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Tax policy and farm capital investment: Section 179 expensing and bonus depreciation

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Abstract

Purpose – The purpose of this paper is to estimate the impact of Internal Revenue Code cost recovery provisions – Section 179 and "bonus depreciation" – on farm capital investment.
Design/methodology/approach – The authors construct a synthetic panel of data consisting of cohorts of similar farms based on state and production specialization using the USDA's Agricultural Resource Management Survey for years 1996-2012. Employing panel data methods, the authors are able to control for time-invariant fixed effects, as well as the effects of past investment on current investment.
Findings – The authors estimate statistically significant investment demand elasticities with respect to the Section 179 expensing deduction of between 0.28 and 0.50. A change in bonus depreciation, on average, had little impact on capital investment.
Practical implications – The estimates suggest there is a modest effect of the cost recovery provisions on investment overall, but a stronger effect on farms that have more than $10,000 in gross cash farm income. There are other implications for the agricultural sector: the provisions may encourage technology adoption with its associated benefits, such as reduced cost of production and improved conservation practices. On the other hand, the policy could contribute to the growing concentration in production as large commercial farms expand their operated acreage to take advantage of increasingly efficient physical capital.
Originality/value – To the authors' knowledge, this is the first research to use a nationally representative dataset to estimate to impact of Section 179 and "bonus depreciation" on farm investment. The findings provide evidence of the provisions' impact on farm capital purchases.

Keywords Taxation, Bonus depreciation, Cost recovery, Farm capital investment, Section 179, Synthetic panel data
Paper type Research paper

1. Introduction

Farming requires a substantial investment in physical capital – machinery, equipment, and other depreciable property. Based on the USDA's annual Agricultural Resource Management Survey (ARMS), in 2012 farms had an average of $106,000 worth of capital equipment (depreciable property). However, that figure can vary significantly by the size of the farm as measured by the farm's cash revenue[1]. Mid-sized farms – those with between $350,000 and $1 million of gross cash farm income (GCFI) – had an average stock of capital equipment worth $396,556, while large commercial farms with at least $1 million of GCFI had an average stock of capital equipment worth nearly $1 million. Replacing and expanding this stock requires investment. In 2012, 39 percent of US farms made a capital investment, although this percentage again varies significantly by farm size. In 2012, 83 percent of large farms reported that they made such an investment,

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compared to only 35 percent of small farms with less than $350,000 of GCFI. On average, small farms reported an annual capital investment of $8,628, while large farms reported an average investment of $201,603.

Two provisions of the Internal Revenue Code that provide the opportunity to accelerate cost recovery, Section 179 and Section 168(k), can benefit farm businesses that make capital investments[2]. Under the current tax system, certain capital purchases may be treated either as a current expense deduction or capitalized and depreciated over time, generating a series of depreciation deductions. Section 179 allows a taxpayer treat the investment as a cost and recover the cost of the investment by deducting or "expensing" it in the year of the purchase[3]. In addition to the expensing deduction, under Section 168(k) farmers may also use additional depreciation or so-called "bonus depreciation" as a method to accelerate the recovery of the capital's cost. Further, the two provisions may be used in coordination, where the bonus depreciation allowance is taken after the Section 179 deduction is used but before regular depreciation under the Modified Accelerated Cost Recovery System is figured[4]. To figure the bonus depreciation deduction, the asset owner applies the bonus depreciation percentage to the asset's basis – to the extent that there is basis left over after the Section 179 expensing is applied. The product of the basis and bonus depreciation percentage is the allowed bonus depreciation deduction.

Changes in the tax code with regard to cost recovery may alter investment decisions by changing the cost of the investment over the life of the asset. These tax code changes create a wedge between the purchase price of capital and the after-tax cost of capital. Increases in allowable depreciation and first-year investment credits shift forward the time period in which investment in capital is recovered. All else equal, the sooner the cost is recovered, the lower the user cost of capital and the greater the value of the tax recovery option. This increase in the value of the tax recovery option should lead to increases in investment.

The objective of our research is to estimate the effect of cost recovery deductions – Section 179 expensing and Section 168(k) bonus depreciation – on farm capital investment. We exploit the considerable variation over time in the value of cost recovery deductions to estimate their impact on farm capital investment. We use seventeen years of nationally representative data from the USDA's ARMS, 1996-2012. Because the ARMS data are not a panel but rather an annual cross-section of farms, a synthetic panel consisting of cohorts of like farms based on state and production specialization was constructed, allowing for the use of a panel data model to control for time-invariant factors that could affect investment.

Our research makes several contributions to the literature. First, we use national data spanning 1996-2012, which captures two distinct time periods: a period of relatively low Section 179 expensing allowance and no bonus depreciation; and a period of rapid expansion in both deductions. We examine the impact of current tax policy on investment over the most recent period and differentiate the impact of a change in the Section 179 limit by those who spent above the limit compared to those who did not, similar to Hadrich *et al.* (2013) Federal tax policy impacts all producers within the USA rather than a single subset of producers. The full impacts of such policy needs to take into account the impacts on all producers while accounting for differences in investment due to farm size, commodity type, and other key differences. Our dataset enables us to accomplish both of these goals. Finally, we improve on the work of previous studies by accounting for the impacts of changes in both current and past levels of allowable Section 179 expensing limits on contemporaneous agricultural capital expenditures. This is one of the many unique aspects of our study. When current tax policy impacts current and future capital expenditure, incorporating these effects is necessary for developing accurate estimates of the impacts of tax policy changes on agricultural investment.

Estimating the effect on investment due to tax reform is best done in years of major changes tax policy in order to mitigate issues of endogeneity or measurement error (Cummins *et al.*, 1996). Over the last decade, the amount of capital expenses a farmer could immediately deduct under Section 179 has increased from less than $25,000 in 2000 to $500,000 in 2014 (see Figure 1). As well, for tax years 2012 through 2014, the additional depreciation allowance, introduced in 2001, was 50 percent of all costs. Combined with the expensing deduction, the ability to accelerate depreciation has meant that much of the capital purchases made during the past decade have been completely deducted in the first year. We will use these significant tax policy to estimate their impact on farm-level capital investment.

The research has several policy implications. Under current tax law (year 2015), the maximum Section 179 expensing amount is $25,000, down from $500,000 in 2014. If the law is not changed, it is likely that many farms will find that their investments exceed the maximum expensing amount, as Figure 1 shows, or they may choose to scale back investment. Policy makers engaging in the debate about whether to continue the expensing and additional depreciation at their current levels or change them will want to know whether and to what extent tax policy influences farm capital purchases. We provide new evidence of the impact of recent tax policy changes on farm capital investment levels, using a nationally representative sample of data.

Additionally, to the extent that the deductions influence farm investment, there are several issues to consider: first, the tax provisions cost the government money. The Joint Committee on Taxation estimates Section 179's cost to the Treasury at $17.6 billion over five years. Together, Section 179 and bonus depreciation will cost the government $57 billion between 2014 and 2018 (Joint Committee on Taxation, 2014); second, encouraging investment in new machines could affect technology adoption and

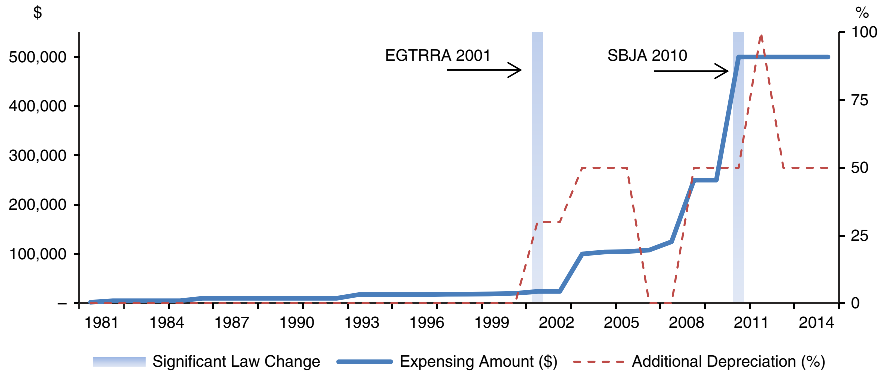

Figure 1.
Section 179 maximum expensing amount and additional depreciation percentage, 1981-2014

Notes: Expensing for 2012 was retroactively changed to $500,000 by the American Taxpayer Relief Act of 2012 (ATRA 2012) (signed into law in January 2013). The Small Business Jobs Act of 2010 (SBJA 2010). Economic Growth and Taxpayer Relief Reconciliation Act of 2001 (EGTRRA 2001). The 2014 expensing and bonus depreciation limits were changed in December 2014, retroactively effective for the entirety of 2014
Source: Internal Revenue Service

associated benefits, such as production cost or conservation practices; and third, because larger farms are able to make larger purchases, the policy may be contributing to the growing concentration in production as farms expand their operated acreage to take advantage of increasingly efficient physical capital.

Controlling for characteristics of the individual farmer and farm business such as age, education, tenure, farm size, and efficiency, our results show that the increased expensing deduction amount (Section 179) has had a statistically significant impact on farm capital investment overall; for every $1 increase in the Section 179 expensing amount, we estimate that farms made an incremental capital investment of between $0.32 and $1.11, with implied investment demand elasticities of between 0.28 and 0.50. On the other hand, our results indicate that increasing the percentage allowance of bonus depreciation, for the most part, does not have a statistically significant effect on farm capital investment. The one exception is that when we limit our analysis to the pre-2004 period we find investment to be responsive. In this instance the effect is nearly unit elastic.

Because the majority of farms are likely to have never made a capital purchase above the maximum expensing amount, we would expect raising the limit to have a small effect on incremental investment overall. On the other hand, farms that are likely to exceed the expensing deduction limit are more likely to be affected by an expensing limit change. Using the synthetic panel of data, we are able to identify cohorts who were, on average, limited by the expensing amount in previous years, i.e., farms in the panel that made purchases above the limit one, two, or three years prior. We find that when we account for the farm's previous purchases above the limit, farms reduced contemporaneous investment, even when the expensing amount was expanded. The effect ranges from −$0.68 to −$2.73 for every dollar change in the expensing limit.

In the next section we discuss the current cost recovery provisions and develop their tax values for investment, as well as discuss the recent literature evaluating investment response to tax law changes. In Section 3, we discuss the theory of investment and incorporate taxes to derive investment demand. In Sections 4 and 5, we discuss the data, as well as the panel data model we estimate and our construction of a synthetic panel of data. This is followed by our results and discussion in Sections 6 and 7.

2. Background and literature

The US tax system imposes a tax on net income, generally allowing for the deduction of the regular costs of doing business from gross income. Capital expenditures are one such cost. Under a "normal" tax system, the cost of a capital asset is amortized and the asset is depreciated over a set period of time. In each period, a depreciation expense is taken in accordance with the income that the capital produces over the useful life of the asset.

One of the first papers to examine the impacts of tax policy on investment through changes in the user cost of capital was Hall and Jorgenson (1967). They examined the impact of accelerated depreciation, shortened tax lives, and investment tax credits on investment in manufacturing and non-farm machinery and equipment in the 1950s and 1960s. They concluded that favorable changes in tax policy during this time period led to large first-year investment expenditures, and smaller but still large subsequent increases in investment expenditures in years following the policy change. They noted that machinery investment was the most sensitive to the new rate of accelerated depreciation. In total, 70 percent of the additional machinery investment within the first year of the tax policy was accounted for by the tax change. Subsequent studies examining the impact of tax policy change on investment in non-agricultural goods found that capital investment responded strongly to changes in tax policy overall, but the impacts varied by type of capital and estimation methodology (Auerbach and Hassett, 1991; Cummins and Hassett, 1992; Goolsbee, 1998). Employing a methodology similar to that of Hall and Jorgenson to agricultural investment, LeBlanc and Hrubovcak (1986) also found similarly large increases in agricultural investment in equipment, structures, and land over the period of 1955-1978 due to favorable changes in tax depreciation lives of the assets, accelerated depreciation, and tax investment credits. They estimated that changes in tax policy accounted for 20 percent of the new investment, or $5 billion net investment in equipment and $1 billion in structures over this time period. Utilizing the same dataset and time period but different methodology, Halvorsen (1991) obtained similar results, but with slightly smaller coefficient values.

Not all tax policy changes had the effect of expanding capital investment. One of the most significant pieces of tax legislation to precede our current tax policy was the Tax Reform Act of 1986 (TRA86). In regard to capital investment, TRA86 eliminated prior investment tax credits and lengthened asset tax lives, while reducing overall marginal tax rates affectively raising the user cost of capital. LeBlanc *et al.* (1992) used a stochastic coefficients framework to measure farm machinery and equipment investment demand in response to the 1986 TRA86. They used data from the two years following the reform, 1987 and 1988, and calculated that the change in the tax law increased the implicit rental rate of capital by 12.7 percent. The increase in the implicit rental rates of capital as well as downturns in the farm economy resulted in lower overall agricultural investment. They found that farm machinery and equipment decreased by $589 million in 1987 and $417 million in 1988.

Jensen *et al.* (1993) also examined the effect of changes made by TRA86. Utilizing farm-level observations from the Kansas Farm Management dataset over the period 1973-1988 and including cash flow measurements in the model, they found that changes in TRA86 decreased the average farm machinery and equipment investment by between $6,081 and $9,679.

Many of the early agricultural capital investment studies do not account for the heterogeneous impacts on the implicit price of capital from changes in tax policy due to differences in farm size. Exploring this issue further, Hanson and Bertelsen (1987) calculated the change in the implicit price of different types of capital for producers by farm size and commodity type. They found that the impact of a change in the implicit price of machinery and structures was larger for farms with larger values of production. Ariyaratne and Featherstone (2009) estimated similar impacts on farm capital investment from a change in tax depreciation expenditures. Using Kansas Farm Management Association data over the period of 1998-2007 to examine differences in investment by farm asset size and age, they estimated that the level of lagged depreciation had a statistically significant impact on investment expenditures, and varied by capital type as well as by farm asset size quartiles. An increase in lagged depreciation led to a $4.31 change in the level of total farm investment per dollars of assets managed. In general, the value of the estimated coefficients increased for farms in the larger asset-level quartiles.

There have been substantial changes in the structure of agricultural production, the farm economy, and depreciation policy since the time period during which the bulk of the studies on tax policy and agricultural investment demand were conducted. While a recent literature has examined the impact of investment in non-agricultural capital in response to recent changes in tax depreciation expensing limits and bonus depreciation (Goolsbee and Desai, 2004; House and Shapiro, 2008; Hulse and Livingstone, 2010;

Edgerton, 2011), only one study has focussed on the agricultural sector. Hadrich *et al.* (2013) estimated the impact of the Section 179 deduction on agricultural machinery investment using North Dakota Farm and Ranch Business Association data over the period of 1993-2011. Using a double-hurdle model, they estimated that for farms which invested in machinery in that period, spending above the Section 179 limit increased the ratio of the investment purchase amount in relationship to gross value of sales by \$0.32. For farms on average, regardless of whether they made an investment that period or not, spending above the Section 179 limit lead to a \$0.13 increase in the ratio of farm investment to gross sales, or more than doubling the investment at the mean. The estimated impact of an increase in the farm's tax depreciation expenses was \$0.012 and not significant. These findings support the idea that the impact of tax policy change varies according to the level of investment. In the next section we develop a structural model incorporating the impact of changes in the Section 179 limit and bonus depreciation on producer investment behavior.

3. Capital investment demand

The investment decision may be addressed according to the principle that one invests in capital until the price of capital is equal to the discounted profits accruing to capital over its lifetime. According to this model, the firm makes an investment in machinery to maximize the net present value (V_0) of expected cash flows from the investment. Using a dynamic model, this can be written as:

$$\text{Maximize} \quad V_0 = \int_{t=0}^{L} R_t e^{-rt} \tag{1}$$

where:

$$R_t = G(K_t|X_t, P_t, E_t) - C\left(\frac{dK}{dt}\right)$$

R_t is the present value of all expected net receipts from the investment over the machine's lifetime, $G(K_t|X_t, P_t, E_t)$ is net revenue from a given level of capital K_t, given other input choices X_t, revenues P_t, and expenses for non-capital items, E_t. $C(dk/dt)$ is the change in costs from a given change in the level of capital. The goal is to choose the capital stock, K_t and other inputs to maximize output over time. This is solved by through dynamic optimization (see Abebe *et al.*, 1989; LeBlanc *et al.*, 1992; Weersink and Tauer, 1989). In general, from (1) the static one-period equation for the stock of capital demand becomes:

$$K_t = f(P_t, E_t, U(K_t)) \tag{2}$$

where $U_t(K_t)$ is the implicit rental rate or cost of capital. The rental rate of capital is the after-tax cost of capital services, or what the firm would need to charge for a unit of capital to earn the required after-tax rate of return (LeBlanc and Hrubovcak, 1986). Employing the method outlined by LeBlanc and Hrubovcak (1986) the implicit rental rate is calculated by setting the purchase price of an asset equal to its present value. For the jth asset, the purchase price becomes:

$$q_j = \int_0^L e^{-rt} u_j n_{jt}(t) dt \tag{3}$$

where q_j is the asset purchase price, L the asset life, $n_{j,t}(t)$ the capacity of the jth asset in year t, and u_j the rental rate of the jth asset. LeBlanc *et al.* (1992) argue that tax policy affects investment through the implicit rental rate of capital. An increase in the amount that can be deducted earlier in the asset's life decreases the implicit cost of capital or, equivalently, increases its marginal value. They incorporate taxes and depreciation into (3) and obtain the following static one-period equation:

$$q_j = (1-\tau_i)u_jN_i + \theta q_j + \tau_i(1-h\theta)Zq_j \tag{4}$$

where:

$$N_i = \sum\nolimits_{t=0}^{T} n_j(1+\pi)^t/[1+i(1-\tau_i)]^t,$$

$$Z = \sum\nolimits_{t=0}^{T} z_j/[1+i(1-\tau_i)]^t, \text{ and}$$

$$\theta = \theta/[1+i(1-\tau_i)].$$

τ_i is the ith farm's marginal tax rate, θ the present value of the tax credit or the portion of the expenditure deducted the first year under Section 179, h the percentage of the deduction from the tax depreciation basis equivalent to the extra bonus depreciation taken the first year, $(1-\tau_i)u$, N_i the present value of the future rents, θq_j the present value of the investment tax credit, z_j the allowable tax depreciation deduction in year t, and $\tau_i(1-h\theta)Z_iq_j$ the present value of tax depreciation deductions. Solving for the implicit rate of capital in (4) we obtain:

$$\begin{aligned} u_j &= q_j[(1-\theta-\tau_i(1-h\theta)Z)]/N(1-\tau_i) \\ &= u_j(\theta, h, \tau_{i,}, q_j). \end{aligned} \tag{5}$$

We express the implicit rental rate of capital in (5) as a function of the firm's marginal tax rate, τ_i, depreciation deductions, where θ represents the Section 179 amount and h represents bonus depreciation, and the purchase price of the asset q_j. Accounting for the different capital items owned by the firm by summing (5) across all j assets owned by the firm and replacing $U(q_j)$ in (2) with this expression, the demand for a stock of capital goods $j = 1, \ldots, J$ for farm i at time t, represented by $K_{i,t}$ is:

$$K_{i,t} = f\left(P_{i,t}, E_{i,t}, \sum_{j=1}^{J} u_j(\theta, h, \tau_{i,}, q_j)\right) \tag{6}$$

Farm production-specific differences, such as crop type, farm size, and degree of specialization will impact the demand function. Cash flow and farm operator characteristics are important in explaining investment behavior (Jensen *et al.*, 1993; Bierlen and Featherstone, 1998). Interest rates and interest expenses may also impact investment choice. Including these in our model, capital demand is:

$$K_{i,t} = f\left(P_{i,t}, E_{i,t}, CF_{i,t}, IR_{i,t}, y_{i,t}, n_{i,t}. \sum_{j=1}^{J} u_j(\theta, h, \tau_{i,}, q_j)\right), \tag{7}$$

where $CF_{i,t}$ represents other cash flow measures, $IR_{i,t,}$ are interest rates charged on farm loans, $y_{i,t}$ represents farm-specific production characteristics, and $n_{i,t}$ are farm operator characteristics that influence investment.

To obtain a function for investment expenditures from the demand for capital, we incorporate a function linking the stock of capital between periods. Each period, the stock of capital increases through gross investment in new capital and decreases as a portion of the current stock depreciates. The difference between the two represents the change in the capital stock (net investment). The one-period representation of this relationship is:

$$K_{i,t} = I_{i,t} + K_{i,t0} - \sum_{j=1}^{J} \delta_{j,t} \times K_{j,i,t0} \quad (8)$$

or equivalently:

$$I_{i,t} = K_{i,t} - K_{i,t0} + \sum_{j=1}^{J} \delta_{j,t} \times K_{j,i,t0}.$$

$I_{i,t}$ is gross investment or additional expenditures on all individual capital items $j = 1, \ldots, J$ for firm i during the period t, $K_{j,i,t0}$ is the capital of all goods j owned by firm i at the beginning of period t, and $\delta_{j,t}$ is the economic depreciation rate for each good j at time t. Using (8), investment becomes a function of the same variables influencing the demand for capital and the deprecation of stock over the given time period t. Finally, this can be written as:

$$I_{i,t} = f\left(P_{i,t}, E_{i,t}, CF_{i,t}, IR_{i,t,} y_{i,t}, n_{i,t} \cdot \theta_{i,t}, h_t, \tau_{i,t}, K_{i,t0}\left(\delta_{i,t}, K_{i,t}\right)\right) \quad (9)$$

Investment is a function of revenues (P_t), expenses (E_t), cash flow variables, farm ($y_{i,t}$) and farmer characteristics ($n_{i,t}$), tax depreciation policy including Section 179 levels, ($\theta_{i,t}$), and bonus depreciation (h_t), marginal tax rates ($\tau_{i,t}$), and the level of initial capital stock ($K_{i,t0}$). The level of initial capital stock is a function of the final year end capital stock, ($K_{i,t}$), and the rate of economic depreciation ($\delta_{i,t}$). Within our study, investment refers to the purchase of all goods j over a given period rather than individual investment in specific goods. The purchase price of capital for each item, q_j, is incorporated into our measure of investment expenditures each period while the remaining tax related variables are estimated as they impact the firm-level purchases of all goods j in a given period.

4. Data

The data we employ in our study are a nationally representative cross-section of farms from the US Department of Agriculture's ARMS. The survey is fielded annually to farm households across the USA and is designed to solicit information about production practices, costs of production, business finances, and operator and household characteristics. The ARMS has the advantage over other sources of farm data, such as the Census of Agriculture, because of its breadth and depth of information. For example, we are able to fully account for the farm's annual capital investment in depreciable property $I_{i,t}$ (from Equation (9)), or purchases that include improvements to land such as irrigation, wells, and feedlots; new construction or remodeling of existing farm dwellings such as barns, buildings, silos, and sheds; cars, trucks, tractors and other self-propelled equipment used by the operation; non-self-propelled such as pumps and capital equipment for livestock and crop production; and farm office equipment placed on a depreciation schedule. The Census of Agriculture on the other hand only reports total value or stock of capital equipment, not the change over the year. As well, the national coverage of the ARMS data gives it an advantage over state-level surveys by allowing us to represent the diversity of commodity production and the respective investment needs of agricultural producers in the USA. If we were to focus on just a few states, or a specific region, the inference based on the sample would be limited. Further, a practical consideration of the ARMS is it allows us a large sample, which will prove necessary as we create cohorts.

We control for a host of farm and farmer characteristics, including the age of the principal operator, years of education, whether farming in the principal occupation, and years of experience farming (see Table I for full list). Revenues ($P_{i,t}$) and expense ($E_{i,t}$)

	Full sample		Cohort sample	
	Mean	SE	Mean	SE
Capital investment	17,352.0	930.3	29,058.8	1,758.4
Revenues and expense variables				
Gross value of production	$106,088.3	3,213.8	$284,180.4	13,562.8
Leasing and custom work expenses	$3,682.2	104.0	$7,920.4	472.0
Cash flow variables				
Total-off farm income	$75,203.8	2,285.4	$67,033.4	874.8
Total net worth	$617,550.8	14,147.7	$807,623.8	18,256.7
Value of real estate	$514,684.1	9,756.6	$665,595.2	16,378.6
Interest expense	$4,582.5	86.1	$8,398.9	320.5
Farm characteristics				
Capital stock minus new purchases	$260,855.8	4,858.7	$389,838.6	11,048.1
Entropy	0.13	0.01	0.121	0.002
Total acres operated	477.0	11.2	472.0	13.3
Farmer characteristics variables				
Age of principal operator	56.2	0.27	55.2	0.12
Education of principal operator	2.6	0.02	2.6	0.01
Years of experience farming	25.0	0.52	24.4	0.137
Farming is primary occupation	0.62	0.018	0.69	0.006
Financial performance variables				
Return on equity	3.7	15.1	−12.5	10.2
Return on assets	−5.6	1.8	0.76	8.65
Economic cost-to-output ratio	967.5	202.9	1,240.9	274.4
Debt-to-asset ratio	23.6	4.4	16.7	2.7
Asset turnover ratio	167.13	97.2	91.3	51.5
Interest rates				
Interest rate	6.85	0.011	6.81	0.032
Tax variables				
Effective marginal tax rate	0.172	0.126	0.157	0.662
Bonus depreciation	0.31	0.31	0.30	0.29
Section 179	$168,101.2	1,568.5	$176,797.2	3,085.7
Made aggregate investment exceeding expensing limit	0.15	0.001	0.0844	0.00294
Sample size	105,562		3,303	

Note: Jackknife standard errors with 15 replications
Source: Agricultural Resource Management Survey (1996-2012)

Table I.
Summary statistics of variables included in regressions: 1996-2012

variables include the value product of sales, interest expenses, and leasing and custom work hire expenses. Cash flow variables ($CF_{i,t}$) include total-off-farm income, interest expenses paid, net worth, and the value of farm real estate assets. Farm characteristics ($y_{i,t}$) include number of acres operated, entropy, and dummy variables specifying the main commodities produced. The variable labeled "entropy" is a value between 0 and 1, and is an index of each commodity's contribution to the aggregate gross value of commodities produced on a farm – essentially, a measure of concentration of commodity production on an individual farm[5].

Farmer characteristics, $n_{i,\ t}$, include age, years of experience farming, education level, and if farming is the primary occupation of the farmer. We include measures of financial health, given by return on equity (ROE) and return on assets (ROA) and the economic cost-to-output ratio, which is total production costs, plus charges to management and principal operator, and contractor expenses over net total value of production (including government payments). As well, we include the asset turnover ratio – a measure of the efficiency of asset use – and a debt-to-asset ratio as a measure of the farm's financial leverage.

The initial level of capital, $K_{i,t0}$, is calculated to account for differences in investment due to differences in replacement capital needs. This is the difference between the end of the year capital stock, less investment that year and estimated economic depreciation based upon Bureau of Economic Analysis figures[6].

The expensing and depreciations variables are obtained from various IRS publications and include the Section 179 expensing amount ($\theta_{i,t}$) and the allowable additional bonus depreciation ($h_{i,t}$). In order to estimate the tax value of the cost recovery provisions, we calculate the effective marginal tax rate of farm households ($\tau_{i,t}$) using an individual tax model developed with ARMS data. To measure the impact of interest rates on investment we use interest rate data on farm machinery loans ($IR_{i,t}$) for USDA farm production regions published in the Federal Reserve Board of Governor's *System of Agricultural Finance Databook*.

Summary statistics

Table I presents a summary of means of variables used in our model, both for the raw pooled sample of microdata from 1996 to 2012, as well as for the cohort data created from it. The original pooled time-series contains 105,562 observations of individual farms. The average age of a principal operator is 56.2 and they have 25 years of experience. The average annual capital purchase is \$17,352. On average they produce \$106,088 worth of product on 477 acres, and the farm household has a total net worth of \$617,550 which includes an average real estate value of \$514,684 and capital stock of \$260,855. As well, income from off-farm endeavors contributes significantly to their well-being; the average off-farm income is \$75,204[7].

On average, farms pay an average effective marginal tax rate of 17.2 percent, annual interest expenses on farm loans of \$4,582, and machinery leasing and custom work expenses of \$3,682. The percentage of farms with primary operator's listing farming as their primary occupation is 62 percent. The average farm operator completed high school with some years of college, as indicated by the operator educator categorical variable. The average ROA earned by farm is negative, −5.6, while the average ROE is positive, 3.7, but exhibits a wide degree of variation between farms, as seen by its standard deviation of 15.1.

In the next section we discuss the creation of synthetic cohorts, well as the sample means for the newly created panel data.

5. Model and estimation

Panel data model and the creation of a synthetic panel

At a basic level, we wish to observe the behavior of an individual farm at two or more points in time, because we believe this provides us with better information than observing only a single instance in time. A panel gives us the ability to model the differences, and in particular control for time-invariant factors. A simple model for panel data can be specified as the following:

$$Y_{it} = a_i + \boldsymbol{\beta}' \boldsymbol{X}_{it} + u_t + e_{it}, \tag{10}$$

where Y_{it} is the outcome of interest, a_i an individual effect for the unit of observation, $\boldsymbol{X_{it}}$ a matrix of independent variables, u_t is a time-specific, individual-invariant component, and e_{it} a random disturbance. The individual effect is specified as:

$$a_i = \overline{Y}_{i.} - \boldsymbol{b}' \overline{\boldsymbol{X}}_i \,. \tag{11}$$

Because ARMS data are an annual cross-section of farms, if we wish to employ a panel data model and control for group-wise heterogeneity we need to construct a synthetic panel with the repeated cross-sectional samples from ARMS. Following the previous econometric literature on synthetic panel models, namely, that of Deaton (1985), Verbeek and Nijman (1992), Moffitt (1993), and McKenzie (2004), our individual units are created with cohorts means of Y_{it}, $\boldsymbol{X}_{it}$, u_t, e_{it} in order to estimate $\boldsymbol{\beta}$ from Equation (10). This is represented in Equation (12), where $\tilde{Y}_{it}\tilde{\boldsymbol{X}}_{it}$, $\tilde{u}_t$, and $\tilde{e}_{it}$ are mean values:

$$\tilde{Y}_{it} = \tilde{a}_i + \boldsymbol{\beta}' \tilde{\boldsymbol{X}}_{it} + \tilde{u}_t + \tilde{e}_{it}. \tag{12}$$

Using cohorts to create a synthetic panel allows us to control for cohort-specific factors that could influence the phenomenon that we are examining. This means that cohorts must be constructed of homogenous individuals, but there must enough heterogeneity in individuals across cohorts for meaningful inference based on the estimates. Furthermore, the cohorts in the synthetic panel must be stable over time with respect to the characteristics of the individuals who populate them. This is a particularly difficult condition given that the synthetic panel is created with repeated cross sections and there are ample opportunities for individuals to move between cohorts along many dimensions, such as operated acreage, or some measure of production level, such as sales or value of production. One way to ensure stability in cohorts over time is through a relatively stationary cohort grouping categories, as we discuss below.

Synthetic panels have the advantage of being both long and wide: that is, following a large sample of the same individual units over a long period of time. It is common for a "true" panel to follow a large group of people over short period of time (wide), for example the Current Population Survey (CPS)[8] or small group over a longer periods of time, as in the Panel Study of Income Dynamics (PSID)[9] or the National Longitudinal Survey of Youth 1997 (NLSY97)[10]. A cross-sectional survey, on the other hand, presents the researcher with one year of data for a large sample of individual units (people, farms, businesses) surveyed once. Cross-sectional surveys are numerous and can be found in almost any discipline, and they are often repeated for many years. In contrast, the relative dearth of true panels is driven by their cost and administrative complexity. Furthermore, following individuals and businesses over time also poses more than just cost and administrative hurdles. A significant issue with panels is that the composition of the panel can change over time, and in ways that may be related to the outcome one is trying to examine creating what is referred to as attrition bias. A major advantage of the synthetic panel over a tradition panel (same individual units followed over time) is the mitigation of attrition bias. With synthetic panels we do not need to be concerned with farms dropping out of the panel for reasons that could bias our results, because each successive year in the synthetic panel is filled with new farms. For example, in a true panel of farms, if investment is positively related to farm survival then exiting farms would leave us with a panel of farms with increasingly larger investments, potentially leading us to over-estimate the impact of changing tax incentives.

The use of synthetic panels has recently appeared in work evaluating agricultural policies by Whitaker (2009) and O'Donoghue and Whitaker (2010). Whitaker (2009) used a synthetic panel to test for the effects of agricultural supports on farm household consumption. He used data from ARMS for years 1998-2004 to create a synthetic panel of data using 48 states and nine production specialty categories. O'Donoghue and Whitaker (2010) studied the decoupling of farm program payments, also using state-commodity groupings to create cohorts. They group cohorts by two-year periods to increase the number of observations. Morrison *et al.* (2004), also used cohorts of farms to create a synthetic panel, but we would argue that choice of dimension upon which to define the cohorts has a major flaw. Morrison *et al.* (2004) used farm type (retirement and residential, family, and corporate farms) and farm size (sales) to create cohorts with ARMS data to study the impact of use of production contracts on risk management, profitability, and farm structure. Using these dimensions, particularly the sales class, is somewhat troublesome, given that farms can easily move from one cohort to the next over time given fluctuations in commodity prices and other factors that influence gross sales value. Further, the propensity to switch from cohort to cohort could be related to the outcome variable being studied, leading to an endogenous relationship. Ultimately, this means their cohorts as constructed may not be stable over time and lead to biased results.

For our purposes, the first dimension we use to create cohorts is location of farm (state), because farms are not likely to move across states, even as the operation expands or contracts. The other dimension is the production specialty (cash grains, beef cattle, dairy, etc.) of the farm, which is also fairly stable across time, since production specialization may entail production-specific capital that creates a substantial hurdle to switching between specialties[11]. As well, climate may also make switching to a different specialty infeasible. We allow that there could be cohort switching among individuals producing certain cash grain crops, such as soybean and corn, as this is a natural rotation. However, so long as the switching of specialties is not permanent, which it should not be with rotational crops, we could expect that over a sufficiently long period, the observations in the cohorts will be homogenous.

We use 17 years of data, containing a total of 105,562 observations. Because we have a reasonably large number of observations in each year, we are able to create cohorts by interacting 48 states with nine production specialty types for a potential total of 432 cohorts[12]. However, because production does not take place in every state for every specialization, the total number of cohorts is 237 and the average size of a cohort is 577 observations. To be in the dataset a cohort must appear in every year[13].

Because the cohorts are constructed by state and production specialization categories, this is likely to result in cohorts averages that differ from the average of the full sample for several reasons. First, farm production specialization tends to cluster by state, for example, large cash grain operations cluster in the Corn Belt and Upper Plains regions, while small general crop farms cluster in the South. From Table I it is clear that differences across cohorts generate differences in variable averages[14]. For example, average annual capital purchase for the cohorts compared to the full sample was considerably higher ($29,059), and the average value of production was significantly larger ($284,180). Higher as well were average total net worth, value of real estate and capital stocks, at $807,624, $665,595, and $389,838, respectively. The average interest expenses on farm loans and leasing and custom work expenses were roughly double that of the full sample, at $8,398, and $7,902 annually. The average marginal tax rate was slightly lower per cohort compared to the full sample at 15.7 percent. Average operator age, education, and years of experience farming, total farm acreage, off-farm income, and farm crop diversity levels are roughly similar among cohorts, illustrating that these characteristics are relatively independent of state and production specialization between farms.

Estimation

Following others (Whitaker, 2009; Moffitt, 1993; Deaton, 1985) we employ a panel data model that allows us to consistently estimate a model with fixed effects. In this way we are able to remove the average effects within cohorts of cohort-specific factors (Equation (12)). Based on the construction of our cohorts (state × production specialty), we are able to remove factors that are specific to row crop production in Iowa, for example, or beef cattle production in Texas. We also include a marker to identify cohorts of farms that made purchases above the maximum Section 179 amount in previous years, $t-1$, $t-2$, and $t-3$.

The investment model for panel data can be specified as the following:

$$I_{it} = \beta_0 + X_{it}\beta_1 + h_{t_{it}}\beta_2 + Section\ 179_{it}\beta_3 + Limited_{it}\beta_4 + Limited_{it-1}\beta_5 + Limited_{it-2}\beta_6 + Limited_{it-3}\beta_7 + u_t + \varphi_i + e_{it}, \quad (13)$$

where I_{it} is the annual investment of cohort i at time t, X_{it} a vector of the independent variables in our model, h_{tit} the bonus depreciation level that year, $Section\ 179_{it}$ the maximum dollar amount of the Section 179 limit that year, while u_t a time-specific, individual-invariant component and e_{it} a random disturbance.

We can specify φ_i as either a "fixed" individual cohort effect or as a random disturbance term created for each group for each period of the panel. In the former case, specifying the individual effects as fixed assumes that the effect is correlated with at least some of the other variables in the model. Fixed effects allow us to remove individual-specific means (de-mean the regression) over t, controlling for individual-specific unobservable characteristics. In the latter case, treating the individual effect as a random disturbance implies that it is uncorrelated with the other variables in the model, including the disturbance term, e_{it}. Treating the individual effects as random and uncorrelated with other variables in the model when in fact that are not would lead to inconsistent estimators. We test the appropriateness of using a fixed effects compared to a random effects model by estimating both and comparing these using a Hausman test. Under the null hypothesis both the fixed and the random effects models are consistent, while the alternative hypothesis posits that only the fixed effects model is the consistent model.

Heterogeneity and serial correlation

Following the same individuals over time, as is done in a true panel dataset, may create two notable and undesirable characteristics related the data's error structure: heteroskedasticity and serial correlation. These could arise because there may be correlation among error terms both across time and within cohorts in the synthetic panel data[15]. In our research, creating a synthetic panel by forming cohorts of like farms based upon heterogeneous qualities (state and commodity production specialty) may further reinforce differences in investment and other key variables between observations across different cross sections.

Heteroskedasticity could arise in our data for multiple reasons. The first reason is the discrete nature of capital investment: farm capital investment is "lumpy," that is farm equipment, machinery, and structures are bought in discrete, whole units. Another cause is based on the different needs of farms based upon farm size. Smaller farms need and purchase a smaller amount of farm machinery compared to larger farms. Larger farms on the other hand may make larger purchase in one year, while make a small purchase in another. Together, these issues could lead non-constant disturbance terms in our estimation.

To test for heteroskedasticity, we perform two tests. The first is a Breusch-Pagan/Cook-Weisberg test for heteroskedasticity, which detects linear forms of heteroskedasticity present in the data. The null under this test is that the variances are equal across observations. The alternative hypothesis is that the variance is a function of one of the variables and thus correlated with the dependent variable of interest. When applying this to the model we obtain a chi squared estimate of 24,798.44 and probability of $p < 0.0001$.

The second test is a modified Wald test for group-wise heteroskedasticity within a fixed effect regression. This tests the null hypothesis that the variances across cross-sectional units over time are equal against the null that variances differ for units across time but are homoscedastic within cross-sectional units. The procedures applied account for unbalanced cross sections as well as makes adjustments for potential non-normality of errors (Baum, 2001). We reject stationary error and thus estimate our results with robust fixed effects as well as with maximum likelihood random effects[16]. The later method imposes the random effects assumption that the individual error in the observations are uncorrelated with the repressors and the assumption of normality in the error structure, but does not impose any other restrictions on the structure of the variance-covariance matrix. This allows for heterogeneity between cohorts and over time in our estimates. Based on the two tests, we reject the null of homoscedasticity and conclude that heteroskedasticity is present in our sample.

Finally, we test for serial correlation using a simple Wooldridge procedure described by Drukker (2003). The Wooldridge test employs the residuals from a first-differences regression to test for-order serial correlation, corr($\Delta\varepsilon_{it}$, $\Delta\varepsilon_{it-1}$). We use the Stata command *xtserial* to calculate the F-statistics and test the null hypothesis that there is no serial correlation[17].

6. Results

We test two types of estimators for the panel data model: a linear regression model – a fixed effects model – as well as a maximum likelihood estimator (MLE)[18]. In addition to the full sample data, we will test for a structural break in investment demand beginning in 2004 – a period that marks the beginning of both high Section 179 expensing limits and bonus depreciation – as well as evidence of heterogeneous treatment effects by farm size (as measure by GCFI).

In Table II, we present the estimates for the impact of Section 179 expensing and bonus deprecation for the full sample over the 1996-2012 time period[19]. We find that despite large changes over time in the Section 179 expensing amount and the introduction and expansion of bonus depreciation, for every dollar the Section 179 expensing amount was raised, investment increased by \$0.32. Evaluating the coefficient estimate at the means of total annual investment and value of Section 179, this implies an investment elasticity of demand of 0.28, statistically significant at the 1 percent level. The coefficients representing bonus depreciation are not statistically different from 0 in either model.

We expect that higher levels of investment in the past due to a decrease in the after-tax cost of capital may lead to lower investment levels in the current period. This will occur to the extent that tax policy encourages producers to replace assets quicker than they otherwise would have without the tax incentive compared to increases in the optimal level of capital stock held by producers. Because our study uses cohorts of farms, we are able to account for whether the cohort had, on average, made an investment that was over the maximum expensing amount in past years. In Table II, this is presented by the variables $Limited_{t-1}$, $Limited_{t-2}$, and $Limited_{t-3}$. We find that cohorts of farms that were limited by the maximum expensing amount in the past, that is cohorts which made annual investments exceeding the maximum expensing amount, made smaller investments in the present year (*t*) – even in the face of an increased deduction amount. For the sample overall, we find a coefficient of between −1.47 and −2.28 for farms that were limited in the previous year ($t-1$), and −1.59 for farms that were limited two years ago ($t-2$). We do not find statistically significant effects for farms limited at $t-3$.

In Table III we test for differential investment responses before and after 2004. The pre-2004 period encompasses five years of relatively little change in the expensing provisions, followed by a quadrupling of the Section 179 maximum amount. In all, the maximum amount increased 471 percent between 1996 and 2003. In this period, we find a relatively large coefficient on the current Section 179 limit. For every dollar increase in tax value of Section 179, we find a \$1.11 incremental investment (Table III). The investment elasticity pre-2004 is 0.25. In period 2004 and beyond we estimate a coefficient on the Section 179 limit of 0.41, which implies an investment elasticity of 0.50.

	FE 1/	MLE	FE 1/	MLE
Section 179	0.37 (0.27)	0.32 (0.13)**		
$Limited_{t-1}$	−2.28 (0.93)**	−1.47 (0.66)*		
$Limited_{t-2}$	−2.06 (1.30)	−1.59 (0.40)*		
$Limited_{t-3}$	0.11 (0.37)	0.10 (0.38)		
Bonus depreciation			−46,133.0 (86,428.80)	−40,716.40 (64,168.70)
R^2	0.28		0.25	
Log likelihood		−38,714.16		−42,169.35
LR χ^2 (Prob > χ^2)		1,039.98 (< 0.0001)		1,027.27 (< 0.0001)
Sample size	3,035		3,035	

Notes: 1/, standard errors are clustered by cohort to control for within-panel first order correlation in errors, as well as conditional heteroskedasticity. Includes dummies for year, farm type, cohort × year interaction, and lagged limited marker. *,**Statistically significant at the 5, and 1 percent level, respectively
Sources: USDA Economic Research Service and National Agricultural Statistics Service, Agricultural Resource Management Survey (1996-2012)

Table II. Estimates of the impact of Section 179 and bonus deprecation: full sample, 1996-2012

Table III. Estimates of the impact of Section 179: pre- and post-2004

	Dependent variable: capital investment							
	Pre-2004				Post-2004			
	FE 1/	MLE	FE 1/	MLE	FE 1/	MLE	FE 1/	MLE
Section 179	1.00 (0.70)	1.11 (0.38)**			0.48 (0.35)	0.41 (0.16)**		
$Limited_{t-1}$	1.53 (1.13)	0.92 (0.71)			−2.30 (1.55)	−1.01 (0.98)		
$Limited_{t-2}$	−2.73 (0.65)**	−1.62 (0.56)**			−3.56 (2.41)	−2.70 (0.54)*		
$Limited_{t-3}$	−0.078 (1.02)	−0.39 (0.68)			0.39 (0.68)	0.18 (0.52)		
Bonus depreciation			1,711,296.00 (132,571.60)	266,084.90 (69051.40)**			−20,766.79 (70,983.90)	−43,312.74 (85,949.83)
R^2	0.42		0.39		0.32		0.32	
Log likelihood		−12,320.76		−15,903.29		−25,410.00		−25,542.81
LR χ^2 (Prob > χ^2)		644.37 (< 0.0001)		691.39 (< 0.0001)		822.86 (< 0.0001)		770.05 (< 0.0001)
Sample size	1,065	1,065	1,327	1,327	1,970	1,970	1,976	1,976

Notes: 1/, standard errors are clustered by cohort to control for within-panel first order correlation in errors, as well as conditional heteroskedasticity. Includes dummies for year, farm type, cohort × year interaction, and lagged limited marker. *,**Statistically significant at the 5, and 1 percent level, respectively

Sources: USDA Economic Research Service and National Agricultural Statistics Service, Agricultural Resource Management Survey (1996-2012)

The larger coefficient value that we find in the pre-2004 period is consistent with the conditions that are necessary for a farm business to take advantage of the deduction. Prior to 2004, on average 16.5 percent of farms had made total annual purchases over the expensing limit; after 2004, only 2.9 percent had done so. Falling marginal tax rates were also responsible. Again, prior to 2004, the average effective marginal tax rate was 17.2 percent, while in the post-period the average was 14.4 percent.

On the other hand, we find a larger elasticity estimates in the post-2004 period due to the underlying values of the Section 179 expensing amounts. The tax value of the change to Section 179 post-2004 was much larger. On average the tax value of the Section 179 deduction was $38,873 in the post-2004 period, while it was less than $6,000 in the pre-2004 period. As a result when measured as an investment elasticity, post-2004 is more responsive than pre-2004.

Additionally, the pre-2004 period also coincides with the introduction of bonus deprecation. Before 2001, there was no allowance for additional depreciation (see Figure 1). Bonus depreciation was introduced in 2001 at a rate of 30 percent and raised to 50 percent in 2013. In the pre-2004 period, the coefficient on bonus depreciation is statistically significant in MLE model and returns an elasticity of investment demand of 0.30 (Table III). We find the post-2004 elasticity of investment demand is 1.04, but cannot reject the null hypothesis of no effect of bonus depreciation on farm investment.

We also conduct tests for heterogeneous treatment effects by farm size, because in general larger farms, as measured by GCFI, make larger capital purchases. Given this difference, we investigate capital investment by GCFI. When we subset the data by GFCI, we find that the effect of the tax incentives are increasing in farm size as measured by GCFI. Table IV reports investment coefficients, using $10,000 of GCFI as the sample cutoff. We find a statistically robust effect on investment given changes in the expensing deduction. The estimated coefficient on the expensing limit is 0.36, implying an elasticity of 0.30. We find no effect on investment given a change in the expensing provision for farms with less than $10,000 of GCFI.

Like the results in the full sample, we find that farms with at least $10,000 reduced their investment at time t if they had made an investment above the limit at time t−1 or t−2.

If we consider only mid-sized or larger farms, defined as those with at least $350,000 of GCFI, the estimated coefficients increase in size (Table V). However, the standard errors become large, thus the coefficients are not statistically significant.

Again, in Table V, we find that cohorts of farms that were limited by the maximum expensing amount in the past, that is cohorts which made annual investments exceeding the maximum amount, made smaller investments in the present year (t) – even in the face of an increased deduction amount.

7. Discussion

The vast majority of farms do not make annual investments in machinery, equipment, and other qualified property that, in aggregate, exceed the Section 179 limit. We calculate only 7 percent of large farms made an investment exceeding $500,000. In this context, raising the expensing limit would provide the greatest incremental benefit to farms that are likely to make investments above the limit. A priori, given the structure of the agricultural sector – a majority of small farms and a concentration of production on relatively few large commercial farms – we do not expect the Section 179 deduction to have a large effect. Our expectations are confirmed for several reasons. First and foremost, few farms make a purchase that exceeds the maximum expensing amount. In our sample just under 10 percent of farms made a purchase that was over the

Table IV. Estimates of the impact of Section 179: excluding small farms

	Dependent variable: capital investment							
	Farms with less than \$10,000 of GCFI				Farms with at least \$10,000 of GCFI			
	FE 1/	MLE	FE 1/	MLE	FE 1/	MLE	FE 1/	MLE
Section 179	−0.044 (0.051)	−0.041 (0.029)			0.40 (0.29)	0.36 (0.14)**		
Limited$_{t-1}$	0.54 (0.22)	−0.20 (0.12)			−3.17 (1.46)*	−2.15 (0.83)**		
Limited$_{t-2}$	0.65 (0.46)	−.10 (0.39)			−2.18 (1.29)	−1.69 (0.42)**		
Limited$_{t-3}$	−0.23 (0.17)	0.012 (0.11)			−0.043 (0.46)	−.020 (0.47)		
Bonus depreciation			−16,856.59 (31,963.59)	6,065.05 (20,836.87)			−75,852.18 104,271.70	−56,391.93 (69,334.56)
R^2	0.09		0.1234		0.291		0.267	
Log likelihood		−1,683.44		−1,965.12		−36,654.8		−39,805.01
LR χ^2 (Prob $> \chi^2$)		92.19 (0.0048)		66.32		970.58 ($<$ 0.0001)		951.25 ($<$ 0.0001)
				0.1212				
Sample size	167		192		2,868		3,111	

Notes: 1/, standard errors are clustered by cohort to control for within-panel first order correlation in errors, as well as conditional heteroskedasticity. Real gross cash farm income less than \$10,000. Includes dummies for year, farm type, cohort × year interaction, and lagged limited marker. *,**Statistically significant at the 5, and 1 percent level, respectively

Sources: USDA Economic Research Service and National Agricultural Statistics Service, Agricultural Resource Management Survey (1996-2012)

Table V.
Estimates of the impact of Section 179: large commercial farms

	Dependent variable: capital investment							
	Excluding farms with more than $349,999 GCFI				Excluding farms with less than $350,000 GCFI			
	FE 1/	MLE	FE 1/	MLE	FE 1/	MLE	FE 1/	MLE
Section 179	0.016 (0.066)	0.032 (0.047)			0.72 (0.65)	0.56 (0.44)		
$Limited_{t-1}$	−1.99 (0.69)**	−0.68 (0.28)*			−4.93 (2.73)	−2.89 (2.17)		
$Limited_{t-2}$	−0.14 (0.51)	−0.11 (0.31)			−2.33 (2.36)	−2.51 (0.96)*		
$Limited_{t-3}$	0.54 (0.57)	0.46 (0.15)**			0.12 (0.99)	−0.33 (1.28)		
Bonus depreciation			33,011.98 (46,406.91)	38,285.06 (25,008.57)			−380,728.90 (375,987.9)	−327,658.7 (225,482)
R^2	0.18		0.23		0.23		0.23	
Log likelihood		502.55		658.01		267.40		−9,862.89
LR χ^2 (Prob > χ^2)		−27,121.73 (< 0.0001)		−29,655.13 (< 0.0001)		−9,187.06 (< 0.0001)		242.16 (< 0.0001)
Sample size	2,351	2,351	2,570	2,570	684	684	733	733

Notes: 1/, standard errors are clustered by cohort to control for within-panel first order correlation in errors, as well as conditional heteroskedasticity. Real gross cash farm income over $350,000. Includes dummies for year, farm type, cohort × year interaction, and lagged limited marker. *,**Statistically significant at the 5, and 1 percent level, respectively
Sources: USDA Economic Research Service and National Agricultural Statistics Service, Agricultural Resource Management Survey (1996-2012)

expensing amount. In fact, in the latter years of the data, few farms made total annual investments that were even close to the maximum amount. If we consider the maximum amount to be a threshold, only 4 percent of farms made total annual capital purchases that were within 25 percent of the maximum expensing amount over the 1996-2012 time period. Of these, less than 2 percent were within 10 percent of the maximum amount. Practically, this means that farms are already able to take advantage of full expensing amount, to the extent that they have income to offset with the deduction. Consequently, raising the deduction should have little effect on farms already spending below the limit.

Second, the value of the tax deduction is based on the effective marginal tax rate faced by the farm. While we find that the effective marginal tax rate could be as high as 56 percent, the average rate faced by farms was 15.7 percent (SD = 0.067) over the 1996-2012 time period. Even large commercial farms with GCFIs over $1,000,000 – the farms that are most likely to make a purchase that exceeded the expensing limit had – on average face an effective marginal tax rate of only 22 percent (SD = 0.098)[20]. The same reasoning holds for bonus depreciation. For example, at the mean effective marginal tax rate, the percent change in the tax value of the 30 percent allowance is less than 0.5 percent[21]. Furthermore, for large commercial farms with an average effective marginal tax rate of 22 percent, the percent change in the tax value of bonus depreciation is still less than 1 percent[22]. For these reason, we do not see large sector-wide effects from raising the investment incentive.

Our findings of small impacts from changes in the tax policy on agricultural producers as a whole are similar to those of other non-agricultural firm survey results. According to Cohen and Cummins (2006): "The Empire State Manufacturing Survey for September 2004 indicated that only three of thirty respondents cited expensing as a reason to increase capital spending." Further they report the 2004 NABE Survey found only 10 percent of respondents reported expensing was a priority of management. Finally, they cite a 2004 Philadelphia Fed Survey that again illustrated the small impact of tax policy changes on the majority of firms. Within this survey, only 12 percent of manufactures and 2 percent of non-manufacturers listed expensing a one of the factors leading to a change in capital spending.

8. Conclusion

Expensing of capital investment under Section 179 and Section 168(k) of the tax code can offer significant savings to some farmers, particularly if a large purchase is made and the two provisions are used together. All else equal, the sooner the cost is recovered, the more valuable is the tax deduction. Over the last decade, the amount of capital expenses a farmer could immediately deduct under Section 179 has increased substantially. Between 2000 and 2014, the maximum amount that could be expensed under Section 179 rose from $25,000 to $500,000. Bonus depreciation allowance, not available prior to 2001, was 50 percent in 2014. Using detailed microdata from the US Department of Agriculture, we create a synthetic panel and follow cohorts of like farms over a 17-year period and test for the impact of changes in the cost recovery provisions on farm capital investment demand. We estimate investment demand elasticities of between 0.25 and 0.50, after controlling for a host of farm and farmer characteristics, as well as the effective marginal tax rate of the farmer. We find that increasing the percentage allowance of bonus depreciation only had a statistically significant effect if we limit our analysis to the pre-2004 period, the period which saw the introduction of the allowance.

Moving forward, policy makers may want to know whether and to what extent the tax code influences farm capital purchases. Our estimates suggest there is a modest effect of the provisions on investment, and it is driven by farms that have more than $10,000 in GCFI. To the extent that the deduction influences farm investment, there are implications for the agricultural sector that need to be addressed, such as the impact of encouraging investment in new machines on technology adoption and associated benefits, including cost of production or conservation practices. Furthermore, because larger farms are able to make larger purchases, the policy could contribute to the growing concentration in production as farms expand their operated acreage to take advantage of increasingly efficient physical capital. The next step in our research will be to examine the linkage between investment and technology adoption and farm concentration.

Notes

1. Author's calculations from USDA's 2012 Agricultural Resource Management Survey.
2. 26 US Code, Subtitle A, Chapter 1, Subchapter b, Part VI – Itemized Deductions for Individuals and Corporations.
3. The deduction takes place in the year in which the property is placed in served, but we assume the purchase year is the same as the placed-in-service year.
4. The mechanics of how the expensing and bonus depreciation deductions are coordinated are illustrated in the Internal Revenue Form 4562 (Depreciation and Amortization) published by the Internal Revenue Service.
5. Commodities are divided into 26 mutually exclusive groups for which we calculate a value of product. Values that approach 1 imply production of a greater number of commodities.
6. Calculations were performed separately for: (1) buildings/structures and (2) machinery, tractors, trucks, and equipment. Within each category and for each farm separately, investment during the year was subtracted from the value of capital stocks on December 31. The results were multiplied by (1+ economic depreciation rate ($\delta_{i,t}$)). The BEA estimate of 0.0239 for depreciation on farm building and structures was used for (1) and an average of their estimate of 0.1452 for farm tractors, 0.1179 for agricultural machinery, and 0.1925 for trucks was used to calculate economic depreciation for (2).
7. All dollar figures are adjusted to reflect 2012 dollars.
8. The CPS samples 60,000 occupied households, but follows them for only 16 months. Available at: www.census.gov/cps/methodology/
9. The PSID started with 5,000 families and 18,000 individuals. Available at: http://psidonline.isr.umich.edu/
10. The NLSY97 began with a nationally representative sample of 9,000 youth 12-16 year old and are interviewed annually.
11. A farm is assigned a production specialty based on the value of production. If a commodity accounts for at least 51 percent of the farm's total value of production, that commodity regarded as the specialty.
12. The production specialization categories are: cash grains (corn, soy bean, wheat, and rice); tobacco, cotton, and peanuts; fruits, nuts, and vegetables; nursery and greenhouse; beef cattle; hogs; poultry; dairy; and other crops and livestock. Farms are placed into categories based on the majority of their production, i.e., if 51 percent of their production is beef cattle, they are placed in the beef cattle production specialization category.

13. Verbeek and Nijman (1992) report that cohorts with 100-200 individuals are needed in order to avoid bias associated with a synthetic panel.
14. The difference in values from the pooled data reflects the differences across cohorts.
15. For the error term U, the condition that $\mathrm{cov}(U_{it}, U_{js}) = 0$ is likely to fail when $i = j$ for $t \neq s$ (correlated errors within cohorts across time).
16. We obtain a test statistic of χ^2 (234) = 5.5e+06 and prob > $\chi^2 \leqslant 0.00001$
17. We reject the null of no serial correlation, $F = 13.253$, prob > $F = 0.003$.
18. The test hypothesis is $(b-B)'[(V\_b-V\_B)\hat{}(-1)](b-B)$ where b is the set of fixed effects estimates, consistent under H_0 and H_a, and B are the set of random effects estimates, inconsistent under H_a, efficient under H_0, and V is the variance-covariance matrix of B and b, respectively. Given the null hypothesis, this has a χ^2 distribution and $K-1$ degrees of freedom. Performing the Hausman test we obtain a χ^2 statistic of 145.98 and probability of $p < 0.000$. We reject the random effects model in favor of the fixed effects model.
19. Bonus depreciation and Section 179 are strongly positively correlated (pairwise correlation coefficient of 0.728) and significant at the 1 percent level of significance. When they are both estimated simultaneously using Equation (13), the bonus depreciation variable is dropped. Therefore, we run separate regressions for each variable; however, this should not result in a large bias for several reasons. First, although they can be used together, average investment was significantly less than the Section 179 limit, especially during the period in which bonus was in effect. Second, we are not estimating the effect of the two provisions together on individual farms – where they may be used together – but rather on cohorts of similar farms. This mitigates the lack of including bonus deprecation in the same equation with Section 179. Finally, bonus only applies to newly manufactured equipment, making it likely that Section 179 would be used before bonus depreciation.
20. Authors' calculation using ARMS data, 1996-2012.
21. From the baseline of no bonus depreciation allowance.
22. The net present tax value of bonus depreciation can be quite small, particularly in times of low nominal interest rates. With a nominal rate of 7 percent and a bonus depreciation allowance worth 100 percent, the maximum tax value of the subsidy is 7.68 percent relative to a baseline of no bonus depreciation. For context, the last time that the nominal ten-year Treasury security yielded 7 percent was in 1991. The average yield between 1997 and 2012 was 4.35 percent; therefore, the value of the tax subsidy has been between 1.5 and 5.2 percent of the cost of the investment (authors' calculations; a full table of NPVs based on different bonus depreciation rates is available from the authors).

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