Taxation Incidence on Rented Agricultural Land

An Evaluation of Ohio's Current Agricultural Use Value Program

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Abstract

Tax incidence of agricultural property tax measures the extent to which land owners can increase the rental rate that they offer to renters of the land. Property tax incidence provides a measure of the competitiveness of the agricultural land rental market. Ohio's Current Agricultural Use Value Program (CAUV) provides a unique method for determining the taxable value of agricultural land that is determined exogenously from market expectations of land value. This program allows for estimation of the property tax incidence on renters of agricultural land. Results indicate that cash rental rates in Ohio from 2008 through 2017 increased between $0.38 to $0.63 for each additional dollar of property tax levied on agricultural land which is similar to the related literature on government payment incidence.

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Introduction

Almost 40 percent of all farmland in the US is operated by someone other than the land owner per Tenure, Ownership, and Transition of Agricultural Land (TOTAL) survey administered by the United States Department of Agriculture (USDA) in 2014 (Bigelow et al., 2016). Land owners that rent their land to other farms are apt to do so for a multitude of reasons. Broadly speaking, land owners may only operate a portion of their land, may have retired from farm operations but continue to own their land, and others may only hold land because of speculative purposes and have limited knowledge of farming operations as approximately 30% of all farmland is owned by non-operators. On the opposite side of the same coin are the renters of farmland – of which only 10% of all farmland is operated by a farmer that does not own any land. Farmers that rent are typically smaller operations in size and involve younger farmers in terms of both age and experience (Mishra et al., 2009).

Renting instead of owning land may occur for a multitude of reasons and is affected by the price of land. Figure 1 displays land value trends since the 1970s for the US and Ohio. Both USDA National Agricultural Statistical Services (NASS) and the Ohio Department of Taxation (ODT) provide estimates for agricultural land values. Trends in agricultural land values are of importance to shifting the decision of farmers to rent versus own land. Increasing land prices encourages non-farm investors of land and indeed, the share of farmland operated by renters declined from 1982 through 1992 in part due to the 1980s farm crisis when land prices plummeted (Bigelow et al., 2016).

A farmer may rent because they lack access to capital to finance the purchase of land. These types of renters would represent a disadvantaged group and may warrant farm policy programs to aid in land acquisition. Other farmers may engage in the operation of rented land as a way to quickly scale their current operation without making a long-term commitment. Another group may find that both owning and renting land is a risk-reducing measure in a farm's portfolio to changing land values (Kaplan, 1985; Katchova et al., 2002). Others may have a strong relationship with the land owner over the years that they have built up enough social capital with the land owner that purchasing the land would not be a wise financial decision (Katchova

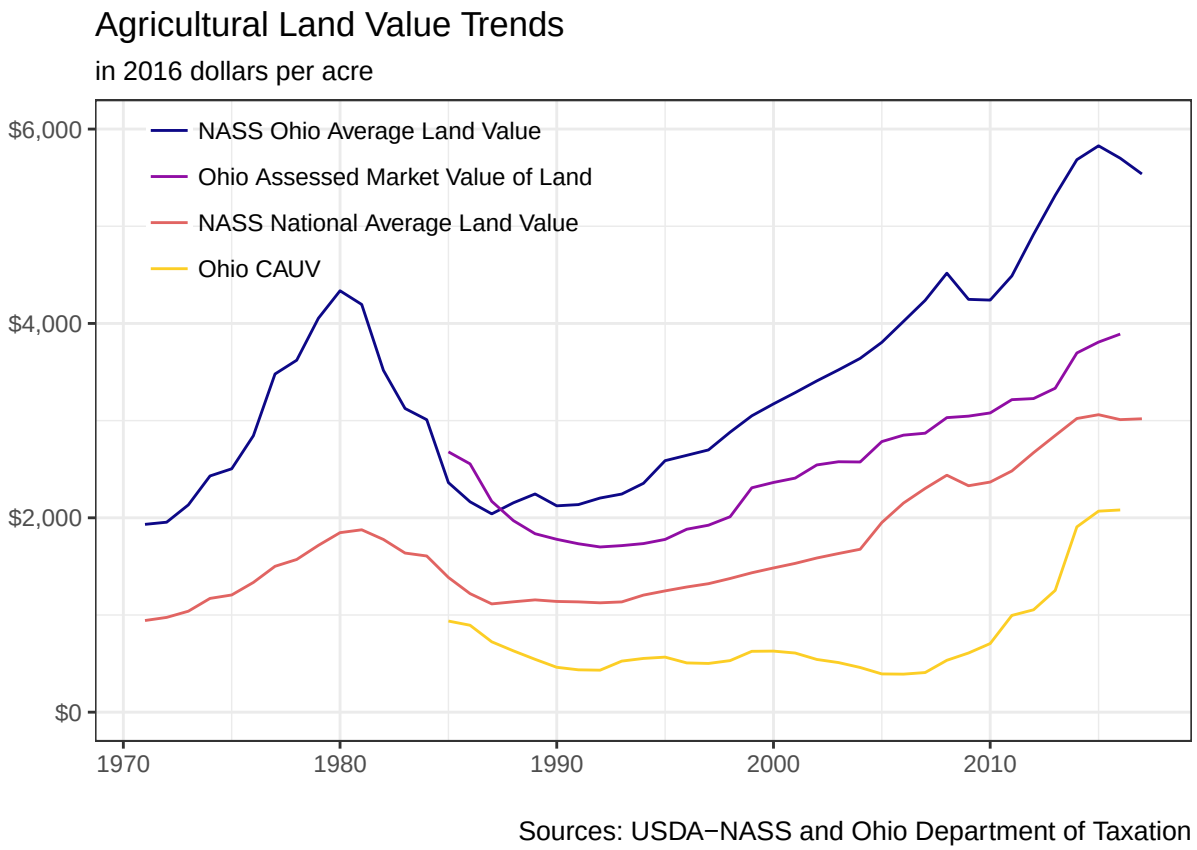
Agricultural Land Value Trends
in 2016 dollars per acre
$6,000
$4,000
$2,000
$0
NASS Ohio Average Land Value
Ohio Assessed Market Value of Land
NASS National Average Land Value
Ohio CAUV
1970
1980
1990
2000
2010
Sources: USDA−NASS and Ohio Department of Taxation

Figure 1:

and Ahearn, 2015). Whatever the reason, renters represent a large segment of the farming population and have heterogeneous preferences and characteristics which affect their relationship with owners of land.

Understanding the relationship between owner and renter can help shape policies that are intended to affect production decisions for farmers. Since renters are the operators of farmland, if a tax is fully passed onto the renter then its effects would deter production or change the riskiness of the planting decisions of the renter. However, if none of the tax is passed onto the renter and fully paid by the landowner, then taxing of agricultural land would be decoupled from farming decisions of the operators. Increasing tax on agricultural land would deter investment, shifting ownership moreso towards operators and suppressing the land values

In spite of the trend of increasing agricultural land value in the state of Ohio since the mid-1980s, its cash rental rate of cropland stagnated from 1994 until approximately 2006. Figure 2 displays a time series of the state's average rental price for an acre of cropland with the corresponding average amount of property tax paid per acre of agricultural land. The two series track each other fairly well over this time, suggesting a relationship exists between the two. Cash rental rates of cropland in Ohio have seen a marked increase in values around 2006 which coincides with Ohio Department of Taxation (ODT) revising their valuation procedure of agricultural land. The revision has resulted in an acceleration of property tax bills for Ohio farmers in part due to the changing valuation formula but also because of rising commodity prices and declining interest rates.

Ohio assesses their agricultural land for property tax purposes via a differential tax treatment program called the Current Agricultural Use Value Program (CAUV) – which assigns property values to soil types in Ohio. The calculation of CAUV involves the past 7 to 10 years worth of state-level data on yields, prices, costs, and interests in deriving a property's taxable value. CAUV inherently reflects past market conditions and does not account for the present expected value of market returns to land. CAUV calculations are independent of actual planting decisions of farmers – therefore a corn farmer and a soybean farmer with identical soil types would have the same CAUV value even if the price of corn and soybeans substantially differed. CAUV values generally trend in the same direction as the assessed market value of agricultural land, although the magnitude has changed over time. In 1985, CAUV represented 35% of market value and this ratio declined to

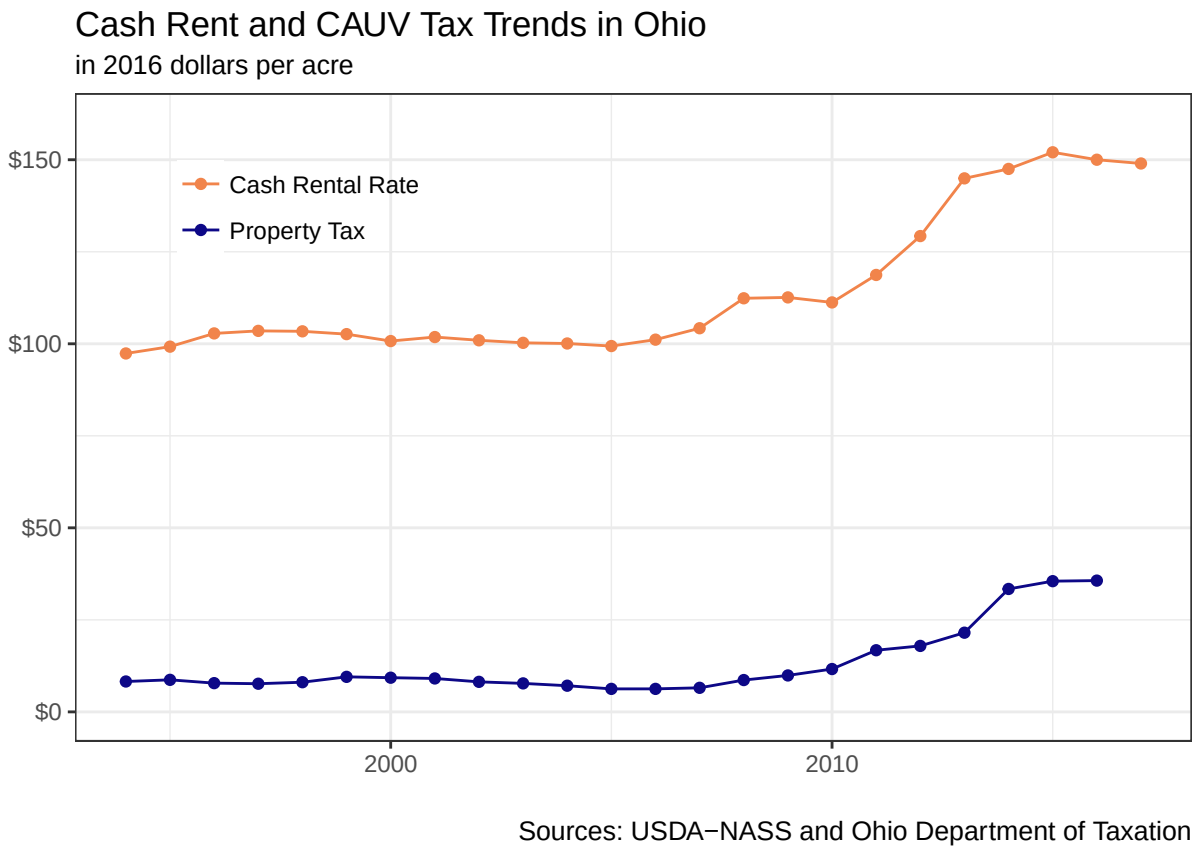
Cash Rent and CAUV Tax Trends in Ohio
in 2016 dollars per acre
$150
$100
$50
$0
Cash Rental Rate
Property Tax
2000
2010
Sources: USDA−NASS and Ohio Department of Taxation

Figure 2:

less than 14% in 2006 when the ODT modified its CAUV calculation. CAUV eclipsed 50% of market value in 2014 and reaching its apex in 2015.

Utilizing knowledge of Ohio's differential tax treatment of agricultural land, tax incidence is estimated via exogenous changes in the property tax paid per acre of agricultural land. Results indicate an additional $1 of property tax levied on an acre of rented land leads to a $0.35 to $0.63 increase in the cash rental rate. Estimates control for agricultural factors, temporal trends, and spatial patterns across Ohio. The estimates are comparable to a similar line of research which evaluates the incidence rate of government payments on rented land and find the marginal dollar of an additional government payment leads to.

Empirical Strategy

The goal is to provide an estimate for how much the cash rental rate per acre of farmland increases due to a change in the property tax paid per acre of farmland. In doing so, factors which affect both cash rents and property tax need to be controlled for to isolate the effects of taxation changes on rents – which will provide an estimate of property tax incidence on land owners. Ohio provides a unique natural experiment for estimating these changes due to its differential tax treatment of agricultural land.

The taxable value of property in Ohio is 35% of its assessed value. Full property assessments occur once every six years with an adjustment occurring three years prior to the full assessment based upon sales data of similar properties. These adjustment schedules vary by county, but each county has been on the same schedule since the 1970s. Figure 3 displays the adjustment schedule for the 2017, 2018, and 2019 years with half or one-quarter of the counties receive an adjustment each year. CAUV values adjust once every three years while other property tax assessments alternate between a full re-assessment and a percentage adjustment based on similar properties sales transaction data in that county. After their adjustment date, land owners know their CAUV values for the next two years but the CAUV value is not known until after the taxable year because of the backwards nature of CAUV calculations. Further complicating the timing is that a tax bill is split up equally into two payments – the bill for the 2008 tax year is first given in mid-December

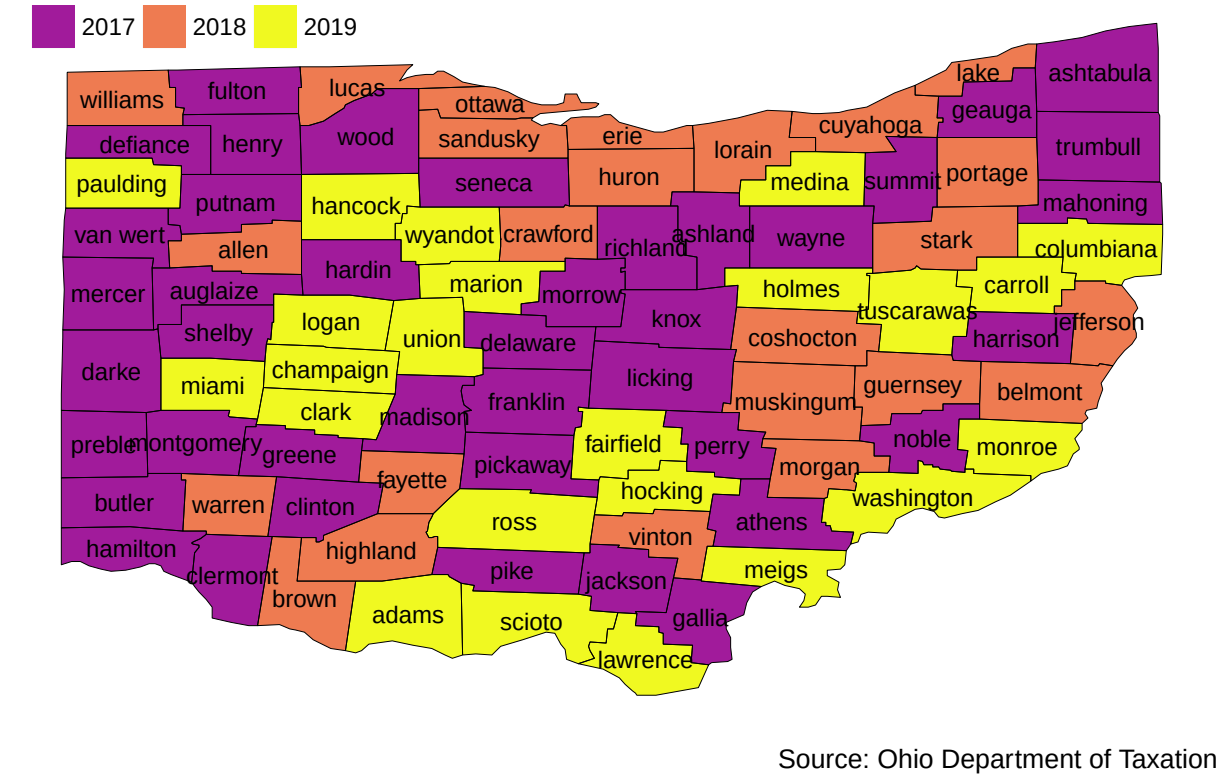

Figure 3:

2008 and then the second half in mid-May of 2009. The land owner has 60 days to pay each tax bill or else they will incur a penalty and interest charges. In other words, the tax bill for 2008 is fully paid by the land owner in mid-2009.

The property tax due for an acre of agricultural land is based on the taxable value as well as the millage rate for the taxing districts that the land may be a part of. A millage rate represents the dollar amount due for every $1,000 of taxable value; for example, a millage rate of 1.5 on $10,000 in property value would result in $15 in taxes owed. Counties, municipalities, and school districts all have varying degrees of taxation powers within Ohio which creates an element of spatial variation for property tax values. Millage rates vary across counties in Ohio although they are fairly stable over time and are typically higher near urban centers.

The predetermined and backwards looking nature of changes in assessed values is the main crux for identification of tax incidence for renters. Although land owners and renters can anticipate when they will receive new

CAUV values, they are unlikely to accurately anticipate what the actual change in the CAUV value will be. This layer of uncertainty and its delayed payment helps in identifying tax incidence on renters. However, enrollment into and out of CAUV will affect the supply of agricultural land for a county which can put pressure on the agricultural rental market. To the degree that CAUV may rise (fall) because marginal – and thus lower quality – land in a county is removed from (added to) the agricultural market, this effect may pose endogeneity concerns for the estimates on property tax incidence. This limitation cannot be addressed with current data because we cannot identify parcels entering or leaving the CAUV program, we only observe total enrolled acreage and its aggregate CAUV value for each county since 1985.

Regression Framework

Farmland property tax incidence is the additional amount paid by a landowner for one more dollar of property tax levied. For owner operators, all of the additional tax is paid by the operator.[1] However, if a land owner rents out their land, they can potentially raise rents to offset property tax increases. If the owner of land pays 100% of the additional tax, then the tax incidence for a renter is 0 and would represent a situation where land is supplied perfectly inelastic or demand is perfectly elastic. Vice-versa, a renter pays 100% of the additional tax when demand for rented agricultural land is perfectly inelastic or supply is perfectly elastic. Alston and James (2002) provides a general two-factor model of agricultural production to consider the implications of subsidies for land rents – which is analogous to the taxation of land.

We first start off with a naive estimate of cash rental rates against property tax for all counties in Ohio for non-irrigated cropland – the dominant rental market of farmland in Ohio:

$$Rent_{i,t} = \alpha + \beta Tax_{i,t-1} + u_{i,t} \tag{1}$$

Where β represents the property tax incidence for the rented – the additional increase in rent from a one

[1] Alston (2010) mentions the possibility for farm programs to have an impact on consumers to the degree of receiving \$0.20 of each additional dollar of farm program. Due to data limitations on fine-scaled price data, this aspect cannot be evaluated in the study.

dollar increase in property tax. Without accounting for any aspects that affect both the cash rental rate and property tax, the property tax incidence estimate of β will be biased in an unknown direction – although in all likelihood the estimates are upwardly biased due to omitted factors that positively affect both rent and taxes.

Property taxes are known to be positively affected by past values of soil quality, yields, and prices by negatively affected by costs and interest rates – which is described in more detail in the data section. Because many of the factors affecting property taxes are either time or spatially invariant, our preferred specification for dealing with omitted factors affecting rent and property tax is to provide a fixed effects estimator for time and county fixed effects:

$$Rent_{i,t} = \alpha + \alpha_i + \alpha_t + \beta Tax_{i,t-1} + u_{i,t} \tag{2}$$

Where α_i represents county fixed effects and α_t represents time fixed effects. County fixed effects capture any time-invariant factors, which mostly proxies for soil quality and long-standing agricultural practices or policies in place at the county level. The time fixed effects pick up shocks which affect all counties in Ohio the same and includes prices, costs, interest rates, and weather events for all intents and purposes.

If there are factors which vary across time and space that affect both cash rental rate and the property tax paid on farmland, then equation 2 does not provide a consistent estimate of the property tax incidence, β. While data on agricultural and economic factors affecting rental rate and property taxes has limitations – described in the following data section – inclusion of relevant economic factors can be incorporating into the estimation procedure as a robustness check of estimated property tax incidence. Inclusion of these agricultural and economic factors in a matrix, X, of covariates provides an estimating equation of the form:

$$Rent_{i,t} = \alpha + \alpha_i + \alpha_t + \beta Tax_{i,t-1} + \gamma X_{i,t-1} + u_{i,t} \tag{3}$$

A concern with agricultural and economic factor inclusion is the timing lag of negotiated rental rates and these factors. Rents are typically negotiated prior to the planting season based upon expectation of the agricultural and economic factors that the farmer will face during harvest when they receive revenues from their crops. These expectations are unobservable to the econometrician and may pose an errors-in-variables problem if these expectations are correlated with $u_{i,t}$. The errors in variables problem will affect γ estimates and present attenuation bias where the estimated coefficient is closer to 0.

The effects on β are less obvious as $Tax_{i,t-1}$ does not suffer from an expectation due to the timing of the tax bill. Mismeasured X variables does not present a bias of estimating β as long as the expectation error is not correlated with the $Tax_{i,t-1}$ – which is unlikely as the tax is a lagged value and expectations deal with future expectations. However, inclusion of X is necessary in order to correct for potential omitted variable bias that may arise from correlation of $Tax_{i,t-1}$ and the X.

Data

Cash rental rate per acre of farmland for each county in Ohio is provided by the June Area Survey conducted by USDA-NASS. The series begins in 2008 with a partial set of counties (64 of 88), then the full range of counties from 2009 until 2014 plus 2016 and 2017. Rented acreage for each county is only available for Agricultural Census years, which occur once every 5 years with the most recent reported values being the 2012 Census. With the unit of analysis being an arbitrary unit of a county, the rented acreage is a necessary component to weight regression coefficients via the rented acreage in order for coefficient interpretations to be per rented acreage. Figure 4 displays the distribution of cash rents over time for Ohio, which implicitly highlights the soil productivity across the state. The western portion of Ohio tends to have better soil quality than the foothills across the Appalachian mountains on the eastern portion and is partially reflected in rents.

The main variable of interest is agricultural property tax paid per acre of farmland with particular emphasis on how it affects the cash rental rate. ODT provides county level values for total CAUV assessed value, the number of acreage enrolled in CAUV, and the net millage rate. Net millage rates are found in table PR6

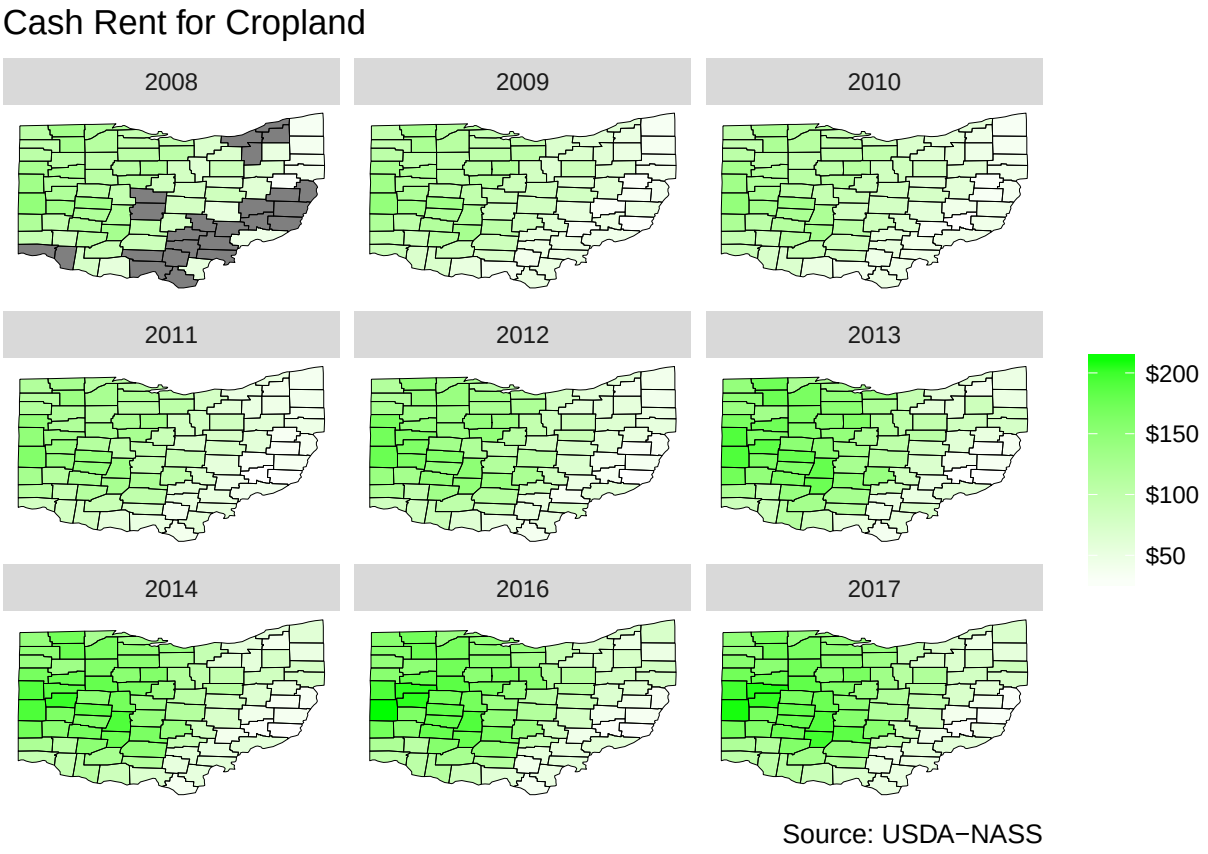
Cash Rent for Cropland
2008
2009
2010
2011
2012
2013
2014
2016
2017
$200
$150
$100
$50
Source: USDA−NASS

Figure 4:

while the other information is from table PD32. The average property tax paid for a county is defined as 35% of the total CAUV value divided by the number of acres enrolled and multiplied by the millage rate. The overwhelming majority of farmland in Ohio is enrolled in CAUV and it may be the case that more land is enrolled in CAUV than farmable per Prindle (2014). The process of calculating CAUV is described further in the next section to better understand its complexity and backwards nature. In short, the factors affecting CAUV calculation are soil quality, commodity costs/prices/yields, and interest rates – with the non-time-invariant factors reflecting past values of each factor. As our unit of analysis is the county, the property tax due per acre is an average value and all analysis throughout is based off of county level estimates. A farmer level interpretation of results is not appropriate due to data limitations.

The general economic factors affecting cash rental rates boil down to expected revenues (commodity prices and/or potential yields of the land), expected costs of production, the land owner's opportunity cost of putting the land on the rental market, and the renter's opportunity costs. Table 1 provides summary statistics for the variables utilized to control for these factors as well as cash rental rates and property taxes across the period of interest in Ohio (2009 to 2014). In order to account for any potential inflationary issues, which Moss (1997) indicates that inflation is the largest contributor to explaining farmland valuation changes, all financial values are converted to 2016 dollars through the GDP deflator.

Two measures of soil quality are calculated in order to account for expected revenues since price data on crops across Ohio are only available at the state level.[2] USDA National Resources Conservation Services (NRCS) provides a productivity index of soil types as well as county level values of acreage for each soil type which ranges from 0 to 100. An average productivity index of soil quality type is constructed from this data with each soil type weighted by its respective acreage in a county. Average productivity index is a time-invariant component which would be absorbed in any fixed effects model. As an alternative for a variable related to soil quality that varies over time, an effective soil quality index is constructed with knowledge of the total planted acreage of crops for a county in Ohio. Soil types are arranged in order of productivity index – based upon total acreage planted for corn, soybeans, and wheat – and a weighted averaged based on total planted

[2]Historical elevator grain cash bid prices in Ohio is not readily available. It is also not clear how a county level price index would be calculated from elevator grain prices across the state.

Table 1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Cash Rent (per acre)	528	101.60	43.76	24.58	205.89
Property Tax Owed (per acre)	528	15.51	12.16	1.80	83.86
Average CAUV (per acre)	528	871.48	530.05	126.24	3,389.55
Total Acreage of Farmland	88	158,643.20	75,308.86	2,608	339,981
Total Rented Acreage	88	59,330.74	37,642.87	302	139,269
Average Productivity Index	88	68.27	7.83	53.37	80.79
Effective Productivity Index	528	76.32	4.18	61.86	87.56
Government Payments (per acre)	528	25.23	14.18	0.21	57.72
CRP Acreage	528	3,864.10	5,300.07	0.00	29,205.10
CRP Payments (per acre)	528	97.59	45.19	0.00	217.58
Nonland Expenses (per acre)	528	275.04	467.34	36.99	6,071.47
Population	528	116,266.80	187,952.80	10,488	1,133,523
Population Density (per square mile)	528	258.81	413.84	25.65	2,479.33
Unemployment Rate (in percent)	528	0.09	0.03	0.05	0.17

All counties in Ohio from 2009 to 2014. Financial data converted to 2016 real dollars with the GDP deflator.

acreage is constructed from the ordered soil types. The variation in planted acreage for counties creates a time-varying component that can be utilized in a county fixed effects context.

Another potential source of revenues include government payments on cropland, data on which is provided by the Environment Working Group at the county level from 1995 through 2016. Government programs that made potential payments across 2009 to 2014 can be generally grouped in terms of commodity, conservation, crop insurance, and disaster subsidies. The total payments less conservation payments are aggregated at the county level and divided by total acreage to provide an estimate for government payment per acre of agricultural land. As a cross check and to correct for potential expectation of government payment bias concerns, a four year average of previous year's government payments are also constructed per Goodwin et al. (2011) to alleviate concerns about government payment expectations.

Conservation payments – largely from the Conservation Reserve Program (CRP) – are not included in government payments because land in a conservation program cannot be farmed and thus not in the rental market. However, CRP does have an affect on the rental market because land in the conservation reserve program is taken off the market for 10 to 15 years at a time. For land to qualify for CRP, the land must be environmentally sensitive land which generally implies land of lower soil productivity. Enrollment into CRP is optional and induced by payments for removing cropland from production. Agricultural land in CRP is also eligible for CAUV treatment.[3] Total acreage enrolled affects the available land in the rental market and the total acreage is influenced by the payment rate for CRP enrollment – although the CRP payment rate is partially determined by a county's average cash rental rate. Therefore, both acreage enrolled in CRP divided by total farmable acreage in a county as well as the CRP payment rate are potential variables affecting both cash rental rates and average CAUV value in a county.

Expected costs of production at the county level is estimated using the Bureau of Economic Analysis Regional Data table CA45 – Farm Income and Expenses. Total production expense data are available for each county across Ohio since 1969 and this component includes costs associated with feed, livestock, seed, fertilizer and lime, petroleum products, hired labor, and other costs (depreciation, interest, rent, and taxes). To accurately

[3]Prindle (2014) notes that in 2012 a court case in Ohio caused some parcels enrolled in conservation programs to be disqualified from CAUV because the land was not in active commercial agriculture.

reflect the costs associated with the average rented acre of cropland that are associated with crop production we include total seed, fertilizer, and lime costs for each county and divide this amount by total cropland acreage for the county.

And finally, urbanization pressure affects the land owner decision to offer their land in the agricultural rental market or potentially convert the land to commercial or residential development. Urbanization effects is proxied with the unemployment rate and population. The Bureau of Labor Statistics (BLS) provides annual data on county level unemployment rates – which largely reflect the profitability of non-agricultural economy. We use Internal Revenue Service (IRS) tax return data for yearly county level values of population and divide by the land area of the county. Population density provides a continuous measure related to urbanization pressures and are preferable to alternative options such as urban-rural dummy variables. Urbanization pressures induce land to leave the agricultural rental market, which puts upward pressure on cash rental rates and increases the average CAUV value for a county since marginal land is more susceptible to conversion.

CAUV Overview

In 1974, Ohio enacted the Current Agricultural Use Value Program (CAUV) as a tax incentive for farmers to continue agricultural production on their land instead of selling it due to urbanization pressure. CAUV provides an appraisal method for valuing agricultural land by use of only agricultural inputs rather than the market value of land (Jeffers and Libby, 1999). Throughout the 1970s, other states adopted similar programs of differential appraisal methods of agricultural land in the same vein and, as of 2014, all 50 states within the US provide some sort of differential tax treatment of agricultural land (Sherrick and Kuethe, 2014). While each state has its own impetus for enacting preferential tax treatment and its particular calculation, the intent behind differential taxation is generally understood as applying a net present valuation of agricultural production that is not tied to potential urbanization development pressures. Ohio is no different and has developed its own calculation method that depends on soil quality, commodity yields/prices/rotation, operational costs, and capitalization rate. The basic premise has been in place since the late 1970s although the program has become more sophisticated and received substantial updates in 2006, 2015, and most recently

in 2017 that have affected the calculation of CAUV (Shaudys, 1980).

No matter what a farmer produces, their CAUV value is determined solely off of their soil quality and a formula from ODT which attempts to represent the expected market value for an average farmer in Ohio. For each of the over 3,500 soil types (s) in Ohio, a particular year's (t) CAUV value is calculated as the soil's net income divided by the capitalization rate:

$$CAUV_{s,t} = \frac{NOI_{s,t}}{CAP_t} \tag{4}$$

where CAP_t represents the capitalization rate and $NOI_{s,t}$ represents the net operating income. Prior to 2015, the capitalization rate was based on a 60% loan and 40% equity appreciation with interest rates for each value based on a 7-year Olympic average[4] where the value for the loan interest rate came from a 15-year mortgage from Farm Credit Services (FCS) and the equity interest rate was the Federal Funds rate plus two percentage points. For the 2015 tax year, the capitalization rate changed to an 80% loan (based on 25-year mortgage from FCS) and 20% equity appreciation. Then in 2017, ODT changed the interest rate used for equity appreciation to the 25-year average total rate of return on farm equity from USDA-ERS. The capitalization rates used by the ODT in CAUV calculations since 2003 are displayed in table **??**, which shows a steady decline until the change in 2015.

Table 2: Source: Ohio Department of Taxation

Tax Year	Capitalization Rate
2003	9.2%
2004	9.0%
2005	8.6%
2006	8.5%
2007	8.4%

[4]An Olympic average is a simple mean with the highest and lowest value removed from calculation. If the values are 1, 3, 4, 5, 6, 7, and 100, then the simple mean is 18 while the Olympic average is 5.

Tax Year	Capitalization Rate
2008	8.3%
2009	7.9%
2010	7.8%
2011	7.6%
2012	7.5%
2013	6.7%
2014	6.2%
2015	6.6%
2016	6.3%
2017	8.0%

Net operating income captures the average returns to an acre of land under normal management practices which is adjusted by the state-wide rotation pattern of crops. This is defined as:

$$NOI_{s,t} = \sum_{c} w_{c,t} \times (GOI_{s,c,t} - nonland_{s,c,t}) \tag{5}$$

where c denotes the crop type, which is either corn, soybeans, or wheat[5] which represent the dominant crops in Ohio and $w_{c,t}$ is crop's share of state production. Each crop's share of state production is based off of a 5-year average of total production between the three crops – the weights always sum to 1. The non-land costs are represented by $nonland_{s,c,t}$, which are calculated as 7-year Olympic averages for typical costs of producing each crop. The Department of Agricultural, Environmental, and Development Economics' extension office at The Ohio State University conducts annual surveys for costs of production which serve as the yearly estimates that go into the 7-year Olympic average. Prior to 2015, the values in $nonland_{s,c,t}$ were lagged one year – i.e. tax year 2014 used the values from 2007 to 2013. From 2015 onward, the current year

[5]Prior to 2010, hay was used in this calculation but never represented more than 5% of the rotation. Hay was dropped in 2010 due to unreliable estimates of prices and yields due to a lack of formal markets throughout Ohio.

values are included in the $nonland_{s,c,t}$ calculations.

Gross operating income, $GOI_{s,c,t}$, is based off of historical yields and prices for each crop. The gross operating income across each soil and crop types is defined as:

$$GOI_{s,c,t} = \frac{Yield_{c,Ohio,t}}{Yield_{c,Ohio,1984}} \times Yield_{c,s,1984} \times Price_{c,Ohio,t} \tag{6}$$

where $Yield_{c,Ohio,t}$ is a 7-year Olympic average for state-wide yields and $Price_{c,Ohio,t}$ is a 7-year Olympic average for state-wide prices. Prior to 2015, both yield and price were lagged two years in its calculation and yields were based on a 10-year Olympic average instead of 7-year. Since 2015, yields and prices only have one year lag and yields are now based on 7-year Olympic averages. Prices are based on USDA-NASS data and are weighted based on state production to further attempt to proxy revenues. The yearly crop prices since 1991 and values used in ODT calculations since 2006 can be seen in figure 5.

Each soil type has a corresponding base yield of production for each crop from 1984 – which is the most recent comprehensive soil survey for the state of Ohio (Zobeck et al., 1983). Prior to 2006, the ODT did not adjust for yield trends and calculated gross operating income for each soil type via their 1984 yields thus suppressing estimated revenues. ODT began adjusting for yield trends through the current method of taking the Olympic average of state-wide yields (irrespective of soil type), dividing by the state-wide yields for each crop in 1984, then multiplying this value based on the 1984 crop yield for the particular soil type evaluated. The scaling factor for all soils and crops is the same, thus the only difference in yields for a soil is due to their 1984 base yield. The state-wide yield trends for crops in Ohio can be seen in figure 6.

Effectively, every soil type throughout Ohio is assigned a CAUV value each year that is dependent on average corn, soybeans, and wheat revenues and costs over the previous 7 to 10 years. Soil types that have higher productive capacity – based on 1984 values – will have higher CAUV values than those with lower productive capacity. However, some soil types are relatively more productive with respect to one crop than the others; there is not a monotonic relationship across soil types ranking of CAUV values. Zobeck et al.

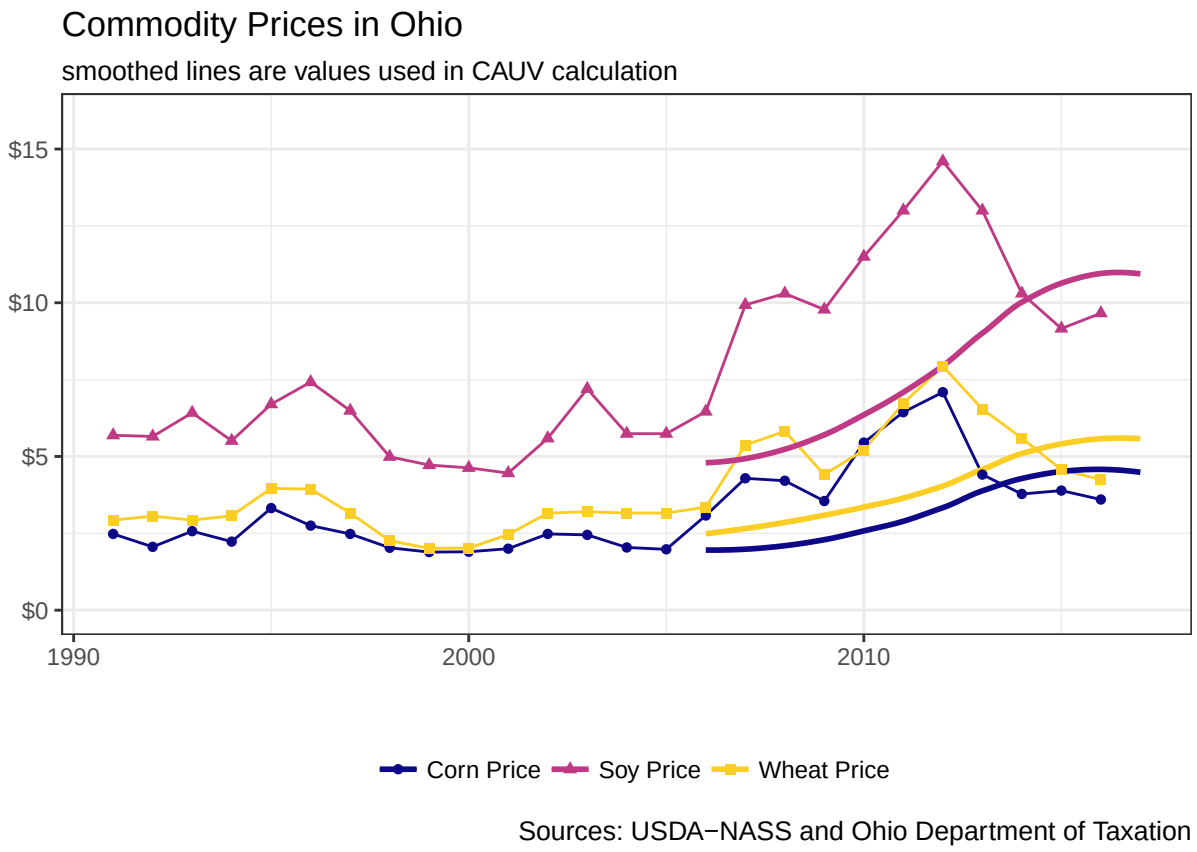
Commodity Prices in Ohio
smoothed lines are values used in CAUV calculation
$15
$10
$5
$0
1990
2000
2010
Corn Price
Soy Price
Wheat Price
Sources: USDA−NASS and Ohio Department of Taxation

Figure 5:

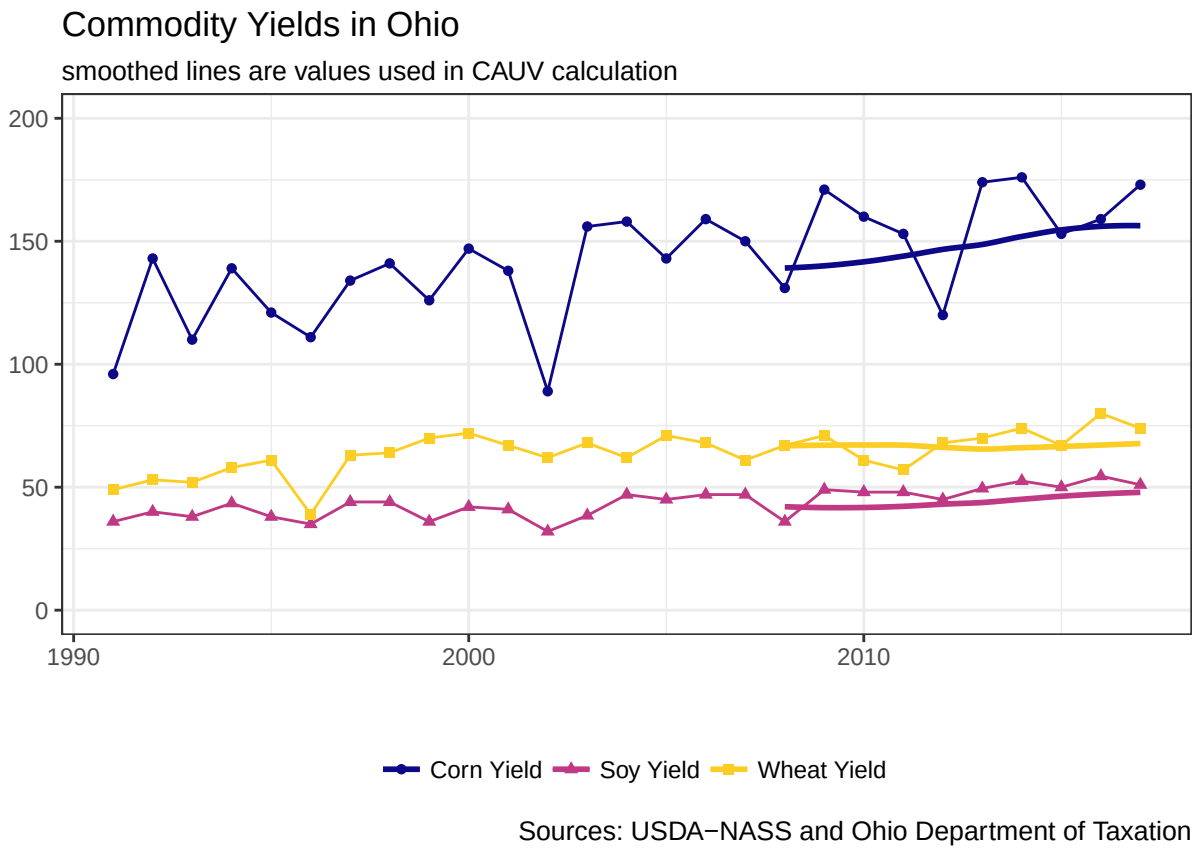
Commodity Yields in Ohio
smoothed lines are values used in CAUV calculation
200
150
100
50
0
1990
2000
2010
Corn Yield
Soy Yield
Wheat Yield
Sources: USDA−NASS and Ohio Department of Taxation

Figure 6:

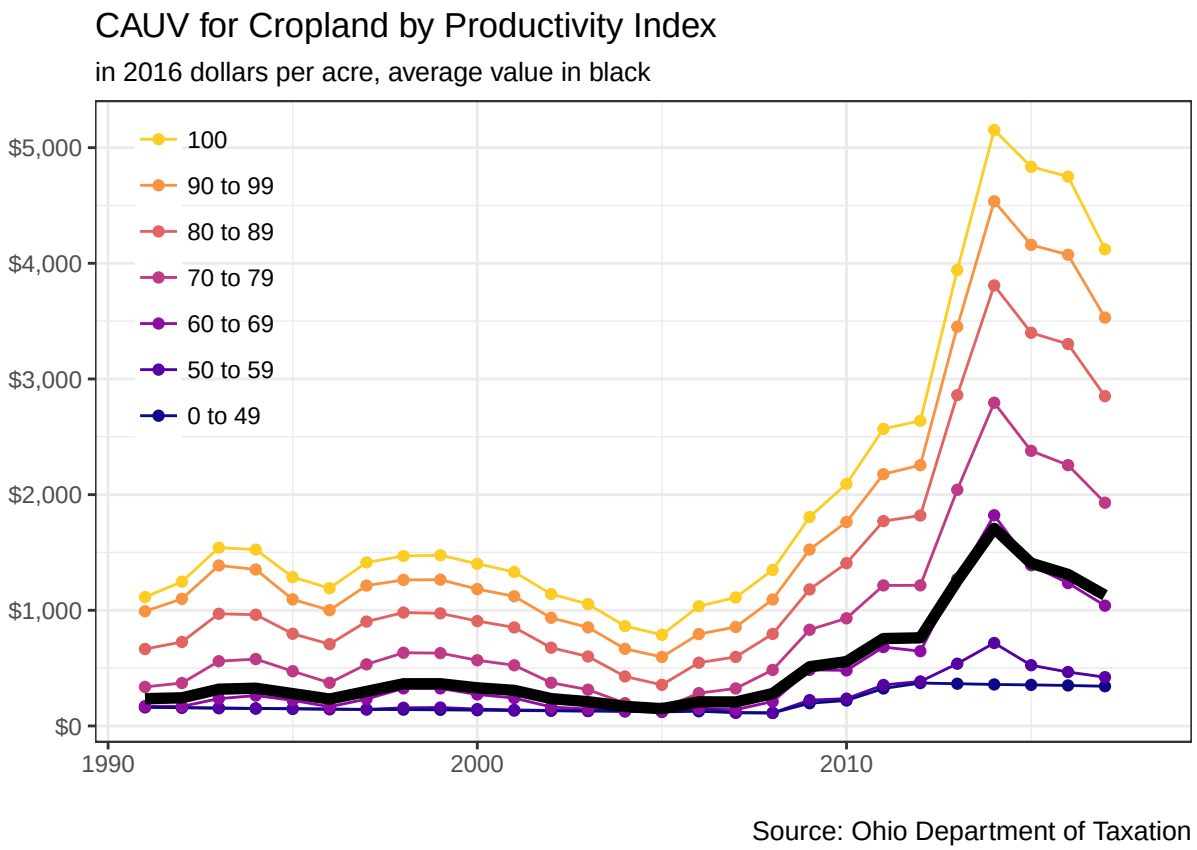

Figure 7:

(1983) provides a comprehensive soil productivity index for every soil type in Ohio based upon relative yields of corn, soybeans, wheat, oats, and hay across the state of Ohio. The index ranges from 0 to 100 and provides a barometer for how productive soil types across the state are. Figure 7 places soil types in bins according to their productivity index and plots the average CAUV value since 1991 to provide a range of CAUV values. ODT provides an additional mandate for a minimum CAUV value. Prior to 2009, this was $100 but the value subsequently rose to $170, $200, $300, and finally $350 in 2012.

The only factor that varies spatially in CAUV calculations is the soil types across Ohio. The central and western portions of Ohio are of high soil quality relative to the rest of the state while the Appalachian foothills along the eastern portion is of lower quality. Further utilizing soil productivity indexes, the acreage weighted productivity index of soil types for every county in Ohio is mapped in figure 8 and mimics the general trends of cash rental rate.

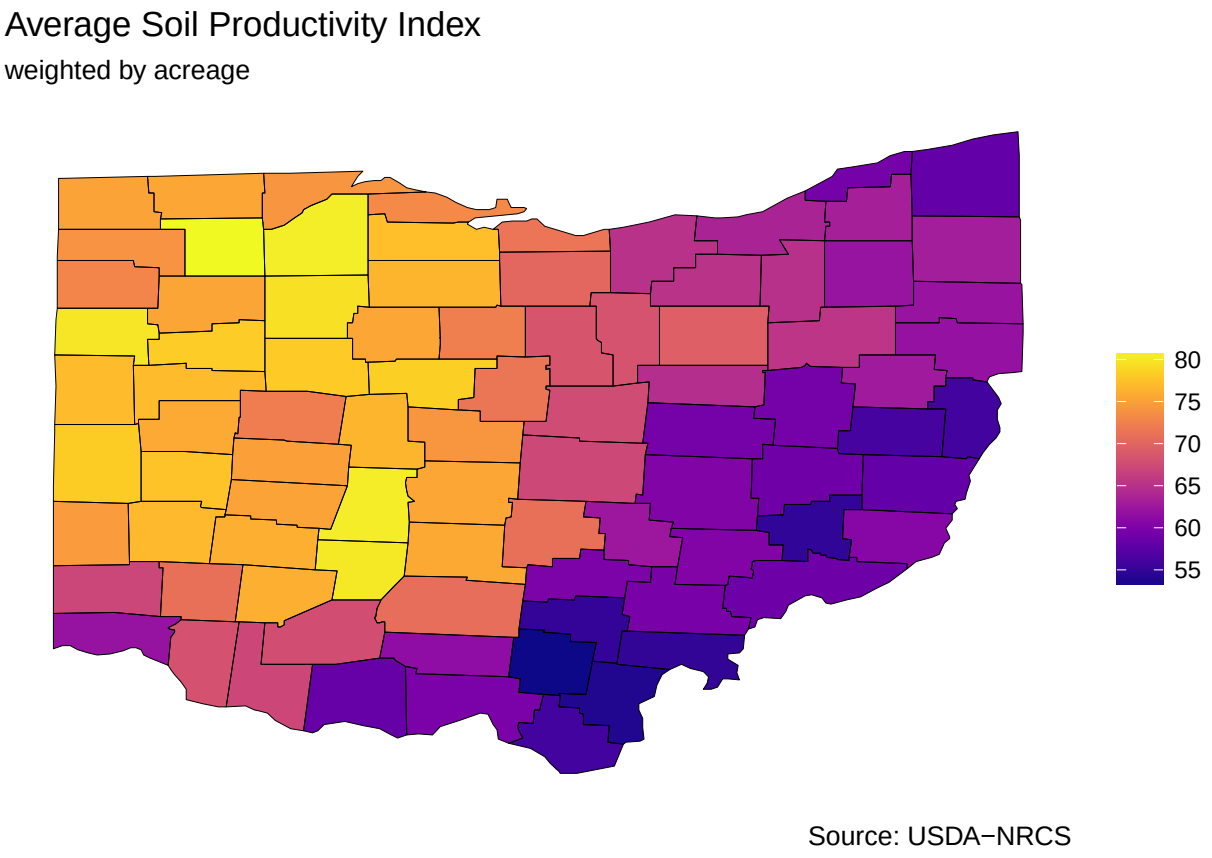
Average Soil Productivity Index
weighted by acreage
80
75
70
65
60
55
Source: USDA−NRCS

Figure 8:

For agricultural land to be eligible for CAUV, it must either be at least 10 acres devoted exclusively to commercial agricultural use or be able to produce more than $2,500 in gross average income. The general trend for the state of Ohio since the 1980s has been a steady increase in the total acreage enrolled in CAUV, although there have been declines in enrolled CAUV acreage for areas under urbanization pressure as farmland is converted to residential or commercial purposes. When a land owner decides to unenroll from CAUV for this purpose, they must pay a recoupment penalty that is equal to the CAUV tax savings for the previous 3 tax years – ie the difference in market value to CAUV. Prindle (2014) notes that it is not clear if ODT has maintained consistent data recording of recoupment penalties in order to assess extent to which land has been taken out of CAUV.

It is clear that the CAUV value for agricultural land across Ohio comes from non-market forces, ie the value is based off of past data and not current expectations. By and large, CAUV values are independent of planting decisions of farmers as the rotation pattern is part of the CAUV calculation and backwards looking as well. These two factors ensure that changes in CAUV value are exogenous to the rental market for crops in Ohio – changes in CAUV are driven by the update schedule and its current calculation based on the 7 to 10 previous years agricultural and economic factors.

Results

Table 3 displays four models involving cash rental rate regressed on property tax with varying level of fixed effects. Column 1 is a pooled regression, column 2 contains year fixed effects, column 3 contains county fixed effects, and columns 4 and 5 combines both year and county fixed effects. Column 4 contains all counties in Ohio from 2009 to 2014 while column 5 contains the subset of counties that contains data on cash rents from 2008 to 2016 except for 2015 when there is not estimate for cash rental rate at the county level in Ohio. Column 4 is considered our baseline and preferred model for estimating the property tax incidence. All standard errors reported are Huber-White standard errors to account for heteroskedasticity in results and are weighted by the reported total acreage of rented land at the county level per the 2012 Agricultural Census to

correct for varying agricultural production from the rental market.

Table 3: Panel Fixed Effects Models for Lagged Tax Incidence Effects

	Cash Rent per acre				
	(1)	(2)	(3)	(4)	(5)
CAUV Tax per Acre	2.417***	2.311***	1.991***	0.632***	0.389***
	(0.180)	(0.222)	(0.126)	(0.156)	(0.100)
County?	No	No	Yes	Yes	Yes
Year?	No	Yes	No	Yes	Yes
Observations	528	528	528	528	512
Adjusted R^2	0.311	0.315	0.910	0.948	0.942
Note:					*p<0.1; **p<0.05; ***p<0.01

The estimates of property tax incidence without controlling for time and county fixed effects highlights the substantial amount of variation in cash rents that are both time and spatially invariant. County fixed effects greatly influences the overall explanation in variation for cash rents as evidenced by the marked increase in adjusted r-squared to above 0.9. Column 4's estimate of 0.632 implies that for every additional dollar levied on an acre of agricultural land, a land owner is able to increase rents by an additional \$0.63. The counties which have cash rental rates in 2008 are counties with higher levels of rented production and suggests a smaller incidence of around \$0.38 per additional dollar of property tax.

However, these estimates potentially suffer from omitted variables bias insofar as some of the factors which affect the CAUV calculation are not controlled for by county and year fixed effects while these factors may also affect the cash rental rate. As such, table 4 progressively adds on additional agricultural and economic variables to explicitly control for these particular omitted variables with the final column including all of the

variables – all of which contain county and time fixed effects.

Table 4: Models for Tax Incidence Effects

	Cash Rent per acre							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CAUV Tax per Acre	0.636***	0.637***	0.640***	0.578***	0.609***	0.666***	0.612***	0.583***
	(0.155)	(0.155)	(0.156)	(0.153)	(0.158)	(0.163)	(0.160)	(0.165)
Effective Productivity Index	0.201							0.214
	(0.377)							(0.374)
Government Payments		−0.131						−0.157
		(0.150)						(0.148)
Share Enrolled in CRP			−368.141					−327.168
			(310.184)					(336.050)
CRP Rental Rate				0.358**				0.339**
				(0.158)				(0.157)
Nonland Costs					0.070*			0.068**
					(0.036)			(0.033)
Population Density						−1,683.129***		−1,390.363**
						(619.137)		(658.618)
Density Squared						540.502**		530.833**
						(213.469)		(231.285)
Unemployment Rate							−188.042***	−159.615***
							(57.923)	(56.252)
Observations	528	528	528	528	528	528	528	528
Adjusted R^2	0.948	0.948	0.948	0.949	0.949	0.949	0.949	0.951

Note: *p<0.1; **p<0.05; ***p<0.01

Across all model specifications, the estimated property tax incidence rate is robust to inclusion of other factors. None of the individual factors reduce the estimated incidence below $0.57 or above $0.67 which confirms what is largely known after understanding the CAUV formula – that CAUV calculation is largely independent of current market factors affecting cash rental rates.

Of potential interest is that the results for government payments are null results except for the CRP rental rate. This result is in contrast to previous research which has largely determined that government payments

lead to a significant increase in the cash rental rate (Goodwin and Ortalo-Magné, 1992; Hendricks et al., 2012; Kirwan, 2009; Roberts et al., 2003). Results presented in table 4 for government payments do not account for potential endogeneity concerns arising from the difference between *expected* government payments and *actual* government payments aside from using the lagged value of government payments. Goodwin et al. (2011) suggests using average payments over the previous 4 years. Table 5 presents 4 models which increase the number of previous years used to average the government payments. Each model includes county and year fixed effects for the full set of Ohio counties from 2009 to 2014.

Table 5: Models for Tax Incidence Effects – Government Payments

	Cash Rent per acre			
	(1)	(2)	(3)	(4)
CAUV Tax per Acre	0.637***	0.624***	0.618***	0.633***
	(0.155)	(0.157)	(0.157)	(0.157)
Government Payments	−0.131			
	(0.150)			
Average Payments for 2 Years		0.233		
		(0.234)		
Average Payments for 3 Years			0.617**	
			(0.304)	
Average Payments for 4 Years				−0.238
				(0.321)
Observations	528	528	528	528
Adjusted R^2	0.948	0.948	0.949	0.948
Note:				*p<0.1; **p<0.05; ***p<0.01

The average government payments per acre over the previous 3 years appears to be the only significant effect found, although the finding is only significant at the 5% level and all other versions are not significant. The government payments involve a mixture of types of programs but spans the end of the Farm bill through most of the 2008 Farm Bill. The imprecise nature of estimating the expectation of farm payments – and accounting for how expectations changed with the passage of the 2008 Farm Bill – may not be a sufficient measure for covernment payments. However, these expectation changes are only relevant for this study insofar

as expectations may be correlated with the property tax paid per acre. The various averaging of government payments do not greatly affect the estimate of property tax incidence.

Conclusions

Within Ohio, estimation of property tax incidence appears to indicate a roughly equal dispersion of the burden for tax increases as owners appear to be able to increase the cash rental rate by between $0.38 and $0.63 for each additional dollar of property tax paid. These effects are largely independent of market forces that affect the assessed value of property and the value of farmland due to the unique differential tax treatment in Ohio for agricultural land. Even while controlling for known factors that affect the cash rental rate, the estimated property tax incidence remains robust to their inclusion which highlights the exogeneity of Ohio's differential tax treatment.

As the average property tax levied on an acre of land rose from $9 in 2009 to $33 in 2014, a rough back-of-the-envelope calculation from the models implies that cash rents would rise by approximately $15 over this time due to the property tax changes. The corresponding observed change in cash rental rate over this time was $43. The increased burden of higher property tax is felt by renters, although the factor does not fully explain the observed increases.

That land owners cannot fully pass on the increased property tax onto renters indicates some degree of monopsony power of renters. Renters have multiple options for either operating land or other opportunities outside of farming that affords renters some leverage in negotiations of cash rent terms. However, the individual relationship of renters and owners cannot be adequately addressed within this study. While the macro effects of leverage for a renter exists across Ohio, this is an average effect and the cause cannot be addressed without an analysis of micro level data on renting relationships.

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