Relationship between Cash Rent and Net Return to Land in Indiana

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Abstract

This paper examined the relationship between cash rent and net return to land in Indiana. Short-term and long-term adjustment coefficients for low, medium, and high productivity land in Indiana were used to explore the impact of a $100 per acre change in net return to land on cash rents in subsequent years. There was a significant and positive relationship between cash rent and net return to land for medium and high productivity land. The relatively low coefficients on lagged net return to land in the cash rent equations reinforce the existing literature that asserts that cash rent values are "sticky." For high productivity land, a $100 per acre drop in net return to land would result in a $7.40 per acre drop in cash rent in the subsequent year and a long-term drop of $32.30 per acre in cash rent.

INTRODUCTION

Over the past five years, corn and soybean producers in the United States witnessed a dramatic decline in commodity prices. In 2012, the price of corn per bushel was $7.34 and the price of soybeans per bushel was $14.67 (USDA-NASS, *Agricultural Prices*). In 2017, the price for corn was $3.36 per bushel, while the price for soybeans was $9.39 per bushel (USDA-NASS, *Agricultural Prices*). This denotes a price decline of 54 percent for corn and 36 percent for soybeans. Low commodity prices will likely be the extended norm for the next several years (FAPRI, 2018).

Within the state of Indiana, the impacts of low commodity prices are particularly striking. Corn and soybean revenue peaked in 2013 at $4.61 billion and $3.53 billion, respectively (USDA-NASS, *Quick Stats*). From these peaks, corn revenue was 30.1 percent lower and soybean revenue was 13.4 percent lower in 2017. The declining crop production values have Indiana corn and soybean producers looking for ways to decrease their costs and improve their profitability.

Cash rent is a major production cost for producing corn and soybeans in Indiana. From 1990 to 2017, cash rent accounted for, on average, 30 percent of all corn production costs and 39 percent of all soybean production costs. As the profitability of corn and soybean producers continues to stagnate, it is unknown how cash rent values will change across Indiana. Because of the significance of cash rent as a major cost for corn and soybean producers, it is vital that an effective metric exist for evaluating the potential impact of decreased net returns upon cash rent within the state of Indiana.

Research that examines the relationship between cash rent and net return to land is quite limited. Featherstone and Baker (1988) examined the relationship between cash rent and net return to land, and between land values and cash rent for Tippecanoe county in Indiana. Net return to land and cash rent were significantly related to cash rent and land value, respectively. The coefficient on lagged net return to land in the cash rent equation was 0.08. Featherstone et al. (2017) found a significant relationship between land value and net farm income. The authors found that land values adjusted slowly to changes in net farm income.

The objective of this paper is to examine the relationship between cash rent and net return to land in Indiana. At present, research analyzing the relationship between cash rent and net return to land within Indiana by land productivity category is not readily available. Quantifying this relationship across the entire state and by land productivity category would help farm operators in planning financial investments and other farm-related activities.

MODEL OVERVIEW

To provide clarity, the key terms frequently used within this paper are defined below.

Crop Revenue:

Commodity Price per Bushel × Crop Yield (Bushels per Acre)

Crop Insurance Proceeds:

Indemnity payments for a revenue protection plan with an 80 percent coverage level.

Government Payments:

Per acre payments from the federal government directly related to crop production, excludes CRP payments and conservation payments.

Crop Costs:

The sum of per acre costs related to fertilizer, seed, pesticides, dryer fuel, machinery fuel, machinery repairs, hauling, interest, utilities, general farm insurance, crop insurance, machinery ownership, and family and hired labor.

Cash Rent:

The market price paid per acre to rent farmland.

Net Return to Land:

Crop Revenue per Acre + Government Payments per Acre + Crop Insurance Proceeds per Acre – Crop Costs per Acre (excluding land).

Additional detail pertaining to the items defined above is contained in the data section below. To quantify the relationship between cash rent and net return to land in Indiana, a simple econometric model is utilized. The model is as follows:

(1) $R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 NRL_{t-1} + \beta_3 T + \mu_t$

where *t* is time period t, T is a time trend, R is cash rent, and NRL is net return to land. It is necessary to use lagged net return to land since when landowners are determining cash rent for the current year, the previous year's net return represents the most recent information. Additionally, lagged cash rent is a useful variable because of the sticky nature of cash rent values; that is, landowners are unwilling to make large changes in cash rent annually. Although this is almost identical to the model utilized by Featherstone and Baker (1988), it improves upon their results by expanding the analysis from Tippecanoe County to the entirety of Indiana and adding a variable representing the time trend. This time trend, T, depicts the influences of unknown variables affecting the value of cash rent, thus improving the statistical accuracy of the model. This paper also improves upon Featherstone and Baker's (1988) work by running regressions using real values of cash rent and net returns to land for low, medium, and high productivity land.

One of the issues that arises when using time series data sets such as those used in this paper is stationarity. An augmented Dickey-Fuller test can be used to check for the presence of a unit root. If a unit root is present, a time series is highly persistent and the sum of the assumptions associated with the estimation of equation (1) will be violated (Wooldridge, 2012). An augmented Dickey-Fuller test was conducted for each land productivity regression. If a unit root was discovered to be present, a first difference model was estimated. The first difference model can be expressed as follows:

(2) $\Delta R_t = \gamma_0 + \gamma_1 \Delta R_{t-1} + \gamma_2 \Delta NRL_{t-1} + v_t$

Short-term and long-term adjustment coefficients are computed for each regression. The short-term adjustment coefficient is represented by the coefficient on lagged net return to land or the change in lagged net return to land depending on whether a unit root exists. The long-term adjustment coefficient is computed by multiplying the coefficient on lagged net return to land (change in lagged net return to land if a unit root exists) by one minus the coefficient on lagged cash rent (change in lagged cash rent if a unit root exists). Short-term and long-term adjustment coefficients are analogous to short-run and long-run marginal propensities to consume (see Langemeier and Snider (2009) for a discussion of short-run and long-run marginal propensities to consume).

DATA

This paper utilizes a 50/50 corn/soybean rotation to compute net return to land for low, medium, and high productivity land. Land productivity categories were based on potential crop yields. Specifically, low productivity referred to the southeast region of Indiana. Medium productivity was represented by the north, northwest, and southwest regions of Indiana and high productivity was represented by the west central and central regions of Indiana.

Crop revenue per acre is calculated by multiplying the commodity price per bushel for corn and soybeans by the yields for corn and soybeans. Data from USDA-NASS (*Quick Stats*), are used to determine commodity prices and yields for corn and soybeans. The value of crop insurance indemnity payments for corn and soybean production is obtained from author computations (Langemeier, 2015). These computations assume producers utilize an 80 percent revenue protection plan (Schnitkey, 2017). Government payments for corn and soybean production are obtained from three separate sources. The first source of data on government payments is from USDA-NASS (*Quick Stats*) and contains information on the total value of government payments made in each Indiana county from 1990 to 2002. This data set includes government payments related to the Conservation Reserve Program (CRP). CRP payments (USDA-FSA) are subtracted out of the total government payments to obtain the government payments for corn and soybeans used in this paper. The second source of data comes from Purdue's annual Crop Cost & Return Guides from 2003 to 2013 (Purdue Crop Guide Archive). The third source of data originates from ARC-CO government payments related to corn and soybean production for each county in Indiana for the years of 2014 and 2015 (USDA-FSA). Average government payments during the study period ranged from $37 to $40 per acre for low, medium, and high productivity land. Government payments were the lowest in 2013 ($0 per acre) and were over $100 per acre for each land productivity category in 2000 and 2001.

Crop production costs for corn and soybeans from 1990 to 2015 are estimated using the 2015 Purdue Crop Cost & Return Guide (Dobbins et al., 2015) and USDA price indices (USDA-NASS, *Agricultural Prices*). To account for seeding rate changes in corn production over time, an index is created using data from USDA-NASS (*Quick Stats*) on corn plant populations per acre in Indiana.

The dataset used to determine the value of cash rent from 1990 to 2015 within the state of Indiana originates from the Purdue Agricultural Economics Report (Purdue Agricultural Economics Report, Land Values Archive). This report aggregates cash rent data for different qualities of land by region in Indiana.

Finally, the GDP implicit price deflator is used to compute real cash rents and net returns to land by productivity category. The last year of the data set, 2015, is used as the base year for these computations.

Table 1 presents real gross revenue, production cost, cash rent, and net return to land per acre for the three land productivity categories. Other income includes government payments and crop insurance indemnity payments. Crop revenue comprises approximately 89 percent of gross revenue for low productivity ground, and 92 percent of gross revenue for medium and high productivity ground. Machinery cost includes fuel, repairs, and ownership costs. Labor cost includes family and hired labor. Miscellaneous cost includes dryer fuel, utilities, hauling, interest, general insurance, and crop insurance. Earnings per acre, obtained by subtracting cash rent from net return to land, is also presented in the table. Earnings per acre are negative for each land productivity category indicating that over the study period not all cash and opportunity costs were covered.

Net return to land was considerably more variable than cash rent over the study period. The coefficient of variation (computed by dividing the standard deviation by the mean) for the net return to land for low, medium, and high productivity land was 0.55, 0.51, and 0.44, respectively. In contrast, the coefficient of variation for cash rent for low, medium, and high productivity land was 0.14, 0.19, and 0.19, respectively. These coefficients of variation suggest that movements in the net return to land and cash rent are not one to one (i.e., a $1 movement in net return to land does not necessarily correspond with a $1 movement in cash rent). Figure 1 illustrates that relationship between cash rent and net return to land for high productivity land.

RESULTS

The results of the econometric models represented by equation (1) are presented in Table 2. These results indicate a significant and positive relationship between cash rent and lagged net return to land. The coefficients on lagged net return to land range from 0.0502 for low productivity land to 0.1038 for medium productivity land, which are consistent with the coefficient on lagged net return to land found by Featherstone and Baker (1988) using data from 1960 to 1985. The lagged cash rent coefficients are positive and significant for each land productivity category. The relatively larger coefficient for the high productivity land suggests that cash rent is more persistent for this land productivity category. The time trend was also positive and significant for each land productivity category.

The augmented Dickey-Fuller tests (Z statistic in Table 2) indicate that a unit root is present for all three of the land productivity regressions in Table 2. The first difference results are presented in Table 3. The coefficients on the first difference of lagged net return to land range from 0.024 to 0.076. However, the F-statistic for low productivity land is not significant. The 0.076 and 0.074 coefficients on lagged net return to land for medium productivity land and high productivity land indicate that a $100 per acre change in net return to land results in a $7.60 and $7.40 per acre change in the subsequent year's change in cash rent, respectively, for medium and high productivity land. The coefficient on lagged cash rent is significant for high productivity land. This coefficient indicates that a $10 per acre change in lagged cash rent results in a $7.70 per acre change in the subsequent year's cash rent.

The short-term and long-term adjustment coefficients in response to a change in net return to land are presented in Table 4. The short-term adjustment coefficient in Table 4 represents the coefficients on lagged net crop returns in the regressions illustrated in Table 3. The short-run adjustment coefficient for low productivity land is not shown in Table 4 because the coefficient on lagged net return to land for this land category was not significant in Table 3. The long-term adjustment coefficients were computed using the regression coefficients on the lagged net return to land and lagged cash rent coefficients. The coefficients depicting long-term cash rent adjustments are only shown for the cases in which the coefficients related to lagged net return to land and lagged cash rent in Table 3 are significant.

The short-term adjustment coefficient for medium productivity land category was 0.076. Using the short-term adjustment coefficient, a $100 drop in net return to land per acre would result in a $7.60 per acre drop in cash rent in the subsequent year. The coefficient on lagged cash rent for the medium productivity land category is insignificant. As a result, the long-term impact on the medium quality land category is unknown. For the high productivity land category, the short-term and long-term adjustment coefficients are 0.074 and 0.323. Using the short-term adjustment coefficient, a $100 drop in net return to land per acre would result in a $7.40 per acre drop in cash rent in the subsequent year, which is very similar to the drop for medium productivity land. The long-term coefficient indicates that a permanent drop of $100 in net return to land per acre would result in a drop of $32.30 per acre in cash rent for the high productivity land category. Using the coefficients on short-term and long-term adjustment coefficients for high productivity land, only 23 percent of the total adjustment in response to a drop in net return to land occurs in the first year.

CONCLUSIONS AND IMPLICATIONS

This paper examined the empirical relationship between cash rent and net return to land in Indiana. The results indicate a positive relationship between cash rents and net return to land. The low F-statistic exhibited for the low productivity land regression indicates that factors other than net return to land and lagged cash rent drive the value of cash rent for low productivity land in Indiana. The relatively low coefficients for lagged net return to land in the regressions for the medium and high productivity land suggest that cash rent values are sticky, that is, landowners are unwilling to make large changes in annual cash rent.

Using the coefficients on lagged net return to land in our empirical models, a $100 drop in net return to land per acre would result in a drop in the subsequent year's cash rent of approximately $7 to $8 per acre for medium and high productivity land. The significant coefficient on lagged cash rent for high productivity land suggests that the impact of a drop in net return to land would have a long-term impact on cash rent for high productivity land. The long-term impact of a $100 drop in net return to land per acre for high productivity land on cash rent was estimated to be approximately $32 per acre.

This paper explored the relationship between cash rent and net return to land with relatively aggregate data. Further analysis that uses more micro level data would be helpful. Specifically, matching cash rent and net return to land data for individual parcels or farms would provide robustness checks for the results in this paper.

REFERENCES

Dobbins, C.L., M.R. Langemeier, W.A. Miller, B. Nielsen, T.J. Vyn, S. Casteel, B. Johnson, and K. Wise. 2015. "2015 Purdue Crop Cost & Return Guide." Purdue Extension, March.

Featherstone, A., and T. Baker. 1988. "Effects of Reduced Price and Income Supports on Farmland Rent and Value." *North Central Journal of Agricultural Economics*. 10(July):177–189.

Featherstone, A.M., M.R. Taylor, and H. Gibson. 2017. "Forecasting Kansas Land Values Using Net Farm Income." *Agricultural Finance Review*. 77(Issue 1):137–152.

Food and Agricultural Policy Research Institute 2018. *U.S. Baseline Outlook*, FAPRI-MU Report #01-18, March 2018.

Langemeier, M. “Crop Insurance Guarantees.” Center for Commercial Agriculture, Purdue University, February 2015.

Langemeier, M., and L. Snider. “Marginal Propensity to Consume for a Sample of Kansas Farms.” Selected paper presented at the Southern Agricultural Economics Annual Meeting in Atlanta, Georgia, January 31–February 3, 2009.

Purdue Agricultural Economics Report, Land Values Archive. https://ag.purdue.edu/commercialag/Pages/Resources/Farmland/Land-Prices/PAER-Archive.aspx [Accessed January 11, 2017].

Purdue Crop Guide Archive. https://ag.purdue.edu/commercialag/Pages/Resources/Management-Strategy/Crop-Economics/Crop-Budget-Archive.aspx [Accessed January 11, 2017].

Schnitkey, G. “Revenue Protection (RP) Use on Corn in the Midwest.” Farmdoc daily (7):2, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January 4, 2017.

United Stated Department of Agriculture, Farm Service Agency. 2016. *ARC/PLC Program Data*. https://www.fsa.usda.gov/programs-and-services/arcplc_program/arcplc-program-data/index [Accessed January 11, 2017].

United States Department of Agriculture. Farm Service Agency. 2016. *Conservation Reserve Program Statistics*. https://www.fsa.usda.gov/programs-and-services/conservation-programs/reports-and-statistics/conservation-reserve-program-statistics/index [Accessed January 11, 2017].

United States Department of Agriculture. National Agricultural Statistics Service. *Agricultural Prices*, various issues.

United States Department of Agriculture. National Agricultural Statistics Service. 2016. Quick Stats. https://quickstats.nass.usda.gov/results/5b45736d-d5a6-3966-b0e6-c216519f4d42 [Accessed Various Dates].

Wooldridge, J.M. 2012. *Introductory Econometrics: A Modern Approach*. Fifth Edition. Mason, OH: South-Western.

Table 1. Average Gross Revenue, Production Costs, Cash Rent, and Net Return to Land in Indiana.

		Low Productivity	Medium Productivity	High Productivity
Gross Revenue (per acre)				
	Crop Revenue	423	470	511
	Other Income	50	42	46
Production Costs (per acre)				
	Fertilizer	73	77	81
	Seed	49	52	54
	Pesticides	37	37	37
	Machinery	107	107	107
	Labor	39	39	39
	Miscellaneous	54	57	60
Cash Rent and Net Return to Land (per acre)				
	Net Return to Land	113	142	179
	Cash Rent	121	158	186
	Earnings	-8	-16	-6

Notes: Data were for the 1990 to 2015 period. Low, medium, and high productivity categories were based on potential crop yields.

Table 2. Cash Rent Model Results by Land Quality Category.

	Variable	Low Productivity	Medium Productivity	High Land Productivity
	Intercept	36.73**	19.55**	3.01
	NRLt-1	0.0502***	0.1038***	0.1010***
	Rt-1	0.5335***	0.7078***	0.8513***
	Time Trend	1.0891***	1.0166***	0.6855***
	F(3,21)	65.29	179.01	339.06
	Prob > F	0.0000	0.0000	0.0000
	Adjusted R2	0.889	0.957	0.977
	Z(t)	0.044***	0.141***	0.915***

Notes: * depicts 10% significance level; ** depicts 5% significance level; and *** depicts 1% significance level. Low, medium, and high productivity categories were based on potential crop yields.

Table 3. First Difference Cash Rent Model Results by Land Quality Category.

	Variable	Low Productivity	Medium Productivity	High Land Productivity
	Intercept	2.377	2.556	0.723
	Δ NRLt-1	0.024	0.076***	0.074***
	Δ Rt-1	-0.126	0.287	0.771***
	F(2,21)	1.03	6.62	17.47
	Prob > F	0.3731	0.0059	0.0000
	Adjusted R2	0.003	0.589	0.589

Notes: * depicts 10% significance level; ** depicts 5% significance level; and *** depicts 1% significance level. Low, medium, and high productivity categories were based on potential crop yields.

Table 4. Short-Term and Long-Term Adjustment Coefficients in Response to a Change in Net Return to Land.

	Time Frame	Low Productivity	Medium Productivity	High Land Productivity
	Short-Term	N/A	0.076	0.074
	Long-Term	N/A	N/A	0.323

N/A = not applicable (i.e., regression coefficients were not significant)
Note: Low, medium, and high productivity land categories are based on potential crop yields.

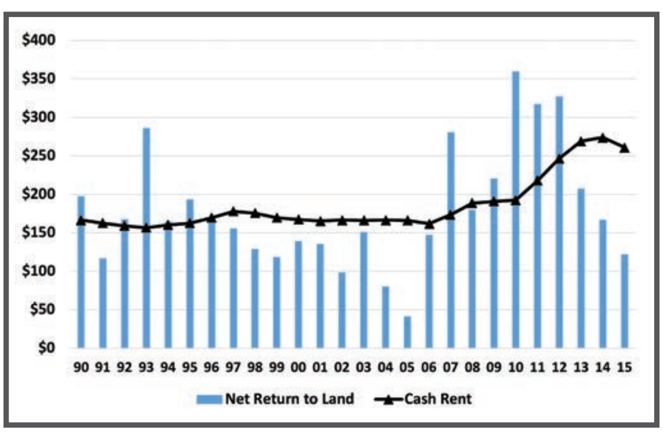

Figure 1. Cash Rent and Net Return to Land, High Productivity Land in Indiana