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Signaling Credit Risk in Agriculture: Implications for Capital Structure Analysis

Jianmei Zhao, Peter J. Barry, and Ani L. Katchova

Signaling is an important element in the lender-borrower relationship that influences the cost and availability of debt capital to agricultural borrowers. This paper analyzes the effects of signaling on farm capital structure in conjunction with the pecking order and trade-off theories. The aggregate estimation indicates that signaling does affect agricultural credit relationships through measures of past cash flow and profitability. High-quality borrowers achieve greater credit capacity by providing lenders with valid signals of their financial status, while adjusting toward target debt levels over time and following the pecking order relationship in the short run.

Key Words: farm businesses, pecking order theory, signaling theory, trade-off theory

JEL Classifications: G11, G32, Q14

Signaling is an important element in the lender-borrower relationship that directly influences the cost and availability of debt capital to agricultural borrowers. It is based on the premise that lenders prefer to finance higher-quality borrowers with lower credit risk. In determining a borrower's credit capacity, lenders need information that allows them to accurately distinguish between high- and low-quality borrowers, thus minimizing adverse selection problems. High-quality borrowers strive to inform lenders of their status by sending credible, unambiguous, and meaningful signals. In contrast, low-quality borrowers are unable to send such signals.

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Although signaling is a generic strategy applicable to many types of relationships, the signaling instruments for financial relationships rely on measures of strong financial performance (e.g., high profitability and cash flow) that strengthen risk ratings made by financial institutions.

The sensitivity of farmers' credit capacity to various financial characteristics and risk management was conceptualized by Baker, empirically tested in several studies, and found to differ significantly among such factors as farmers' use of crop insurance, forward contracting, choice of lender, financing instrument, income variability, asset structure, enterprise mix, and degree of vertical coordination (Barry and Robison). These studies are consistent with the signaling paradigm to various degrees, although Baker's approach was motivated primarily by liquidity considerations, while more recent studies have emphasized agency relationships, asymmetric information, and incentive alignments between borrowers and lenders (Hart; Hubbard; Jensen and Meckling). The results of these studies

underscore the importance of endogenizing credit capacity in the capital structure analysis of farm businesses (Barry and Ellinger).

Signaling also interacts with other dimensions of capital structure theory. Past econometric studies have concluded, for example, that the pecking order and trade-off (target or partial adjustment) theories contribute significantly and jointly to understanding the capital structure of corporate firms (Fama and French; Shyman-Sunder and Myers; Vogt). Barry, Bierlen, and Sotomayor (2000) observed that farm businesses may follow a pecking order in adjusting to changes in or deviations from long-run targets on capital structure. Myers (2003), who originated the pecking order theory in 1984, suggested that joint consideration of the pecking order and trade-off theories is insightful but may fall short of explaining innovations and advancements in corporate finance (e.g., convertible debt, options, and stock repurchases).

Signaling strategies should be considered together with the joint effects of the pecking order and trade-off theories to more completely reflect the capital structure effects. Joint consideration will combine the borrower's side of the financing transaction with the credit cost and capacity issues on the lender's side. The latter considers how the lender's evaluation of the borrower's credit capacity responds to changes in financial conditions, new investments, and other financial characteristics of farm businesses.

The goal of this study is to systematically examine the financial effects of signaling on the farm's credit capacity and investment conditions, while jointly considering the implications of the traditional trade-off and pecking order theories of capital structure. Joint consideration of these theories combines the borrower's capital structure decisions with the lender's determination of borrower's credit capacity, thus encompassing both sides in the lender-borrower relationship. Our method applies a simultaneous equation system to Illinois farm-level data. The results clearly support the hypothesized signaling results. That is, high-quality borrowers achieve greater credit capacity by providing lenders with

valid signals of their financial status, while adjusting toward target debt levels over time and following the pecking order relationship in the short run.

Farm Businesses and Capital Structure Theories

Farm businesses generally present a less complex setting for capital structure than do large corporate firms. Ownership and management are concentrated in one or a few individuals who may have family or community ties. Internal equity and debt are the major financing alternatives, while external equity and direct access to capital markets are beyond the reach of most farms. Nonetheless, capital intensity of farm businesses is high, production cycles can be lengthy and seasonal, life cycle effects are present, and rates of return on assets are relatively low and volatile.

Currently prevalent capital structure studies have primarily included the pecking order and trade-off theories. Originally developed by Myers (1984) and Myers and Majluf, the pecking order theory considers market imperfections in the form of asymmetric information between firms and capital markets about presently held assets and investment opportunities. Under the pecking order theory, firms use internal funds (e.g., free cash flow) first because they are less costly than external funds. When external funds are used, the sequence is debt followed by equity, reflecting the ordering of costs, although external equity (e.g., issuing shares) is seldom used. These ideas were formulated into testable hypotheses and confirmed by many studies, including Baskin, Hubbard, and Jensen, Solberg, and Zorn.

The trade-off theory predicts a target debt ratio that depends on the costs and benefits of financial leverage. Benefits of higher leverage include the tax deductibility of interest paid and the use of debt to indicate high-quality performance induced by managerial efforts to meet the financial obligations. Costs of higher leverage include the greater likelihood of liquidation and its associated costs, and agency costs due to borrowers' incentives to take actions that are detrimental to lenders. If

adjustment to a changing target is costly, the theory implies that a partial adjustment model is appropriate. Partial adjustments arise primarily because of market imperfections that prevent firms from fully adjusting when capital structure deviates from its target and, thus, prevent optimal funding of new investments. The optimal debt target is not observed directly and likely varies over time. Early tests of target models include Jalilvand and Harris and Taggart. Hovakimian, Opler, and Titman conducted a more extensive search for evidence of target-adjustment financing; they found that management acts to move the firm toward a target debt ratio, and the target depends on characteristics of the firm.

In agricultural capital markets, asymmetric information prevents lenders from completely distinguishing financial health among diverse farm borrowers. Although lenders tend to require similar types of information from borrowers, the quality, completeness, and extent of documentation they provide may vary widely. In addition, some lenders, especially the U.S. Farm Credit System, rely heavily on credit bureau scores and limited financial data for smaller loan sizes. Thus, good-quality farmers have incentives to convey their advantageous credit risk information to lenders through credible signals. Especially important is the information about key financial factors, such as profitability, repayment capacity, solvency, and liquidity. Effective use of risk management practices, marketing alternatives, and educational programs are other signaling examples, although their effects are more difficult to measure and evaluate (Miller et al.).

Signaling theory applied to finance was developed by several authors, including Diamond, Ross, and Spence. A credible signal can distinguish a high-quality firm from a low-quality firm, if the latter is unable to mimic the signal or finds it too costly to do so. Ross showed how debt could serve as a costly signal that separates different classes of firms. Signaling of higher debt by managers implies an optimistic earnings environment and evidence of a high-quality firm, while a low-quality firm would want to avoid discovery. Most of the conceptual work on signaling is in corporate finance, followed by a large body of application related to the use of signals by lenders to evaluate start-up firms, entrepreneurial research, and small business (Backes-Gellner and Werner; Levine and Hughes; Voordeckers and Steijvers). Shenoy and Koch tested the pecking order and signaling theories using past earnings and cash flow as the signals for corporate firms. They found significant evidence in support of both theories, although they did not consider the trade-off theory.

Conceptualizing and Empirical Modeling of Capital Structure Theories

Financing Costs Affect Farm Capital Structure

The characteristics of the signaling, pecking order, and trade-off theories summarized above can be conceptualized in terms of a model that reflects the weighted average cost of capital for a farm business. Each of the theories emphasizes different relationships among these costs, although their distinct effects can be modeled contemporaneously through alternative types and time dimensions of financial capital. Among these dimensions are debt versus equity capital, short- versus long-term debt, current versus noncurrent equity, and both the lender's and the borrower's contributions to the costs of debt capital.

Consider that the objective of farm business financing is to minimize the weighted average cost of debt and equity capital ($WACC$):

$$
\begin{aligned}
WACC = & \left(i_{CurEq}\right)\left(E_{CurEq}/A\right) \\
& + \left(i_{NCurEqu}\right)\left(E_{NCurEq}/A\right) \\
& + [\left(i_{SD}\right)\left(SD/A\right) \\
& + \left(i_{LD}\right)\left(LD/A\right)](1-t),
\end{aligned}
$$

(1)

with assumptions of

$$
\begin{aligned}
i_{CurEq} &< i_{SD} < i_{LD} < i_{NCurEq}, \\
i_{SD} &= i_{L\_SD} + i_{B\_SD}, \\
i_{LD} &= i_{L\_LD} + i_{B\_LD}, \\
i_{L\_LR} &< i_{L\_HR}.
\end{aligned}
$$

Variables E_{CurEq}/A, E_{NCurEq}/A, SD/A, and LD/A are the respective ratios of current equity, noncurrent equity, and short- and long-term debt to assets, with i_{CurEq}, i_{NCurEq}, i_{SD}, and i_{LD} as their corresponding financing costs. Here i_{L_SD}, i_{B_SD}, i_{L_LD}, and i_{B_LD} are short- and long-term debt components from lender's side and borrower's side, and i_{L_HR} and i_{L_LR} are the lender's interest rates for high- and low-risk borrowers.

Current equity is defined as current assets minus current liabilities, or the traditional measure of working capital. Included are the net cash flow from operations and investment, and the net changes in short- and long-term debt. Current assets also include liquid holdings of farm inventories and other financial assets. Noncurrent equity is the difference between noncurrent assets (e.g., machinery, land, and buildings) and noncurrent liabilities, mostly comprised of intermediate and long-term debt. Short-term debt should be paid off within one year while long-term debt is paid off over multiple years, thus experiencing the higher risk position.

Under the pecking order theory, the short-term financing cost relationship is dominated by $i_{CurEq} < i_{SD} < i_{LD}$, indicating that the cost of current equity (internal funds) is less than the cost of external debt capital. Internal funds likely have opportunity costs (e.g., debt repayment, nonfarm investment), but debt has the higher transaction costs. The result of these cost relationships is the pecking order preference in the short run for first using less costly internal funds until they are depleted or at minimum liquidity levels, and then considering external funds.

Over the long run, the financing cost relationship implied in the trade-off theory is primarily characterized by $i_{SD} < i_{LD} < i_{NCurEq}$, reflecting the tax shield of interest payments on debt and the higher risk position of the equity holder (i.e., lenders have first claim on the borrower's cash flow and asset values in the event of default and foreclosure). Moreover, the traditional view in finance theory is that the costs of both debt and equity will eventually increase as leverage increases because of greater financial risk for

both parties (Brealey, Franklin, and Myers). The result is a minimum weighted average cost of capital, at some level or range of leverage, which becomes the target level.

The signaling effect is reflected, in principle, through the credit risk assessment and loan pricing polices of the lender. By sending credible, unambiguous signals, lower-risk borrowers achieve lower credit risk premiums than higher-risk borrowers ($i_{L\_LR} < i_{L\_HR}$). Farm financing costs (i_{SD}, i_{LD}) are determined by both the lender and the borrower. The lender's component of debt costs (i_{L_SD}, i_{L_LD}) includes the cost of funds acquired from the financial market, administrative costs, and credit risk expressed as an anticipated loss rate. These components comprise the rate of interest on debt. The borrower's cost (i_{B_SD}, i_{B_LD}) of external funds, over and above the interest rate, includes less observable transaction and agency costs for relationship building, financial documentation, reporting requirements, communications time, potential loss of control through covenants attached to loan agreements, and uncertainties about contract performance.

All these elements of financing costs are not directly observable for the empirical analysis. Absent from the data source are explicit observations of costs of equity and interest rates on various types of debt. However, the effects of these costs on changes in levels of investment (INV) and types of financial capital will allow clear linkages between the conceptualization presented above and the econometric tests of the three theories. To show these relationships, consider a firm's accounting Statement of Cash Flows that is categorized in terms of its operating, investing, and financing activities, within a given accounting period. In summary form, this statement shows that total net cash flow is the sum of net cash flows from the operating (CF), investing (INV), and financing activities, where financing may be classified into the changes in short-term debt (SD) and long-term debt (LD). The contemporaneous and interactive effects of these activities can be expressed as a set of simultaneous dependencies among each of the variables, which are

designated as

(2.1) $CF = f(INV, SD, LD)$,

(2.2) $INV = f(CF, SD, LD)$,

(2.3) $SD = f(CF, INV, LD)$,

(2.4) $LD = f(CF, INV, SD)$.

That is, a farm's investment capital in Equation (2.2) is associated with the net cash flows from operations and changes in short- and long-term debt, and so on.

Conceptually, changes in the financing costs expressed in the weighted average cost of capital equation can be related to changes in the respective components of total net cash flow. Under the pecking order theory, for example, the effects in Equations (2.1) and (2.2) of lower costs of internal funds would be an increase in the use of internal funds (CF) and a reduction in use of debt (SD, LD) to finance investments (INV). In contrast, the cost relationships under the trade-off theory would result in an increased use of both internal funds and debt to finance new investments, thus maintaining the target level of leverage. Similarly, the cost effects of favorable signals should result in lower costs of debt capital and allow relatively greater debt use and larger investments. The empirical model to follow is based on joint modeling of the relationships in Equations (2.1)–(2.4), with additional refinements to accommodate data availability, the partial adjustment process, structuring of alternative types of debt, the specific signaling instruments, and other specifications for estimating a system of equations.

Empirical Modeling

Based on previous studies and the conceptual discussion, we develop a simultaneous equation system composed of cash flow, investment, short-term debt, and long-term debt equations to systematically investigate whether signaling theory works well with the pecking order and trade-off theories, and jointly apply to farm businesses. The formulation follows that of other finance studies (Barry, Bierlen, and Sotomayor; Shenoy and Koch), in which an investment equation interacts with financial equations for cash flow and debt to motivate the respective relationships among the variables and to drive the need for capital structure decisions. The simultaneous equations are as follows:

$$
\begin{aligned}
CF_t = {}& a_0 + a_1 SD_t + a_2 SD_{t-1} \\
& + a_3 LD_t + a_4 LD_{t-1} \\
& + a_5 INV_t + a_6 INV_{t-1} \\
& + a_7 ROA_t + a_8 ROA_{t-1} \\
& + a_9 FM + a_{10} YR + \varepsilon_{1t},
\end{aligned}
\tag{3.1}
$$

$$
\begin{aligned}
INV_t = {}& b_0 + b_1 SD_t + b_2 SD_{t-1} \\
& + b_3 LD_t + b_4 LD_{t-1} \\
& + b_5 CF_t + b_6 CF_{t-1} \\
& + b_7 ROA_t + b_8 ROA_{t-1} \\
& + b_9 FM + b_{10} YR + \varepsilon_{2t},
\end{aligned}
\tag{3.2}
$$

$$
\begin{aligned}
SD_t = {}& c_0 + c_1 CF_t + c_2 CF_{t-1} \\
& + c_3 INV_t + c_4 INV_{t-1} \\
& + c_5 ROA_t + c_6 ROA_{t-1} \\
& + c_7 LD_t + c_8 \left(SD_t^* - SSD_{t-1} \right) \\
& + c_9 FM + c_{10} YR + \varepsilon_{3t},
\end{aligned}
\tag{3.3}
$$

$$
\begin{aligned}
LD_t = {}& d_0 + d_1 CF_t + d_2 CF_{t-1} \\
& + d_3 INV_t + d_4 INV_{t-1} \\
& + d_5 ROA_t + d_6 ROA_{t-1} \\
& + d_7 SD_t + d_8 \left(LD_t^* - SLD_{t-1} \right) \\
& + d_9 FM + d_{10} YR + \varepsilon_{4t},
\end{aligned}
\tag{3.4}
$$

where CF_t is the cash flow at time t, and CF_{t-1} is lagged cash flow, and SD_t, LD_t, and INV_t represent net short-term debt, long-term debt, and investment in year t, respectively. Short- and long-term debt are measured as the difference between the end- and beginning-of-year stock variables to obtain flow measures of each year's financial performance. ROA_t is farm's return on assets, SD_t^* and LD_t^* are the targets of short- and long-term debt levels, and SSD_{t-1} and SLD_{t-1} are stock variables of short- and long-term debt from the previous period. Therefore, $(SD_t^* - SSD_{t-1})$ and $(LD_t^* - SLD_{t-1})$ mea-

sure the deviations of short- and long-term debt from their targets. *FM* and *YR* represent farm-specific and year dummies, respectively. In this equation system, variables are divided by total farm assets at the beginning of the year, with the exception of *ROA*, *FM*, and *YR*.

Following Vogt, target financial ratios can be separated into two components: one that varies with time (due to changing interest rates or lack of information about inflation rates) and another that varies cross-sectionally (due to industry and firm-level influences). Information about the true target ratios will be captured by the dummy variables for year and farm and thus are reflected in their contributions to the constant term of each equation. Error terms are assumed to be independent, identically distributed random variables with mean of zero, variance $\text{var}(\varepsilon_{it}) = \sigma_i^2$, covariances $\text{cov}(\varepsilon_{it}, \varepsilon_{it-1}) = 0$ and $\text{cov}(\varepsilon_{it}, \varepsilon_{jt}) \neq 0$ for $i, j = 1, 2, 3, 4$.

A farm's cash flow is the total net cash provided by farm operations and investing activities (excluding debt transactions). Because investment funds are derived partially from internally generated cash flow, we consider the net cash provided by both types of activities in order to match the implication by the pecking order theory. Net cash from operating activities is calculated as the sum of farm operating receipts and net nonfarm income, less cash paid for operating expenses, interest, market livestock and feed, family living, and income and self-employment taxes. Net cash from investing activities is the cash generated by the sale of breeding livestock, machinery, equipment, buildings, securities, and real estate and investment/fund transfers, less cash paid for the purchase of breeding livestock, machinery, equipment, buildings, securities, and real estate and investment/fund transfers.

Short-term debt is current liabilities, which include short-term operating notes, commodity credit corporation loans, feed accounts payable, lease payments, accounts payable with merchants and dealers, estimated accrued tax liabilities, accrued interest, and principal due within 12 months for intermediate and long-term notes. Long-term debt includes

intermediate and long-term liabilities. Intermediate liabilities include intermediate notes and life insurance policy loans, while long-term liabilities include real estate mortgages and contracts. Investment (*INV*) is mainly composed of two parts: (1) machinery and building purchases and (2) land purchase and improvements, since these activities are the main types of investment expenditures for the crop farms in our study. Return on assets (*ROA*) is measured by the net return on the market value of assets.

The Applicability of the Pecking Order and Trade-off Theories for Farm Businesses

An important econometric issue arises because the pecking order theory considers a financing deficit to be exogenous, and financing with debt is more expensive than using internal cash flow. Cash flow, short-term debt, and long-term debt simultaneously affect each other and are influenced by the investment. Farms encountering a good investment opportunity will first draw from their internal cash flow, followed by debt, to finance projects. Thus, the contemporaneous relationship at time t between cash flow (CF_t) and leverage (SD_t, LD_t) would yield the evidence of pecking order behavior. Negative contemporaneous relationships between cash flow and short- and long-term debt imply a higher level of borrowing when internal cash flow is lower, and less borrowing with a higher internal cash flow. Furthermore, we expect a larger impact on cash flow variables from short-term debt (SD_t) than from long-term debt (LD_t) unless long-term investment conditions are highly favorable. These contemporaneous relationships are expressed in the cash flow, short-term debt, and long-term debt equations.

In a more complex version of the pecking order theory, Myers (1984) stated that firms are concerned with both current and future financing costs. Balancing these costs, firms that anticipate large future investment will maintain low-risk debt capacity in order to avoid foregoing future investments or financing them with new risky securities. Thus, controlling for other effects, firms with larger expected invest-

ment may have lower current leverage. We incorporate this idea into the investment equation by observing the relationship between investments (INV_t), lagged short-term debt (SD_{t-1}), and lagged long-term debt (LD_{t-1}). A negative dynamic relationship suggests that farms will keep short- and long-term debt levels lower in the current time period in order to avoid larger financing costs in the future.

Trade-off studies in corporate finance focus on the trade-off between actual capital structure and their corresponding target levels for long-term debt, short-term debt, new equity, and dividends. Our study extends the trade-off theory in two ways. First, we examine the "exogenous adjustment," which implies a partial adjustment of short- and long-term debt to their respective target levels ($SD^* - SSD_{t-1}$ and $LD^* - SLD_{t-1}$). The target level is generally determined by exogenous factors, such as interest rate, business size, and market situation (Jalilvand and Harris). We test for exogenous adjustment by observing the debt deviation variables: if, in the previous time period, farmers borrow less than the target levels, they may increase their debt in the following period, allowing them to benefit from paying lower taxes. Positive dynamic relationships between SD_t and SSD_{t-1}, and between LD_t and SLD_{t-1}, are expected in the short- and long-term debt equations, respectively.

Our second extension of the trade-off theory is an "endogenous trade-off." Because the structure of debt is as important as the level of debt to farm businesses, the internal balance between short-term debt (SD_t) and long-term debt (LD_t) must be considered. The endogenous trade-off predicts a negative simultaneous relationship between short- and long-term debt, with an appropriate debt structure not only lowering the borrowing cost but also increasing farm financial strength, such as its liquidity.

Adding Signaling Theory in the Lender-Borrower Relationships

High-quality farms have an incentive to send credible signals of their strong financial strength and effective risk management to convince potential lenders of their high quality. We test whether two distinct attributes of financial performance—farm profitability (return on assets) and cash flow—can be used as signals for differences in their credit risks. Sustained profitability encourages farmers to make further investments to expand their operations or to adopt advanced technology. These large capital expenditures will induce a financial deficit that cannot be satisfied by internal cash flow (CF_t, which is composed of CF_{t-1} and other temporary income in year t) alone. The financial deficit would be met by external debts (SD_t, LD_t), which implies a simultaneous negative relationship between cash flow (CF_t) and debt (SD_t, LD_t) in the pecking order theory. Meanwhile, lagged cash flow and profitability (CF_{t-1}, ROA_{t-1}) can be financial signals that high-quality borrowers send to lenders, thus helping them to access loans. This signaling process would be represented by positive dynamic relationships between lagged cash flow and profitability (CF_{t-1}, ROA_{t-1}) and debt (SD_t, LD_t).

Similar arguments hold for the investment and cash flow equations. Lenders make their lending decisions by distinguishing borrowers based on the signals of lagged farm profitability and lagged cash flow. Since many farms rely on external capital for their investment activities, a positive dynamic interaction between lagged return on assets (ROA_{t-1}) and current investment (INV_t) in the investment equation implies that profitability is a valid signal that enables borrowers to gain access to debts and therefore make further investments. In addition, subsequent income generated by investments would result in a positive relationship between lagged farm profitability (ROA_{t-1}) and cash flow (CF_t) in the cash flow equation.

Table 1 summarizes the variables representing the signaling, pecking order and trade-off implications and lists the expected signs for these variables.

Data and Method

The empirical analysis utilizes data from the Illinois Farm Business Farm Management

Table 1. Variables and Expected Signs for Theory Testing

Pecking Order	Cash Flow	Investment	Short-Term Debt	Long-Term Debt
Theory	SD_t $(a_1 < 0)$; LD_t $(a_3 < 0)$ and $|a_1| > |a_3|$ The simple version of the pecking order theory: short- and long-term debt should have simultaneous negative relationships with cash flow. Furthermore, short-term debt would have greater impacts on cash flow than long-term debt.	SD_{t-1} $(b_2 < 0)$ LD_{t-1} $(b_4 < 0)$ The complex version of the pecking order theory: when farms predict a good investment opportunity, they would keep lower short- and long-term debt levels in current period to avoid larger financing costs in the future.	CF_t $(c_1 < 0)$ Cash flow would have a simultaneous negative relationship with short-term debt.	CF_t $(d_1 < 0)$ Cash flow would have a simultaneous negative relationship with long-term debt.
Signaling theory	ROA_{t-1} $(a_8 > 0)$ Farm's previous profitability can be a valid signal to facilitate investment and bring more income into the later periods.	ROA_{t-1} $(b_8 > 0)$	CF_{t-1} $(c_2 > 0)$ ROA_{t-1} $(c_6 > 0)$ Previous cash flow (CF_{t-1}) and profitability (ROA_{t-1}) are used as signals to facilitate debt financing.	CF_{t-1} $(d_2 > 0)$ ROA_{t-1} $(d_6 > 0)$
		Exogenous adjustment:	$(SD^* - SSD_{t-1})$ $(c_8 > 0)$ If farms currently borrow less relative to their targeted debt levels, they may borrow more in the next period.	$(LD^* - SLD_{t-1})$ $(d_8 > 0)$
Trade-off theory		Endogenous trade-off:	LD_t $(c_7 < 0)$ Farms trade-off their short-term debt and long-term debt internally to maintain an appropriate debt structure.	SD_t $(d_7 < 0)$

Table 2. Descriptive Statistics for All Farm Businesses

Variable	Mean	Std. Dev.	Observations
Total assets ($)	1,253,716	1,018,202	18,603
Debt-to-asset ratio	0.31	0.23	18,603
Return on assets (%)	4.33	7.86	18,603
Age of operator	51	11	18,603
Net cash flow ($)	−9,945	94,896	18,603
Net short-term debt ($)	5,743	55,602	18,603
Net long-term debt ($)	9,191	77,514	18,603
Total investment ($)	32,511	46,261	18,603

Notes: Net short- and long-term debt are measured as the difference between the end- and beginning-of-year stock variables to obtain flow measures of each year's financial performance, and dollar amounts are in current dollars.

Association (FBFM). The sample contains crop farms from the years 1997 through 2006 with at least two years of continuous operation during that period. Farm labors are generally farmers themselves, supplemented by a few months of seasonal hired labor. The land composition is generally 20% of owned and 80% of leased farmland. Following Ellinger et al., we include farms with asset values of at least $40,000 or annual gross farm income of least $40,000 in order to focus the analysis on commercial scale farms. As shown in Table 2, the farms in our sample average over $1.25 million in assets with an average debt-to-asset ratio of 0.31 and show considerable variation in net cash flow and levels of debt. Corn and soybeans are the major crops, usually grown in about equal proportions.

In the simultaneous equation system, the dependent variables cash flow (CF_t), investment (INV_t), short-term debt (SD_t), and long-term debt (LD_t) are contemporaneously and endogenously determined by each other in each time period. Prior to the estimation, we must ensure that the equation system is identifiable. The dynamic model has sets of predetermined variables, such as lagged cash flow (CF_{t-1}), lagged leverage (SD_{t-1}, LD_{t-1}), and lagged investment (INV_{t-1}). Though these variables themselves are not exogenous, they are predetermined with respect to current values of endogenous variables; therefore, they can be considered exogenous. We also assume that a farm's return on assets (ROA_t) is exogenously determined by industry characteristics, and that year- and farm-specific characteristics are exogenous and independent

of the disturbances in the system. Dummy variables for farm characteristics and time period are used to control for farm- and time-specific variations in the data. Lagged stock short-term debt (SSD_{t-1}) and lagged stock long-term debt (SLD_{t-1}) are predetermined in period t. These exogenous variables and the lagged endogenous variables are used to obtain instrumental variables. The equation system also satisfies the necessary identification condition: the number of predetermined variables excluded from the system is at least as great as the number of endogenous variables included less 1. All endogenous variables can be identified within the equation system.

The three-stage-least-squares (3SLS) approach is employed to estimate the parameters; this method enables us to overcome the endogeneity problems in the estimation process and improve the efficiency of parameter estimates by taking advantage of potential cross-equation correlation in the residuals. In the first stage, each of the endogenous variables is regressed on all exogenous and predetermined variables to obtain the fitted values for the endogenous variables; the second stage least-squares step yields residuals to estimate the cross-equation correlation matrix; and the final 3SLS step provides the estimates.

Empirical Results

Aggregate Estimation

Table 3 presents the results of the 3SLS estimation for all sample farms. These results

Table 3. 3SLS Simultaneous System Estimation for All Farms

Variables	Cash Flow	Investment	Short-Term Debt	Long-Term Debt
Cash flow (CF_t)		−1.1166*** (0.1487)	−1.0749*** (0.0830)	−0.3564*** (0.1072)
Lagged cash flow (CF_{t-1})		−0.0369 (0.0288)	0.0829*** (0.0154)	0.0351** (0.0184)
Short-term debt (SD_t)	−0.4738*** (0.0840)	−0.3069** (0.1434)		−0.5313*** (0.0604)
Lagged short-term debt (SD_{t-1})	−0.0185 (0.0144)	−0.0210 (0.0297)		
Long-term debt (LD_t)	−0.4684*** (0.0840)	−0.2809* (0.1489)	−0.8764*** (0.0586)	
Lagged long-term debt (LD_{t-1})	−0.0481*** (0.0113)	−0.0623*** (0.0243)		
Investment (INV_t)	−0.6610*** (0.0578)		−0.1222 (0.0891)	0.2268** (0.0907)
Lagged investment (INV_{t-1})	0.0344** (0.0177)		0.0730** (0.0251)	0.0541** (0.0255)
Return on assets (ROA_t)	−0.00003 (0.0002)	−0.0002 (0.0003)	0.0003*** (0.0001)	0.0001 (0.0001)
Lagged return on assets (ROA_{t-1})	0.0038*** (0.0003)	0.0049*** (0.0005)	0.0031*** (0.0003)	0.0009** (0.0003)
Stock short-term debt (SSD_{t-1})			0.0322*** (0.0044)	
Stock long-term debt (SLD_{t-1})				0.0464*** (0.0059)
Adjusted R^2	0.4677	0.1484	0.2661	0.4202
Farm observations	18,603	18,603	18,603	18,603
F-value	1,130.36	225.00	467.03	932.44

Notes: Standard deviations are in parentheses. *F*-values are from single equation estimations.
*, **, *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

provide strong evidence that the signaling theory presents another important dimension in studying the agricultural lender-borrower relationship and farm capital structure. The parameter estimates for the signaling effects indicate that farm businesses employ financial signals, such as previous cash flow and profitability (CF_{t-1}, ROA_{t-1}) to expand their credit capacity. Since farm investment is generally large and cannot be carried out solely by internal cash flow, the resulting financial deficit is met by borrowing an amount equal or above total investment expenditure less the cash flow from the current year. As the pecking order theory predicts, debt (SD_t, LD_t) and cash flow (CF_t) exhibit a simultaneously negative relationship.

As predicted, lagged cash income and profitability are valid signals for lenders to assess a borrower's credit ability during his debt application. Farms with credible signals in terms of these variables will have access to greater credit in the following year. Thus, lagged cash flow and profitability (CF_{t-1}, ROA_{t-1}) should have positive dynamic relationships with debt variables (SD_t, LD_t). In the short-term debt equation, the positive coefficients on lagged cash flow and lagged return on assets are consistent with the signaling theory: when borrowing is competitive in the capital market, high-quality farms tend to present valid evidence to lenders about their low credit risk and obtain greater loans. A higher return on assets (ROA_{t-1}) in the previous year promotes farms to increase their investment (INV_t) in the following year, which shows a coefficient of 0.0049 in the investment equation. Past profitability also results in an increased cash flow, represented in the cash flow equation by a dynamic relationship between the lagged return on assets (ROA_{t-1}) and the current period cash flow (CF_t).

The negative "endogenous trade-off" coefficients of long-term debt (LD_t) in the short-term debt equation and of short-term debt (SD_t) in the long-term debt equation indicate that farms balance different debt maturities, trying to maintain an appropriate debt structure. To examine a farm's "exogenous adjustment" performance, the positive significant coefficients for stock short-term debt and stock long-term debt (SSD_{t-1}, SLD_{t-1}) demonstrate that farms partially adjust their debt levels to prevent large deviations from target leverage ratios.

Furthermore, the negative coefficients for short- and long-term debt (SD_t, LD_t) in the cash flow equation support the simple version of the pecking order theory. A farm that generates more cash flow would borrow less, because using debt is more costly than employing internal equity as a source of financing. Similarly, short-term debt is slightly preferred to long-term debt due to its lower borrowing costs. This relationship is illustrated by comparing the absolute values of the coefficients for short-term debt (-0.4738) and long-term debt (-0.4684) in the cash flow equation. Therefore, short-term debt has a slightly greater impact on cash flow than long-term debt. We also try to explore Myers's complex version of the pecking order theory in the investment equation. Myers suggests that, in order to avoid larger financing costs for future projects, farmers keep lower current leverage levels, thus implying a dynamic negative relationship between investment (INV_t) at time t and short- and long-term debt (SD_{t-1}, LD_{t-1}) at time $t-1$. The regression results support such arguments for the long-term debt, but the coefficient for the short-term debt is not significant.

Group Estimation

All farms are disaggregated into age and credit risk groups in order to further explore how the signaling theory as well as the pecking order and trade-off theories apply to different types of farms. The group approach is used instead of entering variables directly for age in order to sharpen the differences between the farms and to observe the effects on other simultaneous relationships among the variables. We first define the youngest one third of farm observations (under age 46) over the time period as "young farmers" and the older one third (over age 55) as "old farmers." Barry, Bierlen, and Sotomayor argued that "old farmers should be less financially constrained

than young farmers because they may have longer relationships with lenders, greater equity accumulations, and generally stronger financial measures." Their results indicated that young farmers adhere more strongly to the pecking order theory than do old farmers. We hypothesize that old farmers tend to operate high-quality farms that generate more cash flow and higher profitability. In the presence of asymmetric information and a competitive capital market, old farmers would therefore have greater capacities to send financial signals that enable them to acquire more debt.

Based on the analysis described above, we reestimate the model with the two age groups considered separately. Table 4 shows the econometric results. Consistent with Barry, Bierlen, and Sotomayor's study, our estimates show those young farmers follow the pecking order theory more closely than old farmers. This relationship is indicated by the negative significant coefficients on short- and long-term debt for young farmers in the cash flow equation, while the long-term debt coefficient is insignificant for old farmers.

Signaling function would help good quality farms to more easily access debt. Our results imply that old farmers employ previous cash flow and profitability as financing signals to expand their debt. In contrast, young farmers may only depend on previous profitability and cash flow to persuade lenders for short-term loans: those financial indexes are less convincing for them to get long-term debt. This is indicated by the insignificant coefficients of lagged cash flow in the young farmers' long-term debt equation, whereas these coefficients are significant for old farmers. The positive relationships between debt variables and signaling instruments for old farmers suggest that previous cash flow and profitability are valid signals to facilitate their debt application.

The endogenous trade-off variables indicate that old farmers, depending on their longer farming experience, could more quickly regulate their short- and long-term debt internally to reach an appropriate debt structure. This conclusion draws from the signifi-

cant larger absolute coefficients in the short-term debt (-0.7455) and long-term debt (-0.5653) equations from old farmers. In addition, old farmers follow the trade-off theory in adjusting both short- and long-term debt toward their target levels. In contrast, young farmers show significant adjustment only toward the target for long-term debt.

The credit scoring model considers financial ratios recommended by the Farm Financial Standards Council, which represent a farm's solvency, repayment capacity, profitability, liquidity, and financial efficiency. Solvency and repayment capacity are weighted more heavily than the other variables. Each farm is assigned a calculated credit score and is classified into one of the five rating classes (from class 1 to class 5), with a lower credit class implying a better financial situation for the farm. We combine farms ranked into classes 1 and 2 into a low credit risk group due to their similar financial characteristics, while those in classes 4 and 5 are included in the high credit risk group. Middle class 3 is omitted to obtain greater differences in the credit risk groups. Reclassification occurs annually.

The results from estimating the two credit risk groups are presented in Table 5, which indicates that farms in a strong financial position have greater access to credit than farms in a poor financial situation. This is reflected in the positive dynamic coefficients for lagged cash flow and profitability (CF_{t-1}, ROA_{t-1}) in the debt equations for low credit risk farms (except for ROA_t in long-term debt) and in the insignificance of these relationships for the high credit risk farms. Effective signaling in the borrower-lender relationship enables low credit risk farms to be more financially flexible than those farms with higher credit risk, as evidenced by significant coefficients of previous cash flow (CF_{t-1}) in both debt equations, and past return on assets (ROA_{t-1}) in the short-term debt equation for low credit risk farms. In contrast, none of those coefficients indicate significant signs for high credit risk farms.

Finally, the credit group study reveals that only low credit risk farms follow the simple

Table 4. 3SLS Simultaneous System Estimation for Age Groups

Variables	Young Farmers				Old Farmers			
	Cash Flow	Investment	Short-Term Debt	Long-Term Debt	Cash Flow	Investment	Short-Term Debt	Long-Term Debt
Cash flow (CF_t)		0.7868***	−0.8537***	−0.0869		−0.7494**	−0.5345***	−0.6149***
		(0.1287)	(0.0590)	(0.2474)		(0.2521)	(0.1360)	(0.1217)
Lagged cash flow (CF_{t-1})		−0.1233**	0.0886***	0.0118		0.0076	0.0538**	0.0884***
		(0.0394)	(0.0178)	(0.0559)		(0.0452)	(0.0220)	(0.0184)
Short-term debt (SD_t)	−1.5936***	0.8088***		−0.2915	−0.2571*	−0.2858**		−0.5653***
	(0.1586)	(0.1215)		(0.2179)	(0.1574)	(0.1197)		(0.0692)
Lagged short-term debt (SD_{t-1})	−0.0943**	−0.0415			−0.0160	−0.0296		
	(0.0326)	(0.0321)			(0.0331)	(0.0405)		
Long-term debt (LD_t)	−0.7908***	0.6187***	−0.6785***		−0.1036	−0.1452	−0.7455***	
	(0.1326)	(0.1009)	(0.0793)		(0.1713)	(0.1422)	(0.0753)	
Lagged long-term debt (LD_{t-1})	−0.0681***	−0.0367**			0.0302	0.0218		
	(0.0195)	(0.0212)			(0.0400)	(0.0430)		
Investment (INV_t)	1.1564***		0.8359***	0.2242	−0.9642***		−0.1176	−0.2523*
	(0.2531)		(0.1220)	(0.2771)	(0.1746)		(0.1661)	(0.1509)
Lagged investment (INV_{t-1})	0.0316		0.0274	0.0271	−0.0251		0.0776**	0.0657
	(0.0593)		(0.0267)	(0.0705)	(0.0570)		(0.0476)	(0.0450)
Return on assets (ROA_t)	0.0018***	−0.0011***	0.0013***	−0.0003	0.0014***	0.0011**	0.0009***	0.0011***
	(0.0003)	(0.0002)	(0.0002)	(0.0005)	(0.0002)	(0.0004)	(0.0003)	(0.0002)
Lagged ROA (ROA_{t-1})	0.0006**	−0.0001	0.0003**	0.0002	0.0002	0.0004	0.0004**	0.0001
	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
Stock short-term debt (SSD_{t-1})			−0.0056				0.0672***	
			(0.0050)				(0.0080)	
Stock long-term debt (SLD_{t-1})				0.0868***				0.0513***
				(0.0242)				(0.0066)
Adjusted R^2	0.5189	0.1506	0.2670	0.4639	0.3351	0.0847	0.2339	0.3034
Farm observations	6,510	6,510	6,510	6,510	7,016	7,016	7,016	7,016
F-value	455.12	75.66	154.39	365.29	252.84	47.27	153.55	218.67

Notes: Standard deviations are in parentheses. *F*-values are from single equation estimations.
*, **, *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

Table 5. 3SLS Simultaneous System Estimation for Credit Risk Groups

Variables	Low Credit Risk Farms				High Credit Risk Farms			
	Cash Flow	Investment	Short-Term Debt	Long-Term Debt	Cash Flow	Investment	Short-Term Debt	Long-Term Debt
Cash flow (CF_t)		-0.2090**	-0.4785***	-0.2950***		0.4915***	-0.9080***	-0.8179***
		(0.0859)	(0.0315)	(0.0461)		(0.1198)	(0.1319)	(0.0997)
Lagged cash flow (CF_{t-1})		0.1315**	0.0643***	0.0380**		-0.0298**	0.0064	0.0130
		(0.0582)	(0.0117)	(0.0166)		(0.0160)	(0.0259)	(0.0189)
Short-term debt (SD_t)	-1.8538***	0.2888		-0.6401***	-0.7533***	0.3312***		-0.6295***
	(0.1963)	(0.1824)		(0.0945)	(0.0748)	(0.0915)		(0.0800)
Lagged short-term debt (SD_{t-1})	-0.1125***	0.0549			-0.0293	-0.0150		
	(0.0345)	(0.0471)			(0.0222)	(0.0174)		
Long-term debt (LD_t)	-1.6247***	0.3420**	-0.5879***		-0.8728***	0.5212***	-0.9418***	
	(0.2006)	(0.1815)	(0.0799)		(0.0738)	(0.1083)	(0.1021)	
Lagged long-term debt (LD_{t-1})	-0.2879***	0.2980**			-0.0375**	0.0046		
	(0.0532)	(0.1021)			(0.0231)	(0.0158)		
Investment (INV_t)	-0.4258**		0.0808	0.4047***	0.1276		1.3040***	0.4613**
	(0.1899)		(0.0809)	(0.1040)	(0.2385)		(0.2932)	(0.1967)
Lagged investment (INV_{t-1})	0.1733**		0.0352	-0.008	0.1751		-0.0809	0.0638
	(0.0562)		(0.0227)	(0.0283)	(0.1582)		(0.1671)	(0.1333)
Return on assets (ROA_t)	0.0021***	0.0021***	0.0009**	0.0001	-0.0009	0.0009**	-0.0008	-0.0003
	(0.0006)	(0.0004)	(0.0003)	(0.0003)	(0.0005)	(0.0004)	(0.0006)	(0.0005)
Lagged ROA (ROA_{t-1})	0.0012***	-0.0002	0.0004**	0.0001	0.0002	0.0004**	-0.00004	-0.0002
	(0.0003)	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0002)
Stock short-term debt (SSD_{t-1})			0.0407***				0.0458***	
			(0.0093)				(0.0141)	
Stock long-term debt (SLD_{t-1})				0.0400***				0.0324**
				(0.0078)				(0.0104)
Adjusted R^2	0.3914	0.1179	0.2406	0.3212	0.5862	0.2047	0.4007	0.5380
Farm observations	7,537	7,537	7,537	7,537	7,143	7,143	7,143	7,143
F-value	330.32	69.44	163.24	243.29	716.23	130.91	338.52	588.93

Notes: Standard deviations are in parentheses. F-values are from single equation estimations.
*, **, *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

version of the pecking order theory, where their short-term debt has a greater impact on cash flow than does long-term debt. High credit risk farm financing does not completely follow the pecking order theory, as evidenced by a larger long-term debt effect on cash flow than that of short-term debt. This result could occur because high credit risk farms generate less cash income in the short run and experience greater financial burdens from repayment of long-term debt than do low credit risk farms.

Conclusions

This study has conceptualized and tested the joint effects of the signaling, pecking order, and trade-off theories on farm capital structure. Regression results from the aggregate estimation confirm that, under asymmetric information, effective signaling behavior in the lender-borrower relationship works well with the pecking order and trade-off theories to influence farm capital structure. The most robust findings are that farm businesses tend to employ previous cash flow and profitability as financial signals to expand their credit capacity in the competitive capital markets. The simple version of Myers's (1984) pecking order theory is confirmed by our study. The empirical results indicate that farm businesses adjust their leverage ratios over time according to exogenous economic conditions as well as farms' endogenous capital structures.

The age group investigation suggests that old farmers, generally in a strong financial position, send effective financial signals to facilitate their access to debt. Young farmers more strongly follow the pecking order theory in their financing process. The trade-off theory results indicate old farmers are more experienced in balancing short- and long-term debt internally, while young farmers have less flexibility to adjust to their external debt targets as well as internally balance their debt structure. The credit risk group comparison shows that low credit risk farms can better signal to lenders about their advantageous financial positions.

The insights gained from exploring the signaling theory concurrently with the pecking order and the trade-off theories benefit both parties in the agricultural credit relationship. The signaling effects encourage high quality agricultural borrowers to send credible signals to facilitate their farm loans. Since past financial performance, such as profitability and cash flow measure, is considered as a valid signal, it promotes farm operators to keep organized financial reports and otherwise improve farm financial management. The lenders, on one hand, could effectively identify borrowers' credit risk through credible signals. On the other hand, the demonstration of the coexistence of the signaling, pecking order, and trade-off theories in farm businesses enables lenders to better understand the farm financing patterns in the short run as well as in the long run.

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