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Building in the Mountains: A hedonic analysis of the value of degraded mountain views using GIS modeling*

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The Harvard Environmental Economics Program

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CONTENTS

ABSTRACT

Homebuyers make their purchase decisions based on a number of structural, environmental and neighborhood characteristics. Using Geographic Information Systems data and a hedonic price model this study attempts to empirically demonstrate the value placed on one of the environmental characteristics: unobstructed mountain views. Home sales data from Buncombe County, North Carolina in 2005 provided 626 observations, from which a log-linear model was employed to assess the impact of view degradation measured by the number of houses visible from an observer house. The study hopes to further the discussion of ideal land-use policy given the mutually exclusive nature of land development and scenic view maintenance.

"The charming landscape which I saw this morning, is indubitably made up of some twenty or thirty farms. Miller owns this field, Locke that, and Manning the woodland beyond. But none of them owns the landscape. There is a property in the horizon which no man has … This is the best part of these men's farms, yet to this their land deed gives them no title."

- Ralph Waldo Emerson

That people derive utility from a high quality view from their home should be readily apparent to anyone who has ever scanned the pages of a real estate flyer. Along with the standard description of square footage, number of rooms, and other characteristics, real estate flyers invariably advertise the presence of "mountain," "stream," "farm," ocean, and lake views from the properties in their pages.[1]

The preference for purchasing homes surrounded by natural rather than built environments is supported by psychological research as well. Kaplan (2003) found that sixty-six percent of homeowners surveyed in Michigan said that natural views were the most important aspect of where they chose to live. Furthermore, a majority of respondents from the same study used nature as the primary descriptor of where they lived. Clearly, views of nature are an important utility bearing characteristic of homes.

In theory then, the houses that have superior views – hereafter views and view-sheds will be used interchangeably – should be sold at a premium to those with mediocre or no view-sheds. Rational individuals purchase goods for the utility that they derive from the good and, generally, the greater the utility, the greater the price. If individuals derive utility from a good view-shed then they should be willing to pay a premium for a house with a good view-shed. This expectation is borne out by empirical reality as houses that have good view-sheds are consistently sold at a premium to those that do not (Garrod and Willis 1997, Malprezzi 2002, Jim and Chen 2009). The size of this premium

[1] "Western North Carolina Real Estate Guide." Volume 38, Issue 9. September 2009.

has not yet been settled (Bond Seiler and Seiler 2002, Bourassa Hoesli and Sun 2003) but the fact that it exists provides an opportunity for economists to attempt to valuate the utility derived from a high quality view-shed.

In this study I plan to assess the premium added by high quality view-sheds in Buncombe County, North Carolina. One of the more desirable retirement communities in the country, Buncombe County is well known for having high quality mountain view-sheds and this is one of the primary attractions of the region. As a result, homes in Buncombe County that possess a view-shed of the mountains with few or no obstructions should sell for a higher price than similar homes without such a view-shed.

In order to conduct this assessment I will utilize a hedonic price model of Buncombe County's real estate market. Hedonic regression is a model that breaks down the price of a good into its component parts and attempts to assign a value to each individual part. The use of such models is based on the theory that goods are not one single good but a package of desirable characteristics that each have value to the consumer. Hedonic price models assume that the value of each characteristic can be extrapolated from the final price of the larger good based upon the level of each characteristic present in the larger good. This model is often applied to real estate markets with high rates of success. In this work, I will apply it to Buncombe County's real estate market in 2005 to isolate the impact of a high quality, mountain view-shed.

Beyond providing an accurate assessment of the value of a mountain view-shed in Buncombe County this paper will contribute to the literature through its use of geographic information systems (GIS) data in the hedonic model. GIS is a digital mapping system that allows for the creation of digital images and models of the physical world. The use of GIS in hedonic real estate analysis is a relatively new concept but one that is very important for the robustness of the data used in these models. This work will focus specifically on the view-shed analysis features of GIS. View-shed analysis in GIS uses digitized geographic information to determine and demarcate what can be seen from a property. The value of this technology with respect to this study is readily apparent. It allows for the creation of a variable that considers not just whether a certain property has a view, but what exactly that view contains, without having to visit each of the properties themselves. In this study GIS will be utilized to create the primary variable of interest, measuring whether a house has a mountain view as well as the number of homes visible from each house sold in Buncombe County at the time of sale. To my knowledge, no other study has used GIS data in quite this manner before and this study will provide a test of its appropriateness and applicability.

This ends the introduction of the study. The rest of this paper will proceed as follows: Section II will give additional background on view-sheds and the Buncombe County real estate market, Section III will provide an overview of selected literature on hedonic models and view-shed analysis, Section IV will discuss the data in greater depth and address some of the problems encountered, Section V will discuss the results and robustness of the regressions and Section VI will conclude with a discussion of the policy implications of the results. .

II. Background

Although it is readily apparent that view-sheds have some level of economic value, measuring this value has historically been very difficult. All goods can be broken down into one of two categories of use (Halstead Bouvier and Hansen 1997) and, like other environmental goods, view-sheds fall into the category of non-rival goods, which makes them difficult to valuate. Rival goods are those that the user can capture the full value of by preventing others from using the good without payment or permission. It is easy to valuate these goods because they are regularly traded in a market and thus have well defined, if sometimes fluid, price points. Most environmental goods fall into a second category, that of non-rival goods. These are goods whose use is difficult, if not impossible, to make exclusive and thus are not traded on a market – no one owns these goods. As Emerson notes, view-sheds fall into this category. While it is theoretically possible to exclude access to the view of a small landscape feature – such as a waterfall – it is nearly impossible to exclude access to the view of an entire landscape – a mountain range for example. Thus, landscape views, like other non-rival goods, are inherently more difficult, and accordingly less likely, to be owned and exchanged than rival goods, and thus more commonly lack a consensus valuation and defined price point.[2]

The lack of well defined price points makes it difficult to assign a specific value to the utility derived from a high quality view-shed and this, in turn, can make it difficult to make well informed policy regarding views and land use policy. Without having accurate knowledge of the economic value of a good view-shed, policymakers are likely to misallocate land policy to unduly favor of activities that have well defined revenue streams.

Although view-sheds are not traded in a direct market, the premium they add to the price of a home can serve as a measure of the value of the utility derived from a good

[2] A second aspect of non-rival goods that should be readily apparent from the example of view-sheds is that, because no one owns them, no one is able to capture the full value of their preservation and thus no one has an incentive to pay to preserve them. This is the classic tragedy of the commons problem.

view-shed. When consumers purchase a home they reveal their preferences for certain aspects of the property – the number of bedrooms, the number of bathrooms, etc. – through the purchase price. View-sheds are just one of these many characteristics. The price differentiation that is found in real estate markets is a result of the varying levels of amenities associated with a certain home. Homes with a higher quantity of desirable amenities will be sold for a higher price than homes with fewer of these valued amenities. In the context of views, a home with a high quality, unobstructed view-shed of a beautiful landscape should be sold for a much higher price than a home with similar levels of other amenities but no view-shed. Thus, real estate markets can serve as sources of revealed preference data about the value of a view-shed. This allows economists to provide policy makers empirical data concerning the value of a view without resorting to the use of contingent valuation surveys.

The policy implications of analyzing a view-shed's economic value are, as mentioned above, significant. Most local and regional governments derive a substantial portion of their income from property taxes and thus have an incentive to maximize the value of the property in their jurisdiction. Furthermore, a favorable, safe, and aesthetically pleasing environment can serve as a selling point to attract both business and tourism to a region. High quality views are a particularly attractive feature to tourists (Mathews Greden and Kask 2003).

Policy makers have a range of tools available to direct development in ways that will generate high value properties and create a climate that is attractive for business and tourism. These include zoning laws, planning requirements and, in mountain regions specifically, elevation, and steep slope regulations. These tools all restrict the rate and type of development in favor of maintaining the natural environment and, as a result, there are substantial economic trade-offs involved in their execution (Land of Sky 2008). While properties with good views – and thus high-assessed value – may generate increased tax revenue, there are significant losses associated with restricting development that include decreased jobs in construction and affiliated industries. Thus, in order to balance the promotion of construction growth and jobs and the need to create an attractive environment, policy makers must have information about the extent to which homeowners value a good view. With this information, they can estimate the costs – in terms of decreased property tax revenue – of allowing increased development and compare that with the value of the construction revenue foregone if the development is restricted.

A final layer that policy makers must consider is the time difference between when the costs of the various policy decisions are felt. For example, restricting development has an immediate effect on the rate of construction and the level of construction employment (Land of Sky 2008). Allowing for development will increase short-term employment rates and have a negligible effect on short-term tax revenue. However, the impacts on tax revenue of damaging view-sheds in an area are long-term. Thus, without information about the value of view-sheds in the long term, policy makers will almost certainly allow an inefficient amount of development in the short term. This can have disastrous long-term effects on property tax revenues and the attractiveness of an area to outsiders. Studies on visitation rates in scenic regions have demonstrated that visits decline when views are degraded (Mathews Greden and Kask 2003). Preventing these types of problems requires extensive and far-reaching planning to balance the need for development and growth and the need to maintain the scenic beauty that can attract people to an area to begin with.

One area of the United States in which the debate over regional planning and development has been front-page news for several years is Asheville, North Carolina. Located in the southern Appalachian Mountains in Western North Carolina it is well known for both its outdoor community and the scenic attractiveness of the mountains in the region (Mathews Greden and Kask 2003, Land of Sky 2008). However, Asheville's popularity has begun to threaten the existence of the unobstructed mountain views that make it so popular. Buncombe County, in which the city of Asheville is located, has experienced a ten percent increase in population since 2000 and a growth of thirty percent since 1990. In comparison, there was an eight percent growth in population from 1980 to 1990.[3] This rapid growth has led to a correspondingly rapid expansion of development in and around the city. Requests for new building permits increased between eleven and nineteen percent annually from 2000 to 2005.[4]

At the same time, the land use regulations in the city and county have not kept pace with the rate of development. The only current restriction on the elevation of ridge top development in Buncombe County is the statewide Mountain Ridge Protection Act (Land of Sky, 2008). This has not prevented the development of several high profile ridge top developments that have significant implications for the view-sheds of the houses around them.[5] In an effort to limit the expansion of these developments regional planners in both the city and county governments have attempted to create new restrictions on the acceptable slope and elevation of development sites but these

[3] U.S. Census Data. 5/10/09. Accessed here: http://factfinder.census.gov
[4] Buncombe County Ordinance #09-12-01
[5] For examples see Appendix 1

regulations have been fought by developers and others.

Opponents of the regulations suggest that restricting development will destroy the economy of the region and decrease outside investment. Construction is the third largest industry in Buncombe County and provides one out of every eight jobs (Land of Sky 2008). It is unclear how many of these jobs depend on the premiums outsiders pay for mountain top homes that developers allege are vital to the economy of the region. However, it is clear that restrictions on ridge top development will have a substantial impact on the economy of the region in both the short and long term.

Residents are keenly aware of both the benefits of development and the potential costs – from erosion to degradation of scenic values – that may not be measured directly (Wilson 2009). The intent of this examination is to provide a direct measure of the costs of adding ridge-top homes into the view-sheds of already built homes in Buncombe County. By doing so it is hoped that the debate on development regulations in Buncombe County and Asheville can move forward with empirical information on the precise price change due to a view in the region and therefore an estimate of the economic impacts of changes in views caused by ridge-top development.[6]

III. Selected Literature Review

Hedonics

The use of Hedonic Price Models (HPM) is a well-established means for assessing the market value of the individual characteristics of a given good. First introduced by Griliches (1971) and Rosen (1974) hedonic price modeling is based on the

[6] If this cost (when combined with the other costs of development) is less than the revenue to the region from premiums paid for ridge-top development than, under the Kaldor-Hicks criterion, the developers have good reason to oppose the restrictions. If this cost is greater than the supporters of restrictions can make a strong argument for the restrictions.

theory that goods are valued for their utility bearing characteristics. The hedonic price model assumes that the final price of a good is a function of the values of the individual characteristics (Rosen 1974). By observing the prices of differentiated products the implicit prices of these characteristics can be determined based on the specific amount of each characteristic in a given product.

Hedonic models were first introduced to the real estate market by Polinsky & Rubinfeld (1977) and have since been used to assess the value added by proximity to water parks (Darling 1973), the costs associated with living in close proximity to airports or nuclear facilities (Pennington Topham and Ward 1990, Metz and Clark 1997), the impact of living near oil facilities (Boxall Chan and McMillan 2005), the benefits of clean air on property prices (Beron Murdoch and Thayer 2001), and various other property characteristics including proximity to schools and the central business district (CBD). Because hedonic models are a revealed preference model they have been especially popular among those interested in the impact of environmental attributes on property prices (Garrod and Willis 1992).

The foundational underpinnings of the hedonic price models used in housing markets are reviewed in great detail by Malprezzi (2002); who emphasizes two points. The first is that the feasibility of HPM arises because of heterogeneity in supply and demand. Any given market contains a heterogeneous stock of housing with characteristics that are not easily modifiable. Thus, paying slightly more to acquire a house with the characteristics that a homebuyer desires often has more utility than buying a less suitable house and remodeling it. The second aspect of markets that makes these studies feasible is heterogeneity among consumers. Each individual homebuyer values characteristics of a house differently. Therefore, they value the bundles of characteristics that each house represents differently. Mcleod (1984) and others note that the price of each house is a result of the homebuyer jointly acquiring characteristics related to the house (number of rooms, square footage, etc), the location (proximity to shops and businesses), the neighborhood (demographics and socio-economic background conditions), and the environment (clean air, good views, etc). The variation in housing prices arises both because of the heterogeneity in available characteristics and because each homebuyer derives a different level of utility from any given set of characteristics. Furthermore, because there is a substantial investment required to change the characteristics of a home, the prices of each characteristic cannot simply be summed to provide a price of the house (Malprezzi 2002, Mcleod 1984, Milon Gressel and Mulkey 1984). This cost of adjustment, and the variation in utility derived from characteristics, leads to the non-linear nature of house prices.

A further characteristic of hedonic price modeling is that it assumes markets are in equilibrium (Mcleod 1984). The housing market is assumed to be at a market clearing equilibrium and each consumer chooses a house that maximizes utility by maximizing the presence of characteristics that they value. This assumption can be hard to justify in housing markets due to the costly nature of adjustments (Malprezzi 2002). While there has been some work on measures to correct for this disequilibrium (Malprezzi 2002), few studies employ measures that correct for problems of disequilibrium and, in turn, implicitly dismiss this concern as having an insignificant effect on the regression results (Boxall Chan and McMillan 2005, Follian and Jimenez 1985, Metz and Clark 1997, Pennington Topham and Ward 1990). The general conclusion from the literature is that, while the assumption of equilibrium may not be perfectly tenable, the effects of disequilibrium do not categorically bias the results of hedonic price modeling.

The general equation used in hedonic modeling is the following (Mcleod 1984, Malpezzi 2002, Garrod and Willis 1992):

$$\mathbf{P(A) = f(S,N,E)} \quad \textbf{(1)}$$

Where **P** is the price that the house is sold at in an open real estate market, in (or close to) equilibrium with a heterogeneous stock of housing and consumers with different utility functions and heterogeneous demands for housing characteristics. **A** represents the characteristics bundled into a given house. **S, N,** and **E** are, respectively, vectors of structural, neighborhood and environmental characteristics related to **P(A)** by a chosen function.

In the model that Rosen (1974) introduced, equation 1 is interpreted as a locus of the equilibrium points in the market where each consumer has a bid price function of $Ø(S_{1...i}, N_{1...i}, E_{1...i})$ which is the maximum that the consumer is willing to pay for that house. Each builder has a similar price function, $\gamma(S_{1....i}, N_{1...I}, E_{1....i})$, for the supply of houses. In equilibrium, the consumers and homebuilders should optimize so that the marginal price of a given characteristic is equal to the marginal bid price and marginal supply price.

$$\boldsymbol{\delta Ø/\delta N_i = \delta\gamma/\delta N_i = \delta P/\delta N_i} \quad \textbf{(2)}$$

The first order hedonic price model is simply the locus of prices at equilibrium and provides no information about the underlying structure of the market for characteristics (Mcleod 1984). The first order model provides information about the marginal price of an attribute at equilibrium. This information is useful, as it can be used to estimate the overall market's willingness to pay for a characteristic. Its primary downside is that it can only be applied to estimate individual household demand if every household has the same demand curve (Follian and Jimenez 1985). Regardless, the first order function provides useful macro-level data about the general economic value of a characteristic in a given area.

Beyond the basic structure of the model, there is an important question of which functional form to use in the model. The general equation does not specify what function form should be used to relate the vector of characteristics to the house price and while a substantial part of the literature has been devoted to this question there is little consensus on which form is best (Pollakowski and Halvorsen 1979). A selection of studies and the functional form they used is presented in Figure I but, as Pollakowski and Halversen (1979) note, there is no compelling theoretical case for any form in particular.

The benchmark form in recent years has been the semi-log form (Bonn et al 2001) and a preponderance of studies focusing on view variables have utilized this functional form. This is true for a number of reasons. Generally, less detailed functional forms are less prone to errors (Day Bateman and Lake 2008) because simple, non-quadratic forms avoid interactions among the variables (Garrod and Willis 1992). The extreme example of this is the linear functional form. However, while it minimizes errors, the linear form also imposes constant marginal prices on the model. This is not a theoretically tenable assumption (Mcleod 1984). House values do not increase in a linear fashion because of the relationship between the various characteristics that make up any given house.

Figure I: Survey of Functional Forms used in Hedonic Price Studies

Study	Year	Form Used	Variable of Interest
Benson et al	2002	Box-Cox	View of lakes, moutains and ocean
Beron et al	2001	Semi-log	Visibility
Bond et al	2002	Linear	View of lake Erie
Brown and Pollakowski	1977	Linear	Value of proximity to open space
Correll et al	1978	Linear	Impact of Greenbelts
Darling	1973	Linear	Lake views
Garrod and Willis	1997	Double log	Woodland Access
Gillard	1981	Linear	Distance to parks
Hite et al	2001	Semi-log	Distance to a landfill
Jim and Chen	2009	Semi-log	Ocean and Mountain view
Metz and Clark	1997	Semi-log	Proximity to spent nuclear facilities
Paterson and Boyle	2002	Semi-log	Level of visible development
Pompe and Rinehart	1995	Double log	Beach quality
Rodriguez and Sirmans	1994	Semi-log	Undefined view
Yu et al	2007	Semi-log	Ocean view

At the other end of the spectrum, some of the literature has focused on the flexibility afforded by the Box-Cox transformations as a way to avoid imposing unwarranted constraints on the data. The Box-Cox form allows potentially every variable to be transformed and allows the variables to interact without restraint. However, work comparing Box-Cox transformations to more standard log forms found that there is no evidence that Box-Cox forms are better in every circumstance (Halstead Bouvier and Hansen 1997). As a result, in choosing a functional form it is necessary to balance the need to minimize errors while selecting a form that also has a suitable amount of flexibility in the model. A final consideration, relevant to this paper, is that studies focusing on environmental characteristics – which often have a small relative effect on home prices – have avoided complex functional forms because these forms can warp the estimates of the coefficients on the environmental characteristics (Jim and Chen 2009). Because views are environmental attributes that do not always have a dramatic effect on prices this observation is important to remember when determining a functional form.

The other important, and oft discussed, aspect of hedonic studies is the selection of appropriate variables to represent house characteristics. The general form is to have a vector for structural, environmental and neighborhood characteristics of the house (Milon Gressel and Mulkey 1984, Garrod *et al* 1997, Malprezzi 2002). Many studies have attempted to include as many variables as possible, leading to one of the major problems with conducting hedonic model analyses – that of assembling large data sets to describe the house characteristics. Assembling such large data sets helps avoid omitted variable bias, but may not be necessary. Garrod and Willis (1992) found that a well selected data set of five to ten variables across each of the above three categories performs as well as data sets of more than forty variables. The correct number of variables to include likely lies somewhere in the middle of these two figures and, in line with work by Metz and Clark (1997), Pennington Topham and Ward (1990) and Milon Gressel and Mulkey (2001) this paper will include a set of approximately thirty variables.

The final area of the literature to review with regard to the hedonic aspect of this paper is the discussion of problems with the hedonic model and potential sources of error. Price (1995) offers a succinct criticism of the use of hedonic models to assess the value of a view-shed because of the danger of interactions with unmeasured variables. In summary, he argues that aesthetic value is a very complex attribute and cannot be captured by one variable. Rather it is a combination of aspects; both noticed and unnoticed, that combine to form a pleasant aesthetic. Because some of these aspects are unnoticed, or may be deemed too small to be considered, a hedonic model assessing the value of a larger feature – an ocean view-shed – would be biased because it ignored the presence of smaller aspects that came with ocean views – the visibility of breakers for example. As a result, Price claims that at their best hedonic models can only assign value to a landscape holistically and cannot be used to assess individual aspects of a view-shed.

There are a number of responses to this argument. The first is that Price levels his criticism against studies that attempt to valuate positive aspects of a view-shed and separate them from other positive aspects. This study is interested in a negative element of a view-shed. Therefore, while it might be difficult to disentangle the contributions of a waterfall and a mountain to making a view pleasant, separating the positive contribution of a mountain from the negative of an electric pole should not suffer from the same difficulties. Furthermore, the chosen variable – the number of visible houses – is a feature easily identifiable when assessing the view-shed from a home as a potential buyer. While more subtle and unnoticed features may combine to form a pleasant aesthetic as time is spent examining the view-shed, when first purchasing a home most homebuyers do not have time to appreciate the subtle features, instead focusing on the macro elements of a view-shed. Thus, the number of homes in a view-shed can have a direct and independent impact on the value of a home. Because people make a purchase decision with a very brief consideration of the view-shed, it is the large, apparent elements of the view-shed that add (or subtract) value to the purchase price. Price's concern that many subtle elements of a view-shed combine to create its value may be true but only applies to situations in which people have time to evaluate the view-shed at a more leisurely pace than during a tour of a potential house purchase.

A second source of error in hedonic models of the value of a view-shed is the assumption that the purchaser of the house recognized the same level of view-shed quality as measured by those conducting the study (Pompe and Rinehart 1995). If the buyer of the house only perceived ten units of view-shed quality while those conducting the hedonic study of his property measured fifteen, the estimated value of the view-shed will be biased downward and vice versa if the owner recognized more units of view-shed quality. This is primarily a problem with studies that are concerned with assessing an undefined quality variable or those that measure whether a view-shed exists. This is one of the reasons that the present study has chosen the number of houses as the variable of interest. Counting the number of houses visible from a property is an objective, readily apparent measurement and therefore the measured value should be the same as the value perceived by the purchaser of the property.

Malpezzi (2002) suggests that price endogeneity may be a problem with housing studies that use hedonic models with large data sets. In non-linear price functions, the consumer is able to choose both the quantity of a characteristic in the house and, implicitly, its price. Follian and Jimenez (1985) note that this is a problem that occurs in large aggregate data sets because the observation unit is large enough to influence the market-clearing price. They also note, though, that this is not a significant source of error in smaller, micro data sets such as the one used here.

Views

Economic literature on view-sheds confirms that there is a premium assigned to houses sold with a view-shed, although that premium is not always a substantial amount or significant in the regressions (Rodriguez and Sirmans 1994, Benson *et al* 1998). Previous research has found premiums that range between one percent and eighty-nine percent of the price of the home (see Figure II). As is apparent from Figure II, the size of the premium associated with a view-shed is highly dependent upon the type of view-shed. It is also apparent that there is less work on the impact of the quality of the view-shed and some of the largest premiums come from studies that have no variable assessing view-shed quality (Bond Seiler and Seiler 2002). By far the most common examination in the literature is that of undefined view-sheds. This term is applied to studies that utilize only a dummy variable for whether or not a view-shed exists, do not assess the type of view-shed (ocean, mountain, river, etc) and do not assess the quality of the view-shed. Beron Murdoch and Thayer (2001) found that a view-shed of indeterminate quality adds two to seven percent to the price of a home and a one-unit improvement in visibility added 3.8% to the price of homes in the Los Angeles basin. In contrast, Correll Lillydahl and Singell (1978) found that view-sheds in Boulder, Colorado added a positive but not statistically significant value to homes in their study. However, they believe that this result is specific to their study due to the nature of construction in Boulder. In order to withstand heavy winds houses at high elevation – the houses with good view-sheds – are built with

Figure II: Overview of Hedonic Studies of View-sheds

Study Authors	Year	View Type	Value Added	Statistically Significant
Bastian et al	2002	Diversity of landscape types	Positive	Yes
Benson et al	1998	Ocean, Lake and Moutain views with a measure for obstruction	Ocean: +60% Lake: +18% Mountain: +	Ocean: Yes Lake: Yes Mountain: No
Beron et al	2001	Visibility	+2-7%	Yes
Bond et al	2002	Views of lake Erie	+89%	Yes
Bourassa et al	2003	Ocean views with a measure for scope of the view	Wide view: +59% Medium view: +33% Narrow view: +12%	Yes
Boxall et al	2005	Mountain	+3%	Yes
Brown and Pollakowski	1977	Lake	Positive	No
Correll et al	1978	Valley with a rating of excellent, moderate or none	Positive	No
Darling	1973	Lake	Positive	Yes
Do and Sirmans	1994	Undefined	Positive	Yes
Franklin and Waddell	2003	Mountain and lake	Moutain: 1% Lake: 9%	Yes
Garrod and Willis	1992	Woodland	Negative	Yes
Gillard	1981	Undefined	$3,887	Yes
Jim and Chen	2009	Full Ocean Confined Ocean Full Mountain Confined Mountain	Full Ocean: +2.97% Confined Sea: +2.18% Full Mountain: -6.7% Confined Mountain: -1%	Full Ocean: Yes Confined Ocean: Yes Full Mountian: Yes Confined Mountain: No
Luttik	2000	Water and open space	Water: +8-10% Open Space: +6-12%	Yes
Mcleod	1984	Unimpeded river view	+28%	Yes
Paterson and Boyle	2002	Percent of visible land developed	-1%	Yes
Rodriguez and Sirmans	1994	Undefined	+8%	Yes
Tse	2002	Ocean view	+9%	Yes
Yu et al	2006	Ocean view	+22.5%	Yes

small, heavily reinforced windows that make it difficult to realize the value of the view-shed when living in the house. Their work underlines the importance of ensuring that the measured level of the attribute is the same as the level perceived by the purchaser of the property.

Both Gillard (1981), and Rodriguez and Sirman (1994) found that a simple view-shed added statistically significant premiums to houses sold in Fairfax, VA and the Los Angeles area. Their estimates of $3,887 and eight percent respectively are within the standard range for non-defined view-sheds. The premium for views in Gillard (1981) was slightly more than the premium added by a fireplace but slightly less than the premium added by a swimming pool. So even with a non-exact measure of the view-shed, the results are non-trivial and suggest that view-sheds are important considerations for consumers purchasing a house.

The next category of view-sheds studied in the literature is those with water in the view. This includes views of rivers, lakes, and the ocean. The water view category is by far the most studied category of view-sheds and, almost universally, the literature finds that the coefficients on the view-shed variables are statistically significant and positive (Tse 2002, Luttik 2000, Darling 1973, Jim and Chen 2008, Pompe and Rinehart 1995, Yu Han and Chai 2009). The only work surveyed that did not find a statistically significant premium for a water view-shed was Brown and Pollakowski (1977), who found a positive coefficient on view-sheds of lakes but the estimate was not significant. However, view-sheds were not the variable of concern in their study and they do not have a description of their view-shed variable. As a result, it is difficult to compare their study to the rest of the literature. In none of the literature surveyed was the premium for a water view-shed negative.

Surveying the remaining literature on water view-sheds is not possible in this space but several of the notable studies are discussed below. [7] One such study is Bond Seiler and Seiler (2002), which found a nearly ninety percent premium for houses with view-sheds of Lake Erie. This is notable because of the unusually large premium for a view-shed. Most of the other literature fails to assign a premium greater than sixty-five percent to any type of view-shed (Bourassa Hoesli and Sun 2003). The disparity between Bond *et al*'s estimates and the bulk of the literature is certainly worth noting. A possible explanation is the lack of neighborhood and other environmental variables in their regression. If any of the variables omitted were correlated with the view-shed variable (distance to the central business district for example) the coefficient on the view-shed variable would be significantly biased.[8] Furthermore, the standard structural variables are condensed and some are left out – including bedrooms, bathrooms and fireplaces. Each of these has been shown to have a substantial impact on prices in past studies and each could be correlated with the view-shed variables – houses with view-sheds are likely to be larger, more expensive houses with more bedrooms, bathrooms and fireplaces – and therefore bias the results upward.

Mcleod (1984) is also notable for his examination of the value of a river view-shed in Perth, Australia. In nearly all the other literature surveyed only view-sheds of the ocean or a lake were considered. These view-sheds, in many cases, are unobstructed and pristine to the horizon. There is little in the view-shed to disturb the quality of the view.[9]

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[7] See Bourassa Hoesli and Sun 2003 for a very complete review of view-shed studies.

[8] Homes with good views are likely to be further from the central business district because they are more likely to be on the outskirts of the urban area.

[9] This is not always the case as Jim and Chen (2009) point out because shipping lanes in busy harbors can interfere with the quality of a water view. Even with this interference,

However, a river view-shed is a limited view-shed and includes other, perhaps negative, aspects. Mcleod's work is interesting because he finds that an unimpeded view-shed of a river adds a twenty-eight percent premium to the value of a home. This is comparable to some estimates of the premium for ocean view-sheds and substantially higher than others.

A third notable study on the premium associated with water view-shed is Bourassa Hoesli and Sun (2003). Examining homes in Auckland, New Zealand they found that wide scope view-sheds of the water from oceanfront properties add a premium of sixty-five percent to the price of a home. However, what is notable about their work is that they categorize view-sheds into wide, medium and narrow; these categories are then divided by the distance to the coast. As would be expected, the value of a view-shed declines as the property gets further from the coast and the view-shed moves from wide to narrow. A medium view-shed, 2,000 meters from the coast only commands a premium of twelve percent while a narrow view-shed is positive but statistically insignificant. These results are interesting because they indicate that many of the studies previously conducted utilizing a dummy variable that did not consider the quality of a view-shed may have been under-estimating the premium for a high quality view-shed while over estimating the premium for a low quality view-shed. By examining the number of homes in a view-shed, rather than just the presence of a view-shed, the current study will attempt to add to the work in Bourassa Hoesli and Sun (2003) by adding multiple layers to the assessment of the quality of a view-shed, moving beyond simply the scope of the view-shed.

Rather than water view-sheds however, this study is interested in the impact of

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there remains a fundamental difference between and ocean and river view with regard to the limits and content of the view.

quality variation in mountain view-sheds. As opposed to water view-sheds, the unique price effects of mountain view-sheds are relatively unexplored. Much of the work that has been conducted (Jim and Chen 2009, Benson *et al* 1998) has examined mountain view-sheds jointly with water view-sheds. This may help to explain why in many of the studies mountain view-sheds have been found to be positive but statistically insignificant. In areas that have a view-shed of water the mountain view-shed becomes secondary and is overwhelmed by the desirability of a water view-shed. No reviewed study has examined this phenomenon but it is a potential avenue for future research.

The work surveyed that did examine mountain view-sheds was limited by the dearth of research in this area but the work that was reviewed consistently found positive premiums. The majority of these estimates, however, were not statistically significant. Benson *et al* (1998) examined both mountain and ocean view-sheds outside of Bellingham, WA and found that mountain view-sheds had positive premiums between seven and eight percent but these estimates were not statistically significant. Benson does not offer an explanation for this but two possibilities come to mind. The first was touched on above, that the presence of high quality ocean and lake view-sheds in the same sample outweighed the importance of mountain view-sheds. In the sample used only sixty-six homes had view-sheds of the mountains while nearly 500 had view-sheds of the ocean. The small relative sample size of mountain view-sheds could have skewed the results. A second explanation is the distance to the mountains. In previous work (Hull and Bishop 1988), the scenic value of view-sheds was found to rapidly decline after one kilometer. If the view-sheds of the mountains were at distances greater than this – a reasonable expectation given that many of the homes were ocean front property – it might explain why the results were not statistically significant.

My work attempts to address both of these issues by utilizing a larger relative sample size and examining view-sheds at distances of no more than one kilometer. As a result, it is expected that the estimates for the premium on mountain view-sheds in this sample will be both positive, in line with Benson *et al* (1998), and statistically significant.

Consistent with Benson *et al* (1998) the work of Boxall Chan and McMillan (2005) finds that view-sheds of the mountains outside of Calgary, Alberta add a three percent premium to homes but unlike Benson *et al* (1998) they find this premium to be significant at the five percent level. In Boxall *et al* this is a similar premium to that of a deck, but it must be noted that their variable for the view-shed also fails to consider distance, quality or scope of the view-shed. They simply use a dummy variable for the presence of a view-shed. Franklin and Waddell (2003) found a similar result – a nearly two percent premium that was significant at the one percent level – for mountain view-sheds in Seattle, WA. However, like Benson, the variable for view-shed used was simply a dummy variable that indicated whether a view-shed existed or not and provided no information about the quality or contents (beyond mountains) of the view-shed. By considering the distance, scope and contents of the view-shed this paper hopes to move beyond the work of both Franklin and Waddell (2003) and Benson *et al* (1998).

The most recent notable study on mountain view-sheds reviewed is the work done by Jim and Chen (2009). Using data from Hong Kong they examined the impact on high-rise prices of harbor view-sheds and mountain view-sheds. But, unlike the previous studies, they found that mountain view-sheds had a negative impact on prices. This negative impact extended across both full and partially obstructed view-sheds of the mountains but only the coefficients on full mountain view-sheds were statistically significant. One potential explanation for this contradictory result is the lack of a term for distance from the mountains in their regression. They acknowledge that high-rises in Hong Kong with view-sheds of the mountains are located in close proximity to the mountains themselves and that there are cultural and location specific reasons – including a perception of increased disease in the mountains and an increased threat of burglary for houses near the mountains – that a high-rise close to the mountain might be undesirable. Thus, without a consideration of the distance to the mountains, their results cast only marginal doubt on the results found in the work cited above.

In addition to the works above there are several papers in the literature on view-sheds that are worth mentioning but do not fit into any of the previously discussed categories. Beron Murdoch and Thayer (2001) found that improvements in visibility – the ability to see from a house based on levels of particulates in the air rather than the presence of a certain view-shed – added between two and seven percent to the value of a home. In Wyoming work by Bastian *et al* (2002) found that a view-shed with a diversity of landscapes, rather than any certain type of landscape, as measured by a variable considering the number of different types of landscape within a total view-shed, added a positive and significant premium to the value of homes. Their findings indicate that considering the contents of a view-shed – rather than just the presence of a view-shed – is a central aspect of assessing the value of a view-shed.

Within this miscellaneous category the study with the most direct implications for the current work was done by Paterson and Boyle (2002) in Connecticut and examines the impact of visible development on the price of homes. They examined the percent of the total visible land that had been developed and found that a one percent increase in visible land developed resulted in a negative impact on home prices of one percent. They also followed the convention of limiting their assessment to area visible within one kilometer of the homes. If this relationship holds across states there should be a clear decline in prices for homes in this study as the number of other visible houses increases.

Geographical Information Systems

The use of GIS data in hedonic price models of real estate sales is not unique to this paper (Hayles 2006, Lake *et al* 2000, Garrod and Willis 1997, Boxall Chan and McMillan 2005, Bastian *et al* 2002, Rod and Van Der Meer 2009). Although it is a relatively new tool in the development of data about housing characteristics and its use is not yet widespread it has been gaining popularity since the mid-nineties. Its attractiveness as a tool stems from its ability to quickly generate an extensive amount of information about view-sheds and other geographic information linked to each house. This is information that would have traditionally been collected by fieldwork or may simply have been unavailable. Specifically with regard to view-sheds, GIS offers the ability to move beyond the dummy variables utilized by the previous studies and makes it easier to create detailed data sets about the contents and scope of a view-shed without extensive field visits.

The first major study to utilize GIS data in combination with housing information to assess the value of a view-shed was done by Lake *et al* (1998) in Glasgow, Scotland. This study was unique in being the first to utilize GIS data but it also has several major flaws. Primary among these is the lack of information about the structural characteristics of the buildings. They have none of the standard variables for bedrooms, square footage, bathrooms, etc. Furthermore, their view-shed analysis did not consider the presence of large natural features, instead focusing on industrial features. Finally, in order to minimize computational difficulty they only extended their analysis to 500 meters – leaving half of the one-kilometer range in which views still have a significant impact on value unexamined. The only aspect of a view-shed that was statistically significant in those that they considered was the visibility of railroads from the back of the house. This result is surprising and is not substantiated in later studies but as the pioneering study using GIS Lake *et al* (1998) merits a careful reading.

Later works, such as Yu Han and Chai (2007) have taken the framework laid down by Lake *et al* (1998) and expanded on it. With data from Singapore, Yu Han and Chai analyze the impact of obstructions to a sea view-shed on the price of high-rise apartments. Utilizing GIS data they divide the visible area into cells and create a variable that represents the percentage of the total visible cells that remain visible after obstructions are added into the model. A dummy variable indicating the type of view-shed is used in conjunction with the visibility analysis to assess the value of different scopes and types of view-sheds. They report that their view-shed variable was significant throughout their results but only positive when the dummy for type indicated a sea view-shed. After interacting the sea view-shed and visibility variables, they found that a relatively unobstructed view-shed of the ocean adds a twenty-two percent premium to the price of a home. This result is more robust than the results reported by Lake *et al* (1998) due to their inclusion of the standard structural and neighborhood variables. What makes this study particularly notable is that it was their use of GIS that allowed them to conduct one of the most extensive analyses of the impact of the scope of a view-shed to date.

The current work hopes to build on the work by both Yu Han and Chai and Lake *et al* by expanding on their models and applying them to mountain view-sheds. The next step in the examination of view-sheds is to add a variable that provides some indication of what is in the view beyond the general major landscape features. By doing that here this study intends to begin objectively to address the inherently subjective question of the value of a "good" view of the mountains objectively.

This concludes the literature review aspect of the paper. The next section will move into a discussion of the data used, its source, and limitations before moving on to the presentation of the regression results.

IV. Data and Methodology

In order to isolate the effect of a single characteristic without the danger of omitted variable bias a hedonic price model must contain measurements of the other characteristics that make up a good. In the case of houses this includes, as mentioned, the three broad categories of structural information, environmental information and neighborhood characteristics.

The data set employed in the present examination is from Buncombe County, North Carolina and contains 626 observations. Each observation is a single, owner-occupied, residential, non-doublewide house sold in Buncombe County in 2005. The data was assembled from the Buncombe County Tax Department's database on home sales in the county and includes the date and price of each sale as well as a unique PIN for each sale. These PINs were used to find each house from the sales database in the Tax Department's assessment database and match the sales information with assessment information that indexed the structural characteristics of each home. Thus, the data set utilized contains the address of each home, the date of sale, the final sale price, and a list of structural characteristics. The original data set contained 125,000 observations, corresponding to every residential property sale in Buncombe County from 1995 to 2007. After the data was downloaded it was indexed by type of home and pared down in size in order to make the GIS aspects of this research feasible. The decision was made to only examine single, owner-occupied, residential, non-doublewide houses because this provided easily identifiable categories into which to divide the data. Using residential homeowners is appropriate because they seem to be the category most likely to make purchasing decisions with a view-shed in mind. Renters may consider the view-shed, as some previous work has found, but due to the generally short tenure of their stay, are unlikely to place as much emphasis on a good or bad view-shed as a home buyer. Doublewides were dropped because of the restrictions on where they can be located. Although the quality of a view-shed is probably important to owners of these homes, like renters, they are not likely to place as much emphasis on it due to the other factors that are considered when choosing a location for a doublewide.[10]

The dependent variable in the model will be the sales price of each home. The independent variables in the structural category include thirty variables that cover the size and quality of the home and lot, the materials and style used in the construction of the building, the year of construction, the number and type of rooms, the heating and cooling systems employed and any luxury features in the house. The list of variables selected is extensive but in line with previous work (Anderson and Cordell 1988, Metz and Clark 1997, Gillard 1981, Beron *et al* 2001). Tables I and II contain a full list of variables and

[10] First among this is a consideration of where the trailer transporting the doublewide is able to reach.

their definitions at the conclusion of the paper.

In the neighborhood category, eight variables measure the characteristics of the communities surrounding each house. These are, the racial breakdown of each community by percent; the percentage of households that are families with children under eighteen; the percentage of single parent households; the percentage of households over 65; the percentage of families below the poverty line; the percentage of occupied housing units in a neighborhood; the percentage of individuals with a college degree; and the median income. The data used to assemble each of these measures comes from tract level census data in the 2000 *Census of the Population and Housing*. Buncombe County is broken down into twenty-nine census tracts that correspond to the municipalities in the county. Because the assessment database used for structural characteristics includes the municipality that each house is located in, the tract level data can be matched to each house to reflect the socio-economic qualities of the neighborhood where the house is located. While this data may not be specific to the street for within the data set, the variation spatially within census tracts is not large (Beron et al 2001) and for the purpose of controlling for neighborhood characteristics the data in the census tracts is sufficiently precise. In addition to the neighborhood characteristics taken from the census data, there is a variable indicating in which school district each house is, taken from the assessment database, and a variable for the fire district of each house. The fire district dummy is intended to serve as a proxy for the distance to the CBD as the fire districts are much smaller than the municipalities or the school districts and the variation in distance to the CBD within the geographic area they cover is small. The final neighborhood variable is a dummy that represents whether the home is rural. This is an attempt to control for bias in the mountain view-shed variable caused by the fact that homes with mountain view-sheds are more likely to be rural, and thus have better access to environmental amenities and poorer access to the amenities of downtown Asheville.

The environmental variables measured are the final category of independent variables and include the variables of interest in the regression. In line with the previous work on view-sheds, there is a variable for a mountain view-shed (*mtnview*) within one kilometer of the home and, in an attempt to test the finding that the contents of a view-shed beyond one kilometer have no impact on price, a variable for a mountain view-shed within two kilometers of the home (*mtnview2km*). Both of these variables measure the presence of a visible mountain within one or two kilometers of a home, respectively. In other words, these variables will take on a value of one if a house has a view-shed of a mountain and that mountain is located within one or two kilometers of the house. They will take a value of zero otherwise. Next, there is a variable that measures the number of houses visible on a mountain within one and two kilometers (*housesin1km* and *housesin2km*). Within each of these variables houses are not repeated. *Housesin1km* measures only the number of houses on a mountain within one kilometer of the observer point and *housesin2km* measures only the houses between one kilometer and two kilometers. Additionally, there is a variable that measures the scope of mountain view-shed as wide, medium or narrow (scope). This is included in an attempt to control for the fact that a house with a wide view-shed will almost certainly have more houses in the view-shed than a house with a narrow view-shed. However, the house with the wide view-shed has the additional benefit of a larger mountain view-shed.

Several neighborhood/environmental interaction variables were also included to assess the variation in the value of a view-shed across neighborhoods in the study. The *mtnview* variable was interacted with the median income variable to assess the impact of increased incomes on the price paid for a high quality view-shed. Theoretically, a neighborhood with greater median incomes would have more disposable income to spend on views, which might be considered a luxury good. For the same reason interaction terms of square footage and *mtnview*, and bedrooms and *mtnview* were used to see if buyers of larger houses were willing to spend more for a good view-shed. Finally, an interaction term of over 65 and *mtnview* was included to see if retirees were willing to spend more on a good view-shed than younger homebuyers.

Creating view variables in GIS

The view variables used here were created using the 3D analyst extension in ArcMap 9.3. This program allows the spatial elements of the properties to be visualized and analyzed remotely and a visibility model to be generated for each house. The Buncombe County and City of Asheville GIS departments provided the data used in this process. Contained in this data are digital representations of the parcel outlines defined by the Buncombe Tax Department, the physical features of the county (parks, rivers, roads, county infrastructure, etc.) and the building footprint information for the City of Asheville. Each file was imported into ArcMap and merged together to create a single digital representation of the spatial elements of the county. This single file was then combined with a ten-meter digital elevation model (DEM) from the United States Geological Survey. The DEM records and visualizes the land elevation in the study area and, therefore, delineates the geographic restrictions on the land visible from each property.[11] It also provides a visualization of the mountains in the area that allows the

[11] In other words, the DEM is what ensures that if there is a mountain between two homes

user to determine if a mountain is visible from a given home. Merged with the spatial file containing the information about the built aspects of the county's geography it provides a digital representation of the natural and man-made physical features of the county.

Once the spatial parcel information was combined with the DEM, the homes built after 2005 were removed from the map. In order to do this the parcel data was indexed in Stata 10.0 by year built. This data set was then exported into ArcMap as a table and overlaid on the spatial parcel data. Once each spatial parcel had a date of construction they were identified by construction date and homes built after 2005 were dropped. Removing these homes was necessary because the spatial information downloaded from the GIS department contains all of the houses in Buncombe County as of June 2009. However, because the prices of the houses sold in 2005 do not reflect the presence of houses built after 2005, including these houses in the view-shed analysis would overestimate the number of houses visible at the time of sale. This, in turn, would bias the estimation of the coefficient on the variable measuring the number of homes in view-shed. Although the prices houses were purchased at in 2005 might reflect some expectation about changes in the view-shed, the assumption that home buyers would have enough knowledge to predict the future number of homes in a view-shed is not realistic. Developers do not widely publish sufficient information about their projects and the impact on view-sheds to allow homebuyers to make accurate predictions. Although the effect of expectations should be examined in the future, this paper will focus solely on the impact of homes visible at the time of purchase.

The next step was to separate the houses sold from the general population of homes in Buncombe County. This was done by generating a second layer of parcel data

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the view-shed analysis will recognize that they cannot see each other.

from the original GIS data set in ArcMap and merging it with the sales data set from the Tax Department. Each parcel in the GIS layer is identified by the same set of unique PINs used by the Tax Department. Thus, the second layer of parcel data can be pared down by matching it with the list of homes sold in 2005 from the Tax Department and marking homes that were sold. Any house not marked was then dropped from the layer. The result of this process was a parcel layer with the 626 observations that correspond to the homes sold in 2005. This final parcel layer was overlaid on the combined DEM and parcel information already in ArcMap and provided the set of observer points from which the visibility analysis was conducted.

The actual visibility analysis was conducted with the view-shed feature in the 3D analyst extension. The precise steps of the algorithm utilized in this computation are not public domain, however it is assumed that there is no impact on the visibility results due to the algorithm itself (Yu Han and Chai 2009). However, there are several settings that regulate how the visibility analysis is conducted that can be adjusted by the user. Most of these are left in their default positions with the exception of the setting that controls the horizontal sweep of the view-shed. By adjusting the horizontal sweep setting a user can determine if the visibility analysis will consider a 360°-degree view-shed from the observer point or some subset of 360°. Previous work dealing with the view-shed from urban apartments (Yu Han and Chai 2009, Lake *et al* 2000) has adjusted this setting to restrict the sweep to a 90° segment of the full 360°. The adjustment is made because the properties analyzed are high-rise apartment buildings that only have windows in one or two of the walls of the property and thus the 90° segment corresponds to the slice of the view-shed visible from a window in those walls. In these cases the restriction makes intuitive sense since most apartment buildings have a very limited scope of view-shed. When looking at the view-shed from freestanding homes that have windows on each side of the home this restriction does not make sense. While geographic features may impact a view-shed from a certain side of a house (if it is built into a hill for example), there are no structural features in a single family residential home that suggest the horizontal sweep of the view-shed should be restricted *a priori*. Any geographic features that restrict the scope of the view-shed will be considered in the DEM and included in the visibility analysis without necessitating the adjustment of the default settings. As a result, the horizontal sweep is left at 360° and the only change made in the default settings is the use of a factor of .3 to convert from the default distance unit of meters used in the visibility analyst tool, to feet used in the projection of the parcel data.

With all of the data in ArcMap and the visibility settings properly adjusted the view-shed command is run individually for each of the 626 observations in the data set. This process takes approximately five minutes for each observation and generates an output providing a visual representation of the areas visible and not visible. Two examples of the output are in Appendix III. Once the view-shed command had been run a double ring buffer at one kilometer and two kilometers was added to the visualization. The double ring buffer command simply creates a ring around the property that delineates circles of one kilometer and two kilometers centered on the property. This limits the view-shed assessed to the distances of interest and is another example of the advantage of conducing this analysis in GIS rather than on the ground. If the contents of the view-shed of each home had been assessed by site visits it would have been extremely difficult to measure exactly which homes were within one kilometer and two kilometers. Once the buffer was added, the GIS output for each observation was then visually assessed and the variables described above (*mtnview*, *housesin1km*, *mtnview2km*, *housesin2km*, and *scope*) were coded, and using the PIN for each observation, added to the structural and neighborhood database. Overall the GIS coding aspects of this project took approximately 100 hours and was the limiting factor in the size of the data set used.

One comment is due regarding how the data set treats the presence of trees. Information regarding the presence of trees was not included in the visibility analysis because the data does not exist in either the Buncombe County GIS database or the larger NC State database. This is in line with previous work (Lake et al 2000, Yu et al 2008) and there are two reasons why this should not have a substantial impact on the visibility analysis. The first is that, due to the lack of any ordinances mandating the presence of trees around ridge top development (Buncombe County 2006), ridge top development in Buncombe County typically involves clear cutting of the top of a ridge and homes are built on the newly bare ridge. This means there are simply no trees on the ridge top to shield the home from view and thus no reason to consider them in this analysis. Visual inspection of properties in Buncombe County – see Appendix I – confirms that there is little, if any, impact on visibility caused by the presence of trees on developed lots.

A secondary impact of trees comes from their presence on the lot of the house serving as an observer point. It is assumed, however, that the visual impact of these trees is low because few lots are so surrounded by trees that visibility is drastically reduced. Additionally, if trees on an observer lot interfere with a desirable mountain view-shed they are easily removed.[12] These assumptions are supported by on-the-ground

[12] Obviously trees could also be left in place to block the view of ridge top development, but if this is done there is still a loss in value in the observer home due to the absence of a possible mountain view.

inspections of homes in Buncombe County.

Finally, the sales data used in this paper has been restricted to homes sold in the months between November and March in an attempt to further minimize the impact of vegetation on the visibility analysis. Because Buncombe County is located in a temperate climatic zone and the forests in the area are part of the southern broadleaf hardwood forest, the trees are primarily deciduous and have no leafy vegetation from November to March. Thus, their visual impact is further reduced at the time the views from the houses sold would have been considered by the homebuyers. While restricting the observations to houses sold in the winter months may lead to a higher estimate of the coefficient on *homesin1km* and *homesin2km* relative to the estimate if homes sold through the year were considered, this restriction makes sense both in order to simplify the visibility analysis and because of the nature of how a view-shed is valued. Although a home sold in the summer may have a slightly different view-shed, there is little to suggest that this would systematically bias the results in one direction. Changes in the view-shed caused by trees will affect both the positive and negative aspects of the view-shed.

Furthermore, there is no reason to believe that the value assigned to a view-shed at a time of the year when other homes are obscured is the accurate value. It is far more intuitive that a rational homebuyer would only want to pay for the value of the worst view-shed from a property. In other words, given that for five months of the year the view-shed from a home is without trees, and therefore potentially worse than with trees, a home buyer with knowledge of the view-shed in the winter would not pay for the value of the higher quality summer view-shed, but rather the lower quality winter view-shed. Thus, the higher value that might be found if summer sales data were used is simply a result of the homebuyer's imperfect knowledge of the year-round quality of the view-shed while the price paid during the winter months is closer to the accurate value of the view-shed. Therefore, utilizing only the winter sales data should provide a more accurate estimation than if full year data were used.

Comparisons of the area deemed visible by the view-shed analyst tool in ArcMap and actual visible area from several properties in Fairview confirms the essential accuracy of the view-shed tool. Running a visibility analysis from 713 Garren Creek Road, for example, suggests that there is a mountain view-shed within one kilometer and there are seven visible homes. In reality there is a mountain view-shed with six homes visible within one kilometer. This is an acceptable level of error. With a standard deviation in *housesin1km* of more than four across the data set, an error of plus or minus one home in the visibility analysis will not systematically bias the results in either direction.

Methodology

As discussed previously, the model employed here is a log-linear or semi-log model. This appears to be the most widely used form across the literature and gives a good fit with the data in this study.

On the independent variable side the primary variable of interest is the dummy indicating whether or not there is a mountain view-shed within one and two kilometers. The secondary variables of interest are those indicating the number of houses in any mountain view-sheds. *Housesin1km* and *housesin2km* are entered in both their linear and quadratic forms. Taking the squared value allows the impacts of the number of houses in view to vary non-constantly across the data. This is important because, theoretically, adding a home into a view-shed when there are only one or two other homes visible will have a different effect than if there are twenty homes visible.

For the same reason a dummy variable representing homes that have a mountain view-shed but have no houses in the view is also included (*no_houses)*. A pristine view-shed is substantially different from a view-shed with even one other home in it and this is supported by the significance of the dummy at the one percent level.

Finally, constants are used to control for the school district, township and several of the building materials used – including roof type, interior finish and foundation type – in order to minimize the reporting of extraneous coefficient results. Because this study is not interested in measuring the effect of these variations, simply in controlling for them, these results are not reported in the following section.

The final regression equation used, ignoring the non-reported control regressors, is as follows:

$$\ln sellingprice = \beta_0 + \beta_1 bedrooms + \beta_2 square\ footage + \beta_3 bathrooms + \beta_4 halfbaths + \beta_5 acres + \beta_6 fireplace + \beta_7 township + \beta_8 median\ income + \beta_9 percent\ college + \beta_{10} percent\ occupied + \beta_{11} percent\ poverty + \beta_{12} percent\ over\ 65 + \beta_{13} single\ mothers + \beta_{14} percent\ family + \beta_{15} percent\ african\ american + \beta_{16} percent\ hispanic + \beta_{17} mtnview + \beta_{18} housesin1km + \beta_{19} housesin1km^2 + \beta_{20} mtnview2km + \beta_{21} housesin2km^2 + \beta_{22} scope + \beta_{23} nohomes$$

A full explanation of the contents of the variables and their summary statistics is reported in Tables I and II. The next section will discuss the results of the above regression.

V. Results & Summary

The full results of the primary regressions are recorded in Table I presented at the conclusion of the paper. When viewing and interpreting the coefficients on the variables of interest, it is important to remember the functional form selected and the implications that this has for the meaning of the coefficients.

Most importantly, because the dependent variable is the natural log of selling price, most of the coefficients should be read as the percentage change in the price due to a unit change in the variable measured. For example, the coefficient on the *scope* variable in regression IV is -0.041. This translates to a decline in value of 4.1% associated with moving from a wide to medium or medium to narrow view-shed. Using the median value of $221,828 for the sales prices in the data set, this translates to a loss in value of $9,094 associated with a change from a view-shed with a wide scope to medium scope or medium scope to narrow scope.

The second category of variables consists of variables entered in natural log form. In the case of these variables the coefficients should also be interpreted as the percentage change in the sales price caused by a change in the variable. However, when the independent variable is a logarithmic transformation, the change in the variable is measured in percent rather than units. Thus, the coefficients are the percentage change in the sales price caused by a one percent change in the value of the variable. This allows the impact of the characteristic to vary depending on the level at which it is present.

Of the results listed in Table I there are several that are notable. First, the adjusted R^2 value of the regression including the control regressors ranges between .61 and .76. This suggests a very good fit for the log-linear functional form and, when compared with the R^2 of the log-log and linear forms, confirms the initial expectation that this was the proper functional form. These R^2 results are in line with previous work, which has adjusted R^2 values between .63 (Beron Murdoch and Thayer 1998) and .94 (Jim and Chen 2009).

Moving into the specific coefficient values, the first variable of interest – *mtnview* – has the expected sign and is significant at the one percent level in regression I. The coefficient of .12 suggests that a view-shed of the mountains within one kilometer of a home adds twelve percent, or, using the median value again, $26,619 to the value of a home in Buncombe County. A twelve percent premium for a mountain view-shed is within the expected range based on previous work (Bourassa *et al* 2003, Box 2005). It is slightly higher than the average results of previous work on mountain view-sheds; however, as noted above, many of the other studies examined the view-shed of a body of water, not the mountains, and those that did examine mountain view-sheds selected their data from areas where a water view-shed was predominate and the mountain view-shed was some distance away. That Benson *et al* (2002) found a positive effect for mountains that were much further than one kilometer from the homes examined suggests that the results here, for mountain view-sheds within one kilometer, should be higher than those of previous work. Furthermore, Buncombe County is somewhat unique in the literature surveyed due to its reputation as a locale with excellent view-sheds of the mountains. Because people come to Buncombe County, in part, specifically because of the view-sheds, they may be forced to pay an unusually high premium for good view-sheds due to increased demand for these view-sheds relative to other areas in the country. More important than the size of the estimation, however, is the significance of the result. Much of the previous work has found that there is a positive relation between view-sheds of the mountains and house prices, but that same work often finds this relation to be insignificant. That these results are significant at the one percent level is an important distinction between this work and previous work.

It is worth noting the ninety-five percent confidence interval for this estimation is .027 to .21 given that the value is well within the range of the previous literature it should not be dismissed out of hand. Although a twenty-one percent premium is remarkably high for a mountain view-shed, the high level of significance of the twelve percent premium makes it very likely that the true premium is between ten and fifteen percent.

As expected, adding the measure of a mountain view-shed within two kilometers does not significantly change the estimation. The coefficient on *mtnview* remains the same, although the t-score falls to 2.42 and it is only significant at the five percent level. The coefficient on the variable for mountain views within two kilometers is .015, suggesting a very slight positive relationship between views within two kilometers and the price of a house. However, this relationship is not significant. The lack of significance confirms the findings of Hull and Bishop (1988) that views beyond one kilometer do not have a significant impact upon prices. Finally, including the control for the scope of the view-shed slightly reduces the estimation of the coefficient on *mtnview* – to seven percent – but the variable *scope* itself remains insignificant.

The second variable of interest, *housesin1km*, has the expected negative coefficient with a value of -.001 but is not significant. Thus, there is the suggestion that the addition of a home into the view-shed of a house up for sale will reduce the sale price by .1% or, put another way; the addition of ten homes into a view-shed will reduce the sales price by one percent. This is not a large figure for a single home but the addition of homes to a view-shed rarely occurs in such small numbers. The relevant unit to consider when analyzing this variable is not the impact of one home but the impact of adding a development and therefore a minimum of ten to twenty homes.

An excellent example of the large scope of development is the planned neighborhood The Cliffs in Fairview, in the southeast corner of Buncombe County. The plans for this development call for the construction of 300 homes on the side of Minert's Mountain overlooking Highway 74 and Fairview. Following from the result above it is conceivable that the sales price of a home in Fairview with a full view-shed of the homes in that development could decline by as much as thirty percent ($66,548). This is an extreme example because it is unlikely that all 300 new homes would be visible from an existing home but it is conceivable that 100 or more would be visible, which would have a substantial price effect.

Regardless of the precise number of homes visible, this example serves to illustrate the point that, although the impact of each individual home is not substantial, the overall impact of ridge top development could have a large effect on the sales price of homes in Buncombe County. The Cliffs is not unique in its size either. The Cane Creek Crossing development, five miles south of The Cliffs on highway 74, plans to add fifty houses to Fairview's housing stock and, on the opposite side of Minert's Mountain a new development overlooking the local high school is slated for approximately sixty new houses.

An alternative way of viewing this result is from the perspective of the total loss in utility as a result of the construction of the ridge top home. In other words, rather than consider the amount the value of one home declines based on the number of homes visible on a ridge, consider all of the houses that can see a single home and the total loss as a result. For example, if the addition of a home into a view-shed results in a $200 in the value of each home that can see it and 100 homes can see it, then there is a total loss in value of $20,000 caused by the new home. This assumes that all the homes viewing the new construction have the same utility functions and thus the process of finding he actual value is not as simple as multiplying the individual value lost by the number of homes in the view-shed, as was done here. However, as a conceptual exercise, considering the impact of a new home from this perspective is useful as it illustrates how large of an impact these indivudal homes can have by virtue of their high visibility. The value lost by any one individual as a result of their construction may not be large, but when the loss in value of every home affected is considered, the totals are significant.

When *scope* is added as a control the coefficient on *housesin1km* remains unchanged while the significance declines slightly. The *scope* coefficient takes on a value of -.037, suggesting that moving from a wide view-shed to medium or a medium to a narrow view-shed decreases the value of a house by 3.7 percent ($8,207). Although not significant, this decline is similar to the results in previous work and, while the result cannot be interpreted as suggesting anything more than a negative relation, the strong theoretical support for this suggestion, combined with the congruence with previous work, indicates that the lack of significance is likely due to the small sample size rather than the absence of a negative effect. Finally, further defining the scope of the view-shed and testing the impact of a clear delineation of how much can be seen might provide stronger evidence for the negative effects of a reduction in view-shed scope. However, as this was simply a control in myregression that examination must wait for further work.

Adding a dummy for view-sheds that have no houses in them does not significantly change the estimates on the other view-shed variables but the coefficient on *no_houses* itself is the most significant of the view variables with a value of .07. The large size of this coefficient is not surprising, as the intuition behind including it in the regression is that there is a significant difference between a pristine view and a view with even one other house. The coefficient on *no_houses* confirms this intuition.

The coefficients on several other variables are also of note. Beginning at the top of the table, the coefficient on bedrooms is positive but not significant. However, the negative coefficient on the square of bedrooms is significant at the ten percent level. The significance here is not surprising – the number of bedrooms should, theoretically, be one of the primary considerations of a house buyer. The final room variable, the natural log of full bathrooms has a positive coefficient significant at the one percent level. Although the value of .51 is remarkably high in the context of other work the lower end of the ninety-five percentile, at .24, is well within the range of the previous work.

Variables on several other attributes of the house were also included and are worth noting. Looking at the variable measuring total square feet in a home we see that this is in fact positive and significant at the one percent level as well. Thus, increasing the square footage of a home raises the price, which is intuitive. *Hottubs* has a positive coefficient indicating that a hot tub adds a premium of thirty-eight percent but the coefficient is not significant. *Fireplace* has a coefficient of .08, suggesting an increase of eight percent in the value of a house that includes a fireplace, but it is also only significant at a twenty percent level. The relative equality of the estimation for the coefficient on the value of a mountain view and fireplaces is also found in the previous literature (Beron Murdoch and Thayer 2001) and offers some validation of the results found here.

In the final category of reported variables, the social variables, only *percent_poverty*, *percent_65*, *percent_single*, and *percent_family* are significant. *Percent_poverty* and *percent_single* are both significant at the ten percent level and both have the expected negative signs. *Percent_65* was included as a proxy for the level of retirement in a neighborhood with the expectation that a higher percentage of retirees would have higher home prices. The positive coefficient on *percent_65* is significant at the ten percent level and indicates that an increase in the percentage of residents over sixty-five results in a price increase of approximately twenty-five percent. Finally, *percent_family* has a positive coefficient, significant at the five percent level, that indicates an increase in the percentage of households with children under eighteen adds a premium of twenty-six percent.

In an attempt to examine the impact that mountain view-sheds have on prices when combined with other aspects of a house several interaction terms were included in the regression. The first of these – *income_view* – was generated by interacting mountain views within one kilometer with the median income values from the U.S. Census for each tract. When included in the regression, *income_view* had a very slight (0.000028) positive effect on prices that was significant at the one percent level. A one-unit change, or the addition of a dollar of income, in the neighborhood's median income will increase the price of a home by 0.0028% when the home also has a view of the mountains. However, a change of one standard deviation ($10,800) results in a thirty percent change in the value of a home. This suggests that as the income of a neighborhood increases, the value of a view-shed increases and provides a weak indication that homebuyers with a higher income are willing to pay more for a view-shed of the mountains.

The next interaction variable examined was added in an attempt to determine if retirees will pay a higher premium for view-sheds than younger homebuyers. The percentage of a census tract over sixty five was interacted with mountain view-shedss and included in the regression with a coefficient of 0.032 that is also significant at a one percent level. Thus, a one percent increase in the number of individuals in a neighborhood results in slightly more than a three percent increase in the value of a home with a view-shed. This confirms the expectation that a home with a mountain view-shed in a neighborhood with a high percentage of retirees will have a premium over other homes with mountain view-sheds.

Two interaction terms to examine the impact of view-sheds on larger houses are also included. *Bedrooms_view* and *footage_view* are both added to the regression to test the theory that larger houses with a view-shed will be more valuable than smaller houses with a view-shed. The coefficients on both interaction terms – .0072 for *footage_views* and .335 for *bedroom_views* – are positive and significant at the one percent level and indicate that a view-shed is more valuable in larger, rather than smaller, houses.

Robustness Checks

As a robustness check both log-log and linear functional forms were tested. In the log-log the R^2 improves by .01 but the coefficients change very little in either magnitude or significance. The partial results of this regression are reported as regression VI in Table I.

Because the differences between the log-log and log-linear model are not substantial with regard to our variables of interest the choice was made to remain with the log-linear model as the primary estimator. This choice was made because of the previous work that uses the log-linear model and to minimize the transformations of the variables of interest. Although the overall fit is slightly better with the log-log model, the log-linear model provides a better fit for the variables of interest.

Testing the results against the linear model provides additional support for the decision to utilize the semi-log form. Recall the theoretical basis for not utilizing a linear form – that doing so imposes a constant marginal change regardless of the level of the variable measured. In the case of many of the variables this does not make sense. There is little reason to suspect that the variables will have the same impact across all the ranges of prices. Thus, using a flexible form to allow for differing marginal rates of change makes theoretical sense. The results of the linear regression confirm this. Although the overall adjusted R^2 improves to .79, this improvement is not, in and of itself, necessarily indicative of greater accuracy in the estimation of individual coefficients (Garrod and Willis 1992). Rather, there are compelling theoretical reasons that dictate that the log-linear form is the most appropriate in the current context. It should be noted, however, that under a linear model, the significance of the variables of interest (excepting *no_houses*) decline while the conclusions remain intact; nonetheless, for the reasons previously discussed concerning the flaws with the linear model, these estimates are not considered of import here.

As a final robustness check the regressions listed in Table III are run with the qreg command in Stata, forcing the drop of outliers in the data as a check to ensure that the results are not influenced unduly by a single observation. The results of these regressions are not reported because the coefficients did not change noticeably. *Mtnview* and *housesin1km* became more significant in several of the regressions but the magnitude of the coefficients remained the same.

Discussion

The general conclusion that can be drawn from these results is the suggestion that mountain view-sheds within one kilometer have a positive impact on the prices of homes in Buncombe County. Furthermore, the addition of a home into a view-shed has a small but, in the context of the large scope of development, relevant negative effect on the price of a home. Individually these homes may not have a dramatic effect on the price of a home but because most development in Buncombe County adds tens, if not hundreds, of homes into a view-shed the overall damages can be as much as thirty percent of the value of a home.

Taking a step back from the individual coefficient estimations and analyzing these results in the context of a realistic, model home is also informative. To do this the effects of a change in several of the variables will be compared across a large and small home which have an excellent view-shed – defined as a view-shed of the mountains with no other homes – a moderate view-shed – defined as a home with a mountain view-shed with other houses in the view-shed – and no view-shed – defined as a house without a view-shed of the mountains. Varying a selection of variables from the equation described above provides estimates of the approximate value of a home in Buncombe County with several combinations of characteristics.[13] Measuring variation in the price of homes in this way provides a more realistic estimate than simply examining individual coefficients because it allows the coefficients to vary relative to each other in realistic ways. For example, returning to bedrooms and square footage, the regression considers each of

[13] $\ln \textit{sellingprice} = \beta_1 \textit{bedrooms} + \beta_2 \textit{bedrooms}^2 + \beta_3 \textit{square footage} + \beta_4 \textit{bathrooms} + \beta_5 \textit{halfbaths} + \beta_7 \textit{acres} + \beta_8 \textit{fireplace} + \beta_9 \textit{mtnview} + \beta_{10} \textit{housesin1km} + \beta_{11} \textit{housesin1km}^2 + \beta_{12} \textit{scope} + \beta_{13} \textit{nohomes} + \beta_{14} \textit{rural}$

these individually, holding the other constant. This results in a negative coefficient on *bedrooms*^{2} because the number of bedrooms is increased while square footage remains the same; creating more, but smaller bedrooms. In reality, however, a home with 2500 square feet is far more likely to have five bedrooms than one and it is extremely unlikely that a 1200 square foot home will have five bedrooms. The regression utilized does not make this distinction. Considering the impact of several variables simultaneously makes it possible to consider these types of relationships.

The first examination reveals that large houses with an excellent view-shed are sold for a premium of 245% over the median, which amounts to $543,478.60. The large home was assumed to have five bathrooms, three bedrooms, 2500 square feet, and two fireplaces. The selection of these values was made based on a specific home in Buncombe County for the purpose of comparing the predicted value to the assessed value of the home. Compare this estimate with a 2500 square foot home with six bedrooms and three bathrooms assessed at approximately $700,000. That predicted value is within thirty percent of the assessed value of a very similar home when only including a selection of the variables in the regression makes a strong case for the accuracy of the regression.

The next step is to keep the structural variable selections the same and reduce the quality of the view-shed by assuming a reduction in scope from wide to medium and add four houses – the median value of visible houses in one kilometer – which reduces the premium to 233%. Increasing the number of visible homes by a standard deviation – to nine homes – further reduces the premium to 231%. Testing the impact of scope and reducing from a medium to narrow scope, while reducing the number of homes visible back to four to account for a narrower view-shed, reduces the premium to 229%. By way of comparison the premium associated with a large house that does not have any view-shed is also considered and is found to be 187%. So even a narrow view-shed with the median number of visible homes adds a substantial premium to the value of a house.

The package of characteristics associated with a small house was also considered and, like the values chosen to represent a large house, are selected with a specific home in mind. The number of bedrooms associated with a small house is set at three, the square footage is set at 1800, two full bathrooms, one half bathroom and one fireplace. A home with this set of characteristics and an excellent view has a premium of 232% while reducing the scope and adding the median number of homes results in a premium of 226%. Applying the premium associated with the lower quality view to the median house price suggests that a small home with these characteristics should sell for $501,331.28. As a robustness check this estimate is compared with the price of a newly built home with the same set of characteristcs. The estimated assessed value of the newly constructed home is approximately $460,000.00, which places the estimate within ten percent of the assessed value (Tulimy 2009).

As expected the larger homes are associated with a higher premium and the relative decline in value associated with declining view-shed quality is also smaller with small houses. Increasing the number of visible houses by a standard deviation results in a decline in the premium to 219% and the final change, to a narrow scope, results in a premium of 217%. The same perspective check was applied to small homes as well and the premium associated with this combination of characteristics without a view is 175% - again, significantly smaller than the premium associated with the lowest quality view-shed.

One particularly interesting aspect of the results is the superiority in fit of the linear form of the *housesin1km* variable. The quadratic variation is tested across all three functional forms and with and without the scope and *no_houses* control. In each regression the linear form of the variable is a slightly better fit with the data but in the final regression – with *no_houses* – the linear form has an unexpected, positive sign. These results suggest that the marginal change from an additional house is relatively constant. This result is interesting because the intuition is that there will be an increasing and then decreasing marginal effect for each house added. It is expected that the effect of a home added to a view-shed that already included twenty houses would be far less than that of a house added to a view-shed with fifteen other houses. However, it is also expected that the impact of adding a house to a view-shed with ten houses would be greater than adding a house to a view-shed with one house because, in the view-shed with one house, an additional house can be ignored with greater ease because a smaller percentage of the view-shed is developed.

If this were the case the quadratic should be a better fit to the data than the linear form. The fact that the linear form is the better fit indicates that the impact of each additional home is constant. There are two possible explanations for this. The first is that the theoretical expectation is simply incorrect – there is no change in the impact of an additional house as a view-shed becomes saturated. The second, and in this case more likely, explanation is that the sample measured here lies on a linear section of the curve relating the number of house in a view-shed and their impact on prices. Although development is a growing problem in Buncombe the overall level of development is still low. It is conceivable, even likely, that the view-sheds in Buncombe County still have few enough houses that the price effect of adding an additional home moves in a linear manner. In theory, adding an additional house to a view-shed would only begin to have a noticeably decreasing marginal impact after a certain threshold value had been crossed. Given that many of the view-sheds measured have fewer than ten homes it is possible that the marginal impact of an additional home is close enough to constant that a linear form is the best approximation.

One final consideration when viewing these results is that they are tied to both the time and location from which they are drawn. The estimates suggest that in Buncombe County in 2005 there was a negative premium associated with an additional house in a view-shed of .1% while a mountain view-shed added approximately twelve percent to the value of a home. However, extending this analysis too far into the future, or to other geographic areas, would require additional data and subsequent analysis to determine similarity or lack thereof, across spatial and temporal dimensions.

VI. Conclusions

Assigning value to a view-shed is an inherently difficult task. View-sheds are not traded on an open market and they are not given exact price points. Rather, they are appreciated for their value in ways rarely measured by the market. One of the few ways they are measured by a market is through the premium paid by homebuyers for houses that have a high quality view-shed. These markets offer an estimate of the utility that individuals derive from a high quality view-shed and as such serve as a source of potentially important information for policy makers about the economic incentives for crafting land policy.

Examining Buncombe County, where the debate over ridge top development has gone on for several years with little progress in either direction, provided an opportunity to attempt to provide a value of view-sheds that would be directly relevant to public policy. As a location well known for its high quality mountain view-sheds, Asheville has significant revenue at stake in the debate over how much a view-shed is worth and what level of protection they should receive. Previous work provides some guidance as to the value of a high quality view-shed of ambiguous content but it has done little to focus specifically on the impact of mountain view-sheds in the absence of ocean or lake view-sheds. The data utilized here examines precisely that and, taking a snap shot of the Buncombe County real estate market in 2005, provides an opportunity to assess the change in value caused by degradation in the view-sheds of houses in Buncombe County. In an ideal situation, this information could be used to help push the debate about slope regulations and elevation restrictions forward on more empirical grounds.

The snap shot taken indicates, as expected, both that there is a positive premium paid for mountain view-sheds in Buncombe County and that there is a negative impact on prices from increasing the number of homes visible in this view-shed. In the sample analyzed, having a mountain view-shed added a twelve percent premium to the value of a home, which, using the median value of a home in Buncombe County at the time, amounted to an increase of $24,049, that is significant at a one percent level. This is a strong, and unsurprising, indication that the real estate market in Buncombe County demands a premium for mountain view-sheds within one kilometer. The lack of significance of the estimate for a mountain view-shed within two kilometers also confirms the findings in previous work that view-sheds beyond one kilometer do not have a substantial impact on house prices.

Finding that mountain view-sheds have a positive premium associated with them is unsurprising. Although not as focused as this study the previous work has found similar results. More interesting, and a unique contribution to the previous work, is the examination of the impact of the addition of houses into a view-shed of the mountains. In this case the sample used here does not provide conclusive answers. There is a suggestion that the addition of a house into a mountain view-shed reduces the selling price of the house with the view-shed by .01%. Individually this is not a substantial figure. However, when the scope of development is considered and this result is examined with the knowledge that developments rarely add fewer than houses to the view-shed of an existing house this number becomes more substantial. The addition of ten homes will cause a one percent, or slightly more than a $2,000 decline in value. Individually a new house does not cause a massive decline in value, but the overall scope of development can have a large negative effect on the value of an existing home.

When the controls for scope and no other houses are added they both have the expected signs. As the scope of a view-shed becomes narrower the value of a home declines by three percent for each step down in scope. Adding scope has an insubstantial effect on the coefficient on the variable for the number of houses visible, which suggests that the value of wider view-sheds is not negatively affected by the presence of a greater number of visible houses. A view-shed with no other houses increases the value of a home by seven percent but at an insignificant level.

The estimates for the structural and neighborhood variables included add nothing to the literature already written on hedonic regressions in real estate markets. The results of the estimation provide the expected signs on most of the variables and the significance is too low on those with unexpected signs to draw solid conclusions from the results. The overall fit of the regression and general range of the estimates is within the expected values found in previous work and lends support to the overall validity of the results here.

The important aspects of this work with regard to the advancement of the literature are the estimates on the mountain view-shed variable and the attempt to assess the decline in value caused by the presence of other houses. As the first study, in my knowledge, to examine only mountain view-sheds this work provides a starting point for additional examinations of the value mountain view-sheds. It also provides initial estimates of the value of a mountain view-shed in areas with no other type of view-shed. This is important for areas like Buncombe County where a significant amount of tax revenue comes from residents attracted to the region because of the mountains. It is highly unlikely that the estimates of a mountain view from a place like Bellingham, Washington (Benson *et al* 1998), where the mountain view-shed is considered in concert with an ocean front view-shed, will be accurate for somewhere like Buncombe County; set directly in the mountains and where mountain view-sheds are the only type of view-shed available. Thus, as the first study to utilize data from a mountain town to examine the price effects of a mountain view-shed this study offers a unique step forward in the literature.

Furthermore, this study continues a trend in the literature on view-sheds of creating increasingly complex variables for the contents of a view-shed and examining the impact of individual components of a view-shed. When view-sheds were first examined in the mid-70s the variables were simply dummies for the presence or absence of a view-shed. Since then these dummies have evolved to account for the type of view-shed, the scope of the view-shed and, recently, the contents of the view-shed. This study is a continuation of that evolution. Including and examining the variable for the number of houses built on the mountains in a view-shed this study adds a layer of analysis that none of the reviewed studies possessed. Although this analysis must be further refined in future research with additional measure of the location of the homes and more accurate measures of the number of homes visible this study serves as an important starting point.

Finally, although not unique in its use of GIS as a source for variable creation this study is on the progressive side of hedonic view-shed studies. The use of GIS is still a new concept in this field and this study introduces another way in which it can be utilized to create variables that would otherwise require intense fieldwork. By allowing view-shed data to be collected without site visits GIS expands the range of potential areas that can be analyzed and simplifies the process. GIS also allows for the creation of more robust variables measuring the content of a view. It is very simple to add a ring at one kilometer around a property in GIS and thus measure the impact of objects within one kilometer and beyond one kilometer. However, doing this through site visits is far more difficult and time consuming. Using GIS expands both the realm of potential examination sites as well as the ways in which these sites can be analyzed by providing a powerful tool for variable creation.

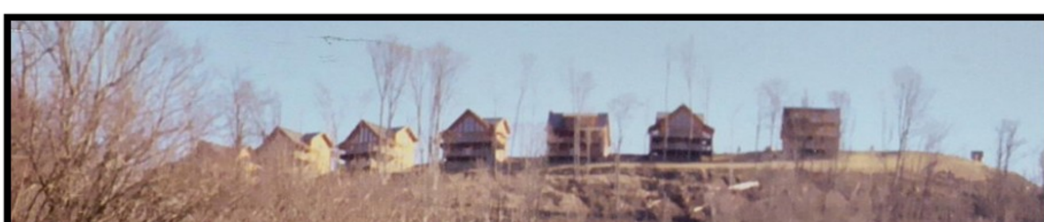
The results here are important for more than just their contribution to the field however. The direct application is to Buncombe County's debate over elevation and steep slope restrictions. Although the results are not conclusive they provide the first empirical indication of the value lost from ridge top development in Buncombe. Due to their low significance it is not possible to say with certainty that development has the estimated negative effect on the price of homes but it is an indication that there is, as suspected, a negative effect and it provides a starting point for approximating the exact value of this decline. These are the first results that provide some evidence in contrast to the economic growth numbers provided by developers and, as such, are very relevant to public policy creation in Buncombe County.

Attempting to extrapolate to other mountain communities across the country is more problematic. These results, while providing an indication of the value of a mountain view-shed, are specific to the time and place in which the data was collected. Attempting to apply the premiums found here to other communities would likely lead to a substantial amount of inaccuracy as many of the underlying factors that contribute to the creation of Buncombe County's real estate market would not remain constant. What can be taken away from this study is additional support for the theory that mountain view-sheds generate a positive premium for houses and that this premium declines as visible houses are added to the view-shed.

Moving forward, future areas of investigation should begin by expanding the sample size utilized here. With regard to Buncombe County, the data is readily available to expand to as many as 35,000 observations. This work was constrained in its sample size by the amount of time required to generate the GIS outputs but future work should begin by generating full GIS data for the complete set of 35,000 observations available from the Buncombe Tax Department. Another step future research could take is to refine the view-shed variables in GIS. With the release of ArcMap 10.0 in 2011 the tools available in GIS will increase making it possible to create even more robust variables for view-sheds. Although the current tools are extremely useful, their output is still not a perfect representation of the real world. As GIS programs improve and additional tools become available the output can be improved to more accurately model the real world.

View-shed valuation will continue to move forward and more accurate models will provide ever more detail for policy makers to use in making land use decisions. This study has provided a specific examination of Buncombe County with the goal of both advancing the literature on view-sheds and the debate on land use policy in Buncombe County. It has made contributions in both areas. By utilizing GIS data and focusing solely on mountain view-sheds and their contents this study has added to the literature on the subject. At the same time, the results of this work will provide a starting point for a more empirical debate over land use policy in Buncombe County and, ideally, will lead to the creation of more informed policy.

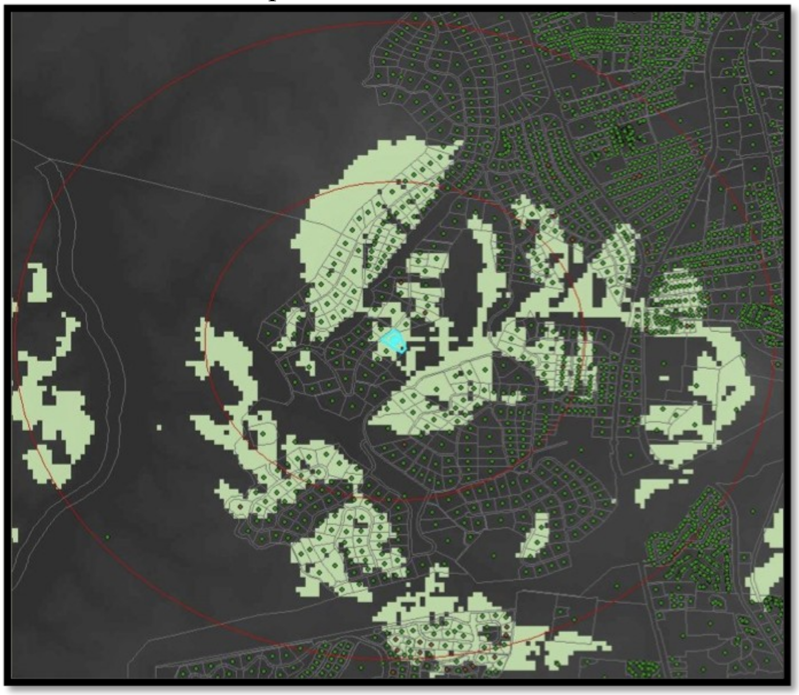
APPENDIX I: Ridge top Development in Buncombe County



APPENDIX II: Examples of an Unobstructed View

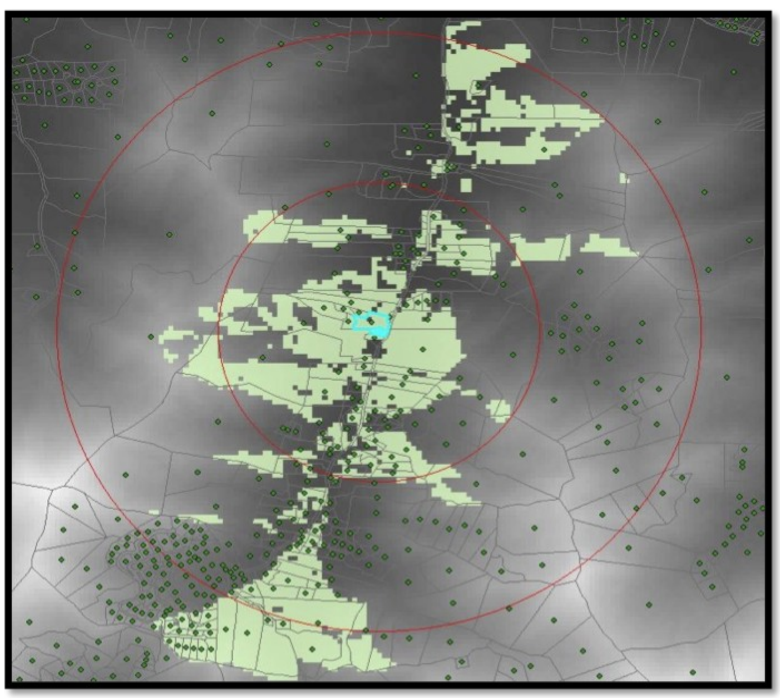
APPENDIX III: Example of GIS View-shed Output

Example 1 – No Mountain View



The rings represent the buffer while the green area is the visible area. The grayscale represents the elevation. The constant shade indicates a relatively flat elevation.

Example 2 – Mountain View in 1km & 2 km



The symbols here are the same as above. The large amount of white here indicates several mountains within one and two kilometers.

Table I: Description of Variables

Continuous variables	Definition
acres	The number of acres of the lot the home is situated on
bedrooms	Bedrooms in the home
$bedrooms^2$	The square of bedrooms in the home
fireplaces	The number of fireplaces in the home
fullbaths	The number of fullbaths, measured as a shower, commode and sink
halfbaths	The number of halfbaths or baths without a shower
hottubs	The number of hottubs
housesin1km	The number of other houses built on a mountain visible in one kilometer
$housesin1km^2$	The square of the number of visible houses built on a mountain
housesin2km	The number of other houses built on a mountain visible between one and two kilometers
$housesin2km^2$	The square of other houses built on a mountain visible between one and two kilometers
ln_houses1km	The natural log of the number of houses built on a mountian visible in one kilometer
$ln\_housesin1km^2$	The natural log of the square of houses built on a mountian visible in one kilometer
Median_Income	The median income of the census tract the house is located in from the 2000 Census
Percent_65	The percentage of the population over 65 of the census tract that the house is located in
Percent_Afam	The percentage of the population in the census tract identified as African American
Percent_College	The percentage of the population in the census tract with at least a bachelor's degree
Percent_Family	The percentage of households in the census tract with childern under 18
Percent_His	The percentage of the population in the census tract identified as Hispanic
Percent_Occupied	The percentage of houses in the census tract that are occupied

Table I: Description of Variables (cont)

Percent_Poverty	The percent of families in the census tract under the poverty line
Percent_Single	The percent of households identified as being led by a single mother
scope	The scope of a viewed, measured as wide (1), medium (2) or narrow (3)
sellingprice	The price at which the house was sold in 2005
total_footage	The total square footage of the house at the time of sale
view_bedrooms	An interaction between mtnview and the number of bedrooms
view_income	An interaction between mtnview and the median income of the tract
view_retired	An interaction between mtnview and the percent of the tract over 65
view_sqft	An interaction between mtnview and the total footage of a house
Dummy variables	
mtnview	A dummy equal to 1 if a home has a mountian view in one kilometer and 0 otherwise
mtnveiw2km	A dummy equal to 1 if a home has a mountian view between one and two kilometers and 0 otherwise
no_houses	A dummy variable equal to 1 if a house has a mountain view but there are no houses in that view and 0 otherwise
rural	A dummy equal to 1 if a home is rural, defined by having more than 5 acres sold with the house, and 0 otherwise
Non-reported Controls	
Township	Each township in Buncome County
Roof Structure	The framing style of the roof
Roof Type	The finish on the roof (i.e. shingles, tin, etc)
Floor Type	The predominate floor type in the house.
Interior Finish	The primary interior finish material (i.e. drywall, cement board, etc)
Exterior Finish	The primary exterior finish materail (i.e. brick, cedar siding, etc.)

Table II: Summary Statistics

Continuous variables	Observations	Mean	Std. Dev.	Min.	Max.
acres	626	0.96	2.84	0.1	52.45
bedrooms	626	2.99	0.77	0	6
bedrooms^2	626	9.54	4.81	0	36
fireplaces	626	0.71	0.62	0	4
fullbaths	626	1.96	0.77	0	5
halfbaths	626	0.33	0.49	0	2
hottubs	626	0	0.06	0	1
housesin1km	196	3.71	4.17	0	33
housesin1km^2	196	31.1	91.23	0	1,089
housesin2km	369	6.23	8.64	0	53
housesin2km^2	369	113.3	316	0	2,809
ln_houses1km	196	0.96	0.85	0	3.5
ln_housesin1km^2	196	1.93	1.71	0	6.99
Median_Income	581	37,356	10,800	27,572	119,526
Percent_65	581	26.9	5.77	19.6	51.4
Percent_Afam	581	7.74	7.82	0	17.6
Percent_College	581	25.81	13.9	9.5	83.7
Percent_Family	581	26.88	5.74	11.4	36.4
Percent_His	581	2.68	1.28	0.1	6.7
Percent_Occupied	581	90.24	10.4	32.3	93.6
Percent_Poverty	581	8.43	2.34	0.4	14.6
Percent_Single	581	5.95	1.52	1.5	7.4
scope	389	2.08	0.83	1	3
sellingprice	626	221,828	146,703	22,500	1,300,000
total_footage	625	1,764	846	308	7,015
view_bedrooms	625	0.95	1.49	0	6
view_income	581	10,655	16,890	0	46,818
view_retired	581	8.11	13.26	0	51.4
view_sqft	625	592.5	996	0	4,530
Dummy variables					
mtnview	626	0.31	0.46	0	1
mtnveiw2km	619	0.59	0.49	0	1
no_houses	196	0.15	0.36	0	1
rural	626	0.04	0.2	0	1

Table III: Hedonic OLS Regressions

Variable	Regression I ln_price	Regression II ln_price	Regression III ln_price
mtnview	.117***	.114**	.921***
mtnview2km		0.02	
scope			
no_houses			
housesin1km			0
housesin1km^2			
housesin2km			
housesin2km^2			
ln_houses^2			
acres	-0.002	-0.003	0.04
total_footage	.0002***	.0004***	.0002***
footage^2			
bedrooms	0.12	0.12	0.32
bedrooms^2	-0.015	-0.015	-0.06
ln_bedrooms			
fullbaths			
ln_fullbaths	0.01	0.05	.513***
halfbaths	-0.035	0.01	0
fireplace	.112***	.113***	.086[a]
ln_fireplace			
hottubs	-0.049	-0.033	0.39
rural	.383***	.388***	0.03
Median_income	0.00005[a]	0.00005[a]	0
Percent_College	-0.08*	-0.08*	-0.09
Percent_Occupied	-0.033	-0.034	-0.02
Percent_Poverty	-0.005	-0.006	-0.2
Percent_65	-0.06	-0.06	0.26
Percent_Single	-0.189[a]	-0.189[a]	-0.49
Percent_Family	-0.198*	-0.201*	0.27
Percent_Afam	0.02	0.02	0.28
Percent_His	-0.073	-0.075	-0.06
Controls	Yes	Yes	Yes
R^2	0.68	0.68	0.87
Adjusted R^2	0.61	0.61	0.76

Table III: Hedonic OLS Regressions (cont)

Variable	Regression IV	Regression V	Regression VI
	ln_price	sellingprice	ln_price
mtnview	0.55	65,031	0.57
mtnview2km		606	
scope	-0.04	-856	-0.042
no_houses	0.07	36961*	0.05
housesin1km	0.01		
housesin1km^2	0		
housesin2km			
housesin2km^2			
ln_houses^2			0.01
acres	0.04	8,614	0.04
total_footage	.0002***		.0002***
footage^2		.014***	
bedrooms	.467*		.441[a]
bedrooms^2	-0.08	4,213**	-0.082**
ln_bedrooms			
fullbaths	.24***		.239***
ln_fullbaths		125,021***	
halfbaths	0	11,764	-0.001
fireplace	0.08		0.08
ln_fireplace		-44,650	
hottubs	0.42	54,818	0.42
rural	0.07	6,524	0.07
Median_income	0	14	0
Percent_College	-0.09	-6,565	-0.092
Percent_Occupied	-0.01	7,292	-0.009
Percent_Poverty	-0.211*	-61,217**	-0.212**
Percent_65	0.302*	56,073*	0.303**
Percent_Single	-0.38	-162,614**	-0.378
Percent_Family	0.282**	77,540***	.279**
Percent_Afam	0.2269[a]	68,595*	.27[a]
Percent_His	-0.172[a]	-32,837	-0.17
Controls	Yes	Yes	Yes
R^2	0.87	0.89	0.87
Adjusted R^2	0.74	0.79	0.75
n	169	169	169

REFERENCES

Anderson, L.M., and H.K. Cordell. 1988. Influence of Trees on Residential Property Values in Athens, Georgia (U.S.A.): A Survey based on Actual Sales Prices. *Landscape and Urban Planning* 15:153-164.

Bastian, Chris T., Donald M. Mcleod, Matthew J. Germino, William A. Reiners, and Benedict J. Blasko. 2002. Environmental amenities and agricultural land values: a hedonic model using geographic information systems data. *Ecological Economics* 40: 337-349.

Benson, E.D., Hansen, J.L., Schwartz Jr. A.L., and Smersh, G.T. 1998. Pricing residential amenities: the value of a view. *Journal of Real Estate Finance and Economics* 16: 55-73.

Beron, Kurt, James Murdoch, and Mark Thayer. 2001. The Benefits of Visibility Improvement: New Evidence from the Los Angeles Metropolitan Area. *Journal of Real Estate Finance and Economics* 22, no. 2/3: 319-337.

Bond, Michael T., Vicky L. Seiler, and Michael J. Seiler. Residential Real Estate Prices: A Room with a View. *Journal of Real Estate Research* 23, no. 1/2: 2002.

Bourassa, Steven C., Martin Hoesli, and Jain Sun. 2003. What's in a View. *Research Paper N° 79.* International Center for Financial Asset Management and Engineering Research Paper Series.

Brown Jr., Gardner M., and Henry O. Pollakowski. 1977. Economic Valuation of Shoreline. *The Review of Economics and Statistics* 59, no. 3: 272-278.

Boxall, Peter C., Wing H. Chan, and Melville L. McMillan. 2005 The impact of oil and natural gas facilities on rural residential property values: a spatial hedonic analysis. *Resource and Energy Economics* 27: 248-269.

Buncombe County. 2006. Comprehensive Land Use Plan Update. County of Buncombe Planning and Development. Asheville, North Carolina.

Cobb, Steven. 1984. The Impact of Site Characteristics on Housing Cost Estimates. *Journal of Urban Economics* 15: 26-45.

Correll, Mark R., Jane H. Lillydahl, and Larry D. Singell. 1978. The Effects of Greenbelts on Residential Property Values: Some Findings on the Political Economy of Open Space. *Land Economics* 54, no. 2: 207-217.

Crompton, J.L. Parks and economic development. *No. 502*. APA Planning Advisory Service Reports. American Planning Association, Washington, DC.

Darling, Arthur H. 1973. Measuring Benefits Generated by Urban Water Parks. *Land Economics* 49, no. 7: 22-34.

Day, Brett, Ian Bateman, and Iain Lake. 2008. *What Price Peace? A Comprehensive Approach to the Specification and Estimation of Hedonic Housing Price Models.* CSERGE Working Paper EDM 03-08. ESRC Centre for Social and Economic Research on the Global Environment.

Do, A. Quang, and C.F. Sirmans. 1994. Residential Property Tax Capitalization: Discount Rate Evidence from California. *National Tax Journal* 17, no. 7: 341-348.

Franklin, Joel P., Paul Waddell. 2002 A hedonic regression of home prices in king county washington, using activity-specific accessibility measures. Program in Urban Design & Planning, University of Washington.

Fisher, Peter F. 1996. Extending the Applicability of Viewsheds in Landscape Planning. *Photogrammetric Engineering & Remote Sensing* 62, no. 11: 1297-1302.

Garrod, G.D., and K.G. Willis. 1992. Valuing Goods' Characteristics: an Application of the Hedonic Price Method to Environmental Attributes. *Journal of Envrionmental Management* 34: 59-76.

Garrod, G.D., N.A. Powe, C.F. Brunsdon, and K.G. Willis. 1997. Using a geographic information system to estimate an hedonic price model of the benefits of woodland access. *Forestry* 70, no. 2: 139-149.

Gillard, Quentin. 1981. The Effect of Environmental Amenities on House Values: the Example of a View Lot. *The Professional Geographer* 33: 216-220.

Halstead, John M., Rachel A. Bouvier, and Bruce E. Hansen. 1997. On the issue of functional form choice in hedonic price functions: further evidence. *Environmental Management* 21, no. 5: 759-765.

Halvorsen, Robert, and Henry O. Pollakowski. 1981. Choice of functional form for hedonic price equations. *Journal of Urban Economics* 10: 37-49.

Hite, Diane, Wen Chern, Fred Hitzhusen, and Alan Randall. 2001. Property-value impacts of an environmental disamenity: The Case of Landfills. *Journal of Real Estate Finance and Economics* 22, no. 2/3: 185-202.

Houck, Richard. 2005. A Study of Ridgeline and Steep Slope Regulations in Mountain Communities Throughout the United States. Land of Sky Regional Council. Asheville, North Carolina.

Hull, R.B., and I.D. Bishop. 1988. Scenic Impacts of Electricity Transmission Towers;

the Influence of Landscape Type and Observer Distance. *Journal of Environmental Management* 27: 99-108.

Jim, C.Y., and W.Y. Chen. 2009 Value of scenic views: hedonic assessment of private housing in Hong Kong. *Landscape Urban Planning*. doi

Kaplan, Rachel. 2001. The nature of the view from home: psychological benefits. *Environment and Behavior* 33: 507-544.

Kaplan, Rachel and Maureen E Austin. 2004. Out in the country: sprawl and the quest for nature nearby. *Landscape and Urban Planning* 69: 234-243.

Lake, Iain R., Andrew A. Lovett, Ian J. Bateman, and Brett Day. 2000. Using GIS and large-scale digital data to implement hedonic pricing studies. *International Journal of Geographical Information Science* 14, no. 6: 521-541.

Lake, Iain R., Andrew A. Lovett, Ian J. Bateman, and Ian H. Langford. 1998. Modelling Environmental Influences on Property Prices in an Urban Environment. *Comput., Environ. and Urban Systems* 22, no. 2: 121-136.

Land of Sky. 2008. Mountain Ridge and Steep Slope Protection Strategies. *Mountain Ridge and Steep Slope Protection Advisory Committee*. Land of Sky Regional Council. Asheville, North Carolina.

Lange, E., and P.V. Schaeffer. 2001. A comment on the market value of a room with a view. *Landscape Urban Planning* 55: 113-120.

Luttik, J. 2000. The value of trees, water and open space as reflected by house pries in the Netherlands. *Landscape Urban Planning* 48: 161-167.

Malprezzi, Stephen. 2002. Hedonic Pricing Models: A Selective and Applied Review. Prepared for: *Housing Economics: Essays in Honor of Duncan Maclennnan*. The Center for Urban Land Economics Research. The University of Wisconsin.

Mathews, Leah Greden, Steven Stewart, and Susan Kask. 2003. Blue Ridge Parkway Scenic Experience Project Phase 2 Final Report. University of North Carolina at Asheville. Asheville, North Carolina.

Mcleod, P.B. 1982. The demand for local amenity: an hedonic price analysis. *Environment and Planning A* 16: 389-400.

Metz, William C., and David E. Clark. 1997. The Effect of Decisions About Spent Nuclear Fuel Storage on Residential Property Values. *Risk Analysis* 17, no. 5: 571-582

Milon, J. Walter, Jonathan Gressel, and David Mulkey. 1984. Hedonic amenity valuation and functional form specification. *Land Economics* 60, no. 4: 378-387.

Paterson, R.W., K.J. Boyle. 2002. Out of sight, out of mind? Using GIS to incorporate visibility in hedonic property value models. *Land Economics* 78: 417-425.

Pennington, G., N. Topham, and R. Ward. 1990. Aircraft Noise and Residential Property Values Adjacent to Manchester International Airport. *Journal of Transport Economics and Policy* 24, no. 1: 49-59.

Polinsky, A.M., D.L. Rubinfeld. 1977. Property values and the benefits of environmental improvements: theory and measurement. In <u>Public Economics and the Quality of Life</u>. L. Wingo and A. Evans (eds). The Johns Hopkins University Press for Resources for the Future, Baltimore, Maryland.

Pompe, Jeffery J., and James R. Rinehart. 1995 Beach Quality and the Enhancement of Recreational Property Values. *Journal of Leisure Research* 27, no. 2: 143-154.

Price, C. 1995. The Pros and Cons of Alternative Valuation Methods. *Environmental Valuation: New perspectives*: 160-177.

Randall, A., and J. Stroll. 2002. Existence value in a total valuation framework. In <u>Managing air quality and scenic resources at national parks and wilderness areas</u> R. Rowe and L. Chestnut (eds.). Westview Press, Boulder, Colorado.

Rod, Jan Ketil, and Diana van der Meer. 2009. Visibility and dominance analysis: assessing a high-rise building project in Trondheim. *Environment and Planning B: Planning and Design* 36: 698-710.

Rodriguez, Mauricio, and C.F. Sirmans. 1994. Quantifying the Value of a View in Single-Family Housing Markets. *The Appraisal Journal*: 600-603.

Rosen, Sherwin. 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *The Journal of Political Economy* 82, no. 1: 34-55.

Schrader, Jordan. 2009. "Tough Fight ahead for Slope Rule." Asheville Citizen-Times; March 2, 2009. A3.

Smith, Charles. 2007. Annual Report to The Buncombe County Board of Commissioners. Submitted by: The Buncombe County Environmental Advisory Board. Asheville, North Carolina.

Tulimy, Eben. 2009. Interviewed by Patrick Behrer, 9 December 2009. Asheville, North Carolina.

Tse, R.Y.C. 2002. Estimating Neighborhood Effects in House Prices: Towards a New Hedonic Model Approach. *Urban Studies* 39, no. 7: 1165-1180.

Tse, R.Y.C., and P.E.D Love. 2000. Measuring residential property values in Hong Kong. *Property Management* 18: 366-374.

U.S. Census Bureau, Census 2000. Profile of General Demographic Characteristics: 2000.

U.S. Census Bureau, Census 2000. Profile of Selected Economic Characteristics: 2000.

U.S. Census Bureau, Census 2000. Profile of Selected Housing Characteristics: 2000.

U.S. Census Bureau, Census 2000. Profile of Selected Social Characteristics: 2000.

Wilson, Ashley. 2009. "Woodfin Annexes 138 Acres: Some foresee building boom." Asheville Citizen-Times; November 24, 2009. A1.

Yu, Shi-Ming, Sun-Sheng Han, and Chee-Hian Chai. 2007. Modeling the value of view in high-rise apartments: a 3D GIS approach. *Environment and Planning B: Planning and Design* 34: 139-153.