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INTERNAL NET WORTH AND THE INVESTMENT PROCESS: AN APPLICATION TO U.S. AGRICULTURE

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ABSTRACT

Recent models of firm investment decisions stressing informational imperfections in capital markets provide a foundation for interpreting evidence that movements in internal finance can predict investment opportunities. While such evidence is suggestive, it is often open to other interpretations.

We present new evidence in favor of these models that addresses this gap in two ways. First, we focus on the U.S. agricultural sector; the sector has experienced large fluctuations in net worth and the profitability of investment, and reasonable measures of net worth can be constructed. Second, rather than relying on investment function representations (e.g., the q-theory approach), we make use of predictions generated by firms' Euler equation for capital accumulation. Intuitively, during periods in which net worth is high, the Euler equation should hold across adjacent periods; the equation will not hold for periods in which the shadow price of external finance is high because of low net worth. Such an approach offers an alternative model for periods in which internal net worth is low (holding constant investment opportunities), and generates a link between internal net worth and investment spending during periods of significant deflation in the value of net worth.

Our empirical evidence is presented in three parts. First, the neoclassical, perfect-capital-markets model for investment is rejected by the data. Omitting periods during which there were substantial negative shocks to farmers' net equity positions, the model's overidentifying restrictions can no longer be rejected. Second, allowing for movements in net equity positions contributes importantly to explaining investment. Third, the effect of changes in net worth on investment is significantly more important during the deflationary periods than during "boom" periods. Taken together, these findings provide support for a class of "internal funds" models of investment under asymmetric information.

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I. INTRODUCTION

That financing and investment decisions are not in general independent has been recognized in applied discussions of the investment process for some time (see for example Eckstein and Sinai, 1986). Indeed, the potential role of internal finance in the investment process -- holding constant investment opportunities -- was stressed in early empirical investment models (notably in Meyer and Kuh, 1957). However, dissatisfaction with the theoretical underpinnings of these models led the profession to search for more completely specified optimizing models. By the late 1960s, the "neoclassical"[1] model (and its adaptations) had become the accepted framework for analyzing investment. Subsequently, the "q" theory[2] has also served as a benchmark for discussing investment. In these models, internal and external funds are generally treated symmetrically, as if they are perfect substitutes. While both of these models are elegant in their derivation, they have had only limited empirical success. In fact, perhaps the most forceful criticism of these models has been that they are often outperformed by simple ad hoc accelerator models that assert a central role for internal funds.[3]

Recent research on the effects of asymmetric information in capital markets has made it possible to reinterpret the accelerator mechanism.[4] This reinterpretation is possible because, in the canonical asymmetric information model, agency costs vary inversely with the level of "inside finance." Thus there is direct role for internal funds to affect investment: When borrowers' net worth improves, lenders becoming more willing to lend, and additional investment can be financed. A second implication of these models is that at sufficiently high levels of net worth, incentive problems should be less important. This paper shows that for U.S.

agricultural investment, this model does appear to be relevant and these implications are borne out by the data.

Internal worth has traditionally been identified as being an important determinant of the availability of agricultural finance, particularly during agricultural credit crises. For instance, Tostlebe (1957) notes the historical importance of internal finance in agricultural investment finance, especially in periods of contraction. Stock (1984) concludes that the problem of heavy debt-service burdens in periods of low farm prices and the associated risks of foreclosure figured significantly in movements of agrarian unrest prior to World War I. Alston (1983), writing about the interwar period in the U.S., emphasizes the interaction of low collateral values and restrictions on credit in accounting for the very high farm foreclosure rates during the period. Calomiris, Hubbard, and Stock (1986) discuss the role of financial factors in amplifying the farm debt crisis of the 1980s.

For several reasons, the agricultural sector is a natural one to use to test models of the effects of internal net worth on investment. First, most models are cast in terms of an entrepreneur or small number of insiders negotiating with outsiders for financing. While this is an accurate characterization of the financing of agricultural investment, it is a less appropriate description for most large firms for which data are available.[5]

A second reason for investigating agricultural investment is that it generally requires considerable upfront financing. There is a lengthy period between the purchase of input and the sale of agricultural output, and short-run variable costs are a small portion of total costs relative to the typical manufacturing industry. The volatility of profitability and the value of net worth (as measured by farm land values) is high; we return to this point later.

A third advantage of studying this sector is that movements of the central variable of interest -- insiders' net worth -- can be identified. Both proprietors' equity and the value of farm land, the two most likely forms of collateral, are observable. In contrast, for most other types of firms, insiders' net worth is difficult to quantify. For instance, a corporation's internal funds are not equivalent to insiders' stakes, although this proxy has been employed by almost all past researchers, including ourselves, in testing these theories. A related problem in most other applications is that measuring future collateralizable net worth is difficult.

A related point is that our data for the U.S. agricultural sector encompass episodes in which "debt deflations" have reduced farmers' net worth. This is important. The most appropriate experiment here is a change in internal net worth unaccompanied by a change in investment opportunities. Most existing studies have considered movements in proxies for inside finance that may be correlated with shifts in investment opportunities (e.g., "cash flow"). This problem is compounded when controls for investment opportunities (e.g., Tobin's q) are imperfect. We will examine on the type of "debt deflation" episodes described by Fisher (1933) and Kindleberger (1973) and others in identifying periods where low collateral was likely to have inhibited investment. Such episodes occurred for prices in general in the early 1920s, 1930s, and again in 1980s (with respect to farm prices) and were all exacerbated by coincident declines in land values. As we show below, these periods stand out as being unusual in many respects.

A final advantage of studying agriculture is that the sector's market structure and technology simplify the interpretation of the effects of "output" or "sales" on investment. For instance, the assumptions that farmers are price-takers that produce with a constant-returns-to-scale technology are widely employed and are relatively non-controversial. If these assumptions are correct, then market-power considerations should not be responsible for a correlation between investment and output. In contrast, if firms do have market power, there can be a link between sales and investment apart from that arising from capital-market frictions, complicating analysis of the influence of financial factors on investment.

The paper is organized as follows. Section II reviews models linking internal net worth an the investment decision under asymmetric information, and discusses pitfalls in previous empirical studies of the effect of movements in internal finance on capital spending. In section III, we derive an investment model based on the Euler equation corresponding to farmers' intertemporal optimization problem for capital accumulation. In the presence of finance constraints during periods of low net worth, the Euler equation contains additional terms involving measures of internal net worth. We outline a set of tests designed to exploit predictions of this framework for differences in the appropriate specification of investment models in "falling net worth" and "rising net worth" periods. Our empirical tests are reported in section IV, using a data set we constructed for the U.S. agricultural sector over the period from 1914 to 1987. The episodes of deflation in farmers' net worth that we examine occur during the early 1920s, 1930s, and 1980s. The results are consistent with an important role of internal net worth in agricultural investment decisions in "low net worth" periods -- particularly during the 1920s and 1930s (as we discuss below) -- with a much smaller role in other periods. Section V concludes.

II. INTERNAL NET WORTH AND THE INVESTMENT PROCESS

Recent empirical studies have tried to test indirectly the predictions of "information" models by exploiting cross-sectional heterogeneity. That is, the strategy has been to isolate *a priori* groups of firms as plausibly constrained, and test whether their investment behavior rejects a symmetric-information null model, while the investment behavior of the complement does not. Using panel data on U.S. manufacturing firms, Fazzari, Hubbard, and Petersen (1988) grouped firms by long-run dividend payout[6] in order to test whether the sensitivity of investment spending to internal finance -- holding constant investment opportunities (measured by q) -- varied systematically across groups. They found that excess sensitivity to expected movements in firm cash flow were a feature of low-payout firms, which were primarily smaller, rapidly growing enterprises. In a similar vein, Hoshi, Kashyap, and Scharfstein (1989) exploited Japanese panel data, grouping firms according to whether they were members of industrial groups, or *keiretsu*. They find that membership in a group and the presence of a group "main bank" are important in the provision of information and the avoidance of credit rationing when investment opportunities are promising. While liquidity effects on investment are quite important for non-group firms, they are much less important for member firms.

Such approaches are instructive in highlighting the importance of cross-sectional heterogeneity, but do not provide a test of a structural model of internal finance and investment. Instead, the results reject a null hypothesis of perfect capital markets for some firms which might plausibly be credit constrained. Recent studies by Bond and Meghir (1989), Whited (1989), Gilchrist (1989), and Himmelberg (1989) make use of an Euler equation approach to testing the cross-sectional heterogeneity stressed by Fazzari, Hubbard, and Petersen (1988).

One shortcoming of existing tests is that they do not exploit the prediction of many of the asymmetric information models that there is a critical level of net worth, below which changes in internal finance (holding constant investment opportunities) affect investment and above which such changes are irrelevant.[7] That is, the role of internal finance should be most pronounced in periods of low internal net worth. When considering the importance of internal funds for investment in aggregate data, this suggests that standard symmetric-information models should work well in "good times" and poorly in "bad times." Applications to public policy will require the identification of this pattern. An average measure of the importance of internal finance for investment from a reduced-form model may be misleading.

Data on agricultural investment provide an excellent laboratory for testing effects of movements in inside finance on investment under asymmetric information. Agriculture contains "information-intensive" investment; monitoring of projects (and treatment of the land) and returns is difficult.[8] As we noted before, a number of models based on asymmetric information stress the role of inside finance, holding constant investment opportunities.[9] With low levels of internal net worth, information and incentive problems force a wedge between the costs of internal and external finance. Over a range of values of internal net worth (that is, proprietors' equity and collateralizable future resources), increases in net worth raise investment. Alternatively, once net worth is sufficiently high to obtain the first-best allocation, further increases in the value of net worth have no effect on investment spending. This is a feature of models based on adverse selection and equity constraints (e.g., Stiglitz and Weiss, 1981; Greenwald, Stiglitz, and Weiss, 1984; and Calomiris and Hubbard, 1990) and models based on moral hazard and endogenous contracts (e.g., Bernanke and Gertler, 1990).

An additional problem with previous studies is that the q model is a questionable framework for analysis under the asymmetric-information alternative, as expectations reflected in prices quoted on centralized securities markets will not in general reflect insiders' valuations of future investment projects. Both Fazzari, Hubbard, and Petersen and Hoshi, Kashyap, and Scharfstein include q as a reduced-form control for investment opportunities (so that an internal funds variable does not proxy for expected future profits). However, the possibility remains that q is a poor proxy for investment opportunitites. Finally, there is a measurement problem -- cash flow is an imperfect proxy for the insiders' net worth variable stressed by the theories.

The structure of agricultural credit markets makes the sector a particularly appealing one for examining the importance of "net worth." Agricultural finance has historically been dominated by local lending (from individuals or local commercial banks), with virtually no finance raised through securities markets for debt and equity (see for example Tostlebe, 1957; and Calomiris, Hubbard, and Stock, 1986). We take up the issue of government intervention in agricultural credit markets later. Reductions in outside finance to farmers with low net worth -- holding constant long-run investment opportunities -- is likely to have real effects. First, foreclosures and the closing of farm operations can leave crop land idle, reducing planted acreage and production. In addition, long-run productivity can be adversely affected during a credit crunch through distressed sales of farm equipment, reductions in maintenance and fertilizer and seed expenses, or by substitution of inferior feed or crop mixes to decrease current cash expenditures.

III. MODELING THE INVESTMENT DECISION

A. Background

The standard approach for controlling for the role of "opportunities" in the investment process is to incorporate marginal q, the increase in firm value from an increment to the capital stock. By specifying a functional form for costs of adjustment, one can solve for an investment function, relating the rate of investment to q (see for example Summers, 1981; and Hayashi, 1982). As we noted before, the empirical success of such models in explaining the variation in investment (using aggregate data or micro data) has not been impressive. A major stumbling block is that the empirical proxy for marginal q -- average q -- may be a poor proxy (because of, inter alia, imperfect competition in the product market, non-constant returns to scale in production, or imperfect capital markets).[10]

We depart from this approach, and instead make use of the firm's Euler equation to model the investment decision (see for example Abel, 1980).[11] Our Euler equation incorporates the possibility that borrowing constraints may be important. So, when internal net worth is "high," the usual Euler equation should hold across adjacent periods. Alternatively, when net worth is low, investment will also depend on collateralizable wealth, holding constant investment opportunities. This approach is in the spirit of the "excess sensitivity" tests performed by Fazzari, Hubbard, and Petersen (1988) and Hoshi, Kashyap, and Scharfstein (1989) which we described previously, but corrects two deficiencies. First, by not relying on the "investment function" representation (i.e., that using q explicitly to control for investment opportunities), we avoid problems of measuring marginal q which can complicate the interpretation of other (i.e., "liquidity") regressors. Second, by allowing the effect of net worth on investment to vary systematically, we are able to model directly its role in the investment process, so that links between internal finance and investment are less subject to alternative interpretations.

B. Firms' Intertemporal Optimization Problem

Farmers maximize the present discounted value (V) of profits (Π) from the investments,[12] where

(1) $$V_0 = E_0 \sum_{t=1}^{\infty} \beta^t \Pi_t,$$

and β is the discount factor (i.e., the inverse of one plus the discount rate). The maximization takes place subject to the following constraints:

Capital Accumulation: $K_t = (1-\delta)K_{t-1} + I_t$, where I and K represent investment and the end-of-period capital stock, respectively, and where δ is the (assumed constant) rate of depreciation.

Profits: Profits are the residual after taxes, payments to variable factors, investment (and adjustment costs), and debt service. Finance is composed of internal equity and debt; no external equity is permitted.[13]

Let:

N = vector of variable factors of production

w = vector of variable factor prices

L = land

ℓ = rental rate on land

B = value of net debt outstanding (one-period loans)

i = interest rate on loans

p = agricultural price

p^I = effective price of capital goods at time t (incorporating tax considerations)

$F(K_{t-1},L_{t-1},N_t)$ = revenue function ($F'_K > 0$, $F''_K < 0$)

$A(K_{t-1},I_t)$ = costs of adjusting the capital stock.

Then,

$$(2) \quad \Pi_t = p_t F(K_{t-1},L_{t-1},N_t) - w_t N_t - \ell_t L_{t-1} - A(I_t,K_{t-1}) - i_{t-1}B_{t-1} + B_t - B_{t-1} - p_t^I I_t \quad .$$

All prices and values are expressed relative to the general price deflator (i.e., so that "real" profits are maximized).

<u>Transversality Condition</u>: So that a farming enterprise cannot borrow an infinite amount to distribute, we require that

$$\lim_{T\to\infty} \sum_{t=0}^{T-1} \beta^t B_T = 0, \quad \forall_t .$$

Let λ represent the multiplier associated with the capital accumulation constraint (i.e., "marginal q"). The first-order conditions for the revised optimization problem with respect to I, K, and B are given by[14]

(3) $$-A_I(K_{t-1}, I_t) - p_t^I + \lambda_t = 0 ,$$

(4) $$\beta E_t(p_t F_{Kt}) - \beta E_t(A_K(K_t, I_{t+1})) - \lambda_t + \beta(1-\delta)\lambda_{t+1} = 0,$$

and

(5) $$1 - \beta(1+i) = 0.$$

To obtain an equation for investment, it is necessary to parameterize the adjustment cost function A. We let[15]

(6) $$A(K_{t-1}, I_t) = [\alpha_0((I_t/K_{t-1}) - \mu) + (\alpha_1/2)((I_t/K_{t-1}) - \mu)^2]K_{t-1},$$

where μ is the average (normal) investment rate. Now,

(7) $$A_{It} = \alpha_0 + \alpha_1(I_t/K_{t-1} - \mu), \text{ and}$$

(8) $$A_{Kt} = -(\alpha_1/2)(I_{t+1}/K_t)^2 - \mu(\alpha_0 - \alpha_1\mu/2).$$

The recent tradition in the q-theory literature is to use equation (7) in conjunction with equation (3) and an assumption about the equality of marginal and average q to obtain an estimating equation. Instead of following this route, we eliminate the shadow value of capital from the equation and work with the dynamic equation for investment. Thus, substituting for λ_t and λ_{t+1} using equations (3) and (4) yields

(9) $$\beta E_t\{p_t F_{Kt} - A_K(K_t, I_{t+1}) + (1-\delta)[A_I(K_t, I_{t+1}) + p_{t+1}^I]\}$$
$$- A_I(K_{t-1}, I_t) - p_t^I = 0.$$

Substituting (7) and (8) into (9) yields

$$\text{(10)}\quad \beta E_t p_t F_{Kt} + \beta E_t[(\alpha_1/2)(I_{t+1}/K_t)^2] + \mu(\alpha_0 - \alpha_1\mu/2)$$
$$- \alpha_0 - \alpha_1(I_t/K_{t-1} - \mu) - p_t^I$$
$$+ \beta(1-\delta)E_t[\alpha_0 + \alpha_1(I_{t+1}/K_t - \mu) + p_{t+1}^I] = 0.$$

We assume that expectations are rational, and allow for an expectational error η, where $E_t(\eta_{t+1}) = 0$ and $E_t(\eta_{t+1}^2) = \sigma_\eta^2$. Hence,

$$\text{(11)}\quad \beta p_t F_{Kt} + (\beta\alpha_1/2)(I_{t+1}/K_t)^2 - \alpha_0 - \alpha_1(I_t/K_{t-1}) + \alpha_1\mu$$
$$+ \mu(\alpha_0 - \alpha_1\mu/2) - \beta(1-\delta)\alpha_1\mu - p_t^I + \beta(1-\delta)\alpha_1(I_{t+1}/K_t)$$
$$+ \beta(1-\delta)p_{t+1}^I = \eta_{t+1}.$$

The model in (11) is a nonlinear equation in I/K, which could be estimated to identify α_1 and β.

We incorporate financial factors by adding a constraint on the use of debt finance by farmers. In particular, we assume that the outstanding debt, B, must be less than an debt ceiling B^*. The ceiling, while possibly unobservable to the econometrician, depends on measures of collateralizable net worth.[16] That is, movements in the value of farmers' net worth will affect farmers' ability to finance investment, holding constant actual investment opportunities. If we let ω be the Lagrange multiplier associated with the constraint that $B \leq B^*$, we can rewrite the first-order condition in (5) as

$$\text{(5')}\quad 1 - \beta_t(1+i) - \omega_t = 0,$$

so that when ω is nonzero, $\beta_t = (1-\omega_t)/(1+i)$. We can, now rewrite equation (11) as:

$$(12)\quad \{\alpha_0[\beta(1-\delta)(1-\omega_t) - 1 + \mu] + \alpha_1\mu(1 - \mu/2)\} + \beta(1-\omega_t)[p_tF_{Kt} + (\alpha_1/2)(I_{t+1}/K_t)^2 + \alpha_1(1-\delta)(I_{t+1}/K_t) + (1-\delta)p^I_{t+1}] - \alpha_1(I_t/K_{t-1}) - p^I_t = \eta_{t+1},\ \text{or}$$

$$(12')\quad \{\alpha_0[\beta(1-\delta)(1-\omega_t) - 1 + \mu] + \alpha_1\mu(1-\mu/2)\} + \beta[p_tF_{Kt} + (\alpha_1/2)(I_{t+1}/K_t)^2 + \alpha_1(1-\delta)(I_{t+1}/K_t) + (1-\delta)p^I_{t+1}] - \alpha_1(I_t/K_{t-1}) - p^I_t = \eta_{t+1} + \omega_t\beta[p_tF_{Kt} + (\alpha_1/2)(I_{t+1}/K_t)^2 + \alpha_1(1-\delta)(I_{t+1}/K_t) + (1-\delta)p^I_{t+1}],$$

where $\beta = 1/(1 + i)$. During periods in which collateralizable net worth is low and the credit constraint is binding, $\omega > 0$, and the error term contains the additional expression in (12').

This approach in general underestimates the importance of financial constraints on the investment process. That is, merely satisfying the Euler equation between adjacent periods does not mean that investment corresponds to that predicted by the null "perfect capital markets" model. There are in principle a set of financial constraints for all future periods. Hence, the Euler equation for investment does not hold for current adjacent periods if -- conditional on all future constraints -- the contemporaneous constraint is binding. It will nonetheless be the case that, even if the current constraint is not binding, farmers may accumulate financial resources against the possibility of binding future constraints.[17] Our intent is not to simulate long-run "under-investment" because of "precautionary saving" by firms, but rather to study the effects of shocks to net worth on the timing of investment.[18]

C. Problems for Econometric Estimation

Three issues arise in the estimation of (12′). First, because the model is nonlinear in I/K (the dependent variable in the linear regression model in the q framework), estimation by nonlinear least squares is required. Second, there is an obvious simultaneity problem because of the presence of the expected marginal product of capital F_K in the model. The exact set of instrumental variables used are shown in the tables outlining our estimation results. Generally, we used single lags of a number of quantity and financial variables along with current and (once-) lagged values of prices -- the interest rate, price of land, and relative price of agricultural output. Many of the instruments were first-differenced to induce the stationarity required in the use of generalized method of moments estimation.

Land prices are an important instrumental variable to permit evaluation of competing hypotheses. Movements in land prices affect not only the value of land as a part of farmers' net worth, but also the expected marginal product of capital invested in agriculture. The land price variable allows for the role of expectations of movements in commodity prices. Hence, when we examine the effects of movements in internal net worth on capital spending, we are holding constant the impact of the associated price effects of those movements on investment opportunities.

Finally, the estimation strategy must reflect the fact that the appropriate model depends on whether the financing constraint is binding. We consider three approaches here. After estimating the basic model without credit constraints (i.e., equation (11)), we estimate (12) over a restricted sample including only periods in which, a priori, $\omega = 0$. Second, we parameterize ω as a function of an observable proxy for internal net worth, including interaction terms in (11) where appropriate; the estimated coefficients on those interaction terms should be zero under the symmetric-information null hypothesis. In addition, these first two strategies can be combined to test whether departures from the null model in equation (11) in the direction of the alternative in which net worth is important (equation (12)) are significantly greater during (a priori) "low net worth" periods. Finally, we investigate an implication of some models of the role of internal net worth in the investment decision that large decreases in net worth are more likely to depress capital spending, ceteris paribus, than are large increases in net worth likely to increase capital spending (see for example Gertler and Hubbard, 1988). We discuss these approaches in more detail in section IV, after reviewing sources of data for the variables in the model.

IV. DATA AND ESTIMATION

A. Construction and Data Sources

Before presenting our econometric evidence, we describe briefly the data we used in the estimation. Details of the data construction are contained in the Appendix; we summarize the principal points below. Proceeding term by term through equation (11), the capital stock series is calculated using the perpetual inventory method. The geometric depreciation rate used in the calculation is 0.12, which is consistent with estimates for tractors and agricultural machinery in Hulten and Wykoff (1981).[19]

The investment series that we used in forming the capital stock is the series on agricultural equipment provided by the Bureau of Economic Analysis of the U.S. Commerce Department. Equipment capital is an important factor of production that has traditionally accounted for much of the investment in the agricultural sector.[20] In addition, a long consistent time series is available for this type of investment. Since the data are available back to 1910, we can include several important pre-war credit crises in our analysis.

The components of equipment investment consist of tractors, agricultural machinery except tractors, metal working machinery, automobiles, trucks, buses and truck trailers and other equipment. However, tractors, agricultural machinery, and trucks, buses, and truck trailers are the dominant components of the series, accounting for over 80 percent of the investment in most years.

We use a series on the average product of capital to proxy for the marginal product of capital. The two variables will be proportional when the technology is constant returns to scale and factors are paid competitively, plausible assumptions in the agricultural sector. Our approximation to this average product is gross income less payments to variable factors. This measure also includes returns to land, of course. If output is Cobb-Douglas in capital, "labor" (variable factors), and land, the coefficient we estimate can be transformed to an estimate of the capital share if we multiply it by one plus the ratio of land's share to capital's share.[21]

The last variable in the equation, the relative price of investment goods, is multiplied by a tax correction factor that recognizes the benefits of the investment tax credit and the tax shields arising from depreciation expenses. None of our subsequent results is noticeably affected by whether or not we make the tax adjustment.

In the Appendix, we also describe our sources for the variables we use as instruments and as proxies for creditworthiness. This set of variables includes measures of land prices, equity and asset values, agricultural exports, interest rates, and government subsidies.

B. Summary Statistics: Investment and Net Worth

Figure 1 plots the ratio of equipment investment to the stock of equipment (at the beginning of the year). The figure demonstrates that agricultural investment has been (and continues to be) quite volatile. Major swings have taken place around both World Wars, during the Depression, and during the 1980s. The first column in Table 1 shows that despite these large fluctutations the mean and variance of the investment rate are quite similar during the pre-war and post-war periods. In each case, the average rate is between 14 and 15 percent and the standard deviation is approximately 5 percent.

The next two figures illustrate proxies for of net worth. Figure 2 shows the evolution of the price of land (relative to the GNP deflator). The top portion of this figure shows that the relative price of land has moved over a wide range during the last seventy years, including a change of more than sixty percent over the last decade. The bottom portion of the figure highlights this volatility by graphing the annual percentage change in the relative price.

Figure 3 shows movements in the ratio of farm equity to farm capital (at the beginning of the year). As with the land price series, the large fluctuations are quite common; over the last ten years of the sample, the ratio declined by over thirty percent before partially recovering in 1986 and 1987. The bottom portion of the figure, which shows percentage changes in the ratio, demonstrates that such swings are not unusual.

We use the movements in measures of net worth to identify periods where farmers creditworthiness is likely to be particularly high or low.

The series suggest two clear episodes where net worth collapsed in the pre-war period. First, all measures indicate large declines following the 1920-21 deflation. A second major collapse occurred at the onset of the Depression, say between 1930 and 1933, although net worth remained low for some time thereafter. Standard accounts of this period, for instance Tostlebe (1957), corroborate the view that these two episodes were quite severe. In our empirical work we will focus on the suggestion by Kindleberger (1973) and others that the entire 1921-33 period should be treated as a single regime where farmers' net worth was unusually low.

Following World War II, the situation was much better. As discussed by Calomiris, Hubbard, and Stock (1986), the period between 1955 and 1979 was one without any major crises. Indeed, the commodity and land price boom of the seventies suggest that creditworthiness was especially high over the last few years of this period. However, agriculture was particularly hard hit during the general macroeconomic decline in the early 1980s. As the two figures suggest, the 1981-86 period was another episode where insiders' stakes were likely to have been very low. On balance, it appears that the 1921-33 and 1981-86 periods were "busts" while the 1955-79 period was a "boom" period.

These impressions are confirmed by the lower two rows of Table 1. The average annual decline in the relative price of land over the low-net-worth years was 4.76 percent; in terms of the equity-to-capital ratio, the fall was also dramatic, averaging 3.5 percent per year. That these year were unusually poor can also be seen in the investment data. The investment rate averaged only 11 percent per year during these episodes, so that net investment would typically have been negative.

A striking contrast emerges when these years are compared to the period between the Korean War and the second oil shock. As reported in the table, the average increase in the two measures of farmers' net worth over these years was 3.44 and 1.25 percent, respectively. The low standard deviation and steady rate of investment also suggest that this was a healthy period for U.S. agriculture.

C. Estimation

We pursue three sets of tests with a common underlying strategy. Under the null hypothesis that financial factors are irrelevant, the overidentifying restrictions associated with the basic model should be rejected. Under the alternative model, ω should be nonzero on average, and the overidentifying restrictions should not be rejected.

As a starting point we estimate equation (11), the Euler equation under perfect capital markets, over the entire sample; in all of what follows we omit the period surrounding World War II (1941-1947). After allowing for lags of the instruments, the feasible sample period is 1914 to 1987, and we estimate four parameters: the discount factor, (a transformation of) the share of capital in output, the cost-of-adjustment coefficient, and the constant term. The first column of Table 2 presents estimates for the first test described above; the constant is a nonlinear combination of the structural parameters and thus cannot be interpreted.

The overidentifying restrictions can be rejected for the sample as a whole with ω set equal to zero. The estimated implied discount rate of approximately 8.8 percent is high, especially in a sector in which significant public subsidies and non-pecuniary income are often argued to be responsible for continued participation by farmers in much of the postwar period. We return to this point below in considering the possibility of implicit credit constraints linked to movements in internal net worth. The implied share of equipment is in line with estimates reported in Tostlebe (1957), Griliches (1963), and Mundlak and Hellinghausen (1982).

The cost-of-adjustment parameter is estimated to be slightly greater than unity. This estimate is very encouraging since the typical q model typically leads to estimates that are implausibly large. One way to assess the plausibility of this estimate is to use it to infer the equilibrium value of q that is consistent with this sized adjustment parameter. Since depreciation is assumed to be 12 percent, a quadratic adjustment parameter of one implies an equilibrium value of q of 1.12.[22]

To test whether the ability of the investment model to explain the data is altered in "low net worth" periods, we estimated the model in equation (10) over the sample period excluding one of two sets of observations -- (i) 1921-22, 1930-33, and 1981-86; or (ii) 1921-33 and 1981-86. The former is motivated by the sharp decline in farmers' net equity positions noted in Figures 2 and 3. The latter is motivated by the concern in Kindleberger (1973) and Tostlebe (1957) that much of the agricultural sector is credit-constrained during the 1920s. Results from this experiment are also reported in Table 2. The overidentifying restrictions cannot be rejected. In both cases, the point estimate of β rises (though it is not statistically different), and the estimated share of equipment capital remains roughly constant.

To investigate further the role of declines in net worth in generating rejections of the model, we also estimated the basic model without using the (change in the lagged) equity-to-capital ratio as an instrument. These results are shown in the fourth column of Table 2. Omitting this instrumental variable eliminates the correlation between the equation residuals and the remaining instruments. The estimate of the discount factor also rises further so that the implicit interest rate is actually estimated to be negative; correspondingly the estimated (transformed) share of capital falls.

Taken together, the results in the second and third columns of the table strongly suggest that large declines in internal net worth are responsible for the rejection of the model. That the model is not rejected when we omit the net worth proxy is evidence that interest rate shifts alone are not responsible for the model's rejection, even though ex post real rates may have been high during periods in which internal net worth was low. Put differently, shifts in land prices and interest rates are not correlated with the investment residuals, while movements in net worth are. Moreover, the movements in net worth outside of episodes of significant declines are not important predictors of unexplained movements in investment.

Our second set of tests takes a more parametric approach to studying the effects of movements in internal net worth on investment spending, holding constant investment opportunities. We allow ω, the multiplier on the credit constraint, to depend negatively on changes in internal net worth, a, so that

$$(13) \qquad \omega_{t+1} = \gamma a_t ,$$

where $\gamma < 0$. Here we use the first difference in the value of farmers' net worth (assets less liabilities) relative to beginning-of-period capital stock as a proxy for the internal net worth measure. Using instead changes in land values produced very similar results.[23]

The results reported in Table 3 incorporate this generalized version of the model that allows for the possibility that net worth constrains finance and investment. Given this parameterization, γ, the constant of proportionality in (13), should be negative. We find that γ is indeed negative and large enough to suggest that net worth effects on finance and investment are potentially very important. Taken literally, the estimated value of γ indicates potentially large effects of movements in net worth on capital spending, all other things equal. Using the coefficient estimates obtained for the full sample, a 5-percentage-point decline in farmers' real net worth would lead to an increase in the implied discount rate to more than 20 percent; we discuss the interpretation of this effect below. There is another coefficient to be estimated in equation (12) because the γ also multiplies part of the constant term. The signs of the estimates suggest that α_0 is positive.

In the second column of Table 3, we report results allowing a role for internal net worth only in the "low net worth" periods identified before (that is, here, 1921-33 and 1981-86; results using 1921-22, 1930-33 in place of 1921-33 were virtually identical for this experiment and all that follow, and thus are not reported).

While the point estimate of γ is larger (in absolute value), the overidentifying restrictions are still rejected under this specification. The rejection could arise for several resons, although (from the design of the experiment) the effects of decline in internal net worth during the 1980s may have differed from the effects during the earlier deflationary periods. Our concern is due principally to the significant role of government programs in maintaining farm incomes during the 1980s.[24] Our measure of net income of farmers includes direct payments under government programs, but it does not incorporate implicit subsidies from renegotiated debt settlements or partial or complete loan chargeoffs. In particular, there were substantial injections of funds from the Economic Disaster Program and Farm Operating Loan Program of the Farmers Home Administration (FmHA) in the middle 1980s. Though there were official funding limits prescribed by the Congress, some loan programs (e.g., the FmHA's Economic Disaster Program) had "entitlement" status with broad funding limits, so the Secretary of Agriculture could transfer funds from them to operating loan programs to circumvent official lending ceilings (see Calomiris, Hubbard, and Stock, 1986). To the extent that this extra lending or reduced debt burdens were important, farmers' effective resources are understated, making it difficult to isolate the role of internal net worth in the investment process, holding constant investment opportunities.[25]

To assess further the importance of the low-net-worth episodes, we reestimated the model allowing the multiplier to depend on net worth only during the 1921-33 period (again, results are similar using 1921-22 and 1930-33). The results are presented in the third column of Table 3. The failure to reject the models' overidentifying restrictions is stronger than that in the results in the first column. Relative to the results in the second column, the estimate of γ is much larger, and the residuals are no longer correlated with the instrumental variables. Using the point estimates of β and γ in the third column (along with the data on movements in internal net worth reported in Table 1), the estimated discount factor was substantially lower (0.86 as opposed to 1.03 over the sample as a whole). Though not reported, when we estimated the model explored in Table 3 with separate γ coefficients for the 1921-33 and

1981-86 episodes, the point estimate for the earlier period was about 50 percent higher than for the later period (although the standard errors were sufficiently large to make the difference statistically insignificant). We conclude that the earlier period constituted a more severe internal net worth shock (along the "redistribution" dimension important for our conceptual experiment) and that it is inappropriate to treat the two episodes symmetrically.

Finally, to consider asymmetric effects of increases and decreases in internal net worth, we reestimated equation (11), allowing different values of γ in "low net worth" and "high net worth" periods. For the former, we used the 1921-33 and 1981-86 periods. For the latter, we use the periods from 1955 to 1979, a long period without important deflationary shocks to farmers' net worth, including periods of rising commodity prices and land values. Because of the greater number of parameters being estimated, the standard errors associated with some of the coefficients are higher, but the results are very suggestive. In particular, the negative estimate of γ (the link between movements in net worth and the multiplier on the credit constraint) is traceable only to the falling-net-worth periods. The estimated value of γ during the rising-net-worth period has the wrong sign and is not statistically significant from zero at the 5 percent confidence level.

The second column of Table 4 reports estimated coefficients when the 1980s are removed from the "financial factor" periods. The failure to reject the model's overidentifying restrictions is much more dramatic. The incremental role of internal net worth is larger during the "low net worth periods" (during the 1920s and 1930s) and is more precisely estimated. The estimated coefficient during the 1955-79 period again has the wrong sign. The contribution of movements in net worth in explaining movements in capital spending -- holding constant investment opportunities -- is a feature of the "low net worth" periods only.

In summary, the tests presented above support the idea that movements in collateralizable net worth are economically important factors in the determination of investment spending during periods in which net worth is low or falling. Absent consideration of such effects, estimated discount rates are implausibly high. By excluding periods identified *a priori* as corresponding to periods of falling real net worth, the overidentifying restrictions associated with the investment model can no longer be rejected. Moreover, violations of the Euler equation for investment in the direction of an alternative model in which net equity constrains finance and investment are pronounced only in deflationary periods. The pattern is not symmetric to boom periods in which net worth is rising.

V. SUMMARY AND CONCLUSION

Recent models of firm investment decisions stressing problems of asymmetric information in capital markets provide a foundation for interpreting evidence that movements in internal finance can predict investment spending, even after controlling for measures of firms' investment opportunities. While such evidence is suggestive, it is often open to other interpretations; most models stress the importance of collateralizable net worth, while empirical studies using aggregate time-series data or firm-level panel data have employed proxies like "cash flow."

Our paper addresses this gap in two ways. First, we focus on the U.S. agricultural sector during the twentieth century; the sector has experienced large fluctuations in farmers' net worth and in the profitability of agricultural investment, and reasonable measures of net worth can be constructed. Second, rather than relying on investment function representations (such as the often used q-theory approach), we make use of predictions generated by firms' Euler equation for capital accumulation. Intuitively, during periods in which net worth is high, the Euler equation should hold across adjacent periods; the equation will not hold for periods in which the shadow price of external finance is high because of low net worth (loosely speaking, periods in which "finance constraints" bind). Such an approach offers an alternative model for periods in which internal net worth is low (holding constant investment opportunities), and generates a link between internal net worth and investment spending during periods of significant deflation on the value of net worth.

Our empirical evidence is presented in three parts. First, the null structural model for investment is rejected by the data. As a result of omitting periods during which there were substantial negative shocks to farmers' net equity positions (either because of significant reductions in land values or "debt deflation" episodes or both), the model's overidentifying restrictions can no longer be rejected. Second, allowing for movements in farmers' net equity position contributes importantly to explaining investment. Third, the effect of changes in net worth on investment is significantly more important during the deflationary periods previously identified than during "boom" periods. Taken together, these findings provide support for a class of "internal funds" models of investment under asymmetric information.

NOTES

[1]See the derivation in Hall and Jorgenson (1967).

[2]See for example Hayashi (1982) and Summers (1981).

[3]Various forms of "accelerator" models appear to fit the data better than the more structured q or neoclassical models (see the review of studies in Fazzari, Hubbard, and Petersen, 1988). Recently, Abel and Blanchard (1986) found strong output and profits effects on aggregate investment in a q model.

[4]See for example Jaffee and Russell (1976), Leland and Pyle (1977), Stiglitz and Weiss (1981); Greenwald, Stiglitz, and Weiss (1984); Myers and Majluf (1984); Bernanke and Gertler (1990); Calomiris and Hubbard (1989, 1990); and the review of approaches in Gertler (1988).

[5]This, of course, does not imply that agency-cost-related problems cannot be important for large firms. See discussion in Gertler and Hubbard (1988).

[6]The intuition is as follows. If the cost disadvantage of external finance is small, then retention behavior over a long period of time should be irrelevant for real investment decisions. On the other hand, firms that finance most of their investment from retained earnings (i.e., that have low average payout) may do so because they face high costs of obtaining external finance at the margin. Fluctuation in internal net worth should affect investment for such firms.

[7]This is a feature of models based on moral hazard (e.g., Bernanke and Gertler, 1990; and Gertler and Hubbard, 1988) and adverse selection (e.g., Calomiris and Hubbard, 1990).

[8]Woodruff (1937) concluded that, during the Depression of the 1930s, poor soil maintenance practices were thought by lending agents of life insurance companies to accompany credit constraints for farmers. More recently, Lee (1980) notes a relationship between uncommitted cash flows and expenses for soil conservation.

[9]By way of example, Gertler and Hubbard (1988) consider a problem in which entrepreneurs produce output from "hard capital" (standard investment goods) and "soft capital" (organizational and maintenance expenditures). The former category of investment spending is observable by both the entrepreneur and suppliers of external capital; the latter is observable only by the entrepreneur. Because soft capital; the latter is observable only by the entrpreneur. Because soft capital improves the likelihood of good output realizations, an agency problem arises. Namely, the entrepreneur can misappropriate funds intended for soft capital.

[10]An alternative to using financial variables as proxies for marginal q is to use a forecasting approach, as in Abel and Blanchard (1986). As that approach requires imposting structure on the expectations process, it is subject to the Lucas (1976) critique.

[11]Related issues have, of course, been addressed in models of consumption. One can solve for "consumption functions" out of (human and nonhuman) wealth from consumers' intertemporal utility maximization. Alternatively, the approach pioneered by Hall (1978) makes use of the Euler equation, avoiding the problems of measuring wealth. This approach has been used in a test for "liquidity constraints" by Zeldes (1988), who finds that the Euler equation holds for "high wealth" individuals, but is

rejected for "low wealth" individuals, for whom current resources help to predict consumption.

[12]The question arises as to whether an observed sensitivity of investment spending to movements in net worth or internal finance might reflect "risk aversion" on the part of farmers. We chose not to model risk aversion in this context for two reasons. First, risk-averse farmers could hedge in futures markets or sell output via long-term contracts to risk-neutral borrowers (as in Carlton, 1979; or Hubbard and Weiner, 1989). Second, that farmers appear to care about the variance of cash flows need not reflect risk aversion per se. A very large fraction of farmers' net worth is held in farm land, so that their portfolios are poorly diversified. This lack of diversification corresponds more closely to the capital-market frictions we discuss, wherein insiders' stakes in projects are important, holding constant investment opportunities.

[13]That is, we assume that the dissociation of farm ownership and management leads to efficiency losses associated with agency costs (see e.g. Jensen and Meckling, 1976, 1979). As an example, ownership-management separation can create disincentives for soil conservation and maintenance (hence decreasing output in the future) because of short-term leases or inequitable sharing of the benefits and costs of conservation investments (see Calomiris, Hubbard, and Stock, 1986).

[14]There are also first-order conditions for land and variable factor, of course.

[15]This formulation assumes convex adjustment costs. In addition, costs are decreasing in the size of the capital stock.

[16]Another way to incorporate this feature would be to allow B^* to depend on, say, asset values less debt. If we denote net worth by W, the constraint on finance would then be

$$B_t \leq B_t^*(W_{t-1}), \text{ or}$$

$$B_t \leq dW_{t-1},$$

if d is a constant leveraging factor. Equation (5') in the text would then become

$$(5'') \qquad 1 - \beta_t(1+i) - \omega_t + \beta_t d\omega_{t+1} = 0.$$

If, for example, $\omega_{t+1} = \rho\omega_t + u_{t+1}$, where $E_t(\omega_{t+1}|\omega_t) = \rho\omega_t$, then,

$$(5''') \qquad 1 - \beta_t(1 + i) - (1 - \beta_t d\rho)\omega_t = 0.$$

[17]This point is general to the Euler equation formulation. See for example the discussion in the context of "borrowing constraints" and consumption in Zeldes (1988).

[18]These issues are discussed in detail in Gale (1983, Chapter 4).

[19]We varied this rate between 0.10 and 0.20, and found that none of the results was substantively affected.

[20]Tostlebe (1957) notes that, historically, most non-real-estate debt is used to finance equipment investment rather than additions to working capital.

[21]To see this, let $F = K^a L^b N^{1-a-b}$. We use as our proxy for the average product of capital $\tilde{F}_K$, where

$$\tilde{F}_K = \frac{pF - \text{Production expenses}}{p^K K},$$

where $p^K K$ is the value of capital. Under the Cobb-Douglas assumption,

$$\tilde{F}_K = (1+b/a)F_K.$$

[22]This calculation assumes that adjustment costs apply to gross investment, and that the value of α_0 in the cost-of-adjustment equation

is zero. The basis of this calculation is that the simplest q setup implies a linear relation between (I/K) and q -- specifically that q will equal α_0 plus α_1*(I/K). If, in equilibrium, net investment is zero, then (I/K) will equal the product of the depreciation rate and α_1. This can be seen from combining equations (3) and (8) in the paper, while setting $p^I = 1$ and $\mu = 0$.

[23]Hayashi and Inoue (1990) have criticized the use of "cash flow" as a proxy for "a," since movements in cash flow may be correlated with shocks to the production function (which are not explicitly considered here). In our case, movements in the net worth variables are (historically) in large part accounted for by redistributions (i.e., "debt deflation"), so that any correlation with shifts in the production function are much weaker.

[24]We use changes in asset values (land prices) as an instrument for the marginal product of capital, so that the role of net worth proxies as separate variables is purged of an expectational interpretation. Second, the periods during the early 1920s and 1930s were ones for which, on account of deflation, the real value of existing liabilities increased substantially. For these periods, the decline in net worth as a result of revaluation of existing debt was over half as large as the contribution from the decline in asset (largely land) values (Melichar, 1987, Table 101). Hence, reductions in net worth were substantial, holding constant any change in investment opportunities.

[25]We experimented with proxies for federal farm lending through the Farmers Home Administration in parameterizing (13) (treating such lending as endogenous), but we were unable to isolate any important effect in lowering the multiplier associated with the net worth constraint.

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Figure 1

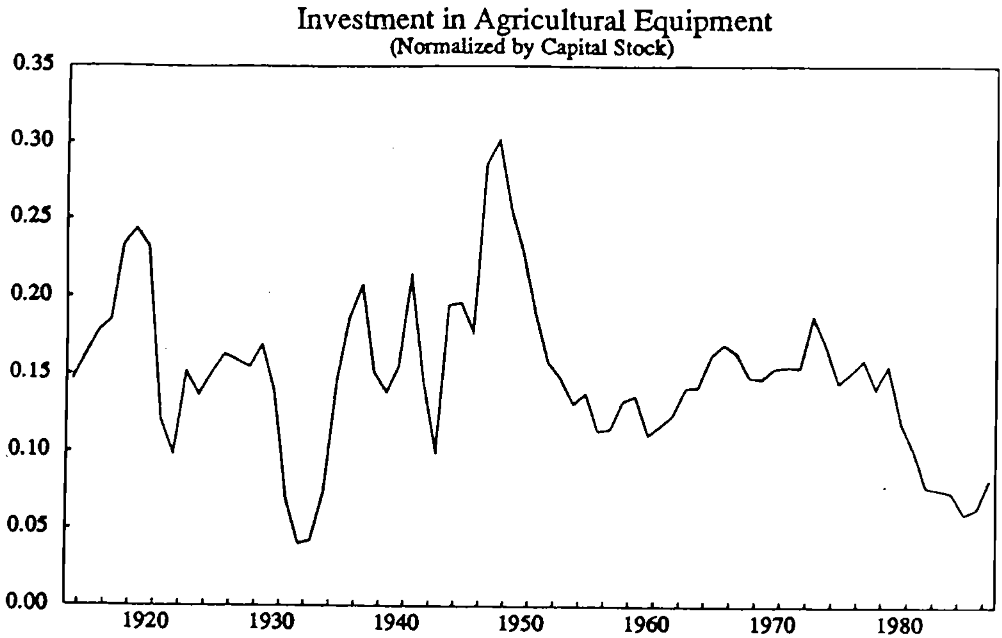
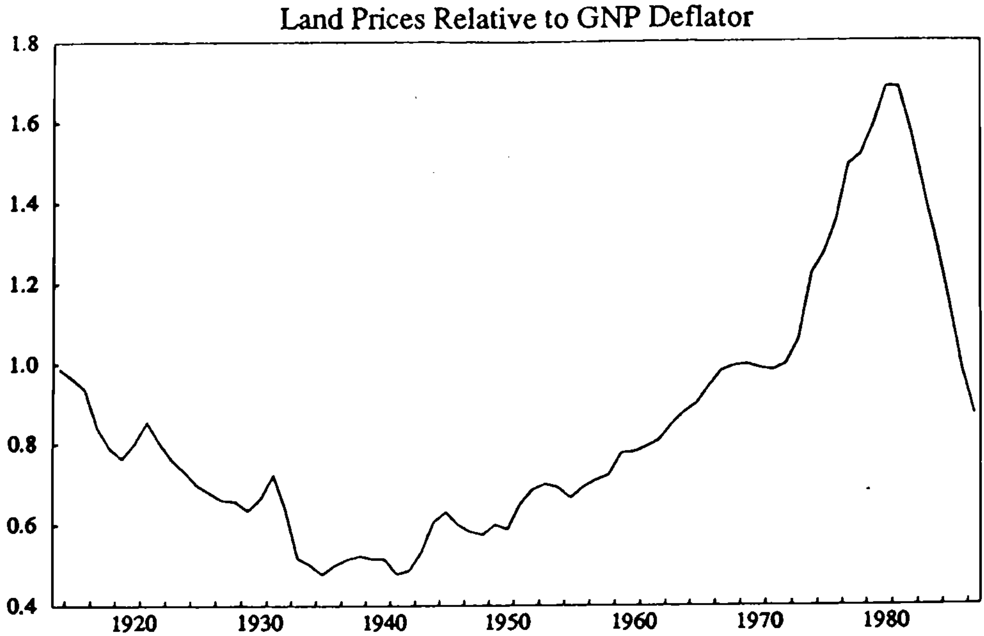

Investment in Agricultural Equipment
(Normalized by Capital Stock)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1920
1930
1940
1950
1960
1970
1980

Figure 2


Land Prices Relative to GNP Deflator
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
1920
1930
1940
1950
1960
1970
1980

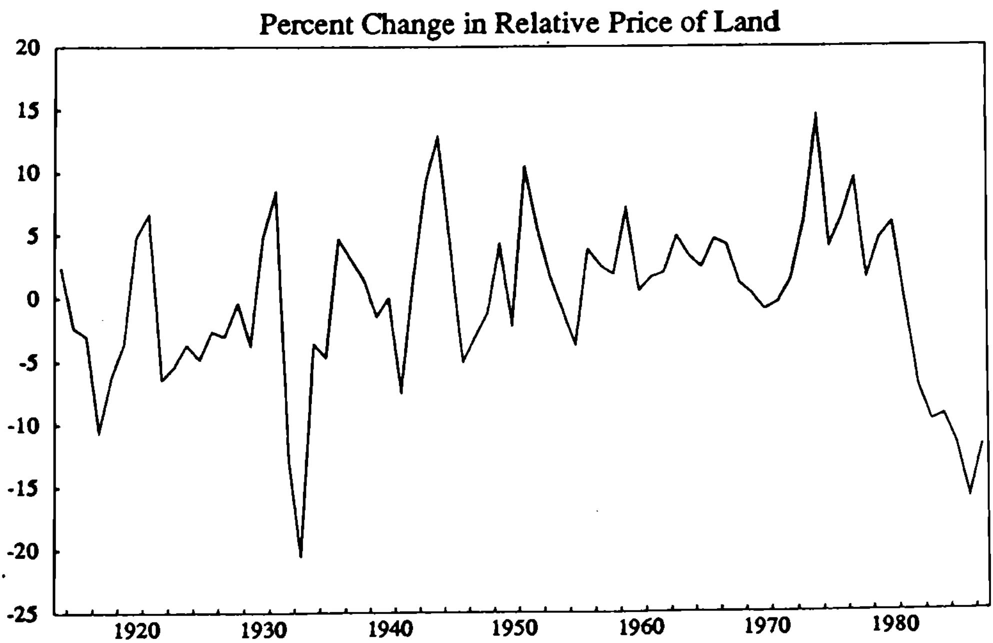
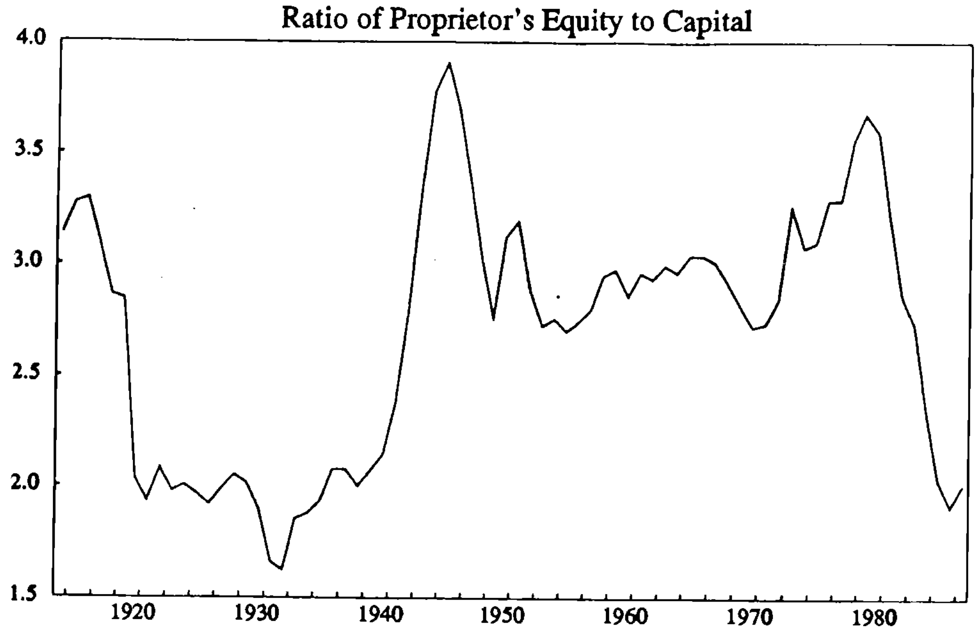

Percent Change in Relative Price of Land
20
15
10
5
0
-5
-10
-15
-20
-25
1920
1930
1940
1950
1960
1970
1980

Figure 3


Ratio of Proprietor's Equity to Capital
4.0
3.5
3.0
2.5
2.0
1.5
1920
1930
1940
1950
1960
1970
1980

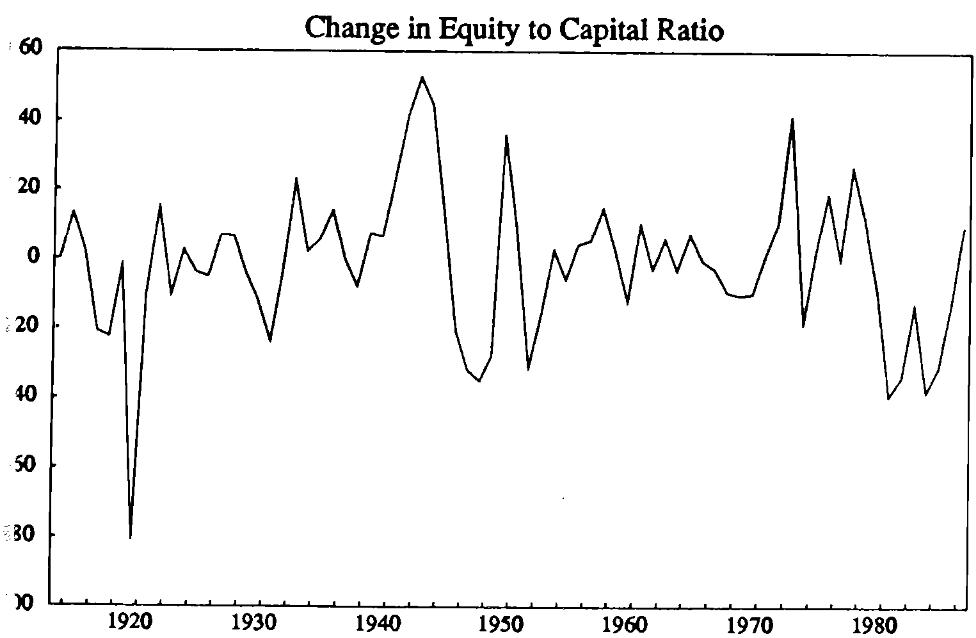

Change in Equity to Capital Ratio
60
40
20
0
20
40
1920
1930
1940
1950
1960
1970
1980

Table 1

SUMMARY STATISTICS FOR INVESTMENT AND MEASURES OF NET WORTH

	Investment / Capital		% Change in Relative Land Price		% Change in Equity to Capital Ratio	
Period	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1914-87	.15	.05	.07%	6.38%	-.29%	4.70%
1914-39	.15	.05	-2.20	6.03	-1.25	7.80
1948-87	.14	.05	1.21	6.18	-1.08	6.48
1921-33; 1981-86	.11	.04	-4.76	7.05	-3.48	.38
1955-79	.15	.02	3.44	3.84	1.25	4.36

Source: Authors' calculations as described in the text.

Table 2

EULER EQUATION ESTMATES FOR INVESTMENT MODEL

(U.S. AGRICULTURAL SECTOR, 1914-1987)

Parameter	Basic Model (Equation (11))	Basic Model (Excluding 1921-22, 1930-33, 1981-86)	Basic Model (Excluding 1921-33, 1981-86)	Basic Model (No Net Worth Instrument)
Constant	-0.191 (0.067)	-0.156 (0.069)	-0.148 (0.065)	-0.041 (0.091)
Discount factor (β)	0.919 (0.076)	0.948 (0.072)	0.957 (0.069)	1.08 (0.090)
Equipment share	0.074 (0.031)	0.073 (0.025)	0.074 (0.025)	0.025 (0.029)
Quadratic adjustment cost factor (α)	1.30 (0.356)	1.47 (0.446)	1.52 (0.533)	1.89 (0.439)
χ^2-Orthogonality test (p value)	20.45 (0.040)	16.79 (0.114)	16.50 (0.123)	10.06 (0.439)

Note: The models are estimated using generalized method of moments. Instruments used in the baseline specification include a constant; a single lag of I/K, $(I/K)^2$, and Y/K; the change in real exports; the change in Farmers' Home Administration lending (normalized by K); the change in the ratio of farmers' equity to capital; the rate of real capital gains on farm debt; contemporaneous and once-lagged values of the relative price of capital; the change in land prices; and the change in the interest rate. Additional dummy variables are used as instruments in models in which parameters are allowed to vary over certain periods. Heteroscedasticity consistent standard errors are reported in parentheses.

Table 3

EULER EQUATION ESTIMATES FOR ALTERNATIVE INVESTMENT MODEL

(U.S. AGRICULTURAL SECTOR, 1914-1987)

	Net Equity Effect		
		Low-Net-Worth Periods Only	
Parameter	All Years	1921-33; 1981-86	1921-33
Constant	-0.230 (0.056)	0.039 (0.069)	-0.072 (0.083)
Discount factor (β)	0.852 (0.069)	1.16 (0.084)	1.05 (0.081)
Equipment share	0.105 (0.028)	0.019 (0.018)	0.025 (0.028)
Quadratic adjustment cost factor (α)	0.605 (0.169)	0.797 (0.398)	0.918 (0.537)
Proportionality factor (γ) between credit-constraint multiplier (ω) and change in net worth	-0.014 (0.004)	-0.020 (0.009)	-0.055 (0.036)
Shift in constant due to time varying credit-constraint multiplier (ω)	0.011 (0.029)	0.021 (0.009)	0.062 (0.045)
χ^2--Orthogonality test (p value)	15.78 (0.071)	20.19 (0.027)	13.62 (0.191)

Note: "Low net worth" periods incorporate 1921-33 and 1981-86; or 1921-33, as indicated. The models are estimated using generalized method of moments. Instruments used in the baseline specification include a constant; a single lag of I/K, $(I/K)^2$, and Y/K; the change in real exports; the change in Farmers' Home Administration lending (normalized by K); the change in the ratio of farmers' equity to capital; the rate of real capital gains on farm debt; contemporaneous and once-lagged values of the relative price of capital; the change in land prices; and the change in the interest rate. Additional dummy variables are used as instruments in models in which parameters are allowed to vary over certain periods. Heteroscedasticity consistent standard errors are reported in parentheses.

Table 4

EULER EQUATION ESTIMATES FOR ALTERNATIVE INVESTMENT MODEL:

DIFFERENTIAL EFFECTS OF CHANGES IN NET WORTH ON INVESTMENT

(U.S. AGRICULTURAL SECTOR, 1914-1987)

Parameters	Including 1980s in "Low Net Worth"	Excluding 1980s from "Low Net Worth"
Constant	-0.010 (0.102)	-0.081 (0.083)
Discount factor (β)	1.109 (0.106)	1.059 (0.081)
Equipment share	0.022 (0.022)	0.008 (0.024)
Quadratic adjustment cost factor (α)	1.107 (0.428)	2.02 (0.313)
γ: Low-net-worth periods (1921-33)	-0.016 (0.011)	-0.076 (0.039)
γ: High-net-worth period (1955-79)	0.018 (0.038)	0.113 (0.072)
Shift in constant (low - net-worth - periods)	0.017 (0.012)	0.080 (0.047)
Shift in constant (high - net-worth periods)	-0.019 (0.038)	-0.122 (0.078)
χ^2 -- Orthogonality test (p value)	16.33 (0.062)	7.61 (0.574)

Note: The models are estimated using generalized method of moments. Instruments used in the baseline specification include a constant; a single lag of I/K, $(I/K)^2$, and Y/K; the change in real exports; the change in Farmers' Home Administration lending (normalized by K); the change in the ratio of farmers' equity to capital; the rate of real capiatl gains on farm debt; contemporaneous and once-lagged values of the relative price of capital; the change in land prices; and the change in the interest rate. Additional dummy variables are used as instruments in models in which parameters are allowed to vary over certain periods. Heteroscedasticity consistent standard errors are reported in parentheses.

DATA APPENDIX

The data used in this paper are taken from a number of sources and are available on a diskette from the authors. The details regarding the data sources and data construction are as follows:

Investment: The basic data are the Commerce Department's constant-cost series for Farm Equipment Investment. Data prior to 1985 are published in Table B-4 of Fixed Reproducible Tangible Wealth in the United States, 1925-1985 (published by the Commerce Department). The more recent data were obtained from unpublished Commerce Department data. We also used investment data for Farm Structures to construct a second capital series to use in the net worth proxy described below. These data are collected from the same sources shown above.

Capital Stock: The capital stock series are built up using a perpetual inventory method with an assumed depreciation rate of 12 percent for equipment and 2.37 percent for structures. The initial values for these series were taken from the 1910 Census of Agriculture, which is reprinted in Tostlebe (1957, Table 9).

Proprietors' Equity: Our proxy for farmers' net worth is the ratio of farm proprietors' equity to capital. The equity series is taken from Table 411 in Melichar (1987). The capital series is the sum of the equipment and structures series whose construction was discussed above.

Price Indices: The land price index we use is the Farm Real Estate Index which is stored online in the Federal Reserve Board's Macro Data Library. The original source for this series is the USDA's Farm Real Estate Market Developments publication. The GNP deflator is taken from the Economic Report of the President and Balke and Gordon (1986). The investment-goods price deflator is inferred from the difference between the Commerce series for nominal and real investment.

Tax Corrections: The relative price of investment goods is corrected for the presence of the depreciation allowances and the investment tax credit. Time series for corporate tax rates, investment tax credit rates, and the present value of one dollar's worth of depreciation allowances are taken from Pechman (1987).

Average Product of Capital: The average product of capital is calculated by taking the ratio of net income to capital. Net income is the difference between the gross income and production and labor expenses. The "Gross Income" series is taken from Table 111 in Melichar (1987). The "Production Expenses" series appears in the USDA's Economic Indicators of the Farm Sector, 1987 National Financial Summary, Table 24. "Labor expenses" are reported in Table 60 (column 2) of the same publication. (Data prior to that which appears in the National Financial Summary are taken from the Federal Reserve Board's Macro Data Library.)

Rates of Return: The interest rate used as an instrument in the estimation is a spliced rate that combines the average contract rate on farm mortgages obtained from banks and the Production Credit Association's (PCA) average cost of loans. The splice was necessary because the PCA did not exist prior to 1934. We view this rate as the best proxy for farm lending rates and therefore use it as soon as it becomes available. This series is taken from the USDA's Agricultural Statistics publication. The rate we use for the 1910 to 1934 period is taken from USDA Miscellaneous Publication 478, "Farm-Mortgage Credit Facilities in the Unites States." The real rate of capital gains on farm debt was also used as an instrument. This series was taken from Table 101 of Melichar (1987).

Agricultural Exports: This series is also used as an instrument in the estimation. It is taken from the Economic Report of the President, 1988; US Foreign Agriculture Statistics-- Calendar Year Supplement for 1970; and Historical Statistics of the United States from the Colonial Times to 1970. The data from the first two sources are on a calendar-year basis and are available back to 1930. The data from the Historical Statistics is on a fiscal-year basis; we spliced the two series assuming that growth rates across fiscal years is the same as across calendar years.

Government Payments and Lending: Data on the value of total government payments to farmers was also used as an instrument. This series is taken from the USDA publication titled Agricultural Statistics. The most recent data come from Table 583 in the 1988 edition, data from earlier editions along with the Historical Statistics of the United States from Colonial Times to 1970 were used to construct the complete series. The value of Farmers Home Administration (FmHa) lending was also used in constructing an instrument. These data are taken from Table 511 in Melichar. The GNP deflator was used to convert both these nominal series into constant dollar series.