What Should Farmers Pay for Cash Rents

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Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Mobile, Alabama, February 1-5, 2003

Abstract

Determining what to pay for cash rental rates is a big problem for most farmers. Typically, crop budgets are used for this decision. However, problems arise from this approach because the average revenue contained in the budget is often not the true marginal revenue. Farm size differences certainly affect the average and thus the marginal revenue. This paper calculates the true marginal revenue per acre so that a better estimate can be made of the cash rental rate. Farm analysis data is used to calculate the total revenue per acre. The first derivative then gives the marginal revenue.

What Should Farmers Pay for Cash Rents

Introduction

A big question for many farmers is deciding how much to pay to cash rent crop land. There are two reasons that make this a very important decision for farmer. First, the majority of grain farmers rent land with the rented land making up a large percentage of the crop acres. Second, profit margins are very thin for most farmers. Thus, paying too much is likely to make the rented land unprofitable. Even worse, many cash leases are based on multi-year contracts. This compounds the problem because loses then accumulate.

Typically, crop budgets are a way to examine farm profitability on a per acre basis. Farmers can look at these to get an expected idea of the costs and revenues associated with growing a certain crop. The profit per acre would then be a guide to how much to pay per acre for cash rent.

Using crop budgets may have some limitations for determining how much to pay for cash rents, however. The biggest potential problem is that budgets are just averages. This is fine for most variable costs that truly vary on an acre by acre base. However, many of the fixed costs are just calculated to give a cost per acre. These costs depend more on the size and the type of the operation. The end result is that the profit per acre may be an accurate guide to how much farmers can really afford to pay in cash rent per acre.

Other potential problems with using budgets to guide cash rental rates are that most farm follow some type of crop rotation, different farm types might use different machinery than the budget assumes, and farm sizes change the type and amount of machinery required. The crop rotation issue requires combining budgets to come up with a weighted average net profit per acre that reflects the crop rotation. Budgets that allow for various planting techniques and size of farm are probably better indicators of the true profit that can be used to pay cash rents.

A second approach to determining cash rental rates is to use the market as a guide. Most farmers have a pretty good idea of cash rental rates in their counties. Farmers will likely have to pay near these values in order to rent land. However, current rates are no guarantee that renting the land is profitable. On the other hand, some farmers may find land highly profitable at current market prices. In addition, there may be other conditions such as location driving rental rates other than just the profitability. Farmers need another approach to guide the cash rent price determination.

Because of the difficulties with using average profits and current rental rates as a guide to determining cash rents, a better approach is to use marginal revenue. This approach would truly give the economic principle of marginal cost equals marginal revenue. Normally, one assumes that marginal revenue equals average revenue when there is perfect competition. This assumption also means that average revenue and marginal revenue are the same for all levels of output. However, as discussed above, marginal and average revenue almost certainly increase as farms move from small to medium sized. This increase in marginal and average is due to increased efficiency in machinery, labor, etc. Thus actually calculating marginal revenue is a better approach.

This paper presents a way to actually calculate marginal revenue based on actual farm income statement information. The data provides information to determine total revenue for different farm sizes. Once this total revenue function is determined, the marginal revenue per acre is calculated by taking the first derivate. We will then have an accurate estimation for the true cost farmers can pay per acre for cash rent.

Previous Literature

Ibendahl, Trimble, and Isaacs examined farmer's ability to pay cash rental rates. Their conclusion is that planning horizons and farm size are important to the cash rent price decision. The authors believe that when farmers commit to new machinery, buildings, and equipment, the costs for those items become fixed. Thus farmers may base their cash rent decisions on their ability to cover variable costs only.

However, the more concrete conclusion from Ibendahl, Trimble, and Isaacs is that farm size affects rents. As shown in Figure 1, depreciation decreases on a per acre basis as farm size increases. Thus, it is expected that larger farmers could pay more in cash rent than could smaller farmers. Ibendahl, Trimble, and Isaacs also speculated that farmers may also misinterpret this savings from a farm size increase. Even though efficiencies from size may be exaggerated they still exist.

Data and Methods

Data from the Kentucky Farm Business Analysis Program (KFBM) are used to provide detailed information about the net farm income used to calculate marginal revenue per acre. In addition, other information is available from the dataset that can help predict the marginal revenue.

Four years of Kentucky farm business analysis data was available for this study. The dataset includes location within the state, the relative value of livestock feed fed, crop and livestock returns, cash rent paid, net farm income, total acres, owned acres, crop-share acres, cash rent acres, no-till acres, the number of acres of each crop grown in a given year, and the revenue produced by each crop.

Because the problem is to examine cash rents for crops, the data is filtered to remove any livestock farms. In addition, only farms that had useable data for all four years were used in the analysis. Normally, the KFBM program has around 200 to 300 useable farms each year. After removing the livestock farms and farms without a continuous four year history, 136 farms were left representing 544 total observations over 4 years. These farms ranged in size from 100 acres up to 9,000 acres.

Using this data set, ordinary least squares is used to determine the relationship between farm size and total revenue (Equation 1). The advantage of this approach is that we are also able to determine what factors other than farm size affect net farm income. Variable descriptions are included in Equation 1. The variables Ac^2 and Ac^3 are the square and cube of Ac. Dummy variables for wheat (Wht) and tobacco (Tob) are included because county revenue data indicates that lower NFI is associated with farms that predominately grow wheat and higher NFI is associated with farms that grow tobacco. Kentucky's division of the National Agricultural Statistics Service separates the state into 6 regions representing distinct soils, cropping patterns, and farming systems. The Appalachian region of Eastern Kentucky is represented by few crop farms, thus is excluded from analysis. To avoid perfect colinearity, dummy variables representing 4 of the 5 remaining regions are included in the regression model (the Bluegrass region is excluded). Similarly, exogenous factors like annual crop price changes are captured using temporal dummy variables. Again, perfect colinearity is avoided by dropping the dummy variable for the first year of data (1988). With respect to interpretation of regression results, the affect of the excluded dummy variables (the Bluegrass Region and year 1988) on NFI is measured by the intercept (b_0).

Equation 1.

$$NFI = b_0 + b_1 Ac + b_2 Ac^2 + b_3 Ac^3 + b_4 Wht + b_5 Tob + b_6 Pur + b_7 PR \\ + b_8 OV + b_9 LT + b_{10} Yr99 + b_{11} Yr00 + b_{12} Yr01$$

NFI	Net Farm Income
Ac	Tilled Crop Acres
Wht	Wheat Dummy Variable: If wheat grown then Wht = 1; 0 otherwise.
Tob	Tobacco Dummy Variable: If tobacco grown then Tob = 1; 0 otherwise.
Pur	Region Dummy Variable: If Purchase Region then Pur = 1; 0 otherwise.
PR	Region Dummy Variable: If Pennyroyal Region then PR = 1; 0 otherwise.
OV	Region Dummy Variable: If Ohio Valley Region then OV = 1, else 0.
LT	Region Dummy Variable: If Lincoln Trail Region then LY = 1 else 0.
Yr99	Temporal Dummy Variable: If crop year = 1999 then Yr99 = 1 else 0.
Yr00	Temporal Dummy Variable: If crop year = 2000 then Yr00 = 1 else 0.
Yr01	Temporal Dummy Variable: If crop year = 2001 then Yr01 = 1 else 0.

Results

Regression results were obtained using SAS. Regression diagnostics indicate that the data used to estimate Equation 1 suffers from multicolinearity, infinite error variance, and non-spherical errors including both heteroscedasticity and autocorrelation. Infinite error variance was corrected by deletion of observations indicated as outliers or as exerting strong influence (using DFBETA/influence option in SAS). This correction reduced the data set to 498 observations. Heteroscedasticity and autocorrelation were corrected following standard econometric procedures.

Multicolinearity plagued results prior to and following correction of the aforementioned problems. The root of the problem is the use of power terms for Ac; the only continuous variable. As anticipated, results of the variance inflation factor test (VIF option in SAS) suggest a high degree of multicolinearity between Ac, Ac^2 and Ac^3. With multicolinearity the parameter estimates of Ac, Ac^2 and Ac^3 are inefficient. Thus, statistical evaluation is not precise meaning that one can conclude that the parameter estimates for Ac, Ac^2 and Ac^3 are not different from zero when, in fact, they are.

Regression results (Table 1) indicate that the variables of the model capture 41 percent of the variation in net farm income (NFI). Crop type (Wht and Tob) and region (Pur, PR, OV, and LT) do not contribute to the explanation of NFI (i.e., fail to reject the null hypothesis that the parameter estimates for these variables are equal 0 with 95% confidence). These variables did not suffer from multicolinearity, thus one can be confident in these results. The parameter estimates for Ac, Ac^2 and Ac^3 were also not statistically different from 0. However, because of the degree of multicolinearity between these variables, little confidence is ascribed to these results and these variables are retained in the model.

Given results of the regression analysis, Equation 1 can be defined as Equation 2. Here NFI is a function of tillable crop acres and the temporal dummy variables. Presence of the dummy variables indicates that exogenous factors including input and output price changes have a direct impact on NFI. Relative to Bluegrass farmers in 1988, average NFI was highest in 2000 and lowest in 1990.

Equation 2.

$$\begin{aligned} NFI &= 68.755Ac - 0.019Ac^2 + 0.0000028Ac^3 \\ &\quad + 29{,}281Yr99 + 95{,}522\,Yr00 + 75{,}682\,Yr01 \end{aligned}$$

Because larger farms are more efficient than smaller farms, we expect the marginal and average revenue to increase for a certain range. This rate of increase should slow as farms become larger. However, the model specification may limit the ability to show all the actual characteristics of marginal revenue. Figure 3 plots the net farm income by farm size as calculated from Equation 2.

Marginal revenue (MR) is calculated by taking the first derivative of Equation 2 (see Equation 3). The function identified in Equation 3 is a quadratic and convex. NFI decreases at a decreasing rate with increases in tillable acreage (Ac) up to 2,262 acres and then increases at an increasing rate. Figure 2 plots the marginal revenue for farm sizes used in this study. This finding is in contrast to the expectation that the rate of increase in MR would slow as farms become larger.

Equation 3.

$$\frac{\partial NFI}{\partial Ac} = MR = 68.755 - 0.038Ac + 0.0000084Ac^2$$

Summary statistics on the cash rents paid for each farm for each year are shown in Table 2. The cash rent per acre is calculated by dividing the total cash rent paid by the number of acres cash rented. These summary statistics are calculated by discarding the top and bottom six numbers. These were removed because they seemed to be outliers. In addition, several farms had no cash rented acres and these were not included either.

Conclusions

The R-square statistic indicates there are additional factors for explaining cash rents that the model is not picking up. Even so, the model does show the relationship behind farm size that Figure 1 hints at. That is, larger farms (i.e., farms above 2,500 acres) can afford to pay more for land than can smaller or mid-sized farms.

This type of result helps explain why we see an increasing number of large and small farms while the midsize farms are disappearing. Large farms are more efficient and will make more money from an additional acre than would a smaller farm. Mid-sized farms are at an extra disadvantage. Thus, these larger farms can afford to outbid the smaller farms whenever a new piece of land becomes available.

Left unanswered is at what point do these size efficiencies stop. The range of farms studied here goes up to 9,000 acres. There are similar sizes or larger farms throughout the Midwest so the optimal farm size must be beyond the scope of farms in this study. However, it seems unlikely these size efficiencies continues forever. At some size point, the marginal revenue from renting an additional acre of land is likely to trend downward.

This study has given a better idea of what farmers can afford to pay for cash rents because it examines the true marginal revenue. Farmers may find these results help with their planning decisions. Other interested parties include Extension educators and policy makers.

Readers should keep in mind that these results are very preliminary. The authors are still experimenting with different models for net farm income and marginal revenue. The results are likely to change before this paper is presented.

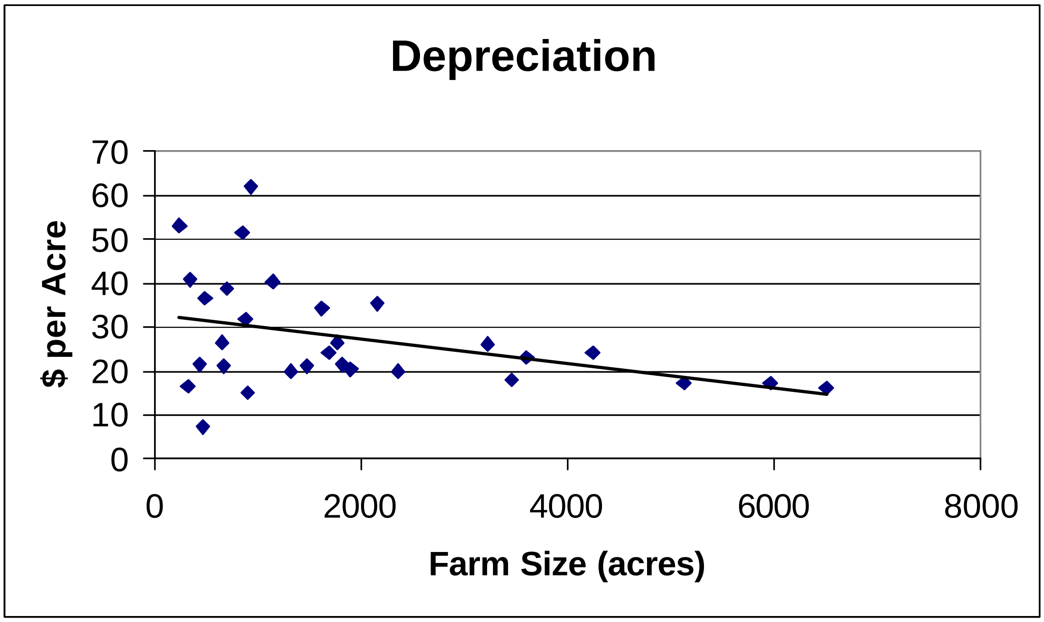

Figure 1. Depreciation per Acre at Various Farm Sizes

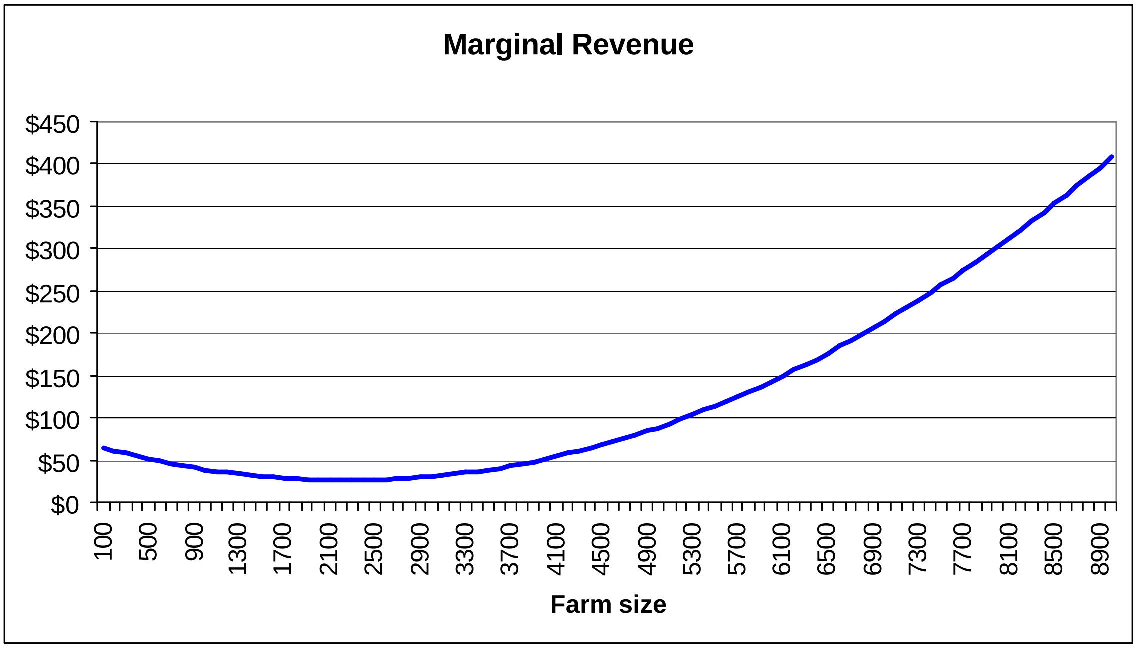

Figure 2. Marginal Revenue at Various Farm Sizes

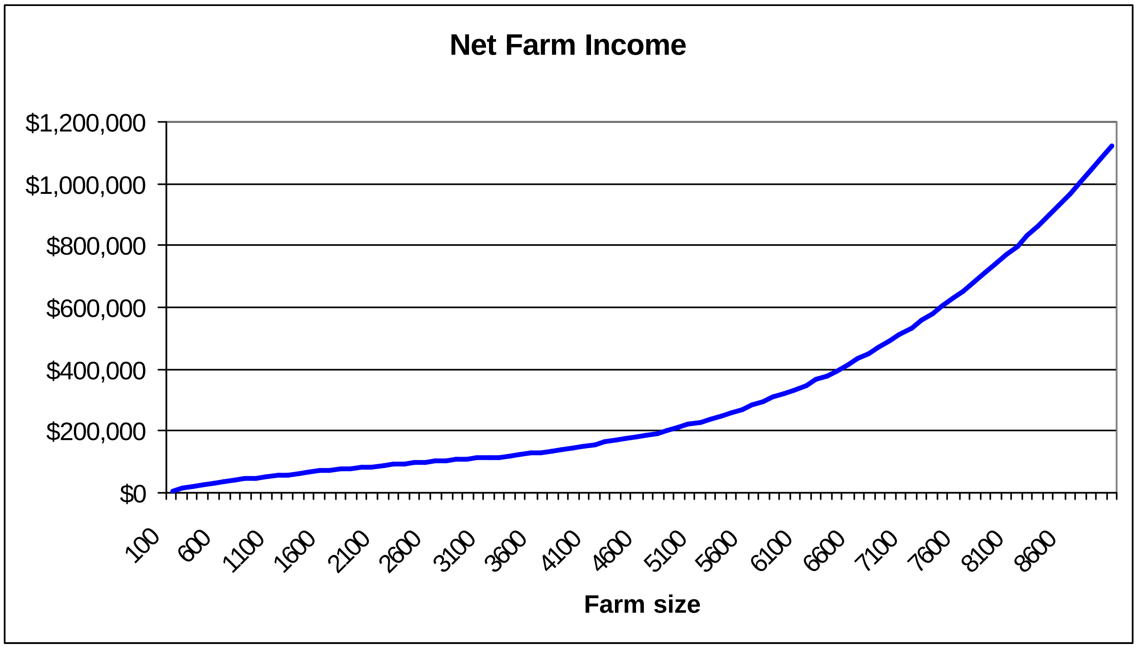

Figure 3. Net Farm Income at Various Farm Sizes

Table 1. Regression results for Net Farm Income as a function of Tilled Crop Acres, Crop Type, Region, and Year.

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                          GLS ANOVA Table

                      Dependent Variable: NFI

          VALUE         DF         R2    ADJ_R2    F_STAT    F_CRIT    PROB_F

SSREG 4.9544E11         12  0.4216372 0.4073566 30.656278 1.7721095         0
SSERR 6.5452E11        486          0         0         0         0         0
SSTOT 1.1317E12        498          0         0         0         0         0


                         Parameter Estimates

                 ESTIMATE         SE    T_STAT    T_CRIT    PROB_T

        INTERCEPT -54607.02  37448.43 -1.458192 1.9648572 0.1454334
        AC         68.75516 43.690194 1.5736977 1.9648572 0.1162081
        AC2       -0.018748 0.0210295 -0.891525 1.9648572 0.3730886
        AC3       2.7813E-6  2.514E-6 1.1062963 1.9648572 0.2691456
        WHT       5855.7579 14242.987 0.4111327 1.9648572 0.6811564
        TOB       12640.427 13320.574 0.9489401 1.9648572 0.3431227
        PUR       -787.8138 40901.359 -0.019261 1.9648572 0.9846406
        PR        -12231.19 33276.962 -0.367557 1.9648572 0.7133635
        OV        -6892.487 35720.261 -0.192957 1.9648572  0.847073
        LT        564.42372 62422.319  0.009042 1.9648572 0.9927893
        YR99      29281.219 11943.974 2.4515475 1.9648572 0.0145753
        YR00      95521.973 13010.219 7.3420724 1.9648572  8.92E-13
        YR01      75682.088  12331.19 6.1374521 1.9648572 1.7421E-9
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Table 2. Summary Statistics

Summary Statistics	
Mean	89.47
Standard Error	1.46
Median	87.30
Mode	80.00
Standard Deviation	30.21
Sample Variance	912.46
Kurtosis	1.76
Skewness	0.83
Range	199.56
Minimum	23.36
Maximum	222.92
Sum	38559.73
Count	431.00
Confidence Level(95.0%)	2.86