Incentives for Machinery Investment

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Abstract:

Machinery investment directly effects agricultural production efficiency and profitability. Machinery investment decisions are a function of tax policy, financial, and structural characteristics. This study uses a double hurdle model to determine the factors that affect the decision to purchase machinery as well as the intensity of the machinery purchase. Results indicate that depreciation expense, type of farm, experience, and tax policy are significant determinants in the decision to purchase machinery and the level of machinery purchased.

Introduction

Machinery investment is typically induced by technology innovation. Purchasing new machinery can provide efficiencies which increases costs savings and farm profitability. In other cases, machinery investment results from a farms' financial status, in particular tax obligations. This is of increasing importance with the Section 179 tax deduction allowance which has increased from $17,500 in 1993 to $500,000 in 2010. With record high commodity prices, many producers are trying to find ways to manage and/or minimize their tax obligations, and buying new machinery is one potential solution. However, there are questions regarding the economically feasible amount of machinery investment and how this has changed over time due to tax depreciation incentives.

Previous literature evaluated the effect of financial and structural characteristics on machinery investment using farm level data (Gustafson, Barry, and Sonka, 1988; Bierlen and Featherstone, 1998; Leblanc et al., 1992). Bierlen and Featherstone (1998) evaluated the trade-off between production efficiency and financial stability of machinery purchases to find that young producers were highly leveraged in order to produce more efficiently. This resulted in larger debt levels and a higher probability of failure due to large credit constraints.

Other studies have used surveys to determine investment decisions based on expectations of commodity prices and yields and potential tax reform policy change (Gustafson, Barry, and Sonka, 1988; Ariyante and Featherstone, 2009; Leblanc et al., 1992). Leblanc et al. (1992) evaluated the effects of tax policy changes to find that increased taxes increased the implicit rental rate of machinery, hence decreasing overall machinery investment levels. The survey results from Gustafson, Barry, and Sonka (1988) found that income tax credits play a minor role

in machinery investment decisions while financial and structural characteristics played a larger role such that farmers with higher leverage levels decreased investment while higher investment was associated with older producers. Ariyante and Featherstone (2009) estimated the machinery investment system to find that government payments, depreciation, and income were significant determinants in machinery investment decisions.

Micheels, Katchova, and Barry (2004) evaluated non-financial motivations for investment by testing the Treadmill theory and "keeping up with the Jones" to find that non-financial foundations play a large role in machinery investment—for example keeping up with the neighbor's investment level. This increased emphasis on the emotional effect of machinery purchases was supported by the fact that smaller farms tended to purchase larger equipment than what was needed for their farm operation size. They also found that once a large investment was made, investment levels tended to decrease in size the following year.

Tax policies play an important role in financial decisions on a farm, in particular the effects of depreciation expense. This analysis evaluates the effect of the level of the Section 179 tax deduction on machinery purchase decisions. We use a balanced panel data set from 1993-2009 which allows for five different tax depreciation allowance levels. In this analysis two questions will be answered. First, did the producer purchase new machinery, and if they did, what financial, structural, and tax policy factors affected that decision. Then, secondly, we will evaluate the specific financial, structural, and tax policy factors that affected the level to which they invested.

Empirical Model

The decision to purchase machinery and the level of the machinery purchase can be made jointly or separately. A tobit model assumes that the two decisions are made jointly and affected by the same explanatory variables (Greene, 1993). Double hurdle models use two separate stochastic processes to determine the decision to purchase machinery and the level of the machinery purchases. This method does not place a restriction on the explanatory variables, which is important because one explanatory variable may have an opposite effect in the two stages. The double hurdle model allows us to estimate first if a producer chooses to make a machinery purchases and then secondly what factors affect the intensity of the machinery purchase. The maximum likelihood estimator (MLE) in the first hurdle can be obtained from a probit estimator. In the second hurdle the MLE is estimated from a truncated normal regression.

The first hurdle model is represented as a probit model (Cragg, 1971):

$$(1)\begin{cases} Purchase^{*} = X_{it}\gamma + \varepsilon_{it}, if\ \ Purchase = 1[Purchase^{*} > 0] \\ \quad Purchase^{*} = 0, if\ \ Purchase = 0[Purchase^{*} = 0] \end{cases}$$

where *Purchase =1* if the agricultural producer purchases machinery, and zero otherwise. X_{it} are factors affecting the decision to purchase machinery and ϵ_{it} is the error term.

In the second hurdle the dependent variable is the actual dollar amount of machinery purchases divided by gross sales (*PUR/GS*). Machinery purchases were standardized by accrued gross sales rather than acres due to the diversity of farms in North Dakota and capture the effect of inventory which is present on cash grain operations. The second hurdle of the model is represented as a truncated normal regression (Cragg, 1971):

(2) $Pur / GS = Z_{it}\beta + u_{it}$

where *Pur/GS* is the intensity of machinery purchases standardized by accrued gross sales, Z_{it} are factors affecting the decision to purchase machinery and u_{it} is the error term. It is assumed that the error terms between hurdle 1 and hurdle 2 are independent and normally distributed and the covariance between those two errors equals zero.

Data

The data used in this analysis consisted of 120 farms that were enrolled continuously in the North Dakota Farm and Ranch Business Association (NDFRBA) over the 1993-2009 time period. The sample period contains five distinct tax policies for the Section 179 tax deduction. Explanatory variables were categorized as financial characteristics, structural characteristics and tax policies.

Financial Characteristics

Previous studies found that cash flow was a significant determinant of machinery investment (Barry, Bierlen and Sotomayor, 2000; Bierlen and Featherstone, 1998). Cash flow is typically used as a proxy for investment opportunity using net present value as a base for calculating the cash flows. While cash flow is a good indicator of investment opportunity, this analysis is not looking at the net present value of future cash flows, but rather the implication of available financial resources. Working capital (*WC*) has not been used in earlier studies as an explanatory variable. *WC* is included in this analysis as a proxy for investment opportunity while simultaneously capturing the short-term liquidity of the farm in a cardinal number format. The rate of return on equity *(ROE)* is used to measure farm profitability. *ROE* measures the individual farmer's ability to make a return on their investment and excludes any potential effect

a lender would have on that return, which is present in the rate of return for assets. The debt-to-asset ratio, *(D/A),* is included to capture the solvency or financial leverage of the farm operation. It is hypothesized that as solvency increases, machinery purchases will decrease. Depreciation expense, (*Dep),* is included to determine the effect potential tax policies may have on the depreciation level as well as machinery purchases.

Structural Characteristics

Structural characteristics have been found to be significant determinants of machinery investment (Gustafson, Barry, and Sonka, 1988; Bierlen and Featherstone, 1998). North Dakota grows a diverse set of agricultural commodities. An explanatory variable capturing farm type was included in this analysis. *Crop* farms generated 80% of gross sales from grain and oilseed commodities, while *LVST*, livestock farms generated 80% of gross sales from livestock enterprises. *COMBO*, represented those farming operations where 80% of gross sales was generated from livestock and crop enterprises. Experience, *EXPER*, represents the years of experience the principal operator of the farm has from farming enterprises.

Tax policy

Tax policy dictates the level of depreciation expense allowed which has the potential to lower the tax liability for an agricultural producer. Since 1993, five different tax policies have been put in action which directly influenced the amount of depreciation expense allowed. These five tax policies have been coded as the following: *Tax 1* is a Section 179 tax deduction of $17,500 which was in effect from 1993-1995. In 1996 the tax deduction was increased to $25,000, which was in effect until 2002 (*Tax 2).* The Section 179 tax deduction was increased to $100,000 from 2003 to 2005 and was coded as *Tax 3*. In 2006 and 2007 the tax deduction was

increased to $125,000 (*Tax 4*) and for 2008 and 2009 it was increased again to $250,000 *(Tax 5).* For each of the tax variables a dummy variable was created where "1" represented the years that the tax deduction was in effect, and all else was coded as zero. Summary statistics for explanatory variables are presented in Table 1.

Results

Double hurdle results are presented in Table 2. As demonstrated, different explanatory variables affect the decision to purchase machinery and the intensity of the machinery purchase. Working capital, *WC*, was found to have a small, but positive increase on the likelihood of purchasing machinery (hurdle 1). Depreciation had a negative effect, but it was reported as a negative value in the data since it is an expense, so as depreciation expenses increases (or becomes more negative) the probability of buying machinery increases. Crop farmers compared to combination farms were more likely to buy machinery while as years of experience increased the probability of purchasing machinery decreased. The negative sign for experience may be due to the life cycle of the farm and indicate more producers are nearing retirement. All tax variables decreased the probability of buying machinery, which was not expected.

Financial characteristics had a similar effect in hurdle 2 as hurdle 1. The intensity of machinery purchases decreased for crop and livestock producers compared to combination farms. A diversified farm will likely need to purchase machinery specific to their diversified enterprises, which may increase their overall machinery purchases compared to more specialized producers. Again, experience had a negative effect on machinery purchases which indicates the possibility that producers have built a solid base of equipment and potentially adds to their machinery base for minor updated. These results follow that of Bierlen and Featherstone (1998)

where they found that young producers tend to buy more machinery so they can produce more efficiently. All tax policies except *Tax3* were found to be significant. *Tax5* was the only tax policy that was found to be positive, and was valued at $250,000. This indicates that $250,000 was a large enough incentive for producers to buy additional machinery compared to *Tax1* ($17,500).

The double hurdle model uses two separate stochastic processes, which makes it beneficial to evaluate the average partial effects (APEs) of the explanatory variables on the unconditional expected value. The delta method was used to evaluate the statistical significance of APE (Burke, 2009). As the APE of the depreciation expense increased (a larger negative number) by $10,000, the ratio of machinery purchases to gross sales increased by 1.2%. This demonstrates that the depreciation expense does play in role in machinery purchase decisions, but it is not as large as anticipated, more than likely due to the lower Section 179 tax deductions in the early 1990s. Livestock producers compared to combination producers decreased the ratio of machinery purchases to gross sales by 2.53% indicating livestock operations in general buy less machinery compared to combination operations, more than likely due to the specialization. Again, the APE of experience is negative and significant implying the potential effect of contraction of farm resources due to the potential of the retirement stage of the farm life cycle. Analyzing the tax APEs, only *Tax2* and *Tax4* were found to be significant and negative. A negative sign on tax implies one of two things, either accrued gross sales increased or machinery purchases decreased. Looking at the annual averages for gross sales and machinery purchases (Table 4), we can see that during from 1996 – 2002 (*Tax2*) accrued gross sales had a steady increase while from 2006-2007 (*Tax4*) gross sales more than doubled. During the equivalent

time periods we saw a similar pattern with machinery purchases, but gross sales seemed to increase at a higher and more substantial level.

Conclusions

Machinery purchases are a function of financial, structural, and tax policy characteristics. The preliminary findings of this working paper suggest that depreciation expense, type of farm, experience, and tax policy are significant determinants in the decision to purchase machinery and intensity of the machinery purchase. These findings capture the importance of all three types of explanatory variables, but also the interaction between depreciation expense and tax policy implications. Potential extensions of this paper include creating a numerical value for tax policy rather than a dummy variable which would be compared to the cardinal machinery purchase.

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Table 1. Summary statistics of explanatory variables

Variable	Definition	Obs.	Mean	Standard Deviation
Purchase	Dummy variable, 1 if machinery purchases > 0, 0 otherwise	2,040	0.9333	0.2495
Pur/GS	Machinery purchases standardized by gross sales	1,904	0.1157	0.1224
Depreciation	Machinery depreciation expense	2,040	-20,912	19,048
ROE	Market value rate of return on equity	2,040	9.783	45.30
Experience	Years of experience (principal operator)	2,040	22.9418	8.2616
Livestock	Dummy variable, 80% gross sales from livestock enterprises = 1, 0 otherwise	2,040	0.0838	0.2772
Crop	Dummy variable, 80% gross sales from crops = 1, 0 otherwise	2,040	0.2755	0.4469
Combo	Dummy variable, 80% gross sales generated from livestock and crop enterprises, 0 otherwise	2,040	0.5700	0.5792
D/A	Debt-to-asset ratio, ending market value	1,915	0.3824	0.3854
WC	Working capital, current assets less current liabilities, market value	2,040	137,206	223,482
Tax 1	Dummy variable =1 if Year = 1993-1995	2,040	0.1764	0.3813
Tax 2	Dummy variable =1 if Year = 1996-2002	2,040	0.3529	0.4780
Tax 3	Dummy variable =1 if Year = 2003-2005	2,040	0.1764	0.3813
Tax 4	Dummy variable =1 if Year = 2006-2007	2,040	0.1176	0.3222
Tax 5	Dummy variable =1 if Year = 2008-2009	2,040	0.1176	0.3222

Table 2. Double hurdle results

	Hurdle 1: Probit			Hurdle 2: Truncated normal		
Variable	Coefficient	P-value	Sig	Coefficient	P-value	Sig
Dependent variable						
Purchases				--	--	--
Purch/GS	--	--	--			
Financial Characteristics						
WC	9.91e-07	0.039	**	-3.15e-07	0.055	**
ROE	0.0006	0.522		-0.0006	0.286	
D/A	0.0174	0.886		-0.0812	0.142	
Dep	-0.00003	0.000	***	-9.08e-.06	0.001	***
Structural Characteristics						
CROP	0.2379	0.096	*	-0.1459	0.061	*
LVST	-0.1654	0.245		-0.2641	0.090	*
COMBO						
EXPER	-0.0154	0.016	**	-0.0222	0.002	***
Tax Policy						
Tax 1						
Tax 2	-0.0252	0.853		-0.2233	0.023	**
Tax 3	-0.1715	0.307		-0.0519	0.595	
Tax 4	-.4096	0.028	**	-0.2490	0.074	*
Tax 5	-0.3429	0.097	*	0.2596	0.049	**
Constant	1.4037	0.000	***	-0.405	0.069	*
N	2,040			1,905		
Sigma	0.3726	0.000	***			
Wald Chi2(11)	84.28	0.000	***			

***1% significance level, **5% significance level, *10% significance level

Table 3. Post-estimation results, Average Partial Effects (APE) on the unconditional expected value

Variable	Coefficient	P-value[τ]	Sig
Financial Characteristics			
WC	-1.47e-08	0.2126	
ROE	0.0004	0.263	
D/A	-0.0069	0.1638	
Dep	-1.20e-06	0.000	***
Structural Characteristics			
CROP	-0.0097	0.1678	
LVST	-0.0253	0.099	*
COMBO			
EXPER	-0.0021	0.0255	**
Tax Policy			
Tax 1			
Tax 2	-0.0199	0.0628	*
Tax 3	-0.0067	0.2905	
Tax 4	-0.0270	0.0644	*
Tax 5	0.0183	0.1404	

[τ] p-value was calculated using the delta method

***1% significance level, **5% significance level, *10% significance level

Table 4. Summary statistics of accrued gross sales and machinery purchases by year

		Gross Sales				Machinery Purchases			
Year	Obs	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
1993	120	214,472	129,466	37,514	793,765	28,049	27,576	0	114,300
1994	120	228,784	146,623	36,531	948,728	35,549	40,547	0	220,753
1995	120	247,774	173,649	37,356	853,473	29,229	31,622	0	148,880
1996	120	281,209	193,716	22,388	1,124,041	32,803	41,527	0	296,869
1997	120	267,982	173,379	44,690	833,048	25,262	26,861	0	115,197
1998	120	292,106	196,396	33,009	971,059	24,388	27,754	0	112,141
1999	120	339,804	242,561	66,166	1,384,029	29,780	30,906	0	128,458
2000	120	386,373	313,109	39,499	2,163,302	37,548	35,270	0	180,710
2001	120	351,476	271,587	47,613	1,786,837	43,017	42,246	0	169,826
2002	120	385,451	301,812	42,540	2,017,542	39,548	47,020	0	284,876
2003	120	428,866	309,417	52,664	1,571,738	52,080	53,235	0	290,867
2004	120	439,240	282,825	64,239	1,460,792	48,802	52,904	0	255,306
2005	120	449,008	290,737	61,553	1,446,853	56,491	75,873	0	607,078
2006	120	497,331	348,302	62,111	1,857,299	44,623	61,184	0	487,007
2007	120	719,100	493,065	67,883	2,586,604	66,786	69,042	0	348,798
2008	120	790,488	556,370	59,435	3,099,700	99,752	115,288	0	464,351
2009	120	657,172	463,755	56,156	2,210,882	115,895	122,909	0	530,517