Is U.S. farm sector debt underestimated? Evidence from equipment lending

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Abstract

Purpose

The growth of lending from nontraditional lenders may pose challenges for official U.S. Department of Agriculture (USDA) farm sector debt estimates, but it is difficult to find data to assess official estimates. The purpose of this study is to examine whether debt provided by nontraditional lenders is accurately accounted for in official estimates.

Design

We compare traditional and nontraditional lending data from farm equipment lien collateral values and the USDA Agricultural Resource Management Survey (ARMS). After analyzing trends in equipment lending implied by farm equipment lien data and ARMS, we estimate whether changes in farm equipment lien values predict changes in equipment debt reported in ARMS and whether lender type influences that relationship.

Findings

We find that credit provided by nontraditional lenders is likely underreported in ARMS. Our econometric model shows that equipment debt volumes for nontraditional lenders are consistently lower than traditional loan volumes in ARMS across a variety of model specifications. We also find that an increase in lien values for nontraditional lenders is less likely to predict an increase in ARMS equipment debt volumes than an increase for traditional lenders.

Practical Implications

Official farm sector debt estimates may not fully account for nontraditional lenders.

Originality/Value

This study demonstrates how growth of nontraditional lending poses challenges for estimating U.S. farm sector debt. We evaluate farm sector debt estimates and advance knowledge of the role of nontraditional lenders in farm equipment credit provision. The farm equipment lien dataset provides a rich source of novel data on local and national equipment debt and investment.

Keywords: U.S. farm sector debt, nontraditional lending, farm equipment lending

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Introduction

Farm sector stakeholders, financial regulators, and policymakers rely on consistently measured data on farm debt levels to track the financial health of the farm sector. The majority of farm debt is held by lenders that are required to report summaries of their lending activity to their regulators, including Farm Credit System (FCS) lenders and commercial banks. Other institutions, such as the Farm Service Agency and life insurance companies, also play a substantial role. However, a growing number of "nontraditional lenders'' provide agricultural credit (Brewer, Ifft and Key, 2022). While there is no official definition of a nontraditional lender, it could be used to refer to (1) credit from entities whose primary relationship with producers is not lending, such as vendors offering financing (Sherrick, Sonka, and Monke, 1994); (2) lenders who operate outside of the predominant local branch or relationship lending model (Fiechter and Ifft, 2020); or (3) lenders not subject to public reporting of debt volumes. This study is broadly motivated by lending that could be characterized by all three classifications but is most directly related to (3): lenders who are not subject to public reporting.

Some lenders that have been classified as nontraditional, such as life insurance companies and vendor-originated finance held by commercial banks, may be subject to public reporting of debt volumes. Others, such as private lenders (non-deposit taking), are subject to different (and often less stringent) regulations, including no public reporting of their debt volumes (Barry, 1995). In cases of no public reporting, official estimates of U.S. farm debt rely on responses to the Agricultural Resource Management Survey (ARMS), which specifically is typically based on the respondent reporting the five largest loans held by a farm operation (Briggeman, Koening, and Moss, 2012). The major challenge to evaluating measurement of non-publicly reported debt using ARMS data is the availability of alternative data sources on farm debt.

The objectives of this study are to (1) analyze trends in equipment lending implied by farm equipment lien data and ARMS and (2) estimate whether changes in farm equipment lien values predict changes in equipment debt reported in ARMS and whether lender type (traditional vs. nontraditional) influences that relationship. The dataset used for this analysis includes all publicly registered liens filed from 2001-2019 on farm equipment primarily suitable for field crop

production, excluding tractors under 100 horsepower, across 14 states.[1] Based on USDA Agricultural Resource Management Survey (ARMS) data, these 14 states contribute over half of the sector's farm equipment assets and debt. Further, ARMS suggests that equipment loans made up 11-15% of total farm lending from 2013-18. As a part standard lending practices, nearly all lenders file a lien on loan collateral with a state governments agency, based on the Uniform Commercial Code (UCC). This lien creates a public record of collateral commitments, which can be used in bankruptcy proceedings or legal disputes. This data is novel to agricultural economics research and allows for analysis of trends in volume and lender type for an entire sub-population of farm loans.

First, we compare lender shares based on the two different datasets: (1) equipment lien information from the UCC and (2) equipment lending information from ARMS. This descriptive analysis suggests different trends in market share between the two datasets, so we also compare debt volumes implied by equipment liens to ARMS farm equipment debt volume and find a similar pattern. Second, we estimate an econometric model that tests whether equipment lien collateral values predict changes in ARMS state-level equipment debt volumes. While ARMS debt levels do reflect actual equipment collateral values, we find strong evidence that nontraditional equipment debt volumes are substantially and consistently underestimated in ARMS, even though standard lending practices imply that lien values may overestimate the role of traditional lenders.[2]

Studies that evaluate national farm debt estimates or ARMS-based estimates of farm debt are limited, largely due to a lack of data. Briggeman, Koening, and Moss (2012) provide several suggestions for improved data collection of debt information in ARMS. Ahrendsen et al (2016) caution that some FSA loan recipients (10-13 percent) indicate on ARMS that they have no outstanding farm debt. A few studies have considered the growth of nontraditional lenders, using ARMS as well as other datasets. Research using ARMS found higher use of nontraditional finance by farms with all beginning operators (Thilmany et al. 2022); a limited relationship between use of nontraditional finance and socially disadvantaged farm operators (McDonald et al. 2022); and heterogenous relationship between local credit access and farm financial status (Nadolnyak and Hartarska, 2022). Ifft, Kuethe, and Patrick (2017) analyzed the growth of implement dealer lending, a type of nontraditional finance, from 2003-16 using ARMS data on long-term nonreal estate lending. This study found growth in the implement dealer market share, but no observable differences in financial characteristics of farms using implement dealer financing.

Brewer et al. (2014) and Brewer et al. (2019) analyze use of multiple lenders by farms that participate in the Kansas Farm Management Association. Fiechter and Ifft (2023) find that feed manufacturers are a major creditor for New York dairy farms during low milk price periods, using

[1] Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, North Dakota, Nebraska, Ohio, Oklahoma, South Dakota, Texas, and Wisconsin

[2] This is due to traditional lenders typically having lower loan-to-value ratios and being more likely to use blanket liens on non-equipment farm loans (or using equipment to secure non-equipment loans).

both farm management survey data and confidential feed manufacturer reported trade credit volumes. While farm management survey data is especially useful for analysis of the relationship between farm-level characteristics and debt use, these datasets only cover a subset of commercial farms in certain states (Kuethe et al. 2014).

This study substantiates the growth of nontraditional lending and demonstrates how this growth poses a serious challenge for estimating U.S. farm sector debt. We know of no other study that has used a *population* of farm lien data to assess the role of nontraditional lenders or evaluate farm sector debt estimates. We advance knowledge of the role of nontraditional lenders in farm equipment credit provision and introduce a dataset that is novel to agricultural economics research, which provides a rich source of data on local and national equipment debt and investment.

We first provide background information on the UCC system and data collection, as well as procedures USDA uses to estimate farm sector debt. Next, we describe the equipment lien data used in our study and ARMS data on farm debt and compare trends in debt share and volume by lender type for both studies. We then introduce our econometric model and discuss results. We conclude with future research needs and policy implications.

Background

Estimation of U.S. Farm Debt

The United States Department of Agriculture (USDA) has long sought effective methods for tracking the patterns of farm debt, with varying degrees of success and continuity (Briggeman, Koenig, and Moss, 2012). Currently, the USDA makes annual estimates of total U.S. farm sector debt used for farm business purposes as part of its Farm Income and Wealth Statistics data product. These estimates seek to provide a consistent measurement of the outstanding farm sector real and non-real estate debt held by major lender groups as of December 31st each year.

Where possible, USDA uses publicly reported data, including FCS and bank data[3] reported by their regulators, data from the life insurer trade association[4], and Farmer Mac's Securities and Exchange Commission filings. When public data is not available, USDA relies on administrative data for FSA's direct lending programs and ARMS survey data is used to estimate debt held by individuals or other lenders that are not covered by the other sources. USDA also relies on ARMS to adjust publicly reported and administrative debt data to exclude real estate debt associated with farm dwellings and debt collateralized by farm assets, but used for non-farm purposes (Briggeman, Koenig, and Moss, 2012; Economic Research Service, 2021b).

[3] The USDA Economic Research Service (ERS) uses banks that are included in the Federal Reserve Bank's "Ag Finance Databook."

[4]Where possible, USDA uses non-public data from major life insurers to adjust the public data reported by the life insurer trade association to exclude loans to agribusiness and timber operations that are considered outside of the farm sector for USDA's purpose.

One focus of this study is evaluating the measurement of non-publicly reported debt estimated from ARMS in the farm sector accounts and referred to as “Individuals and Others” by USDA. USDA reports separate estimates for real estate and non-real estate debt held by each lender group including “individuals and others”. The lien data used in this study covers loans collateralized by equipment and machinery, a subset of the non-real estate debt total USDA reports for each lender group. Therefore, comparisons between the lien data and the farm sector’s equipment and machinery loan volume relies on additional ARMS tabulations to calculate the debt outstanding for the appropriate subset of loans (see the Data section for more details).

Farm Equipment Lien Data and the Uniform Commercial Code (UCC)

Most loans made to finance agricultural production, equipment, machinery or real estate are self-collateralized or self-liquidating (Office of the Comptroller of the Currency, 2018). In other words, the borrower pledges the item being financed as collateral for the lender. If the borrower cannot or does not repay the loan, the lender can collect the collateral in lieu of repayment. Thus, when a loan is made, the lender will file a “lien” on the collateral, which provides legal documentation that specific property has been pledged as loan collateral. In the case of bankruptcy or other legal proceedings, such as lawsuits filed between borrowers and lenders, liens provide substantiation for lenders to legally collect or possess loan collateral. Filing a lien with the respective Department of State for loan collateral is a standard process for new loans. This study takes advantage of publicly available lien data which arguably includes liens on all loans secured by farm equipment (Gopal and Schnabl, 2022).

The "Uniform Commercial Code” (UCC) is a collection of laws that determine the conduct of commercial transactions in a way that can be applied to state law across the United States. The use of UCC data is ideal for national-level research because the procedures and regulations governing these financial transactions are standardized from state to state. In other words, individual state commercial law need not be considered to consistently analyze financial activities across the U.S. Furthermore, liens filed with the UCC have the weight of the law behind them: UCC liens are filed through each U.S. State’s Department of State. Liens provide legal substantiation for the posting of collateral on loans to the secured party, preserving the integrity of the transactions to which borrowers are liable.

The UCC reflects over a century of legal and political efforts to address inconsistent governance of economic transactions across U.S. states. Since the nineteenth century, measures to standardize commercial law were introduced in state and federal legislatures across the United States. After several iterations, a `Uniform Commercial Code' was ratified by the Uniform Law Commission in 1953. It was introduced to individual state legislatures and has since been universally adopted. The Uniform Law Commission is an organization comprised of attorneys, judges, legislators, and other legal professionals commissioned by the federal government to draft laws for the purpose of uniform adoption by state legislatures across the United States (Virginia Division of Legislative Services, 2020).

The lien data used in this study is a novel data source for agricultural economics research and its use in other fields has been limited. Gopal and Schnabl (2022) use a data set of UCC lien filings in a study on evolving lending practices to small business by finance and fintech companies since the 2008 financial crisis. Murfin and Pratt (2019) use UCC lien data on construction equipment manufacturer captive finance subsidiaries to study how captive finance affects resale values by equipment manufacturers where equipment is posted as collateral.

Data

Farm equipment lien data

The lien data used in this study comes from Equipment Data Associates (henceforth, EDA) of Randall Reilly. Information in the dataset includes four major components: (1) secured party (lender) information, (2) buyer information, (3) equipment information, and (4) UCC filing information. Lender information includes unique lender identification numbers, lender classification numbers representing lender type, lender names, and separate variables for states and cities where lenders are based. Buyer variables also include unique buyer identification numbers and states where liens are filed, as well as separate variables for county names, ZIP codes, and FIPS codes.

Financed values of loans are not recorded in the data set. EDA does, however, include equipment values either recorded on the lien or estimated by EDA (only 3 percent of liens disclose the actual value of the equipment). The quality of these estimates likely benefits from EDA's specialization in marketing research for farm and other equipment and their investment in large, detailed datasets. EDA imputes equipment values using equipment type and size classification, while controlling for the age of equipment on the lien filing date. The restrictions this study puts on equipment types analyzed also likely improves accuracy, as we avoid analysis of specialty equipment.

Our analysis is restricted to 14 states where row-crop or field crop production is predominant: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Ohio, and Michigan. This fourteen-state region contains approximately 4,470,000 equipment liens classified as agricultural by EDA from June 2000 to June 2020. The analysis in this paper uses data from 2001-2019, which excludes years without complete data (2000 and 2020 are incomplete). To ensure a high likelihood that equipment in the data set was used primarily for agricultural production purposes, the data was restricted to include equipment that was likely to be used in field crop production, with tractors restricted to those greater than 100 horsepower. Further, this restriction excludes specialized equipment, which may be more difficult to estimate values due to lower volumes and standardization. A full list of equipment types can be found in Supplemental Appendix Table A1. The total number of liens by state and year is reported in Table A2 and total equipment collateral value reported by state and year is reported in Table A3. State-level collateral values range from $55 million to $1.2 billion and vary widely by year and state, with a general increasing trend.

Several statistical tests and spot checks were used to assess the accuracy of estimated equipment values. EDA's estimates correlate strongly with equipment size and type indicated on the lien. Horsepower is recorded on roughly 70% of liens and is nearly perfectly correlated with equipment size classification, which appears on every lien. Adjusted for equipment type, size classification operates as a proxy for horsepower (Byers, 2022). In addition to confirming that equipment values are correlated with size, we also did several spot checks on lien values and actual new and used prices for specific types of farm machinery, including tractors and harvesters/combines. We found that these published values were consistent with what was reported in the lien data.

Liens analyzed in this study are classified as traditional if they are held by Farm Credit System lenders or banks. Liens held by equipment manufacturers, equipment dealerships, and vendor credit providers were classified as nontraditional. The 20 largest nontraditional lenders other than John Deere Credit and Case New Holland (CNH) are listed in Table A4. Lenders classified as "other" included Farm Service Agency, Credit Union, Corporate Financial Leasing, Insurance, and Individual and Trust categories, which constituted no more than 3.6% of all collateral equipment value on an annual basis. In other words, traditional and nontraditional lenders held no less than 96.4% of collateral equipment value in each year contained in the data. Thus, our analysis focuses on traditional and nontraditional lenders only.

Agricultural Resource Management Survey (ARMS)

ARMS is an annual survey of around 20,000 farm operations that has been conducted by the USDA since 1996. Data is collected on production and financial characteristics of the farm operation, as well as information on the farm household. ARMS data is used widely to support official statistics on the characteristics and economic well-being of the U.S. farm sector (i.e., Key et al. 2019) and in academic research (Kuethe and Morehart, 2012). The farm equipment lien data used in this study is from fourteen states, so state-level ARMS data were similarly restricted to those fourteen states. Of those fourteen, nine are among states that are more heavily sampled to support the publication of state-level estimates (these states are often referred to as "ARMS states") (Economic Research Service, 2021a).

The debt data from ARMS used in this study is from the "debt table" (Figure A1), a table that collects detailed information on an operation's 5 largest loans[5], including information on loan use and lender type. Nonreal estate debt used for equipment purchase was identified in ARMS for a shorter period (2005-2018) than overall nonreal estate debt (2003-2019). Both long-term nonreal estate debt and long-term nonreal estate equipment debt are discussed in this study, but the latter provides the basis for the primary empirical analysis, as overall nonreal estate debt includes data on operating debt and other uses not related to equipment purchase, such as breeding stock.

[5] In a few years, information on a larger number of loans was collected.

Lenders reported in ARMS are defined as traditional or nontraditional using the same classifications as in the farm equipment lien data. ARMS data was aggregated (summed) to the state-level and the entire study region (i.e., all 14 states). Survey weights were applied to the underlying ARMS data; these weights account for farms missing from the sample due to non-response or not being present in NASS's list frame. While these weights are calibrated to match farm numbers and production reported in the U.S. Census of Agriculture and *not* debt volumes, application of the weights does provide a more comparable representation of ARMS loan data with farm equipment lien data.

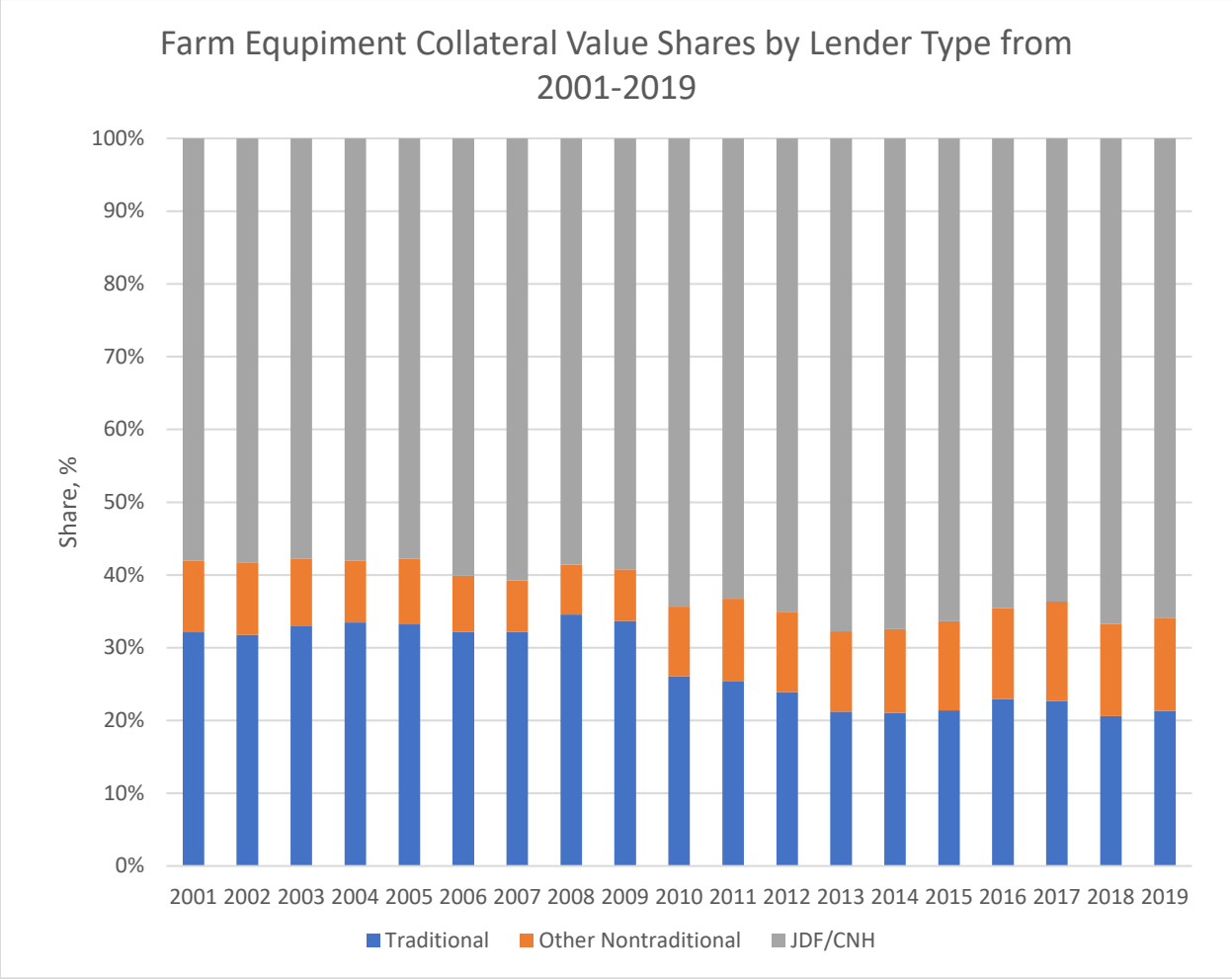
Descriptive Statistics

Figure 1 shows the share of aggregate collateral values by year for groups of traditional and nontraditional lenders.[6] Given their large market share, nontraditional lenders John Deere Credit and CNH were combined and reported separately out from other nontraditional lenders. All other equipment manufacturers, implement dealers, and vendor finance providers are labeled as "Other Nontraditional". The combined share of collateral value for nontraditional lenders (JDF, CNH, and other nontraditional) has been growing over time and was nearly four times as large as the share of traditional lenders by 2019. This likely underestimates their share of outstanding equipment debt volume, as traditional lenders tend to have smaller loan-to-value (LTV) ratios.[7] Since collateral values reflect the "value" portion of the LTV ratio, it is likely that for the same amount of collateral reported by a traditional and nontraditional lender, the nontraditional lender holds a larger loan. Thus, it is likely that nontraditional lenders have at least an 80 percent market share in the farm equipment markets analyzed in this study.

[6] For clarity, lenders falling the "other" category are excluded.

[7] Loan to value ratios are not publicly available, but the authors consulted with multiple lenders and experts and determined that loan to values ratios range around 0.65 for traditional lenders and over 0.8 for nontraditional lenders. Further, we found several promotional offers from farm equipment lenders from implement dealers/nontraditional lenders that were for zero down payment or a very low down payment, which implies a loan to value ratio near 1 (for more information, see table 4-4 in Byers, 2022).

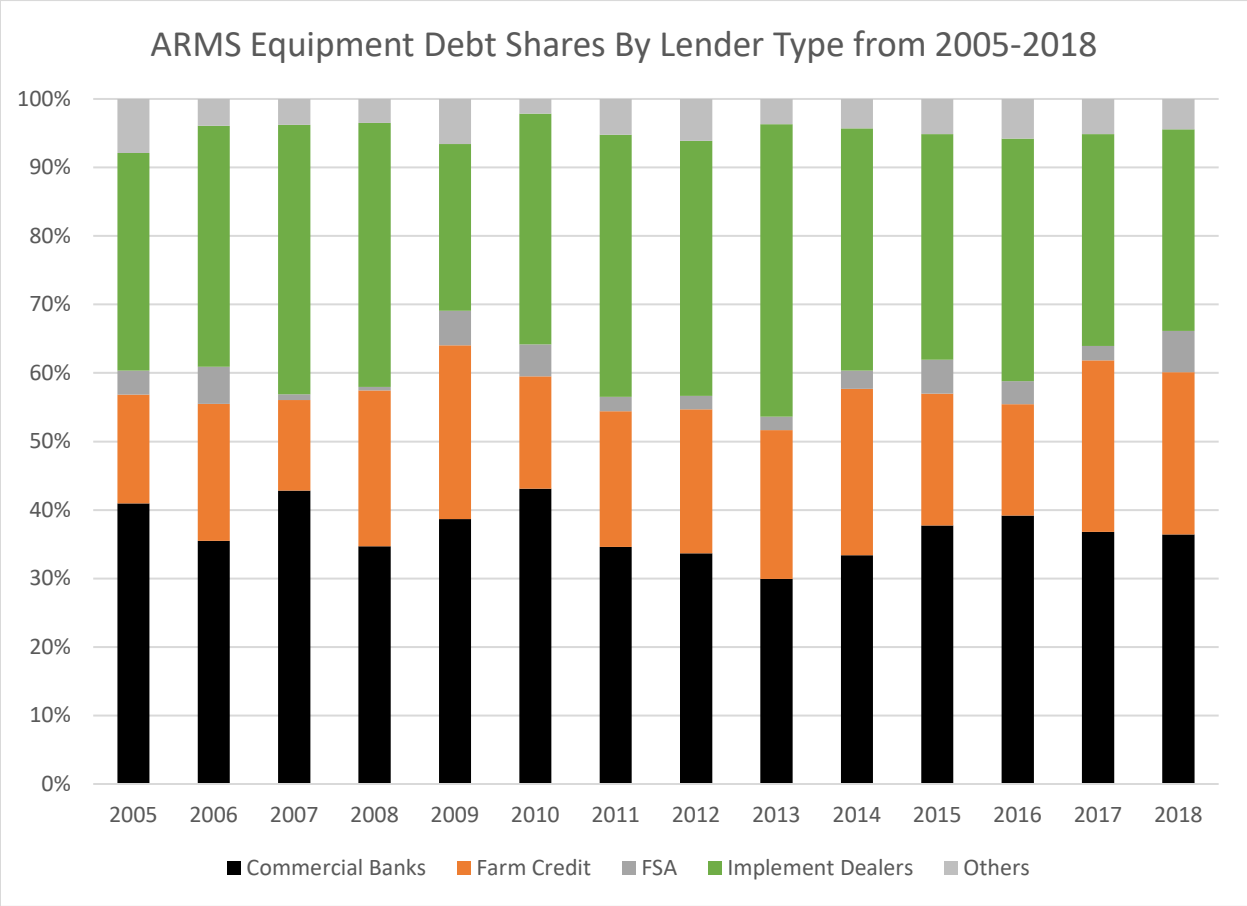
Figure 1. Farm equipment collateral value share for nontraditional lenders is large and increasing.



Note: Shares are estimated using farm equipment lien data provided by Equipment Data Associates (EDA). The category "other" is excluded. This data is from the following states only: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Ohio, and Michigan. Source: Authors' analysis of EDA data.

ARMS farm equipment loan shares by lender type are reported in Figure 2, using categories that reflect ARMS reporting conventions. Traditional lenders (Farm Credit and Commercial banks) make up the majority of loans but implement dealers (the major type of nontraditional lender reported in ARMS, which is not broken out further), also make up a sizeable share of loan volume. However, compared to the farm equipment lien data, the share of implement dealers, or nontraditional lenders in general, is much smaller and does not appear to be increasing over time.

Figure 2 Over half of farm equipment debt reported in ARMS is held by traditional lenders.



Note: Shares are estimated using long term non-real estate equipment debt data reported in the Agricultural Resource Management Survey (ARMS) from 2005-2018. ARMS is designed and implemented by the USDA National Agricultural Statistics Service and Economic Research Service. This data is from the following states only: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Ohio, and Michigan. Source: Authors' analysis of ARMS data.

Next, we use typical equipment loan characteristics to estimate total equipment loan volume implied by farm equipment collateral value reported in liens. These estimated loan volumes are compared with aggregated ARMS data. ARMS equipment debt volumes implicitly consist of new debt (debt being first taken out in that period) and outstanding debt (debt taken in out in previous periods that has not been repaid). As the farm equipment lien data provides collateral values rather than the amounts of loans, we must both (1) convert collateral values to current loan amounts and (2) estimate the value of outstanding debt from previous years. We estimate debt volume using equipment collateral values, with standard values for loan-to-value ratios,

interest rate, and repayment length. We estimate the debt volume in state s, lender type l (traditional or nontraditional), and year t as

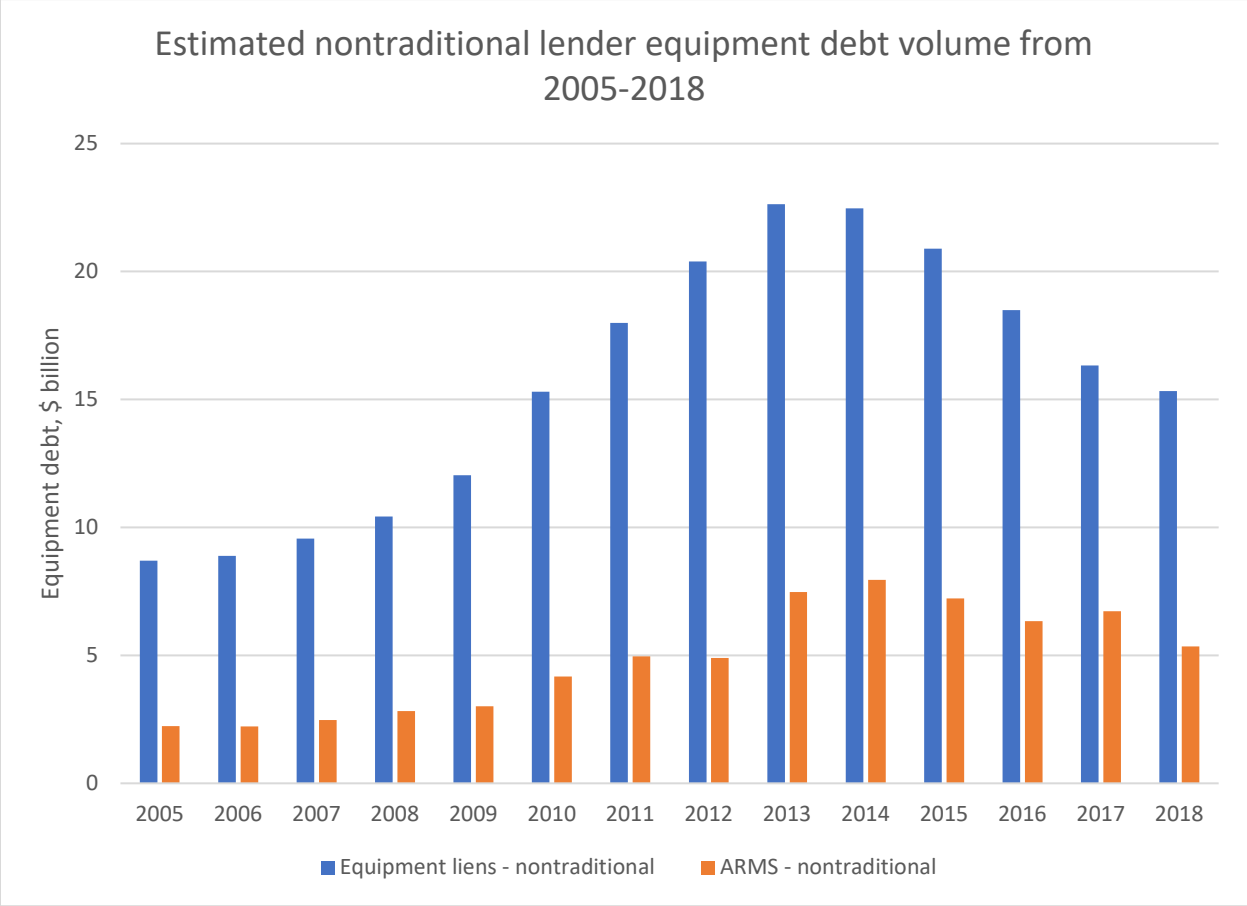
$$\boldsymbol{D_{slt} = \sum_{j=1}^{J} \left(\psi_l v_{sltj} + \sum_{k=1}^{n} \left(\left(1 - \frac{rk}{1-(1+r)^{-n}}\right) \psi_l v_{sl(t-k)j} + \sum_{m=1}^{k} r \left(1 - \frac{r(m-1)}{1-(1+r)^{-n}}\right) \psi_l v_{sl(t-k)j} \right) \right)} \quad (1)$$

where v_{sltj} is the value of j th equipment in state s , lender type l , and year t , ψ_l is the lender-type-specific loan-to-value ratio, n is the time length of a loan, and r is the annual interest rate. The first term in Equation 1, $\psi_l v_{sltj}$, represents new debt in year *t.* The second term, $\left(1 - \frac{rk}{1-(1+r)^{-n}}\right) \psi_l v_{sl(t-k)j}$, uses the amortization formula to estimate the outstanding or unpaid principle from previous periods. The third term, $\sum_{m=1}^{k} r \left(1 - \frac{r(m-1)}{1-(1+r)^{-n}}\right) \psi_l v_{sl(t-k)j}$, is the cumulative interest at year t from the loans in year $t-k$.

Our general approach to estimating Equation 1 is to use straightforward, transparent assumptions that are *not* likely to overstate nontraditional lending volumes. However, after presenting estimated debt volumes, we will discuss the sensitivity of our estimates to variations in loan terms. We assume a nontraditional lender loan to value ratio (ψ_l) of 0.8, a traditional lender loan to value ratio (ψ_l) of 0.65, an interest rate (*r)* of 5% and a loan length (*n*) of 5 years. As the equipment lien data are at the individual lien level, we aggregate the lien-level data across the 14 states in our study.

Figure 3 reports our estimate of nontraditional lender debt volumes using equipment collateral values and aggregated ARMS equipment debt volumes from nontraditional lenders. The lien data-derived volumes are consistently at least double the implied ARMS volumes every year, with the difference larger in some years. Declining loan volumes in each dataset from 2015 likely reflect the overall decline in farm income. In Figure 4, we report results of our estimate of traditional lender debt volumes using equipment collateral values and compare them to ARMS equipment debt volumes. The farm equipment lien-implied volumes are largely comparable and somewhat higher than ARMS-implied debt through 2014, but ARMS volumes are larger from 2014 onwards.

Figure 3. Farm equipment lien data implies much higher nontraditional lender loan volumes than is reported in ARMS



Note: Estimated debt volumes are based on (1) farm equipment lien data provided by Equipment Data Associates (EDA) and (2) long term non-real estate equipment debt data reported in the Agricultural Resource Management Survey (ARMS) from 2005-2018. ARMS is designed and implemented by the USDA National Agricultural Statistics Service and Economic Research Service. This data is from the following states only: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Ohio, and Michigan. Source: Authors' analysis of EDA and ARMS data.

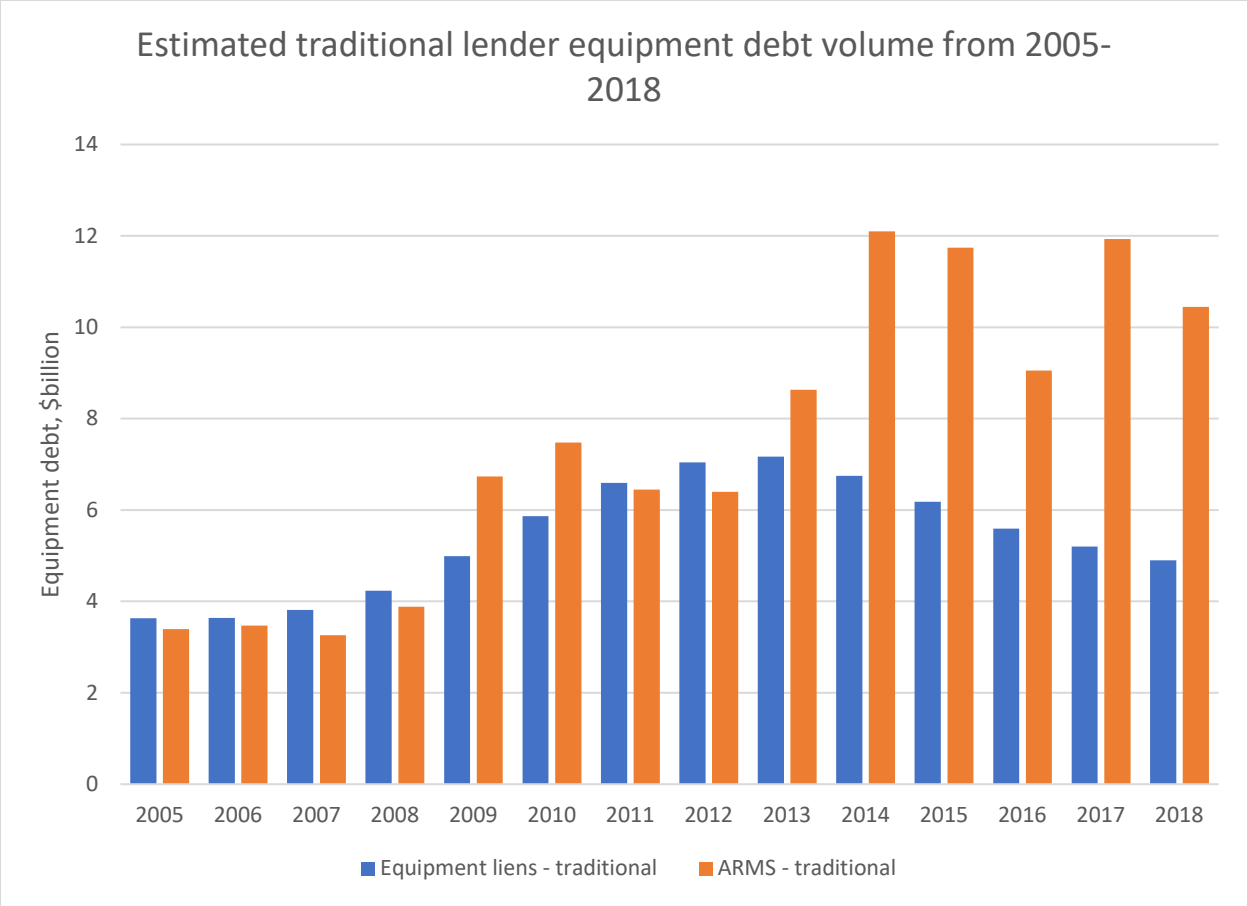
Farm equipment lien data measures actual loan collateral values, while ARMS collects farm-level loan information from a representative sample of producers. It is not certain why traditional loan volumes would be higher in the later part of our survey period, although the sampling methodology for ARMS did change around 2013 (Economic Research Service, 2021a). Before this year, the 'loan table' was only reported on a subset of ARMS observations that received a longer survey. Due to this change, different weights were applied to ARMS data from 2013. Alternatively, it is also possible that loan terms changed over time, while we used consistent loan to value ratios, etc. throughout our estimates. Although, the large abrupt change

suggests that weighting may be more of an issue. Analysis of the change in ARMS weights and sampling is beyond the scope of this study, but may have implications for the use of ARMS data in official farm sector debt estimates. While neither dataset is designed to directly measure total equipment debt volumes, comparing the two datasets suggests traditional lending volumes implied by both datasets were similar in the early part of our study.

Our results for nontraditional lender volumes are markedly different, suggesting consistent underreporting of loans made by implement dealers throughout our study period. To check our underlying assumptions, we compared reported domestic debt volume by John Deere Capital Corporation (2019) throughout our study period. While the reporting classification (loans for agricultural production not secured by real estate) includes some operating loans, it also allows for direct comparison. John Deere Capital Corporation reported domestic lending volume of $12-13 billion from 2017-19. In addition to some of this lending not being for equipment, some of this lending is for states not included in our study. We estimate that operations in our study states hold over half of all farm equipment debt nationally. Our equipment debt volume estimates have John Deere Credit as holding around $4.5-5 billion of equipment debt for our study region during the same period, which is comparable to reported volume once our study period and debt type are considered.

One of our key assumptions is loan to value ratios; we use industry-reported norms of 0.65 for traditional lenders and 0.80 for nontraditional lenders. Our traditional lender estimates from Figure 4 suggest that 0.65 is reasonable, at least in the beginning of our study period. However, nontraditional loan volumes implied by the lien data are much larger than ARMS estimates. A loan-to-value ratio of 0.2-0.3 would be required for nontraditional implied loan volumes to be similar between the two datasets. While actual ratios are not possible to observe, 0.2-0.3 is two to three times lower than industry-reported norms; it is highly unlikely that our assumed loan-to-value ratio for nontraditional lender drives the substantial difference between lien and ARMS. While we cannot observe actual interest rates for loans from the lien data, 5% is close to average rates reported in the Ag Finance Databook for machinery and equipment loans during our study period. Rates would have been slightly higher in the first few years of our study period (around 2005-2008), which would have increased debt volumes implied by equipment liens. Ifft, Kuethe, and Patrick (2017) report that interest rates may be lower than nontraditional lenders. As such, use of the uniform 5% interest rate may bias lending volumes, especially from nontraditional lenders, downward. This works in the opposite direction of our finding that ARMS may underestimate nontraditional lender volume.

Figure 4. ARMS and farm equipment liens provide similar traditional lender farm equipment debt volume estimates from 2005-2013.



Note: Estimated debt volumes are based on (1) farm equipment lien data provided by Equipment Data Associates (EDA) and (2) long term non-real estate equipment debt data reported in the Agricultural Resource Management Survey (ARMS) from 2005-2018. ARMS is designed and implemented by the USDA National Agricultural Statistics Service and Economic Research Service. This data is from the following states only: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Ohio, and Michigan. Source: Authors' analysis of EDA data and ARMS data.

Methods

We use a regression model to estimate the degree to which changes in farm equipment collateral value predicts a change in ARMS debt levels. While the descriptive statistics provide evidence of underreporting of nontraditional loans in ARMS, our overarching objective is to test whether there is statistically robust relationship between changes in lien data (actual lending) and loans reported in ARMS. The most granular level of analysis that is feasible is the state level, as individual ARMS observations cannot be matched to individual lien data and the majority of states in our study have large enough samples to support state-level estimation (Economic Research Service, 2021a). Further, the sampling procedure of ARMS does not support zip code or county-level inference. While we use all 14 states for our primary analysis to take full advantage

of available data, we restrict our analysis to the 9-states that have sampling sufficient to support state-level analysis in a robustness check.

We begin our econometric analysis with a naïve model that links state level ARMS debt estimates ($ARMS_{slt}$) for state *s* in year *t* for lender type *l* to aggregated equipment lien values ($EQTVALUE_{slt}$). Unobserved factors influencing ARMS equipment debt volumes are represented by an error term classified as ε_{slt}. β_1 measures the degree to which changes in equipment collateral value are related to changes in ARMS equipment debt volumes. If ARMS equipment debt volume estimates "perfectly" reflected new equipment debt, we would expect β_1 to equal the loan to value ratio or the ratio of new loan value to collateral value, which is often reported to be around 0.5-0.85. Our constant term, β_0, could be interpreted as average annual volume of outstanding loan balances throughout our study period. In our second model, we add a time trend ($trend_{slt}$) to reflect changing equipment debt volume trends and an indicator for nontraditional loans, η_{slt}. β_3 measures the average annual increase in equipment debt volume across loan types and β_2 represents the average annual difference between traditional and nontraditional loan volumes.

In our third model, we add an interaction term ($EQTVALUE_{slt} * \eta_{slt}$) that allows us to test whether equipment loans from nontraditional lenders is less likely to be reflected in ARMS equipment debt volumes than loans from traditional lenders. In other words, if this hypothesis is true, we would expect β_4 to take a negative value. Equation (2) represents the third model but also nests the first and the second models, in the sense that they can be represented by removing the additional variables.

$$ARMS_{slt} = \beta_0 + \beta_1 EQTVALUE_{slt} + \beta_2 \eta_{slt} + \beta_3 trend_{slt} + \beta_4 (EQTVALUE_{slt} * \eta_{slt}) + \varepsilon_{slt} \quad (2)$$

We also conduct several robustness checks, including changing our construction of time trends. Specifically, we replace our linear time trend variable with a regime indicator variable for 2009-14, when equipment lending volumes increased; this also corresponds with a period of high farm income. We also add triple interactions of our $(EQTVALUE_{slt} * \eta_{slt})$ variable, interacting this term with both a regional indicator and a time trend. The regional indicator is equal to one for the four states in our sample that typically have the largest level of field crop production: Iowa, Illinois, Minnesota, and Nebraska. Separately, we also add a nontraditional loan-time trend interaction. We add state level effects, s_{lt}, to test whether our results are driven by unobserved state-level factors. We also estimate our primary model with ARMS states only or states with sufficient sampling to support state-level estimates.

We estimate two extensions of our primary model. First, we add lags of equipment collateral values to test whether there is lag in debt estimates reported in ARMS. Second, we estimate our primary model with ARMS estimates of equipment expenditure on new equipment as the outcome variable. The purpose of this analysis is to test whether (total) new equipment loan collateral predicts annual equipment expenditure in ARMS. If this relationship is markedly

different than in our primary model of equipment debt volumes, it would suggest an issue with elicitation using the "loan table" as opposed to the ARMS survey instrument in general.

Results

Results of our primary model are provided in Table 1. In our baseline model, we find that a $1 increase in equipment collateral value is related to an approximately $0.21 increase in ARMS equipment debt volume estimates. While lower than predicted, this does illustrate that ARMS debt estimates reflect new equipment debt. In our second model, we find that on average ARMS nontraditional loan volume is nearly $300 million lower than traditional loan volume. The time trend is positive and statistically significant, suggesting increasing loan volumes across both lender types across the study period. Model 2 also suggests an increase in equipment collateral value is related to an approximately $0.38 increase in ARMS equipment debt volume estimates, which is closer to industry-reported loan-to-value ratios than that implied by Model 1.

We find that the degree to which the equipment value is correlated with the ARMS loan volume is substantially lower with nontraditional lending. Addition of a nontraditional-equipment value interaction in Model 3 suggests that nontraditional equipment values are less likely to be reflected in ARMS debt estimates, albeit with marginal statistical significance. More specifically, from column (3), while we see that a dollar of equipment value translates to 61 cents of the loan volume for the traditional lending, the point estimate of the interaction indicates that the conversion rate is lower by about 26 cents for nontraditional lending. The $0.61 coefficient in Model 3 on equipment values is remarkably close to the traditional lender loan-to-value ratios.

In Models 2 and 3, the addition of nontraditional lender controls leads to a stronger predicted relationship between equipment values and ARMS debt estimates. Further, the nontraditional indicator is negative and statistically significant in both models, suggesting substantially lower nontraditional loan volumes on average. This finding is the opposite of what is indicated by the actual equipment lien trends (Figure 1), despite the likely overestimation of traditional loan volumes based on lien data.

Table 1. Regression Results for Primary Econometric Models of ARMS Nonreal Estate Equipment Debt Data for 2005 to 2018

	ARMS state level loan volume		
Variable	Baseline Model (1)	Nontraditional Dummy Model (2)	Combined Model (3)
Equipment Value	0.21*** (0.054)	0.38*** (0.049)	0.61 (0.158)
Nontraditional		-298.9*** (29.22)	-221.6*** (53.56)

Nontrad. X Equip. Value			-0.26+	(0.152)
Time Trend		35.93*** (3.212)	35.81***	(3.205)
Intercept	355.1*** (27.47)	167.3*** (31.05)	107.1** (55.73)	
Adjusted R^2	0.03	0.41	0.41	
Observations	392	392	392	

Note: Intercept, nontraditional indicator, and time trend are reported in $million. *** p< 0.001, **p<0.01, *P< 0.05, + p< 0.1. Source: Authors' analysis of EDA data and ARMS data.

In the Supplemental Appendix we report the results of additional robustness checks. Our primary results do not change when we change how we measure region or time trends. The primary results also do not meaningfully change when we add additional interaction terms or state fixed effects to our model, although state fixed effects likely result in a loss of statistical power (Table A5).

In another extension, we add combinations of one and two-year lagged terms of equipment collateral values to our primary model (Table A6). We find some evidence that older nontraditional debt may be less likely to be reported in ARMS (negative, statistically significant coefficients on equipment value – nontraditional indicators in columns 2 and 4), but this finding is not consistent across specifications. Further, our results do not change when we restrict our sample to "ARMS states" or states with higher sampling rates (Table A7).

We also use farm equipment asset value as our dependent variable and estimate it as a simple function of total equipment collateral values, a time trend, and state fixed effects (Table 2). Generally, we find strong statistical significance for equipment collateral values, that is consistent with inclusion of state fixed effects. Specifically, we estimate that a $1 increase in collateral values leads to a $0.47 to $0.54 increase in asset values. The relationship is statistically significant and robust to inclusion of state effects, in addition to being substantially larger in magnitude to our most comparable specification reported in column 1 of Table 1. We interpret this as suggestive evidence that elicitation using the 'loan table' in ARMS may be related to the underreporting of nontraditional lending, as opposed to simply attributable to the ARMS sampling methodology or general survey design. As such, this finding supports testing direct elicitation of equipment loan volume in ARMS to test whether this approach might better capture nontraditional loan volumes.

Table 2. Regression Results for Econometric Models of ARMS Asset Data Measures for 2005 to 2018

	Capital Expenditure on Farm Equipment	
Equipment Value	0.47*** (0.033)	0.54*** (0.045)
Time Trend	1.9 (3.6)	0.3 (3.0)
Adjusted R^2	0.53	0.70
Observations	196	196
State FE		X

Note: Farm equipment expenditure in this specification includes spending on tractors and self-propelled equipment only. The intercept is not reported, while the time trend is reported in $million. *** p< 0.001, **p<0.01, *P< 0.05, + p< 0.1. Source: Authors' analysis of EDA data and ARMS data.

Conclusion

This study uses information on the value of publicly registered farm equipment loan collateral to assess the role of nontraditional lenders in this market and explore the implications for official U.S. farm sector debt estimates. We first analyze market share trends in farm equipment debt volumes using equipment lien data from the 14 field-crop intensive states in our study. The majority and increasing nontraditional market share demonstrated by the lien data is much larger compared to the market share implied by ARMS. A similar pattern is displayed when lien values are converted to potential equipment debt volume. We estimate a state-level econometric model to test whether changes in equipment lien collateral values predict changes in ARMS state-level equipment debt volumes. While ARMS debt levels do reflect actual equipment collateral values, we find strong evidence that nontraditional equipment debt volumes are substantially and consistently underreported in ARMS across a variety of model specifications.

This study only considered one type of nontraditional farm lending, however, nontraditional real estate lending (Lyons and Takach, 2022) and production loans (Dodson, Ahrendsen, and Short, 2022) are also of interest. However, implement dealer loans are the most prevalent nontraditional lender reported in ARMS (Ifft, Kuethe, and Patrick, 2017). Thus, it is possible that other types of nontraditional loans are also underreported in ARMS. Collateral values reported in our dataset reflect actual equipment debt volumes, but nontraditional lenders likely have higher loan-to-value ratios. Thus, our results may *underestimate* levels of nontraditional lending relative to traditional. Our results may be affected by ARMS weights, as apparent on Figure 4.

This is a separate issue from our evidence that nontraditional lender loan volumes are underreported in ARMS and is beyond the scope of this study and likely biases our estimate of underreporting of nontraditional loans further downward. One other concern is that the lien data may include loans made by businesses that do custom work or machinery hire. Such businesses would likely not be classified as farms and, thus, not included in official farm sector debt estimates. We cannot disprove that such businesses are included in the lien data, but we do not believe such businesses would have a large impact on our results, as machine hire and custom work only make up about 1.3 percent of total farm production expenses.[8]

Future research should explore alternative types of nontraditional finance, including for real estate lending, operating loans, and vendor finance, both related to farm sector debt estimates as well as the broader evolution of agricultural credit markets. Nontraditional lenders that provide vendor credit or operating loans may play an important role during farm sector downturns (Fiechter and Ifft, 2023); whether this relationship extends nationally across industries and loan types is an important topic for future research. Analysis of the role of different drivers of nontraditional financing is also relevant; specifically, the role of financial constraints, financial/bank regulation, and credit market imperfections. Another related topic is the role of changing interest rates in competition in agricultural credit markets (Miller, Ifft, and Mashange, 2024).

Consistent and reliable measurement is an important component of U.S. farm sector debt estimates and makes changing established methodologies challenging, especially when supplemental information is not publicly reported. However, for a full picture of the current agricultural credit landscape, current U.S. farm sector debt estimates need to be supplemented by information of nontraditional lending volumes. While official estimates of farm sector leverage are below the peak from the 1980s, growth of total farm sector debt is expected to outpace growth in asset value in 2023 (Economic Research Service, 2023). If farm sector debt estimates are underestimated due to growth of nontraditional lending, current farm sector solvency may be closer to the 1980s than currently believed. With growing bank regulation (Moss and Suh, 2020, Regmi et al., 2021), there may be continued demand for nontraditional finance from more financially stressed and less risk averse borrowers.

There are several potential approaches to improving information on nontraditional or nonreporting lenders in farm sector debt estimates. Lien data is one potential source of alternative data; including commercial lenders not reported in the Ag Finance Databook may be another approach. Further, USDA may be able to confidentially access information on lenders that privately report volumes to financial regulators, such as currently done with life insurers. Testing alternative approaches to soliciting debt information on ARMS is another approach, including directly eliciting information on nontraditional loan volumes. Our analysis of asset values in ARMS suggests that the “loan table” may be of particular concern, as opposed to

[8] This was calculated using USDA Economic Research Service data, with 2021 U.S. total production expenses (excluding operator dwelling) of $369 billion and machine hire and custom work expenses of $4.9 billion.

broader on issues in ARMS response rate and sampling (Economic Research Service, 2021a). Ultimately, our research suggests that changes to agricultural credit markets, including growth of nontraditional lenders, is a major challenge for official farm sector debt estimation.

References

Ahrendsen, B. L., B. L. Dixon, C. B. Dodson, D. Danforth, and N. McMinn (2016). *ARMS respondent errors: A case of farm service agency loans.* Agricultural and Applied Economics Association. doi: 10.22004/AG.ECON.235908.

Barry, P. J. (1995). *The Effects of Credit Policies on U.S. Agriculture.* American Enterprise Institute.

Brewer, B. E., J. S. Bergtold, F. A. M., and C. A. Wilson (2019). Farmers' choice of credit among the farm credit system, commercial banks, and nontraditional lenders*. Journal of Agricultural and Resource Economics 44*, 362–379. doi: 10.22004/ag.econ.287984

Brewer, B., Ifft, J., and Key, N. (2022). Guest editorial: Nontraditional Credit in U.S. Agriculture. *Agricultural Finance Review*, *82*(2), 205-213. doi: 10.1108/AFR-04-2022-187

Brewer, B. E., C. A. Wilson, A. M. Featherstone, and M. R. Langemeier. (2014). Multiple vs single lending relationships in the agricultural sector*. Agricultural Finance Review*. 74(1), 55-68. doi: 10.1108/AFR-04-2013-0014

Briggeman, B. C., S. R. Koenig, and C. B. Moss (2012). U.S. farm debt: the role of ARMS*. Agricultural Finance Review. Vol. 72, No.2, pp. 254-261. doi: 10.1108/00021461211250483.*

Byers, L. (2022). *Nontraditional agricultural equipment lending trends in the Agricultural Resource Management Survey and Uniform Commercial Code data*. MS Thesis, Kansas State University.

Dodson, C. B., Ahrendsen, B. L., and Short, G. (2022). Does use of nontraditional credit increase risk? *Agricultural Finance Review*, *82*(2), 359-378. doi: 101108/AFR-06-2021-0085

Economic Research Service. (2021a). *ARMS Farm Financial and Crop Production Practices: Documentation.* U. S. Department of Agriculture. Available at https://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/documentation-for-the-farm-sector-balance-sheet/. (accessed 23 May 2022.)

Economic Research Service. (2021b). *Documentation for the Farm Sector Balance Sheet.* U. S. Department of Agriculture. Available at https://www.ers.usda.gov/data-products/arms-farm-financial-and-crop-production-practices/documentation/. (accessed 16 Dec 2021).

Economic Research Service. (2023). *Farm Sector Income and Finances: Assets, Debt, and Wealth.*

U. S. Department of Agriculture. Available at https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/assets-debt-and-wealth/. (accessed 15 July 2023.)

Fiechter, C., and Ifft, J. (2020). What makes nontraditional finance nontraditional? *farmdoc daily*, *10*(50), Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, March 18, 2020.

Fiechter, C., and Ifft, J. (2023). Trade credit and agricultural commodity prices: evidence from the U.S. dairy industry. *European Review of Agricultural Economics*, *50*(2), 529-562. doi: 10.1093/erae/jbac010

Gopal, M., and Schnabl, P. (2022). The rise of finance companies and fintech lenders in small business lending. *The Review of Financial Studies*, *35*(11), 4859-4901. doi: 10.1093/rfs/hhac034

Ifft, J., Kuethe, T., and Patrick, K. (2017). *Nontraditional lenders in the U.S. Farm economy*. Presentation at the 2017 Agricultural and Rural Finance Markets in Transition Multistate Meeting, 2-3 October, Minneapolis, Minnesota.

John Deere Capital Corporation. (2019). Consolidated Financial Statements for Holding Companies—FR Y-9C. Board of Governors of the Federal Reserve System.

Key, N., C. Burns, and G. Lyons (2019). *Financial Conditions in the U.S. Agricultural Sector: Historical Comparisons*, EIB-211, U.S. Department of Agriculture, Economic Research Service.

Kuethe, T. H., B. Briggeman, N. D. Paulson, and A. L. Katchova. (2014). A comparison of data collected through farm management associations and the agricultural resource management survey. *Agricultural Finance Review*. Vol 74, No. 4, pp. 492-500. doi: 10.1108/AFR-09-2014-0023

Kuethe, T.H. and Morehart, M. (2012). The Agricultural Resource Management Survey: An information system for production agriculture*. Agricultural Finance Review. Vol. 72, pp.191-200. doi: 10.1108/00021461211250429*

Lyons, G. A., and Takach, J. (2022). A profile of nontraditional agricultural real estate lender activity in the secondary market. *Agricultural Finance Review*, *82*(2), 397-416. doi: 10.1108/AFR-06-2021-0081

McDonald, T. M., Law, J., Giri, A. K., and Subedi, D. (2022). The role of nontraditional lending for socially disadvantaged and financially stressed farmers. *Agricultural Finance Review*, *82*(2), 247-267. doi: 10.1108/AFR-06-2021-0072

Miller, N.J., Ifft, J., and Mashange G. (2024). Farm loan interest rate trends by major lender groups. *farmdoc daily*, 14(31), Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, February 14, 2024.

Moss, C. B., and Suh, D. H. (2020). Effect of compliance cost on the supply of bank credit to agriculture: A differential approach. *American Journal of Agricultural Economics*, *102*(2), 713-726. doi: 10.1002/ajae.12074

Murfin, J. and R. Pratt. (2019). Who finances durable goods and why it matters: captive finance and Coase conjecture. *The Journal of Finance 74*(2), 755–793. doi: 10.1111/jofi.12745

Nadolnyak, D., and Hartarska, V. (2022). Nontraditional lenders and access to local agricultural credit markets by beginning and female farmers. *Agricultural Finance Review*, *82*(2), 268-284. doi: 10.1108/afr-06-2021-0073

Office of the Comptroller of the Currency. (2018) Agricultural lending. In Comptroller's Handbook. U.S. Department of Treasury, Washington D.C.

Regmi, M., Featherstone, A. M., Cowley, C. A., and Taylor, M. R. (2021). Big banks versus agricultural banks: Has too-big-to-fail regulation affected efficiency and scale economies measures. *American Journal of Agricultural Economics*, *103*(3), 1164-1178. doi: 10.1111/ajae.12143

Sherrick, B. J., S. T. Sonka, and J. D. Monke. (1994). Nontraditional lenders in agricultural credit markets. *Agribusiness 10*(4), 341–357. doi: 10.1002/1520-6297(199407/08)10:4<341

Thilmany, D., Bauman, A., Hadrich, J., Jablonski, B. B., and Sullins, M. (2022). Unique financing strategies among beginning farmers and ranchers: differences among multigenerational and beginning operations. *Agricultural Finance Review*, *82*(2), 285-309. doi: 10.1108/afr-05-2021-0070

Virginia Division of Legislative Services. (2020). *Uniform Law Commission.* http://dls.virginia.gov/commissions/ulc.htm