A Modern Application of Hedonics for Valuing Irrigation

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and

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In 1998, the state of Georgia passed a moratorium on the issuance of irrigation permits in the Flint River Basin as part of the Flint River Basin Protection Act in 1998. In order to fully understand the effects of the Flint River Basin Protection Act, the sale price of irrigated land before and after the moratorium should be analyzed. Through this analysis the actual marginal value of irrigation water to farmers in the Flint River Basin can be inferred and it can be determined whether farmers were able to capitalize on the scarcity rents from the irrigation permits attached to their land. This value can be used by policy makers when making decisions on the allocation of water resources to Georgia's irrigators and other users. This article will expand and improve a preliminary study by Jeffrey D. Mullen and Julia Beckhusen (2005) of irrigation permits in the Flint River Basin.

The main improvement to the previous model will be the addition of a variable that captures the effect of development on sale price. Growing urban centers demand the conversion of rural land into urban uses (Shonkweiler, 1986). This makes it highly likely for any agricultural land that in the path of development to be split up into smaller parcels for residential and commercial purposes. The exact pattern of development is area specific: each urban center has its own way in which it expands. One way for the direction of expansion to materialize is in land prices. Agricultural land that is in the corridor of development may be sold at a premium many years before the development actually occurs (Shi, 1997). This premium reflects the speculative value of the land. In order to estimate the increase in agricultural land value with respect to irrigation permits, it is important to separate the additional value induced by speculation from the additional value due to having an irrigation permit. Developing a correctly specified model will establish the different attributes effecting land value.

The main objective of this article is to expand the previous study of Sumter County to better estimate the value of irrigation land in the Flint River Basin through including a variable which accounts for the speculative purchases brought on by development. First, the pattern of development within Sumter County must be determined. Then a method for ascertaining which lands sales occurred within these development corridors will be developed. Finally, a new model will be estimated using the appropriate functional form and the implications of the results shall be discussed.

Background

The Flint River runs from Atlanta, Georgia, 349 miles down to Lake Seminole on the Georgia-Florida border (see figure 1). Along the way, the river provides water to municipalities, industries, agriculturists, and various ecosystems – fresh water mussels, Shoals Spider Lily, and Prothonotary Warbler to name a few (Sherpaguides). In addition to providing water to Georgia, the Flint River also supplies water to Alabama and Florida. Since 1992, Georgia, Florida and Alabama have been attempting to negotiate the allocation of the Flint River's resources in what has been termed the "tri-state water wars" (EPD).

Historically, the Flint River Basin has always had a seemingly inexhaustible water supply. With an average annual rainfall of 45 to 55 inches (FRB), many tributaries, three reservoirs, and five major aquifers, the Flint River Basin's water supply has only recently become an issue. Since the 1970s population growth, increased water usage by both industry and agriculture, and greater environmental awareness has put a strain on water resources. Furthermore, an extended drought between 1998 and 2002 forced Georgians to look more seriously at the future water supply of the Flint River basin.

The population of Georgia has risen on average 1.95% since 1970, with a current population of over 8.8 million. According to the Georgia Environmental Protection Division (EPD), statewide water use is at 168 gallons per person per day, 15 gallons higher than the national average. Also, the amount of water demanded by the agricultural sector in Georgia has grown significantly. One reason for this is the increase in irrigated acres. In 1970, there were 145,000 irrigated acres in Georgia; in 2004 this number had increased ten-fold to 1.49 million acres (EPD). Total water use in withdrawals from the Flint River basin increased by 42% from 1970 to 1990. While surface water withdrawals increased by 29%, ground water withdrawals increased even more unsustainably: by 240%.

Another growing demand on the basin's water resources is the desire to promote and sustain ecosystems. The Flint River Basin is well known for its remaining biological diversity in the midst of encroaching human activity. More than 8% of the land area in the Basin, or 412,000 acres, is in wetlands. Most of these wetlands are located in the flood plain of the Flint River and are relied upon to sustain the quality of water and habitats. In addition, the lower half of the Flint River Basin, along with the upper half of the Apalachicola River Basin, has the highest amphibian and reptile species density north of Mexico (Flint River basin Plan). This large amount of biological diversity in the basin is something to be protected. The number of people in the basin is growing and an increasing number of flora and fauna are becoming endangered. One way to protect this diversity is to maintaining in-stream flows of Georgia's rivers. In the future, policymakers must find ways to meet the increasing demands of irrigators and other water users while conserving the basin's natural resources.

The historic abundance of water in the state allowed Georgia's government to ignore water use in every sector. This is especially true for agricultural irrigation, the largest user of the state's water supply: over 55% of all water consumed in Georgia (GWPPC). Agricultural water use permits, for withdrawals of 100,000 gallons per day or more, on a monthly average, have only been required since 1988. Even so, an irrigator would obtain this permit by filling out an application and taking it down to the local government office. The permit would allow the irrigator to pump as much water as he requested on the form, though not exceeding the capacity of his or her pump. Clearly, it was in the irrigator's best interest to request a permit equal to the pumping capacity of his or her water pump. It is possible that the permit application process created incentive for irrigators to purchase a new pump with the largest pumping capacity possible. By 1998, over 20,000 agricultural water permits existed.

Currently in the Flint River Basin there are over 714,000 acres of irrigated land. At the peak of the growing season, farmers in southwest Georgia may use as much as two billion gallons of water per day (Georgia EPD). At least 30% of the water used for irrigation is supplied by a combination of groundwater (80%) and surface water (20%) from the Flint River basin (Flint River Basin Plan).

When a severe drought began in 1998, the Flint River reached record low-flow levels within one year. The amount of irrigation water used put a strain on the Basin's water resources. Thus, a new way to control the state's largest water users was needed. It was clear that the current permit system would not allow it to happen. In 1998, a moratorium was placed on the issuance of new surface water withdrawal permits in the Basin. Three years later, in 2001, the government passed the Flint River Drought Protection Act. The act had two major provisions: extending the moratorium to groundwater withdrawal permits from the Floridian aquifer and instituting a "buy-out" program (Cummings, 2002).

Like water rights in many Eastern states, Georgia follows a riparian doctrine (Flint River Basin Plan). Water rights are attached to the land and can only be transferred or sold along with that land. During the moratorium, if an irrigator wanted to increase their water use beyond what their current permit allowed, they would have to purchase land that had a water permit connected to it. In addition to irrigators, developers wanting to purchase land would be interested in irrigated land more so than dry land. The moratorium created a fixed supply of the type of land desired by both irrigators and developers. This created a scarcity with respect to access to irrigation water. Because access to water permits was limited, a parcel of permitted land may have been sold at a premium. The exact amount of the premium would depend on the demand for these parcels versus the amount of parcels available.

Besides the scarcity of water permits, the moratorium created a ceiling on the total amount of water available to irrigators and developers (the total number of permits multiplied by the pumping capacity they allow). This second type of scarcity, scarcity in respect to total amount of irrigation water available, would also increase the value of irrigated land. The total actual increase in the value of irrigated land in the Flint River Basin created by the moratorium is unknown. It is also unclear if the sellers of the permitted land were able to capitalize on any of the scarcity rents.

In addition to the moratorium, the Act allocated $10 million dollars to purchase, or "buy-out," permitted surface water withdrawals from local farmers for a single year (Cummings, 2002). The Georgia Environmental Protection Division (EPD) administered a program that took place over the 2001 and 2002 summer cropping season. In 2001, the type of auction used was a multiple round competitive auction; while in 2002, there was a posted price auction with a reservation price (the EPD refused to pay more that $150/acre). In both years, using sealed bid auctions, farmers offered to sell their right to withdraw irrigation water for the season. The EPD purchased 208 permits over 33,101 acres for an average of $136 per acre in 2001. In 2002, they purchased 272 permits over 40,386 acres for an average of $126 (Cummings, 2002). In an estimated 30% of the cases, the farmers leased to the state water permits that they had no intention of using that year. This suggests the true per acre value for irrigation permits may be higher than the average offer in the auctions.

Through the Flint River Basin Protection Act, Georgia hoped to mitigate the effects of the drought through decreasing water demand in its largest sector. The Act was implemented as a short term solution during the time it takes to formulate a statewide plan. In order to formulate a statewide plan which efficiently allocates Georgia's water resources, it is necessary to know how the different users (e.g. Georgia irrigators) value those resources. By knowing this value, policymakers will be better able to implement a allocation of Georgia's water resources.

Methodology

Non-Market Valuation

Water permits in the Flint River Basin are not traded on the open market and thus, have no observable market value. In order to estimate a value for this non-market good, a valuation method can be used. The majority of environmental goods are not traded on the open market, and as a result, there has been a considerable amount of development in terms of non-market valuation techniques. Currently, there exist two major types of such techniques: revealed preference and stated preference.

Stated preference techniques use data based on hypothetical behavior (Freeman, 2003). Various types of surveys are employed which ask people ranges of questions from stating their willingness to pay for some environmental good to how a person would react in terms of behavior to a change in some environmental amenity. The largest concern with this type of valuation method is the inherent biased-ness in the resultant data. When asking hypothetical questions, the experimenter can never be sure if the responses would truly materialize in the real world. For example, if a survey question asked land owners their willingness to pay for a water permit, some may respond with zero because they believe that owning the land gives them an inherent right to the water. If one of the surveyed already had a water permit but was looking to sell it sometime soon, he may respond with a higher price than what he valued it to be. These biases are sometimes difficult to overcome when transforming the survey answers into prices seen in the market.

Revealed preference methods use people's real world behavior and established markets to determine the value of the non-market good. This method more directly looks at an individual's choices brought about through their utility maximizing behavior. Most commonly there is determined to be some relationship between the market price of a good and the value of its characteristics which affects the consumer's preferences. There are two main types: travel cost method and hedonic method (Freeman, 2003). The travel cost method looks at the cost people actually incur in traveling to the site in question, in time as well as money. This method is mainly used when valuing large parks or wetland regions, both of which are found far from urban areas (McConnell, 2005). For example, a person's value of a state park can be inferred through the price they pay in gasoline and the opportunity cost of time spent to travel to that park.

The other revealed preference method, hedonic, is used when the value of the environmental good is inherently included in price of a market good. For example, the market price of a hybrid vehicle includes the value of the reduced emissions, and the market price of land includes the value of the soil and availability of water resources.

Hedonic Method

In a 1966 paper, Kelvin Lancaster helped develop a growing idea in economics: utility is not generated simply from the good per se but from the characteristics of that good, i.e. its size, quality or location. The theory of hedonics directly stems from this idea. The earliest recognized hedonic studies were attempts by Court (1939) and

Griliches (1958) to model automobile and fertilizer demand, respectively. The hedonic method has since been used in looking at real estate to determine the effects of, among many others, irrigation (Hartman and Anderson, 1962, Chicoine, 1981) and effects of open space (Bolitzer and Netusil 2000, McConnell, 2005) on land value. According to Freeman (2003), as long as the market contains goods which are heterogeneous and thus vary by certain attributes, the hedonic method can be employed to estimate the marginal value of each of those attributes in respect to the total value of the good.

The hedonic method reflects the theory of implicit markets (Sheppard, 1998). Goods that are traded primarily in bundles (personal computers, automobiles, and land) are included in both explicit and implicit markets. The explicit market is where the bundle itself is traded with observed price and transactions. When there exists one explicit market for the bundle, there also exists numerous implicit markets for the components of the bundle. Each bundle in the explicit market is heterogeneous and contains different quantities of each of the components within them. Analyzing and identifying the structure of prices of the component attributes can be accomplished with hedonic analysis. This leads to one of the major assumptions of hedonics: there must exist a variety of bundles, or class of goods, with varying attributes so that consumers can choose any bundle they wish while only being constrained by their incomes and the prices of the resulting bundle (Sheppard, 1998).

The market price of a class of goods, X, is a function of its varying n attributes (Rosen, 1974). In general, if A is a vector of attributes, $A = (a_1, a_2, \ldots, a_n)$, of the class of goods X, then any particular good, x_i, can be expressed as a function of those attributes,

(1) $x_i = f(a_{i1}, \ldots, a_{ij}, \ldots, a_{in})$

Due to differentiation between each individual x_i, there exist a large variety of such bundles. The price of any x_i, P_x, can be described:

(2) $P_x = f(a_{i1}, \ldots, a_{ij}, \ldots, a_{in})$

If the above price function is continuous and differential, the hedonic method can be applied (McConnell, 2005). Following the data collection of the good's market price and characteristics of each observation, (2) is estimated using multiple regression analysis.

In the particular market of agricultural land, the attribute vector can be more specifically defined. The value of agricultural land, Q, is composed of a vector of building attributes, B, e.g. square footage, a vector of land attributes, L, e.g. soil type, irrigation ability, a vector of distance attributes, D, e.g. distance to the nearest town or landmark, and time, T, e.g. year sold. Any individual parcel of land can thus be expressed,

(3) $q_i = (B_i, L_i, D_i, T_i)$

and the price of that parcel, q_i, can be written,

$$(4) \qquad P_{qi} = f(B_i, ,L_i, D_i, T_i)$$

After the equation P_q is estimated, further inference can be made of the individual attributes. The derivative of P_q with respect to each of the attributes is equal the marginal effect of each attribute on the market price of agricultural land. For example, the partial derivative of P_q with respect to B_i is the amount that the price would change for a given one unit change in B_i.

The application of the hedonic method to a particular market, e.g. the agricultural land market, is based on some assumptions that may not be valid in all situations (Freeman, 2003). First, all observations used in each model estimation must be located within the same market. Second, purchasers must have full information of all property available in the market. The result of these two assumptions is that any model developed is location-specific. That is, the model developed for the Flint River Basin won't be applicable to any other region. Although the estimated model can't be duplicated, many of the variables will remain constant, e.g. the larger the parcel is in acres the higher the sale price in any region (Sirmans, 2005).

Model Specification

Due to Georgia's riparian doctrine, water permits in the Flint River Basin are attached to the land and thus the hedonic method is the most appropriate valuation technique. With the hedonic method, the value of the non-market good is estimated by analyzing some observable market price in which the value of the non-market good is implicitly included. For example, the market price for agricultural land in the Flint River Basin is a function of, among others, the presence of an irrigation permit, the soil quality, the distance to the nearest town and soil quality. By disaggregating the land price through econometric modeling, the marginal increases or decreases in the land value caused by each individual factor can be estimated.

Price Variables

Revealed preference methods attempt to model people's real world behavior, therefore the price that a person pays for the parcel (i.e. the market price) best reflects the actual value of the parcel. According to Melpezzi (2003) and Sirmans (2005) the most recently observed sales price is the most unbiased estimate of land value relative to alternative choices such as appraised value or the owner's estimated value. Sale price is established by not only the bargaining of the buyer and seller but also the current market for parcels in the area. Appraised values are normally produced by the county's tax appraisal office and are based on comparable market sales chosen by the appraiser. These are quite often very different from the actual sale amount. Similarly, the owner's estimated value is based on what knowledge they think they have about the parcel in question. If the parcel has had the same owner for years, that owner may not have full information on the current market. Out of the three alternatives, observed market price, appraised value and the owner's estimated value, the actual observed sale price is the best estimate, in terms of the revealed preference method, of the parcels market value.

Exogenous Variables

The exogenous variables chosen are directly related to the study area at hand: agricultural land sales in the Flint River Basin. Agricultural land markets will be more related to the attributes of the land and distance variables than on the characteristics of the house. This is quite different than urban markets which are largely based on the structural characteristics and amenities of the parcel (Sirmans, 2005). The three main categories of attributes used for this study include: land, distance, and time.

Land variables include all physical attributes related to the parcel. This includes variables such as acreage, soil quality, presence of permit and infrastructure on the parcel. Distance variables are the relational attributes of the parcels with respect to specified locations, distance to nearest town or highway entrance for example. For the study at hand, the parcels relationship with nearby development will be included in the class of distance variables. Lastly, time is an attribute related to the sale of each parcel; usually expressed as year or month of sale. A detailed description of the actual data used to estimate the model is included later in the article.

Functional Form

The functional form of the price equation depends on the relationship between the price of the good and its attributes and thus will vary among markets. Unfortunately, there is no set functional form used in hedonics; the theory does not provide much guidance as to what form is best, except that, in equilibrium, the price function must be convex (Jones, 1988). According to Sheppard (1998) and McConnell (2005), the most common is some form of parametric approach: the actual values of the functional form are determined by a finite number of parameters. Linear, log-linear, log-log, quadratic, semi-log and Box-Cox transformation are some of the most common parametric models used (McConnell, 2005).

The most preferred functional forms in hedonics are semi-log (Sirmans, 2005) and linear (McConnell, 2005). Semi-log is advantageous because it allows for variation in the dollar value for each characteristic, it is easily interpreted and can help minimize the problem of heteroscedasticity (Malpezzi, 2003). Linear forms are superior when key explanatory variables are omitted (Cropper, 1988). The difficulty in identifying every attribute that is important to consumers makes the problem of omitted variables very common in hedonic analyses. These variables lead to increased biases in more complicated functional forms than they do in the simpler linear forms (McConnell, 2005). The linear regression model takes the general form:

(4) $$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + e_i, \text{ where } e_i \sim N(0, \sigma^2) \text{ and } i = 1, 2, \ldots, n$$

In this article, alternative functional forms will be estimated.

Study Area

There are 159 counties in the state of Georgia, all of which have their own preferred data collection and storage methods. Using data from more than one county will prove trying when attempting to merge data sets within and across county lines. The study area includes two counties in the Flint River Basin: Dougherty and Sumter. They were chosen because of their geographical location within the Basin and because of their data availability. Both are in the southern portion of the basin where agriculture is most prominent (see figure 1). The northern segment of the Flint River Basin contains the southwest portion of the Atlanta Metropolitan area which is unrelated to this study of irrigation land. Sumter County is in the geographical center of the Basin. Most importantly, both counties maintain digital parcel maps and online land sale databases which makes data collection and analysis more efficient.

Both Sumter and Dougherty Counties are home to large agricultural industries. In 2002, there were 381 farms in Sumter County and 162 in Dougherty. The average size of a farm in Sumter County is 437 acres and 603 acres in Dougherty. There are more farms in Sumter County; however the average size of farms is larger in Dougherty. In Dougherty, there are over 16,000 irrigated acres of cropland while in Sumter County there are over 27,000 (Census of Agriculture). Dougherty County is more densely populated with over 291 persons per square mile in 2004 while in Sumter County there are only around 68 persons per square mile. In 2004, the population of Dougherty County was 95,681, and the population of Sumter County was 32,873, a 9% increase from 1990 (2004 US Census).

In order to model the agricultural land sales in these counties, data on the land, distance and time attributes, discussed in the previous chapter should be included. The data included depends on the particular land market in Sumter and Dougherty counties. The largest category of variables is land attributes. Each county must be examined in order to determine the exact variables to be included. Fortunately, the agricultural land markets in Dougherty and Sumter appear to be quite similar and thus most variables will be important factors in estimating land sales in either county.

When buying land for agricultural uses, one of the concerns of the purchaser will be the size of the parcel. Increasing the total acreage of a parcel will increase the total value of that parcel. Acreage does, however, have diminishing marginal returns: an additional acre to a small parcel has a higher marginal value than does an additional acre to a large parcel (Xu et. al., 1993). According to Dunford, Marti and Mittelhammer (1985), the amount of acres may only account for less than 25% of the explained variation in sales price.

Another land attribute governing land value is soil quality and land usage of the parcel. Georgia uses the Natural Resource Conservation Service classification system, which rates soil quality on a scale of 1 through 9, where 9 is the best quality. Good soil quality relates to ability to grow higher valued crops and have a larger array of crop choices. Poor soil reduces the possibilities of land usage: fewer choices among lower valued crops or possibly no crops at all (NRCS). Related to the soil quality variable is the proportion of woods, ponds, orchards and open land on the property. These land types typically have different effects on land value. Wooded acreage, ponds and orchards commonly have a lower value than open land. Woods, orchards and ponds are long-term assets and potentially hold a smaller discounted present value to landowners than open land used to grow crops that create a return every year. Therefore, the presence of woods, orchards and ponds will decrease the land value relative to open space, which will increase land value. The model will include one variable for acres of orchards, ponds and woods and another variable for acres of open space.

The variables in the land attribute category of most interest in this study are the presence of an irrigation permit and whether or not having one increased the value of agricultural land after the moratorium. If the parcel being sold has an irrigation permit attached, it is theorized that it will be sold for more than if no permit exists. A dummy variable will be included in the model to account for the premium caused by the permit: 0 if no permit exists and 1 if it exists. In addition, permitted parcels sold after the moratorium in 1998 should be sold at a premium because of the scarcity of water permits created by the moratorium. This characteristic will also be included in the model as a dummy variable: 1 if the parcel was sold after the moratorium, 0 if sold before. Including these variables will enable the model to determine whether or not land owners were able to capitalize on the scarcity rent of agricultural permits potentially created by the moratorium. Agricultural land with secured water resources is hypothesized to be worth more than a parcel with no guaranteed water sources and worth even more after the moratorium was announced.

In the early 1990s, the state of Georgia introduced two tax savings programs to agricultural property owners. First passed was the conservation use valuation (CUV) program, in 1991. The land owner agreed to keep his or her land in conservation use for ten years and in return they would receive a tax savings. The second is the agricultural preferential assessment (APA) program, passed in 1992. This program involves a ten year agreement of the land owner to keep their land in agriculture.

A particular tract of land of up to 2,000 acres can only be enrolled in one of the programs. In return the owner receives a tax savings of 25%. Whether or not a parcel was enrolled in either program at the time of sale will positively affect the sale price and therefore a variable to account for this will be included in our model. The similarity in the two programs will allow them to be included as one dummy variable in the model: 1 if the parcel sold is enrolled in either the CUV or APA programs, 0 if not.

Another important factor in the sale of agricultural land is the presence of timber involved in the sale. Many farmers grow timber as a long term asset on their land. When the land sells, timber may be involved in the sale. The presence of timber included in the transaction will be included as a dummy variable: 1 if timber was included in the sale and 0 if not. The sign of the estimated coefficient is expected to be positive: a land sale that involves timber will sell at a higher value than a land sale not involving timber.

The second category is distance, another of the main focuses of this study. The first type of distance variable will be the linear distance from the center of the parcel to the center of the nearest town. The second type will take into account the influence of development in the value of the parcel. It will be represented as a dummy variable with 0 if not in a development corridor and 1 if it is. Any parcel sold within a development corridor is hypothesized to be sold at a premium because of its speculative value.

Time is the last category. Any time trend or temporal attribute to the data is captured in this variable. It is represented as a set of dummy variables: 0 if sold in 1990, 1 if in 1991, 2 in 1992 and so on. The resultant estimated coefficient is the effect of the temporal attribute of that year relative to the base year of 1990. Any sort of temporal characteristic of the respective year will be captured by its coefficient. For example, if there is a short recession in one of the study years, the effect of that would be captured in that dummy variable's coefficient. Thus, the expected sign of each coefficient may be different for each year.

Data

The data for the model was collected from three major sources. First the tax assessor of both Dougherty and Sumter County each provide their own online database of land sales through the company QPUBLIC, LLC. The Sumter county database provides information on the date of sale, sale price, acreage of parcel, land type (e.g. wooded, orchards, open land), and soil quality. In addition, the land sale data also includes information on whether the parcel was involved in any tax savings programs: conservation use valuation or agricultural preferential assessment. The second source of data was the Georgia Department of Natural Resources (GADNR) which provided data related to irrigation permit variables: the location of the permitted pump, and the capacity of the water pump on the parcel. The data set from the GADNR consists of spatial variables indicating the point of withdrawal for the permit, designated in latitude and longitude. Unfortunately, these spatial variables are incompatible with the data from the tax assessor which is labeled by parcel number and not latitude-longitude data. Using GIS, the location of each permit was over-laid on the county parcel maps in order to determine in which parcels the permit was located.

The third source of data is digital parcel maps from each county. The distance variable, or distance from the center of the parcel to the nearest urban center, was calculated by analyzing the parcel maps using ArcGIS Desktop 9.1, a geographical information systems (GIS) software. A development corridor variable was used in order to fully capture the effect of the presence of water permits on sale price. For both counties, parcel maps, road maps and land sale data were compared using ArcGIS. The corridors of development were determined a dummy variable was included in the model: 1 if the parcel was in the corridor, 0 if not.

Model Estimation

The model to be estimated is similar to that used by Faux and Perry (1999) in their analysis of agricultural land sales in Oregon. The specific empirical model to be estimated is as follows:

$$(5) \quad PRICE/ACRE = \beta_0 + \beta_1 ACRES + \beta_2 SOIL + \beta_3 WOOD + \beta_4 OPEN + \beta_5 TIMB + \beta_6 PROG\ \beta_7 PERM + \beta_8 PUMP + \beta_9 MOR + \beta_{10} DIST + \beta_{11} DEV + \beta_{12} TIME$$

Table 1 provides a description of each variable and the expected sign of its estimated coefficient. The specification of the endogenous variable as price per acre allows for a simple interpretation of the β's as per acre marginal effects of each attribute to the land value.

Estimation results to follow.

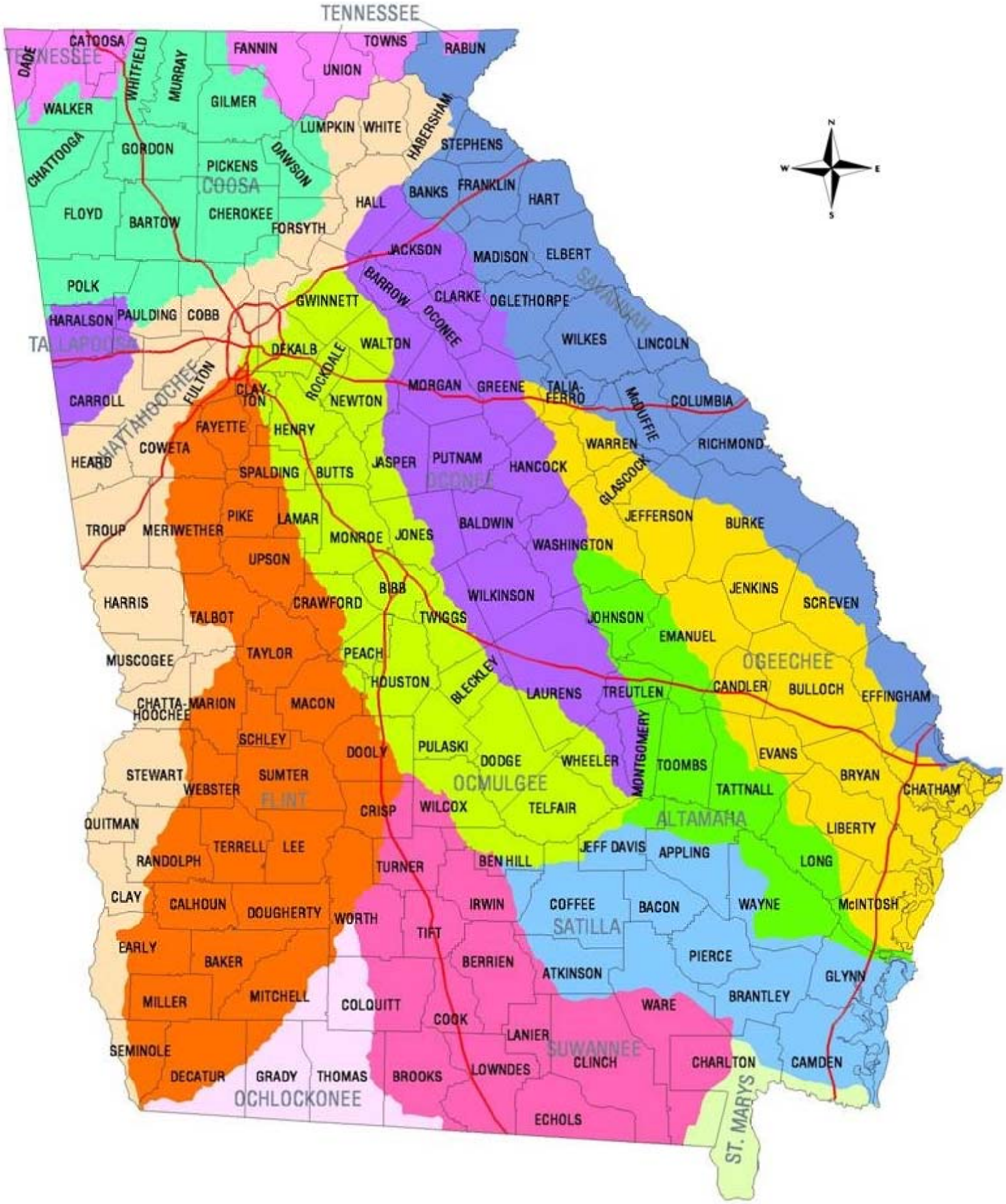

Figure 1. Map of the Flint River Basin in Southwest Georgia

Table 1. Descriptions of variables used in the model along with the expected signs of their coefficients

Variable	Description	Expected Sign
PRICE/ACRE	Sale price of the parcel in 2000 dollars divided by number of acres in each parcel	N/A
ACRE	Number of acres in each parcel	Negative
SOIL	Categorical value representing soil quality based on the NCRS classification system	Positive
WOOD	Proportion of parcel that is wooded, in orchards or ponds	Negative
OPEN	Proportion of parcel that is open land	Positive
TIMB	1 of timber was involved in the sale, 0 if otherwise	Positive
PROG	1 if parcel was enrolled in the Conservation Use Valuation or Agricultural Preferential Assessment Program at the time of sale, 0 if otherwise.	Positive
PERM	1 if the parcel has an irrigation permit at the time of sale, 0 otherwise	Positive
PUMP	Gallons/minute/acre permitted withdrawal	Positive
DIST	Distance in meters from the centroid of the parcel to the nearest urban center	Negative
DEV	1 if the parcel is within the specified development corridor, 0 if otherwise	Positive
MOR	1 if the permitted parcel was sold after the moratorium in 1998, 0 if otherwise	Positive
TIME	Time trend, 0 if sold in 1990, 1 if sold in 1991, …, 15 if sold in 2005	Positive

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