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The impact of natural amenity on farmland values: A quantile regression approach

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ABSTRACT

Farmland values are influenced not only by agricultural production but also by several other economic and environmental factors. Among the attributes that contribute value to farmland are certain amenity characteristics. Using farm-level data this study examines the impact of natural amenity on farmland values in the United States. In contrast to previous studies that assume a homogeneous relationship across the entire distribution of farmland values, this study uses quantile regression to estimate the empirical model. Our quantile regression analysis offers some insightful results. Natural amenity is positively correlated with farmland values and its impact is often more pronounced at higher price range of farmland. On the other hand, land retirement programs like CRP and WLP have positive impacts on farmland values but, at the lower quantiles. Direct farm payments have a significantly positive effect on farmland values and the impact increases monotonically across quantiles. Finally, policy implications are discussed.

Introduction

Land is a unique input in agriculture. Unlike other inputs, it is immovable, fixed in supply, and non-depreciable (Raup, 2003). Land is also one of the most important assets in agriculture, accounting for 75–85% of the value of total U.S. farm sector assets (Gloy et al., 2011; Sherrick and Barry, 2003). The well-being of farm households is critically dependent not only on earnings from a farming operation, but also on value of the farmland—as a store of wealth. Investment in farmland is considered relatively safe and attractive options in the U.S. farm business sector. Gandel (Times magazine, 2011) explains farmland business as one of the “hottest' investments in the U.S. reporting an increase in farmland values up to 20% in 2011. Moreover, a consistent annual return of about 11%, 2007–2011, is much higher than returns in other sectors of the economy (Gandel, 2011). Identifying the determinants of farmland values is, therefore, a classic topic in agricultural economics yet featuring greater implications on current land use policies, financial planning, and investments.

A large number of empirical studies have investigated the determinants of farmland value from a wide range of perspectives (Raup, 2003). The basic premise of the empirical studies is that the current land price captures the net present value of future returns from the land (Guiling et al., 2009). More recent empirical estimation of farmland values centers around the urban growth model developed by Capozza and Helsley (1989) to incorporate the impact of urban development pressure on farmland values (Hardie et al., 2001; Plantinga and Miller, 2001; Yue Jin et al., 1997). Open farm and forest lands are important for the recharge of ground water in our communities. Farms also provide critical habitat for local wildlife populations, attracts visitors, keeps quality of life high for local citizens, and provide fresh food that is much nutritious and less costly, and finally, local farmland keeps property taxes down. Despite the growing concern for natural resource conditions in rural America, only a few studies have utilized variables representing natural amenity in the estimation of farmland values (e.g., Bastian et al., 2002; Ready and Abdalla, 2005; Libby and Erwin, 2003). Natural amenity and environmental indices can be used to assess environmental factors influencing farmland values.

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Chang and Boisvert (2009) used Environmental Benefit Index (EBI) in assessing the participation decisions to the conservation reserve programs. Bastian et al. (2002) found that wildlife habitat, angling opporunities, and scenic vistas contribute to higher land prices in Wyoming. Ready and Abdalla (2005), using data from Pennsylvania, discovered that agricultural open space increases nearby property values whereas a large-scale livestock operation has an opposite impact. While these studies rely on regional data, the relationship between natural amenity and farmland prices has yet to be examined on a national scale, to the best of our knowledge. Many rural, non-farm residents want to preserve farmland while many farmers also want to preserve the land while retaining the option to sell. Preserving farmland often draws a fine line between private property rights and the obligation of a community to protect and preserve land resources for future generations. As development increases and volatility in agricultural commodity increases, the challenges to preserving the farmland become greater.

Land quality plays an important role in farmland pricing; land quality is hetergenous across states. Some of the efforts to adjust for the heterogeneity of land quality include adjusting for land quality variables; locational characteristics that can affect the agronomic capacity of farmland; and for other factors affecting the potential of farmland for conversion to urban uses (Livanis et al., 2006). However, most of the empirical formulations are deeply rooted in the concept that a single market value of farmland exists based on a stylized (possibly Hedonic) model of earnings capacity. It is plausible that buyers of land may value farmland characteristics diffeently. Both amentiy value and governemtnet payments may be calptailized into the farmland differently. For example, if a particular farmland characteristic is priced differently for farmland in the upper-price range as compared to farmland in the lower-price range, the typical OLS regression may not provide useful information for either price range since it is based on the mean of the entire farmland price distribution. This article departs from the standard farmland valuation problem by assuming that each individual has a different value for a parcel of farmland depending on the characteristics of the farmer and his perception of the characteristics of the farmland.

Moreover, a majority of empirical studies on this topic employs a standard parametric model, ordinary least squares (OLS) and its variants. Surprisingly, few published studies have used a more flexible semi-parametric regression model to explore potentially complex and heterogeneous relationship between farmland attributes and prices. This study attempts to address these limitations. We estimate the impact of natural amenity on farmland values by a semi-parametric quantile regression approach using a nationwide farm-level data.

The rest of the paper is organized as follows. First, we present a conceptual framework in farmland valuation. We then extend our discussion about previous studies and advantages of quantile regression over conventional OLS. In the next section results are discussed followed by a summary and conclusions section.

Data and methodology

Conceptual framework

Farmland prices are influenced not only by agricultural production but also by several other economic and environmental factors. Besides agricultural activities, a potential for other activities in land may lead to an increase in the price of farmland. We use a hedonic pricing function where the price of land is explained by a vector of objectively measured attributes (Rosen, 1974). Let P be the price of land, then Hedonic price function is represented as:

$$P = P(z), \tag{1}$$

In the context of this study, P is self-reported per acre price of farmland, obtained from the survey data and $z = (z_1, z_2, \ldots, z_n)$ with $z_i, i = 1, \ldots n$, represents individual attributes of the product (Palmquist, 1991). In particular, z consists of two groups of land attributes: amenity attributes represented as z_A and other attributes as z_0 (Bastian et al., 2002). Consumers of farmland maximize their utility choosing a farmland parcel so that the marginal implicit price of the parcel with respect to z_i is equal to the marginal rate of substitution between z_i and wealth (Ready and Abdalla, 2005).

A common approach in previous studies in estimating farmland values is to apply a standard parametric model, OLS and its variants. In such a model, conditional means of the dependent variable, i.e., farmland prices are estimated under a specific assumption that the variance is constant over the entire range of farmland prices. One major disadvantage of these approaches is that some attributes of farmland can have heterogeneous impacts on farmland prices. Some attributes may be "luxury" and only impact farmland values that have a relatively higher price range while other attributes may be "necessity," affecting property values only at a lower price range. While this limitation needs closer attention, we propose a semi-parametric quantile regression approach in this study, originally developed by Koenker and Bassett (1978). In the subsequent section, in the empirical model, we include fundamental theories behind quantile regression and its relative advantages over the conventional least square method (OLS).

Empirical model

The fundamental objective of empirical studies is to delineate the true relationship between variables that are of interest to researchers, practitioners and policymakers by drawing inferences about the population based on sample data. In empirical studies, we strive to make prediction as accurate as possible, or make the prediction errors as small as possible so that we can approximate the true relationship. To clarify the difference between the conventional least square method and quantile regression, we introduce concept of loss function, which is a general theoretical framework from which one can derive both least square and quantile regression methods by applying different sets of assumptions.

Following Cameron and Trivedi (2005), loss function, L, is defined as

$$L(e) = L(y - \hat{y}), \tag{2}$$

where e is the prediction error, y is the dependent variable and $\hat{y}$ is the prediction of y. In this context, we aim to minimize the expected value of loss function, that is,

$$\min E[L(e)] = \min E[L(y - \hat{y})], \tag{3}$$

In choosing an appropriate estimator, a researcher chooses to decide on the functional form of $L(e)$ and specification of $\hat{y}$. For every combination of loss function and specification of the prediction, there exists a unique estimator. Least squares estimator, for example, has the squared error loss function that minimizes sum of squared errors in the sample: $\min E(e^2) = \min E(y - x'\beta)$. Prediction in least squares estimation is a linear combination of a set of regressors, x, and estimated parameters, $\hat{\beta}$ and the optimal $\hat{y}$ is the conditional mean function, $E(y|x)$ (Cameron and Trivedi, 2005).

Least squares estimator is pure location shift model (Heckman, 1979) in the sense that it only estimates conditional means of y