Journal of Rural Development 13(1990) : 37 ~ 53

FARM INVESTMENT AND EXPECTATIONS

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The study of investment behavior has held an important place in the macroeconomic literature. Investment is essential for economic growth, and it plays a central role in determining the movement of business cycles, employment, and inflation. Investment behavior in the U.S. farm sector affects asset fixity, productive capacity and costs of production. It also represents an important transmission variable for macroeconomic policy to the farm sector, one of the most highly capitalized sectors in the U.S. economy. The adoption of emerging technologies embodied in durable goods may also improve the comparative advantage of an export-oriented U.S. agriculture in the competitive world market. Thus, it is important to identify the determinants of investment behavior and to correctly specify empirical investment functions for different categories of durable farm assets.

Investment is essentially dependent upon past and current market conditions as well as expectations of future market conditions. The unobservability of expectations poses a serious problem for empirical applications of investment theory. The specification of expectations is crucial because the desired stock of capital is hypothesized to be dependent upon expected future output and prices over investment period. Indeed, the importance of expectations in investment models has been recognized for two decades ; however, most studies still specify expectations based on the distributed lag model.

This study is motivated by the need to study the interrelationship between alternative expectation hypotheses and investment behavior of producers in the U.S. farm sector. A major problem confronting the U.S. farm sector is overinvestment and the asset fixity of farm physical assets. While previous studies have ignored the importance of expectation specifications to explain farmers' investment behavior, this study will focus on the linkage between farmers' investment decision and expected implicit revenue from crop production. In addition, there is a lack of studies addressing the effects of farm program policy on investment in the U.S. farm sector.

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The aggregate model used in this study explicitly accounts for the interaction among sectors in the economy in a simultaneous fashion. Using an existing general equilibrium model emphasizing agriculture, this study will compare the effects of specific macroeconomic and farm policies under the various expectations regimes on farm investment expenditures. Environmental issues and food safety are receiving increased attention in the current 1990 Farm Bill debate[1]. In addition to a baseline scenario for farm durable investment over the 1990–98 period and a macroeconomic policy scenario focusing on budget deficits, therefore, this study will examine a scenario dealing with reduced chemical use in crop production. The focus in each instance will be on the nature of the shock to farm durable input expenditures transmitted through each expectations hypothesis.

I. Neoclassical Investment Model

The neoclassical investment model is chosen over the alternative models in this study because of the direct linkages it enables us to establish between farmers' investment decisions and government policies[2]

The point of departure for the neoclassical investment model in this study is the specification of the cash flows in current and future periods. Coen(1975) advanced the concept of an implicit rental price of capital in studies of aggregate investment behavior in the U.S. manufacturing sector. Penson, Romain and Hughes(1981) developed a net investment model to investigate several capacity patterns that incorporate their measure of the implicit rental price for capital. Under the assumption of Cobb–Douglas production technology, the desired stock of durable goods can be expressed as follows :

(1) $$K^*_j = \beta \ (E(R)/E(C_j))^*$$

Where K^*_j is the desired stock of capital measured according to the j th capacity depreciation pattern, $E(R)$ is the expected implicit revenue from crop production, β is partial production elasticity associated with K_j , and $E(C_j)$ is the expected implicit rental price of capital

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[1] See Knutson, Taylor, Penson, and Smith(1990) ; Johnson, Wolcott, and Aradhyula (1990) for more detail discussions on environmental issues in the 1990 Farm Bill debate.

[2] Three of the more frequently utilized investment specifications are (1) the accelerator model, (2) the neoclassical model, and (3) Tobin's q model, The accelerator and q models are not as appropriate for policy analysis because these models are not structural in design.

associated with the j th depreciation pattern[3]. This specification implies that the desired stock of durable goods used in crop production is positively affected by expected revenue from crop production and negatively affected by the expected implicit rental price for farm durable goods.

An important innovation to the neoclassical investment model is the concept of implicit rental price of capital as a determinant of the desired stock of capital. The market price of a durable input alone does not reflect the full marginal factor cost that producers should consider when making purchasing decisions. The studies initiated by Jorgenson(1971) more than two decades ago introduced the notion of implicit rental price of capital to evaluate the effects of monetary and fiscal policies upon capital investment behavior. In agricultural investment studies, Penson, Romain and Hughes proposed a modification to the measure of the implicit rental price for durable inputs originally advanced by Coen. Their measure of the implicit rental price of capital for durable goods is adopted in this study.

Annual gross investment for a durable input is composed of net investment and replacement investment. Annual net investment according to the j th capacity depreciation pattern is given by :

(2) $$N_{jt} = K_{jt} - K_{jt-1} = I_t - R_{jt}$$

where :

(3) $$R_{jt} = \sum_{k=0}^{\infty} h_{jk+1} I_{t-k}$$

(4) $$K_{jt} = \sum_{k=1}^{\infty} (1 - \sum_{i=1} h_{ji}) I_{t-k}$$

I_t represents the level of real gross investment in capital during the year, R_{jt} is the real replacement investment needed according to the j th capacity depreciation pattern, and h_{ji} is the fraction of the capital's original capacity lost in the i th year of its sevice life. Substituting desired stock of capital equation (1) into the net investment equation (2), the desired expansion of durable capital goods in period t is given by :

(5) $$N^*_{jt} = \beta \ (E(R)/E(C_j))^*_t - K_{jt-1}$$

This equation assumes that the adjustment from actural to desired stocks is completed within time period t.

[3] The engineering depreciation pattern is adapted for equipment and the one–hoss shay pattern is used for structures. Engineering depreciation pattern is that the productive capacity of capital deteriorates in a concave rather than the convex pattern described by geometric depreciation pattern. One–hoss shay pattern is that no depreciation occurs until the very end of the service life. For more detailed description of depreciation patterns, see Pensons, Hughes, and Nelson(1977)

The approach taken in this study to account for the adjustment to desired net investment in equation (5) is the partial adjustment model. The model is suitable where investment depends on the speed of adjustment from the previous period's actural stock of capital to the current desired level of the capital stock. It is assumed that the actual net investment is stochastic but the desired net investment is deterministic. The relationship between the desired and actual net investment is given by :

$$(6) \qquad N_t - N_{t-1} = (1 - \lambda)(N^*_t - N_{t-1})$$

As it stands, (6) is not an estimatable relationship since N^*_t is unobservable. The linkage of unobservable desirable net investment and actual net investment can be obtained by substituting (5) into (6). The result gives

$$(7) \qquad N_t = \beta_0 + (1 - \lambda)\beta(E(R)/E(C))_t - (1 - \lambda)K_{t-1} + \lambda N_{t-1} + \varepsilon$$

where β is partial production elasticity, $(1 - \lambda)$ represents partial adjustment coefficient that describes the speed of adjustment of actual net investment to desired net investment, and ε_t is the disturbance term. The β_0 coefficient is included here because it is not entirely sure a priori that the intercept should be zero.

II. Expected Implicit Revenue from Crop Production

Before applying econometric procedures to the neoclassical investment model, we must first specify the expected revenue from crop production. In measuring expected revenue for crop production, an implicit revenue approach is chosen in this study because it enables one to capture the full direct linkages between agricultural commodities policies and investment in capital utilized in crop production. Just as the expected implicit rental price of capital captures macroeconomic policy transmission mechanisms not reflected in an input's purchase price, an implicit revenue specification can capture U.S. farm policy transmission mechanisms not reflected in the product market price(Chen, Penson and Teboh, 1988).

Expected implicit revenue from crop-related activities depends upon whether or not farmers choose to participate in the Acreage Reduction Program(ARP). The five major crops considered in this study are wheat, corn, sorghum, cotton, and soybeans. The expected revenues per acre for non-participants in the ARP can be specified for the *i* th crop as follows :

(8) $E(R_i)^{np} = E(Y_i) * E(P_i)$

where E is the expectations operator, np is the non–participant in ARP, $E(Y_i)$ is the expected yield for the i th crop, $E(R_i)^{np}$ is the expected revenues per acre for non–participants in ARP for i th crop, $E(P_i)$ is the expected market price for the i th crop.

Non–participants in the ARP do not receive direct farm program benefits from federal government. In addition, indirect benefits such as those provided by loan rate mechanism are also absent. For this reason, the expected implicit revenues per acre for non–participants can be determined by multiplying the expected market price by the expected yield from crop production.

The following specification is proposed for the expected implicit revenues per acre by participants in the ARP for the i th crop :

(9) $E(R_i)^p = [E(Y_i)*Max((P_i), L_i) + \{ TP_i - Max(E(P_i), L_i \} * Y_{gi}]$

Where $E(R_i)^p$ is the expected revenues per acre of participants in ARP for the i th crop, MAX is the maximum operator, L_i is the loan rate for the i th crop, Y_{gi} is the farm program payment yield for the i th crop, TP_i is the target price for the i th crop.

The deficiency payments portion per acre of the equation is represented by the following expression :

(10) $[TP_i - Max(E(P_i), L_i)] * Y_{gi}$

Constrained to be nonnegative, this expression states that the difference between the target price and the higher of the loan rate and expected market price, along with the program yield, influences the size of the deficiency payment.

The number of acres harvested for i th crop(HA_i) is expressed as a function of planted acreage (PA_i), among other factors ($Z_{HA,i}$)[4]. In this study acres harvested of participants (HA^p_i) and non–participants (HA^{np}_i) in the ARP are expressed by the following behavioral relationships :

(11) $HA_i = f(PA_i , Z_{HA,i})$

(12) $HA^p_i = HA_i * P_{ARP,i}$

(13) $HA^{np}_i = HA_i - HA^p_i$

Where $P_{ARP,i}$ represents the rate of participation in the ARP program for the i th crop.

[4] Harvested acreage is directly taken from AGSIM model instead of being estimated. Since harvested acreage is not much different from planted acreage known by farmers at planting period, the specification of expected harvested acreage is not necessary.

The aggregation of expected revenue for each individual crop leads to total expected implicit revenue from crop production, or :

(14) $$E(R) = \sum_{i=1}^{N} [E(R_i)^{p} * HA^{p}_i + E(R_i)^{np} * HA^{np}_i]$$

Where N is the total number of crops produced. The above specification of total expected implicit revenue from crop production can capture both the explicit market sources of revenue as well as the income-enhancing effects of U.S. farm commodity programs on farm investment decisions.

III. Expectations Formulation

A major objective of this study is to illustrate the performance of a wide range of empirical expectations about future crop prices and yields per acre. Eight different expectation specifications for major crop prices and yields will be discussed. The expectation specifications examined in this study can be classified into three categories : (1) expectations based solely on past own information, (2) expectations based on past own information and other exogenous information, and (3) expectations based on solutions from an existing structural sector model for agriculture.

1. Expectations Models Based Solely on Past Own Information

Naive, extrapolative, adaptive expectation and ARIMA models are based solely on past own information. The expected values for yields and prices are a function of various combinations of own lagged variables.

Naive Expectations Model

The naive model is the simplest form of this category of expectations specifications. It is given by ;

(15) $$E(P)_t = P_{t-1}$$

(16) $$E(Y)_t = Y_{t-1}$$

where $E(P)_t$ and $E(Y)_t$ represent expectations of market price and yield for crop formed at the beginning of year t based upon last year's actual values.

Extrapolative Expectations Model

A simple extrapolative model could take the following form :

(17) $$E(P)_t = P_{t-1} + a_0(P_{t-1} - P_{t-2})$$

(18) $$E(Y)_t = Y_{t-1} + a_1(Y_{t-1} - Y_{t-2})$$

which represents the naive expectations model modified for past changes in prices and yields.

Adaptive Expectations Model

The adaptive expectations model suggests that farmers revise expectation of price and yield from one period to the next in proportion to the difference between actual price and yield in the most recent period and expected price and yield. The adaptive expectation hypothesis can be rewritten as follows :

(19) $$E(P)_t = \sum_{k=1}^{\infty} a_0(1 - a_0)^{k-1} P_{t-k}$$

(20) $$E(Y)_t = \sum_{k=1}^{\infty} a_1(1 - a_1)^{k-1} Y_{t-k}$$

The coefficients of adjustment, a_0 and a_1 , reflect the weight farmers put on new price and yield information. The expected prices and yields here are expressed as an infinite weighted average of past actual prices and yields. In this study, the lag will be truncated at 4 years ; it is assumed that farmer's investment decisions are based on the last four years experiences. This limitation is not very restrictive since annual data series are employed in this study.

ARIMA Expectations Model

Autoregressive integrated moving average(ARIMA) modeling of expectations is based on Nerlove's notion of quasi rational expectations-(Nerlove, Grether, and Garvalho, 1979). This approach assumes that expectations are formed optimally on the basis of an ARIMA model fitted to past observations using a suitable time-series modelling strategy such as the one suggested by Box and Jenkins. Within the context of ARIMA modelling, the expected value of prices and yields can be generated as follows :

(21) $$E(P)_t = f(P_{t-1}, \cdots\cdots, P_{t-p}, e_{t-1}, \cdots\cdots, e_{t-q})$$

(22) $$E(Y)_t = f(Y_{t-1}, \cdots\cdots, Y_{t-p}, e_{t-1}, \cdots\cdots, e_{t-q})$$

where p and q represent orders of autoregressive process and moving average respectively, e is white noise.

The above four expectations models ignore relevant information that may be available to farmers at the time of expectations formation other than past information.

2. Expectations Models Based on Past Own Information and Other Exogenous Information

The augmented adaptive expectation model, the error correction model and the vector autoregression (VAR) have the advantage of explicitly incorporating other variables besides the past history of the variable under consideration without involving the structural specification. The simple lag adjustment model based on past own information may be inappropriate to represent farmers' price and yield expectations since exogenous shocks(e.g. government intervention, weather) have an impact on crop production processes. The choice of exogenous variables for price any yield expectations is based on the economic theory and crop production environment in the augmented adaptive expectations and error correction expectations models, while the VAR expectations model is atheoretical.

Yield per acre is a function of the lagged yield, the expected own price, the expected prices of substitutable crops, a purchased input price index, and a time trend in the augmented adaptive expectations and error correction expectations models. The time trend serves as a proxy for technological change. Expected price is a function of lagged price, the announced loan rate, the target price and carryover stocks. The carryover stock is included under the norm of Walrasian price adjustment mechanism, in which past excess supply or demand in a crop market determines the amount carried over and hence affects the farmer's expected price. The announced loan rate and the target price are included to capture how farmers response to government support program.

Vector Autoregression Expectations Model

Because of the poor forecasting performance by large structural models in recent years, the use of VAR models for forecasting purposes has been proposed by some economists(e.g. Sims, 1980) as an alternative. VAR models are atheoretical models that use only the observed time series properties of the data to forecast economic variables. All variables in the VAR system are initially considered endogenous, whereby each variable influences itself and all others in the system with lags. While VAR models are useful for forecasting, their value for policy analysis has been criticized by Cooley and LeRoy(1985), and Penson and Gardner(1988).

In this study, VAR expectations models are restricted to three variables : price, yield, and harvested acreage. The lags in VAR models will be specified with Akaike's Final Prediction Error(FPE) criterion, using a methodology suggested by Hsiao(1981). The expected price and yield are specified in the reduced form equation as follows :

$$(23) \quad \begin{aligned} E(P_i)_t &= a_{11}(L)P_{it} + a_{12}(L)Y_{it} + a_{13}(L)HA_{it} \\ E(Y_i)_t &= a_{21}(L)P_{it} + a_{22}(L)Y_{it} + a_{23}(L)HA_{it} \\ E(HA_i)_t &= a_{31}(L)P_{it} + a_{32})Y_{it} + a_{33}(L)HA_{it} \end{aligned}$$

where HA_{it} is harvest acreage for i th crop at the period of t, L is the lag operator.

Augmented Adaptive Expectations Model

Unlike the "past information" models, the augmented adaptive expectations model allows farmers to take into account other information in forming expectations. It also corrects a possible deficiency of past information models, systematic over–and underprediction(Throop, 1988). Expected price and expected yield in the augmented adaptive expectations model will be estimated by the following behavioral relationship:

$$(24) \qquad E(P)_t = f(P_{t-1}, \cdots\cdots, P_{t-p}, SP_{t-1}, \cdots\cdots SP_{t-q}, L_t, TP_t, S_{t-1})$$

$$(25) \qquad E(Y)_t = f(Y_{t-1}, \cdots\cdots, Y_{t-p}, E(P)_t, E(SP)_t, W_t, time)$$

where L_t is the loan rate at t period, S_{t-1} is the total carryover from $t-1$ period to t period, W_t is the purchasing input price index for crop production, SP_t is the market price of substitute goods, TP_t is the target price at t period.

Error–Correction Expectations Model

The error–correction model was developed by Hendry and others to capture the dynamic adjustment(see Hendry, 1979; Engle and Granger, 1987). An alternative error–correction model might include first differences and the lagged levels of the variables. The short–run relationships are captured by the coefficients on the changes of the variables, while long–run relationships are captured by the coefficients on the lagged levels of the endogenous variable.

Error correction model can be written as follows:

$$(26) \qquad \triangle Y_{it} = b_o + \sum_{j=1}^{p} \beta_{ij} \triangle X_{jt} + (a_i - 1)\left[Y_{it-1} - \sum_{j=1}^{p} \gamma_{ij} X_{jt-1} \right] + u_{it}$$

where Y_{it} is output of the i th crop in the time t; X_{jt} is a vector of exogenous variables i, including expected output and input prices; $\triangle$ is the first–difference operator; β_{ij} are the short–run parameters; a_i represents lag adjustment in output; b_o is the intercept; γ_{ij} is the long run parameters for i th crop and j th exogenous variable; and u_{it} is the disturbance term. The second expression in equation (26) is an error correction component. The adaptive feature of the error correction model can be noted from the term within the square bracket in equation (26). If output grows at a rate faster than the steady–state growth rate, then term in the brackets will be positive, giving rise to an error. Under the stability conditions, with $a_i - 1$ being negative in the range between -1 and 0, an error for the term in the square brackets will reduce output. Thus, the system will adjust to the long–run solution, and hence the name for the term in the square bracket, the error correction model. The expected price equations, which are a function of the lagged price, the loan rate and target price, and the carryover stock will first be identified and estimated for the expected yield equations. The equations for expected price and yield in the error-correction model used in this study are expressed as follows :

(27) $$\triangle E(P)_t = f(\triangle P_{t-1},\ \triangle SP_{t-1},\ \triangle L_{t-1},\ \triangle TP_{t-1},\ \triangle S_{t-2},\ P_{t-2},\ SP_{t-2},\ L_{t-2},\ TP_{t-2},\ S_{t3})$$

(28) $$\triangle E(Y)_t = f(\triangle E(P)_t/W_t,\ \triangle E(SP)_t/W_t,\ E(P)_{t-1}/W_{t-1},\ E(SP)_{t-1}/W_{t-1},\ Y_{t-1},\ time)$$

3. Expectations Based on Solutions from an Existing Structural Sector Model for Agriculture

More complex measures of expected prices and expected yields are given by the projections of a large farm sector simulation model, AGSIM, developed by Taylor(1990) for policy analysis purposes. The expected price and expected yield from the projections of AGSIM is chosen for two reasons. First, AGSIM is an econometric-simulation model covering regional crop and national livestock production in the United states. It is assumed farmers have hired AGSIM to project expected prices and expected yields. Second, it is assumed that the marginal benefit of incorporationg rational expectations is less than its marginal cost in a given large-scale structural model. From a structural perspective, the other seven expectations models can be seen as a subset of reduced forms of the equations in the AGSIM model.

IV. Empirical Estimation and Model Validation[5]

Prior to the empirical estimation, the expected price and yield data series are examined to determine whether or not they are stationary using unit root test by Dickey and Fuller(1979). The estimation methods used in this study are ordinary least squares(OLS), seemingly unrelated regression(SUR), and maximum likelihood estimation(MLE). The naive, extrapolative, and adaptive expectations models are estimated by OLS ; the VAR, augmented adaptive, and error correction expectations models are estimated by SUR ; and the ARIMA expectations model is estimatd by MLE. The econometric procedures for estimating farm investment behavior in this study treat various expectations' forecasts as data ; as if they were either predetermined by the producer or purchased from a forecasting sevice. The net investment equations for equip-

[5] Further details on empirical estimation and model validation results can be found in Han(1990). Space limitations do not permit their inclusion here.

ment and structures are estimated by nonlinear estimation methods. The initial performance of the neoclassical investment model is measured by standard gooness–of–fit criteria. The VAR and the error correction expectations models outperform the other models in net investment for equipment baed upon goodness–of fit criteria ; however, none of the expectations models dominates the other models in net investment for structures. The AGSIM–based expectations model is excluded from this comparison since its use is limited to ex–ante simulations.

All equations are initially estimated using annual data over the period 1956–86 for within–sample and out–of–sample(1987–1988) for model validation purposes. These equations are later re–estimated over the 1956–1988 period for simulation purposes. An intercept dummy variable is used in the latter instance to capture the unique effects of the 1988 drought. An overall comparison between the two sets of econometric estimates indicates that estimated coefficients with fewer observations are less likely to be close to the actual values.

Model validation in this study is performed in the multidimensional context. The measures of predictive accuracy used in this study are the root mean squared error, the mean absolute error, and the turning point error. Static validation procedures indicate : (1) the net investment equations both within–sample and out–of–sample are well explained by the error correction and VAR models, (2) the out-of–sample errors are greater than within–sample errors, and (3) the errors associated with equipment investment are greater than the errors associated with investment in structures. Dynamic validation of the investment equations is initially performed within–sample over the 1985–1988 period. The error correction model outperforms the other expectations models for net investment in farm equipment ; however, the naive expectations model is slightly better than the other models for net investment in farm structures.

V. Alternative Simulation Results

The estimated equations are then incorporated into a general equilibrium macroeconomic model, AG–GEM[6], to generate full model simulations. An exogenous change in a policy instrument in this model will have indirect as well as direct effects on the model's endogenous vari-

[6] AG–GEM is the result of a merger between the AGSIM agricultural sector model developed by Taylor and others at Auburn University and the COM-GEM macroeconomic model developed by Penson and others at Texas A&M University(see Penson and Taylor, 1990 ; Penson and Chen, 1990 ; Taylor, 1990)

ables, including investment in farm equipment and structures. The principal channels for the direct effects can be identified from the model's structure, but the total effects of policy changes can only be completely understood by a full model simulation. A baseline and two policy scenarios are examined with AG–GEM in this study : (1) a chemical use ban scenario, and (2) a higher deficit scenario. The choice of scenarios was based on consideration of current policy–related issues confronting U.S. policymakers.

The major assumptions used in developing the baseline projections have to do with the future direction of macroeconomic and farm program policy. The macroeconomic policy assumptions included the following goals : (1) to keep the annual inflation rate below 5 percent, (2) to achieve the Gramm–Rudman–Hollings balance budget target by 1993, and (3) to keep the economy's annual growth rate in excess of 1.5 percent. The third goal is assumed to take precedence over the second goal in any particular year they are in conflict. The basic farm policy con-

TABLE 1 Impacts of Two Alternative Scenarios on Net Investment in Farm Equipment under Alternative Expectations Specifications[1,2]

Expectations Model	Baseline Scenario	No Chemical Use Scenario	High Deficit Scenario
1991–1994 Period			
AGSIM Expectations[1]	$8.845	$8.963	$8.825
Naive Expectations[2]	9.414 (6.43%)	9.451 (5.44%)	9.406 (6.58%)
VAR Expectations[2]	8.706 (–1.57%)	8.733 (–2.57%)	8.693 (–1.50%)
Error Correction Expectations[2]	8.027 (–9.25%)	7.757 (–13.46%)	8.051 (–8.77%)
1995–1998 Period			
AGSIM Expectations[1]	$10.111	$10.342	$9.942
Naive Expectations[2]	12.242 (21.08%)	12.382 (19.73%)	12.171 (22.42%)
VAR Expectations[2]	9.864 (–2.44%)	9.945 (–3.84%)	9.748 (–1.95%)
Error Correction Expectations[2]	10.097 (–0.14%)	9.226 (–10.79%)	10.296 (3.56%)

[1] The AGSIM solutions are expressed in billions 1967 dollars, and represents the annual average net investment over the period.

[2] The number in parenthesis is the percentage deviation from simulated solutions under the AGSIM–based expectations for farm prices and yields.

TABLE 2 Impacts of Two Alternative Scenarios on Net Investment in Farm Structures under Alternative Expectations Specifications[1,2]

Expectations Model	Baseline Scenario	No Chemical Use Scenario	High Deficit Scenario
1991–1994 Period			
AGSIM Expectations[1]	$4.136	$4.244	$4.104
Naive Expectations[2]	4.039 (–2.35%)	4.107 (–3.23%)	4.012 (–2.24%)
VAR Expectations[2]	4.004 (–3.19%)	4.027 (–5.11%)	4.981 (–3.00%)
Error Correction Expectations[2]	2.013 (–51.33%)	1.602 (–62.25%)	2.081 (–49.29%)
1995–1998 Period			
AGSIM Expectations[1]	$6.067	$6.303	$5.775
Naive Expectations[2]	5.887 (–2.97%)	6.159 (–2.28%)	5.627 (–2.56%)
VAR Expectations[2]	5.804 (–4.33%)	5.869 (–6.89%)	5.590 (–3.20%)
Error Correction Expectations[2]	2.430 (–59.94%)	0.974 (–84.55%)	3.036 (–47.43%)

[1] The AGSIM solutions are expressed in billions 1967 dollars, and represents the annual average net investment over the period.

[2] The number in parenthesis is the percentage deviation from simulated solutions under the AGSIM–based expectations for farm prices and yields.

cepts contained in the 1985 Food Security Act are assumed to be continued, with target prices held constant in nominal terms at 1990s level. The no chemical use scenario requires an additional assumption ; namely, that import quotas would be imposed to prevent products from being imported if they were produced by chemicals banned in the United States.

This study solves the full AG–GEM model to develop the baseline projections for net investment in equipment and structures. AG–GEM macroeconomic model is used to analyze the performance of alternative expectations hypotheses over the intermediate–run(the 1989–1994 period) and the long–run(the 1995–1998 period). In addition to the seven expectations hypotheses, an eight expectations formulation based upon projections of farm prices and yields given by the AGSIM agricultural sector model is employed(see Taylor). The AGSIM model has been widely–used by various government agencies in a policy analysis context for a number of years. The AGSIM–based projections will serve, therefore, as the basis for comparing the relative performance of the other expectations hypotheses. The baseline simulations indicate several general results. First, the baseline projections under the VAR expectations model are closest to the AGSIM–based projections for net investment in farm equipment. Second, net investment in structures is virtually identical under all but the error correction expectations specifications. Third, long–run investment in farm equipment is much more sensitive to the choice of expectations model than farm structures.

Table 1 and 2 reports the potential impacts of both the no chemical use and the higher deficit on the farm investment under alternative expectations[7]. In the policy decision making, there exists a decision lag, or a delay between the recognition of the need for action and the eventual policy decision. It is assumed that policy scenarios will not implement until 1991.

Policy simulation results suggest general results. First, net investment in farm equipment as well as farm structures under the AGSIM, naive, and VAR expectations models increase slightly if chemical use is banned. This reflects the higher levels of expected crop production associated with crop revenue as well as overinvestment in the U.S. farm sector. The VAR and error corrections expectations models, however, lead to an undershooting of the AGSIM–based projected impacts on farm equipment while the naive model substantially overshoots the AGSIM–based projections for farm structures. Second, higher deficits which remain constant in nominal term over the 1991–1998 period at 1990 levels are shown to crowd out farm investment. Here, however, the other expectations models undershoot the AGSIM–based projected impacts on structures. The VAR expectations model again undershoots the AGSIM–based projections for farm equipment, while the naive model again overshoots the AGSIM–based projections. Third, the error correction model does not perform well in an ex–ante simulation context in the sense that it alone signals theoretically wrong directions. Finally, the AGSIM–based projection is most closely approximated by the VAR expectations projection for net investment in farm equipment, and by the naive expectations projection for net investment in farm structures.

VI. Conclusions

The major objective of the study is to identify the interrelationship be-

[7] Since baseline projections in autoregressive expectations patterns are similar to each other, only the AGSIM, naive, VAR, and error corrections expectations models are chosen for policy simulation.

tween alternative expectation hypotheses and investment behavior of producers in the U.S. farm sector. After analyzing empirical estimations as well as model validations, this study investigates the degree to which alternative expectations hypotheses filter the impacts of major policy-related shocks(reducing chemical use and higher federal budget deficits) on investment in durable farm inputs.

This study provides evidence that economists must be careful in their choice of expectations models in investment studies. If economists choose the error correction model to project future investment in agriculture for policymakers, durable goods manufacturers, lending institutions and others, they would incorrectly project expansion when contraction is more likely to occur, and vice versa. Importantly, the simulation results from the error correction expectations model suggest that equations providing good ex-post performance may be poor approximations of the future.

The results presented in this study suggest that farmers' expectations may also be dependent upon the durability of a asset or commodity. The naive model most closely approximated the AGSIM-based projections for structures, which have an average 40-year service life. The VAR expectations models, on the other hand, most closely approximated the AGSIM-based projections for equipment, which have an average 15-year service life. These results are consistent with those reported by Just(1988), who found that the naive expectations model better explained farm land prices (an infinitely-lived asset) than other expectations models. This relationship, which suggests that shorter-lived assets are more sensitive to current information-based expectations, could be further tested by examining the demand for nondurable goods such as fertilizer under the alternative expectations hypotheses.

This study provides a basis for farm policymakers to improve their decision-making by identifying the impacts of farm price and income programs on investment in fixed assets under well defined expectations specifications. An understanding of farmers' investment in durable goods helps : (1) farm policy makers understand potential trends in asset fixity and excess capacity, (2) farm financial intermediaries evaluate potential loan demand and (3) manufactures of farm equipment and structures formulate production and marketing strategies.

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