# An Examination of the Relationship Between Net Crop Returns and Cash Rent Values in Indiana

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## Abstract

This paper examined the relationship between cash rent and net crop returns for Indiana. As expected, there was a significant and positive relationship between net crop returns and cash rent values. The relatively low coefficients on lagged net crop returns in the cash rent equations reinforces the existing literature that asserts that cash rent values are sticky. As a result, the recent decline in net crop returns in Indiana will not be fully realized for several years.

## Introduction

Over the past four 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*, 2016). In 2015, the price for corn was $3.93 per bushel while the price for soybeans was $8.86 per bushel (USDA-NASS, *Agricultural Prices*, 2016). This denotes a price decline of 54 percent for corn and 60 percent for soybeans. Commodity prices for corn and soybeans are their lowest since 2006. Furthermore, low commodity prices will likely be the extended norm for the next five years (Office of the Chief Economist 2016).

Within the state of Indiana, the impacts of low commodity prices are particularly striking. In 2015, USDA estimated the value of Indiana corn production to be approximately $3.16 billion and the value of soybean production to be approximately $2.43 billion (USDA-NASS, 2015). Compared to 2014, these figures represent a 22 percent decrease in the value of corn production and a 21 percent decrease in the value of soybean production from approximately $4.07 billion and $3.08 billion for corn and soybeans, respectively. The declining crop production values have Indiana corn and soybean producers looking for ways to decrease their costs and improve their profitability.

Unfortunately, cash rent is one of the major impediments to reducing cost. From 1990 to 2015, cash rent accounted for an average 25 percent of all corn production costs and 35 percent of all soybean production costs. As the profitability of corn and soybean producers continues to stagnate, it is presently unknown how cash rent values will change across Indiana. Due to 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 crop returns upon cash rent within the state of Indiana.

At present, most research analyzing the relationship between net crop returns and cash rent within Indiana focuses on the West-Central region. Quantifying the relationship between net crop returns and cash rent across the entire state would help farm operators in planning financial investments and other farm-related activities. The objective of this paper is to examine the relationship between cash rent and net crop returns in Indiana. The results of this paper will assist farm operation decision making for Indiana corn and soybean producers.

**Model Overview**

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

- *Net Crop Returns*: Crop Revenue Per Acre + Government Crop Payments Per Acre + Crop Insurance Proceeds Per Acre – All Crop Costs Per Acre (except for Land).
- *Crop Revenue Per Acre:* Commodity Price Per Bushel x Crop Yield (Bushels Per Acre)
- *Cash Rent:* The market price paid per acre to rent farmland. Also known as land cost.
- *Insurance Payments:* Payments from insurance which assumes an 80 percent revenue protection plan. The estimated payments use a predicted yield forecast to project crop revenues for the year.
- *Government Payments:* Payments from the U.S. federal government directly related to crop production.
- *Crop Costs:* The sum of costs related to fertilizer, seed, chemicals, dryer fuel, machinery fuel, machinery repairs, hauling, interest, insurance, miscellaneous expenses, machinery ownership, and family and hired labor.

To validate and quantify the relationship between cash rent and net crop returns in Indiana, a simple econometric model is utilized. The model is as follows:

$$R_t = \beta_{10} + \beta_{11}R_{t-1} + \beta_{12}NCR_{t-1} + \beta_{13}T + \mu_{1t}$$

where *t* is time period t, T is a time trend, R is cash rent, and NCR is net crop returns. It is necessary to use the lagged net crop returns since when landowners are determining cash rent for the current year, the previous year's net crop returns represent the most recent information. Additionally, lagged cash rent is a useful variable due to the sticky nature of cash rent values, that is, landowners are unwilling to drastically change the cost of rent each year. 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 impacting the value of cash rent, thus improving the statistical accuracy of the model. Furthermore, this paper will run regressions using both the nominal and real values of cash rent and net crop returns to account for the possible impact of inflation.

**Data**

This paper utilizes a 50/50 corn/soybean rotation to compute net crop returns. The crop revenue per acre is calculated by multiplying the commodity price per bushel for corn and soybeans by the yields in bushels per acre for corn and soybean within Indiana. Data from USDA-NASS is used to determine the commodity price per bushel and bushel yields per acre for corn and soybeans.

The value of crop insurance indemnity payments for corn and soybean production is obtained from a model formulated by the authors. This model assumes producers utilize an 80 percent revenue protection plan. Government payments per acre for corn and soybean production are obtained from three separate sources. The first source of data on government payments is from USDA-NASS and contains information on the total value of government payments made in each Indiana county from 1990 to 2002. This dataset 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" 2017). 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).

Crop production costs for corn and soybeans from 1990 to 2015 are simulated through the use of USDA price indices (Agricultural Prices). To account for seeding rate changes in corn production, an index is created using data from USDA-NASS 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 annual Purdue Agricultural Economics Report ("Purdue Agricultural Economics Report Land Values Archive" 2015). This report aggregates its cash rent data for the entire state of Indiana.

Finally, the GDP implicit price deflator is used to compute real cash rents and net crop returns. The last year of the dataset, 2015, is used as the base year for these computations.

**Results**

The relationship between nominal cash rent and net crop returns is depicted in figure 1. Cash rents and net crop returns appear to be correlated. After adjusting for inflation in figure 2, similar movements of real net crop returns and real cash rent values are evident. It is also evident from the figures that net crop returns are more variable than cash rents. This suggests that the movement in these items is not one to one (i.e., a $1 movement in net crop returns does not necessarily correspond with a $1 movement in cash rent).

The results of the econometric models quantify the relationship between cash rents and net crop returns in Indiana. Table 1 depicts the relationship between nominal cash rent and nominal net crop returns. These results indicate a significant and positive relationship between nominal cash rent and net crop returns. The beta coefficient for nominal lagged net crop returns states that for every $100 change in net crop returns in the current year, there will be an $11.80 change in cash rent in the subsequent year. The lagged cash rent coefficient states that for every $10 change in the current cash rent, next year's cash rent will change by $7.29.

The next step was to test for the presence of a unit root for the equation used to estimate the results in table 1. The Dickey-Fuller unit root tests are depicted in table 2. The findings of the Dickey-Fuller Test clearly indicate that a unit root is present (Wooldridge 2012). To correct for this problem, the econometric model is rerun using the first differences (Wooldridge 2012). The new model is

$$\Delta R_t = \beta_{20} + \beta_{21}\Delta R_{t-1} + \beta_{22}\Delta NCR_{t-1} + \mu_{1t}$$

Table 3 shows the econometric results for the first difference model for nominal cash rent. According to table 3, the relationship between cash rent and net crop returns is still significant. The first difference results indicate that for every $100 change in net crop returns in the current year, cash rent will change $9.81 in the next year. Additionally, the coefficient on lagged cash rent remains significant, indicating the dynamic nature of cash rent over time.

To better understand the relationship between cash rent and net crop returns, the impact of inflation must be taken into account. After adjusting for inflation, the aforementioned econometric models are rerun. Table 4 depicts the results.

The regression results in table 4 reveal a significant and positive relationship between real cash rent and real net crop returns. However, the results in table 4 differ from the results in table 1. After adjusting for inflation, the beta coefficient for lagged net crop returns decreases to 0.1005, indicating if net crop returns this year increase by $100 the following year's cash rent value will increase by $10.05. Similarly, the inflation adjusted cash rent coefficient notes that a $10 change in the value of cash rent in the previous year will result in a $7.08 change in the value of cash rent during the current year. We also use a Dickey-Fuller Test to determine the presence of a unit root in the equation used to examine the relationship between real cash rent and real net crop returns. The results of the Dickey-Fuller Test are depicted in table 5.

The findings of the Dickey-Fuller Test clearly indicate that a unit root is present (Wooldridge 2012). Again, the first difference approach is used to correct the econometric model for the problem of a unit root (Wooldridge 2012). Table 6 shows the results for the inflation adjusted first difference model.

According to table 6, the relationship between net crop returns and cash rent is still significant. The coefficient on real net crop returns for the first difference model indicates that for every $100 change in the value of net crop returns in the current year, the value of cash rent will change $7.60 the following year. However, the coefficient on lagged cash rent is not significant. This finding is surprising and would suggest the impact of inflation must be taken into effect when discerning the factors which impact real cash rent in Indiana.

## Conclusions and Implications

This paper examined the empirical relationship between cash rent and net crop returns in Indiana. The results indicate a positive relationship between cash rents and net crop returns. This relationship holds true for both nominal and inflation adjusted models. The low coefficients for both nominal and inflation adjusted lagged net crop returns in the first difference models reinforces the existing literature that asserts that cash rent values are sticky, that is landowners are unwilling to drastically change the cost of rent each year. As a result, the impacts of declining net crop returns upon cash rent in Indiana will not be fully realized for several years.

Further work will examine the relationship between cash rent and net crop returns for different qualities of land. The relationship between cash rent and net crop returns is likely to vary by land productivity class.

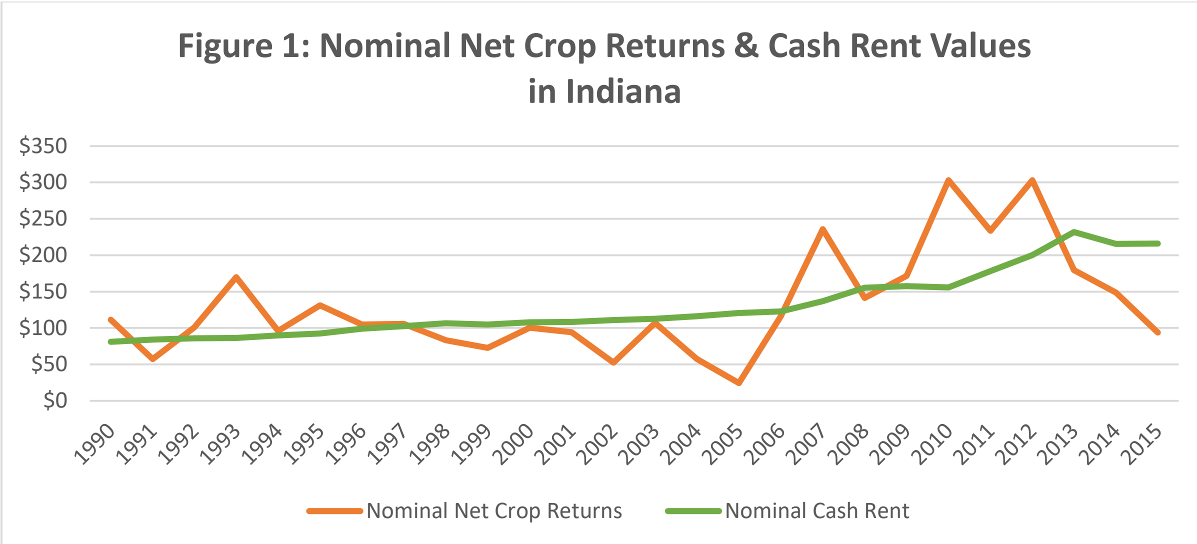
Figure 1: Nominal Net Crop Returns & Cash Rent Values in Indiana
$350
$300
$250
$200
$150
$100
$50
$0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Nominal Net Crop Returns
Nominal Cash Rent

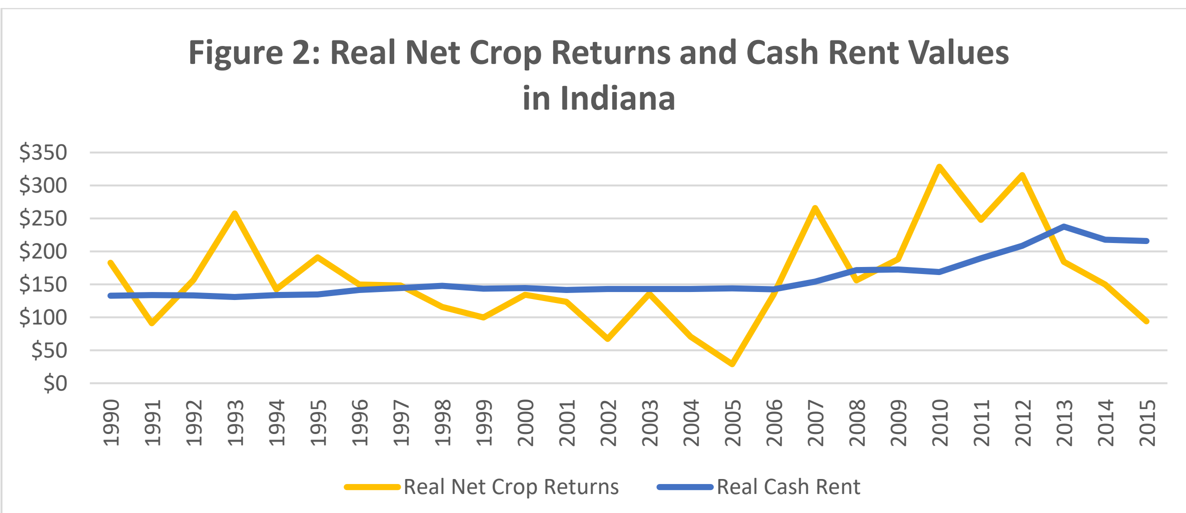
Figure 2: Real Net Crop Returns and Cash Rent Values in Indiana
$350
$300
$250
$200
$150
$100
$50
$0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Real Net Crop Returns
Real Cash Rent

| Table 1: Nominal Cash Rent Model Results | | |
|---|---|---|
| $F(3,21) = 428.21$ | | |
| **Variable** | **Coefficient** | **Standard Error** |
| $NCR_{t-1}$*** | 0.1180 | 0.0214 |
| $R_{t-1}$*** | 0.7228 | 0.0761 |
| T*** | 1.1790 | .4159 |
| Constant* | 8.3722 | 4.6582 |

*Note: *** depicts 1% significant level, ** depicts 5% significant levels, * depicts 10% significant level*

| Table 2: Dickey-Fuller Test Results for Nominal Cash Rent | | | |
|---|---|---|---|
| Test Statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value |
| Z(t): 0.731 | -3.750 | -3.000 | -2.630 |
| MacKinnon approximate p-value for Z(t) = 0.9904 | | | |

| Table 3: Nominal Cash Rent First Difference Model Results | | |
|---|---|---|
| $F(2,21) = 7.81$ | | |
| **Variable** | **Coefficient** | **Standard Error** |
| $D1.NCR_{t-1}$*** | 0.0981 | 0.0254 |
| $D1.R_{t-1}$* | 0.3402 | 0.1738 |
| Constant* | 3.4293 | 1.8699 |

*Note: *** depicts 1% significant level, ** depicts 5% significant levels, * depicts 10% significant level*

| Table 4: Inflation Adjusted Cash Rent Model Results | | |
|---|---|---|
| $F(3,21) = 169.39$ | | |
| **Variable** | **Coefficient** | **Standard Error** |
| $NCR_{t-1}$*** | 0.1005 | 0.0196 |
| $R_{t-1}$*** | 0.7081 | 0.0846 |
| T*** | 0.9538 | 0.3198 |
| Constant* | 19.1548 | 9.4995 |

*Note: *** depicts 1% significant level, ** depicts 5% significant levels, * depicts 10% significant level*

| Table 5: Dickey-Fuller Test Results for Inflation Adjusted Cash Rent | | | |
|---|---|---|---|
| Test Statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value |
| Z(t): 0.141 | -3.750 | -3.000 | -2.630 |
| MacKinnon approximate p-value for Z(t) = 0.9688 | | | |

MacKinnon approximate p-value for Z(t) = **0.9688**

| Table 6: Inflation Adjusted Cash Rent First Difference Model Results | | |
|---|---|---|
| $F(2,21) = 5.48S$ | | |
| **Variable** | **Coefficient** | **Standard Error** |
| $D1.NCR_{t-1}$*** | 0.0760 | 0.0234 |
| $D1.R_{t-1}$ | 0.2826 | 0.1857 |
| Constant | 2.5279 | 1.8675 |

*Note: *** depicts 1% significant level, ** depicts 5% significant levels, * depicts 10% significant level*

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