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The Changing Organization and Well-Being of Midsize U.S. Farms, 1992-2014

Christopher Burns and Ryan Kuhns





United States Department of Agriculture

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Abstract

This study uses data from the Census of Agriculture and the Agricultural Resource Management Survey to investigate the well-being and changing organization of U.S. midsize farms from 1992 to 2014. During this period, changes in midsize farms reflect a farm economy experiencing rapid technological development, rising costs of production, and the increasing profitability of larger farms. While the number of midsize farm operations has declined slightly since 1992, they constituted 21 percent of total production in 2014. During the study period, total production on midsize farms has shifted toward grain and oilseed crops, hogs, and poultry and away from dairy and high-value crops. The households operating midsize farms have been transformed as well, enjoying more diversified income portfolios and much higher net worth. Moreover, midsize farms have less debt relative to their assets. Using census data from 2007 and 2012, the authors find that one-third of midsize farms saw their income increase or decrease by more than 50 percent. During this same period, Government payments played a small but positive role in the survival of midsize cash-grain and oilseed farms. One common growth pathway for these farms that increased in size from 2007 to 2012 was renting greater amounts of land.

Keywords: direct payments, gross cash farm income, farm household income, farm exits, farm financial performance, farm operators, farm structure, farm survival, farm type, midsize farms, value of production

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The Changing Organization and Well-Being of Midsize U.S. Farms, 1992-2014

Christopher Burns and Ryan Kuhns

What Is the Issue?

Midsize farms—defined as those with gross cash farm income (GCFI) between \$350,000 and \$1 million—represent an important link in the U.S. chain of family farms; many are the result of successful small commercial farms that grew in size. The number of midsize farms declined by about 5 percent between 1992 and 2012. Coupled with a significant increase in farms with very low sales and farms with more than \$1 million in GCFI over the same period, the decline has led to an interest in whether midsize farms are disappearing. Most midsize farm operators receive the majority of their household income from the farm operation. Thus, their well-being is heavily influenced by the broader farm economy, as well as by agricultural policy. The authors examine how midsize farms and their households changed from 1992 to 2014 and how economics and Government policy influenced their well-being.

What Did the Study Find?

Declining midsize farm numbers could have implications for farm sector and farm household well-being. ERS examined farm-level data to capture how they are unique relative to small and large-size farms. This study addressed the following questions:

How do midsize farm numbers, total production, and acreage compare to other farm sizes? Midsize farms accounted for about 21 percent of total production and 6 percent of U.S. farms in 2014. Together, very-low-sales and small commercial farms—those with less than \$10,000 in GCFI and those with \$10,000-\$350,000 in GCFI, respectively—represented 90 percent of farms but produced only about 22 percent of total agricultural output. Large farms—those with GCFI greater than \$1 million—accounted for only 4 percent of farms but almost 57 percent of total production.

How did midsize farms and their households change from 1992 to 2014? Principal operators of midsize farms are older today and more experienced, and a higher share have some college or a college degree. There has been a trend toward a greater proportion of female principal operators since 2002. Midsize farms generated more net farm income and operated with higher levels of financial efficiency in 2014 than in 1992. Household net worth has also increased dramatically, driven by rapid appreciation in farmland values over the latter half of this period. In 2014, production on midsize farms that specialized in dairy, high-value crops, or other crops (e.g., peanuts, tobacco, hay, and cotton) represented a smaller share of total

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production on midsize farms compared to 1992. In contrast, production on midsize farms that specialized in cash grains and oilseeds, hogs, and poultry represented a greater share of total production.

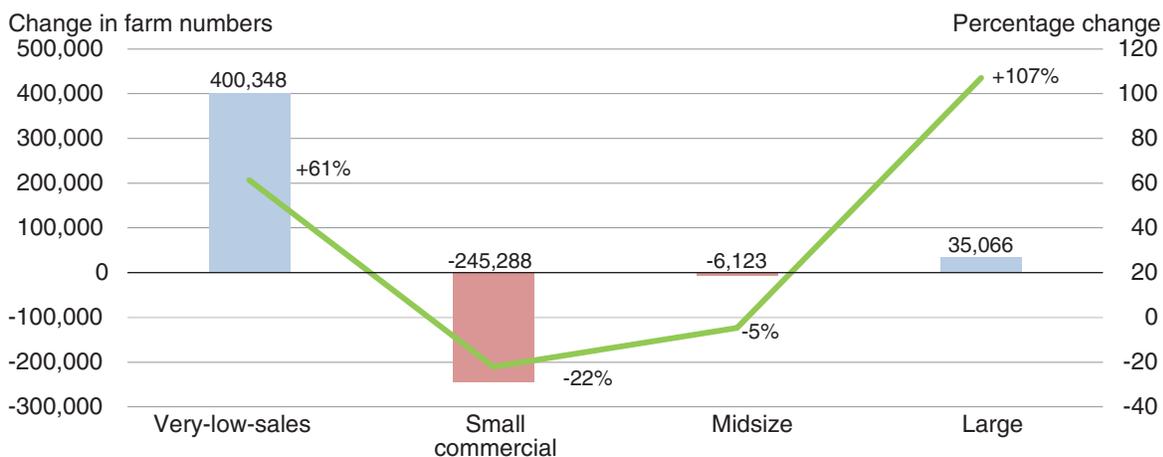
Are midsize farms “disappearing?” If so, where are they going? While their numbers fluctuate from year to year, census data show that the number of midsize farms has declined about 5 percent from 1992 to 2012.

There is evidence that the decline in midsize farms is due to farm exits and farm transitions (moving to another size category). More midsize farms exited than entered in the periods 1992-97 and 2007-12. Most continuing midsize farms (i.e., those that did not exit farming between periods) remained midsize between the same time periods. However, they were more mobile than large or small commercial farms. About 42 percent of continuing midsize farms transitioned to another size category (measured by change in GCFI) between census years, though this may partially reflect the GCFI range used in the midsize farm definition.

What are the characteristics of continuing midsize farms? What role does Government policy play in their survival? Midsize operations with beginning farmers, retired farmers, or those that rented most of their land (tenant renters) were more likely to exit farming in the years 2007-12 in comparison to operations without those characteristics. We find that midsize cash-grain and oilseed farms that received Government fixed direct payments in 2007 had a small but significantly greater probability of survival through 2012. Fixed direct payments were a commodity-based program that paid farmers based on enrolled acreage and historical production of specific commodities—mostly field crops such as barley, wheat, corn, and soybeans.

Change in farm numbers by size category¹ from 1992 to 2012

Midsize farm numbers decreased by about 6,000 during this period.



¹We define a very-low-sales farm as having less than \$10,000 in GCFI, a small commercial farm as having between \$10,000 and \$350,000 in GCFI, and a large farm as having \$1 million or more in GCFI.

Source: USDA, Economic Research Service calculations based on the USDA, National Agricultural Statistics Service, 1992 and 2012 Census of Agriculture.

How Was the Study Conducted?

The authors used the updated ERS typology to define a midsize farm, based on gross cash farm income (GCFI). GCFI is a measure of the total revenue accruing to the farm in a given year. GCFI is measured in constant 2012 dollars using the Producer Price Index (PPI) for Farm Products. In this report, the analysis of farm numbers, exits, and entries is based on the Census of Agriculture (1992-2012), which is administered by the USDA’s National Agricultural Statistics Service (NASS). Analysis of farm households, farm finances, and production is based on the 1992 Farm Costs and Return Survey (FCRS); the 1996-2013 Agricultural Resource Management Survey (ARMS); and the 2014 Tenure, Ownership, and Transfer of Agricultural Land (TOTAL) survey. These three surveys are jointly administered by NASS and ERS.

The Changing Organization and Well-Being of Midsize U.S. Farms, 1992-2014

Introduction

The U.S. farm economy has seen significant changes during the 22-year period from 1992 to 2014. Midsize farms—defined as having gross cash farm income (GCFI) between \$350,000 and \$1 million—have had to adapt to an environment of rapid technological change, rising costs of production, and the increasing profitability of large farms. In 2014, there were about 125,000 midsize farms, representing about 21 percent of total U.S. agricultural production. While midsize farm numbers have trended downward (-5 percent since 1992), it is important to note that their numbers fluctuate annually with changes in the broader farm economy. They remain an important link in the chain of family farms, and many are the result of successful small commercial farms that grew in size.

This report seeks to answer some questions about how midsize farms have changed from 1992 to 2014. What is a meaningful and consistent measure of a midsize farm that can be usefully applied to farm data collected since 1992? How do the numbers, total production, and acreage of midsize farms compare to other farm sizes? How have midsize farm operations and households changed? Are midsize farms disappearing? What are the characteristics of continuing midsize farms?

Understanding the changing landscape for midsize farms is important for three reasons.¹

- The midsize farm designation can be viewed as transitional, that is, as a successful small commercial farm that grew in size or as one that could transition into a large farm in the future. From this perspective, knowledge about midsize farms adds to our understanding of how markets can facilitate incremental growth in agriculture in general.
- The structure of farming in the United States has shifted over the last few decades, resulting in a greater share of production occurring on large farms. The slight decline in midsize farm numbers since 1992 may indicate that new technologies and economies of scale limit the role of the midsize farm in modern agriculture.
- Knowing the pathways followed by midsize farms to expand, shrink, or exit farming altogether may be useful to policymakers interested in the continued survival or transition of midsize farms.

This report examines midsize farms between 1992 and 2014 because this period provides a large window for seeing if significant changes have occurred for this group. We chose this period for two additional reasons. First, classifying midsize farms before 1992 is difficult due to a lack of data needed to measure GCFI accurately. Second, going further back in time would mean including the period around the 1980s farm crisis, potentially leading to a skewed picture of how the numbers and characteristics of midsize farms have changed since that period.²

¹For a broader discussion of issues surrounding midsize farms and their importance to the food system and the rural economy, see *Food and the Mid-Level Farm: Renewing an Agriculture of the Middle* by Thomas A. Lyson, G. W. Stevenson, and Rick Welsh (2008).

²For a discussion of the U.S. farm crisis of the 1980s, see *American Agriculture in the Twentieth Century: How It Flourished and What It Cost*, by Bruce L. Gardner (2002).

Defining Farm Size

In order to analyze midsize farms over time, it is necessary to determine an appropriate measure of farm size. Given the importance of land to agricultural production, acreage operated is one potential measure. However, farmland varies in quality, as well as in its relative commercial importance across farms producing different commodities (e.g., an acre of strawberries generates more revenue than an acre of corn). Therefore, rather than focusing on a production input such as land, this report defines farm size using a measure of gross income. Previous studies have used different benchmarks for midsize farms. For example, Ahearn et al. (2009) defined a midsize farm as having between \$100,000 and \$250,000 in farm sales.

Defining Farm Size by Gross Cash Farm Income (GCFI)

In this report, we use gross cash farm income (GCFI) to define farm size through time (see box, “Classifying farms using GCFI”). GCFI is the gross revenue received by a farm operation in a year. It is defined as the sum of the farm’s cash and market contract revenues from the sale of crops, animals, and animal products, plus Government payments and other farm-related income, including commodity insurance indemnities and fees from production contracts. In general, other farm-related income includes any other revenues flowing to the farm operation but would exclude income earned from operations set up as a separate business. For example, if the farm has sales through farmers’ markets, other direct sales, or sales from agrotourism,³ then these revenues would also be included in GCFI. However, if these sales are part of a separate business, they would not be included.

GCFI focuses on the farm operation, excluding returns to share landlords and contractors. It includes all farm-related revenue, not just crop and livestock sales, and is based on annual sales, not the value of annual production. Because it captures other farm income such as custom work and Government payments, GCFI is a better measure of total economic activity of the farm than other measures, such as market value of agricultural products sold. For a comparison of different ways to measure farm size, see appendix I.

Due to data limitations in the Census data, GCFI is approximated for years 1992 and 1997. To approximate GCFI, we use supplemental data from the 1992 Farm Costs and Returns Survey (FCRS) and 1997 Agricultural Resource Management Survey (ARMS) to calculate median values for total value of production under production contract, production contract fees, and landlord share of production. These median values are stratified by region, commodity specialization, and sales class. We then impute for these variables and calculate approximate GCFI. After adjusting for inflation, we can classify farms as very-low-sales, small commercial, midsize, or large, using the approximate values of GCFI. For more details about how we approximate GCFI in 1992 and 1997, see appendix II.

³Any activity that brings people to the farm, such as to buy from a vegetable stand, pick fruit, or, where applicable, to stay at a Bed & Breakfast run by the farm.

Box 1

Classifying Farms Using Gross Cash Farm Income (GCFI)

Using the updated ERS farm typology (Hoppe and MacDonald, 2013), we divide farms into more homogenous groups based on GCFI, the sum of the farm sales of crops and livestock, Government payments, and other farm-related income. We classify farms as:

- **Very-low-sales farms** – GCFI less than \$10,000
- **Small commercial farms** – GCFI of \$10,000 - \$349,999
- **Midsized farms** – GCFI of \$350,000 - \$999,999
- **Large farms** – GCFI of \$1 million or more

All GCFI boundaries are defined in 2012 constant dollars using the Producer Price Index for Farm Products.

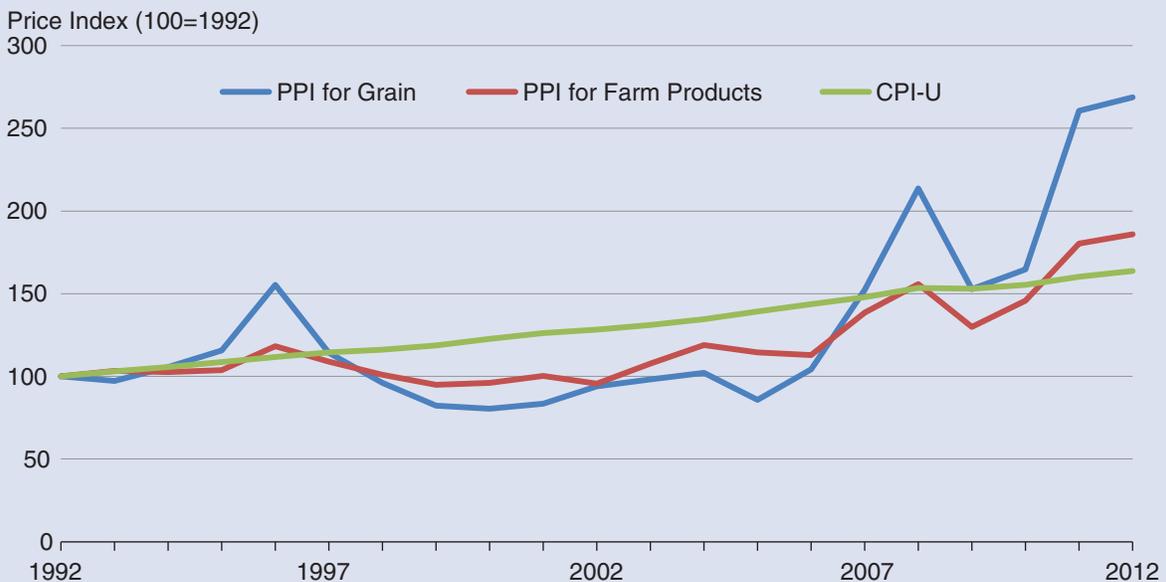
One challenge in measuring farm size with gross cash farm income over time is accounting for commodity price volatility and high levels of net farm income that occurred from 2009-13. Total commodity revenue grew by 38 percent over this 5-year period, driven largely by increases in commodity prices (Patrick et al., 2016). Volatile commodity prices were observed in this period as well, particularly in grain commodities.

As shown in the figure below, the average producer price for grains (PPI for Grains) rose much faster than the average producer price for farm products (PPI for Farm Products) or the Consumer Price Index (CPI-U) from 2007 to 2012. In fact, grain prices rose nearly 60 percent across those 5 years. As a result, a midsize grain farm would have had a much higher GCFI during this period.

Box figure 1.1

Producer price indices for grains and farm products and the Consumer Price Index, from 1992 to 2012

Grain prices rose almost 60 percent from 2007 to 12, compared with a 30-percent increase for all farm products.



PPI = Producer Price Index; CPI-U = Consumer Price Index.

Source: USDA, Economic Research Service calculations based on the Producer Price Index for Farm Products, U.S. Bureau of Labor Statistics.

Box 1

Classifying Farms Using Gross Cash Farm Income (GCFI)— continued

Because crop and livestock receipts typically make up the largest portion of GCFI, swings in commodity prices can play a large role in defining a farm's size category over time. For example, a cash-grain farm may be classified as midsize in 1 year and small commercial in the next, depending on whether grain prices are high or low, all while producing the same quantity and mix of grains.

We deflate GCFI into real dollars using the Producer Price Index for Farm Products (PPI for FP). This deflator will reflect changes in actual cash income generated on the farm or cash available to the farmer. It also reflects changes in overall farmer well-being and captures the amounts of income available to cover living expenses and pay off debt.

However, the PPI for FP is an aggregate price deflator and may understate large swings in the price level of specific commodities. To understand how the choice of price deflator impacts our analysis, we explored a less aggregated price deflator. In applying this to the ARMS data, we did not find an effect on farm numbers over time. However, we did find the choice of price deflator can affect the change in the share of production by commodity. For more details about how the choice of price deflator can affect measures of production over time, see appendix II.

Data Sources

Our analysis relied on four data sources: the Agricultural Resource Management Survey (ARMS); the 2014 Tenure, Ownership, and Transfer of Agricultural Land (TOTAL) survey; the Census of Agriculture (Census); and the Farm Costs and Returns Survey (FCRS). We also used ERS estimates to supplement our analysis in several places.

The ARMS represents a sample of 20,000 farms in a given year, covers all types of farms, and is designed to accurately represent farm and production in the continental United States. ARMS collects detailed data about farm finances and the farm operator's household, tying them to information about farm production and resources. The FCRS was the forerunner to the ARMS data and is also a representative sample of farm production in the continental United States. Both surveys are administered jointly by NASS and ERS.

The Census of Agriculture is administered by NASS every 5 years.⁴ The census elicits information on all U.S. farms, including Alaska and Hawaii, and is valuable for following long-term trends. The Census of Agriculture forgoes the detailed financial and demographic information collected in ARMS, while collecting more detailed information about the physical production of crop and livestock commodities. While ARMS is a repeated cross-section sample of U.S. farms, the census permits longitudinal analysis because farms can be linked with administrative data from census to census. Analysis of farm growth and entry and exit rates would not be possible without census data.

The 2014 TOTAL survey provides information on a variety of topics related to farmland, including ownership, income, expenses, debt, assets, and demographic characteristics of non-operator landlords, as well as information specific to land such as the acquisition and transfer of land, sale and leasing of gas and oil rights, and rental agreements. The TOTAL survey was administered with two separate instruments, one for farm operators, who may or may not rent out land, and another for non-operator landlords. The survey sampled over 40,000 operators and non-operator landlords and is representative of all agricultural land owners and all farm operations. It was jointly administered by NASS and ERS.

For the remainder of the report, we use the FCRS, ARMS, and the 2014 TOTAL survey to report summary statistics on the financial condition, production, and demographics of midsize farm operations and households. The 2012 Census is used to report the most recent farm numbers, while census data from 1992 to 2012 are used to estimate farm exits, entries, and transitions over time.

Comparing Midsize Farms to Other Farm Sizes

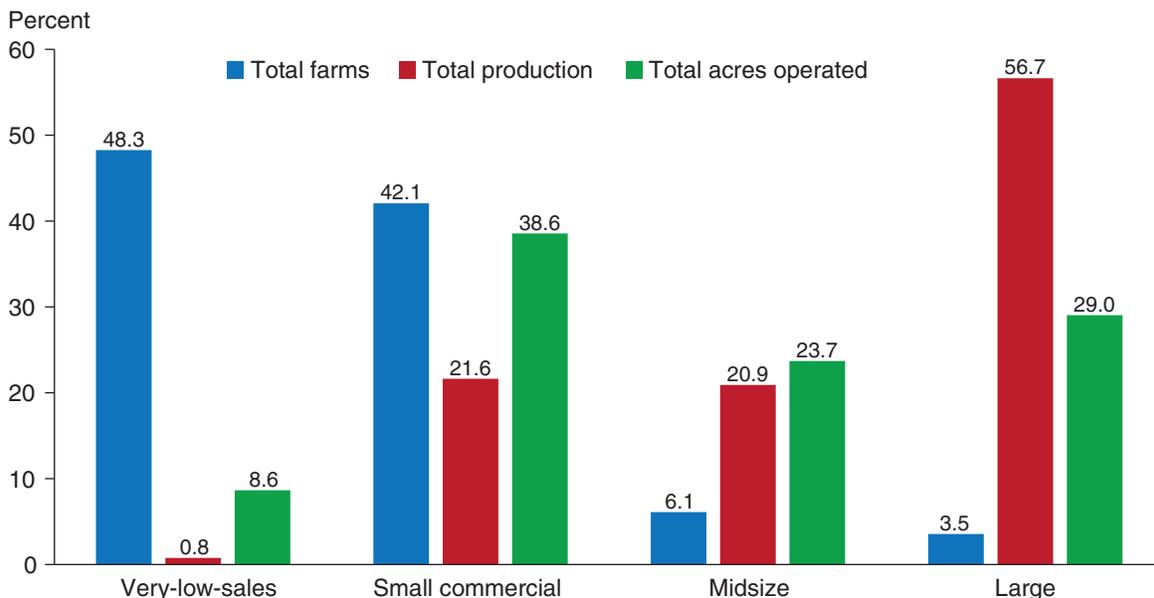
The distributions of U.S. farms and total production are highly skewed (fig. 1). Midsize and large farms together made up only 9.6 percent of total farms but represented 78 percent of the total production in 2014, with midsize farms accounting for 21 percent of the total value of production. Together, small commercial and very-low-sales farms accounted for more than 90 percent of farms but produced only about 22 percent of total agricultural output, roughly equivalent to the midsize farm share of production.

⁴ARMS data are collected in coordination with the Census in census years (such as 2012), and ARMS questions are integrated into the census questionnaires of farms selected for the ARMS sample.

Figure 1

Distribution of farm numbers, production, and acres operated in 2014

Midsized farms represented 20.9 percent of total U.S. agricultural production and 23.7 percent of total acres operated.



Source: USDA, ERS calculations based on the USDA, Economic Research Service and National Agricultural Statistics Service, 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Technological Change and the Shifting Structure of U.S. Agriculture

The structure of U.S. agriculture has shifted significantly in the last three decades. Technological advances in farming, combined with the increased use of production contracting, have accompanied the growth of larger and more specialized farms. Key and McBride (2007) found that technological innovations combined with the use of production contracts had a significant impact on the structure of U.S. swine production from 1992 to 2007. They found that the number of hog farms fell by more than 70 percent from 1992 to 2004, while the output of U.S. hog operations remained steady. They also showed that hog operations had become larger and more specialized in a single phase of production, leading to increases in hog farm productivity. MacDonald (2014) found that U.S. broiler production relies almost exclusively on production contracting and that production has shifted toward growing larger birds to meet consumer demand. Larger contract operations were shown to generate better financial returns than smaller farms. Similar shifts toward larger farms have been observed with U.S. crop farms. A study by MacDonald et al. (2013) found that most cropland (midpoint acreage) was on farms with at least 1,100 acres in 2007, while this number was only 600 acres in the early 1980s.

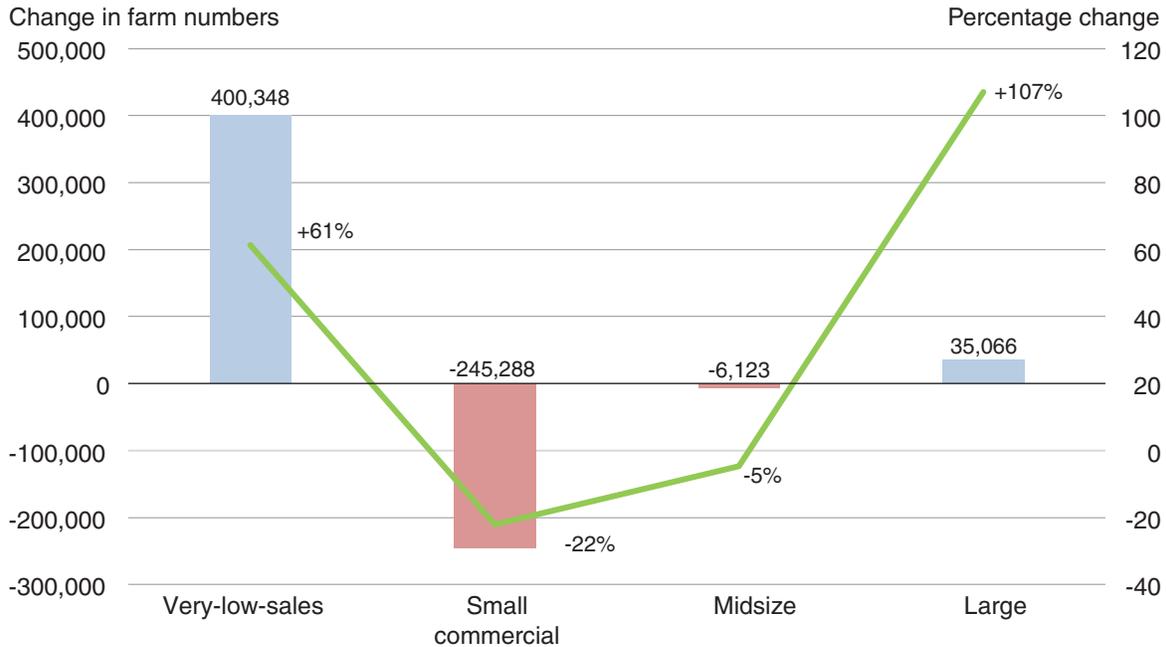
Changes in the Distribution of Farm Numbers From 1992 to 2012

As figure 2 shows, the shift toward a higher percentage of production taking place on large farms has been accompanied by an increase in the number of those farms, which more than doubled from 1992 to 2012.

Figure 2

Percentage change in farm numbers by size category from 1992 to 2012

Midsized farm numbers have declined by about 5 percent.



Source: USDA, Economic Research Service calculations based on the USDA, National Agricultural Statistics Service, 1992 and 2012 Census of Agriculture.

Small Commercial Farms Declined From 1992 to 2012 While Very-Low-Sales Farms Increased

Small commercial farms had the largest drop in both percentage terms and numbers from 1992 to 2012 (fig. 2). Meanwhile, very-low-sales farms increased by over 60 percent during the period. Some of this increase may reflect greater efforts by NASS to count all farms, which has had the largest impact on the numbers of very-low-sales farms and point farms.⁵

Previous work by Hoppe et al. (2010) analyzed small farms in detail. They found that small farms are largely residential, that many are point farms, and that they rely heavily on off-farm income. Small commercial farms have been able to persist, but often gradually go out of business because of the age of the operator and the farm’s unprofitability. The decline in small commercial farms may be tied to both the increasing age of principal operators and their marginal profitability.

Midsized Farms Had Become Less Common by 2012

This report seeks to understand another portion of midsized farms that has not been examined in detail. From 1992 to 2012, midsized farm numbers fell by about 5 percent, as noted, declining from about 132,000 to 125,000 farms. As we discuss in the next sections, this decline is partly due to exits from farming, but may also be attributed to midsized farms transitioning to other farm sizes at higher rates than small commercial or large farms.

⁵This increase may be due to adjustments for undercoverage of “point farms” starting in the 2002 Census. Point farms have sales of less than \$1,000 but are considered farms because they would normally be expected to sell at least \$1,000 of agricultural products.

Many midsize cash-grain farms grew in size to large farms from 2007 to 2012, largely due to high grain prices. We note that some large farms will shrink to a midsize farm during periods of lower commodity prices; thus, the exact number of midsize farms is constantly changing. Previous studies (MacDonald et al., 2013) have found that the number of midsize crop farms declined from 1982 to 2007, while farms at the extremes (large and small) had grown. This topic is explored in more detail later in the report.

Large Farm Numbers More Than Doubled From 1992 to 2012

During 1992-2012, the number of large farms in U.S. agriculture increased by 107 percent (fig. 3). Recent studies have examined the factors leading to both the increasing numbers and increasing total agricultural production of large farms. A few studies (MacDonald et al., 2013; Ahearn et al., 2005) have found that advances in labor-saving technologies have increased the concentration of U.S. production occurring on large farms.

Hoppe et al. (2010) discussed the shift in total production and sales to very large farms in livestock farming. They find that technological advances in transportation, disease-handling, nutrition, and the use of climate-controlled buildings has resulted in more standardized production practices. This has made it easier for large-scale livestock operations to reduce per unit costs and grow in size and number. In addition, the use of contracts—both production and marketing, which can reduce price and marketing risks faced by farmers—has increased with this shift toward large-scale livestock farms.

Most Midsize Farms Specialize in Cash Grains and Oilseeds

In 2012, there were 125,441 midsize farms. The majority of these farms (over 70,000) specialized in cash grains and oilseed crops. More than 15,000 midsize farms specialized in beef cattle, and approximately 10,000 farms each specialized in dairy, high-value crops, and other crops (fig. 3).

In 2012, midsize farms were more common in the Northern Great Plains (North Dakota, South Dakota, and Nebraska) and the Heartland (Iowa, Illinois, and Indiana) (fig. 4). Midsize farms became relatively more common in these regions from 1992 to 2012.

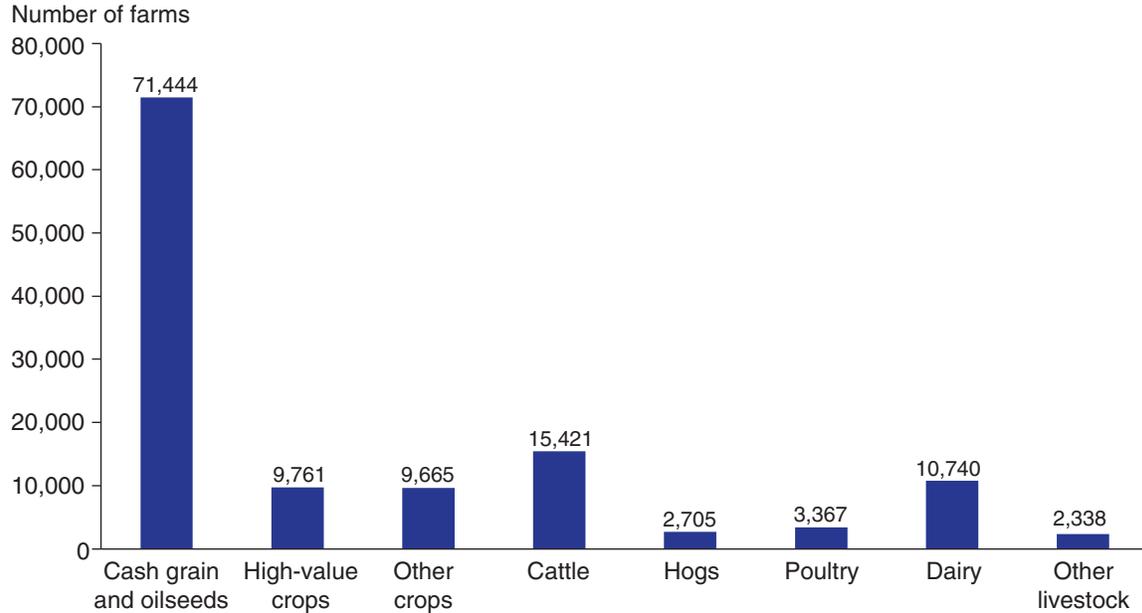
Given that most midsize farms specialized in cash-grain and oilseed production, it is not surprising that they are found in greater numbers in the Northern Great Plains and Heartland because these regions are best suited to growing these types of crops. In 2014, these two regions accounted for 46.5 percent of total value of production on midsize farms.

We note that many of these farms would have been affected by the 2012 drought. This drought affected much of the field corn, wheat, and soybean crop, further contributing to already high commodity prices (ERS, 2013). Farms that were unaffected by the drought or had stored stocks available for sale were able to sell their crops at the high prices, leading to large gains in their gross cash farm income. For farms affected by the drought, the resulting damage to crops led to crop insurance indemnity payouts. These crop insurance indemnities are included in gross-cash farm income and would partially offset the farmers' lost revenue.

Figure 3

Midsize farm numbers by commodity specialization in 2012

Most midsize farms were cash-grain and oilseed farms.

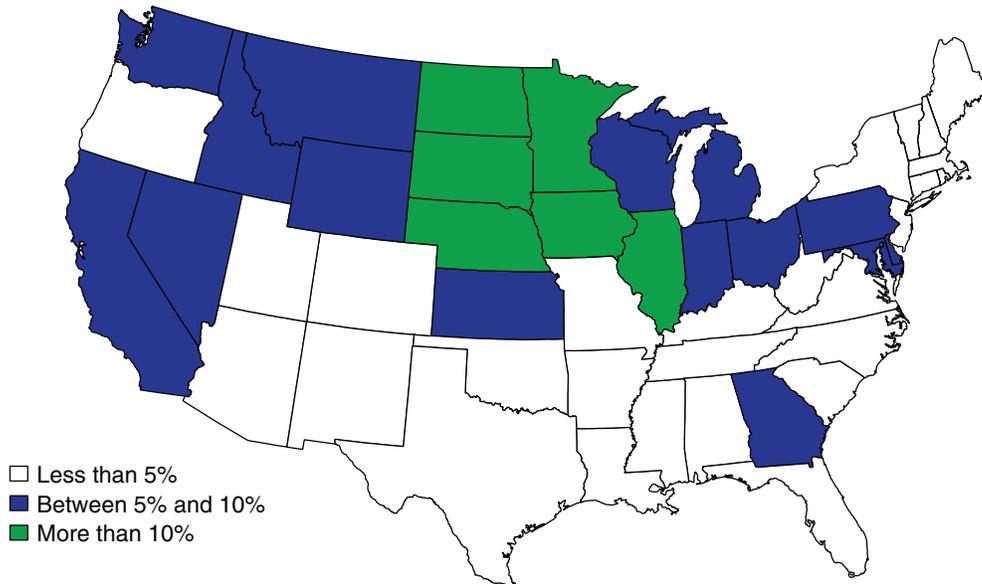


Source: USDA, Economic Research Service calculations based on the USDA, National Agricultural Statistics Service, 2012 Census of Agriculture.

Figure 4

Percentage of farms that were midsize, by State, 2012

Midsize farms are more common in the northern Great Plains and Heartland regions.



Note: Farm size assigned using adjusted GCFI.

Source: USDA, Economic Research Service calculations based on the USDA, National Agricultural Statistics Service, 2012 Census of Agriculture.

Changes in Midsize Farms From 1992 to 2014

Changes in Midsize Farm Households

Midsize farm households have undergone substantial changes between 1992 and 2014. Principal operators have become older, consistent with the upward trend in operator age across all farm sizes. This may explain why those who consider farming to be their primary occupation declined from 97 to 92 percent (table 1). The median midsize farm household got smaller, shrinking to around 2 persons. An upward trend is seen in the both the percentage of female principal operators and operators who have some college or have completed college.

Table 1

Selected characteristics of midsize farm households in 1992, 2002, and 2014¹

	1992	2002	2014
Median principal operator age	47	50	56
Median household size	N/A	3	2
	<i>Percent</i>		
Family farm ²	N/A ³	96.9	97.8
Primary occupation is farming ⁴	97.6	91.6	91.7
Female principal operator	N/A	1.9	3.3
Principal operator educational attainment:			
Completed high school	43.1	43.4	36.3
Some college	25.8	28.0	30.7
Completed college (BA or higher)	20.3	22.5	28.0
Financial indicators (medians)			
	<i>Inflation-adjusted \$</i>		
Farm household income ⁵	\$67,291	\$49,978	\$127,979
Off-farm income	\$11,175	\$26,905	\$42,796
Total household income ⁶	\$89,622	\$83,248	\$183,858
Household net worth	\$815,927	\$874,891	\$2,112,438
Percentage with more than \$10,000 in household debt	82.8	84.2	83.4
Percentage of household income from off-farm sources ⁷	12.5	32.3	23.3

¹Weighted medians are reported for continuous variables and weighted means are reported for variables listed as percentages. Farm household income, total off-farm income, household income, and household net worth are reported in 2012 dollars using the Gross Domestic Product deflator.

²Since 2005, ERS has defined a family farm as one in which the majority of the operation is owned by the operator and individuals related to the operator by blood, marriage, or adoption, including relatives who do not live in the operator household.

³Not available in the 1992 ERS Farm Cost and Returns Survey.

⁴The primary occupation of the principal operator is considered to be farming if he/she spends at least 50 percent of the time engaged in farming.

⁵Farm household income is the sum of the operator household's share of farm operation income (net cash farm income less depreciation), wages paid to the operator and other household members, and net rental income from renting farmland. Net cash farm income is the difference between gross cash farm income and cash operating expenses.

⁶Total household income = farm household income + off-farm income. In the table, these numbers will not necessarily sum up, because the median midsize farm in these categories is not necessarily the same farm.

⁷Household off-farm income dependence = total off-farm income/total household income, where the numerator and denominator are evaluated at their weighted median value.

Source: ERS calculations based on the USDA, Economic Research Service, 1992 Farm Cost and Returns Survey, 2002 Agricultural Resource Management Survey Phase III, and USDA, Economic Research Service and National Agricultural Statistics Service, 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Midsize farm households have seen substantial increases in income and wealth. Total household income has doubled, while off-farm income has more than tripled.⁶ As a result, the share of total household income accounted for by off-farm sources has increased from 1992 to 2014. The upward trend in midsize farm household off-farm income mirrors the trend in all farm households, particularly since 2010 (ERS, 2016a).

Household net worth has also increased dramatically. This fact reflects high levels of appreciation in land values in the 2000s, driven by factors such as high levels of farm income and low interest rates. Farmland accounted for about 81 percent of total farm assets in 2014. Farmland appreciation in the middle and late 2000s (ERS, 2016b) was particularly strong in regions of the Midwest, which saw double-digit land appreciation. As a result, midsize farm households saw their wealth more than double from 2002 to 2014.

The aging of the overall farm population has led to concerns about whether there are enough beginning farms to replace those that exit farming, with a farm considered to be beginning when all of the operators have less than 10 years of experience on the farm or ranch. Given that the average age of the median midsize principal operator has increased from 47 to 56 years, this would be a concern for midsize farms as well. As figure 5 shows, the percentage of beginning midsize farms has held steady from 2005 to 2014⁷ at about 9 percent. These represented about 12,000 midsize farms in 2014. Additionally, there are many midsize farm operations that have a beginning operator who is not the principal operator. When we include farms with any beginning operators, we find that 23,000 midsize farms, or 17.9 percent, met this criteria in 2014.

Changes in Midsize Farm Operations

In 2014, the median midsize farm operated about 839 acres and owned about one-third of those acres. Census data show that midsize farms have operated between 800 and 900 acres from 1992 to 2012. In contrast, the median large farm has grown considerably. In 2012, it operated about 400 more acres than in 1992, increasing from 1,399 to 1,799 acres (fig. 6).

Midsize farm production is concentrated in grains and oilseeds. This concentration has increased since 1992, with more than 40 percent of production occurring on midsize farms that specialize in grains and oilseeds in 2014 (fig. 7). In 2014, midsize farms that specialized in dairy, high-value crops, and other crops (e.g., tobacco, peanuts, and cotton) represented a smaller share of total production than in 1992. However, a larger share of production came from midsize farms that specialized⁸ in hogs and poultry. The decline in midsize dairy operations has been examined in previous ERS reports; see box, “A Shift in Dairy Production by Farm Size.”

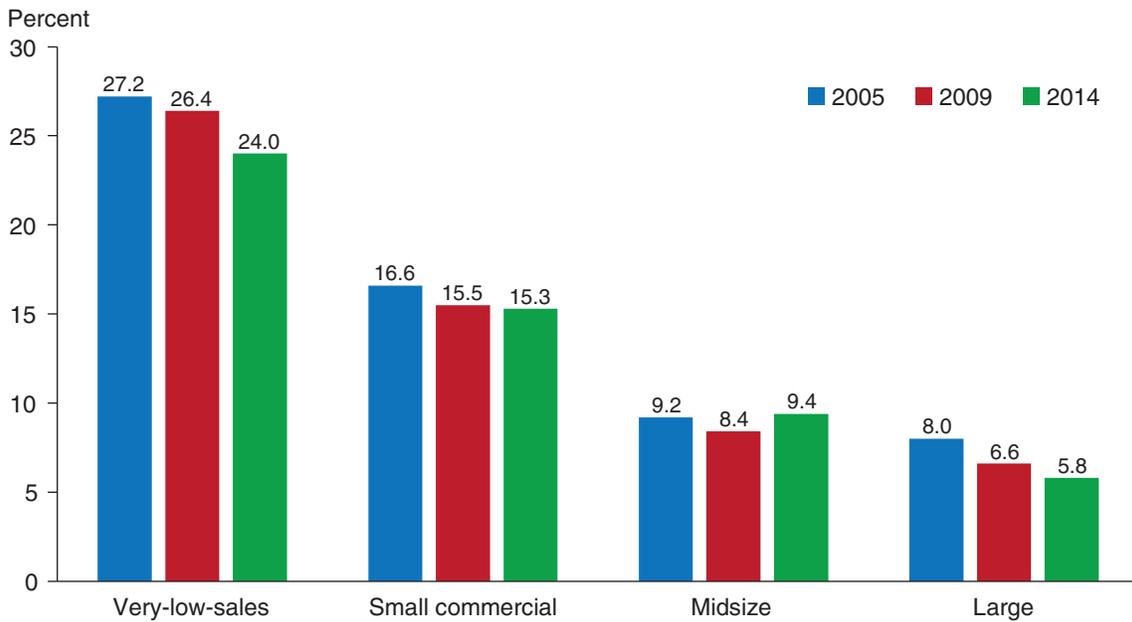
⁶We note that the ERS FCRS and ARMS/TOTAL differ in how they asked respondents about their total off-farm income. ARMS/TOTAL asks respondents several questions about off-farm income sources in order to estimate a total, while the FCRS only asked a single question about total off-farm income. This may partially explain why total off-farm income is much lower in 1992 when compared with 2002 and 2014.

⁷We report data on beginning farmers starting in 2005 because this was the first year these data were collected in the ARMS.

⁸A farm is considered specialized if a commodity accounts for at least half of the farm’s value of production.

Figure 5

Percentage of beginning farms by size category, 2005-2014

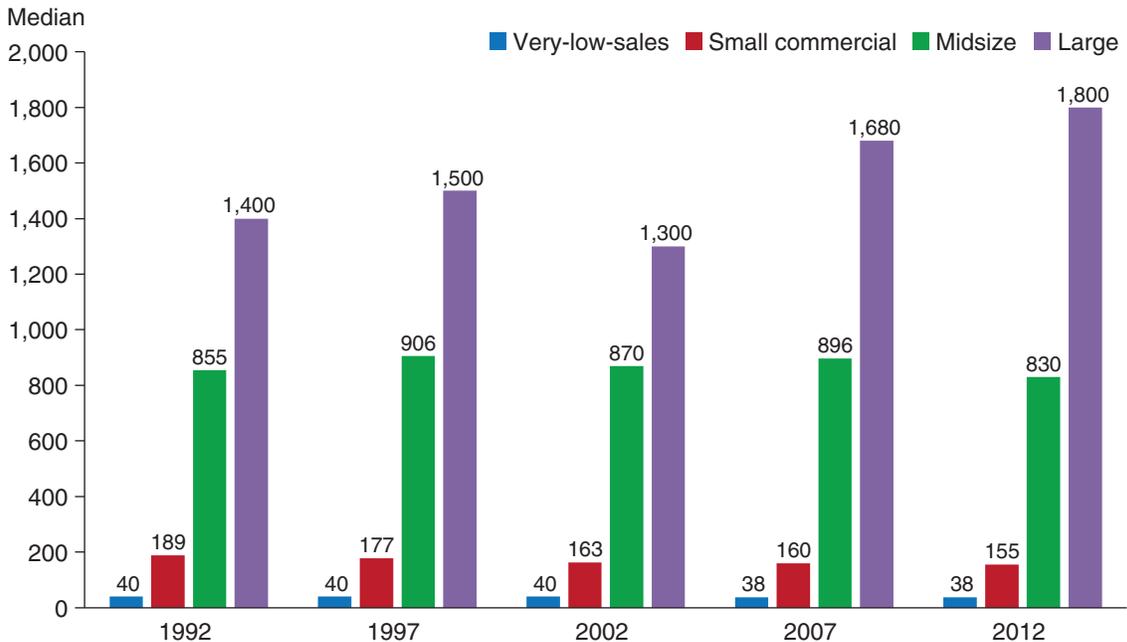


Source: USDA, ERS calculations based on the USDA, Economic Research Service, 2005, 2009 Agricultural Resource Management Survey, Phase III, and USDA, Economic Research Service and National Agricultural Statistics Service, 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Figure 6

Median acres operated by farm size, 1992-2012

The median midsize farm operated between 800 and 900 acres from 1992 to 2012.

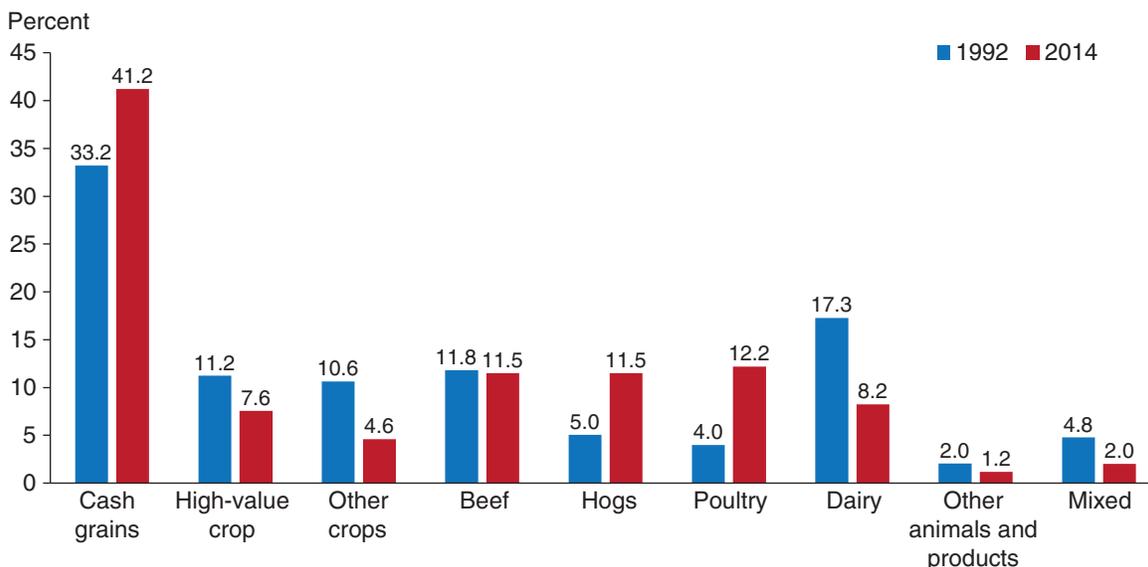


Source: USDA, Economic Research Service calculations based on the USDA, National Agricultural Statistics Service, 1992, 1997, 2002, 2007, and 2012 Census of Agriculture.

Figure 7

Distribution of total value of production on midsize farms by specialization in 1992 and 2014

The share of production on midsize farms specializing in cash grains increased by 8 percentage points, while the share of production on midsize dairy farms decreased by 9 percentage points.



Source: ERS calculations based on the USDA, Economic Research Service, 1992 Farm Costs and Returns Survey and USDA, Economic Research Service and National Agricultural Statistics Service, 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Box 2

A Shift in Dairy Production by Farm Size

The decline in the share of dairy production occurring on midsize farms has been explored by MacDonald and Newton (2014). Midsize dairy farms have declined in number over this period, while total dairy production has become more concentrated on large farms. From 1992 to 2012, the percentage of milk cows that were in herds of 1,000 or more increased from 10 percent to 49 percent, while the percentage in herds of less than 100 declined from 49 percent to 17 percent (MacDonald and Newton, 2014).

By selected financial performance measures, midsize farms were in good financial health in 2014. Total equity for the farm operation increased nearly 70 percent, driven up by rapid farmland appreciation in the middle to late 2000s, shown in table 2. Net farm income increased by almost 50 percent, though the percentage with positive net farm income has remained roughly constant at about 80 percent. We note that these financial performance numbers will reflect broader trends in the overall farm economy.

The financial performance of midsize farms improved using most standard measures (see box #3, “Defining Financial Ratios”) during the period 1992-2014. As table 2 shows, in terms of leverage, profitability, and financial efficiency, they are doing better in 2014. Debt-to-asset ratios have fallen by 2 percentage points, and fewer farms have substantial debt obligations. Operating profit margins have increased by a percentage point.

Table 2

Selected midsize farm performance measures¹

	1992	2014
Financial relations	<i>Percent</i>	
Return on equity	4.2	3.7
Return on assets	4.9	3.6
Operating expense ratio	76.8	66.3
Debt-to-asset ratio	12.5	10.5
Operating profit margin ratio	14.4	15.5
Asset turnover ratio	31.4	22.3
Current ratio	4.0	3.5
Financial indicators	<i>Inflation-adjusted \$</i>	
Farm operation equity (median)	\$958,447	\$1,627,105
Net farm income (median)	\$94,734	\$139,399
Percentage with positive net farm income	82.7	78.7
Percentage with more than \$10,000 in farm debt	80.0	82.6

¹Assets and income are reported in 2012 dollars using the Gross Domestic Product deflator. Dollars are reported in weighted median values; financial ratios are reported as the ratio of weighted median values.

Source: ERS calculations based on the USDA, Economic Research Service, 1992 Farm Costs and Research Survey and USDA, Economic Research Service and National Agricultural Statistics Service, 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Box 3

Defining Financial Ratios

Definitions follow of the financial ratios used in this report. These ratios are broken into categories that measure different financial aspects of the farm operation.

Solvency

Debt-to-asset ratio = 100% X (total liabilities/total assets)

Liquidity

Current ratio = 100% X (current assets/current liabilities)

Financial Efficiency

Operating expense ratio = 100% X (total cash operating expenses/gross cash farm income)

Profitability

Return on equity = 100% X (net farm income – charge for unpaid operators' labor and management)/net worth

Operating profit margin = 100% X (net farm income + interest paid – charge for unpaid operators' labor and management)/gross farm income

Return on assets = 100% X (net farm income + interest paid – charge for unpaid operators' labor and management)/total assets

Asset turnover ratio = 100% X (value of production/ average total assets)

Other financial measures show slightly weaker performance in 2014. Returns on equity and assets have declined slightly, reflecting the large increase in real estate assets combined with a smaller proportional increase in net farm income. Asset turnover, which measures the efficiency with which farm assets are used to generate production, has also declined. This drop in asset turnover has been larger than the increase in operating profit margins, which explains why return on assets has declined.

Previous work by Hoppe et al. (2008) showed that farm profitability generally improves with farm size. Thus, many midsize farms outperform smaller farms in financial outcomes. However, they still lag behind large and very large farms in profitability. This difference is due to lower costs of production on large farms, not to higher per unit revenue. Larger farms can also realize more production per unit of labor and capital. They typically have higher returns on equity as well (MacDonald et al., 2013).

The gap in the operating profit margin (OPM) between midsize and large farms has grown wider since 1992 (fig. 8). While midsize and large farm profitability has trended upward over time, large farm profitability has increased at a faster rate. We note that both midsize and large farms saw a dip in their OPMs in 2002 because of lower farm income.

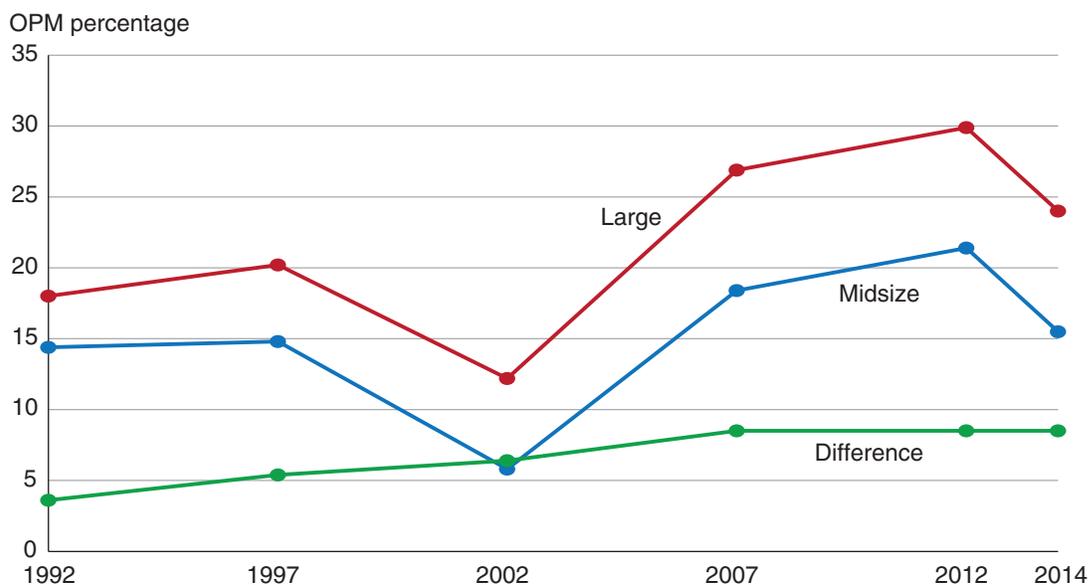
Midsized Farms Were in Good Shape Financially in 2014

In table 3, we compare the financial health of midsize farms in 1992 and 2014 based on the ERS financial position classification (see box, “How ERS Classifies a Farm’s Financial Position”). Overall, midsize farms were in a similar financial position in 2014 compared to 1992. About 82 percent were classified as having favorable or marginal income in 2014, compared with 84 percent in 1992. Farms in these two income categories have low debt-to-asset ratios and are less likely to be financially stressed.

Figure 8

Operating profit margin (OPM) for midsize and large farms, 1992-2014

The gap between the operating profit margin for midsize and large farms has more than doubled from 1992 to 2014.



Source: USDA, ERS calculations based on the USDA, Economic Research Service, 1992 Farm Costs and Returns Survey; USDA, Economic Research Service and National Agricultural Statistics Service, the 1997, 2002, 2007 and 2012 Agricultural and Resource Management Surveys and the USDA, ERS/NASS 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

About 18 percent of midsize farms were classified as having marginal solvency or being vulnerable in 2014. This is similar to the 16 percent found in these two categories in 1992. Farms in either of these categories are highly leveraged, with farms in the vulnerable category being most financially stressed. We note that a marginally solvent farm may have enough net farm income to compensate for its high leverage, but it would likely require higher levels of net farm income to compensate.

Table 3

Distribution of midsize farms based on ERS financial-position classification

	1992	2014
	<i>Percent</i>	
Favorable	69.7	65.6
Marginal income	14.5	16.8
Marginal solvency	12.8	13.2
Vulnerable	3.0	4.4

Source: USDA, ERS calculations based on the USDA, Economic Research Service, 1992 Farm Costs and Returns Survey; and USDA, Economic Research Service and National Agricultural Statistics Service, 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Box 4

How ERS Classifies a Farm’s Financial Position

The ERS measure of farm financial positions classifies farms using two separate financial measures: the debt-to-asset ratio and net farm income. The debt-to-asset ratio measures the proportion of assets (e.g., value of land and buildings) owed to creditors to cover the farm’s outstanding debt obligations. A higher debt-to-asset ratio indicates that more of the assets are financed through debt and the farm has a higher leveraged position. Net farm income is a measure of income available to the farm operation after production expenses, noncash benefits to labor, and inventory changes have been subtracted from gross farm income. Gross farm income is the sum of gross cash farm income, non-money income, the value of commodities consumed on the farm, and the imputed rental value of the principal operator’s farm dwelling.

Farms classified as favorable are considered to be in good financial health, with a low leverage position and positive net farm income. Farms classified as vulnerable are considered financially stressed because they have both a high debt-to-asset ratio and negative net farm income.

Favorable: Debt/assets < 40% and Net Farm Income >0

Marginal Income: Debt/assets <40% and Net Farm Income <0

Marginal Solvency: Debt/assets>40% and Net Farm Income>0

Vulnerable: Debt/assets>40% and Net Farm Income<0

Understanding Changes in Midsize Farm Numbers, 1992-2012

There are two ways in which midsize farm numbers (or numbers for any farm size) can change over time. The first is through transitions into and out of the midsize category. For example, if a small commercial farm grows in size or a large farm shrinks, it would move into the midsize category, increasing that number. A second way midsize farm numbers can change is through the creation of new farms—i.e., entries—and farm exits. We measure the net change in midsize farm numbers caused by entries and exits using the net entry rate. The net entry rate is defined as the entry rate minus the exit rate. A positive net entry rate suggests more farms are entering than exiting, while a negative entry rate suggests the opposite. We note that if the number of transitioning farms is large, it could potentially have a larger effect on midsize farm numbers than the net entry rate.

Tracking Farm Operations With the Census of Agriculture

Using census data from 1992 to 1997 and 2007 to 2012, we examine midsize farm transitions (both into and out of the midsize category) and entry and exit rates. We then compare them with small commercial and large farms. In order to track operations and not individuals through these periods, we use the Census File Number (CFN) for the period 1992-97, and the Operation Identification Number (OID) from 2007 to 2012. Because of changes in the administration of the census, we cannot track operations accurately in the intervening periods (see appendix III for more details on tracking operations through time by using the Census of Agriculture). Tracking operations is important because the principal operator may retire or leave farming, while the operation may continue to exist.

Transition Rates for Farms Remaining in Business

To understand where midsize farms go, we examine transition rates⁹—movement from one farm size category to another—for farms that remain in business, or “continuing farms.” We then compare them to small commercial and large farms. Transition matrices for years 1992-97 and 2007-12 are shown in table 4. Each transition matrix shows the rate at which a continuing farm stays in its own size category or transitions to another category. For example, table 4 shows that from 1992 to 1997, about 57.6 percent of the continuing midsize farms remained in the midsize category. The remaining 42 percent of continuing midsize farms, representing about 40,000 farms, either grew or shrank in farm size. Note that the rows do not sum to 1 because we have left very-low-sales farms out of the analysis.¹⁰

⁹Transition rates for 1992-97 and 2007-12 were estimated only for farms with observable data on gross cash farm income in both census periods. About 400,000 U.S. farms survived between each intercensal period but did not have data on GCFI for the next census year. The vast majority of these were farms with GCFI of less than \$10,000.

¹⁰We leave out very-low-sales farms from the transition matrix for several reasons: (1) they represent the least accurately measured group of farms; (2) most of these farms are not farm businesses and thus would not be expected to expand or shrink significantly between years; and (3) for ease of visual presentation.

Table 4

Transition rates for continuing farms, 1992-97 and 2007-12*Midsize farms stayed in their size category at a rate of 58 percent*

		1997		
		Small commercial farm	Midsize farm	Large farm
		<i>Percent</i>		
1992	Small commercial farm	78.6	0.4	0.4
	Midsize farm	31.9	57.6	9.4
	Large farm	7.0	26.1	66.1
		2012		
		Small commercial farm	Midsize farm	Large farm
2007	Small commercial farm	73.3	5.2	0.6
	Midsize farm	24.6	57.8	16.6
	Large farm	5.5	16.6	77.3

Source: USDA, ERS calculations based on the USDA, National Agricultural Statistics Service, 1992, 1997, 2007, and 2012 Census of Agriculture.

Overall, farms of all sizes are more likely to remain in the same size class between census years. However, relative to small commercial and large farms, midsize farms are a mobile group. Table 4 shows a consistent story for midsize farm transitions between census years. In each period, about 58 percent of continuing midsize farms remained in their size category, while the remaining 42 percent grew or shrank. Transitions into the midsize category were also greater from 2007 to 2012. About 5.2 percent of continuing small commercial farms transitioned to midsize during this period compared to 0.4 percent from 1992 to 1997, resulting in a sizable number—roughly 30,000—of new midsize farms.

A closer inspection of the data reveals that transitions represented a net gain of about 2,000 midsize farms from 1992 to 1997. In contrast, transitions did not have an effect on midsize farm numbers (i.e., transitions into the midsize farm category equaled transitions out) from 2007 to 2012. In the latter period, about 15,300 midsize farms transitioned up to large farms, a substantial increase over 1992-97. As noted, during the period from 2007 to 2012, the Producer Price Index for grain crops such as corn, wheat, sorghum, and soybeans increased much faster than for farm products as a whole. Increases in grain prices during this period likely encouraged farmers to increase their acres operated, leading to growth in farm output and GCFI. Increasing acreage by renting land is one way a midsize farm can grow into a large farm, which we explore later in the report.

The relatively high rate of transition for midsize farms is also related to how changes in farm size accompany the lifecycle of the farm household. As noted by Ahearn et al. (2009), farms of all sizes are continually expanding or contracting due to changes in economic conditions or because of changes in the farm household. In fact, those authors found that from 1992 to 1997, only about 30 percent of continuing farms did not expand or reduce the acres they operated.

Changes in Gross Cash Farm Income Between 2007 and 2012

Between 2007 and 2012, midsize farms resembled large farms in how much their GCFI changed. As table 5 shows, about 64 percent of midsize farms saw a change of less than 50 percent in their GCFI from 2007 to 2012, a rate similar to large farms. Small commercial farms were more likely to see large changes (greater than 50 percent) in GCFI between these 2 census years. The median midsize farm that saw its GCFI grow by more than 50 percent had a younger operator (50 years versus 52

Table 5

Percentage of farms that saw their GCFI increase by less than 50 percent, increase more than 50 percent, and decrease more than 50 percent from 2007-12

Years	Typology	Within range (+ or – 50 percent)	Grew by more than 50 percent	Decreased by more than 50 percent
<i>Percent</i>				
2007-2012	Small commercial	47	19	34
2007-2012	Midsize	64	15	21
2007-2012	Large	66	11	23

Source: ERS calculations based on the USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture.

years), operated more acres (1,200 acres versus 923 acres), and was more likely to specialize in cash grains and oilseeds than farms that did not achieve that growth.

From 2007 to 2012, 21 percent of midsize farms saw their GCFI decline by more than 50 percent. This rate was very similar to large farms. We note that a decrease of 50 percent in GCFI for a midsize and large farm is much larger in terms of absolute GCFI than for a small commercial farm (see box, “GCFI Level Matters in Understanding Farm Transitions and Income Volatility”).

In total, about 35 percent of midsize farms saw their GCFI increase or decrease more than 50 percent from 2007 to 2012, demonstrating high volatility in gross cash farm income. In general, commercial farms have more volatile farm household income because a larger share of total household income comes from the farm operation.

Understanding Midsize Farm Exits

Like all farm size classes, most midsize farms are family farms. As a result, the survival and growth of the farm is highly correlated with the life of the farm principal operator. Younger farmers often take more risks to grow their operation. Some will succeed and expand the operation, while others will fail or quit farming. Older operators often downsize their operations and rent out their land, and eventually quit farming. In fact, about one-third of the land of elderly operators is either rented to others or enrolled in the Conservation Reserve Program of USDA’s Farm Service Agency. This pattern is important to understand because midsize farms as a whole may represent an intersection point in the lifecycle for both younger and older operators.

Farms may exit for a variety of reasons. For example, the farm may fail financially, the operator may decide to change careers, or the operator may become elderly and sell the farm or land to another farmer. While farms do not always exit farming because of business failure, for those who do—for whatever reason—it can be costly. This has prompted many studies that attempt to explain factors that affect farm exits.

Previous work on farm exits by Hoppe and Korb (2006) used the Census of Agriculture longitudinal file from 1978 to 1997 to estimate exit and entry rates in farming and the probability of exit by operator age, gender, and race. They found that U.S. farm exit rates are about 9-10 percent annually, which is close to the U.S. nonfarm small business exit rate. Their study finds annual exit rates are from 6 to 7 percent for farms with annual farm sales greater than \$250,000. Exit rates decline as farm size increases (measured in farm sales). They also found that operator age significantly affected the probability of exit. Exit rates decline with operator age up until 45-54 years, where it

GCFI Level Matters in Understanding Farm Transitions and Income Volatility

The level of GCFI is a factor in whether a farm transitions to a different size category. For example, a small commercial farm with GCFI of \$130,000 (midpoint of category) in the first period and a 50-percent increase in GCFI would generate \$195,000 in the next period, remaining a small commercial farm. This small commercial farm would need almost a 200-percent increase in GCFI to move into the midsize category. In contrast, a midsize farm with GCFI of \$675,000 (midpoint of category) in the first period and a 50-percent increase in GCFI would generate \$1,012,500 in the next period and become a large farm. Thus, a 50-percent increase in GCFI is sufficient for many midsize farms to transition to large ones.

Box table 5.1

Percentage of farms within 5, 10, and 20 percent (measured in GCFI) of neighboring size category in 2007

	Total farms	Within 5 percent of neighboring size category	Within 10 percent of neighboring size category	Within 20 percent of neighboring size category
<i>Percent</i>				
Small commercial	924,005	3.0	6.3	11.7
Midsize	127,156	9.1	18.1	36.9
Large	62,297	5.8	11.4	20.7

Source: USDA, Economic Research Service calculations based on the USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture.

One reason midsize farms are relatively more likely to transition is because a greater proportion are close to a neighboring size class. In 2007, a greater proportion of midsize farms were near farm size thresholds (either small commercial or large) than any other size class. Midsize farms that were within 20 percent (measured in GCFI) of a neighboring size category were more likely to transition into that size category than small commercial farms from 2007 to 2012. Midsize farms within 20 percent of the lower size threshold (\$350,000) also shrank in size at a rate similar to large farms within 20 percent of the lower size threshold (\$1 million).

Box table 5.2

Percentage of farms within 20 percent (measured in GCFI) of neighboring size category that grew or shrank in size from 2007-12

Years	Typology	Grew into a larger size category	Shrank into smaller size category
<i>Percent</i>			
2007-2012	Small commercial	34.9	18.9
2007-2012	Midsize	37.5	37.2
2007-2012	Large	NA	38.1

Source: USDA, Economic Research Service calculations based on the USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture.

reaches 8-9 percent. The exit rates then increase to 12-13 percent for farmers who are at least 65 years old.

A study by Ahearn et al. (2009) found that farm entry and exit rates are somewhat higher than for manufacturing businesses. They also found that prior to 1987, survival rates of farms with between \$100,000 and \$250,000 in sales were similar to the largest farms, but these rates have declined since that time. Previous studies by Key and Roberts (2006; 2007) examined crop farms observed in the census from 1978 to 1997 and found that past per acre Government payments had a small but significant positive effect on farm business survival and growth.

Research on farm exits outside of the United States has used data from Canada and Israel because these countries keep longitudinal data. A study by Kimhi and Bollman (1999), using longitudinal data on farms in Canada and Israel, found that the two main factors affecting exit probability are farm size and operator age. In both countries, the probability of exit was shown to decrease with the extent of off-farm work, leading the authors to conclude that off-farm work is a complement to farm work rather than a substitute.

Midsized Farm Exit and Entry Rates

In both the 1992-97 and 2007-12 periods, midsized farms had lower 5-year exit rates than small commercial and large farms. This means that midsized farms were more likely to survive to the next census year. However, they also had negative net entry rates in both periods. The net entry rate shows the net change in numbers from entries and exits, with a positive value indicating more entries than exits and a negative number indicating the reverse.

In figure 9, we show exit, entry, and net entry rates for small commercial, midsized, and large farms for years 2007-12. All three farm sizes experienced negative net entry rates in this period, consistent with the decline in overall farm numbers by 4.3 percent (NASS, 2012). We note that large farms and small commercial farms had more negative rates than midsized farms. An important point is that a negative net entry rate does not necessarily mean farm numbers will decline for a particular size category because this does not factor in farm transitions between size classes. For example, despite having a negative net entry rate from 2007 to 2012, large farm numbers grew during this period, largely due to the fact that so many midsized farms (about 15,300) transitioned to large farms.

When we combine the effect of farm transitions with net entry rates, we conclude that the drop in midsized farm numbers from 2007 to 2012 was due to a combination of both factors: a greater number of midsized farms exited than entered, and more farms transitioned out of the midsized category than into it.

Model for Farm Survival

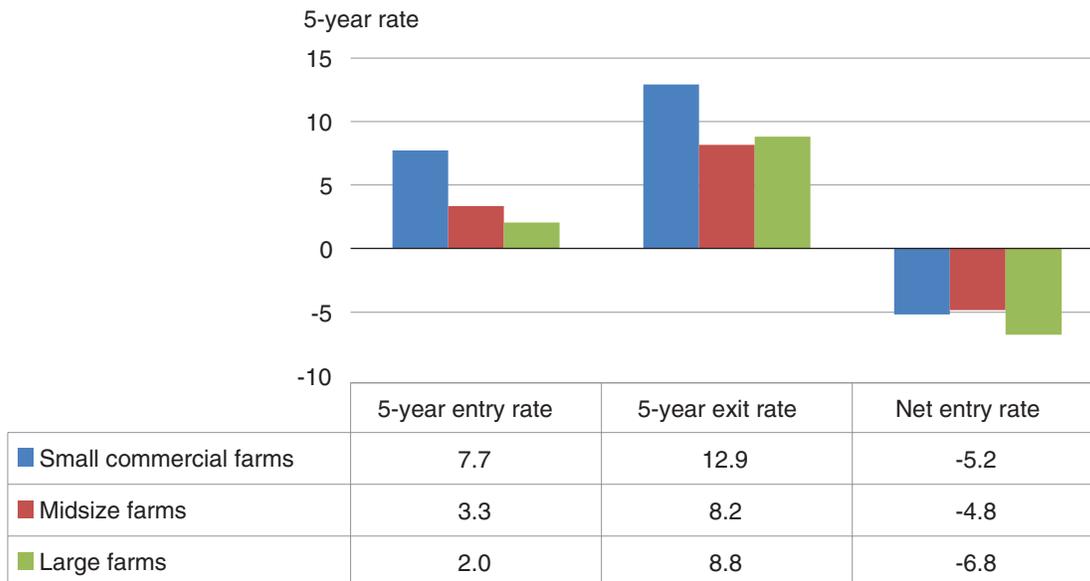
We examine how farm size and principal operator age affect the probability of survival, using data from the 2007 and 2012 Census of Agriculture. We use these years because of methodological improvements in the tracking of operations. The probability of survival measures the probability that a farm observed in 2007 will be observed in 2012. This method does not account for farm transitions, so we classify a farm's size based on its size in the first census year.

We build a logistic regression model to predict the probability of survival for farms following previous work by Hoppe and Korb (2006). This model has a dependent variable equal to 1 if the

Figure 9

Exit, entry, and net entry rates by farm size, 2007-12

Midsized farms had negative net entry rates from 2007 to 2012 but also had the lowest 5-year exit rate.



Source: USDA, ERS calculations based on the USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture.

farm exits and equal to 0 if it does not. The model uses two independent variables for operator age (*age* and *age-squared*) and three farm size categories (small commercial, midsize, large). While the decision to exit farming is complex, previous work by Hoppe and Korb (2006) and Kimhi and Bollman (1999) have identified operator age and farm profitability as most important to farmer decisions to exit. While we do not have an exact measure of farm profitability due to data limitations in the Census of Agriculture, our measure of farm size uses gross cash farm income. This can be considered a proxy for profitability, as previous research suggests this generally increases with farm size (Hoppe et al., 2008). We note that there are differences in costs of production by farm type, making our proxy an imperfect measure of profitability. For a detailed description of the logistic model, see appendix V.

Results From the Model

From 2007 to 2012, midsize farms had significantly higher probability of survival than small commercial and large farms.¹¹ We also find this result using census data from 1992 to 1997. The result is consistent with our earlier finding that midsize farms have lower 5-year exit rates than the other farm sizes.

Midsize farms also have higher survival rates within each principal operator age class. Across all three farm sizes, the probability of survival is shown to increase and stabilize for operators between the ages of 45 and 64 and then to begin a decline for those age 65 and over. This inverse parabolic

¹¹Differences are statistically significant at the 1-percent level.

shape of farm survival across age classes, peaking between ages 45 and 64, is consistent with a previous study (Hoppe and Korb, 2006).

Characteristics of Continuing Midsize Farms

To further examine characteristics of continuing midsize farms, we analyze census data from 2007 and 2012. We build a logistic regression model to predict the probability of survival for midsize farms, similar to the model shown earlier. However, for this analysis we focus solely on midsize farms observed in both 2007 and 2012. For detailed results of the logistic model, see appendix table 5.3.

The results find that both beginning midsize farmers (those with 10 years or less of experience on the operation) and farms with retired principal operators are significantly less likely to survive between census periods. Beginning farmers typically have higher rates of business failure than more experienced farmers (Hoppe and Korb, 2006). Midsize farms that rented almost all of their land had significantly lower probabilities of survival. This may reflect another issue often associated with beginning farmers: they are less likely to own the majority of the land they operate. Survival probabilities also vary by commodity specialization. Midsize poultry farms had the highest probability of survival. The majority of poultry farms have production contracts, which reduce price risks for the farm operation (MacDonald, 2014) and may explain their higher probability of survival. Midsize farms that specialize in other crops (e.g., tobacco, cotton, hay, and peanuts) were less likely to survive than other specializations. Midsize farms that specialize in cash grains and oilseeds, cattle, hogs, dairy, and high-value crops were all found to have similar probabilities of survival.

Midsize farms show a similar pattern of survival across operator age classes within each commodity specialization, as figure 10 shows. Operators between 45 and 64 years old have the highest probability of survival, between 90 and 95 percent. Operators in the 65-and-older age class have a lower survival probability because they are more likely to be retired from farming. Some specializations see a much steeper decline in survival probabilities for this 65-and-older age class, including high-value crops and other crops.

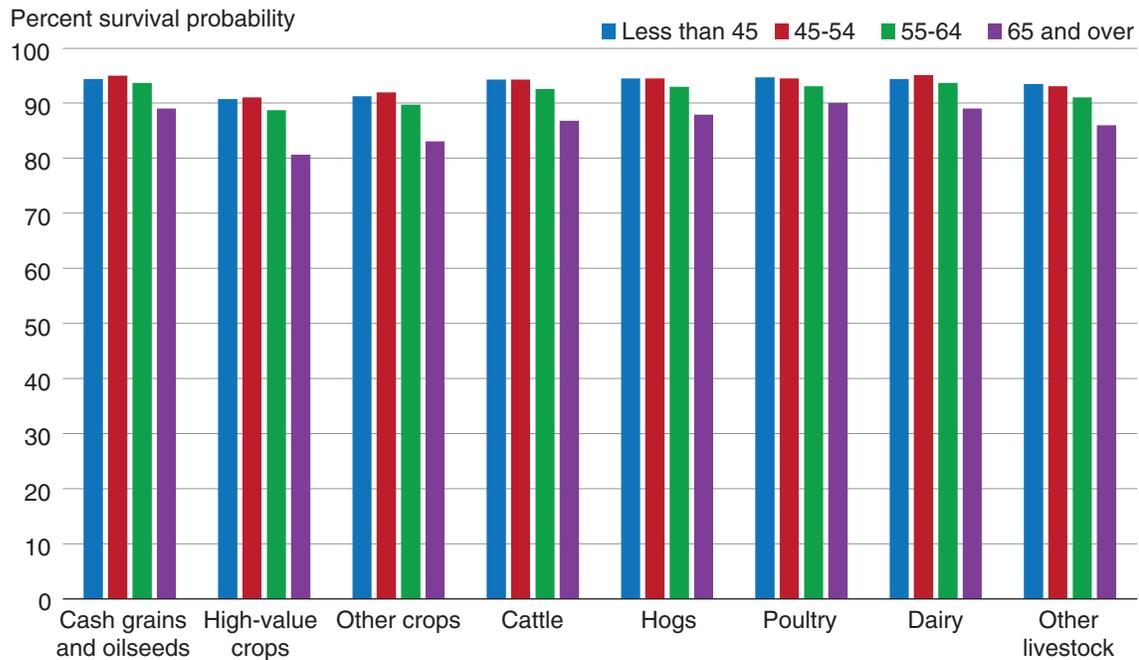
Characteristics of Continuing Midsize Cash-Grain and Oilseed Farms

In 2012, most midsize farms specialized in cash grains and oilseeds. We take a closer look at this group and examine factors that affect their survival. We estimate survival probabilities from census data for 2007 and 2012 by using a logistic regression model to predict the probability of survival for midsize cash-grain and oilseed farms, similar to the model shown in the previous section for all midsize farms. We also examine the impact of Government policies, specifically direct payments.

The model results show significant positive effects on survival for cash-grain and oilseed farms that operated more acres and for operations that own around half the acres operated, when compared to full land ownership. Retired and beginning midsize cash-grain and oilseed farms were found to be significantly less likely to survive, consistent with previous findings for all midsize farms.

Figure 10

Probability of survival for midsize farms from 2007 to 2012, by operator age group and commodity specialization in 2007



Source: USDA, ERS calculations based on the USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture.

Direct Payments and Midsize Cash-Grain and Oilseed Farm Survival

Direct payments, established in the 1996 Farm Bill, were designed to replace a set of farm programs that supported a number of crop commodities at above-market levels. Commodity-related payments¹² such as direct payments were tied to land and to the historical production of specific commodities—mostly field crops such as barley, corn, soybeans, peanuts, cotton, and wheat. These payments are based on historical yields and the number of enrolled acres. The goal of the payments was to help establish farm income support, stabilize production, and provide a financial safety net. The 2014 Farm Bill eliminated fixed direct payments and expanded the crop insurance programs.

Several studies have examined the impact of Government payments on crop-farm survival and growth. Key and Roberts (2006; 2007), using census data from 1987 to 1997, find that higher per acre Government payments have a small but positive effect on crop-farm survival and growth. Young and Prescott (2000) note that lenders may be more willing to make loans to farms that receive direct payments because the payments represent a source of guaranteed income. If farms are credit-constrained, then direct payments may allow them to expand their operations or simply get a loan when they would not have been able to do so otherwise. A recent study by Storm, Mittenzwei, and Heckelei (2014) examines the effect of spatial dependence and direct payments on Norwegian

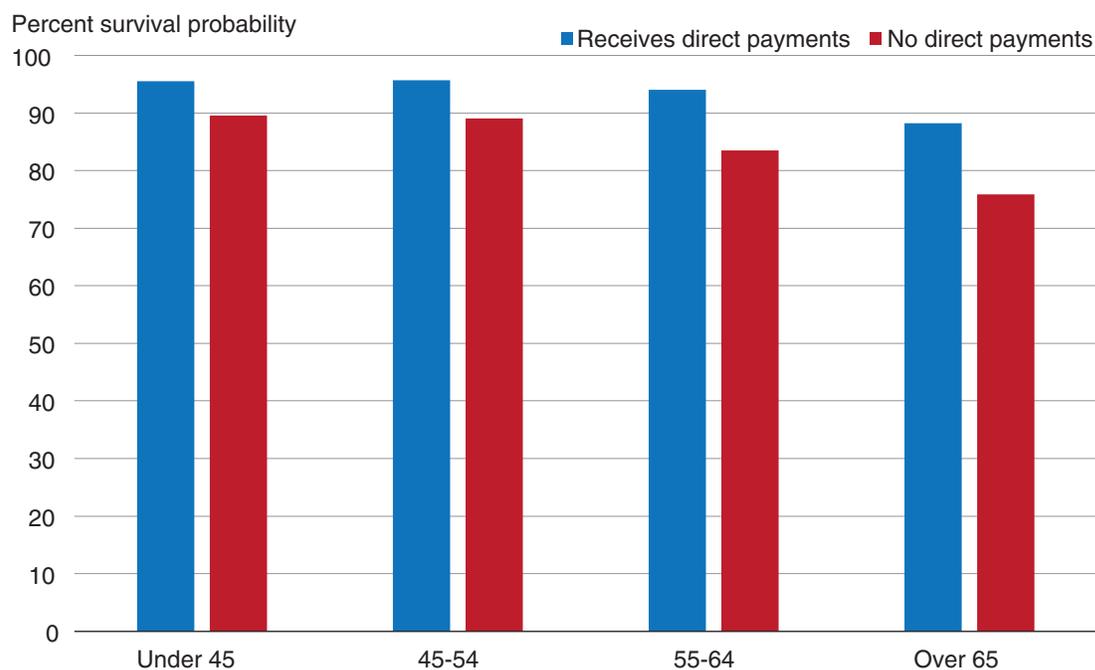
¹²Examples of commodity-related payments include direct payments, loan deficiency payments, marketing loan gains, net value of commodity certificates, milk income-loss contract payments, agricultural disaster payments, and other miscellaneous State, Federal, and local payments.

farm exits. They find that a farm’s survival is affected not only by whether it received direct payments, but also by whether neighboring farms also received such payments.

Because direct payments vary by acres operated, yield history, and historical commodities produced, we control for acres operated in 2007, commodity specialization, and State-level effects in the logistic regression model. We also examine whether the effect of direct payments on farm survival differs by acres operated to see if the effect differs for smaller or larger midsize cash-grain and oilseed farms. For detailed results of the logistic model, see appendix table 5.3. The goal of this analysis is to understand whether this type of program (one where payments are based on historical acreage) has any effect on farm survival.

In 2007, about 93 percent of midsize cash-grain and oilseed farms received some fixed direct payments. The group of farms that did not receive direct payments (non-recipients) is small, representing about 4,000 midsize cash-grain and oilseed farms in 2007. Our results show that midsize cash-grain and oilseed farms that received fixed direct payments in 2007 had a statistically greater probability of survival through 2012 than those that did not receive payments. Compared to the average direct payment recipient, non-recipients received higher Conservation Reserve Program (CRP) and Wetland Reserve Program (WRP)¹³ payments, had more acres enrolled in crop insurance, and were more likely to be beginning farmers. As figure 11 illustrates, midsize cash-grain and oilseed farms that did not receive direct payments had slightly lower survival probabilities (by 5 to

Figure 11
Probability of survival for midsize cash-grain farms from 2007 to 2012 by age-class and whether they received direct payments in 2007



Source: USDA, ERS calculations based on the USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture.

¹³The Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) are land-retirement programs that pay farmers to remove environmentally sensitive farmland from production for long periods of time – at least 10 years, or permanently in some cases.

10 percentage points) than non-recipients, across all age classes. The effect is more noticeable for operators 65 and older.¹⁴ Because direct payments increase farm incomes, this may encourage older operators to continue farming and receive payments rather than retire.

While we do not find any significant effect from higher per acre direct payments on farm survival, the model results do show a small increase in survival probability for larger midsize farms (those who operated at least 1,180 acres) that received higher per acre direct payments.

Characteristics of Midsize Cash-Grain and Oilseed Farms That Grew From 2007 to 2012

Farms can grow in a variety of ways. Cash-grain and oilseed farms typically expand their operations by renting or buying additional land. To understand how midsize cash-grain and oilseed farms grow, we examine their choice of acres operated (both rented and owned) by how much their GCFI changed between 2007 and 2012. For this analysis, we separate farms into four categories based on the change in GCFI: (1) those with a 50-percent or more decline in GCFI, (2) those with GCFI change of between -50 percent and 100 percent, (3) those with a GCFI change of 100 to 200 percent, and (4) those with a GCFI change of 200 percent or more (i.e., GCFI at least tripled).

As shown in table 6, midsize cash-grain and oilseed farms with the largest declines in GCFI (category 1) rented 188 acres and operated 564 acres in 2012. Those with small declines or increases in GCFI (category 2) rented 718 acres and operated 1,120 acres. In contrast, midsize farms that doubled or tripled their GCFI (categories 3 and 4) rented two to three times as many acres as those in category 2. These farms owned about the same number of acres (between 400 and 480 acres) as midsize cash-grain and oilseed farms in categories 1 and 2, but rented more than twice the number of acres (between 1,300 and 2,005 acres). These results suggest that renting land is an important strategy for growing midsize cash grain farms.

Table 6

Median acres operated and rented by midsize cash-grain farms based on change in their GCFI from 2007 to 2012

Change in GCFI from 2007 to 2012	Acres operated 2007	Acres operated 2012	Acres rented in 2012
Category 1: GCFI decrease of more than 50 percent	1,129	564	188
Category 2: GCFI change between -50 and 100 percent	1,146	1,120	718
Category 3: GCFI increase of 100 -200 percent	1,369	1,788	1,300
Category 4: GCFI increase of more than 200 percent	1,380	2,497	2,005

Source: USDA, ERS calculations based on the USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture.

¹⁴These differences are statistically different for each age class at the 1-percent level.

Summary and Conclusions

Midsized farms and their households experienced significant changes between 1992 and 2014. This report summarizes how midsized farms have changed during this period and the characteristics of those that continue to thrive in a dynamic environment. In terms of how midsized farms have changed, we find that:

- Since 1992, midsized farm households have seen their net worth increase and their income become more diversified. The median midsized farm household has seen its farm income double, while its off-farm income has more than tripled. Midsized farms operate with higher financial efficiency than in 1992, have lower debt-to-asset ratios, and higher profitability. However, they still lag behind large farms in many financial performance measures.
- Midsized farms numbered 125,441 farms in 2012, representing a 5-percent decline since 1992. They represented 21 percent of total production in U.S. agriculture in 2014. Between 1992 and 2014, the share of total production on midsized farms that specialized in cash-grain and oilseed crops, hogs, and poultry increased, while the share on midsized farms that specialize in dairy, high-value crops, or other crops (e.g., tobacco, peanuts, and cotton) declined. Midsized farms are more common in the Northern Great Plains and Heartland regions and have become more common in these regions since 1992.
- Midsized farm numbers have changed through both exits/entries and transitions. Using census data, we find that fewer midsized farms entered than exited between the periods of 1992-97 and 2007-12. They are shown to both exit farming at lower rates than either small commercial or large farms and to enter farming at lower rates.
- Between 1992-97 and 2007-12, most midsized farms stayed midsized between census years, but midsized farms are more mobile than small commercial or large farms—meaning they grow and shrink at higher rates. Midsized farms have volatile farm income. Because many are cash-grain and oilseed operations, midsized farm income was particularly affected by increases in grain commodity prices between 2007 and 2012. One-third of midsized farms saw their GCFI increase or decrease by more than 50 percent from 2007 to 2012, a rate similar to that of large farms.
- Using census data from 2007 and 2012, we find that midsized operations with beginning farmers, retired farmers, or operations that rent almost all of their land (tenant renters) were more likely to exit farming in the latter period. Midsized poultry farms were statistically more likely to continue farming compared with other specializations. Government policy was found to play a role in the survival of midsized cash-grain and oilseed farms. Midsized cash-grain and oilseed farms that received direct payments in 2007 had a small but statistically higher probability of survival through 2012.
- Midsized cash-grain and oilseed farms that grew larger between 2007 and 2012 rented substantially more land. Those that grew in size (i.e., at least doubled their GCFI) rented more than twice the number of acres compared with midsized farms that did not double their GCFI. Midsized farms that grew by at least 100 percent operated at least 1,800 acres, 600 acres more than the median midsized cash grain and oilseed farm.

While the structure of U.S. agriculture has changed significantly over the last several decades, midsize farms remain an important group. The continued survival and growth of midsize farms remains of interest to policymakers because many represent small commercial farms that grew in size. Additionally, if past patterns hold, a significant share (perhaps as many as 15 percent) of today's midsize farms will be tomorrow's large farms.

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Appendix I—Comparing Different Revenue-Based Measures of Farm Size

Measuring the Gross Income of a Farm Operation

Farm operations accrue revenue from one or more agricultural activities, including the sale of agricultural commodities, collection of Government payments, and other income sources such as custom work, grazing, the sale of forest products, and recreation. Farms may also engage in productive activities, such as share-renting farmland and production contracting, where revenue accrues jointly to the operation as well as to landlords and production contractors. Because share rent and revenue from the sale of commodities removed under production contract accrue to external stakeholders, the inclusion of this income will overstate the revenue available to the farm operation.

Gross Cash Farm Income (GCFI)

GCFI* is the gross revenue received by a farm operation in a year. It is defined as the sum of the farm's cash and market contract revenues from the sale of livestock and crops, Government payments, and other farm-related income, including fees from production contracts. Other farm-related income could include receipts from custom work, machine hire, livestock grazing fees, timber sales, and outdoor recreation.

Does the Choice of a Farm Size Measure Matter?

While we classify a farm according to its GCFI, other revenue measures of farm size may assign a different farm-size class. In order to illustrate the importance of using GCFI, we examine two other revenue measures of farm size to see how they reflect different numbers of midsize farms. Descriptions of those alternate measures follow.

Market Value of Agricultural Products Sold

A measure of farm size reported in the Census of Agriculture is the market value of agricultural products sold (MVAP). This measure focuses on the revenue from all commodities produced on the farm, including the share to landlords and production contractors, but excludes Government payments and other sources of farm income such as custom work, grazing, the sale of forest products, and recreation.

Unlike GCFI, the market value of agricultural products sold excludes Government payments, as noted above, and other farm income. Although MVAP excludes some income available to the farm operation, it can also include revenues that accrue to landlords and production contractors rather than the operator. As a result, MVAP can overstate or understate a farm's size compared with GCFI. For farms with a high number of production contracts, such as hog and poultry operations, GCFI may be much less than MVAP. However, where Government payments and other forms of farm income are important, MVAP may be much less than GCFI.

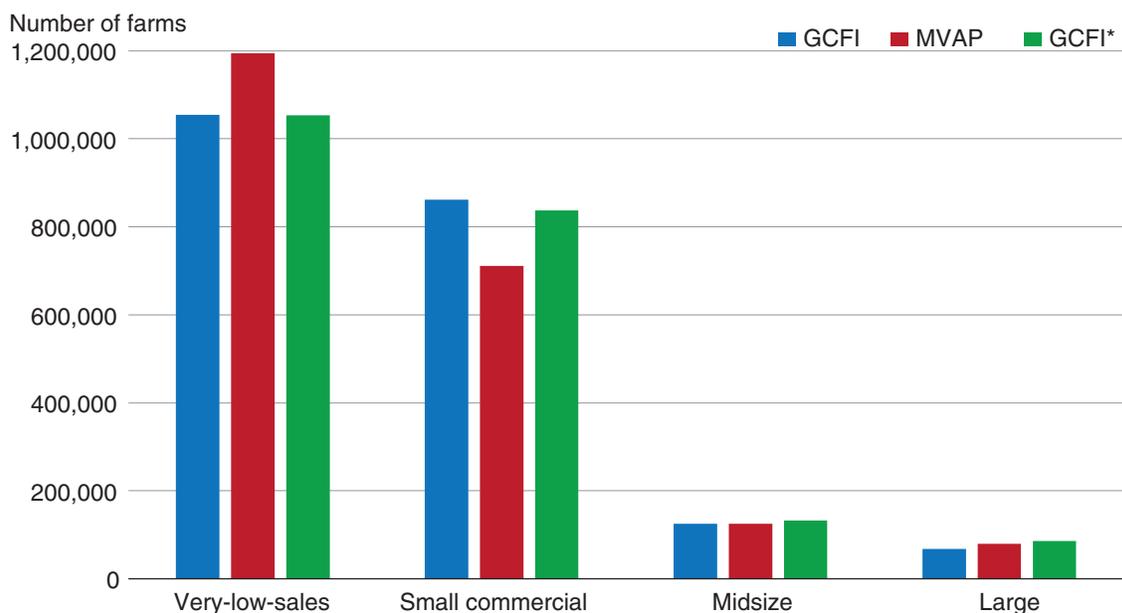
Gross Cash Farm Income, Including Sales Under Production Contract and Landlord Share of Sales (GCFI*)

Another potential revenue measure that can be estimated using data from the census is the GCFI, including sales under production contract and landlord share or GCFI*. This is similar to GCFI but errs in crediting the farm operator with sales that occur under production contract as well as the portion of sales that accrue to the landlord. Like MVAP, GCFI* may greatly overstate the income accruing to the operation for farms with production contracts, such as hog and poultry operations. This is because commodities removed under production contracts are excluded from GCFI, but are included in GCFI* and MVAP. GCFI partially corrects this by excluding the fees received by farmers from contractors for the services they provide—labor, housing, and management—but these fees are usually a small share of the value of commodities removed. For farms without production contracts or landlord share of production, GCFI* will equal GCFI. In appendix I figure 1.1, we compare number of farms classified as very-low-sales, small commercial, midsize, and large in 2012 using each of the three measures of farm size.

There are significant differences in the number of farms in each size category depending on which measure is used. MVAP is shown to bias the number of midsize and small commercial farms downward but to overstate the number of very-low-sales and large farms. Because this measure does not include Government payments but does include sales under production contract, the direction of bias is ambiguous and difficult to predict. This makes MVAP a poor measure of farm size. In contrast, GCFI* is shown to overstate the number of midsize and large farms. Because GCFI* includes the amount of production under contract and the value of production that accrues to landlords, it will tend to make farms appear larger.

Appendix figure 1.1

Comparing farm numbers using three different revenue measures of farm size



GCFI = Gross cash farm income; MVAP = Market value of agricultural products sold; GCFI* = Gross cash farm income, including sales under production contract and landlord share of sales. Source: USDA, National Agricultural Statistics Service, 2012 Census of Agriculture.

Using either MVAP or GCFI* as a farm-size measure means that many hog and poultry operations are classified as large farms because of the high value of production occurring under contracts on these farms. By contrast, GCFI classifies many poultry and hog operations as small commercial farms because it accounts for only the production contract fees that accrue to the operation and not the total sales under production contract.

Appendix II—Understanding How the Choice of Price Deflator Affects Measures of Change in Gross Cash Farm Income (GCFI) and Value of Production

The Produce Price Index for Farm Products (PPI for FP) is an aggregate price index that reports a single number based on average prices received for all farm products. As a result, this deflator may understate or overstate changes in income due to large price swings for a particular commodity.

To understand how the choice of price deflator impacts total value of production, farm numbers by size category, and GCFI*, we examine two deflators, the PPI for FP and a commodity-group price deflator. A commodity-group price deflator is a series of commodity-specific price indices. It will better capture changes in farm output or intensity of production on the farm. In periods of high price volatility, it will better capture changes in farm output than changes in both the output and the price level. We use ARMS data for this analysis because of issues with decomposing total value of production in the census before 2002.

We examine two different methods for deflating prices through time, the PPI for FP and a series of commodity-group price indices. The latter approach uses a set of producer price indices for specific commodity groups, while the former uses a single producer price index for all farm products.

The PPI for FP is an index that measures the change over time in the selling prices received by U.S. farm producers. This is an aggregate measure of prices received and is commonly used to deflate GCFI and total value of production over time.

For the PPI for FP, nominal GCFI dollars are converted to real GCFI dollars with the formula:

$$\text{Real GCFI} = \frac{\text{Nominal GCFI}}{\text{Price deflator}} \times 100$$

where nominal GCFI is a particular year's GCFI and the price deflator is the PPI for FP. In the base year, the price deflator equals 100.

The commodity-group price indices measure the change over time in the selling price for specific groups of farm commodities, such as cash grains, high-value crops, dairy, and livestock. This method uses a commodity-group index for cash grains and oilseeds, high-value crops, cattle, hogs, poultry and eggs, and dairy, as well as overall crop and livestock prices, to deflate each commodity-group component of GCFI separately. The separately deflated components are then summed to create total GCFI for a farm.

For the commodity-specific price indices, GCFI is first decomposed into commodity groups (e.g., income from cash grains, high-value crops, etc.) and then deflated by separate commodity-group price indices. Other farm income is still deflated using PPI for FP. For cash grains, the formula is:

$$\text{Real GCFI for Cash Grains} = \frac{\text{Nominal GCFI for cash grains}}{\text{Price deflator for cash grains}} \times 100$$

The resulting commodity-group GCFI components are then summed, resulting in the commodity-group specific measure of real GCFI.

To illustrate the impact of the choice of price deflator, we use ARMS data from 1992 and 2013. We find that the total value of production and farm numbers by size category are shown to be consistent across time under both price deflators. Total value of production occurring on midsize farms is found to drop from 25 percent to 20 percent, regardless of the deflator method used. Midsize farm numbers are also shown to be consistent over time using both price deflators.

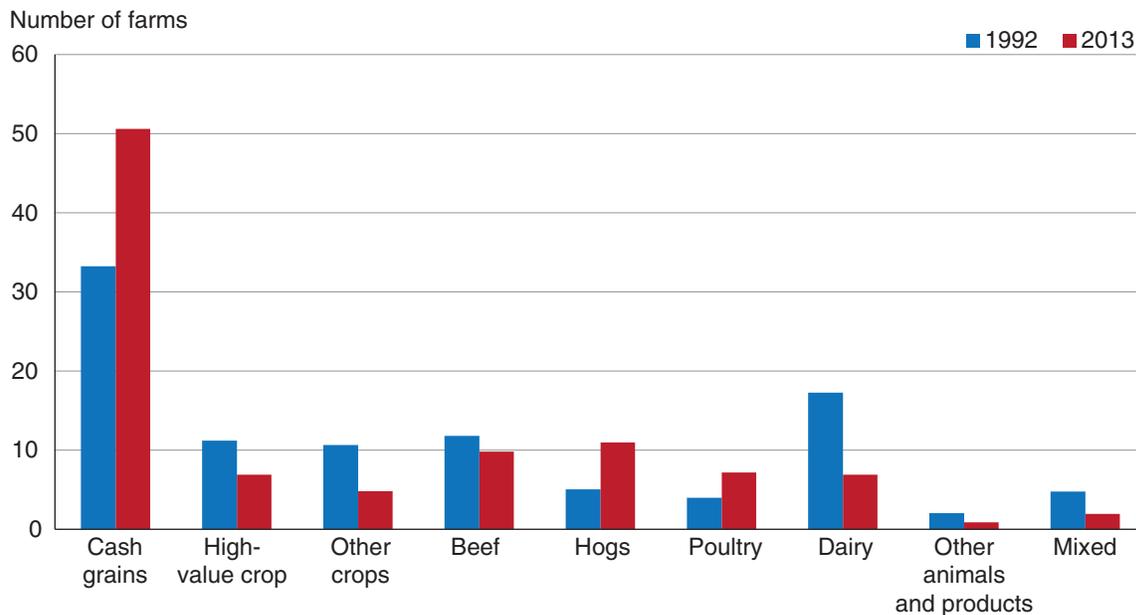
We also find that the distribution of production on midsize farms is affected by choice of price deflator (appendix II figs. 2.1 and 2.2). Our results show that the PPI for FP price deflator yields a much higher share of dairy production on midsize farms in 1992 relative to 2013. This deflator also shows a much larger decline in the share of dairy production on midsize farms in 2013. In contrast, the commodity-group price deflator shows a more moderate decline in the share of dairy production on midsize farms.

This difference can be explained by the fact that grain prices more than doubled between 1992 and 2013 while dairy prices increased by only a third. Thus, the commodity-group price deflator shows how production has shifted to grain farms, but accounts for the separate price trends in grains and dairy.

Appendix figure 2.1

Distribution of production on midsize farms in 1992 and 2013, using PPI for FP deflator

Total production shifted toward farms that specialize in cash grains (17-percentage-point increase) and shifted away from those that specialize in dairy production (10-percentage-point decrease).

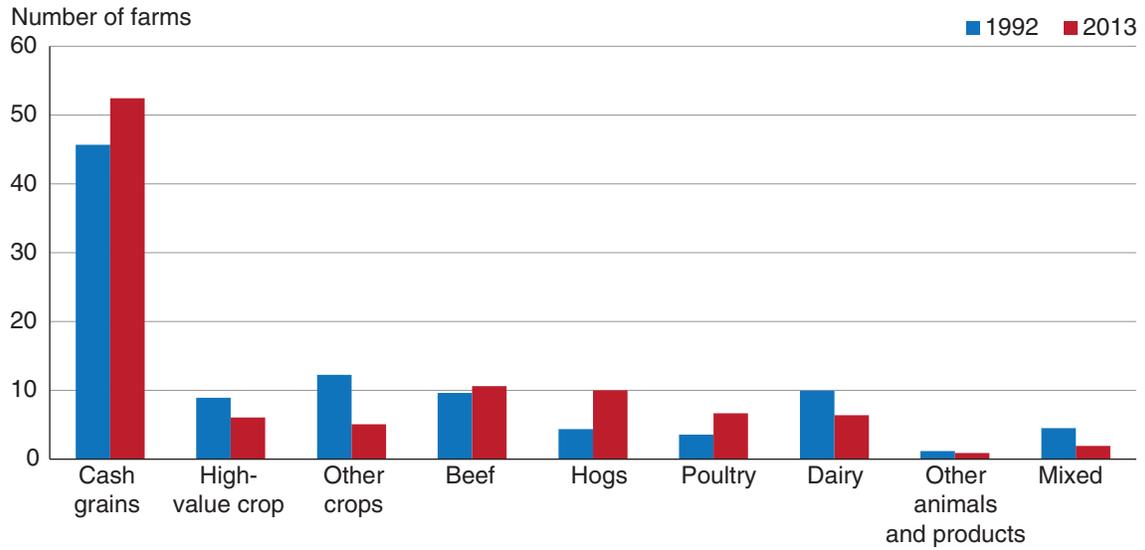


Source: USDA, Economic Research Service, 1992 ERS Farm Cost and Returns Survey and 2013 Agricultural Resource Management Survey, Phase III.

Appendix figure 2.2

Distribution of production on midsize farms in 1992 and 2013, using commodity-specific price deflator

Total production shifted toward farms that specialize in cash grains (7-percentage-point increase) and away from farms that specialize in dairy production (3-percentage-point decrease).



Source: USDA, Economic Research Service, 1992 ERS Farm Cost and Returns Survey and 2013 Agricultural Resource Management Survey, Phase III.

Appendix III—Calculating Gross Cash Farm Income (GCFI) With the Census of Agriculture in 1992 and 1997

Because gross cash farm income (GCFI) measures the amount of revenue available to a farm operation, this report uses GCFI to measure farm size where it is available.¹⁵ However, in the 1992 and 1997 Census of Agriculture (COA), respondents are only asked to report revenues from commodity production, including the share accruing to landlords and production contractors. As a result, it is not possible to directly measure GCFI in the 1992 or 1997 COA. In order to track the changing landscape of midsize farms across time using the COA, it is therefore necessary to determine an alternative measure of farm size. However, potential alternatives—such as the market value of agricultural products sold (MVAP) and the GCFI including sales under production contract and the landlord share of production (GCFI*)—both tend to overstate the number of midsize and large farms.

This report approximates GCFI for farms observed in 1992 and 1997 by adjusting the GCFI* values (see appendix II for description of GCFI*) observed in the 1992 and 1997 COA. We adjust the COA data using supplemental data from the ERS 1992 Farm Cost and Returns Survey (FCRS) and 1997 Agricultural Resource Management Survey (ARMS). The 1992 FCRS and 1997 ARMS contain farm-level data on revenue from crop and livestock sales, as well as Government payments and other farm income received by the farm operation. The surveys also separately contain information on the landlord share of sales and value of production contract removals for both crops and livestock. Using this information, it is possible to calculate the weighted median value for the amount of crop and livestock production, including the landlord share and production contracts (*median sales*, equation 1). In turn, the ratio of median landlord share of sales (equation 2) or production contract values (equation 3) to *median sales* can be calculated. The resulting ratios provide a measure of the magnitude of bias in *sales* for crops and livestock due to the revenue accruing to landlords and production contractors.

$$\text{Median Sales} = \text{Sales}_{C,R,T,S} + \text{Production contract value}_{C,R,T,S} + \text{Landlord share of sales}_{C,R,T,S} \quad (1)$$

$$\text{Median percent landlord share}_{C,R,T,S} = \frac{\text{Median landlord share of sales}_{C,R,T,S}}{\text{Median sales}^*_{C,R,T,S}} \quad (2)$$

$$\text{Median production contract ratio}_{C,R,T,S} = \frac{\text{Median production contract value}_{C,R,T,S}}{\text{Median sales}^*_{C,R,T,S}} \quad (3)$$

$$\text{Median production contract fee ratio}_{C,R,T,S} = \frac{\text{Production contract fees}_{C,R,T,S}}{\text{Median production contract value}_{C,R,T,S}} \quad (4)$$

Where:

C=Crop or livestock, R=ARMS region, T=farm specialization (Cash grain, Hogs,...),
S=Size (Small, Medium, Large)

¹⁵GCFI is directly available in the 2002, 2007, and 2012 Census of Agriculture. GCFI is also directly available in the Farm Costs and Returns Survey (FCRS) and Agricultural Resource Management Survey (1996-2014).

We then match these ratios to the COA according to ARMS region, farm specialization, and size class.¹⁶ Adjusted crop and livestock sales, an estimate of the sales accruing to the farm operation, are then calculated by applying the matched landlord and production contract share ratios (equation 5). The estimated amount of production contract fees accruing to each COA observation is calculated by applying the production contract ratio to arrive at an estimate of the value of product produced under production contract; this estimate is then multiplied by the production contract fee ratio (equation 6). Finally, adjusted gross cash farm income (adjusted GCFI) was calculated by adding the adjusted crop and livestock sales, estimated production contract fees, and the Government payment and other farm income data directly observed in the COA (equation 7). After adjusting for inflation, we can then classify a farm as small, midsize, or large in those years.

$$\text{Adjusted Sales}_{i,C} = \text{Sales}_{i,C}^* * \text{Median percent landlord share}_{C,R,T,S} \quad (5)$$

$$\text{Median production contract ratio}_{C,R,T,S}$$

$$\text{Production contract fees}_{i,C} = \text{Sales}_{i,C}^* * \text{Median production contract ratio}_{C,R,T,S} \quad (6)$$

$$\text{Median production contract fee ratio}_{C,R,T,S}$$

$$\text{Adjusted GCFI}_i = \text{Adjusted Sales}_{i,c=\text{crop}} + \text{Adjusted Sales}_{i,c=\text{livestock}} + \quad (7)$$

$$\text{Production contract fees}_{i,C} + \text{Government payments}_{i,C} + \text{other farm income}_{i,C}$$

Where:

i=Census observation, C=Crop or livestock, R=ARMS region,

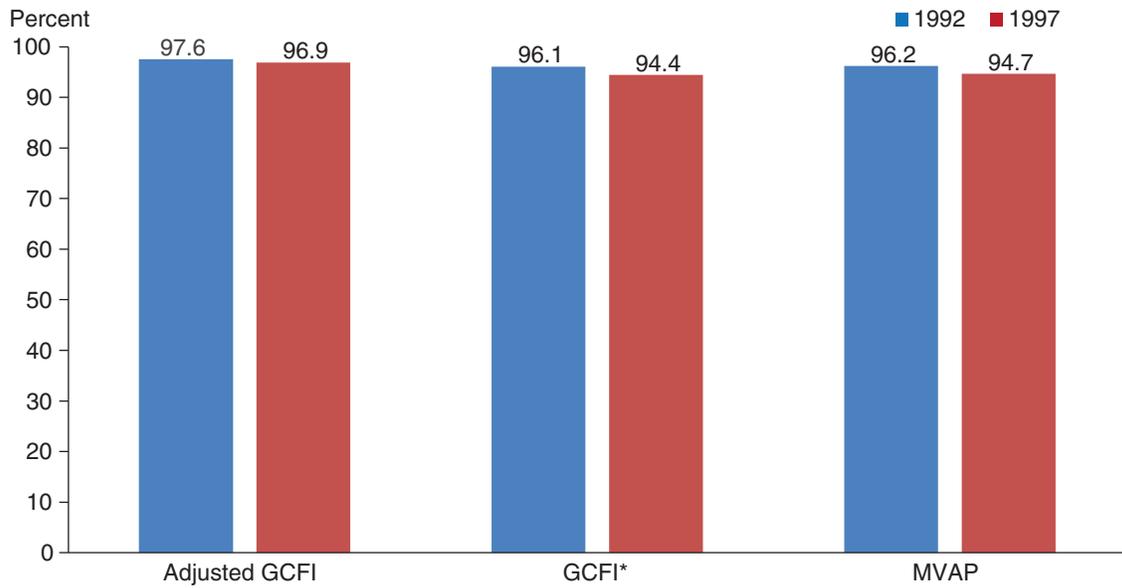
T=farm specialization (Cash grain, Hogs,...), S=Size (Small, Medium, Large).

Because the 1992 FCRS and 1997 ARMS data allow us to measure GCFI with and without sales under production contracts and the landlord share, we are able to use the datasets to compare the accuracy of our method. Relative to other potential measures of farm size—such as MVAP and GCFI*—adjusted GCFI is more likely to assign the same sales class as GCFI in both 1992 and 1997 (appendix fig. 3.1). This results in an additional 22,852 farms being assigned the correct farm size in 1992 and 35,081 farms in 1997.

¹⁶Because FCRS and ARMS do not survey Alaska and Hawaii, the national average ratios by specialty and farm size were matched to the Alaska and Hawaii COA data.

Appendix figure 3.1

Comparing the percentage of farms assigned the same size class as GCFI

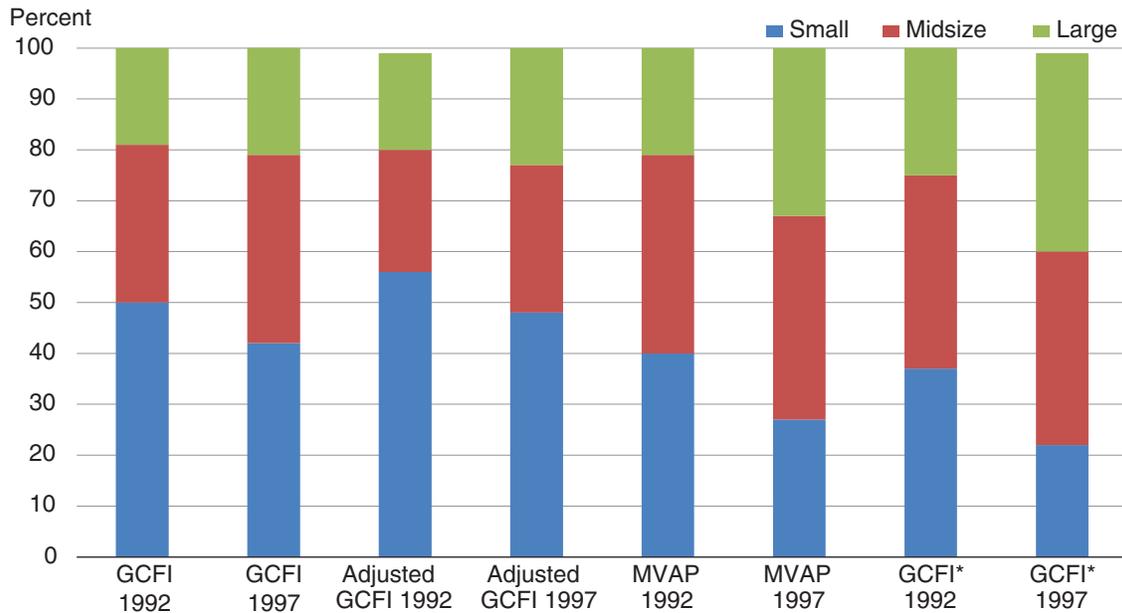


GCFI = Gross cash farm income; GCFI* = Gross cash farm income, including sales under production contract and landlord share of sales; MVAP = Market value of agricultural products sold.

Source: USDA, Economic Research Service, Farm Costs and Returns Survey (1992) and Agricultural Resource Management Survey (1997).

Appendix figure 3.2

Comparing the percentages of farms assigned to size classes, by type of measure



GCFI = Gross cash farm income; MVAP = Market value of agricultural products sold;

GCFI* = Gross cash farm income, including sales under production contract and landlord share of sales.

Source: USDA, Economic Research Service, 1992 Farm Costs and Returns Survey and 1997 Agricultural Resource Management Survey.

It is also possible to approximate the proportion of gross cash farm income by farm size using each of the measures. Using GCFI as a basis of farm size, the amount of production occurring on small farms decreases from 50 percent in 1992 to 42 percent in 1997, while production on midsize and large farms increases by 6 and 3 percentage points, respectively. Each of the other measures shows a similar pattern of production becoming more concentrated on midsize and large farms.

Relative to the GCFI-based size classification, the adjusted GCFI data categorizes approximately 6 percent more production on small farms in both 1992 and 1997. This increase is largely the result of less production being attributed to the midsize farm category. In contrast, MVAP and GCFI both categorize a greater amount of production occurring on midsize and, in particular, large farms.

While all three alternative measures of farm size—adjusted GCFI, MVAP, and GCFI—differ somewhat in the allocation of production by farm size, all demonstrate a pattern of production becoming increasingly more concentrated on larger farms. Ultimately, adjusted GCFI is more closely aligned with the production observed using the actual GCFI series.

Appendix IV—Measuring Farm Exits and Entries With the Census of Agriculture

Data from 5 census years (1992, 1997, 2002, 2007, and 2012) are used in this report to examine midsize farms through time. This appendix presents a brief overview of how entry and exit rates were determined using census data for years 1992-1997 and 2007-2012. For more detailed information about how longitudinal files from the Census of Agriculture are built, see Hoppe and Korb (2006).

Determining Farm Exits and Entries With the Census File Number

In order to measure entry and exit rates for midsize farms, we must follow farm operations instead of operators. Before 2002, the Census of Agriculture used the census file number (CFN) to track operations across census years. The CFN is unique to a farm operation and may follow a farm through subsequent censuses. If the farm continues from one census to the next and the farm operator responds to the census using the same CFN, the information for that period is then added to the census. A farm is considered to be out of business (an exit) when a zero appears in the CFN variable field for a given year. Likewise, a farm operation with a CFN that does not match or link to a previous census year would be considered a new business (an entry). A farm with a CFN for both a beginning and ending intercensus period is considered a survivor.

The CFN was designed to follow farm operations rather than operators; however, the CFN can change for other reasons. An operation that changes hands does not necessarily mean the CFN will change, indicating the farm went out of business and a new farm appeared. A change in operator among relatives due to life-cycle events—such as the widow or adult child assuming operation of the farm upon death of the operator—would also not necessarily trigger a change in the CFN. Similarly, if the farm is sold to an unrelated operator who continues the farm as a separate entity, a new CFN might be issued. In this case, NASS links the old and new CFNs by matching farm operations.

As noted earlier in the report, the exit and entry rates for 1992-1997 are considerably higher than in the more recent 2007-2012. A closer analysis of how the CFN was assigned reveals some possible reasons for these differences. The U.S. Census Bureau, which ran the Census of Agriculture prior to 1997, assigned the CFN to each establishment covered by the census by modifying the nine-digit Employer Identification Number (EIN), which is assigned by the IRS for tax purposes. For multi-establishment firms, the Census Bureau used its own files to create a unique identification number. As a result, the CFN could change if the EIN changed for any reason (conversation with Kirk White at U.S. Census Bureau).

According to IRS rules for a sole proprietor business (IRS, 2015), the EIN can change for several reasons. A few examples include when (1) the farm is subject to a bankruptcy proceeding, (2) the farm incorporates, (3) the principal operator takes on a partner, and (4) the principal operator purchases or inherits an existing business (such as another farm). Given the likelihood of these events occurring for farms throughout the United States in any 5-year period, it makes sense that CFNs would change more frequently, suggesting more farm exits and entries than are actually occurring.

Changes in NASS Methodology for Tracking Farm Operations in 2007

The USDA, National Agricultural Statistics Service (NASS) is responsible for maintaining a list frame that contains a record of all current U.S. farm operations. This list frame is maintained and updated for each Census of Agriculture to reflect operations that exit and enter. Starting in 2007, NASS created a variable called the Operation_ID (OID), based on a State-level variable called State OID (State Operation ID), in order to track operations in each succeeding census period. This change in the operation identifier resulted from a need for a more standardized method for tracking farms longitudinally in moving forward. Ideally, it will improve the quality of intercensus links over time. Unfortunately, the change in operation identifier methodology means that operations cannot be longitudinally tracked in the census before 2007 with the OID variable.

Appendix V—A Logistic Regression Model for Probability of Farm Survival

This report uses a logistic regression model to estimate the probability of farm survival (P) between the census years of 2007 and 2012. Following Greene (2007), we model the log odds ratio for farm survival as a linear model, defined as

$$\ln\left(\frac{P_i}{1-P_i}\right) = Y = X_i'\beta + \varepsilon_i \tag{1}$$

where \ln is the natural logarithm, X is a vector of exogenous variables (for example, operator age or farm size) for the i th farm in 2007, β is a vector of parameters to be estimated, and ε_i is a stochastic term, capturing observed factors that affect the probability of survival. Coefficients in logistic regression (the estimated β 's or $\hat{\beta}$'s) tell how much a change in an independent variable changes the log of the predicted odds ratio $\left(\frac{P_i}{1-P_i}\right)$. Because we are interested in the effects of the independent variable on the predicted probability of farm survival, we derive the predicted probability as

$$\hat{P}_i = \frac{e^{X_i'\hat{\beta}}}{1 + e^{X_i'\hat{\beta}}} \tag{2}$$

where e is the base of the natural logarithms, approximately equal to 2.718.

The logit model is chosen because of the dichotomous nature of the dependent variable, where the farm can either continue farming or exit. The logit model is also preferred when the explanatory variables themselves are dichotomous in nature (Greene, 2007). Equation 2 shows that the predicted probability of exit depends on the values of the independent variables (X) and the estimated β 's. As such, we present the predicted probabilities for different combinations of the independent variables, shown in appendix table 5.1. To obtain the predicted probabilities, we first estimate the parameters of the logistic model in Equation 1. We then calculate the predicted survival probability using Equation 2.

The Base Model

Based on previous work by Hoppe and Korb (2006), we model the probability of farm survival/exit using two determinants, farm size and operator age. This provides a model for testing theoretical assumptions without making it overly complex. Comparing the predicted probabilities across farm size and age class can give insight into the life-cycle impacts on farm survival. The base model uses a variable for principal operator age and its square, plus three farm size categorical variables.

Appendix table 5.1
Variables used in base model

Variable name	Variable type
Operator age	Continuous
Operator age squared	Continuous
Farm size: small commercial	Dummy
Farm size: medium	Dummy
Farm size: large	Dummy

Test of Base Model Specification

The base model was selected from three potential logit models that were evaluated for significance in predicting farm survival. The first alternative model (Model 1) is based on previous work by Hoppe and Korb (2006) and includes three dummy variables for farm size and four age-class categories for the principal operator age. The second alternative model (Model 2) is a simpler version of the base model. It includes a variable for operator age and three dummy variables for farm size. We use the Akaike Information Criterion (AIC) and the log-likelihood to compare these models with the base model, where a lower AIC or higher log-likelihood indicates a better fit to the data. Using these criteria, the base model is shown to be the best fit to the data.

All the models tested (appendix table 5.2) produced highly significant parameter estimates (e.g., significantly different from zero at the 1-percent level). This finding is not surprising given the large number of observations (about 1.5 million) in the data.

The survival model results shown in appendix table 5.3 are based on 85,182 midsize farms observed in 2007. Using a separate dataset that contains the Operator ID variable and matches to the 2007 Census, we can classify operations as survivors or exits in the 2012 census period. The survival model includes covariates such as farm commodity specialization, operator age, whether the principal operator is a beginning farmer, whether the farmer is retired, acres operated, whether the operation owns or rents most of its land, and region. All variables come from 2007 Census except for exit status. The logistic model shown below is jointly significant overall at the 1-percent level.

Appendix table 5.2

Logistic regression results for farm survival¹

Base Model Probability (survival =1)	Estimate	Model 2	Estimate
Intercept ²	1.623*	Intercept	1.947*
Small commercial	0.117*	Small commercial	0.116*
Midsize	0.208*	Midsize	0.211*
Large	0.142*	Large	0.146*
Operator age	0.011*	Operator age	-9e-04*
Operator age squared	-1e-04*		
<i>Log likelihood</i>	-824,655	<i>Log likelihood</i>	-825,293.5
AIC	1,649,322	AIC	1,649,477.3
n	1,523,826	n	1,523,826
Model 1			
Intercept ³	1.868*		
Midsize	0.209*		
Large	0.143*		
Op age <45	0.015		
Op age 45-54	0.060*		
Op age 55-65	0.033*		
<i>Log likelihood</i>	-824,690.7		
AIC	1,649,395.3		
n	1,523,826		

¹A * denotes parameter estimate was significantly different from zero at the 5% level.

²The reference category (i.e., intercept) for the base model and model 2 is a very-low-sales farm with GCFI less than \$10,000.

³The reference category (i.e., intercept) for model 1 is a very-low-sales farm with a principal operator under the age of 45.

Appendix table 5.3

Logistic regression results for midsize farm survival¹

Model probability (survival=1)	Estimate
Intercept ²	2.613*
Acres operated	0.00001
Principal operator age	0.020*
Principal operator age ²	-0.0005*
Operating expense ratio ³	0.032
Beginning farmer	-0.646*
Retired farmer	-0.293*
Rents about half of land (partial land owner)	0.522*
Rents almost all land (full tenant)	-0.200*
High-value crop farm	0.031
Other crop farm	-0.148*
Cattle farm	0.053
Hog farm	-0.098
Poultry farm	0.533*
Dairy farm	0.042
Other livestock	0.175
Region 1 - Atlantic	-0.076
Region 2 - South	-0.419*
Region 3 - Midwest	0.308*
Region 5 - West	-0.271*
<i>-2*Log likelihood</i>	50,036.589
<i>AIC</i>	50,078.589
<i>n</i>	85,182

¹A * denotes parameter estimate was significantly different from zero at the 5% level.
²The reference category is a midsize cash-grain farm with full land tenure located in the Plains region.
³Operating expense ratio=100 x (operating expenses including interest and depreciation/Gross revenue).

The survival model results shown in appendix table 5.5 are based on 43,054 midsize cash-grain and oilseed farms observed in the 2007 Census. Using a separate dataset that contains the Operator ID variable and matches to the 2007 Census, we can classify operations as survivors or exits in the 2012 census period. The survival model also includes covariates such as acres operated, operating expense ratio, whether the principal operator is a beginning farmer, whether the operator is retired, operator age, whether the operation owns or rent most of its land, per acre direct payments, and in which State the farm is located. All variables come from the 2007 Census except for exit status. Because direct payments are correlated with farm size, we condition on acres operated in 2007. This term is interacted with an acreage dummy variable to control for differing effects across farm size. The logistic model shown below is jointly significant overall at the 1-percent level.

Appendix table 5.4

Acreage dummy variables used in logistic regression for midsize cash-grain farm survival

Acreage dummy variables	Acres operated	Acreage quartile range
Acre1	825 – 1,180	Q1 - Q2
Acre2	1,180 – 1,780	Q2 - Q3
Acre3	Greater than 1,780	Q3 and above

Appendix table 5.5

Logistic regression results for midsize cash-grain farm survival¹

Model probability (exit=1)	Estimate
Intercept ²	-2.627*
Acres operated	-0.0001*
Principal operator age	-0.011
Principal operator age ²	0.0004*
Operating expense ratio	-0.131
Beginning farmer	0.671*
Retired farmer	0.361*
Rents about half of land (partial land owner)	-0.560*
Rents almost all land (full tenant)	0.192
Received direct payments in 2007	-0.850*
Direct payments per acre	0.0002
Direct payments per acre*Acre1	0.002
Direct payments per acre*Acre2	-0.003
Direct payments per acre*Acre3	-0.005
Corn farm	0.218*
Soybean farm	0.362*
Wheat farm	0.245*
State fixed effects	Yes
Joint test for significance of model F(53, 430001)	24.730*
<i>n</i>	43,054

¹A * denotes parameter estimate was not significantly different from zero at the 5% level.

²The reference category is a midsize cash-grain farm with full land tenure, in the first quartile of acres operated, and located in the Midwest region.