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TESTING FOR THE PRESENCE OF FINANCIAL CONSTRAINTS IN AGRICULTURAL COOPERATIVES

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Abstract: In this paper, we address the issue of financial constraints in agricultural cooperatives. We estimate an augmented Q investment model for a large sample of US agricultural cooperatives and test whether cooperative investment is sensitive to cash flow. Empirical results suggest that agricultural cooperatives are indeed financially constrained when making investment decisions.

Testing for the Presence of Financial Constraints in Agricultural Cooperatives

Fabio R. Chaddad and Michael L. Cook

1. Introduction

Historically agricultural cooperatives have played an important economic role in market economies as indicated by their substantial asset ownership, turnover, and market share in the US and Western Europe (van Bekkum and van Dijk, 1997; USDA, 2000). However, the traditional cooperative structure faces growing survival challenges as it appears to be constrained in its ability to acquire risk capital at the same time food system participants are affected by the industrialization of agriculture (Cook and Chaddad, 2000).[1] An increasing number of scholars deal with the challenges and opportunities faced by agricultural cooperatives in light of agricultural industrialization. Given the rapid pace of structural change, some authors predict the demise of the traditional cooperative structure. It is commonly argued that factors related to the characteristics of traditional cooperative ownership, capitalization, management, and governance might limit its ability to adjust during transition periods (Hansmann, 1999; Holmstrom, 1999). In particular, financial constraints resulting from restricted residual claims and imperfect access to external sources of finance are considered the "Achilles' heel" of traditional cooperatives in an increasingly concentrated and tightly coordinated food system.

The purpose of this study is to empirically test the cooperative capital constraint hypothesis. In order to do so, financial data is collected from a large sample of US agricultural cooperatives comprising the years 1991 to 2000. The study examines whether agricultural cooperatives' investment is constrained by the availability of finance with panel data econometric techniques. In order to directly test the cooperative capital constraint hypothesis a

[1] In this study, a traditional cooperative is defined as having the following organizational attributes: open membership, democratic control (i.e., one member, one vote), non-transferable residual claims, internally generated equity capital, and benefits to members tied to usage.

reduced-form investment model is estimated for the full cooperative sample.[2] In this model, investment demand is measured by Marginal q, i.e., the expected present value of future profits from additional investment (Hayashi, 1982). Since Marginal q is unobservable, a proxy variable constructed from estimates of a vector autoregression (VAR) procedure is utilized. This technique is known in the investment literature as "Fundamental q" since firm fundamentals – such as current and lagged values of profits and sales – are used to predict future profitability of capital (Gilchrist and Himmelberg, 1995). Fundamental q is a particularly useful technique because it enables the estimation of investment models for firms with restricted, non-transferable residual claims for which Tobin's Average q – a commonly used proxy for Marginal q – cannot be computed. In addition to Marginal q, the investment equation estimated in this study includes cash flow in the set of explanatory variables. After controlling for investment demand, a positive and significant cash flow parameter is interpreted as evidence of financial constraints (Fazzari, Hubbard and Petersen, 1988). In other words, financially constrained firms only invest when they generate sufficient risk capital from operations. In contrast, firms that are not financially constrained are able to acquire risk capital from external sources and, consequently, their capital spending is less sensitive to internal finance. Therefore, if investment is not sensitive to cash flow, the financial constraint hypothesis is rejected.

To accomplish this objective, the paper proceeds as follows. In the following section, we present a review of the investment literature and develop the specification of the reduced-form Q investment model. Additionally, we argue that an augmented Q model with a cash flow variable can be estimated to test financial constraints in cooperatives and discuss theoretical arguments in support of the cooperative capital constraint hypothesis. In section 3, the empirical literature addressing financial constraints in agricultural cooperatives is critiqued. Section 4 describes the cooperative panel data set and the empirical procedures adopted in this study. In section 5 the cooperative investment equation is estimated by fixed effects (OLS), random

[2] In future studies, the authors will explore the cross-sectional heterogeneity in the data set in order to analyze the effects of cooperative types on investment behavior.

effects (GLS), and generalized method of moments (GMM) estimators. Subsequently empirical results are presented and discussed for the entire sample. The last section includes a summary of the paper and concluding remarks.

2. The Investment Literature

The purpose of this section is to review the investment literature and present the necessary theoretical concepts supporting the empirical analysis of the cooperative capital constraint hypothesis. The discussion focuses on the Q theory of investment and its subsequent extensions, including the effects of capital constraints in the model. According to the Q theory of investment, firm investment opportunities are summarized by the market value of its capital stock. In particular, firm investment expenditures are positively related to Average q – also known as Tobin's q – defined as the ratio of the financial value of the firm (V_t) to the replacement cost of its existing capital stock,

$$Q_t^A = V_t / p_t K_t \qquad (1),$$

where p_t is the relative price of investment goods to the price of output and K_t is the capital stock at time t.

Subsequent theoretical work shows that the adjustment cost technology and firm value maximizing behavior lead to a positive correlation between investment and Marginal q. Marginal q is defined as the expected present value of future profits from additional investment – that is, the "shadow price" of capital. Adjustment costs are introduced by Eisner and Strotz (1963) representing "lost output from disruptions to the existing production process […], additional labor for bolting-down new capital, or a wedge between the quantities of purchased and installed capital" (Chirinko, 1993, p. 1885).

It is now appropriate to derive a benchmark Q investment model from the firm's optimization problem. This benchmark estimable investment equation is subsequently expanded with the introduction of financial constraints and serves as the theoretical underpinning of the empirical procedures presented in the following section. Let profits for firm i at any time t (Π_{it}) be determined by its capital stock (K_{it}) and an stochastic variable (σ_{it}), assuming all other production inputs are "maximized out" in that they are already utilized at their optimum levels. Assume further that capital is the only quasi-fixed input as net increments to the firm's capital stock are subject to adjustment costs represented by the convex function $C(I_{it}, K_{it}, \tau_{it})$. Adjustment costs are usually assumed to be increasing in I_{it}, decreasing in K_{it} plus an exogenous technology shock (τ_{it}). In addition, the firm's existing capital stock is a weighted sum of previous investment expenditures, which introduces the capital accumulation constraint $K_{it} = I_{it} + (1 - \delta_i) K_{i,t-1}$, where δ_i represents the firm's constant rate of capital depreciation.

The firm's optimization problem is thus to choose investment to maximize its market value given by:

$$V_{it} = E_{it}\{\sum_{s=t}^{\infty} \beta_i^s [\Pi(K_{is}, \sigma_{is}) - C(I_{is}, K_{is}, \tau_{is}) - p_s I_{is}]\} \qquad (2),$$

subject to the capital accumulation constraint given by $K_{is} = I_{is} + (1 - \delta_i) K_{i,s-1}$. In this formulation of the firm dynamic optimization problem, i and t denote the firm and time period respectively,[3] E_{it} is the expectations operator with a subscript indicating the information available to the i^{th} firm at time t, and β_i^s is the discount factor adopted by the i^{th} firm. New capital resulting from investment is expected to become productive within the year.

The first-order condition for maximizing equation (2) with respect to investment yields the Marginal q specification:

$$p_t + C_I(I_{it}, K_{it}) = q_{it} \qquad (3),$$

where

$$q_{it} = E\{\sum_{s=0}^{\infty} \beta_i^s (1-\delta_i)^s [\Pi_K(K_{i,t+s}, \sigma_{i,t+s}) - C_K(K_{i,t+s}, \tau_{i,t+s})]\} \quad (4).$$

[3] The model introduces the notation for firm and time subscripts to accommodate the panel data econometric techniques that are used to estimate the cooperative investment model. The same results would apply if the subscript i is dropped from the equations, which would then denote a representative firm's investment behavior over time.

The right-hand side in equation (3) is Marginal q, which is defined in equation (4) as the expected discounted value of profits from new capital investment. The intuition is that the firm maximizes its market value by equating the marginal benefits of an additional dollar of investment (Marginal q) to the concomitant marginal costs given by the relative price of investment and the marginal adjustment cost. To obtain an estimable specification for the Q investment equation, a functional form for the adjustment cost function, C, must be introduced. The tradition in the Q theory literature is to follow Hayashi (1982) and specify C as being linearly homogeneous in investment and capital. A convenient and commonly used parameterization of C is given by:

$$C(I_{it}, K_{it}) = (\alpha/2)\ [I_{it}/K_{it} - a_i - \tau_{it}]^2\ K_{it} \qquad (5),$$

where α is the slope of the adjustment cost function, a_i represents firm-specific effects, and τ_{it} is the technology shock. Note that the larger α is, the steeper is the adjustment cost function and the more slowly investment responds to exogenous shocks. Partially differentiating equation (5) with respect to investment and substituting the resulting $C_I(I_{it}, K_{it})$ into equation (3) yields the investment equation:

$$I_{it}/K_{it} = a_i + (1/\alpha)\ [q_{it} - p_t] + \tau_{it} + \varepsilon_{it} \qquad (6),$$

where ε_{it} is an optimization (or expectations) error. Therefore, under the conditions assumed by the Q theory, investment expenditures should be solely determined by Marginal q (less the relative price of investment goods). However, it is important to note that this specification of the investment equation is a representation of a "model under frictionless capital markets [that] should explain investment for firms with low premium in the cost of external relative to internal financing" (Hubbard, 1998, p. 202).

Since Marginal q is unobservable, Tobin's Average q is commonly used as a proxy variable in empirical studies based on the Q theory of investment. However, Average q constructed from financial market data is only an appropriate measure of Marginal q under certain conditions – including competitive product and factor markets, homogeneity of fixed capital, linearly homogeneous production and adjustment cost technologies, and independent investment and financing decisions (Hayashi, 1982). Under these conditions, the value of the firm equals the quasi-rents from the existing capital stock. As a result, the Q investment model is commonly represented by:

$$I_{it}/K_{it} = a_i + b\, Q_{it} + \tau_{it} + \varepsilon_{it} \qquad (7),$$

where $b = (1/\alpha)$ and Q_{it} is the tax-adjusted value of Tobin's q (Summers, 1981).

In his survey of the empirical investment literature following the advent of the Q theory, Chirinko (1993, p. 1891) observes that equation (7) is the most popular explicit model of firm investment behavior, but "the Q model's empirical performance has been generally unsatisfactory" both in terms of the statistical significance of Marginal q and the model overall explanatory power. In addition, the estimated coefficient for Marginal q is in general too low, translating in an unrealistically high adjustment cost parameter (α). More importantly, variables such as cash flow and output are consistently found to be statistically significant when included in the Q investment model specification. The role of financial constraints in firm investment behavior is now explored.

Capital Market Imperfections and the Role of Cash Flow in Investment Equations

The influential applied work by Fazzari, Hubbard and Petersen (1988) is at the roots of an extensive empirical literature examining the consequences of informational imperfections in financial markets on the firm's investment decision. The analytical underpinning of these contemporary models of capital market imperfections is found in economic models relaxing the neoclassical perfect information assumption, which Stiglitz (2000) calls the "Economics of Information" school.

The general implication of theoretical studies in the Economics of Information tradition is the presence of information problems in capital markets leads to a cost wedge between external finance and internally generated funds. In a simple graphical analysis, Hubbard (1998) shows the supply curve of finance is a horizontal segment up to the firm's total net worth (W_0) but is upward-sloping beyond W_0 as the firm needs to access external funds to finance investment projects. Furthermore, the slope of the supply curve of finance is proportional to the (marginal) information costs between the firm and suppliers of external funds. In other words, "in the presence of incentive problems and costly monitoring of managerial actions, external suppliers of funds to firms require a higher return to compensate them for these monitoring costs and the potential moral hazard associated with managers' control over the allocation of investment funds" (Hubbard, 1998, pp. 194-5). In addition, holding information costs constant, an increase in net worth causes a shift of the supply of funds schedule to the right. This finding provides the theoretical underpinning to the inclusion of proxy variables for net worth (e.g., cash flow) in the standard Q investment equation. Consequently, the benchmark Q model of investment presented in the previous section may be expanded as follows:

$$I_{it}/K_{it} = a_i + b\, Q_{it} + c\, CF_{it} + \tau_{it} + \varepsilon_{it} \qquad (8),$$

where CF_{it} represents cash flow for the i^{th} firm at time t.

Empirical studies of capital market imperfections affecting firm investment behavior examine firm-level panel data in which firms are grouped into "high information cost" and "low information cost" categories. This tradition dates back to Fazzari, Hubbard and Petersen (1988), who use a large panel of Value Line data for US manufacturing firms to examine the interdependence of investment and financing decisions. The authors identify "high information cost" firms on the basis of a priori information on observed net income retention practices. They estimate a Q investment equation with cash flow as a proxy for net worth. Their empirical results consistently indicate a substantially greater sensitivity of investment to cash flow in firms with a high net income retention rate. The authors conclude that financial effects are important determinants of corporate investment. Further evidence on the interdependence of financing and investment decisions is found in Hoshi, Kashyap and Scharfstein (1991), Blundell, Bond, Devereux and Schiantarelli (1992) and Schaller (1993), among others.

A significant breakthrough in the applied literature testing for the existence of capital market imperfections is provided by Gilchrist and Himmelberg (1995). In particular, the authors propose an alternative proxy variable to measure firm investment opportunities instead of

Tobin's Average q. Their alternative measure of Marginal q is Fundamental q as it is based on observed firm fundamentals, including sales and cash flow. More specifically, they estimate a set of vector autoregression (VAR) forecasting equations based on the firm's fundamentals and use the estimates from the VAR system to construct Marginal q. They estimate the Q model of investment with both Tobin's q and Fundamental q using firm-level panel data collected from 470 US manufacturing firms. When comparing the results from estimating the benchmark investment model using Tobin's q versus Fundamental q, the authors find that "Fundamental q provides very plausible estimates of adjustment costs and implied speeds of adjustment" (Gilchrist and Himmelberg, 1995, p. 566). In contrast, Tobin's q is a poor proxy of investment opportunities and tends to overstate the sensitivity of investment to cash flow, especially for unconstrained firms.

The importance of Gilchrist and Himmelberg's (1995) work is twofold. First, Fundamental q appears to be a better proxy for Marginal q than Tobin's q as it does not rely on the conditions set forth by Hayashi (1982). Second, with Fundamental q as a measure of Marginal q, the Q model of investment can be estimated for nonpublic firms for which market data is not available. Following Gilchrist and Himmelberg (1995), the Fundamental q approach has been applied to the study of financial constraints in the US farm sector, a subject to which the study now turns.

Bierlen (1994) studies credit rationing in US production agriculture. Based on the Fundamental q approach, the author estimates Q machinery investment equations for a sample of 395 Kansas farms during the period 1973-92. The investment equations are estimated for two asset sizes and three six-year time regimes. Empirical results suggest cash flow and sales are significant determinants of farmers' investment behavior. In addition, larger farmers suffer from less credit rationing than smaller farmers and credit rationing becomes more intense during the 1981-86 agricultural credit crisis. The author concludes, "the Q theory results support the notion of imperfect financial markets and the dependence of financial and investment decision-making in Kansas agriculture" (Bierlen, 1994, p. 112).

Bierlen and Featherstone (1998) use 1976-92 data from 405 Kansas commercial farms and find that debt level is the strongest determinant of credit constraints. In particular, the investment-cash flow coefficient is more pronounced for high-debt farms, especially during the 1980s agricultural credit crisis. In addition, the authors observe the sensitivity of investment to cash flow is also more severe in young operator and small size farms.

Another applied study of financial constraints in the US farm sector based on the Fundamental q approach is found in Barry, Bierlen and Sotomayor (2000). Their empirical test of farm credit constraints is based on a sample of 118 Illinois farms over the period 1987-94. The findings from regression analysis lend further support to the hypothesis that US farms face binding financial constraints when making investment decisions. Additionally, the authors use two alternative sample splitting criteria to group farms in "low information cost" and "high information cost" categories: age of farmer and application of a credit scoring model developed by scholars at the University of Illinois. Contrary to the authors' expectations, older farmers are found to be more credit constrained than younger farmers. However, the result for the credit scored groups are consistent with the hypothesis that "high information cost" farmers are more financially constrained than "low information cost" farmers.

The Cooperative Capital Constraint Hypothesis

This study argues that the augmented Q model of investment specified in equation (8) may be applied to agricultural cooperatives in order to test for the presence of capital constraints. The capital constraint hypothesis in user-owned organizations is usually explained on the basis of the following arguments:

1. Cooperative residual claims are restricted to members;
2. Cooperative members have inappropriate incentives to invest;
3. Equity capital acquisition in traditional cooperatives is tied to member patronage (with consequent dependence on internally generated capital);
4. Cooperative equity capital is not permanent and;

5. Cooperatives have limited access to external sources of funds.

The first argument in support of the capital constraint hypothesis is that cooperatives have restricted residual claims (Fama and Jensen, 1983). In other words, the user-ownership principle limits the extent of agent markets for risk bearing and capital provision since only active members may provide the cooperative organization with equity capital. As a result, risk capital acquisition in the traditional cooperative firm is limited by the wealth and risk bearing capacity of its current members. However, farmers face their own financial constraints due to imperfections in agricultural credit markets. As discussed above, the empirical evidence is largely corroborative of the presence of credit constraints in US production agriculture.

Another restriction on cooperative residual claim rights is their lack of alienability, which prevents the functioning of a secondary market for cooperative equity securities. Voluntary contractual restrictions on residual claim alienability are not efficient in organizations where the "capital value problem" is important, that is, when productive activities are supported by large quantities of long-term assets that are difficult to value (Fama and Jensen, 1985). Furthermore, the non-transferability of cooperative residual claims and the resultant lack of a secondary market for cooperative stock lead to the emergence of portfolio and horizon problems (Jensen and Meckling, 1979; Porter and Scully, 1987).

A second argument supporting the cooperative capital constraint hypothesis is the property rights allocation within the traditional cooperative structure does not provide members with the necessary incentives to invest (Vitaliano, 1983; Knoeber and Baumer, 1983; Cook, 1995; Iliopoulos, 1998). Because cooperatives return their earnings to members on the basis of patronage instead of stock ownership, cooperatives generally pay low dividend rates on capital. In addition, residual claims in traditional cooperatives are not appreciable since they are non-transferable and redeemable only at book value. Consequently, members have an incentive to underfinance the cooperative by increasing their patronage relative to investment. In addition to this free-rider problem, portfolio and horizon problems resulting from the non-transferability of cooperative residual claims further attenuate members' incentives to contribute risk capital. Cook and Iliopoulos (2000) develop a latent variable model and find a statistically significant negative relationship between traditional cooperative property rights attributes and members' incentives to invest.

As there are few incentives for direct member investment in traditional cooperatives, they ultimately depend on internally generated capital and earnings from non-member business to build a permanent stock of equity capital. As a result of the dependence on internally generated capital, approximately 60 percent of the total net worth in the top 100 US agricultural cooperatives is in the form of equity certificates and credits (Chesnick, 2000). In other words, equity capital in a cooperative's balance sheet generally is allocated to individual members, representing a claim against the cooperative by present and former members who still have retained patronage refunds in the firm. This claim is partially redeemable as equity retirement is a discretionary decision of the board of directors. Because redeeming equity is a cash outlay to the cooperative, a large portion of its equity capital stock is not considered permanent.

In addition to being constrained in their ability to acquire and maintain a dependable stock of equity capital, traditional agricultural cooperatives have limited access to external funds. Because cooperative residual claims are restricted to members and cannot be marketed, access to public equity markets is not a viable option unless the firm changes its organizational form. Cooperatives also lack access to adequate sources of debt capital because the "close ties between equity capital and patronage in cooperatives has led traditional lenders to consider cooperative equity capital as insufficiently permanent to support loans" (Vitaliano, 1985, p. 67). As a result, most agricultural cooperatives do not possess enough net worth to have adequate access to outside sources of finance.

In sum, there is sufficient theoretical reason to believe that cooperatives may be financially constrained when making investment decisions. As a consequence of the nature of their residual claims, cooperatives are constrained in their ability to acquire risk capital for investment and growth purposes and incur a higher weighted average cost of capital relative to IOFs (Vitaliano, 1980; Hart and More, 1996). Despite the convincing theoretical arguments analyzed above, the available empirical evidence is not conclusive as to whether agricultural cooperatives actually face binding capital acquisition constraints. In the following section, the empirical literature testing the cooperative capital constraint hypothesis is discussed.

3. Empirical Evidence of Financial Constraints in Agricultural Cooperatives

In this section, the empirical literature testing the cooperative capital constraint hypothesis is analyzed. Two distinct, but related, approaches are identified: growth studies and empirical tests of the cooperative *equity* constraint hypothesis. Cooperative growth studies are part of an extensive applied literature evaluating the economic performance of user-owned organizations in comparison to IOFs and other organizational forms. As such, asset or sales growth is used as an alternative performance measure in addition to economic efficiency, accounting ratios, and firm survival. Growth studies do not directly test the cooperative capital constraint hypothesis. Nevertheless, evidence of sluggish cooperative growth is often interpreted as a consequence of financial constraints.

The most comprehensive study of cooperative performance is the series of reports published by Purdue University's Agricultural Experiment Station during the early 1980s and summarized in Schrader, Babb, Boynton and Lang (1985). In their summary report, Schrader et al. (1985) document the empirical analysis of agribusiness cooperatives' and proprietary firms' growth. Two sets of firms are examined separately: small, specialized and large, diversified firms. Small firm data is collected from 60 Wisconsin cheese plants and 165 grain marketing and input supply elevators located in the Midwest. Financial data on sales, assets, and acquisitions is collected by mail survey and secondary sources comprising a 30-year study period (1950-80). Among the cheese plants, proprietary firms are found to grow at a faster rate than cooperatives, but the difference is not statistically significant. Grain cooperative elevators, on the other hand, appear to experience higher sale and asset growth rates, but the difference with IOFs is also not statistically significant.

Chen, Babb and Schrader (1985) examine 32 large cooperatives and 35 proprietary firms with operations in five food industries from 1975 to 1980 with a "strategic" model of firm growth. Least squares regression results show cooperatives experienced a higher growth rate than IOFs during the study period. Moreover, profitability, leverage, mergers and acquisitions, and industry growth are found to have significant effects on cooperative growth. However, the authors point out that the set of explanatory variables included in the model fail to account for the more rapid growth of cooperatives. In other words, the higher cooperative growth rate is largely left unexplained.

Caves and Petersen (1986) explore the effects of taxation and patronage refund redemption on the cooperative's growth path. They show that an integrated tax system enables the cooperative firm to grow faster than a proprietary firm with identical investment opportunities if both finance their growth from retained earnings. However, the potentially faster cooperative growth rate only occurs before the cooperative starts redeeming equity to members as equity retirement is a source of cash outlay that limits the amount of internal finance for future investments. Based on aggregate financial data of the 100 largest US agricultural cooperatives, the authors show their high growth rate in the 1962-1980 study period is largely due to abnormal return on equity, increased leverage, and rising ratio of retentions to net income.[4]

Fulton, Fulton, Clark and Parliament (1995) extend Caves and Petersen's (1986) model and hypothesize cooperative growth is constrained as a result of the equity capital constraint. The authors study the long-term growth rate of seven large US and Canadian regional multipurpose cooperatives during the 1932-92 period. They first show that cooperative growth is not constrained by size, i.e., Gibrat's Law is not rejected for their sample. Subsequently the authors estimate the seven cooperatives' long run growth rates, which range from 2.5 to 9.6

[4] Note that this conclusion may help to explain Chen et al.'s (1985) finding of higher cooperative growth rate relative to IOFs as Caves and Peterson's study period comprises Chen et al.'s.

percent per annum. However, the growth rates of five cooperatives are not statistically different from zero. Fulton et al. (1995) conclude, "the growth rate for the cooperatives in the sample is low, perhaps even zero," which corroborates Caves and Petersen's (1986) proposition that cooperative growth rate may approach zero due to the redemption of equities over time.

In two separate empirical studies, Lerman and Parliament (1993a and 1993b) attempt to test the cooperative equity constraint hypothesis. According to the authors, cooperatives are viewed as "equity bound" because of "their unique user-based ownership and the resulting non-marketability of their stock" (Lerman and Parliament, 1993b, p. 431). In the first paper, Lerman and Parliament (1993a) compare the capital structure of agricultural cooperatives and IOFs. The sample includes 70 regional cooperatives with operations in several agribusiness industries. Time series accounting data based on financial reports is gathered for the years between 1970 and 1987, allowing the study of capital structure over time. Based on non-parametric statistical analysis of differences in medians between categories, the authors conclude US cooperatives do not borrow more than comparable IOFs. Contrary to the authors' expectations, US dairy cooperatives are found to be less leveraged than IOFs.

Additionally, Lerman and Parliament (1993b) study the financing of asset growth among US agricultural cooperatives. The methodology used is based on a sources and uses of funds equation showing the proportions of asset growth financed by debt and equity capital. Data is collected from audited financial reports of 60 US regional cooperatives for the 1973-87 period in the dairy, food, grain and farm supply industries. The financing of cooperative asset growth with equity capital ranged from 21 to 69 percent with an average of 45 percent during the study period. In other words, cooperatives finance nearly half of their asset growth with equity capital. Contrary to theoretical expectations, the equity financing proportion of cooperatives is found not to be statistically different from the national average of non-financial corporations between 1973 and 1983, and is higher than the national average after 1984 when IOFs became increasingly leveraged.

On the basis of the available empirical findings it might be concluded that US agricultural cooperatives are not financially constrained – they grow as fast and are as leveraged as comparable IOFs. However, one must be careful in interpreting these results because the applied studies discussed above are not specifically designed to directly test the cooperative capital constraint hypothesis. As noted by Lerman and Parliament (1993b, p. 439), “the observation of high equity financing proportions among the sample of cooperatives does not, however, unambiguously resolve the hypothesis of equity constraints in cooperatives.” Furthermore, the authors suggest future analysis of cooperative growth should attempt to link the investment behavior of cooperatives with their financial needs in order to shed further light on the hypothesis of capital “starvation” in cooperatives. That is, the methodologies applied in previous research do not account for the financing needs of cooperatives, i.e., the demand for investment funds. It is this gap in the extant literature that this study attempts to address.

4. The Cooperative Panel Data Set, Variable Construction and Descriptive Statistics

In order to directly test the cooperative capital constraint hypothesis, the investment model specified in equation (8) is estimated with a panel data set of firm-level agricultural cooperatives. Financial data was obtained from annual statements of 1,271 US agricultural cooperatives during the years 1991-2000. Table 1 shows selected aggregate descriptive statistics for the panel. When compared to 1999 cooperative statistics made public by the USDA Rural Business–Cooperative Service (2000), our sample includes 36% of the total number of US agricultural cooperatives. The firms in our sample generated $93.7 billion in sales and had $44.4 billion in assets in 1999, which correspond respectively to 81 and 93 percent of the totals reported by RBS.

Note, however, that the panel is not balanced. Firms with less than 10 years of data for the variables of interest during the study period were dropped from the sample. This procedure reduces the number of cooperatives in the sample to 597. In addition, firms with large discontinuities in the reported book value of their physical capital stock are also excluded from the sample. These large discontinuities in net fixed assets are assumed to be caused by mergers, acquisitions, asset divestitures, and data errors. This criterion removes 90 firms from the sample, leaving a final sample of 507 firms.

Table 1. Selected Aggregate Data for a Panel of US Agricultural Cooperatives, 1991-2000 (US$ Million)

Year	Number of Firms	Total Revenue	Net Income	Total Assets
1991	700	$32,050	$1,058	$12,403
1992	880	$46,670	$1,460	$18,967
1993	998	$51,744	$1,330	$21,995
1994	1,184	$64,040	$1,995	$26,012
1995	1,224	$86,765	$2,145	$33,718
1996	1,241	$105,214	$2,588	$39,318
1997	1,248	$113,334	$2,483	$42,207
1998	1,251	$110,597	$2,081	$48,416
1999	1,245	$93,655	$1,415	$44,420
2000	1,150	$88,421	$1,175	$41,510

The dependent variable, investment (I_{it}/K_{it}), is measured as the change in gross fixed assets between subsequent years. Cash flow (CF_{it}), is measured as the sum of net income, depreciation and amortization, and is net of non-cash patronage income, patronage dividends paid in cash, net retirements of allocated equity, gains or losses on asset sales, and after-tax extraordinary items. Both investment and cash flow are first deflated by beginning-of-period physical capital stock using net fixed assets as a proxy but noting that this may introduce measurement error in the regression model.

The marginal profitability of capital (Q_{it}) is constructed from the estimates of a vector autoregression system of 2 equations of order 3. In this study, we follow Gilchrist and Himmelberg's (1995) procedures and include cash flow, as defined above, and the ratio of sales over capital (S_{it}) in the VAR system. Both variables are first-differenced in order to eliminate fixed-firm effects. The VAR(3) system is estimated by the generalized method of moments (GMM) estimator with the inclusion of time dummies. The instrument list includes lags 2 to 4 of CF_{it} and S_{it}. The use of GMM is necessary in this context as it is a heteroskedasticity robust estimator that accommodates the presence of endogeneity in the model (Greene, 2000). The estimates of the VAR system are then used to construct Fundamental q (F_{it}), defined as:

$$F_{it} = [c' - (I - \lambda A)]^{-1} X_{it} \qquad (9),$$

where X_{it} is a vector containing CF_{it} as the j^{th} element and S_{it}, c is a conformable vector of zeros with a 1 in the j^{th} row, I is the identity matrix, and A is the matrix of VAR (3) coefficient estimates.

Given the order of the VAR and the lags involved in the variable construction, the initial 5 years of the panel cannot be used in estimating the investment model. Therefore the cooperative investment model is estimated for the years 1996-2001. Table 2 below shows summary statistics for the final sample of 507 cooperatives.

Table 2. Summary Statistics for 507 Agricultural Cooperatives, 1996-2000

Variable	Mean	Std. Error
I_{it}	0.35	0.37
CF_{it}	0.29	0.37
S_{it}	12.70	26.07
F_{it}	0.33	0.47

5. Empirical Results

In this section, we report the results from estimating the augmented Q investment model using the panel data described above. The specification of the empirical model includes dummy variables to account for time-specific effects. The model is estimated using firm fixed effects (with the variables in first-differences), random effects and GMM as alternative estimators in order to check the robustness of regression results. In the GMM estimation of the model, the same instrument set applied in the estimation of the VAR(3) coefficients is utilized – that is, lags 2 to 4 of CF_{it} and S_{it} in levels.

Table 3 shows regression results of the investment model for the full sample with F_{it} as a proxy for Marginal q. Both fixed effects coefficient estimates are positive and statistically significant at the 1% level. These results suggest that both Marginal q and cash flow affect the investment behavior of agricultural cooperatives. In other words, the cooperatives in the sample appear to be financially constrained. However, the fixed effects estimator assumes all regressors are exogenous, i.e., not contemporaneously correlated with the error term. If this is not the case, measurement error may lead to inconsistent coefficient estimates. The results from the random effects estimation of the model indicate that this might the case. Despite maintaining their positive signs, the magnitudes of both Marginal q and cash flow coefficient estimates are apparently lower than the fixed effects estimates. In addition, the coefficient on Marginal q is imprecisely estimated. However, the results still lend support to the cooperative capital constraint hypothesis.

Table 3. Fixed Effects, Random Effects and GMM Estimates of the Investment Model

(Dependent variable is I_{it}, N = 507, T = 5)

	Fixed Effects		**Random Effects**		**GMM**	
Variable	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
$\mathbf{F_{it}}$	0.110	0.03*	0.017	0.02	0.084	0.07
$\mathbf{CF_{it}}$	0.230	0.04*	0.105	0.03*	0.311	0.05*
	$R^2 = 0.25$		$R^2 = 0.15$		J = 7.73**	

* Coefficient estimates are statistically significant at 1% confidence level.
** P-value = 0.171
Note: time dummies' coefficient estimates are not reported.

The GMM estimator, which explicitly assumes that Fundamental q is measured with error and also does not require the conditional homoskedasticity assumption for robust estimation, provides stronger evidence of the presence of financial constraints in agricultural cooperatives. The sensitivity of investment to cash flow is positive and statistically significant. Assuming that cash flow is not measured with error, it may be concluded that agricultural cooperatives are financially constrained when making investment decisions. The test for over-identifying restrictions (J-statistic) indicates that the null hypothesis of all instruments being exogenous cannot be rejected as the p-value is well above 10 percent (Hayashi, 2000). That is, the cooperative investment model estimated with GMM appears to fit the data well.

6. Concluding Remarks

It is commonly argued in the literature that traditional agricultural cooperatives are financially constrained, i.e., they are unable to acquire sufficient risk capital to invest in productive assets and thus may have to forego value-enhancing growth opportunities. In this research, we addressed the issue of financial constraints in agricultural cooperatives. We examined whether or not physical capital investment by agricultural cooperatives is constrained by the availability of funds. To do so, we estimated an investment model for a sample of agricultural cooperatives and showed that the sensitiveness of investment to cash flow is positive and statistically significant. Additionally, this regression result is robust across three alternative estimators: fixed effects, random effects, and generalized method of moments (GMM). As cooperative investment appears to be sensitive to cash flow, the financial constraint hypothesis is corroborated by the empirical evidence. Future research exploring the cross-sectional heterogeneity in the sample might lend further support to this conclusion and indicate what types of cooperatives are more financially constrained than others.

7. References

Barry, P. J., Bierlen, R. W. and Sotomayor, N. L. (2000). "Financial Structure of Farm Businesses under Imperfect Capital Markets," *American Journal of Agricultural Economics*, 82 (4): 920-33.

Bierlen, R. W. (1994). *The Interdependence of Investment and Financing Decisions among Kansas Farm Machinery Investors*, Unpublished Ph.D. Dissertation, Kansas State University.

Bierlen, R. W. and Featherstone, A. M. (1998). "Fundamental q, Cash Flow, and Investment: Evidence from Farm Panel Data," *Review of Economics and Statistics*, 80: 427-35.

Blundell, R., Bond, S., Devereux, M. and Schiantarelli, F. (1992). "Investment and Tobin's Q," *Journal of Econometrics*, 51: 233-57.

Caves, R. E. and Petersen, B. C. (1986). "Cooperatives' Tax "Advantages": Growth, Retained Earnings, and Equity Rotation," *American Journal of Agricultural Economics*, 68 (2): 207-13.

Chen, K. S., Babb, E. M. and Schrader, L. F. (1985). "Growth of Large Cooperative and Proprietary Firms in the US Food Sector," *Agribusiness*, 1 (2): 201-10.

Chesnick, D. S. (2000). *Top 100 Cooperatives 1999 Financial Profile*, Washington, DC: USDA Rural Business Cooperative Services.

Chirinko, R. S. (1993). "Business Fixed Investment Spending: Modeling Strategies, Empirical Results, and Policy Implications," *Journal of Economic Literature*, 31 (4): 1875-1911.

Cook, M. L. (1995). "The Future of US Agricultural Cooperatives: A Neo-Institutional Approach," *American Journal of Agricultural Economics*, 77 (5): 1153-9.

Cook, M. L. and Chaddad, F. R. (2000). "Agroindustrialization of the Global Agrifood Economy: Bridging Development Economics and Agribusiness Research," *Agricultural Economics*, 23 (3): 207-18.

Cook, M. L. and Iliopoulos, C. (2000). "Ill-defined Property Rights in Collective Action: The Case of Agricultural Cooperatives," in *Institutions, Contracts, and Organizations:*

Perspectives from New Institutional Economics, Claude Menard (ed.), London: Edward Elgar Publishing Ltd., 335-48.

Eisner, R. and Strotz, R. H. (1963). "Determinants of Business Investment," in *Impacts of Monetary Policy*, Commission on Money and Credit, Englewood Cliffs, NJ: Prentice-Hall, 59-337.

Fama, E. F. and Jensen, M. C. (1983). "Separation of Ownership and Control," *Journal of Law and Economics*, 26: 301-25.

Fama, E. F. and Jensen, M. C. (1985). "Organizational Forms and Investment Decisions," *Journal of Financial Economics*, 14: 101-19.

Fazzari, S. M., Hubbard, R. G. and Petersen, B. C. (1988). "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity*, 1: 141-95.

Fulton, M. E., Fulton, J. R., Clark, J .S. and Parliament, C. (1995). "Cooperative Growth: Is It Constrained?" *Agribusiness*, 11 (3): 245-61.

Gilchrist, S. and Himmelberg, C. (1995). "Evidence on the Role of Cash Flow in Reduced-Form Investment Equations," *Journal of Monetary Economics*, 36: 541-72.

Greene, W. H. (2000). *Econometric Analysis*, Fourth Edition, Upper Saddle River, NJ: Prentice Hall.

Hansmann, H. (1999). "Cooperative Firms in Theory and Practice," *The Finnish Journal of Business Economics*, 4: 387-403.

Hart, O. D. and Moore, J. (1996). "The Governance of Exchanges: Members' Cooperatives versus Outside Ownership," *Oxford Review of Economic Policy*, 12 (4): 53-69.

Hayashi, F. (1982). "Tobin's Marginal q and Average q: A Neoclassical Interpretation," *Econometrica*, 50 (1): 213-24.

Hayashi, F. (2000). *Econometrics*, Princeton, NJ: Princeton University Press.

Holmstrom, B. (1999). "The Future of Cooperatives: A Corporate Perspective," *The Finnish Journal of Business Economics*, 4: 404-17.

Hoshi, T., Kashyap, A. K. and Scharfstein, D. (1991). "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups," *Quarterly Journal of Economics*, 106 (1): 33-60.

Hubbard, R. G. (1998). "Capital Market Imperfections and Investment," *Journal of Economic Literature*, 36 (1): 193-225.

Iliopoulos, C. (1998). *Study of the Property Rights Constraints in US Agricultural Cooperatives: Theory and Evidence*, Unpublished Ph.D. Dissertation, University of Missouri-Columbia.

Jensen, M. C. and Meckling, W. H. (1979). "Rights and Production Functions: An Application to Labor-Managed Firms and Codetermination," *Journal of Business*, 52 (4): 460-506.

Knoeber, C. R. and Baumer, D. L. (1983). "Understanding Retained Patronage Refunds in Agricultural Cooperatives," *American Journal of Agricultural Economics*, 65 (1): 30-7.

Lerman, Z. and Parliament, C. (1993a). "Financing Growth in Agricultural Cooperatives," *Review of Agricultural Economics*, 15 (3): 431-41.

Lerman, Z. and Parliament, C. (1993b). "Capital Structure in Agricultural Cooperatives: US and Israel," in *Agricultural Cooperatives in Transition*, Csaki, C. and Kislev, Y. (eds.), Boulder, CO: Westview Press, 227-42.

Porter, P. K. and Scully, G. W. (1987). "Economic Efficiency in Cooperatives," *Journal of Law and Economics*, 30: 489-512.

Schaller, H. (1993). "Asymmetric Information, Liquidity Constraints, and Canadian Investment," *Canadian Journal of Economics*, 26 (3): 552-74.

Schrader, L. F., Babb, E. M., Boynton, R. D. and Lang, M. L. (1985). "Cooperative and Proprietary Agribusinesses: Comparison of Performance," *Agricultural Experiment Station Research Bulletin 982*, West Lafayette, IN: Purdue University.

Stiglitz, J. E. (2000). "The Contributions of the Economics of Information to Twentieth Century Economics," *Quarterly Journal of Economics*, 115 (4): 1441-78.

Summers, L. H. (1981). "Taxation and Corporate Investment: A q-Theory Approach," *Brookings Papers on Economic Activity*, 1: 67-127.

United States Department of Agriculture (2000). *Farmer Cooperatives Statistics, 1999*, RBS Service Report 59, Washington, DC: Rural Business Cooperative Services.

van Bekkum, O. F. and van Dijk, G. (1997). *Agricultural Cooperatives in the European Union: Trends and Issues on the Eve of the 21st Century*, Assen, The Netherlands: Van Gorkum.

Vitaliano, P. W. (1980). *A Comparative Analysis of the Cost of Long Term Debt Financing for Regional Marketing Cooperatives and Investor-Owned Firms in the US Agricultural and Food Industries*, Unpublished Ph.D. Thesis, University of Wisconsin-Madison.

Vitaliano, P. W. (1983). "Cooperative Enterprise: An Alternative Conceptual Basis for Analyzing a Complex Institution," *American Journal of Agricultural Economics*, 65 (5): 1078-83.

Vitaliano, P. W. (1985). "Potential Benefits and Costs to Agricultural Cooperatives from Assuring Access to Input and Product Markets," in *Proceedings of the Workshop Farmer Cooperatives for the Future*, Saint Louis, Missouri, 64-74.