can be leveraged to help position its economy for long-term success, while improving the health of Michigan's natural assets and environment.

3. One of the unique observations resulting from this study is that people are attracted to both employment centers and natural assets. However, employment centers in Michigan are typically highly urbanized. Urban and suburban communities have an excellent opportunity to increase their locational competitiveness by maintaining, restoring and enhancing their unique natural assets.

4. Obviously, Michigan's natural assets are diverse. This study begins to link various green asset categories to prosperity. We recommend that state agencies be tasked with developing and implementing strategies that recognize the estimated impact of various natural amenities, based on the findings of this report.

One of the keys to facilitating the smart conservation/restoration of green infrastructure is to increase the accessibility of natural features information to local communities and decision makers.

5. Planners and community and economic developers should explicitly consider the role of green infrastructure in all land use planning and economic growth activities, particularly master land use plans, and park and recreation plans.

6. In addition to green infrastructure's effect on economic growth, planners and community and economic developers should also explicitly consider the benefits that ecological services and green infrastructure provide (flood protection, pollution filtration, water storage, climate regulation, wildlife habitat, recreation opportunities, research and education, etc.), when making decisions about the future of Michigan's communities.

7. Since natural features and processes typically do not follow jurisdictional boundaries, regional or watershed planning efforts should be strongly encouraged or incentivized. Jurisdictions that collaborate with their neighboring municipalities should be rewarded with grant funding to help complete planning, design or implementation efforts.

8. Similar to the Michigan Natural Resources Trust Fund (MNRTF) requiring an updated parks and recreation plan for communities to apply for funding, the state should require that all natural features be fully addressed in all land use planning activities, particularly land use master plans, in order to receive certain types of state financial assistance.

9. Since many landscape ecosystems and ecological processes, such as hydrology, occur over large scales, the state should take the lead in developing and promoting large-scale ecosystem management efforts. These efforts should be highly integrated and inclusive of economic, social, and ecological goals and objectives.

10. The old paradigm pitting conservation against economic development will not lead the state to the desired outcome of economic prosperity. In order to fully capitalize on the results of this study, a new form of economic growth will need to be created. This new paradigm will need to implement more of an integrated approach that takes into account the triple bottom line (economic prosperity, social equity and ecological health), and shift toward a model founded upon long-term sustainability.

7.2 Outreach

1. One of the keys to facilitating the smart conservation/restoration of green infrastructure is to increase the accessibility of natural features information to local communities and decision makers. To do this, we will need: 1) a central hub to organize the information and serve as a gateway; 2) a suite of decision support tools for different types of applications, such as utility planning, climate change adaptation and comprehensive land use plans; 3) a clearinghouse to store and share relevant data, information and knowledge; 4) technical support to assist end

users and build capacity within communities; and 5) outreach and education to engage and inspire constituents across the state.

2. There should be support from the state to support additional outreach activities explaining the relationship between green infrastructure and economic growth to planners, economic development officials and other decision makers.

7.3 Funding

1. In order to fully capitalize on a region's natural features, local communities need to know what they have, where it's located, how much they have, and what condition it is in. To accomplish this, there should be long-term financial support from the state to conduct a statewide systematic natural features inventory. This type of effort should be prioritized based on a set of logical criteria, such as the degree of threat to the resources, the amount of natural features, proximity to population centers, etc.

2. Pure Michigan ads have been successful in attracting tourists to Michigan, which translates into additional revenue for future management and consumer spending in our communities. We strongly recommend that the state maintain funding at current levels for the Pure Michigan Campaign to increase natural resource-based tourism activity.

3. Michigan is in desperate need of long-term stable funding to support natural features data management and delivery, smart conservation and restoration, applied research, technical support and outreach. A strategy needs to be deployed that engages a diverse coalition of groups who can build broad support for long-term funding and make it a reality. Successful revenue generation ideas in other states include: the percentage of sales tax, the percentage of real estate transfer tax, and bonds to provide important long-term support.

7.4 Research

1. By conducting this analysis at the MCD scale, this study was able to uncover patterns occurring at a relatively small scale. As a follow up, a better understanding of the proximity effect of various quality-of-life and cultural assets and green infrastructure assets on community growth is needed. For example, someone may live and work in different places. Understanding the effects that nearby jurisdictions have on population, employment and income change is essential. These proximity effects could have a significant impact on the potential growth of a community.

2. Due to the fact that the vast majority of natural features are located in rural MCDs, we should conduct an analysis that distinguishes between rural and urban MCDs, or at least metropolitan and non-metropolitan MCDs. It would be very interesting to compare urban communities rich in natural features with urban communities poor in natural features. This distinction may also show significant differences in regard to quality-of-life and cultural assets.

3. From an ecological perspective, Michigan is a relatively diverse state, to which several different types of regional frameworks have been applied. Because of these regional differences, an econometric analysis of green infrastructure should be conducted based on ecological regions rather than the whole state. The addition of data from the 2010 Census would also determine, spatially, where the concentrations of wealth and growth occurred in the 2000s by MCD.

4. Zoning is decided at the local level. An inventory of zoning ordinances by MCD should be collected and the relationship between various types of zoning ordinances, natural features and economic performance should be explored.

5. Several efforts and trends are currently underway in Michigan—such as development of wind energy in agricultural areas and a new pheasant initiative focusing on private lands by the DNR. Specific studies should be conducted on a case-study basis to determine the effective synergy between different sectors of the economy—such as agricultural wind energy and biofuels-pheasant production—in order to identify new and innovative partnerships that can enhance local economies and promote natural resource use, conservation and alternative energy production.

Part 8: Conclusion

THE RESULTS OF THIS STUDY DEMONSTRATE THAT THE TRADITIONALLY-VIEWED DICHOTOMY OF "THE ECONOMY VERSUS THE ENVIRONMENT" IS LARGELY A FALSE ONE. MICHIGAN POSSESSES AN ABUNDANCE OF NATURAL AMENITIES, AND THESE AMENITIES APPEAR TO BE UNDER-RECOGNIZED AS ENGINES OF PROSPERITY.

THE KEY ISSUE OF FOCUS IN THIS STUDY IS EXPLORING THE ROLES OF GREEN INFRASTRUCTURE AND OTHER NATURAL FEATURES IN ECONOMIC GROWTH, AND DOING THIS FOR SPECIFIC CATEGORIES OF AMENITIES AND GREEN ASSETS. THE ANALYSIS DELVES TO A NEW LEVEL OF DETAIL ABOUT GREEN ASSETS BY ACCOUNTING FOR SPECIFIC ASSETS, FOR WHICH DATA ARE AVAILABLE IN MICHIGAN AND ONLY FROM THE MNFI DATABASE. FOR THE FIRST TIME, WE ARE ABLE TO EXPLAIN HOW GREEN ASSETS RELATE TO ECONOMIC OPPORTUNITIES THROUGH THE PATHWAYS OF INCOME, EMPLOYMENT AND THE ATTRACTION OF PEOPLE SEEKING VARIOUS FORMS OF AMENITIES.

The link between the environment and the economy has not been well established. This may well be the result of having more than 20 decades of economic data collection, while environmental and amenities data collection efforts have been more recent and inconsistent. The environmental community emerged out of individual and community interest in protecting the environment, and the primary focus of the environmental movement has not always been focused on reconciling economic and environmental objectives. The big picture interest in the possible complementarity of economic and environmental issues has been lackluster, but the nation is now increasingly interested in the link between the environment and the economy. This is particularly true in states like Michigan, where there is a strong legacy of natural assets, as well as strong interest in economic recovery.

The MNFI and LPI partnership offers a preliminary, but important, opportunity to better understand the relationships that exist between the environment and the economy. The economic analysis here can serve as the basis for further research on how the environment is linked to economic success and prosperity. A key finding from this analysis is that natural features and other natural amenities not only deliver individual pecuniary benefits, but that they influence the economies of places. The results of this study demonstrate that the traditionally-viewed dichotomy of "the economy versus the environment" is largely a false one. Michigan possesses an abundance of natural amenities, and these amenities appear to be under-recognized as engines of prosperity.

A key finding from this analysis is that natural features and other natural amenities not only deliver individual pecuniary benefits, but that they influence the economies of places.

The key issue of focus in this study is exploring the roles of green infrastructure and other natural features in economic growth, and doing this for specific categories of amenities and green assets. The analysis delves to a new level of detail about green assets by accounting for specific assets, for which data are available in Michigan and only from the MNFI database. For the first time, we are able to explain how green assets relate to economic opportunities through the pathways of income, employment and the attraction of people seeking various forms of amenities.

While various natural amenities, such as lakes, have been known to be associated with direct economic activity, such as fishing, this study shows that a wide array of natural amenities in communities across Michigan are associated with economic growth. Nineteen different natural amenities, ranging across the categories of basic land assets, ecological land assets, basic water assets, ecological water assets, and developed land and water assets, are found to have a direct positive relationship to various factors related to prosperity, including population growth, per capita income and resident employment levels. This is particularly true for many of the water-based assets, as well as developed land and water assets that provide access to Michigan's wealth of natural assets, such as campgrounds, boat launches and trails.

Natural features are inherently place based, though zoning and economic activities hold the potential to enhance them. Different regions of the state, as well as MCDs within those regions, have varying amounts, conditions and types of natural features. All MCDs regardless of location, amount of natural features or proximity to population centers, can employ a set of strategies to capitalize on their inherent natural features and green infrastructure assets. Placemaking is quickly becoming an important tool in the economic growth toolbox, and such natural features as Great Lakes coastal areas, large wetland complexes, or big river systems and adjacent riparian zones, are critical elements to discovering each community's unique sense of place.

It follows that if green infrastructure is essential for the future performance of Michigan's economy, we need to know as much about the state's natural features, or green infrastructure, as we know about roads, bridges, utility corridors, water/sewer lines or gray infrastructure. In order for communities to effectively capitalize on their natural features to help improve economic performance, they need to know what they have, what condition it's in, how much is left, and where it is located. Currently our level of data, information and knowledge of Michigan's natural features is disparate in comparison to the data available for gray infrastructure, the economy and people and households. This is primarily attributable to the fact that natural features are public goods, as well as goods for which people and governments have never really put in the context of economic performance.

Given the positive effects of green infrastructure on economic growth, based on this initial study, we recommend that Michigan develop a strong policy direction centered around green infrastructure and natural assets.

Despite initial evidence that certain natural assets can spur economic growth at the local scale, we are not advocating for the unbridled development of our natural lands or the 100% conservation of all remaining open space. Rather, the findings point communities toward the long-term viability of their most important natural assets coupled with compatible, sustainable economic development. To accomplish this, communities need to take inventory of their natural assets, assess their existing and potential viability and employ a strategic conservation approach, such as green infrastructure planning.

Given the positive effects of green infrastructure on economic growth, based on this initial study, we recommend that Michigan develop a strong policy direction centered around green infrastructure and natural assets. This policy

direction should provide the necessary support for: 1) the continued development of natural features data collection, research and analysis; 2) the targeted conservation, restoration and enhancement of natural lands and waters; 3) increased accessibility to Michigan's great outdoors for the general public; 4) integrating the important role of Michigan's natural assets into placemaking strategies and marketing campaigns; 5) providing better opportunities for local communities, individual residents and children to connect to their surrounding natural environment; and 6) developing a robust system for organizing and sharing natural resource-based data, information and knowledge to support various planning and economic development efforts.

Michigan finds itself at a crossroads. For more than a decade, Michigan has been suffering from an economic crisis from which it is still trying to recover. The impacts have been devastating to state and local governments, businesses, communities and families alike. To truly move the economy forward, a new paradigm is needed based on identifying, sustaining and enhancing its strengths and assets. Despite Michigan's dependence on the automobile sector and associated manufacturing industries over the last half of the 20th century, Michigan's underlying strengths have always been its wealth of natural resources. Bordering four of the five Great Lakes, Michigan is known proudly as the Great Lakes State. The two peninsulas encompass more than 37 million acres of land, and at 19 million acres, the state contains the largest stock of forestland east of the Mississippi River. More than 38,000 miles of rivers and approximately 11,000 lakes can also be found within Michigan's borders. Its 3,200 miles of Great Lakes shoreline also boast the largest collection of freshwater dunes in the world. In moving forward, one of the biggest challenges Michigan faces is finding a way to balance desired economic growth with the long-term viability of its natural assets. Perhaps it is from the very challenge of defining, understanding and implementing long-term sustainability that new ideas and solutions will ultimately emerge for Michigan to become prosperous in the 21st century.

Part 9: Appendices

Appendix 1: Variables and Sources

Table 3: Variables and Sources

Variable	Asset Class	Sub Category	Source
Population Change: 1990–2000	Predicted Endogenous	N/A	U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 1." Available at: http://www.census.gov. U.S. Census Bureau. 2000. "Census of Population and Housing, Summary File 1." Available at: http://www.census.gov.
Per Capita Income Change: 1990–2000			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov. U.S. Census Bureau. 2000. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
Total Employment Change: 1990–2000			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 4." Available at: http://www.census.gov. U.S. Census Bureau. 2000. "Census of Population and Housing, Summary File 4." Available at: http://www.census.gov.
Total Population in 1990	Initial Condition		U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 1." Available at: http://www.census.gov.
Total Employment in 1990			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 4." Available at: http://www.census.gov.
Per Capita Income in 1990			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
Population per Square Mile in 1990	Demographic		U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 1." Available at: http://www.census.gov. Calculated by LPI.
% of Population Age 65 and Older in 1990			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of Population Age 25 to 34 in 1990		Knowledge	U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of Foreign Born in 1990			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of Working Class Total in 1990		N/A	U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 4." Available at: http://www.census.gov. Florida, R. 2002. *The Rise of the Creative Class*. New York, NY: Basic Books.
% of Owner-Occupied	Housing Market		U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 1." Available at: http://www.census.gov.
Median Housing Value of all Owner-Occupied Housing Units			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
Institutional Influence: Universities	Education	Knowledge	Michigan Education Directory. 2001. "2000 Michigan Education Directory." Lansing, MI. Calculated by LPI.
% of Population Age 25 and Older with an Associate's Degree in 1990			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of Population Age 25 and Older with a Bachelor's Degree in 1990			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of Population Age 25 and Older with a Graduate or Professional Degree			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
Rural Interstate Road Density	Grey Infrastructure	N/A	Michigan Center for Geographic Information. 2006. "Allroads Version 6b [ESRI Shapefile]." Available at: http://www.mcgi.state.mi.us/mgdl.

Note: BL=Basic Land; BW=Basic Water; EL=Ecological Land; EW=Ecological Water; NLWA=Negative Land/Water Assets; DLWA=Developed Land/Water Assets; Urban=Urban Amenities Index.

Table 3: Variables and Sources (cont.)

Variable	Asset Class	Sub Category	Source
Rural Freeway Road Density	Grey Infrastructure	N/A	Michigan Center for Geographic Information. 2006. "Allroads Version 6b [ESRI Shapefile]." Available at: http://www.mcgi.state.mi.us/mgdl.
Urban Interstate Road Density			Michigan Center for Geographic Information. 2006. "Allroads Version 6b [ESRI Shapefile]." Available at: http://www.mcgi.state.mi.us/mgdl.
Urban Freeway Road Density			Michigan Center for Geographic Information. 2006. "Allroads Version 6b [ESRI Shapefile]." Available at: http://www.mcgi.state.mi.us/mgdl.
Southern Half of Lower Peninsula	Regional		Land Policy Institute. 2010. Determined using GIS.
Upper Peninsula			Land Policy Institute. 2010. Determined using GIS.
% of People Employed Age 16 and Older: Mining	Economy Structure		U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of People Employed Age 16 and Older: Finance, Insurance and Real Estate			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of People Employed Age 16 and Older: Services			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
% of People Employed Age 16 and Older: Manufacturing			U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
Racial Diversity Index	Other New Economy Assets		U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 1." Available at: http://www.census.gov. Calculated using Simpson's Diversity Index by LPI.
% of Creative Class Employment in 1990		Knowledge	U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 4." Available at: http://www.census.gov. Florida, R. 2002. *The Rise of the Creative Class.* New York, NY: Basic Books.
% of Poverty in 1990	Social/Cultural	Socio-Economic	U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 3." Available at: http://www.census.gov.
Distance to Urban Center (Miles)		Urban	Michigan Center for Geographic Information. 2006. "Minor Civil Divisions – Dissolved Version 7b." Available at: http://www.mcgi.state.mi.us/mgdl. U.S. Census Bureau. 2000. "Urban Areas." Available at: http://www.census.gov/geo/www/cob/bdy_files.html.
# of Arboreta, Botanical and Zoological Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Dance Studios, Schools and Halls			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Theatrical Producer Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Bands, Orchestras, Actors and Other Entertainment/Entertainers	Social/Cultural	Urban	Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Bowling Center Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.

Table 3: Variables and Sources (cont.)

Variable	Asset Class	Sub Category	Source
# of Sports Clubs and Promoters Businesses	Social/Cultural	Urban	Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Racing Tracks and Racetrack Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Physical Fitness Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Coin-Operated Amusement Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Amusement Park Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Membership Sports and Recreational Clubs			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Other Recreational Businesses (Includes Skiing)			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
Eating and Drinking Places per Capita			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA. U.S. Census Bureau. 1990. "Census of Population and Housing, Summary File 1." Available at: http://www.census.gov.
Square Meters of Public Land	Green Infrastructure	BL	Ducks Unlimited and The Nature Conservancy in Michigan. 2007. "Conservation and Recreation Land of Michigan [ESRI Shapefile]." Ducks Unlimited Great Lakes/Atlantic Regional Office, Ann Arbor, MI: Available at: http://glaro.ducks.org/carl. Updated: July 20, 2007.
Square Meters of Private Land			Ducks Unlimited and The Nature Conservancy in Michigan. 2007. "Conservation and Recreation Land of Michigan [ESRI Shapefile]." Ducks Unlimited Great Lakes/Atlantic Regional Office, Ann Arbor, MI: Available at: http://glaro.ducks.org/carl. Updated: July 20, 2007.
% of Agriculture			U.S. Geological Survey. 1992. "National Land Cover Database [ESRI Raster]."
% of Forested Land			U.S. Geological Survey. 1992. "National Land Cover Database [ESRI Raster]."
% of Sand, Rock and Clay			U.S. Geological Survey. 1992. "National Land Cover Database [ESRI Raster]."
% of Shrubland			U.S. Geological Survey. 1992. "National Land Cover Database [ESRI Raster]."
Presence of Important Bird Habitat		EL	The Nature Conservancy. 1999. "IBA_birdsites_USA.shp." Unpublished data.
% MCD Consisting of Natural Vegetation Core Area			Michigan Natural Features Inventory. 2008. "_natveg2 (Grid with water removed)." Unpublished data.
% MCD Consisting of Potentially High-Quality Patches of Natural Habitat			Michigan Natural Features Inventory. 2008. "Unchanged (Grid)." Unpublished data.
% MCD Consisting of Inland Lakes		BW	Michigan Department of Natural Resources. 2005. *Digital Water Atlas, ifr_inland_lakes.shp*. MDNR Fisheries Division, Institute for Fisheries Research.
Miles of River			Michigan Department of Natural Resources. 2009. *Digital Water Atlas, mi_nhd_gap.shp*. MDNR Fisheries Division, Institute for Fisheries Research.

Note: BL=Basic Land; BW=Basic Water; EL=Ecological Land; EW=Ecological Water; NLWA=Negative Land/Water Assets; DLWA=Developed Land/Water Assets; Urban=Urban Amenities Index.

Table 3: Variables and Sources (cont.)

Variable	Asset Class	Sub Category	Source
Miles of Great Lakes Shoreline	Green Infrastructure	BW	Michigan Center for Geographic Information. 2006. "Minor Civil Divisions – Dissolved Version 7b [ESRI Shapefile]." Available at: http://www.mcgi.state.mi.us/mgdl. National Oceanic and Atmospheric Administration. 1999. Lakes Digital Geography. "Polygons of the Great Lakes region [ESRI Shapefile]."
Miles of Inland Lake Shoreline			Michigan Department of Natural Resources. 2005. *Digital Water Atlas, ifr_inland_lakes.shp*. MDNR Fisheries Division, Institute for Fisheries Research.
Presence of State Environmental Area		NLWA	Michigan Department of Environmental Quality. 2003. Unpublished data. MDEQ Land & Water Management, Wetlands, Lakes and Streams Unit.
% of Wetland		EW	U.S. Geological Survey. 1992. "National Land Cover Database [ESRI Raster]."
Presence of a Trout Stream			Michigan Department of Natural Resources. 2003. *Digital Water Atlas v1, Trout Streams 2003*. MDNR Fisheries Division.
# of High-Quality Lakes			Michigan Natural Features Inventory. 2008. "HqCommonLakes_Statewide.shp." Unpublished data.
Miles of Reference/ No Impact Streams			Institute of Fisheries Research and the Michigan Department of Natural Resources. Date Unknown "mi_epastar_nhd_ stresref.shp." MDNR Fisheries.
% of Functional Sub-Watershed			Michigan Natural Features Inventory. 2008. "functional_ subwatersheds.shp." Unpublished data.
# of State Forest Campgrounds		DLWA	Michigan Department of Natural Resources. Date Unknown. "state_forest_campgrounds.shp."
Presence of Identified Trails			Michigan Natural Features Inventory. 2009. "lpi_trails.shp." Unpublished data.
# of Fish Stocking Sites			Michigan Department of Natural Resources. 2000 "Fisheries Stocking Site Points." MDNR Fisheries.
Amount of Developed Inland Lake Frontage (Miles)			U.S. Geological Survey. 1992. "National Land Cover Database [ESRI Raster]." Michigan Center for Geographic Information. 2004. "Michigan Lake Polygons [ESRI Shapefile]." Available at: http://www.mcgi.state.mi.us/mgdl.
# of Boat Launches			Michigan Department of Natural Resources. 2009. "mcd_miv8a_ds.shp." MDNR Forest Minerals and Fire Management Division.
# of Marina Businesses			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Dams			Michigan Department of Environmental Quality. 2003. "dams. shp." Unpublished data. MDEQ Land & Water Management, Wetlands, Lakes and Streams Unit.
# of Public Golf Courses in Each MCD			Walls and Associates. 2006. "NETS: National Establishment Time-Series Database." Oakland, CA.
# of Mines			U.S. Geological Survey. 2005. "mineplant_mi.shp."
# of National Pollutant Discharge Elimination System (NPDES) Sites		NLWA	Michigan Department of Environmental Quality. 2003. Unpublished Data. MDEQ Land & Water Management, Wetlands, Lakes and Streams Unit, NPDES_GW_permits.
# of Part 201 Contaminated Sites			Michigan Department of Environmental Quality. 2012. "Part 201 Site List." Available at: http://www.deq.state.mi.us/part201/.

Appendix 2: Data Descriptive Statistics

Table 4: Descriptive Statistics

Variable	Asset Class	Sub Category	Mean	Standard Deviation	Min.	Max.
Population Change: 1990–2000	Predicted Endogenous	N/A	424.28	2,657.62	-76,704	27,764
Per Capita Income Change: 1990–2000			7,850.02	2,727.70	-812	31,552
Total Employment Change: 1990–2000			311.58	848.66	-4,984	14,209
Total Population in 1990	Initial Condition		6,143.62	29,425.64	15	1,027,974
Total Employment in 1990			2,753.50	10,648.12	5	335,463
Per Capita Income in 1990		Quality of Life	12,056.52	4,616.39	4,768	77,948
Population per Square Mile in 1990	Demographic	N/A	469.62	1,070.22	0.42	8,776.53
% of Population Age 65 and Older in 1990			13.59	5.63	2.11	48.72
% of Population Age 25 to 34 in 1990		Knowledge	15.18	2.88	3.39	34.12
% of Foreign Born in 1990			1.74	1.96	0	22.22
% of Working Class Total in 1990		N/A	35.20	9.07	0	100
% of Owner-Occupied	Housing Market		0.63	0.19	0	1
Median Housing Value of all Owner-Occupied Housing Units			53,880.07	29,473.88	0	500,001
Institutional Influence: Universities	Education	Knowledge	4,479.64	4,046.53	0	27,567.3
% of Population Age 25 and Older with an Associate's Degree in 1990			6.17	2.23	0	19.19
% of Population Age 25 and Older with a Bachelor's Degree in 1990			7.91	5.45	0	38.50
% of Population Age 25 and Older with a Graduate or Professional Degree			4.33	4.19	0	39.57
Rural Interstate Road Density	Gray Infrastructure	N/A	19.11	77.88	0	1,172.59
Rural Freeway Road Density			11.45	52.71	0	572.91
Urban Interstate Road Density			41.03	161.17	0	2,117.50
Urban Freeway Road Density			18.27	99.43	0	1,558.82
Southern Half of Lower Peninsula	Regional		0.60	0.49	0	1
Upper Peninsula			0.11	0.32	0	1
% of People Employed Age 16 and Older: Mining	Economy Structure Factors	N/A	1.01	2.86	0	45.35

BL=Basic Land; BW=Basic Water; EL=Ecological Land; EW=Ecological Water; NLWA=Negative Land/Water Assets; DLWA=Developed Land/Water Assets; Urban=Urban Amenities Index.

Table 4: Descriptive Statistics (cont.)

Variable	Asset Class	Sub Category	Mean	Standard Deviation	Min.	Max.
% of People Employed Age 16 and Older: Finance, Insurance and Real Estate	Economy Structure Factors	N/A	4.10	2.60	0	60
% of People Employed Age 16 and Older: Services			0.28	0.08	0	1.08
% of People Employed Age 16 and Older: Manufacturing			0.25	0.09	0	0.53
% of People Employed Age 16 and Older: Agriculture			0.05	0.05	0	0.48
Racial Diversity Index	Other New Economy Assets		0.08	0.15	0	1.86
% of Creative Class Employment in 1990		Knowledge	25.63	9.32	0	72.89
% of Poverty in 1990	Social/Cultural	Socio-Economic	12.44	7.39	0	57.50
Distance to Urban Center (Miles)		Urban	68,021.38	75,013.91	0	312,036.75
# of Arboreta, Botanical and Zoological Businesses			0.01	0.12	0	2
# Dance Studios, Schools and Halls			0.24	0.83	0	11
# of Theatrical Producer Businesses			0.21	1.39	0	41
# of Bands, Orchestras, Actors and Other Entertainment/Entertainers			0.41	1.61	0	34
# of Bowling Center Businesses			0.29	0.85	0	12
# of Sports Clubs and Promoters Businesses			0.07	0.39	0	9
# of Racing Tracks and Racetrack Businesses			0.11	0.40	0	6
# of Physical Fitness Businesses			0.25	0.95	0	13
# of Coin-Operated Amusement Businesses			0.09	0.42	0	9
# of Amusement Park Businesses			0.04	0.20	0	2
# of Membership Sports and Recreational Clubs			0.47	1.16	0	17
# of Other Recreational Businesses (Includes Skiing)			1.01	2.59	0	54
Eating and Drinking Places per Capita	Quality of Life		0.002	0.003	0	0.05
Square Meters of Public Land	Green Infrastructure	BL	21,593,804.40	58,360,601.50	0	846,759,200

Table 4: Descriptive Statistics (cont.)

Variable	Asset Class	Sub Category	Mean	Standard Deviation	Min.	Max.
Square Meters of Private Land	Green Infrastructure	BL	1,130,552.21	4,710,123.25	0	102,666,500
% of Agriculture			0.41	0.28	0	0.99
% of Forested Land			0.33	0.21	0	0.93
% of Sand, Rock and Clay			0.001	0.01	0	0.10
% of Shrubland			0	0.002	0	0.04
Presence of Important Bird Habitat		EL	0.16	0.36	0	1
% MCD Consisting of Natural Vegetation Core Area			0.13	0.22	0	0.94
% MCD Consisting of Potentially High-Quality Patches of Natural Habitat			0.09	0.16	0	0.79
% MCD Consisting of Inland Lakes		BW	2.47	5.07	0	55.75
Miles of River			14.83	15.46	0	188.97
Miles of Great Lakes Shoreline			2.32	10.73	0	226.91
Miles of Inland Lake Shoreline			17.33	28.58	0	503.3
Presence of State Environmental Areas		EL	0.04	0.20	0	1
% of Wetland		EW	0.12	0.13	0	0.72
Presence of a Trout Stream			0.61	0.49	0	1
# of High-Quality Lakes			0.32	1.48	0	25
Miles of Reference/ No Impact Streams			20.80	30.43	0	380.22
% of Functional Sub-Watershed			0.30	0.41	0	1
# of State Forest Campgrounds		DLWA	0.10	0.55	0	14
Presence of Identified Trails			0.67	0.47	0	1
# of Fish Stocking Sites			2.22	3.83	0	50
Amount of Developed Inland Lake Frontage (Miles)			16.50	21.59	0	195.79
# of Boat Launches			0.87	1.50	0	19
# of Marina Businesses			0.22	0.87	0	20
# of Dams			1.63	2.28	0	18
# of Public Golf Courses	Social/Cultural	Urban	0.31	0.67	0	6
# of Mines	Green Infrastructure	DLWA	0.17	0.59	0	8
# of National Pollutant Discharge Elimination System (NPDES) Sites		NLWA	3.38	6.32	0	111
# of Part 201 Contaminated Sites			2.16	0.13	0	82

BL=Basic Land; BW=Basic Water; EL=Ecological Land; EW=Ecological Water; NLWA=Negative Land/Water Assets; DLWA=Developed Land/Water Assets; Urban=Urban Amenities Index.

Appendix 3: Theoretical Framework for Location Choice

A3.1 The Household Place Choice Problem

The literature on location choice theory offers ideas about factors that determine the location choices of individuals. For the purpose of this study, we assume that individuals try to maximize their welfare by optimally choosing locations that provide access to quality-of-life elements that include: (1) high-quality amenities (including green infrastructure); (2) employment opportunities; and (3) income opportunities. Therefore, households choose locations (communities), given location endowment of natural and developed green amenities (Z_1) and public goods (Z_2) that define place quality, which potentially determines the likelihood of finding employment (E) opportunities (E_μ) and generating income (Y). Obviously, location choice is constrained by income (Y), but income (Y) can enhance future income.

Utility from the flow of services from Z_1 and Z_2 depends on degree of accessibility of natural and developed green amenities (γ) and degree of accessibility of public goods (α). Similarly, employment growth is influenced by Z_1 and Z_2, as communities with enhanced services are likely to attract employment growth (Dorfman et al., 2008; Gottlieb, 1995). We further assume that places differ in cost of living and that this is reflected in wages (w) that must be considered, vis-à-vis employment opportunities. The decision to move from current location (J) to all other potential locations (i) depends on the relative endowment of amenities and employment opportunities in location J, compared with all other potential destination locations, i. The utility maximization framework for location choice is, therefore, expressed as follows:

$$(1)\quad \underset{Z_1, Z_2, E_\mu}{Max}\ U[Q,\ (\gamma_i Z_{1i} - \gamma_J Z_{1J})\ \ (\alpha_i Z_{2i} - \alpha_J Z_{2J})\ \ (E_{\mu_i}(Z_1, Z_2) - E_{\mu_J}(Z_1, Z_2))]$$

$$s.t.\ \ Q + (P_{z_1 i} - P_{J_1 J})(\gamma_i Z_{1i} - \gamma_J Z_{1J}) + (P_{z_2 i} - P_{z_2 J})(\alpha_i Z_{2i} - \alpha_J Z_{2J}) \le Y_J + (w_i(Z_1, Z_2, E_{\mu_i}) - w_J(Z_1, Z_2, E_{\mu_J})$$

where Q = private goods and services (a numeraire); Z_1 = natural amenities endowment; $Z_{1i} - Z_{1J}$ = the difference in amenities endowment between location J all other potential locations, i; Z_2 = public goods; $Z_{2i} - Z_{2J}$ = the difference in amenity services between location J all other potential locations; P_{z1} = the tax price of Z_1; $P_{z1i} - P_{z1J}$ = the difference in tax price of natural amenity services between household's current location J and all other potential locations; P_{z2} = the tax price of $Z2$; $P_{z2i} - P_{z2J}$ = the difference in tax price of public good services between the current location and all other potential locations; $E_i(\mu) - E_J(\mu)$ = the expected likelihood of job opportunities in locations i compared to location J; $w_i(Z_1, Z_2, E_{\mu i}) - w_J(Z_1, Z_2, E_{\mu J})$ = the wage differences between location i and location J; Y_J = disposable income (including current wage); γ = degree of accessibility of amenities (0 = no access, 1 = open access); and α = degree of accessibility of public goods (0 = no access, 1 = open access).

The framework highlights that location choice across communities, given (Z_1, Z_2, E_μ, P_{z1}, P_{z2}, Y, w, γ and α), are made by comparing potential locations with the individual's current residence on the basis of changes in the flow of location specific amenities, tax burdens, employment opportunities and cost of living considerations.

Let $\tilde{Z}_1 = \gamma_i Z_{1i} - \gamma_J Z_{1J}$, $\tilde{Z}_2 = \alpha_i Z_{2i} - \alpha_J Z_{2J}$, $\tilde{P}_{Z_1} = P_{Z_1 i} - P_{Z_1 J}$, $\tilde{P}_{Z_2} = P_{Z_2 i} - P_{Z_2 J}$, $\tilde{E} = (E_{\mu_i}(\gamma,\alpha) - E_{\mu J}(\gamma,\alpha)$, and $\tilde{w} = w_i - w_J$. (or the difference in each variable's coefficient between location *J* and *i*). Therefore, the objective function of the individual household can be specified as:

(2) $$Max\ U[Q, Y_J - \tilde{w} - \tilde{P}_{Z_1}.\tilde{Z}_{1i} - \tilde{P}_{Z_2}.\tilde{Z}_{2i},\ \tilde{Z}_{1i},\ \tilde{Z}_{2i}, \tilde{E}_\mu]$$

Individual households maximize utility by optimally considering $\tilde{Z}_1$, $\tilde{Z}_2$ and $\tilde{E}_\mu$ across locations. The conditions for optimization are as follows:

(3) $$\frac{\partial U}{\partial \tilde{Z}_1} = -\frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{Z}_1} - \frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_1} - \tilde{P}_{Z_1} + \frac{\partial U}{\partial \tilde{Z}_1} + \frac{\partial U}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_1} = 0 \quad \Rightarrow \quad \frac{\partial U}{\partial \tilde{Z}_1} + \frac{\partial U}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_1} = \tilde{P}_{Z_1} + \left[\frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_1} + \frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{Z}_1}\right]$$

(4) $$\frac{\partial U}{\partial \tilde{Z}_2} = -\frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{Z}_2} - \frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_2} - \tilde{P}_{Z_2} + \frac{\partial U}{\partial \tilde{Z}_2} + \frac{\partial U}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_2} = 0 \quad \Rightarrow \quad \frac{\partial U}{\partial \tilde{Z}_2} + \frac{\partial U}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_2} = \tilde{P}_{Z_2} + \left[\frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{E}_\mu}.\frac{\partial \tilde{E}_\mu}{\partial \tilde{Z}_2} + \frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{Z}_2}\right]$$

(5) $$\frac{\partial U}{\partial \tilde{E}} = -\frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{E}} + \frac{\partial U}{\partial \tilde{E}} = 0 \quad \Rightarrow \quad \frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{E}} = \frac{\partial U}{\partial \tilde{E}}$$

The relationships in Equations 3, 4 and 5 characterize and incorporate spatial equilibrium. That is, optimal location choice would occur when the marginal change in utility from natural amenity services and employment enhancement between the current location and potential destination locations equals the marginal tax share differential and the net wage effect of amenities (from Equation 3); the marginal utility from public goods and their job enhancement effect between current location and potential moving locations equals the change in the marginal tax share differential and the net wage effect of public goods (from Equation 4); and the marginal utility from differential employment opportunities equals the wage differential (from Equation 5). These conditions define the decision to move or not, and to which locations to move.

The choice of location by individuals given $\tilde{Z}_1$, $\tilde{Z}_2$ and $\tilde{E}$ is, however, controlled by accessibility. With respect to access to amenities, the optimal location choice given degree of accessibility is:

(6) $$\frac{\partial U}{\partial \gamma} = -\left[\frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{Z}_1}.\frac{\partial \tilde{Z}_1}{\partial \gamma}\right] - \tilde{P}_{Z1}\left[\frac{\partial U}{\partial \tilde{Z}_1}.\frac{\partial \tilde{Z}_1}{\partial \gamma}\right] + \left[\frac{\partial U}{\partial \tilde{Z}_1}.\frac{\partial \tilde{Z}_1}{\partial \gamma}\right] = 0.$$

Rearranging the optimal condition in Equation 6 yields:

(7) $$(1 - \tilde{P}_{Z_1})\left[\frac{\partial U}{\partial \tilde{Z}_1}.\frac{\partial \tilde{Z}_1}{\partial \gamma}\right] = \left[\frac{\partial U}{\partial \tilde{w}}.\frac{\partial \tilde{w}}{\partial \tilde{Z}_1}.\frac{\partial \tilde{Z}_1}{\partial \gamma}\right]$$

which suggests that access to amenities can enhance utility if $\partial U / \partial \tilde{Z}_1 > 0$, and that at equilibrium, the utility enhancing effect of access to amenities is equal to the wage effects (Nosal and Rupert, 2007).

Note that the marginal utility of access to natural amenities is weighted by $(1 - \tilde{P}_{Z_1})$. As $\tilde{P}_{Z_1}$ increases (i.e., the tax share differential), the utility associated with access to amenities declines. When $\tilde{P}_{Z_1}$ equals zero, there is no tax advantage, and the community that households move to provides the same tax share on $\tilde{Z}_1$ as their current community. In this case, the utility associated with enhanced access to amenities increases. Furthermore, as $\tilde{P}_{Z_1}$ becomes negative (i.e., the community that households move to provides lower tax share on $\tilde{Z}_1$ than current community), the utility associated with access to amenities substantially increases.

It is important to note that the weighting factor $(1-\tilde{P}_{Z_1})$ can play a crucial role in determining location choice, given various access potentials to amenities. From Equation 7, derive the following:

(8) $\left[\frac{\partial U}{\partial \tilde{w}} \cdot \frac{\partial \tilde{w}}{\partial \tilde{Z}_1} \cdot \frac{\partial \tilde{Z}_1}{\partial \gamma}\right]$ = A, and

(9) $\left[\frac{\partial U}{\partial \tilde{Z}_1} \cdot \frac{\partial \tilde{Z}_1}{\partial \gamma}\right]$ = B.

It, therefore, follows that:

(10)
$$\begin{cases} A=(1-\tilde{P}_{Z_1})B & \Rightarrow & \textit{Optimal location choice given } \gamma \\ \textit{If } \tilde{P}_{Z_1}\in(0,1) \textit{ and } \tilde{P}_{Z_1}\uparrow & \Rightarrow & A>(1-\tilde{P}_{Z_1})B \Rightarrow \textit{Location J becomes attractive given } \gamma \\ \textit{If } \tilde{P}_{Z_1}=0 & \Rightarrow & A=B \Rightarrow \textit{Location choice indifference} \\ \textit{If } \tilde{P}_{Z_1}<0 & \Rightarrow & A<(1-\tilde{P}_{Z_1})B \Rightarrow \textit{Location J becomes much less attractive given } \gamma \end{cases}$$

The effect of access to public goods can similarly be shown by differentiating the mover's utility function with respect to this access. That is:

(11) $$\frac{\partial U}{\partial \alpha}=-\left[\frac{\partial U}{\partial \tilde{w}} \cdot \frac{\partial \tilde{w}}{\partial \tilde{Z}_2} \cdot \frac{\partial \tilde{Z}_2}{\partial \alpha}\right]-\tilde{P}_{Z_2}\left[\frac{\partial U}{\partial \tilde{Z}_2} \cdot \frac{\partial \tilde{Z}_2}{\partial \alpha}\right]+\left[\frac{\partial U}{\partial \tilde{Z}_2} \cdot \frac{\partial \tilde{Z}_2}{\partial \alpha}\right]=0.$$

Rearranging the optimal condition in Equation 11 yields:

(12) $$(1-\tilde{P}_{Z_2})\left[\frac{\partial U}{\partial \tilde{Z}_2} \cdot \frac{\partial \tilde{Z}_2}{\partial \alpha}\right]=\left[\frac{\partial U}{\partial \tilde{w}} \cdot \frac{\partial \tilde{w}}{\partial \tilde{Z}_2} \cdot \frac{\partial \tilde{Z}_2}{\partial \alpha}\right].$$

Let,

(13) $\left[\frac{\partial U}{\partial \tilde{Z}_2} \cdot \frac{\partial \tilde{Z}_2}{\partial \alpha}\right]$ = B.

(14) $\left[\frac{\partial U}{\partial \tilde{w}} \cdot \frac{\partial \tilde{w}}{\partial \tilde{Z}_2} \cdot \frac{\partial \tilde{Z}_2}{\partial \alpha}\right]$ = A, and

It follows, therefore, that:

(15)
$$\begin{cases} A=(1-\tilde{P}_{Z_2})B & \Rightarrow & \textit{Optimal location choice given } \alpha \\ \textit{If } \tilde{P}_{Z_2}\in(0,1) \textit{ and } \tilde{P}_{Z_2}\uparrow & \Rightarrow & A>(1-\tilde{P}_{Z_2})B \Rightarrow \textit{Location J becomes attractive given } \alpha \\ \textit{If } \tilde{P}_{Z_2}=0 & \Rightarrow & A=B \Rightarrow \textit{Location choice indifference} \\ \textit{If } \tilde{P}_{Z_2}<0 & \Rightarrow & A<<(1-\tilde{P}_{Z_2})B \Rightarrow \textit{Location J becomes much less attractive given } \alpha \end{cases}$$

A3.2 The Business Place Choice Problem

Now, consider the location choices of businesses. Service-dependent firms are particularly tied to population growth. It is assumed, based on economically rational behavior that businesses locate where they do in order to maximize profit. If any other location provides a better return, they are assumed to be flexible, at least in the long-run, to take advantage of location differences in profits. In general, the effect of population on businesses can be assessed in two different ways: 1) population centers provide large markets that allow production and sale in large quantities that lend itself to economies of scale and better returns; 2) population centers also feature concentration of talent and high-quality labor that can enhance productivity and profitability for businesses. Therefore, where population and talent move, businesses are likely to adjust in the long-run, due to the underlying changes in the bottom-line.

Again, let Z_1 and Z_2 mean location-specific natural amenities and public goods. Since firms are motivated by profit maximization, a place's endowment of natural amenities and ability to provide quality public services will have to affect the revenue base or costs to be a relevant decision factor. This can be possible in the above mentioned in two ways: 1) population growth enhances demand for services and, hence, increases revenue; 2) concentration of talent in a given area reduces costs and enhances profitability through productivity gains. Note that to the extent that population itself is driven by economic conditions and taxes, businesses will implicitly consider these parameters.

A simple profit maximization framework that explicitly considers amenities is specified as:

(16) $$Max\ \pi = pq(P(Z_1, Z_2)\ \phi) - cx - w(Z_1, Z_2)T(Z_1, Z_2)$$

where π is the profit equation, p is the price of the service, q is the quantity of the service demanded, P is population size which is a function of amenities, ϕ is all other factors that affect revenue, c is the per unit cost of inputs (x), w is the wage rage for productive labor input (T). Note that both wage and concentration of productive labor are affected by amenities. This is because households trade between high wage and high amenities. Since high-quality natural environments are often away from city centers, there is a locational trade-off between these amenities and wages. Similarly, productive labor force concentration is tied to amenities, since households, given options and ability, will choose high-quality environments. The maximization with respect to q, x and T is:

(17) $$\pi' q = p;\ \ \pi' x = c \ \text{ and } \ \pi' T = w.$$

With respect to the amenity factors, Z_1 and Z_2, the optimal solution is:

(18) $$\pi Z_1 = p\left[\frac{dq}{dP}\frac{dP}{dZ_1}\right] - w\left[\frac{d\pi}{dT}\frac{dT}{dZ_1}\right] - T\left[\frac{d\pi}{dw}\frac{dw}{dZ_1}\right]$$

(19) $$\pi Z_2 = p\left[\frac{dq}{dP}\frac{dP}{dZ_2}\right] - w\left[\frac{d\pi}{dT}\frac{dT}{dZ_2}\right] - T\left[\frac{d\pi}{dw}\frac{dw}{dZ_2}\right]$$

Equations 18 and 19 imply that the optimal firm location choice, given the distribution of amenities and public services, is:

(20) $$p\left[\frac{dq}{dP}\frac{dP}{dZ_1}\right] - w\left[\frac{d\pi}{dT}\frac{dT}{dZ_1}\right] = T\left[\frac{d\pi}{dw}\frac{dw}{dZ_1}\right]$$

(21) $$p\left[\frac{dq}{dP}\frac{dP}{dZ_2}\right] - w\left[\frac{d\pi}{dT}\frac{dT}{dZ_2}\right] = T\left[\frac{d\pi}{dw}\frac{dw}{dZ_2}\right]$$

Equation 20 indicates that the revenue advantage of population concentration and growth, and the productivity gains from productive labor force concentration, will need to be assessed vis-à-vis the wage impacts of amenities. In general, as one moves from urban to rural communities, concentration of population and, hence, market size, diminishes, along with the high concentration of productive labor force. However, amenities often increase at progressively lower wages. These factors are optimally weighted to assess the best location for business. Similarly, Equation 21 indicates that places with high-quality public services attract population and, hence, drive the demand for services up. Such locations are more attractive to service sector activities. High-quality public service locations are also attractive to productive labor force that impact on productivity. However, high-quality public

service places often feature higher wages. Therefore, the market and productivity gains are weighed against the positive wage effects.

Now consider the sensitivity of profit to distribution of amenities. The profit function, after substituting the solution back to Equation 16, is:

(22) $$\pi^* = pq(P(Z_1^*, Z_2^*)\ \phi) - cx - w(Z_1^*, Z_2^*)T(Z_1^*, Z_2^*)$$

Totally differentiating Equation 7 yields:

(23) $$d\pi^* = p\left[\frac{dq}{dP}\frac{dP}{dZ_1}dZ_1\right] + q(.)dP - cdx - xdc - T\left[\frac{dw}{dZ_1}dZ_1 + \frac{dw}{dZ_2}.Z_2\right] - w\left[\frac{dT}{dZ_1}dZ_1 + \frac{dT}{dZ_2}dZ_2\right]$$

Holding all else constant, the effect of natural amenities on business profitability is evaluated as follows:

(24) $$d\pi^* = p\left[\frac{dq}{dP}\frac{dP}{dZ_1}dZ_1\right] - T\left[\frac{dw}{dZ_1}dZ_1\right] - w\left[\frac{dT}{dZ_1}dZ_1\right]$$

Rearranging, the effect of natural amenities on profitability is:

(25) $$\frac{d\pi^*}{dZ_1} = p\left[\frac{dq}{dP}\frac{dP}{dZ_1}\right] - T\left[\frac{dw}{dZ_1}\right] - w\left[\frac{dT}{dZ_1}\right]$$

Note that the sign $d\pi^*/dZ_1$ is indeterminate. The first expression on the right hand side of Equation 25 is greater than zero, $p[(dq/dP)(dP/dZ_1)] > 0$, because high-quality places are attractive to households, and a growing population increases the demand for services. The second term on the right-hand side of Equation 25 is also greater than zero, $T[dw/dZ_1] > 0$, because high-amenity places attract productive labor. However, much of the literature supports the idea that $w[dT/dZ_1] < 0$, that is that high-amenity areas support lower wages. If the first two effects dominate, then the overall effect of amenities on profitability is positive. Otherwise, it is an empirical issue that can be resolved by empirical evidence.

Holding all else constant, the effect of public services on business profitability is evaluated as follows:

(26) $$d\pi^* = p\left[\frac{dq}{dP}\frac{dP}{dZ_2}dZ_1\right] - T\left[\frac{dw}{dZ_2}dZ_2\right] - w\left[\frac{dT}{dZ_2}dZ_2\right]$$

Rearranging, the effect of public services on profitability is:

(27) $$\frac{d\pi^*}{dZ_2} = p\left[\frac{dq}{dP}\frac{dP}{dZ_2}\right] - T\left[\frac{dw}{dZ_2}\right] - w\left[\frac{dT}{dZ_2}\right]$$

Note that the sign of $d\pi/dZ_2$ is positive. $p[(dq/dP)(dP/dZ_2)] > 0$, since high-quality public service provision attracts households, and a growing population increases demand for services; $T[dw/dZ_2] > 0$, since places with high-quality public services attract productive labor; and much of the literature supports that $w[dT/dZ_2] > 0$. That is, high-quality public services support higher wages. The overall effect of quality public services on profitability is, therefore, positive.

In the demonstrated simple framework above, the indirect effect of amenities on location choice of firms is presented. In combination with consumer side analysis in Part 3, note that while amenities have a direct effect on where households want to live, they also have indirect effects on business location through their cost and revenue structure effects. The analysis can be expanded to evaluate more complex location choice problems.

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Michigan Natural Features Inventory (MNFI) is a program of Michigan State University Extension and serves as the natural heritage program for the State of Michigan. The MNFI is part of an international network of 74 other natural heritage programs and conservation data centers in the U.S., Canada, Latin America and the Caribbean dedicated to the collection of information on biological diversity within the Western Hemisphere. The Inventory's mission is to deliver the highest quality information that contributes to the conservation of biodiversity, especially rare and declining plants and animals and the diversity of ecosystems native to Michigan.

Since 1980, MNFI has been developing and maintaining the most comprehensive biological and conservation database on Michigan's rare plants and animals, exemplary natural communities, and other significant natural features. As a repository of knowledge and information about natural feature in Michigan, MNFI enhances the conservation and stewardship activities of public and private natural resource managers, and adds value to the work of others by forming and participating in effective collaborations and partnerships.

In addition to its role as steward of the state's most comprehensive natural features database, MNFI is involved in a variety of applied research such as life history analyses, population viability analyses, predictive modeling, threat analysis and biological surveys and monitoring. This information is then analyzed, synthesized and made available to federal, state and local agencies, universities, consultants, private organizations and private landowners through conservation planning efforts, outreach and educational activities, and information products. http://mnfi.anr.msu.edu/.

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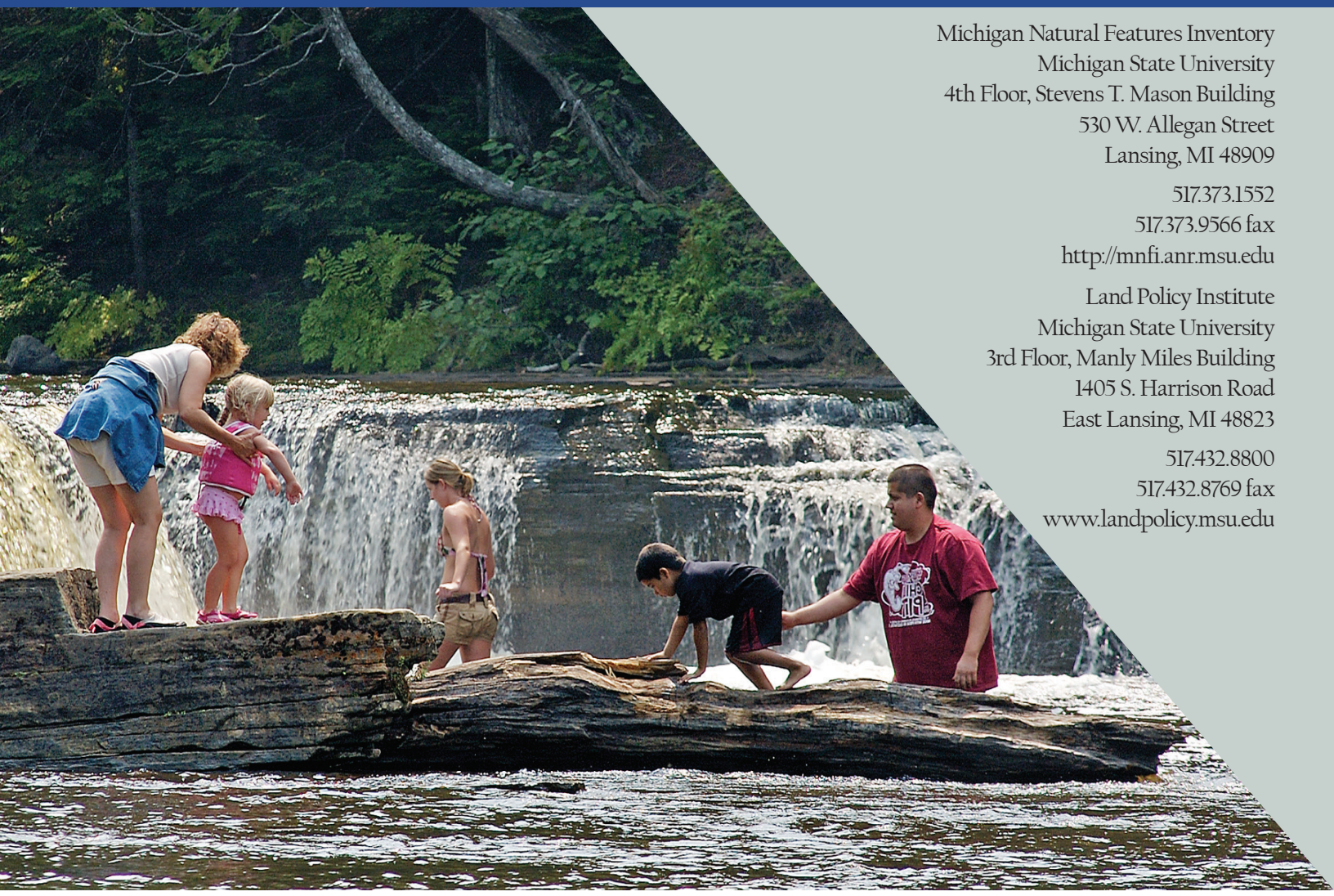

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