Preferential Agricultural Property Tax's Impact on Land Values
Abstract ID: P15889

Robert Dinterman, The Ohio State University - dinterman.1@osu.edu
Ani L. Katchova, The Ohio State University - katchova.1@osu.edu


Copyright 2019 by Robert Dinterman and Ani Katchova. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.
Preferential Agricultural Property Tax’s Impact on Land Values

Robert Dinterman∗

Ani Katchova†

2019-05-15

Abstract

Agricultural land in Ohio is taxed based on its current agricultural use value as opposed to its market value. Large-scale changes in the valuation formula for this method occurred in 2006 which triggered a much higher than anticipated increase in property taxes on farmland in Ohio. Using county level farmland values from the Agricultural Census since 1987, we estimate that the changes in CAUV formula had a small effect on reducing farmland values in Ohio.

Keywords: agricultural land, Current Agricultural Use Value Program, tax capitalization

JEL Codes: Q14, Q15, Q18

∗The Ohio State University
†The Ohio State University
Introduction

The total value of farm real estate assets accounts for 83 percent of 2018 farm sector assets, per the most recent farm income forecast from the Economic Research Services of the USDA, which makes farmland the single most important asset for a farmer. There is a rich literature which addresses the factors affecting farmland values which range from agriculture related factors, to urbanization pressures, to government subsidies, to ethanol plant openings (Weersink et al. 1999; Kropp and Peckham 2015; Zhang and Nickerson 2015; Li, Miao, and Khanna 2018). One aspect that has not received as much attention in the literature is the effects of property tax on farmland values, which has not been sufficiently addressed within the literature since the early 1980s when states were implementing new methods for assessing farmland for property tax purposes (Pasour Jr 1975; Chicoine, Sonka, and Doty 1982).

Estimating an effect of property taxes on farmland value is a difficult task. Endogeneity concerns arise when property taxes depend on farmland values – which would occur when the assessed value of a property is correlated with farmland value. While the vast majority of land and buildings across the United States are assessed in some fashion on recent sales transactions data, farmland in all states receives preferential tax treatment to reduce their assessed value (Anderson and England 2014). The way that a state reduces assessed value of farmland can range from a set percentage reduction (e.g., Georgia assesses at 30 percent of property’s fair market value instead of 40 percent), a capitalization estimation of surveyed cash rents (e.g., California uses typical rental income divided by a corresponding yield rate from the Fed), and even capitalization of a defined net income (e.g., Illinois constructs expected income from average prices paid for agricultural products, production costs, and interests for the last 5-year period). Beyond the endogeneity concerns, a lack of change in the procedural aspects of taxing farmland poses an additional problem because there may not be enough variation in property taxes to be able to identify an effect on farmland values. Economic theory would indicate expected future property taxes are capitalized in farmland values and if property taxes are not changing or expected to change then variation in property tax would have limited explanatory power on changes in farmland values (Pasour Jr 1975).
Farmland in Ohio which qualifies for its tax preferential program, Current Agricultural Use-Value Program (CAUV), has an assessed value that only depends on the soil type and the previous 5-10 years data on crop prices, yields, and costs. Since soil types do not change over time, the assessed value for farmland enrolled in CAUV does not depend on forward looking factors which determine farmland values and only changes based on a rotating schedule for property reassessments in counties across the state on a three year basis. Ohio underwent large-scale changes in their CAUV values formula in 2006 and again in 2015 and 2017 in response to rural residential tax payers paying a disproportionate amount in taxes compared to farmers – the event in 2006 partially caused a rapid increase in farmland property taxes while the changes in 2015 and 2017 were responses to this increase. The CAUV program has provided farmers in Ohio with substantially reduced property tax valuations of their land than an alternative market based approach would as seen in figure 1.

The main variable of interest is the average property tax paid per acre of farmland, which is supplied at the county level from the Ohio Department of Taxation beginning in 1985 onward. Due to the rotating triennial update in CAUV values of farmland in Ohio, the 5 year sampling of farmland values from the Agricultural Census would ensure that the Agricultural Census year has a different set of counties updating in that particular year. We further control for agricultural production patterns, expected net farm income, urbanization pressures, and regional economic factors to account for potentially omitted determinants of farmland value. Preliminary results indicate a negative association between property tax paid and farmland values across the sample with an increase in this magnitude occurring after 2006 when the CAUV formula changed.

**Conceptual Issues**

A frequently used model for determining farmland prices is to start with an infinite-horizon present value model of farmland (Borchers, Ifft, and Kuethe 2014):

\[
V_t = \sum_{t=1}^{\infty} E_t[R_{t+i}] (1+r)^i
\]

Where \(V_t\) is the value of farmland at time \(t\), \(R_t\) is the returns to land in period \(t\), \(r\) is a constant discount rate, and \(E_t[\cdot]\) is the expectation operator at time \(t\). Without loss of generality, \(V_t\) and \(R_t\) can be thought of as per acre values. The formula can be thought of the present value of a future stream of income subject to a constant interest rate. Necessary components to deriving a value farmland would require be the expected returns and interest rate. In our narrow context of Ohio, capital markets are sufficiently fluid that the interest rate is constant across space but does vary over time. However, expected returns do vary across both time and space and can be defined as:

\[
R_t = P_t \times Q_t - C_t \times Q_t - Tax_t
\]
Where $P_t$ is an index of agricultural prices per acre, $C_t$ is an index of agricultural costs, $Q_t$ represents a yield which is correlated across yields and costs, and $Tax_t$ is the per acre property tax. These variables all of intuitive pressures on farmland through the rents on land: higher agricultural prices will lead to higher revenues and farmland values while higher costs or property taxes will reduce revenues and put downward pressure on farmland values. Our goal is to provide an estimate for the tax capitalization – the decrease in the value of farmland due to an increase in the property tax paid per acre of farmland or vice-versa.

**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 using 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 reason 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 (Anderson 2012). Ohio developed its own calculation method that depends on soil quality, crop 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).

The taxable value of class I real (residential and agricultural use) 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.\footnote{In 2017, half of the counties received updated CAUV values while in both 2016 and 2015 a quarter of the counties received updated CAUV values.} 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, landowners know their CAUV values for the current and following two years but the CAUV value is not known until after the taxable year because of the backwards nature of CAUV calculations. Tax bills for a given calendar year are fully paid by the landowner around the middle of the next calendar year.

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. 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.

Specific details on the calculation of the CAUV value in Ohio can be found in the appendix, but from a practical perspective it is the CAUV values which determine the taxable value of farmland in Ohio and this is
the main variation to identify effects of property tax changes on farmland values. As the CAUV values only vary by soil type and year, Zobeck, Gerken, and Powell (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 3 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. There is a clear uptick between 2005 and 2006 which represents the first major change in the CAUV formula by adjusting for yield trends. The next change was in how the capitalization rate was calculated in 2015, which was likely due to the rapid increase in CAUV values that farmers started to experience from the 2006 changes.

Initially in 1974, the requirements for agricultural land to be eligible for CAUV was that it must either be at
least 30 acres devoted exclusively to commercial agricultural use or be able to produce more than $2,500 in gross average income – although the acreage requirement was reduced to 10 acres in 1992. The general trend for the state of Ohio since 1980 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 landowner 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 – i.e. the difference between market value and CAUV. This recoupment period was initially set to 4 years in 1974 but was further reduced to 3 years in 1992. Prindle (2014) notes that it is not clear if ODT has maintained consistent data recording of recoupment penalties in order to assess the extent to which land has been taken out of CAUV, although county level values of acreage enrolled in CAUV does not substantially change for any county.

Regression Framework

We start with a naive estimate of farmland values against property tax for all counties in Ohio:

\[ \text{Farmland}_{i,t} = \alpha + \beta \text{CAUVTax}_{i,t-1} + u_{i,t} \]  

Where \( \text{Farmland}_{i,t} \) is the average value of farmland per acre in county \( i \) in year \( t \) and \( \text{CAUVTax}_{i,t-1} \) is the average property tax per acre of land in county \( i \) for year \( t - 1 \) – which is consistent with the timing of the tax bill for a landowner. The average property tax capitalization for an acre of farmland is represented by \( \beta \).

Property taxes are positively affected by past values of soil quality, yields, and prices and negatively affected by costs and interest rates – which is described in more detail in the data section\(^2\). Because many of the factors affecting property taxes are either time or spatially invariant, our preferred specification for dealing

\(^2\) Agricultural property taxes paid are not a function of income because CAUV is independent of current and expected market forces. If property taxes were based on a market value approach – as are most forms of property tax assessment – then simultaneity would be a concern as the market value of agricultural land is partially determined by expected returns to the land. The independence of market forces and agricultural property taxes paid is evident in reviewing the formula used in CAUV value calculation.
with omitted factors affecting rent and property tax is to provide a fixed effects estimator for time and county fixed effects:

\[
Farmland_{i,t} = \alpha + \alpha_i + \alpha_t + \beta CAUVTax_{i,t-1} + u_{i,t}
\]  

(2)

Where \(\alpha_i\) represents county fixed effects and \(\alpha_t\) represents time fixed effects. County fixed effects capture any time-invariant factors, which mostly proxy for soil quality and long-standing agricultural practices or policies in place at the county level. The time fixed effects include shocks due to prices, costs, interest rates, and weather events.

If there are factors which vary across time and space that affect both farmland values and the property tax paid on farmland, then equation 2 does not provide a consistent estimate of the property tax capitalization rate, \(\beta\). To correct for this, we introduce several factors to correct for omitted factors which would affect both farmland values and the CAUV formula:

\[
Farmland_{i,t} = \alpha + \alpha_i + \alpha_t + \beta Tax_{i,t-1} + \gamma X_{i,t} + u_{i,t}
\]  

(3)

Inclusion of these agricultural and economic factors in a matrix, \(X\). While data on agricultural and economic factors affecting rental rate and property taxes have limitations – described in the following data section – inclusion of relevant economic factors can be incorporated into the estimation procedure as a robustness check of estimated property tax capitalization.

**Data**

The average value of farmland at the county level in Ohio is only recorded in years of an agricultural census. The Quick Stats database by the USDA provides county level census statistics for 1997 and onward, however
previous censuses are accessible from Haines, Fishback, and Rhode (2016) and hosted at the Inter-university
Consortium for Political and Social Research which provides information on county level farmland values in
Ohio. Figure 4 displays a snapshot of county level farmland values across Ohio for each agricultural census
since 1982. In Ohio, the most fertile soil is in the western part of the state while there are also three major
metropolitan cities: Cleveland, Cincinnati, and Columbus. The county for Cleveland is Cuyahoga county
and is consistently the highest valued farmland in the state in spite of not being a major agricultural center.
This is likely due to the urbanization surrounding Cleveland which puts upward pressure on farmland prices
(Zhang and Nickerson 2015).

The main variable of interest is agricultural property tax paid per acre of farmland as well as agricultural
property tax on buildings. ODT provides county level values for total CAUV assessed value, the number
of acres enrolled in CAUV, total taxable agricultural value, and the net millage rate. Net millage rates are
found in table PR6, the total taxable agricultural value is in table PD31, and the additional information is
The average property tax on farmland paid for a county is defined as 35% of the total CAUV value of all agricultural land divided by the number of acres enrolled in CAUV and multiplied by the millage rate. With all land that is enrolled in CAUV, ODT also tracks the assessed market value of this land and denotes these values in their PD32 table for each county. The purpose of tracking the assessed market value of land that is enrolled in CAUV is in order to potentially calculate the recoupment penalty.

However, the average property tax on buildings in agriculture is not explicitly available from ODT. Instead, it is imputed based on knowledge of a counties total taxable value of agriculture. Since CAUV only applies to the land, buildings on farmland is taxed at its market rate. With knowledge of each counties total taxable agricultural property value and the CAUV value in a county, the difference between these two values must be some combination of building on farmland and farmland which is not enrolled in CAUV. 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 according to Prindle (2014) which is where we rely on the difference between these two values to be the property tax on buildings in agriculture.

Figure 5 displays the time trends related to average property taxes paid in Ohio. The difference between the hypothetical tax on land at market value and property tax on land in CAUV is seen as the degree to which preferential tax treatment of agricultural land is in Ohio. In the 1980s, CAUV was approximately 30% of market value and eventually trended downward towards about 15% of market value in 2005. The CAUV changes in 2006 caused the ratio to increase above 50% in 2014 and represented a substantial increase in overall property taxes on farmland. As seen in the trend for property tax on buildings on farmland in Ohio, this has been a fairly stable component of property taxes with a slight upward trend since the 1980s.

**Controls**

The general economic factors affecting farmland include expected revenues (crop prices and/or potential yields based on soil quality), expected costs of production, and the landowner’s opportunity cost of keeping
Figure 5:

Agricultural Property Tax Trends in Ohio
in 2016 dollars per acre

Note: Majority of farmland in Ohio is enrolled in CAUV and thus not taxed at its market value.
the land in agriculture. Table 1 provides summary statistics for the variables utilized to control for these factors as well as farmland values and property taxes across the period of interest in Ohio (1982 to 2017). 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 using the GDP deflator.

A strong factor/predictor of expected revenues on farmland in Ohio is the soil quality. 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 these data with productivity for 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 a way to exploit cross-section and time varying components to account for changes in expected revenues, we utilize the finding from Zhang and Nickerson (2015) that finds that farmland in Ohio which is closer to ethanol plants receive a higher premium in sales. To control for this aspect, we control for the statewide share of planted corn acreage for each county. Our measure uses each county’s value of planted acreage for corn and divides it by the state acreage to account for statewide changes towards corn, which would be captured in time fixed effects, yet allows for variation across counties in Ohio.

Another potential source of revenues includes government payments on cropland, data on which are provided by the Environment Working Group at the county level from 1995 through 2017. Government programs that made potential payments can be generally grouped in terms of commodity, conservation, crop insurance, and disaster subsidies. The total government 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, Mishra, and Ortalo-Magné (2011) to alleviate concerns about government payment expectations.

Government payments from the Conservation Reserve Program (CRP) are not included in government payments but are included in the model. Payments for CRP are based on cash rental rates in a county as
a way to induce farmers to forgo farming on environmentally sensitive lands. The fraction of land in Ohio
enrolled in CRP is less than 2% of farmable land, which makes payments from CRP relatively unimportant.
However, the rental rates provided by CRP allows for a proxy on the expected revenues on an acre of land 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
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 landowner decision to use their land for agricultural production
by farming it, offering it on the farmland rental market or potentially converting the land to commercial or
residential development. Urbanization effects are 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 annual 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.

Results

Table 2 displays the gradual inclusion of county/time fixed effects and economic control variables in estimating
the impact of property taxes on farmland values in Ohio. Model 1 is a pooling model (without fixed effects)
with per acre tax on farmland and buildings plus the time-invariant productivity index control. Model 2 builds on model 1 by adding time fixed effects. Model 3 drops time fixed effects and the productivity index but adds in county fixed effects. Model 4 includes both time and county fixed effects. Model 5 includes both time and county fixed effects while introducing expected return controls with CRP rental rate, share of corn production, and nonland costs. And finally Model 6 introduces urbanization pressures with population density and unemployment rate as well as government payments but at the cost of the 1987 and 1992 observations due to government payments only being available from 1995 onward.

In models 1 through 3, which do not account for expected revenues or costs aside from soil quality, the coefficients on both property tax variables are significant and positive. This would indicate that increases in property tax correspondingly increase the value of an acre of farmland. These results likely arise due to omitted variables which are correlated with assessed value of buildings as well as the CAUV formula. In the context of the CAUV formula, this would be if previous values of returns influence current expectations which very well may be the case.

The coefficients related to capitalization of property tax values on models 4, 5, and 6 account for cross-sectional variation in expected returns and produce null results on the coefficients. This result could indicate that farmers do not consider property taxes when valuing their agricultural land, or this may also indicate that farmers have already capitalized the property taxes into the farmland values over the sample period of time.

**Post-CAUV Changes**

In the event that farmland buyers and sellers are rational and aware of expected property taxes, then the prices will currently reflect this information and identifying effects of property tax on farmland is difficult in the presence of fluid capital markets (Malkiel and Fama 1970). The sudden change in the CAUV formula in 2006 to adjust for yield trends in crops is a reasonable situation where the expectations of property taxes in Ohio changed drastically. Therefore, a dummy variable is introduced into the previous models for post-2006 and is further interacted with the property tax variables. If it is the case that there would be a time that
expectations in property taxes diverged and affected farmland values then it would be found post-2006 when it was harder to predict the

Table 3 reproduces the previous table of results and keeps the models consistent but with the addition of the dummy variable and interactions. The variables of interest are the interaction terms as they indicate divergence from previous expectations in property tax trends. And indeed, there does appear to be significant and negative effects on post-CAUV change property taxes.

Conclusions

Property tax on farmland in Ohio was a stable and fairly easily predictable value prior to 2006. Indeed, the formula’s initial intent was to approximate what would be the derived value on farmland solely from agricultural use. The pre-2006 calculation of CAUV values led to the situation that a farmer could estimate property tax with a fair amount of certainty due to the limited variables in the formula. There was little variation in CAUV values prior to 2006 and thus the largest amount of variation in property taxes for a farmer was based on the millage rates they were subject to (county, municipality, township) as opposed to any change in assessed value on farmland.

Our results indicate that, on the whole, there is no evidence of capitalization of property tax on farmland values in Ohio. This can be seen as the efficient market hypothesis functioning but also could potentially be from data constraints. If there is an effect of property tax capitalization in farmland values, it is difficult to identify with county level observations that are spaced out 5 years at a time. It is further difficult to identify this through surveyed data, which is how the agricultural census collects data on farmland values as opposed to transactional data.

However, there is a small effect of capitalization in property taxes in the expected direction after the changes to the CAUV formula occurred post 2006. While this is not strong support that property taxes are capitalized into farmland values, it does lead to the potential that there was a period in time that farmland valuation was
not totally in lined with the property tax and that capitalization does exist. But without more fine-scaled data, it is hard to pinpoint the degree to which capitalization may exist.
References


### Tables

#### Table 1: Summary Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmland Value (dollars per acre)</td>
<td>704</td>
<td>3,885.99</td>
<td>2,452.20</td>
<td>915.81</td>
<td>28,416.32</td>
</tr>
<tr>
<td>Property Tax on Land (dollars per acre)</td>
<td>2,988</td>
<td>13.45</td>
<td>13.73</td>
<td>1.66</td>
<td>105.61</td>
</tr>
<tr>
<td>Property Tax on Buildings (dollars per acre)</td>
<td>2,988</td>
<td>34.20</td>
<td>61.07</td>
<td>0.00</td>
<td>1,929.34</td>
</tr>
<tr>
<td>Average CAUV (dollars per acre)</td>
<td>2,988</td>
<td>791.75</td>
<td>649.77</td>
<td>126.22</td>
<td>3,818.88</td>
</tr>
<tr>
<td>Total Acreage of Farmland</td>
<td>704</td>
<td>163,662.50</td>
<td>74,654.03</td>
<td>2,248.00</td>
<td>350,450.00</td>
</tr>
<tr>
<td>Average Productivity Index</td>
<td>88</td>
<td>68.27</td>
<td>7.83</td>
<td>53.37</td>
<td>80.79</td>
</tr>
<tr>
<td>Government Payments (dollars per acre)</td>
<td>2,024</td>
<td>4,369,374.00</td>
<td>4,116,237.00</td>
<td>0.00</td>
<td>24,141,979.00</td>
</tr>
<tr>
<td>Rental Rate CRP (dollars per acre)</td>
<td>2,816</td>
<td>95.37</td>
<td>38.08</td>
<td>0.00</td>
<td>220.01</td>
</tr>
<tr>
<td>CRP Acreage</td>
<td>2,816</td>
<td>3,268.92</td>
<td>4,888.98</td>
<td>0.00</td>
<td>33,531.10</td>
</tr>
<tr>
<td>Share of Land Enrolled in CRP (as percent)</td>
<td>2,816</td>
<td>1.21</td>
<td>1.69</td>
<td>0.00</td>
<td>12.64</td>
</tr>
<tr>
<td>State Share of Planted Corn (as percent)</td>
<td>3,256</td>
<td>1.14</td>
<td>0.86</td>
<td>0.01</td>
<td>3.92</td>
</tr>
<tr>
<td>Nonland Expenses (dollars per acre)</td>
<td>3,168</td>
<td>239.64</td>
<td>704.51</td>
<td>22.79</td>
<td>12,739.91</td>
</tr>
<tr>
<td>Population</td>
<td>2,464</td>
<td>112,715.70</td>
<td>183,050.30</td>
<td>7,242.00</td>
<td>1,244,396.00</td>
</tr>
<tr>
<td>Population Density (per square mile)</td>
<td>2,464</td>
<td>251.39</td>
<td>406.58</td>
<td>18.20</td>
<td>2,721.84</td>
</tr>
<tr>
<td>Unemployment Rate (as percent)</td>
<td>2,464</td>
<td>6.90</td>
<td>2.48</td>
<td>1.75</td>
<td>17.28</td>
</tr>
</tbody>
</table>

Financial data converted to 2016 real dollars with the GDP deflator.
Table 2: Models for Tax Capitalization Effects - 1987 to 2017

<table>
<thead>
<tr>
<th>logged Farmland Value per Acre</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUV Tax per Acre</td>
<td>0.022+++</td>
<td>0.017+++</td>
<td>0.018+++</td>
<td>−0.002</td>
<td>−0.001</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.004)</td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>NonCAUV Tax per Acre</td>
<td>0.002+</td>
<td>0.002++</td>
<td>−0.001</td>
<td>−0.0004</td>
<td>−0.0002</td>
<td>−0.001</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Productivity Index</td>
<td>0.012+++</td>
<td>0.015+++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP Rental Rate</td>
<td></td>
<td></td>
<td>−0.0001</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.0005)</td>
<td>(0.001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government Payments</td>
<td></td>
<td></td>
<td></td>
<td>0.0004</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of State’s Corn</td>
<td></td>
<td></td>
<td>−0.024</td>
<td>0.075</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.032)</td>
<td>(0.047)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonland costs</td>
<td></td>
<td></td>
<td>0.0001+</td>
<td>0.0002+++</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population Density</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>−0.001+++</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0004)</td>
<td></td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td></td>
<td></td>
<td>−0.043+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.010)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>County FEs</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FEs</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>616</td>
<td>616</td>
<td>616</td>
<td>616</td>
<td>616</td>
<td>440</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.485</td>
<td>0.716</td>
<td>0.599</td>
<td>0.940</td>
<td>0.943</td>
<td>0.939</td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01
Table 3: Models for Tax Capitalization Effects - 1987 to 2017

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logged Farmland Value per Acre</td>
<td>0.741***</td>
<td>1.120***</td>
<td>0.661***</td>
<td>1.117***</td>
<td>1.085***</td>
</tr>
<tr>
<td>Post-CAUV Change</td>
<td>(0.044)</td>
<td>(0.075)</td>
<td>(0.043)</td>
<td>(0.043)</td>
<td>(0.048)</td>
</tr>
<tr>
<td>CAUV Tax per Acre</td>
<td>0.047***</td>
<td>0.059***</td>
<td>0.016***</td>
<td>0.009**</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>NonCAUV Tax per Acre</td>
<td>0.002</td>
<td>0.001</td>
<td>-0.0004</td>
<td>-0.00001</td>
<td>-0.00002</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.0004)</td>
<td>(0.0003)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>Post CAUV Tax per Acre</td>
<td>-0.035***</td>
<td>-0.044***</td>
<td>-0.008+</td>
<td>-0.008+</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Post NonCAUV Tax per Acre</td>
<td>0.001</td>
<td>0.001</td>
<td>-0.002***</td>
<td>-0.002***</td>
<td>-0.002***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.0004)</td>
<td>(0.0004)</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>County FEs</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FEs</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Economic Controls</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>616</td>
<td>616</td>
<td>616</td>
<td>616</td>
<td>616</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.684</td>
<td>0.782</td>
<td>0.834</td>
<td>0.949</td>
<td>0.950</td>
</tr>
</tbody>
</table>

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

CAUV Calculation

Regardless of the type of commodity a farmer produces (crops, livestock, aquaculture, etc.), the CAUV value for the land is determined solely based on its soil quality and a formula from ODT which attempts to represent the expected use-value of agricultural land 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 net operating income for this type of soil divided by the capitalization rate:

\[
CAUV_{s,t} = \frac{NOI_{s,t}}{CAP_t}
\]  

(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\(^3\) 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 exhibit a steady decline from 10% to 6% until the change in 2015.

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:

\[
NOI_{s,t} = \sum_c w_{c,t} \times (GOI_{s,c,t} - nonland_{s,c,t})
\]  

(5)

\(^3\)An Olympic average is a simple mean after removing the highest and lowest value.
where \( c \) denotes the crop type, which is either corn, soybeans, or wheat\(^4\) 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 on a 5-year average of total production among the three crops with the weights summing to 1. The non-land costs are represented by \( \text{nonland}_{s,c,t} \), which are calculated as 7-year Olympic averages for typical costs of producing each crop. The Ohio State University Extension conducts annual surveys for costs of production which serve as the yearly estimates to calculate a 7-year Olympic average for non-land costs.

Gross operating income, \( \text{GOI}_{s,c,t} \), is based on historical yields and prices for each crop. The gross operating income across each soil and crop types is defined as:

\[
\text{GOI}_{s,c,t} = \frac{\text{Yield}_{c,\text{Ohio},t}}{\text{Yield}_{c,\text{Ohio},1984}} \times \text{Yield}_{c,s,1984} \times \text{Price}_{c,\text{Ohio},t}
\]

where \( \text{Yield}_{c,\text{Ohio},t} \) is a 7-year Olympic average for state-wide yields and \( \text{Price}_{c,\text{Ohio},t} \) is a 7-year Olympic average for state-wide prices. Prices are based on USDA-NASS data and are weighted based on state production to further attempt to proxy revenues.

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, Gerken, and Powell 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.

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

---

\(^4\)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.
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.