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Abstract

The growth of the urban fringe is widespread throughout the United States, and is impacting many parts of the economy. Agriculture is of particular concern since fringe growth involves low-density development, and consumes a great deal of land relative to suburbanization. The impact of fringe growth on farm investment is considered using data collected from a survey of a random sample of Ohio farm producers. Our hypothesis is that farms in counties with fringe growth will exhibit decreased investment associated with the impermanence effect, or the premature idling of farmland due to urbanization pressures.

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Introduction

Agricultural producers in many regions throughout the United States are being impacted by the rapid expansion of the metropolitan fringe (Sharp and Smith; Libby and Sharp; Johnston and Bryant). This low population density urban expansion characterized by scattered development and limited planning has been so widespread as to be called the third major population shift in the U.S. since 1900 following urbanization at the turn of the century, and suburbanization after the second World War (Daniels).

Many researchers have argued that fringe growth is the result of improper incentives created by poor land-use policy that will have significant deleterious effects on the American political, social, and economic structure (Nelson). Others have questioned the significance of it's impact, particularly with respect to agriculture. Viewed in terms of total land-use, only 5% of Midwestern cropland were converted to other uses between 1947 and 1997 (Hart). That said, strictly viewing the issue in terms of aggregate land change is likely an oversimplification. One reason for this can be explained through what has become known as the 'Impermanence Syndrome', which argues that fringe growth indirectly impacts agriculture practices in a larger area surrounding actual new development (Berry).

The competitiveness of U.S. agriculture is a part of the economy that is likely to be affected by fringe growth, particularly in states like Ohio with a large population and extensive agriculture. The most obvious impact on agriculture is that much of the land being urbanized on the fringe of cities is or was used for producing crops or livestock. More importantly, it has been hypothesized that the impact goes beyond the direct removal of land from agricultural use. One example of an indirect impact is that producers near land that is being developed project that in the near future they will possibly sell their own land as land prices increase. As a result, they cease investment in their farm operation years before selling. Also, farm operations are disrupted by the new residential population living near their farm. Increased traffic or complaints about odor from say livestock operations reduces farming choices. These phenomena have been collectively termed impermanence because they cause producers to question the long term viability of their operation.

This study attempts to explore whether there was a detectable impermanence syndrome among Ohio farm producers resulting from development resembling fringe growth. The data used was taken from a survey of 818 Ohio farm operators constructed as a representative cross-section of those in the state. Hobby farmers earning less than $40,000 from farm operations a year were eliminated from the sample. Respondents were asked to provide a detailed description of their financial status. From this, two variables were created as measures of investment that would be impacted by an impermanence effect. These were capital intensity and capital structure. Capital intensity is a measure of the value of machine and buildings per unit of labor time. Capital structure is a variation of the debt-to-assets ratio.

Models and Results

The goal of this study was to see whether farms in counties possessing characteristics of low density urban expansion were exhibiting typical characteristics of impermanence. The ideal model to assess the impact of fringe growth on agriculture would likely involve spatial econometrics. Unfortunately, the need to pinpoint a location for each farm is problematic in our data set given that most operators farm multiple tracts of land that are often quite far apart. As a result, development pressures on farms had to be captured either at the township or county level. This lack of precision presents a major obstacle both in this study and most likely many others as will be discussed later.

As mentioned before, the impermanence variables created were capital intensity (CI) and capital structure (CS). CI is the value of machinery and buildings per unit of labor time. Labor time (LT) was normalized so that a 40 hour work week for 50 weeks a year would correspond to a value of 1. CI then provides a measure of the value of durable assets relative to the amount of labor being used in the operation. It would be expected that if a farmer is impacted by urban expansion they would invest less in new buildings or machinery and possibly use more labor to farm in congested areas with smaller, non-contiguous fields. Thus, as fringe development occurs, CI is hypothesized to decrease.

Capital structure (CS) is simply the debt-to-assets ratio, where only fixed assets are included, i.e., land, buildings, and machinery. We hypothesize that impermanence should be signaled by a decrease in the debt-to-assets ratio. In areas experiencing fringe development, rapidly rising land values would cause debt/asset ratios to fall, *ceteris paribus.* Also, due to impermanence, real estate owners may be less inclined to invest in machinery and buildings, and lenders may be reluctant finance that investment.

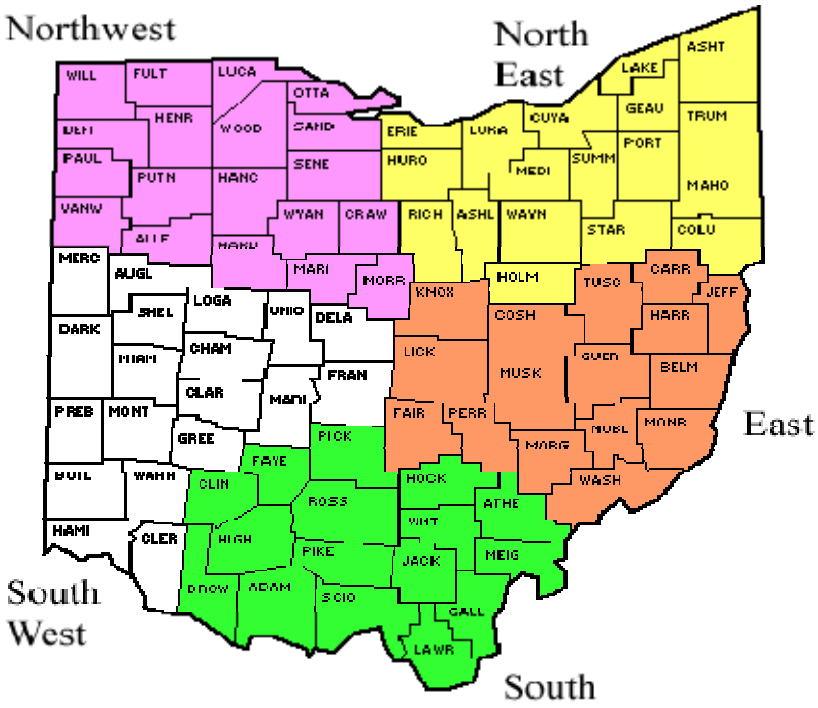
The explanatory variables were a mix of farm and operator specific variables and surrounding region characteristics. The farm specific variables were total tillable acres (totacres), proportion of farmed acres owned by the operator (owned/total), proportion of gross sales from livestock (livestock), number of years farming (experience), and education which is a binary variable equal to one for some post-secondary educational experience. Table 1 provides summary statistics of the values of these variables for the sample population. The mean producer owned about 60% of the land they farmed and leased the other 40%. The average farm operation was close to 500 acres.

Table 1. Summary of Farm Specific Variables of the Sample Population

	Mean	Std.Dev.
Owned/Total	0.595976	0.352758
Totacres	493.781	586.282
Education	0.350123	0.477301
Experience	32.0074	13.0475
Livestock	0.268084	0.382068

The fringe growth / urban pressure variables were township population density (density), percentage of acres in the county categorized as urban (urban), average county wage (wage), average county corn yield (yield), five binary variables for each of five Ohio extension districts in which the farm resides (extd1-5), and individuals per urban acre (IUA). Extension districts were included since types of production vary greatly in different regions of the state. These are shown in Figure 1. Township density provides a representation of more mature densely populated urban centers. Urban captures the extent of both urban and suburban development at the wider county level. IUA is the primary variable to capture fringe growth. A large percentage of urban acres in a county with a relatively small population, resulting in a lower value for IUA, would be a sign of low-density development. Thus, if there is an impermanence effect there should be a positive relationship between IUA and CI and CS. Impermanence would say that as IUA decreases, producers invest less in capital and CS would decrease. Given the nature of population and land-use statistics, and the rather flexible definition of fringe growth, the potential set of variables that could potentially be considered is quite large. This problem will be expanded on in the conclusions.

Figure 1. Regions Used in the Study



Capital Intensity

CI was analyzed using ordinary least squares. Regression results are shown in Table 2. The mean value for CI was $283,959/full time person. CI is predominately explained by farm and operator specific variables, rather than fringe growth / urban pressure variables. Parameter estimates for IUA, density, urban, and wage were all insignificant. Operators with more experience, which is synonymous with age generally, were less capital intensive. More educated farmers, those that owned a larger percentage of the land, and operators of larger farms in terms of acreage were more capital intensive. Capital intensity increases significantly in Corn Belt regions of the state, i.e., EXTD4 (southwest) and EXTD5 (northwest). The conclusion to be drawn here then is that the structure of fringe growth / urban pressure characteristics immediate to a farm have little or no impact on capital intensity, as is hypothesized; however, characteristics of the farm or producer are significantly related to capital intensity.

While not a central focus of this study, these results are interesting in respect to other pressing issues in Ohio agriculture. The percentage of farmland operated through a lease, as opposed to owner operated, has been steadily increasing in the state. These results show that operators that lease a lot of land and have larger operations will be more capital intensive. At the same time, the average age of agricultural producers has also been increasing, which here is related to decreasing CI. The tension between these two forces would be an interesting focus for a future study to understand the overall trend of CI in the state over time.

Table 2. Capital Intensity OLS Regression Results.

	Coefficient	Std.Err.	t-ratio	P-value
Constant	921039	534663	1.72265	0.085669
IUA	-41278.4	53048.3	-0.77813	0.43692
Density	-155.438	336.452	-0.46199	0.644321
Urban	530607	466433	1.13758	0.255926
Wage	-4.92974	9.1511	-0.53871	0.590369
Owned/Total	200541	87206.9	2.2996	0.021948
Yield	125.628	3625.37	0.034653	0.972373
Totacres	153.726	43.2036	3.56E+00	0.000415
Experience	-64795	8853.96	-7.31819	1.25E-12
ExSq	1006.02	125.653	8.00635	1.38E-14
Livestock	130472	82455.8	1.58232	0.114309
Education	103768	55787.3	1.86007	0.063557
EXTD2	134905	104019	1.29693	0.195349
EXTD3	77706.6	106521	0.729496	0.466094
EXTD4	260118	99728.7	2.60826	0.009417
EXTD5	175297	97126.5	1.80483	0.071799

Capital Structure

Of the 814 survey respondents, 454 filled out the debt financing section. Using a logit model to test for sample selection bias on farm or operator characteristics showed no sample selection bias as to who filled out this section and who did not. Because 138 of the 454 had no debt, a Tobit model was used with log-likelihood function:

$$\ln L = \sum_{y_i>0} -\frac{1}{2}\left[\log(2\pi) + \ln\sigma^2 + \frac{(y_i - x_i'\beta)^2}{\sigma^2} \right] + \sum_{y_i=0} \ln\left[1 - \Phi\left(\frac{x_i'\beta}{\sigma} \right) \right]$$

The model then takes on a two-step binary and continuous choice interpretation of first whether to take on debt, and if yes, how much. Of those who had debt, the mean ratio of debt-to-assets is 26%.

Results of the regression show that a mix of parameter estimates for farm and region characteristics are significant with respect to capital structure. Owned/Total was highly negatively significant. So, owning more of total acreage farmed corresponds to a decrease in debt-to-assets. Owned/Total is in decimal form (i.e., 0.05), and debt-to-assets are whole number percentages. Thus, the marginal effect of -15.246 for owned/total implies that for a 10% increase in the ratio of owned land farmed to total, there is a decrease in debt-to-assets of 1.5 percentage points for the average producer. Clearly, the more leasing a producer does, the more debt financing they are doing. A larger livestock operation was also related to more debt financing. The variable livestock was kept in decimal farm so the magnitude of the marginal effect is about half that of owned/total. A 10% increase in percentage of sales from livestock operations corresponds to a 0.64 percentage point increase in debt-to-assets.

Focusing on fringe growth / urban pressure variables, only IUA (individual per urban acre) is significant. For the 88 counties in Ohio, the range of values for IUA is from 1.14 to 4.7. An urban county, like Franklin County where Columbus is located, has a value of 4.6. Delaware county, which is often associated with fringe growth, has an IUA of 1.94. Unfortunately, IUA does not seem to be a wholly satisfying representation of fringe development. While a county like Delaware has a high IUA, so do very rural counties with little or no urban development. Since IUA is a ratio of population to urban acres, some of these rural counties, having both small populations and small amounts of urban acres, have a moderately large IUA.

The marginal effect for IUA is significant and negative at the 90% confidence level. A unit increase in IUA results in a decrease in debt-to-assets of 3.3 percentage points. Given that the range of IUA is 3.56, an increase of 1 person per urban acre represents a significant increase in the characteristics of a county. Thus, the magnitude of the change in debt-to-assets can be viewed as relatively small. Operators in counties with a higher value for IUA showed a decrease in debt-to-assets. Looking at differences in regions, there does seem to be more debt financing in the Southwest district.

In general, the results of the capital structure regression are somewhat surprising in the lack of significance of township density or urban acreage. Much has been made of the changes that more urban farms make in their production choices moving to higher value added crops. It would seem that these would be associated with changes in financing decisions, but that result is not borne out here.

Table 3. Capital Structure Tobit Regression Results

	Coefficient	Std.Err.	t-ratio	P-value	Marginal Effects	M.E P-Value
Constant	46.0877	25.629	1.79826	0.072136	31.38	0.0779
IUA	-4.83634	2.581	-1.87382	0.060955	-3.29	0.0676
Density	21.5085	21.8499	0.984372	0.324933	1.53	0.8857
Urban	0.0055006	0.01646	0.334192	0.738235	0.00359	0.7523
Wage	0.0003195	0.000426	0.749768	0.453395	0.00359	0.4962
Owned/Total	-22.1842	4.20427	-5.2766	<0.0001	-15.246	<0.0001
Yield	-0.14157	0.18015	-0.785845	0.431958	-0.094	0.4548
Totacres	0.0020509	0.002101	0.976302	0.328915	0.0014	0.3442
Experience	-0.0464158	0.416488	-0.111446	0.911263	-0.027	0.9238
ExSq	-0.0091867	0.00602	-1.52595	0.127023	-0.0064	0.1246
Education	3.907	2.68036	1.45764	0.14494	2.696	0.1431
Livestock	8.91834	4.01955	2.21874	0.026505	6.132	0.0267
EXTD2	-1.91675	5.22254	-0.367014	0.713609	-1.266	0.7254
EXTD3	5.29546	5.29964	0.999211	0.317693	3.613	0.3223
EXTD4	9.31673	4.82546	1.93074	0.053515	6.379	0.0549
EXTD5	5.26836	4.74687	1.10986	0.267059	3.691	0.2616
Sigma	25.2522	1.05431	23.9515	2.89E-15	0	<0.0001

Conclusions

This study investigated whether there was any sign of the impermanence syndrome signaled through the financial structure and investment behavior of farmers caused by low-density urban growth, also called fringe growth. The dataset was constructed from individual farm level data collected in a survey sent to a random sample of farmers across Ohio. CI was found to be determined by farm and producer specific variables, while CS was influenced by both farm and region characteristics. Both data limitations and the nature of the data itself presented a number of challenges to analyzing the impact of fringe growth on agriculture that present interesting questions for future studies.

Spatial models are promising in this line of research, but the data requirements are significant. Being able to use exact distances from farm to urban development is a more accurate measure than county level data. The distance from one corner of a county to another can be significant with respect to the impact of nearby urbanization. That said, the extent of farmland leasing poses a problem. Many operators farm two or more tracts that are often not in direct vicinity to each other. To condense an operators reach to a single location may require some difficult simplifications.

The question of representing fringe growth through explanatory variables is an even more challenging problem. The effort to refine the concept fringe growth has been successful at conceptually focusing a general trend in development that is the coalescence of a number of factors. The temptation then is to oversimplify it. There are a number of different factors that play into fringe growth with some being more important in particular parts of the country than others. Fringe growth is far from being a homogeneous concept. The implication of this is that a number of different variables could be included to represent fringe growth, which presents challenges in model specification. As mentioned earlier, while IUA (individuals per urban acre) does somewhat represent fringe growth it is not wholly satisfying given that very rural counties have values close to those counties experiencing this type of development. More specific land-use variables could be valuable additions. For instance, the average house lot size in the county might accurately represent a particular type of fringe growth.

A valuable first step for future studies would be to focus on particular aspects of fringe growth relevant to the area of study. In the Midwest, larger lot size is likely a central issue. In the Northeast, the impact of so-called fringe or edge cities developing on the outskirts of larger cities would be of greater interest.

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