Does proprietor wealth influence small business decisions?
Land appreciation and farm business borrowing, land ownership, and output

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Abstract: We study how increases in wealth from the appreciation of U.S. farmland influenced farm proprietor decisions to borrow, buy land, and expand. Exploiting periods of high and low appreciation that caused different increases in wealth for proprietors owning a larger or smaller share of their farmland, we find that each dollar increase in paper wealth led younger proprietors to increase real-estate-secured borrowing by 48 cents. Land purchases accompanied the increase in borrowing, supporting the view that collateral-based lending may be contributing to the recent run-up in farmland prices. We find no effect of land wealth on production or acres harvested.

JEL Codes: D22, Q12, D3

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Large changes in housing and stock prices in the 2000s have motivated recent studies of how consumers respond to changes in their wealth (Campbell and Cocco, 2007; Bostic et al., 2009; Attanasio et al., 2009; French and Benson, 2011). An asset price change and the subsequent effect on wealth may also influence the decisions of small businesses proprietors to invest and expand. About 12 percent of households in the U.S. include at least one business owner, and sole proprietorships account for roughly 73 percent of U.S. businesses (Haynes, 2010).[1] Credit constraints, risk preferences, or imperfect labor markets could create a link between proprietor wealth and business decisions. Changes in wealth may also affect the decision to own or rent land or other capital items – an implication not addressed in the current literature.

Several recent studies have estimated how increases in wealth from appreciation in housing affects the likelihood of becoming an entrepreneur (Hurst and Lusardi, 2004; Disney and Gathergood, 2009; Fairlie and Krashinksy, 2012). Among the three studies, Fairlie and Krashinsky (2012) use the most geographically specific measure of housing prices (measured at the metropolitan statistical area level) and find that appreciation increases entry into self-employment. Yet no studies that we know of examine how wealth changes from asset appreciation affects the decisions of people who already own a business.

We study how appreciation in farm real estate affected farm borrowing, land purchases, and production. The large increase in farmland values after 2004 and the many households with farm businesses provides an attractive opportunity to study the link between asset appreciation, proprietor wealth, and business activity. In general, small businesses are diverse: they may sell grapes to China or tax services to local businesses; they may require several million dollars to reach a profitable scale or hardly any capital at all; and their assets may be concentrated in specialized machinery or intellectual property. In contrast, farm businesses, especially those

growing crops in the U.S. Heartland – the focus of our article – tend to be similar. They employ land, labor, tractors, seed, and fertilizer to grow crops traded in global commodity markets. Their uniformity reduces the empirical challenging of controlling for confounding factors associated with different business types. And because most of the wealth of farm households and businesses is in farmland, a change in the price of farmland will cause a large change in wealth, making it easier to statistically detect a wealth effect.

In looking at borrowing and land purchases we also assess the possibility that collateral-based lending is contributing to a bubble in farmland values as some have discussed (Shiller, 2011; Gloy et al., 2011; Henderson 2012). In each year from 2010 to 2012, Iowa farmland appreciated by more than 15 percent and a similar trend has been observed nationally (USDA-NASS, 2012; Duffy, Johanns, and Klein, 2013). Collateral-based lending could amplify the effect of an initial increase in land prices, with the land-related increase in wealth leading to more borrowing to buy land, which further increases land prices and wealth (Adrian and Shin, 2010; Rajan and Ramcharan, 2012). Yet, no study has empirically shown that increases in land wealth causes farmers to borrow to buy more land.

To identify the response to changes in wealth, we exploit an increase in land appreciation caused in large part by the 2005 Energy Policy Act, which increased the amount of biofuels required to be mixed with gasoline sold in the U.S. market. In 2004 the ethanol industry accounted for 14 percent of U.S. domestic corn consumption; by 2007 it accounted for nearly 30 percent. Corn prices followed suit: after being stagnant from the late 1990s to the mid-2000s, they doubled from 2005 to 2007 (USDA-ERS, 2013a). Higher corn prices in turn increased agricultural land values. From 1997 to 2002 the average value of farm real estate increased by 20

percent in real terms; from 2002 to 2007 it increased by 44 percent, with the faster appreciation occurring between 2004 and 2007 (see figure 1).

Figure 1.

As land prices increased, farmers who owned more of their land had a larger wealth gain than those with similar farms but who rented more of their land. Linking farms surveyed in the 1997, 2002, and 2007 Censuses of Agriculture allows us to observe farm-level changes in borrowing, land ownership, and production. Identification of the wealth effect comes from farms who own a greater share of their land expanding faster from 2002 to 2007 than from 1997 to 2002 compared with farmers owning less of the land that they operate.

Our empirical approach is similar in spirit to that of Campbell and Cocco (2007) who interact changes in regional housing prices with a variable indicating whether the household owns or rents its home (since only owners experience wealth increases from higher prices). Our approach has several strengths compared to that of Campbell and Cocco. First, whereas most people either own or rent their home, most crop farmers rent some of the land that they farm, allowing us to exploit variation in ownership shares within the renter group, which we define as those owning 10 to 90 percent of the land that they farm. Second, observing the same farm in three different years allows us to control for the possibility that owners (farmers who own a greater share of land) tend to expand more quickly (or slowly) than renters (farmers who own a smaller share). Lastly, rather than relying on spatial variation in real estate appreciation that might be correlated with local conditions affecting business decisions, we rely on an unexpected increase in land appreciation across time caused in large part by the 2005 Energy Policy Act.

We find that younger farmers who experienced larger gains in land wealth increased the real-estate-secured borrowing. They also bought more land but did not expand production more than farmers with smaller gains. Consistent with the theory that collateral-based lending can amplify an initial increase in land values, for each $10,000 dollar increase in wealth younger farmers acquired roughly $4,900 more real-estate-secured debt and bought about six more acres. To test if the findings reflect land-induced increases in wealth or spurious correlation, we re-estimate the model for the 1992 to 2002 period when land appreciated at a stable rate. The effect on borrowing and land purchases disappear, giving us greater confidence that the estimates from the 1997 to 2007 period reflect a causal link between land wealth, borrowing, and land purchases.

I. Why Wealth Can Matter: Theory and Evidence

Much of the literature on household wealth and business activity centers on the role of wealth as a direct source of financing or as collateral for a loan. In modeling occupational choice, Banerjee and Newman (1993) assumed that becoming an entrepreneur requires a minimum investment and because capital markets are imperfect and require collateral for loans, only individuals with sufficient initial wealth become entrepreneurs. This view has been supported by several studies documenting a positive relationship between wealth and the probability of starting a business (Evans and Jovanovic, 1989; Evans and Leighton, 1989; Holtz-Eakin et al., 1994b; Quadrini, 1999; Gentry and Hubbard, 2004).

The correlation between initial wealth and subsequent business entry could be confounded by unobservable factors correlated with wealth such as ability. As a solution,

Blanchflower and Oswald (1998) and Holtz-Eakin, Joulfaian and Rosen (1994a) used inheritances as a source of exogenous variation in wealth. Both studies found that households that received inheritances were more likely to start a business, evidence that liquidity constraints could limit business ownership. But, Hurst and Lusardi (2004) and Disney and Gathergood (2009) showed that inheritances are a poor instrument for wealth since past and future inheritances are correlated with self-employment. Unanticipated changes in housing values provide another potentially exogenous source of variation in wealth. Increases in home equity should allow potential entrepreneurs to more easily obtain financing. Hurst and Lusardi (2004) and Disney and Gathergood (2009) found no statistically significant correlations between housing capital gains and entry into entrepreneurship. Fairlie and Krashinsky (2012), however, use a more geographically-specific measure of housing prices and found a positive effect of appreciation on self-employment.

Although no studies that we know of have looked at how a wealth gain from asset appreciation affects the decisions of existing proprietors, several studies have looked at proprietor responses to cash windfalls. Holtz-Eakin, Joulfaian and Rosen (1994a) found that an inheritance increased the probability of continuing as a sole proprietorship and, conditional on survival, business receipts. Taylor (2001) also found that larger windfalls (e.g. from inheritances or lottery winnings) were associated with greater self-employment income.

Wealth and access to financing should be important for entrepreneurs in industries like agriculture that require substantial capital. A mid-sized John Deere tractor that is used can cost more than $50,000. Even farmers who rent land and machinery need access to substantial funds for operating expenses. Growing corn in the U.S. heartland on 174 acres – the average size of the

beginning farm – would require more than $95,000 in working capital (Ahearn and Newton, 2009; USDA-ERS, 2013b).

Land often serves as collateral for agricultural loans, which is why the boom and bust of farmland prices in the U.S. in the 1970s and the early 1980s contributed to a rate of farm bankruptcies not seen since the Great Depression (Stam and Dixon, 2004; Rajan and Ramchara, 2012). The boom and bust motivated the theoretical studies of capital gains (or losses) from changing farmland values by Plaxico and Kletke (1979) and Lowenberg-DeBoer and Boehlje (1986). In the model by Lowenberg-DeBoer and Boehlje land appreciation increases collateral for loans and the loan to value ratio for land already leveraged, allowing credit-constrained farmers to increase borrowing and expand production.

No empirical work tests the implications of the Lowenberg-DeBoer and Boehlje model, but several studies show that wealth in general is at least correlated with machinery investment. Hubbard and Kashyap (1992) estimate a model of investment in agriculture and find that changes in net worth in the sector were correlated with machinery investments. Similarly, using farm-level data, Bierlen and Featherstone (1998) find evidence that following the 1980's farm crisis, indebted farms faced stringent constraints on new machinery investments. More recently, Briggeman, Towe, and Morehart (2009) find that U.S. farm businesses with greater net worth are less likely to have been denied credit.

A. Wealth, Borrowing, Land Ownership, and Farm Size – A Simple Model

Lowenberg-DeBoer and Boehlje (1986) suppose that the cost of borrowing to purchase land decreases with the farm's debt-to-equity ratio. An unrealized capital gain from land

appreciation serves as equity when applying for a loan, thereby reducing the risk to the lender that the borrower defaults (Plaxico and Kletke, 1979). Here we posit a simple model to better understand a farm proprietor's response to higher crop and land prices when borrowing costs depend on wealth.

The farm proprietor starts with a land endowment of l_e. If the proprietor can increase profits by farming more acres than her endowment, she will expand by renting land for p_{rent} per acre or through buying land for p_{buy} per acre. To keep the model simple, we assume that the proprietor debt finances the entire land purchase l_{buy} at an interest rate that is an increasing linear function of the risk-free interest rate and the proprietor's debt to wealth ratio, which is initially $l_{buy}p_{buy}/l_e p_{buy}$. Specifically, let the interest rate faced by the proprietor equal $r\left[\alpha \frac{l_{buy} \cdot p_{buy}}{l_e \cdot p_{buy}}\right]$, where r is the risk-free interest rate and the term in brackets is greater than one. The total land farmed is the sum of the land endowment, land purchased, and land rented ($L = l_e + l_{buy} + l_{rent}$).

We graphically illustrate the proprietor's response to an increase in crop and land prices and then more fully describe the implications derived from the model. In figure 2 the intersection of the demand curve for land and the wealth-dependent marginal cost of acquiring land through purchase, indicated by $c\left(\frac{debt}{wealth}\right)$, gives the acres of land that the proprietor initially owns ($l_e + l_{buy}^1$). The intersection of the demand curve with the land rental rate gives the total land farmed. The difference between land farmed and land purchased is land rented.

An unexpected increase in the crop price shifts the demand curve for land outward and increases the price of buying and renting land. The figure shows a decrease in the cost of acquiring land through purchase (with the cost curve shifting outward) because of a decline in

the debt to wealth ratio from capital gains on land owned. We note that the proprietor's cost of purchasing land may not necessarily decline since the increase in the price of land could offset the decline in borrowing costs. However, it will always become relatively cheaper to acquire land through purchase than through renting. In response, the proprietor will buy more land. The total land in the farm may increase, decrease or stay the same. Which case occurs depends on the change in the demand for land and the rental price, which in turn affects how much land the farmer will rent. Figure 2 depicts the case where land rented decreases and the total land in the farm is unchanged.

B. The Model in Detail

Before deriving the relationships depicted in the figure, we discuss several assumptions and the stylized facts supporting them. The first assumption concerns the farm proprietor's initial land endowment. Beginning farmers often acquire land through inheritances or by purchasing it from relative, often for a below-market price. A U.S. Department of Agriculture survey of farm operators found that 21 percent acquired land through inheritance and 32 percent purchased land from a relative (Rogers and Wunderlich, 1993). Supporting the notion that farmland is passed to successive generations at discounted rates, another survey revealed that of all the land transacted by family farms in 1999, the price at which family farmers sold land was a third higher than the price at which they bought land ($1,321 versus $989) (USDA-NASS, 1999a).

A second assumption is that crop prices increase farmland rental prices. Most land contracts are annual contracts that specify the landlord's compensation as a share of total production (a share lease) or as a fixed cash payment (a cash lease). Under a share lease, higher

crop prices at harvested time are directly incorporated into the rental payment since a given share of production is worth more when prices are high. Cash leases specify the rental payment before planting and hold for the remainder of the year. But because most cash leases are annual, payments can change from year to year according to prices. From 2006 to 2007, for example, average cash rental rates for cropland in Iowa increased by almost 10 percent (Edwards, 2009).

A third assumption is that land rents determine land prices. Although nonagricultural factors clearly influence land prices, particularly in urbanizing areas, there is ample evidence of a strong relationship between rental income and farmland values (Alston, 1986; Falk, 1991). In particular, Alston (1986) concludes that net rental income to land explains most of the increase in real farmland prices from 1963 to 1982 (Alston, 1986). More recently, Nickerson et al. (2012) show that the price to value ratio for farmland (actual farmland values divided by the present value of a flow of rental payments) was near one for much of the 2000s.

Turning to the model's derivations, we focus on decisions regarding land and assume that the proprietor optimally adjusts other inputs. In the initial period (denoted by the superscript) the proprietor buys and rents land to maximize profits:

$$\pi_1 = p^1_{crop} f(L) - p^1_{rent} l^1_{rent} - p^1_{buy} l^1_{buy} r\alpha \frac{l^1_{buy}}{l_e}. \tag{1}$$

The crop price reflects (implicitly) conditions outside the model, namely policy (i.e. biofuel mandates) and global crop demand and supply. Because the land market is competitive, the land rental price equals the marginal value product of land. The purchase price of land, in turn, is the discounted value of an infinite series of discounted rental payments: $\frac{p_{rent}}{R}$, where the rate at which rent payments are discounted is greater than the risk-free rate ($R > r$). (Though we do not consider risk in the model, the higher discounting of rent payments would reflect the

variability in returns from farming). Both the discount rate (R) and the risk-free interest rate (r) are determined outside the model and are independent of the crop price.

We consider a proprietor who buys and rents some land, in which case profit maximization implies:

$$p^1_{crop} f' = p^1_{rent} = 2p^1_{buy} r\alpha \frac{l^1_{buy}}{l_e}. \tag{2}$$

Because the cost of renting land is the same regardless of how much the proprietor rents, buying any land implies that acquiring land through purchase is initially less costly than renting it. As the proprietor buys more land, $\frac{l^1_{buy}}{l_e}$ becomes larger, increasing the cost of acquiring land through purchase. The cost increases until it equals the rental price, after which the proprietor's land needs are met through renting. Our definition of the land rental rate combined with (2) imply that the optimal acres to purchase, $l^1_{buy} = \frac{l_e R}{2\alpha r}$, depends on the initial land endowment but not the crop or land price.

Now suppose that the crop price increases unexpectedly and by extension so does the land rental and purchase price. Recall that the cost of borrowing depends on the proprietor's debt to wealth ratio. When the land price increases (to p^2_{buy}) the proprietor earns a capital gain on her land endowment and land previously purchased. The new cost of acquiring an acre of land through purchase is then

$$p^2_{buy} r\alpha \left(\frac{\text{debt}}{\text{wealth}}\right) = p^2_{buy} r\alpha \left(\frac{l^1_{buy} p^1_{buy} + l^2_{buy} p^2_{buy}}{l_e p^2_{buy} + l^1_{buy} \Delta p_{buy}}\right) \tag{3}$$

where wealth is the value of the endowment plus the capital gain earned on l^1_{buy}. Using ρ to represent continued payment for land already purchased (whose price and quantity are exogenous to the post-price-increase decision) the updated profit maximization problem is

(4) $$\pi_2 = p_c^2 f(L) - p_{rent}^2 l_{rent}^2 - p_{buy}^2 l_{buy}^2 r\alpha \left(\frac{l_{buy}^1 p_{buy}^1 + l_{buy}^2 p_{buy}^2}{l_e p_{buy}^2 + l_{buy}^1 \Delta p_{buy}} \right) - \rho.$$

Substituting the expression derived above for the optimal initial land purchase into the first order conditions from (4), we can solve for the land purchased in response to the price increase, which gives:

(5) $$l_{buy}^2 = \frac{R}{2\alpha r p_{buy}^2} \left(wealth - \frac{p_{buy}^1 l_e}{2} \right).$$

An increase in land prices ensures that the term inside the parentheses is positive, implying that an increase in crop and land prices causes the proprietor to buy more land.

Empirically, the comparative static of most interest is whether proprietors who received a larger capital gain bought more land compared to those with a smaller gain. Variation in the total capital gain across proprietors reflects how much land they initially owned ($l_{buy}^1 + l_e$), which is determined by the land endowment (l_e). Differentiating (5) with respect to the land endowment shows that proprietors with larger capital gains buy more land:

(6) $$\frac{\partial l_b^2}{\partial l_e} = \frac{R}{2\alpha r p_l^2} \left(p_l^2 - \frac{p_l^1}{2} \right) > 0.$$

A pertinent question is from whom does the proprietor buy land? The most likely scenario is from an older landowner who is not a farmer. In 1999 (the last time nonfarm landlords were surveyed), nonfarmers owned two-thirds of the land in farms. And of the land owned by nonfarmers, the same fraction (two-thirds) was owned by individuals or families. Nonfarm landlords also tended to be older: more than 60 percent were 65 or older (USDA-NASS, 1999).

Despite the land purchase the total land in the farm ($L = l_e + l_{buy} + l_{rent}$) may not increase. The proprietor rents land until its marginal value product equals the rental price, and this holds before and after the crop price increase. Combining the two conditions corresponding to the periods of higher and lower prices and rearranging gives

(7) $$\frac{f_2^{'}}{f_1^{'}} = \frac{p_r^2/p_r^1}{p_c^2/p_c^1}$$

The farm becomes larger if the proportional increase in the rental price (p_r^2/p_r^1) is smaller than the proportional increase in crop prices (p_c^2/p_c^1). When this is the case, $\frac{f_2^{'}}{f_1^{'}}$ will be less than one (assuming *f* is concave), meaning that more land is employed in production in the higher price period. But if *f* is constant returns to scale and the supply of land is fixed, then the rental price increases in the same proportion as the crop price and there is no change in farm size.

More importantly, as long as the farmer rents in some land, the marginal cost of expanding on the extensive margin – the rental price of land – is independent of the wealth gain. In contrast, if the cheapest way to expand is through buying land and the cost of borrowing depends on wealth, then wealth gains will influence the farm's optimal size.

C. Wealth and Risk

Risk appears to matter for entry into entrepreneurship. Fossen (2011), for example, found that individuals owning a business report a higher willingness to assume risk than others. Similarly, Bracke, Hilber, and Silva (2012) found that purchasing a house decreases the likelihood of starting a business by 20 to 25 percent and argue that purchasing a house reduces the diversity of the household's asset portfolio, motivating the homeowner to avoid the risk of entrepreneurship.

If risk affects entry into entrepreneurship, it may also affect the decisions of existing business proprietors. And because crop production can vary dramatically with weather, risk may matter more for proprietor decisions in agriculture than in other sectors less dependent on nature. If risk aversion decreases with wealth in absolute or relative terms, greater wealth would motivate a farmer to expand production or switch to riskier, higher-value crops. On the other hand, farmland appreciation could have little effect on tolerance for risk since most crop farmers already have most of their wealth in farmland. Increases in its value would further decrease the diversity of their asset portfolio.

D. The Life Cycle

Older and younger farmers will likely respond differently to changes in wealth. Unlike firms which are owned by several people at different stages in life, the growth of a sole proprietor business, which characterizes the majority of farm businesses, is linked to the life cycle of the proprietor. Over time, proprietors can accumulate assets, which they can leverage to obtain credit for expansion. For farm and non-farm sole proprietorship households in the U.S., the median net worth of the proprietor household increases until the 55 to 64 age cohort and then declines for those 65 and older (Katchova, 2008). Because a proprietor has more assets to leverage when she is older, credit constraints are more likely to bind earlier in life, leading to a greater wealth response from younger operators. Furthermore, younger farmers are more likely to demand credit since farms operated by younger farms expand faster than those operated by older farmers (Gale, 1994).

Motivated by a greater demand for leisure and the incentive to smooth consumption over time, an unexpected wealth increase may hasten the exit of older farmers from farming. In contrast, a greater ability to borrow could help younger farmers smooth consumption across the low and high income life stages. Benito (2009), for example, finds that the propensity for UK homeowners to withdraw equity from their homes peaked around age 40.

II. Employing Data from Multiple Censuses of Agriculture

The National Agricultural Statistics Service attempts to collect data on all farms and their operators every five years through the Census of Agriculture (hereafter "the census"). The data collected include the land in the farm (rented and owned), how the land is used, the value of the farm's production, and basic information on the farm's principal operator. Each principal operator has a unique identification number, which we use to link farms in the three most recent censuses: 1997, 2002, and 2007.

The long form of the census collects information on business costs including interest expenses on debt. All farms in the 2007 census received the long form but only about a third received it in 1997 and 2002. We use only continuing farms that received the long form, and further narrow the sample to farms that harvested at least 25 acres of crops in 1997. The minimum size requirement is because the definition of a farm used by the census places a low bar for qualifying as a farm – any establishment where at least $1,000 dollars of agricultural productions would be produced and sold in a normal year. The farm population therefore includes many farms with little or no production that are often operated more as a hobby than as a business.

U.S. agriculture covers distinct agro-climatic regions that produce different commodities and have different land tenure patterns. Compared to crop farmers in the Midwest, perennial crop farmers in coastal regions tend to own rather than rent most of the land they cultivate. Similarly, concentrated livestock producers, such hog and poultry farmers, have a large share of their wealth in buildings rather than land. To reduce the risk that unobserved farm characteristics correlated with the share of land owned and farm behavior confound estimates, we focus the empirics on crop farms (those with less than $10,000 in livestock sales in each census year) in the U.S. Heartland. The Heartland is defined by the USDA Economic Research Service by grouping counties with similar farms, soils, and agro-climatic conditions. It includes all counties in Illinois, Indiana, and Iowa, and some counties in Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota.

Given its favorable climate and soils, cash grains like corn and soybeans dominate the agricultural landscape of the Heartland, with the region accounting for more than half of the cash grains produced in the country (Hoppe and Banker, 2010). The region also has active land rental markets. For the five major states of the Heartland – Illinois, Indiana, Iowa, Missouri, and Ohio – 49 percent of the land in farms is rented, of which three-quarters is rented from landlords who do not operate a farm themselves (Nickerson and Borchers, 2011).

For continuing crop farms in the Heartland that do not rent out land, we calculate the share of land operated by the farm that is owned by the farm, where the land operated is the sum of acres owned and acres rented in. We exclude farms that rent out land because they are likely different from farms renting in some land, since they could easily expand by cultivating the land rented to others. Looking at the distribution of farms by the share owned reveals a bimodal distribution (see figure A1 in the appendix), with 20 percent of farms owning less than 10

percent of their land and 14 percent owning more than 90 percent. We further focus on the 66 percent of farms that own between 10 to 90 percent of the land operated – farms that we refer to as partial renters. Doing so reduces the risk of confounding land-related wealth effects with unobserved farm characteristics associated with owning or renting all of the land in the farm.

The number of continuing farms meeting our criteria is 3,592. In 1997 the average farm owned 30 percent of the total land in the farm and produced roughly a half of a million dollars in crops from 1,339 harvested acres. The census does not ask for the quantity of outstanding debt or the interest rate on existing debt, so we use interest expenses as a measure of borrowing activity. In 1997, the average farm paid $29,990 to service debt. According to the Federal Reserve's Agricultural Finance Databook the average fixed interest rate on farm real estate loans in Chicago Federal Reserve District was 8.8 percent, implying about $340,000 in debt. The implied debt is roughly consistent with estimates from the Agricultural Resource Management Survey, which collects debt information from farms. The survey found that in 1997 the average farm in the Heartland with $500,000-$999,999 in sales had $367,000 in liabilities.

Table 1.

III. Responses to Greater Land Wealth

Changes in aggregate land values primarily reflect appreciation, not changes in land holdings since the total amount of land in farms has been stable over time. To estimate the change in land wealth from appreciation alone, we calculate the farm real estate appreciation rate for each crop reporting district. Crop reporting districts group agriculturally similar and

geographically contiguous counties in the same state together. There are roughly 10 counties per district in the Heartland.

We use all crop farms in each census year to calculate each district's average value per acre of farm real estate. The average farm's real estate appreciated by 14 percent from 1997 to 2002 and by 33 percent from 2002 to 2007. The different appreciation rates imply that a dollar more in initial land wealth would have caused wealth to increase by 24 cents more in the second period than in the first period (=(1.14 x 1.33 – 1.14)- (1.14-1)). For the average farm, owning rather than renting one percentage point more of the land in the farm corresponds to roughly 14 acres or about $28,000. Increasing the share of land owned by one percentage point would therefore have increased wealth by $6,720 more in the second period than in the first period ($6,720 =$28,000 x 0.24).

For descriptive comparisons, we group farmers into two groups – those that own at least 50 percent of the land operated (major owners) and those that own less than 50 percent (minor owners) – and calculate the log difference in each outcome for the 1997 to 2002 period and for the 2002 to 2007 period. We then calculate the difference between the two periods and the two groups for five outcomes: interest payments on any debt, interest payments on real-estate-secured debt, acres owned, the value of production, and acres harvested (table 2).

Table 2.

We first note two observations that hold for major and minor owners. First, the growth rate of acres owned and harvested slowed over time. Given that the average farmer was age 48 in 1997, it is unsurprising that land accumulation and farm size growth slowed as the typical farmer

in the sample approached retirement. Less land accumulation combined with lower interest rates may also explain the decline in interest expenses. The second observation is that growth in the value of production increased markedly in the second period. Given the small decline in acres harvested, the increase reflects a combination of higher corn prices in 2007 and the switch from other crops to corn, which generates more gross revenue than other row crops.

If land wealth permits greater borrowing by increasing a farm's collateral, we would expect to find the largest effect on borrowing secured by real estate. Descriptive comparisons across the two periods and across major and minor owners bear this out. For interest payments on any debt the difference across the two groups and periods was 0.06 log points; for payments on debt secured by real estate it was 0.15.

Further comparisons suggest that greater borrowing funded land purchases but not an expansion of production. Relative to the prior period, major owners acquired 0.23 log points (about 25 percent) more land than minor owners. For the sample average, a 25 percent increase in land owned is 122 acres. Major owners owned on average 40 percentage points more of the land in the farm, which gave them a $268,880 greater increase in wealth in the second period relative to the first period compared to minor owners ($268,880 = $6,720 x 40). The comparisons therefore suggest that each $10,000 increase in land wealth led farmers to buy 4.5 acres (=$10,000/($268,880/122 acres)). In contrast, the increase in the value of production over the period when land prices boomed relative to growth in the prior period was 0.07 log points less for major owners than for minor owners. The result for acres harvested is similar.

A. A Double Difference Approach to Estimating Wealth Responses

Our empirical strategy is to compare the responses of farmers who own different shares of the land they operate in periods of small and large increases in farmland values. The base empirical model has three main independent variables: an indicator of rapid land appreciation (*P2*), the share of land owned by the farm (*Share Owned*), and their interaction:

$$\Delta y_{it} = \alpha + \delta_1 P2_{it} + \delta_2 Share_i + + \delta_3 (Share\ Owned_i \cdot P2_{it}) + \delta_4 (Share\ Owned_i^{\ 2}) + X_{i97}\beta_1 + \gamma_{crd(it)} + \varepsilon_{it}. \quad (8)$$

The dependent variable is the log difference in an outcome ($\Delta y_{it} = \ln(y_{it}) - \ln(y_{it-1})$) over one of two periods, 1997 to 2002 or 2002 to 2007. The control vector *X* includes the log of the total land in the farm (owned plus rented), the log of the value of production per acre harvested, an indicator variable for whether the farm is individually owned, and a linear and quadratic term for the age of the farm's principal operator and years of experience operating the farm. The 1997 values are used for all of the control variables. We also include a time-varying crop reporting district effect $\gamma_{crd(it)}$ to control for time-specific local shocks such as the interaction between changing commodity prices and a district's suitability for growing the crops favored by the changes.

Because of a possibly nonlinear relationship between a farm's initial share owned and its expansion of harvested or owned acres, we include a quadratic term for the initial share owned. We assume that the coefficient on the quadratic term is the same in both periods but allow the linear term to change by interacting it with the second period dummy variable. The specification reflects the linear relationship between wealth gains from land appreciation and the share owned when farm size is held constant. Owning one percentage point more of the land in a 100 acre farm corresponds to owning one more acre. If the price of land increased by $500 over the period, each percentage point increase in the share owned corresponds to $500 more in wealth. If

wealth matters for farm expansion, we would therefore expect the 100 acre farm that owns one additional acre to have higher growth than a similar 100 acre farm owning one less acre. The example also highlights the importance of farm size as a control variable.

The setup in (8) fits a difference-in-difference framework with two periods and a continuous treatment variable (*Share Owned*). The interpretation on the coefficient of *Share Owned* is the same as if it were a binary variable: the effect of going from owning none of the land in the farm (*Share Owned* equals zero) to owning all of the land (*Share Owned* equals one). One concern of difference-in-difference models is that members of one group may migrate to another group, changing the group composition and affecting estimates of the interaction effect between time periods and groups (Angrist and Pischke, 2009). Higher ability farmers with more profitable farms may have purchased land between 1997 and 2002, increasing the share of land that they own. In a binary treatment approach the purchase would move the farm from the control group (low share owned) to the treatment group (high share owned). Because the share of land owned is highly correlated with itself over time, we instrument for the share of land owned in 2002 with the share of land owned in 1997. The F statistic on the excluded instrument in the first stage regression (103) shows that the instrument is strong.

Although instrumenting avoids the problems of farms switching groups, the share of land owned in 1997 may be correlated with unobserved characteristics of the farmer, such as wealth endowments, credit constraints, and entrepreneurial ability. On a given acre, high-ability farmers should be able to outbid low-ability farmers in the land rental market, which would tend to reduce the farm's share of land owned (land owned divided by land farmed). Thus, the share owned may be correlated with investment or growth. Equation (8), however, allows farmers who rent most of their land to grow faster (or slower) than those who rent less. The core assumption

for identification of the wealth effect is that the difference in growth rates between major and minor renters in the first period would persist in the second period had land values appreciated at the same rate in both periods.

We look at the same five outcomes used in the descriptive comparisons. Because older and younger farmers likely respond differently to changes in wealth, we estimate (8) for the entire sample and then separately for farmers who in 1997 were younger than 50 and those who were 50 or older. Splitting the sample by age permits estimating different effects for farmers who are more likely to have a demand for credit (because they are in a growth phase of the business) and more likely to be constrained by their wealth (because they have had less time to accumulate it).

We estimate (8) using Two-Staged Least Squares and calculate robust standard errors clustered by farm. The time-specific crop reporting district effect allows for unexplained correlation in behavior among farms in the same district in the same year while clustering errors by farm allows for unexplained correlation in a farmer's behavior across time.

B. Findings

The more rigorous econometric results confirm the conclusions suggested by the descriptive comparison of major and minor owners. We find a statistically weak relationship between land wealth and total interest expenses but a strong relationship between wealth and expenses on real-estate-secured debt of younger farmers. The finding provides evidence that farmers used some of their equity in land as collateral for loans. Owning one percentage point more of the land in the farm was associated with a 1.43 percentage point greater growth in

interest expenses on real-estate-secured debt (table 3). Put differently, a $10,000 increase in wealth led to $395 in interest payments (table 5). According to the Agricultural Finance Databook the average fixed interest farm real estate loan over 2002 to 2007 in the Chicago Federal Reserve District was 8.1 percent, which would imply that total debt increased by about $4,875. For older operators, greater wealth had a weak negative effect on interest expenses for real-estate-secured debt.

Some observations had zero interest payments in at least one year and were excluded from estimation since the outcome is a difference in logged values. To test the robustness of our finding regarding borrowing, we estimate a linear version of the model where the dependent variable is a difference in levels and the control variables are in levels. We find for younger farmers that each percentage point increase in share was associated with an additional $236 in interest payments on real-estate-secured debt in the second period (Table 2A in the appendix). This is close to what is implied by the logged version, where each percentage point led to $265 more in interest payments (table 5). The qualitative result is not driven by solely observations at the ends of the distribution. The correlation between *Share Owned · P2* and interest expenses for debt secured by real estate remains statistically significant at the five percent level when trimming five percent of observations from the upper and lower tails of the distribution for the change in interest expenses.

The linear model results are also helpful in that they imply that real-estate-secured borrowing did not replace borrowing that was secured by other assets or not secured at all. One could imagine that if rates on non-secured loans were higher than those on secured loans, farmers may use their new-found equity to switch their debt portfolio towards secured loans as has been found for some UK households when their home equity increased (Disney et al., 2010).

We also see from the coefficient estimates that growth in total interest expenses declines with age (column 1 of table 3). The large negative coefficient on the second period dummy suggests that younger farmers may have done wave a of borrowing in the first period and then did not increase borrowing in the second period. Alternatively, younger farmers with more years left on their loans may have been more aggressive in refinancing and taking advantage of the substantially lower interest rates in the second period.

Turning to land purchases, we see that the greater borrowing appeared to help younger farmers buy land. The coefficient estimated for younger farmers implies that each $10,000 increase in wealth led to a purchase of 6.4 acres (table 5), which would have cost about $16,000 (for the sample, the average value of farm real estate in 2002 was approximately $2,500 per acre). Combined with the effect of wealth on real-estate-secured borrowing, this result implies that the average young farmer in the sample financed roughly 30 percent of land acquisitions through debt (=$4,875/$16,000).

Table 3.

Turning to the effect of wealth on the scale of the farm, wealth gains from land appreciation did not cause farms to grow more. The finding applies to younger and older farmers. The results for the extensive margin, acres harvested, further support the conclusion that land-induced increases in wealth had no clear effect on the growth of the farm. Combined, the estimates imply that farmers who gained more from land appreciation responded by replacing land rented from others with land that they purchased.

The coefficients on the age variables show how the farmer's life stage life- influences farm growth. The farm's growth rate is the highest when farmers are young. It then declines at a decreasing rate as the farmer grows older as evidenced by the negative coefficient on age and the positive coefficient on its square.

Tables 4 and 5.

C. A Falsification Test Using the 1992-2002 Period

Our identification strategy exploits the increase in farm real estate appreciation during the 1997-2007 period. We now exploit the stable appreciation during the 1992-2002 period: from 1992 to 1997 farm real estate appreciated by 18 percent; from 1997 to 2002 it appreciated by 20 percent (see figure 1). Because of similar appreciation rates, farms owning a larger share of the land in the farm would not have experienced such a large increase in wealth from 1997 to 2002 period relative to the prior five years. If there is no clear correlation between the share owned and changes in wealth in one period relative to the other, then we should not find a correlation between *Share Owned x P2* and our outcomes. If we do, it would reflect confounding factors, not responses to greater land wealth. We therefore re-estimate the model with the sample of continuing farms in the 1992-2002 period and define 1997-2002 as the second period, when land values were, in fact, not booming.

Aside from a weak increase in land owned by older farmers, none of the results from the 1997-2007 panel emerge in the 1992-2002 panel (table 6). Among younger farmers, there is no systematic correlation between *Share Owned · P2* and any of the outcomes. The contrast in

results gives greater confidence that our estimates from the 1997-2007 panel reflect the response to greater wealth rather than spurious correlation.

We also note that in both panels the sign on the coefficient on the share owned variable is the same in all cases, suggesting a persistent relationship between share owned and our outcomes in the two periods. The estimates for the second period dummy variables, on the other hand, are similar in some cases and not in others. The second period dummy captures the average effect of time variant conditions common to all farmers, such as corn prices and interest rates. In the 1997-2007 panel, the second period dummy in the value of production equation is weakly positive, capturing the much higher corn prices in 2007, which offset the decline in acres harvested. The same coefficient in the 1992-2002 panel is negative, likely reflecting the decline in corn prices from 1997 to 2002. It is important to underscore that our empirical strategy is only undermined if changing conditions (outside of land appreciation) substantially affect farmers with a high share owned differently than those with a low share owned.

D. Exit

Finally, we examine the effect of wealth on the decision to exit farming. We estimate a pooled Probit model of the form:

(8) $$\Pr(\text{exit}_i = 1) = \Phi(\theta_1 P2_{it} + \theta_2 Share\ Owned_{it} + \theta_3(Share\ Owned_{it}\ x\ P2_{it}) + \theta_4(Share_i^{\ 2}) + X_{it}\lambda + \eta_{crd(it)})$$

where $\Phi(.)$ is the standard normal cumulative distribution function.

We estimate the model using all farms in the census that meet the sample criteria in 1997 for the 1997-2002 exit decision and the criteria in 2002 for the 2002-2007 decision. To be clear, a farmer who exits in 1998 and one who exits in 2002 are both categorized as having exited during the 1997-2002 period. The sample is larger for the Probit model because we include farmers who exited in 2002, those who entered in 2002, and those who exited 2007. Moreover, all variables used in the Probit appear on the short form version of the census so we are not limited to respondents of the long form version. Another difference with the previous model is that we do not instrument for the share owned variable or fix the control variables at their 1997 values, which the entry and exit of farms precludes.

The coefficient on the interaction between *Share Owned* and the second period is positive but not statistically significant. When we divide the sample by the farm operator's age we find a slightly stronger positive effect for the younger group. We expected the opposite, supposing that greater wealth would help younger farmers survive and encourage older farmers to retire. Since we found little evidence of credit constraints severe enough to affect production, it is unsurprising that land-induced capital gains have no clear effect on survival. Higher land prices may have encouraged some younger farmers to cash out and pursue other endeavors. By comparison, it appears that the wealth increase did not affect the tendency for older farmers to remain involved in farming well past normal retirement age.

Table 7.

IV. Conclusion

We add to several lines of research by providing evidence for how a change in wealth from asset appreciation affected the decisions of business proprietors to borrow, invest, and expand. We find that or each dollar increase in land wealth, younger farmers borrowed roughly 48 cents, using real estate as collateral. The finding is consistent with other studies that examined the response to real estate wealth for households in general. Mian and Sufi (2009) found that over the 2002 to 2006 period U.S. households borrowed on average 25 to 30 cents for every dollar increase in home equity. Disney et al. (2010) found a similar result for UK households likely to be credit constrained.

We also find that the increase in borrowing accompanied purchases of land. The finding supports the view that collateral-based lending is potentially facilitating a bubble in U.S. farmland values. By leveraging their equity to buy land, farmers, and especially younger farmers, contribute to further increases in land values. Outside investors could also be contributing to price increases, although their cost of capital is unlikely correlated with land prices as we have argued it is for farmers.

While increases in wealth from farmland appreciation induced greater land purchases, it did not cause farms to become larger. The results underscore the need to distinguish between wealth effects that affect aggregate output from those that merely alter the incentives to rent or own machinery or to outsource tasks or perform them in-house. Our findings suggest that increases in asset values that can be used as collateral lowered the cost of borrowing and therefore increased the incentives to own land versus renting it. That farmers borrowed more but did not increase production suggests that they were not constrained in their output decisions by the price of capital. As our theoretical model illustrated, for a farmer who rents in some land, the

rental price of land, which is independent of the farmer's wealth, determines the scale of the farm.

To the extent that our results are generalizable to nonagricultural proprietorships, they imply that increases in wealth from asset appreciation would have negligible effects on aggregate business output or economic efficiency. On the other hand, substantial appreciation of assets and the associated wealth increase could cause the ownership of assets to become more concentrated.

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Figures

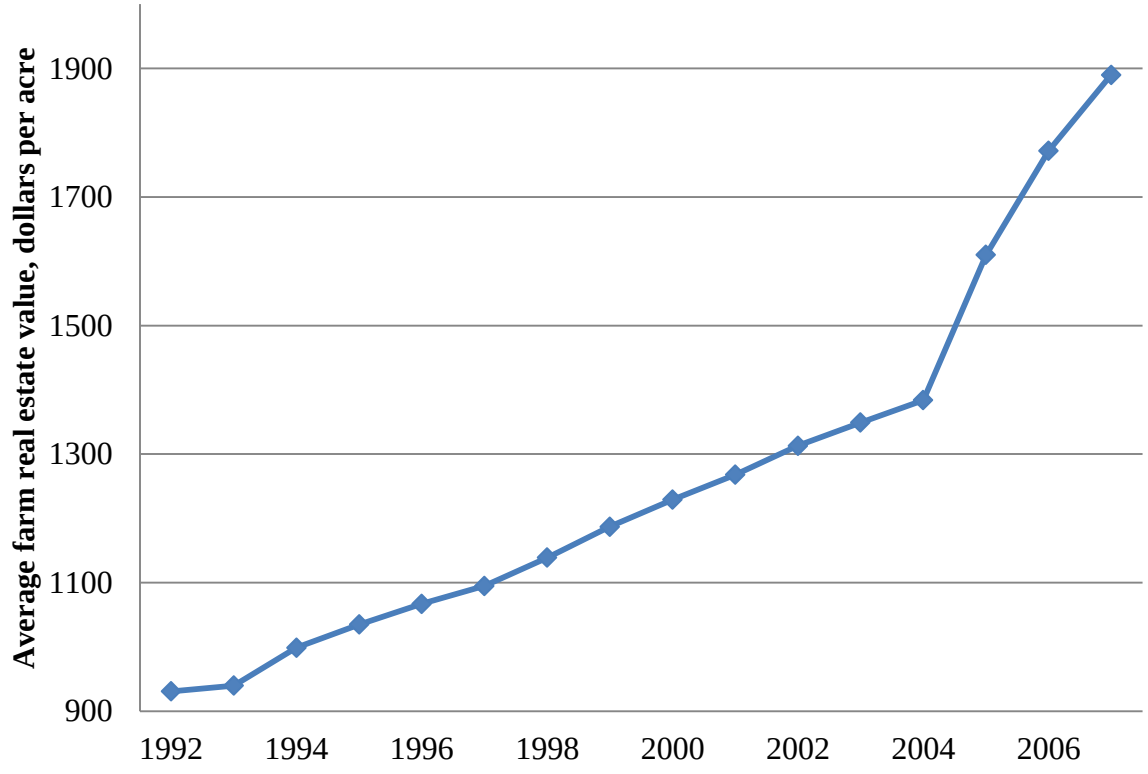

Figure 1. Farm real estate values rose rapidly from 2004 to 2007

Note: USDA-NASS, Land Values and Cash Rents Summary, multiple years. Prices are in 2005 dollars.

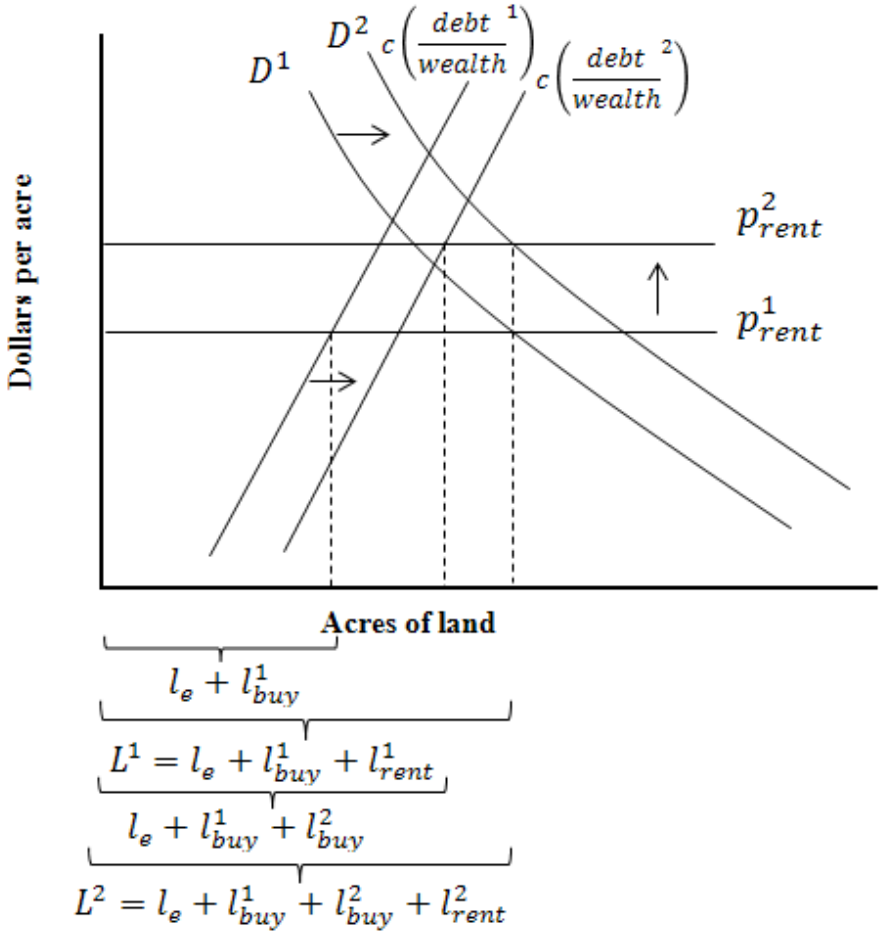

Figure 2. Higher Land Values Increase Land Purchases But Not Necessarily Farm Size

Note: The superscript 1 refers to the quantities prior to the increase in crop and land prices.

Tables

Table 1 – Sample Description (N = 3,592)

	Median	Mean	SD
Total value of production	431,000	473,210	333,293
Acres harvested	1,254	1,358	911
Value of machinery	265,650	310,342	230,358
Interest payments on any debt	22,196	29,990	31,207
Interest payments on real-estate-secured debt	12,594	19,354	23,988
Acres owned	355	487	505
Share owned	0.30	0.35	0.20
Acres in the farm	1,339	1,461	994
Value of production per acre	307	395	773
Individually owned farm (=1)	1.00	0.77	0.42
Operator age	47	48	9
Experience	23	24	10
Value of land and buildings	672,822	927,095	955,931
Value of land and buildings per acre	2,000	2,149	1,510

Notes: Values are in 1997 dollars.

Source: Author calculations from the 1997 Census of Agriculture.

Table 2 – Difference-in-Difference Comparisons of Major and Minor Owners

Outcome	Ownership Category	Log Difference		Difference
		1997-2002	2002-2007	
Interest payments on any debt	Minor Owners	0.187	-0.064	-0.25
	Major Owners	0.082	-0.113	-0.20
	Difference			0.06
Interest payments on debt secured by real estate	Minor Owners	0.230	-0.144	-0.37
	Major Owners	0.076	-0.151	-0.23
	Difference			0.15
Acres owned	Minor Owners	0.274	0.032	-0.24
	Major Owners	0.032	0.022	-0.01
	Difference			0.23
Value of production	Minor Owners	0.012	0.249	0.24
	Major Owners	0.004	0.173	0.17
	Difference			-0.07
Acres harvested	Minor Owners	0.095	-0.033	-0.13
	Major Owners	0.083	-0.071	-0.15
	Difference			-0.03

Notes: Major owners are defined as owning 50 percent or more of the land in the farm; minor owners own less than 50 percent. The sample contains 2,784 major owners and 808 minor owners. Values are in 1997 dollars.

Source: Author calculations from the 1997, 2002, and 2007 Census of Agriculture.

Table 3 – Wealth Effects for Borrowing and Land Ownership

	Interest payments on debt			Interest payments on real-estate-secured debt			Acres owned		
	All	Under 50	50 and Older	All	Under 50	50 and Older	All	Under 50	50 and Older
Share owned x P2	0.208	0.724*	-0.317	0.505*	1.438***	-0.540	0.695***	1.013***	0.336**
	(0.256)	(0.392)	(0.374)	(0.274)	(0.424)	(0.385)	(0.144)	(0.313)	(0.141)
Share owned	-0.144	-0.614	0.388	-0.497	-0.821*	0.380	-0.897***	-0.981***	-0.655***
	(0.308)	(0.413)	(0.500)	(0.333)	(0.420)	(0.573)	(0.143)	(0.248)	(0.188)
P2	-0.313	-0.765***	0.335	-0.758***	-1.437***	0.493	-0.575***	-0.783***	-0.284
	(0.191)	(0.250)	(0.305)	(0.211)	(0.268)	(0.328)	(0.164)	(0.233)	(0.237)
Share owned squared	0.005	0.464	-0.512	0.269	0.194	-0.224	0.292**	0.136	0.292*
	(0.325)	(0.464)	(0.497)	(0.348)	(0.466)	(0.569)	(0.146)	(0.281)	(0.176)
Acres in the farm	0.024	0.013	0.028	0.046	0.028	0.051	-0.020*	0.000	-0.044***
	(0.026)	(0.032)	(0.044)	(0.030)	(0.033)	(0.053)	(0.011)	(0.018)	(0.016)
Value of production per acre	-0.031	-0.007	-0.080	-0.026	-0.026	-0.045	0.012	0.022	0.005
	(0.031)	(0.037)	(0.053)	(0.034)	(0.039)	(0.061)	(0.012)	(0.020)	(0.017)
Individually owned farm	-0.007	-0.011	0.006	0.000	0.005	-0.042	0.030*	0.055**	-0.011
	(0.035)	(0.046)	(0.055)	(0.040)	(0.053)	(0.063)	(0.017)	(0.023)	(0.024)
Operator age	-0.027**	0.014	0.067	-0.006	0.060	0.067	-0.006	-0.004	-0.016
	(0.014)	(0.041)	(0.060)	(0.019)	(0.057)	(0.076)	(0.006)	(0.030)	(0.020)
Operator age squared	0.018	-0.034	-0.056	-0.003	-0.082	-0.061	0.004	0.004	0.012
	(0.014)	(0.052)	(0.049)	(0.020)	(0.070)	(0.064)	(0.006)	(0.038)	(0.017)
Experience	0.007	0.004	0.002	0.002	-0.007	0.005	0.005*	0.010	0.002
	(0.007)	(0.012)	(0.014)	(0.008)	(0.015)	(0.016)	(0.003)	(0.006)	(0.004)
Experience squared	-0.016	0.001	-0.009	-0.007	0.014	-0.012	-0.012**	-0.028	-0.007
	(0.014)	(0.037)	(0.025)	(0.018)	(0.042)	(0.029)	(0.006)	(0.018)	(0.007)
Number of observations	5,590	3,399	2,191	4,510	2,804	1,706	7,078	4,091	2,987

Notes: Two-Stage-Least Squares estimates using *Share owned* in 1997 interacted with *Boom period* as an instrument for *Share owned* in 2002 interacted with *Boom period*. Robust standard errors clustered by farm in parenthesis. The "All" regressions have less than twice the total number of farms because of zero or missing values in 2002 or 2007. Crop reporting district dummy variables interacted with *Boom period* are included in estimation but excluded from the table.
Source: Author calculations from the 1997, 2002, and 2007 Censuses of Agriculture.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 4 – Wealth Effects on the Value of Production and Acres Harvested

	Value of Production			Acres Harvested		
	All	Under 50	50 and Older	All	Under 50	50 and Older
Share owned x P2	-0.133	-0.148	-0.109	-0.013	0.107	-0.022
	(0.107)	(0.163)	(0.153)	(0.086)	(0.154)	(0.102)
Share owned	0.231	0.170	0.365	0.149	0.055	0.256
	(0.148)	(0.199)	(0.234)	(0.120)	(0.172)	(0.185)
P2	0.029	-0.016	0.085	-0.226**	-0.318***	-0.163
	(0.131)	(0.175)	(0.202)	(0.089)	(0.116)	(0.142)
Share owned squared	-0.130	-0.148	-0.170	-0.088	-0.087	-0.121
	(0.153)	(0.219)	(0.228)	(0.128)	(0.189)	(0.188)
Acres in the farm	0.021*	-0.005	0.046**	-0.006	-0.018	0.002
	(0.012)	(0.018)	(0.018)	(0.009)	(0.014)	(0.013)
Value of production per acre	-0.166***	-0.177***	-0.164***	0.002	-0.003	0.001
	(0.018)	(0.023)	(0.027)	(0.015)	(0.020)	(0.020)
Individually owned farm	-0.033**	-0.007	-0.066***	-0.017	0.003	-0.050**
	(0.015)	(0.020)	(0.023)	(0.013)	(0.017)	(0.020)
Operator age	-0.031***	-0.026	-0.097***	-0.026***	-0.023	-0.092***
	(0.007)	(0.021)	(0.026)	(0.006)	(0.020)	(0.020)
Operator age squared	0.019***	0.016	0.074***	0.016***	0.015	0.070***
	(0.007)	(0.026)	(0.022)	(0.006)	(0.025)	(0.017)
Experience	0.008**	0.010*	0.002	0.007***	0.010**	0.003
	(0.003)	(0.006)	(0.005)	(0.003)	(0.004)	(0.005)
Experience squared	-0.015**	-0.019	-0.006	-0.014**	-0.023*	-0.007
	(0.007)	(0.017)	(0.010)	(0.006)	(0.013)	(0.008)
Number of observations	7,158	4,150	3,008	7,137	4,135	3,002

Notes: Two-Stage-Least Squares estimates using *Share owned* in 1997 interacted with *Boom period* as an instrument for *Share owned* in 2002 interacted with *Boom period*. Robust standard errors clustered by farm in parenthesis. The "All" regressions have less than twice the total number of farms because of zero or missing values in 2002 or 2007. Crop reporting district dummy variables interacted with *Boom period* are included in estimation but excluded from the table.

Source: Author calculations from the 1997, 2002, and 2007 Censuses of Agriculture.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 5 – Responses to a Wealth Increase for Sample Farmers Younger Than 50 Years

	Interest Payments on Real Estate Debt	Acres Owned
Results - Elasticities		
Estimated Percent Change	1.438	1.013
Associated Percent Change in Wealth	1.122	1.122
Elasticity	1.282	0.903
Results - Levels		
Estimated Absolute Change	$265	4.3 acres
Associated Absolute Change in Wealth	$6,720	$6,720
Change Per $10,000 Wealth Increase	$395	6.4 acres

Notes: The estimated response is associated with a one percentage point increase in the share of land owned, which would translate into an increase in wealth of $6,720 in the second period relative to the first period. This applies to both the younger and older farmer samples, since they operate farms of similar size. The increase in wealth is then used to calculate the response to a $10,000 increase in wealth. The associated percent change in wealth is 1.12 percent and is calculated by dividing the wealth increase associated with owning one percentage point more of the land in the farm by the initial net farm wealth of the average sample farmer 50 years or younger (roughly 600,000).
Source: Author calculations from the 1997, 2002, and 2007 Censuses of Agriculture.

Table 6 – Falsification Test Using a Period of Stable Land Appreciation Rates

	Interest payments on debt			Interest payments on real-estate-secured debt			Acres owned		
	All	Under 50	50 and older	All	Under 50	50 and older	All	Under 50	50 and older
Share owned x P2	0.360	0.206	0.396	0.312	0.176	0.168	0.187	0.056	0.293*
	(0.247)	(0.420)	(0.333)	(0.243)	(0.399)	(0.336)	(0.118)	(0.183)	(0.170)
Share owned	-0.097	-0.501	0.840	-0.317	-0.735	0.617	-0.701***	-0.908***	-0.075
	(0.324)	(0.437)	(0.619)	(0.368)	(0.479)	(0.727)	(0.176)	(0.225)	(0.304)
P2	-0.343*	-0.114	-0.893**	-0.516**	-0.261	-1.030***	0.055	0.220	-0.365*
	(0.206)	(0.254)	(0.356)	(0.247)	(0.312)	(0.360)	(0.121)	(0.143)	(0.211)
Observations	4,759	3,209	1,550	3,848	2,625	1,223	5,480	3,612	1,868

	Value of production			Acres harvested		
	All	Under 50	50 and older	All	Under 50	50 and older
Share owned x P2	-0.121	-0.170	0.019	-0.133	-0.231	-0.002
	(0.114)	(0.186)	(0.158)	(0.107)	(0.155)	(0.169)
Share owned	0.284*	0.251	0.395	0.316**	0.258*	0.486*
	(0.161)	(0.195)	(0.294)	(0.145)	(0.153)	(0.267)
P2	-0.822***	-0.745***	-1.072***	-0.149	-0.093	-0.289**
	(0.109)	(0.138)	(0.137)	(0.094)	(0.119)	(0.119)
Observations	5,476	3,615	1,861	5,455	3,599	1,856

Notes: The models included all the control variables of prior regressions. The results are based on estimating the same model that generated the estimates for tables 3 and 4 but using continuing crop farms in the 1992 to 2002 period instead of the 1997 to 2007 period. In the falsification test *P2* refers to the 1997-2002 period, which in fact saw land appreciate at roughly the same rate as from 1992 to 1997, hence the grounds for the falsification test.

Source: Author calculations from the 1992, 1997, and 2002 Censuses of Agriculture.

Table 7 – Wealth and Farm Exit

	Propensity to exit		
	All	Under 50	50 and Older
Share owned x P2	0.019	0.036*	0.025
	(0.012)	(0.019)	(0.017)
Share owned	-0.010	-0.001	-0.057
	(0.029)	(0.042)	(0.042)
P2	-0.006	-0.000	-0.016
	(0.018)	(0.027)	(0.024)
Share owned squared	-0.009	-0.029	0.030
	(0.030)	(0.044)	(0.041)
Acres in the farm	-0.037***	-0.039***	-0.034***
	(0.002)	(0.002)	(0.002)
Value of production per acre	-0.015***	-0.024***	-0.006**
	(0.002)	(0.003)	(0.003)
Individually owned/operated farm	-0.039***	-0.050***	-0.031***
	(0.004)	(0.006)	(0.006)
Operator age	-0.010***	0.003	0.015***
	(0.001)	(0.003)	(0.003)
Operator age squared	0.012***	-0.005	-0.005**
	(0.001)	(0.004)	(0.002)
Experience	-0.005***	-0.003***	-0.003***
	(0.000)	(0.001)	(0.001)
Experience squared	0.008***	0.001	0.005***
	(0.001)	(0.003)	(0.001)
Number of observations	98,195	43,836	54,359
Adjusted R2	0.028	0.024	0.025

Note: Probit model estimates for exit in a pooled panel of two periods (1997-2002 and 2002-2007). Robust standard errors clustered by farm in parenthesis. Crop reporting district dummy variables interacted with *P2* are included in estimation but excluded from the table.

Source: Author calculations from the 1997, 2002, and 2007 Censuses of Agriculture

Appendix

Table A1 – Mean and Median Values for Farmers Younger Than 50 Years

	Median	Mean
Total value of production	431,275	471,607
Acres harvested	1,240	1,335
Value of machinery	254,500	296,710
Interest payments on real-estate-secured debt	12,750	18,454
Acres owned	307	424
Acres rented	904	1,005
Share owned	0.257	0.315
Acres in the farm	1,320	1,429
Value of production per acre	310	426
Individually owned farm (=1)	1.000	0.791
Operator age	43	42
Experience	20	19
Value of land and buildings	575,000	797,671
Value of land and buildings per acre	1,956	2,095

Notes: Values are in 1997 dollars.

Source: Author calculations from the 1997 Census of Agriculture.

Table A2 – Linear Model for Changes in Interest Expenses

	Interest payments on any debt			Interest payments on debt secured by real estate		
	All	Under 50	50 and older	All	Under 50	50 and older
Share owned x P2	10,235	28,264**	-11,867	4,098	23,679**	-19,349*
	(7,629)	(12,279)	(11,971)	(6,687)	(10,684)	(10,827)
Share owned	-5,333	-22,246*	17,186	-1,875	-13,835	13,919
	(9,489)	(13,259)	(15,154)	(8,471)	(11,633)	(13,938)
P2	-11,517*	-26,413***	10,543	-12,483*	-32,846***	16,765*
	(6,878)	(9,600)	(10,120)	(6,564)	(9,183)	(9,338)
Observations	6,725	3,912	2,813	6,725	3,912	2,813
	Trimming 5 percent of observations on each end of the distribution					
	Interest payments on any debt			Interest payments on debt secured by real estate		
	All	Under 50	50 and older	All	Under 50	50 and older
Share owned x P2	4,179	8,466*	441	2,426	8,631**	-4,301
	(3,110)	(4,815)	(4,591)	(2,546)	(4,022)	(3,798)
Share owned	-6,540	-3,462	-6,638	1,013	6,103	-1,852
	(5,198)	(7,173)	(7,868)	(4,227)	(6,031)	(6,206)
P2	-1,708	-8,279	5,786	661	-9,673*	13,624***
	(4,035)	(5,191)	(6,036)	(3,886)	(5,502)	(5,090)
Observations	6,051	3,528	2,523	6,051	3,540	2,511

Notes: The models included all the control variables of prior regressions but in nonlogged form, otherwise they are estimated the same as the interest payment results in table 4.

Source: Author calculations from the 1997, 2002, and 2007 Census of Agriculture.

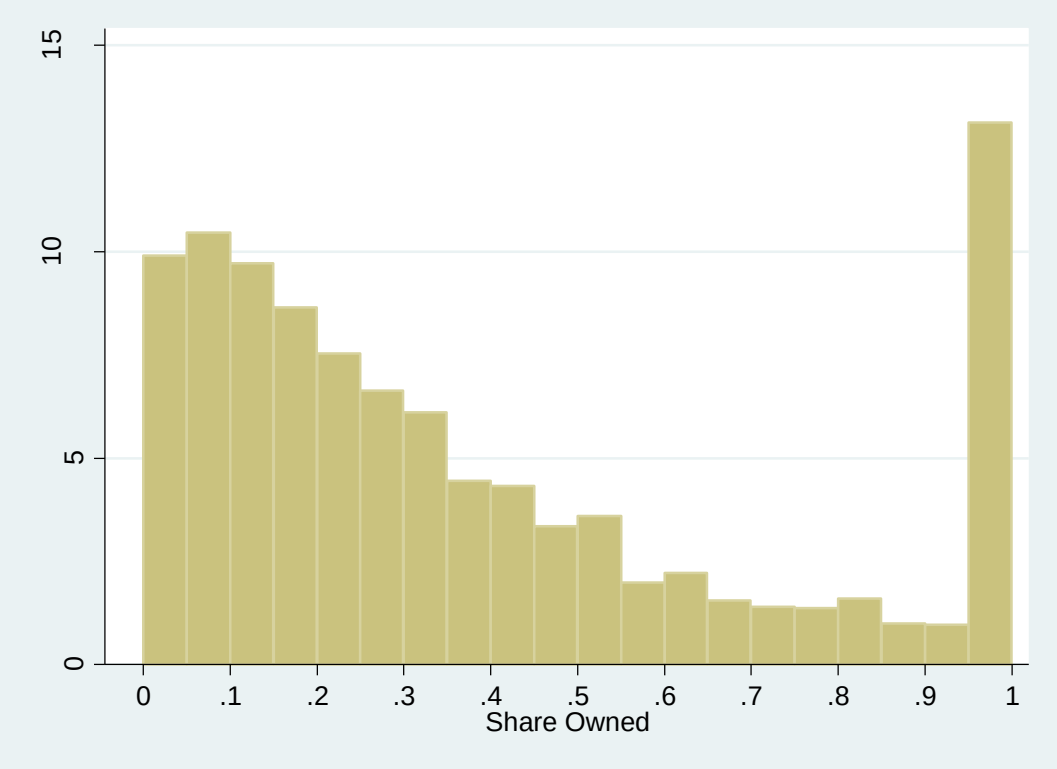

Figure A1 – The Distribution of Farms by *Share Owned*

Notes: The share owned is based on land operated and owned reported in the 1997 Census of Agriculture. Only continuing crop farms in the Heartland are considered.

Endnotes

[1]The 73 percent is taken from IRS data on tax returns by type of business available at http://www.census.gov/compendia/statab/cats/business_enterprise/sole_proprietorships_partnerships_corporations.html. The IRS data excludes farm proprietors, which were added back in using the roughly 2.1million farms in the U.S as reported by the U.S. Department of Agriculture (see: http://www.ers.usda.gov/data-products/farm-household-income-and-characteristics.aspx).