Machinery Investment in Illinois:

A Study Examining Existing Investment Motivations

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Abstract

In this study, we attempt to prove some previously held ideas of machinery investment decisions using farm level data from Illinois. Investment decisions are analyzed taking into consideration past investment decisions in the county and on the individual farm. The results show there is a correlation between county level purchases and individual farm purchases and investment levels decrease the following year after an initial investment. These results display how non-traditional drivers for investment also play an important role in the investment decision.

Key words: machinery, investment, keeping up with the Jones', treadmill theory.

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Farmers choose to purchase machinery for various reasons. Technical as well as emotional factors can influence a farmer's investment decision. Technical factors may be along the lines of purchasing the new(er) machinery to acquire innovative technology. These purchases can lead to cost savings through more technologically advanced equipment which can lower costs or increase efficiency, or both. There can also be purchases due to the current financial status of the firm, such as purchases during good times to minimize tax obligations. Conversely, some reasons for investment are more emotionally based. Emotional grounds include the old adage 'keeping up with the Jones', as well as purchases due to the emotional ties an individual has to a specific brand of tractor or the feeling of owning or operating newer equipment.

This paper will examine two theories, one covering the technical side and one the emotional aspect and test them using farm level data from the Illinois Farm Business Farm Management Association (FBFM). The emotional aspect will reflect the "keeping up with the Jones'" framework in which farmers purchase machinery primarily to solidify the farmer's status in the community. This purchase may decrease costs due to increased leased acres or from lower repair costs, but the cost savings was an unintended benefit from the investment, not the cause for.

As with the technical area of investment investigated, this study will be looking at purchasing decisions based on recent investment decisions. This theory takes into consideration recent machinery investments. This hypothesis follows the treadmill theory from the first half of the century. Treadmill theory of the early part of the century showed how those who invest in new machinery take advantage of the efficiencies of the cost savings or increased returns from the new technology. The cost savings enabled those early adopters to expand their operation to a point where costs were equal to costs before the investment. This return to equilibrium often triggered another investment, thereby simulating a treadmill. This paper will look at the recent investments at the farm level and their affect on current investment. If this follows treadmill theory, one would presumably invest less in a year following an investment in newer technology.

This paper looks at how non-financial aspects of the farm can play an important role in the motivations for investment, specifically, what the neighbors do and what the individual farm has done recently, and how this impacts the investment decision. The findings from this study may help farmers and those involved in purchasing decisions at the farm level come to a better understanding of some otherwise overlooked investment theories, and their impact on the investment in question.

Relevant Literature

Recent studies have increasingly looked at cash flow as a predictor of farm level investment in agriculture (Barry, Bierlen, and Sotomayor; Bierlen and Featherstone). Both studies have cash flow as a relevant variable explaining investment with the former using it to explain land investment decisions while the latter used cash flow as a measure of machinery investment. While land and machinery are not the same in terms of length of use, they are comparable in terms of importance to the farm operation. Both studies also looked at how cash flow importance changed with different structural differences between farms. Barry, Bierlen, and Sotomayor looked at differences among age, credit score, and leverage, while Bierlen and Sotomayor also looked at age and leverage, along with a size component.

Other studies have looked at investment decisions based on other structural characteristics (Gustafson, Barry, and Sonka) and on taxation issues (Batterham and Fraser). Gustafson, Barry, and Sonka look at machinery investment based on tenure, age of machinery, and leverage based on a survey of Illinois farmers participating in the Illinois Farm Business Farm Management Association (FBFM). The study first asked farmers to form investment decisions based on expectations on commodity prices and yields. They were then asked to evaluate investment decisions based on three new policy introductions (market-oriented, tax reform, and interest buy-down). Results showed higher leverage resulted in decreased investment and conversely positively related to the age of the machinery complement of the farm.

While recent studies have focused on financial or structural issues relating to a farmers' investment decision, all investment decisions have their roots in net present value analysis where the expected cash flows from the investment are discounted back to a point in time. These different NPVs are then compared to each other and the investment is chosen if NPV > 0 in the case of one asset, or the largest NPV greater than zero when comparing multiple investment choices.

There have been some studies that have utilized NPV in their investment criterion. Batterham and Fraser examined the effects of taxation issues along with net present values of cash flows associated with tax incentives for investment. They concluded taxation issues are influential in the United States, the United Kingdom, as well as Australia. Reid and Bradford also looked at net present value in their paper using a multiperiod mixed integer programming model examining machinery and equipment replacement decisions regarding a beef operation and three different production systems.

While these previous studies have looked mainly at the investment decision based on financial factors, such as cash flow and profitability, this study will test the relevance of other important non-financial issues. By looking at financial and non-financial parameters, we can see if the investment decision is affected by these non-traditional factors.

Theoretical Models

In the framework of the two previously discussed models, the Jones' model, and the technology adoption model, machinery investment is the dependent variable. The key explanatory variables we will be looking at in the Jones' model are the mean county level cash machinery purchases, and the one-year lag of the county average of machinery purchases. We would expect this to have a positive correlation, due to the large area used for the comparison, but the magnitude of this variable may be difficult to predict for the same reason. The model can be expressed as

1) $CP = \alpha + \beta_1 COU + \beta_2 COU_{t-1} + \beta_3 CF_{t-1} + \beta_4 ROE + \beta_5 age + \beta_6 dta + \beta_7 acres$

2) $MPA = \alpha + \beta_1 MMPA + \beta_2 CF + \beta_3 ROE + \beta_4 age + \beta_5 dta + \beta_6 acres$

Where CP is cash purchases of machinery, COU is mean county machinery purchases, CF is cash flow, ROE is return on equity, age is age of operator, dta is debt to asset level, acres is size of operation in acres, MPA is machinery purchases on a per acre basis, and MMPA is mean county level machinery purchases on a per acre basis.

The technology adoption model again uses cash purchases of machinery and equipment as the dependent variable, but in a similar model we also use net machinery purchases as the dependent variable. In this model the main explanatory variables we will be looking at are the one-year lag of machinery and equipment purchases on the same farm. This model is different from the previous as the technology model only looks at purchases on the individual farm as factors for investment, not purchases at the county level. The technology model can be expressed as

1) $CP = \alpha + \beta_1 CP_{t-1} + \beta_2 CF_{t-1} + \beta_3 ROE + \beta_4 age + \beta_5 dta + \beta_6 mage + \beta_7 acres$

2) $NCP = \alpha + \beta_1 NCP_{t-1} + \beta_2 CF_{t-1} + \beta_3 ROE + \beta_4 age + \beta_5 dta + \beta_6 mage + \beta_7 acres$

Where CP is cash purchases of machinery, CF is cash flow, ROE is return on equity, age is age of operator, dta is debt to asset level, mage is age of machinery complement, and acres is size of operation in acres; NCP is net cash purchases of machinery (purchases minus sales).

Other variables used in these models are cash flow and return on equity, which we expect to be positive. Cash flow has been used in previous studies as a proxy for investment opportunity (Bierlen and Featherstone), and it also stands to reason if the farm has a positive cash flow, it has not only the opportunity, but the ability to make an investment. Return on equity is included for much the same reason. As a measure of the firm's ability to generate profits, firms with high returns on equity again have the ability to make investments in machinery. Also incorporated into this model was a leverage measure. Farms with higher leverage ratios would predictably not base much of their investment decisions on the actions of neighbor's as they should be aware of the financial constraints on their individual farm.

Other variables included which were more demographic were age of operator and size of the operation with regards to acres. Age of the operator was included as it can be used as a measure of experience or management. In this case we could expect a negative effect as investing for the sake of maintaining the farmer's status in the community is not seen as a wise reason for investment. Age could also effect the investment as older operators might not want to take on new investments as they come into the winter of their farming years. On the contrary, as the size of the operation increases, investments in machinery need to be made to help the operation run efficiently.

Data

Data for this study were obtained from the Illinois Farm Business Farm Management (FBFM) database, and was screened to include only grain farms with revenues greater than $40,000. The data go through a rigorous certification process to ensure its validity. Farms in the database from 1995-2002 were used for this study and were required to be in at least two consecutive years. The number of farms obtained from these requirements was higher than in previous studies which used FBFM data as this study did not require farms to maintain certification for the entire seven year period. A total of 16,332 farm-years were available for use, given the stated criteria.

The two models incorporated many of the same variables, but some which were only relevant to the specific model. In the Jones' model, the investment decision was based on the county average of cash purchases of machinery and equipment in the same year, and the one-year lag of the same variable. Purchases were also evaluated based on a flow measure (cash flow) and a profitability measure (return on equity). Leverage (debt to asset) was also included to ascertain the importance of this factor in the investment decision. Finally, age and size of the operation in terms of acres operated were included for robustness of the model. Per acre investment levels were also evaluated using cash purchases divided by acres and a county average level of the same variable.

In the technology model the purchase decision was based on many of the above factors, namely, age, debt to asset, cash flow, return on equity, and acres operated. The new variables for this model were the lag of own farm purchases, both net of cash sales, and strictly cash purchases, and an age of machinery variable. We used the same age of machinery variable as Bierlen and Featherstone (1998) where age of machinery is derived by taking the amount of machinery repairs divided by the total value of the machinery complement (we used market value as opposed to cost basis in computing this figure to eliminate the depreciation effect). In this scenario, a high number is equivalent to an older machinery complement and a small number is the same as a newer machinery line.

Summary statistics for the data are shown in table 1. Average farm size was just over 659 acres, and the average age of the farmer was 51 years. These farms also averaged just over $207,700 in machinery value which equates to an average of slightly over $314 per acre. The average farm earned a return on equity of 4.21%, achieved a net income of $42,920, and had an average cash flow of $17,117. The typical farm was not highly leveraged with the average debt to asset ratio being .323.

Results

In estimating the Jones' model, we first found the county average machinery purchases for each county, and then matched it to the individual farms by county. These values were then lagged in order to determine if there were any differences of magnitude caused by time. We then estimated the full models to determine the full effect of the different contributing factors in the investment decision.

In the first Jones model, we examined the effect of the mean county level machinery purchases on an individual producer's investment decision, and at the mean county level purchases from a year ago to determine if there was any difference with regards to time of the neighbor's purchase. We found considerable difference with regards to year as the same year county average has a coefficient of 0.967 and the lag of the county average has a coefficient of nearly zero. These numbers make considerable sense as if there is a time lag in the investment decision; the farmer is not really 'keeping up' if they wait a year to take action. The time lag also enables the farmer to reassess if the purchase is really needed, or even possible given the financial condition of the farm.

In the second model, we then examined if there was a difference in the investment decision if the purchases were based on a per acre basis. This was done to scale the purchases to better account for the size differential when comparing across farms. We estimated this model with individual farm purchases per acre as the dependent variable and county average purchases per acre as the main explanatory variable. The county average purchases per acre returned an estimate of 1.33.

Full results for the Jones' models can be examined in table 2. The other variables in the model returned mixed results. Age returned expected signs and significance levels in all models, and size returned expected results in model 1. In the second model when we examined purchases based on a per acre basis, the model returned a negative coefficient on size. This is telling us smaller farms are buying more equipment on a per acre basis than their larger counterparts. In essence, the smaller farms are purchasing larger equipment than they need, thus acquiring an overcapacity of machinery. It is these farmers who achieve the unintended benefits from the purchase when they are able to obtain more rental land to spread the additional fixed costs. They are able to farm the additional acres as machinery complements are increasingly being viewed as a proxy for a resume. In effect, the larger farms are investing in machinery correctly sized to their operation, while their smaller neighbors are buying larger machinery than they need to keep up.

The leverage variable (debt to asset) has a positive, significant coefficient in both models. This is contrary to theory as farms which are highly credit constrained are not seen as being so eager to take on any additional debt. Some reasons for this may be purchasing according to what the neighbors are doing is not seen as altogether wise, and purchasing when a farm is highly credit constrained equally not wise. We also did not say the purchase was made with the use of debt capital, which may cause the leverage component to increase due to the use of debt to finance part of the investment.

The cash flow variable returned unexpected results as it gave insignificant coefficients in both models. The causes for these results can be many. One possible explanation could be as this is seen as an emotional motive for investment cash flow might not play as large a role as it should. The profitability measure, return on equity, returned insignificant results in both models for possibly the same reason.

In the case of the technology adoption model, we estimated the response in purchases to purchases the year before. In this model we used two different dependent variables, cash purchases and cash purchases minus cash sales of machinery and equipment. We found an approximate seventy percent decline in purchases in the lag year. There was a small difference in the response between model 1 and model 2 when looking at the impact of the prior year's purchases. When using model 1 and cash purchases the lagged cash purchases returned a coefficient of 0.328, whereas model 2, using net cash purchases, returned a value of 0.300. The difference between the two values may be a result of the lack of trade in property in the case of model 2 to use in recent purchasing arrangements. It is difficult to truly explain this difference as we do not know what was purchased or sold; thereby our ability to theorize causes for the difference is limited.

The full results for the technology adoption models can be seen in table 3. In much the same way as in the Jones' model, estimation results were mixed. Machinery age and return on equity both returned insignificant results. This is contrary to theory as when a farm's machinery complements increase in age, producers are more likely to replace them, especially when the farm is profitable. The leverage measures also returned values not in line with theory, possibly for the same reasons discussed in the Jones' model. However, age and acres again returned expected results with age returning a negative and significant coefficient and acres returning a positive significant value. The lagged cash flow variable returned positive values which show as cash flow increases in the previous year, investments in assets are likely to increase the following year due to the opportunity to obtain a more efficient asset.

Concluding Comments

The results of this study show how non-financial foundations such as what the neighbor's are doing can have a profound effect on the investment decision. The study also shows once an individual farm improves its machinery complement by purchasing additional or replacement machinery and equipment it will purchase a smaller quantity of machinery the following year.

One of the most surprising revelations from this study is how smaller farms buy more/larger machinery when these investments are based on a per acre basis.

These findings are not wholly consistent with theory, but with age-old sayings on investments. Everybody has probably heard of keeping up with the Jones' as it relates to the first model, and of the treadmill theory of investments as it relates to the second model. While other theoretically proven basis for farm level investment did not show to be consistent with earlier studies, we feel there is a great deal of information that can be used in evaluating farm level investment decisions in the future.

The difference in purchases when viewed on a per acre basis can be of great help both to the farmer and the lender when making loan evaluations. Here, both parties can see the effect keeping or building a reputation in the community can have on the investment decision. If this potential investment can be reevaluated without the emotional aspect or even if both parties are made aware of the impact of the emotional aspect, then the assessment can be made on whether to purchase and whether the purchase is correctly sized to the size of the operation.

Further research in this area can be done with other farms in other areas of the country to see if these observations are consistent across regional areas and farm types. Correlations may not be as strong in areas of the country where machinery is not the only major asset other than land to compete for the farmer's dollar. Another useful tool may be the use of surveys to ask the farmer if there were any emotional reasons for the purchase such as to maintain status in the community. These additional sources of information and data will go a long way in helping determine the true effect of non-traditional drivers of investment.

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Table 1. Summary Statistics for FBFM grain farms 1995-2002.

Variable	Mean	Std. Dev
Machinery Sales (Cash)	1497.37	6466.31
Machinery Purchases (Cash)	19731.98	29899.84
Cash Flow	17117.87	57701.75
Machinery Value	207705.85	149715.5
Net Income	42920.00	54302.07
ROE	4.21	342.74
Machinery Repairs	13672.57	11721.03
Acres Operated	659.64	796.87
Age	51.05	10.55

Note: Dollar amounts are in current dollars

Table 2. 1995-2002 Estimation Results for the Jones' Model

	Model 1	Model 2
Dependent Variable	CP	MPA
Variable		
Intercept	7746.824*	31.624*
	(4.25)	-2.82
Mean county purchases	0.967*	
	(31.61)	
Mean county purchases (lag)	0.005	
	(0.17)	
Mean county purchases per acre		1.327*
		(12.67)
Cash Flow (t-1)	-0.009*	
	(1.74)	
Cash Flow		-0.00002958
		(-0.92)
Return on Equity	0.040	-0.00048438
	(0.05)	(-0.09)
Debt to Asset	57.843*	0.192*
	(4.23)	(2.40)
Age	-260.710*	-0.727*
	(-9.23)	(-4.02)
Size (Acres)	6.805*	-0.007*
	(20.97)	(-2.89)
R-squared	0.1707	0.0128

Table 3. 1995-2002 Estimation Results for the Technology Adoption model.

	Model 1	Model 2
Dependent Variable	CP	NCP
Variable		
Intercept	20473*	21166*
	(11.68)	(12.18)
Cash Purchases(t-1)	0.331*	
	(33.57)	
Net Cash Purchases (t-1)		0.303*
		(30.20)
Cash Flow (t-1)	0.011*	0.013*
	(2.02)	(2.35)
Return on Equity	-0.341	-0.250
	(-0.45)	(-0.33)
Age	-198.386*	-218.374*
	(-6.89)	(-7.65)
Debt to Asset	53.749*	43.168*
	(3.66)	(2.97)
Machinery Age	-1.243	-1.201
	(-0.98)	(-0.95)
Size (Acres)	5.733*	5.602*
	(17.14)	(16.92)
R-squared	0.1610	0.1413