PROJECTING NET INCOMES FOR TEXAS CROP PRODUCERS:

AN APPLICATION OF PROBABILISTIC FORECASTING

A Thesis

by

CHRISTOPHER RYAN EGGERMAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2006

Major Subject: Agricultural Economics

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Approved by:

Chair of Committee,	James W. Richardson
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ABSTRACT

Projecting Net Incomes for Texas Crop Producers: An

Application of Probabilistic Forecasting. (August 2006)

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Agricultural policy changes directly affect the economic viability of Texas crop producers because government payments make up a significant portion of their net farm income (NFI). NFI projections benefit producers, agribusinesses and policy makers, but an economic model making these projections for Texas did not previously exist.

The objective of this study was to develop a model to project annual NFI for producers of major crops in Texas. The Texas crop model was developed to achieve this objective, estimating state prices, yields and production costs as a function of their national counterparts. Five hundred iterations of national price and yield projections from the Food and Agricultural Policy Research Institute (FAPRI), along with FAPRI's average production cost projections, were used as input to the Texas crop model. The stochastic FAPRI Baseline and residuals for Ordinary Least Squares (OLS) equations relating Texas variables to national variables were used to incorporate the risk left unexplained by OLS equations between Texas and U.S. variables.

Deterministic and probabilistic NFI projections for Texas crops were compared under the January 2005 and January 2006 FAPRI Baseline projections. With production costs increasing considerably and prices rising moderately in the January 2006 Baseline,

deterministic projections of 2006-2014 Texas NFI decreased by an average of 26 percent for corn, 3 percent for cotton, 15 percent for peanuts, and 12 percent for rice, and were negative for sorghum and wheat. Probability distributions of projected NFI fell for all program crops, especially sorghum and wheat. Higher hay price projections caused deterministic projections of NFI for hay to rise roughly 13 percent, and increased the probability distributions of projected hay NFI. Deterministic and probabilistic projections of total NFI decreased for each year, especially for 2006-2008 when fuel price projections were the highest.

The Texas crop model can be used to simulate NFI for Texas crop producers under alternative FAPRI baselines. The model shows the impact of baseline changes on probability distributions of NFI for each crop and for Texas as a whole. It can also be useful as a policy analysis tool to compare impacts of alternative farm and macroeconomic policies on NFI.

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

Agricultural policy changes directly impact net farm income for crop producers in Texas. Cash receipts, including government payments, from program crops in Texas were just over $4 billion in 2003 (USDA/ERS, 2005c). Production expenses associated with these crops were approximately $2.5 billion, making net farm income roughly $1.5 billion (USDA/ERS, 2005b; USDA/NASS, 2005). Net farm income is the difference between total revenue, including government payments, and total costs. Government payments to Texas crop producers exceeded $1.7 billion in 2003, accounting for more than 113 percent of their net farm income (USDA/ERS, 2005c).

Net farm income is a critical measure of economic viability for farmers and the agricultural sector in Texas because policy decisions are made based on projections of net farm income under alternative farm policy options. The impact of agricultural policy on net farm income is important because government payments make up a significant portion of, and in some years exceed, net farm income for crop producers.

Net farm income projections are useful to producers, agribusinesses and policy makers. They can help producers in making budgeting and operating decisions. Agribusinesses can use net farm income projections when planning future production and potential expansion. These projections can also be analyzed under alternative farm

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This thesis follows the format of the *American Journal of Agricultural Economics*.

program scenarios to show how agriculture is affected by changes in policy variables such as loan rates and target prices.

Economic models estimating relationships within individual crop sectors and interactions between them to develop crop income projections have mostly been national in scope. Because decisions are made at the local level, agricultural producers and other users of net farm income projections would benefit from projections for their own state. Firm-level models such as FLIPSIM (Richardson and Nixon, 1986) project the impacts of policy changes on representative farms, leaving a need for state level projections of net farm income. Most crop models use biological or climatic variables to project crop yields. Yield projections are beneficial, but projections of economic variables such as market price, planted acres, harvested acres, costs of production, per acre net returns, and government payments are needed to project net farm income for crop producers in a particular state. Currently, a model that projects all of these variables at the state level for Texas does not exist.

Objective

The objective of this research is to develop a stochastic, state-level model of Texas crops and use it to project net farm income for crop producers in Texas. The model will incorporate the risk associated with price, yield and production costs to develop probabilistic projections of net farm income for corn, upland cotton, peanuts, rice, grain sorghum, wheat, hay and all crops for 2006-2014. The completed model will be useful for doing policy analysis of the economic impacts for alternative farm policies and macroeconomic policies.

Procedures

To achieve the objective of this study, an economic model for Texas crops will be formulated and parameterized using ordinary least squares regression to estimate and project its endogenous variables. Prices, yields and costs of production will be estimated for each crop as a function of corresponding variables at the national level. National projections for these variables available from the Food and Agricultural Policy Research Institute (FAPRI) will be used as exogenous variables for the Texas crop model. Projected yield, price, per acre production costs, and farm policy variables will be used to project per acre net returns for each crop.

Residuals from the least squares equations will be used to make the projections of the endogenous variables stochastic. A multivariate normal distribution will be assumed to simulate these variables under two scenarios, the January 2005 and January 2006 FAPRI Baseline projections of national prices, yields and production costs. The key differences between these two sets of projections reflect higher input costs driven by rising energy prices, and increasing export demands due to the dollar weakening from 2004 to 2005. Projected net farm income for each individual crop and all crops will be compared under the two scenarios to show the impact of updating national baseline projections of prices, yields and production costs.

Organization of Remaining Chapters

This research will be presented in a total of five chapters. Chapter II will review literature on crop models at both the national and state levels. Chapter III will discuss the proposed Texas crop model, the data, and the methods to be used in model estimation and validation. Chapter IV will discuss the performance of the model, and present projections of the key output variables as well as the results of the model analysis and validation. Chapter V will summarize this study and make recommendations for further research.

CHAPTER II

LITERATURE REVIEW

This study will develop and use a state-level crop model to project net farm income for Texas crop producers. A large number of economic crop models have been used for policy analysis or to project farm income, government costs and other variables. Many of these were developed at universities or by the Economic Research Service (ERS). The objective of this chapter is not to describe every model developed for these purposes, but to portray the scope of existing crop models and how they contribute to this study.

Three national crop models and one state crop model were reviewed in terms of their purposes, procedures and output. The following summaries of these models reflect their original documentation and thus their initial design. Because the models are continually updated to reflect changes in agricultural policy and other variables, current versions are likely to have differences from these descriptions.

FAPSIM Model

The Food and Agricultural Policy Simulator (FAPSIM) is an econometric model of the U.S. agricultural sector developed by Salathe, Price and Gadson (1982) from ERS to make projections for U.S. livestock and crops. It is an updated version of the Cross Commodity Forecasting System, the livestock and crop model previously used by ERS, extended to include policy analysis capabilities.

FAPSIM uses 265 exogenous and 360 endogenous variables to project farm production expenses, cash receipts, net farm income, government payments, participation in farm programs and price indices for food products. Many of the model's exogenous variables are government policy variables such as diversion rates[1], set-aside rates[2], loan rates, target prices and national program yields and acreages. Macroeconomic variables including population, disposable personal income, food processing wage rates, petroleum prices and the nonfood consumer price index also account for a large portion of the model's exogenous variables. The livestock and crop components of the model are solved simultaneously with a Gauss-Seidel solution algorithm for prices. The livestock sub-sector of the model estimates production, market prices, retail prices, civilian consumption and ending stocks for beef, pork, dairy, chickens, eggs and turkeys.

The crops sub-sector of FAPSIM estimates production, total supply, total demand, price and ending stocks for corn, oats, barley, grain sorghum, wheat, soybeans and cotton. Total supply for each crop is calculated as the sum of production, beginning stocks and imports. Yield is estimated as a function of planted acres, set-aside plus diverted acres, weather, trend and the ratio of lagged crop price to the price of fertilizer. Harvested acreage is estimated as a function of acres planted, and is multiplied by yield to calculate production.

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[1] Acreage diversion programs paid producers a given amount per acre to idle a percentage of their base acres (Knutson et al., 2006).

[2] The set-aside rate is the percentage of a farmer's cropland removed from production as a condition for receiving farm program benefits (Knutson, Penn, and Flinchbaugh, 1998).

Acreage response equations, which contain farmers' expectations for prices and yields and predict the level of participation in government crop programs, reflect the relative profitability of the decision whether to participate in the programs. A simple average of monthly prices for the five months prior to planting, which is endogenously determined as a function of the season average market price in the previous crop year, is used to capture price expectations. Expected yields are estimated as a function of trend. Expected program returns (for participants) and expected market returns are used to project program and non-program acreage, and thus the participation rate.

Total demand for each crop is the sum of export, seed, food and feed demand. In general, exports for each crop are estimated as a function of domestic price, major importing countries' exchange holdings, and grain and livestock production in major grain-importing countries. Seed demand for each crop is a function of acreage planted in the following year, current market price and trend. Per capita food demand for each crop is a function of its real price, real price of competing crops and real disposable income. Feed demand for each crop is a function of its real price, the real prices of competing crops, and a livestock production index.

AG-GEM Model

In 1992, Davis developed an econometric model of the agricultural sector to estimate the impact of agricultural policy instruments on crop production and the federal budget. Government costs associated with farm programs of the Food, Agricultural, Conservation and Trade Act of 1990 were separated into fiscal, calendar and marketing years. The study projected these costs for 1992-1995 and examined the differences in government costs between the use of frozen and nominal target prices in farm programs.

Davis' model estimated production equations for the eight program crops (wheat, corn, grain sorghum, barley, oats, upland cotton, rice and soybeans) to reflect the effects of participant and non-participant expected returns per acre on the rate of participation in farm programs, set-aside acres, diverted acres, planted acres, harvested acres and production. This disaggregated the production of these crops between participants and non-participants in government farm programs, allowing alternative policy options to be analyzed.

Most demand-side equations used in the model came from AGSIM, which was developed by Taylor (1993). AGSIM is an econometric simulation model of regional crop supply, national crop demand, and national livestock supply and demand. To disaggregate the demand for ending stocks between private and public holdings, Davis developed theoretical equations along with farm bill based decision rules to separate total ending stocks for each crop into one of four categories: Commodity Credit Corporation (CCC) acquired stocks, CCC loans outstanding, farmer-owned reserve or free stocks.

The components of total government costs for each farm program were specified and government cost accounting procedures were used to report program costs by fiscal year, calendar year and marketing year. These equations were incorporated into the AG+GEM model by Penson, Hughes, and Romain (1984) to project government costs associated with the programs of the 1990 Farm Bill for 1992-1995. The resulting model was named the AG-GEM model. This model was used to compare government cost projections to those under an alternative policy scenario where target prices under the 1990 Farm Bill were frozen in real terms rather than nominal terms.

FAPRI U.S. Crop Model

The Food and Agricultural Policy Research Institute (FAPRI) is a dual-university research program with centers at Iowa State University and the University of Missouri. It uses a comprehensive computer modeling system to analyze economic interrelationships of the food and agriculture industry. The FAPRI modeling system contains five separate models, including the U.S. crop model. This model was developed by Adams (1994) to estimate the impact of exogenous shocks on each crop, in addition to making ten-year baseline projections about the outlook for agricultural markets, farm program spending and farm income. FAPRI uses the baseline for policy analysis by comparing its projections under alternative farm program options (FAPRI, 2005b).

FAPRI's U.S. crop model includes individual econometric equations to estimate supply and demand for corn, grain sorghum, barley, oats, soybeans, wheat, rice, upland cotton and hay. Payment and non-payment planted acreage, set-aside acreage, harvested acreage, as well as prices and yields in some cases, are estimated at the regional level.

Supply determination is similar for every crop other than hay. Estimation of production begins with the decision whether to participate in government farm programs, which depends on policy variables and lagged prices. Participation rate determines complying base acreage, which determines set-aside and diverted acres. Eligible flex acreage[3] is a set percentage of complying base acreage. The number of acres enrolled in the 0/92 acreage reduction program[4] is determined by acreage eligible for this program, and expected prices. Payment planted acreage is calculated by subtracting set-aside, diverted and flex acres from complying base acreage. Set-aside, diverted and flex acres existed under past farm programs, but are not currently included in the model because they are not present under current policy. Non-payment planted acreage is a function of expected prices and program acreage. Harvested acreage and yield are a function of planted acreage, which is the sum of payment and non-payment planted acreage. Total supply is the sum of production, imports and beginning stocks.

Total demand for each of these crops is the sum of exports, commercial stocks, government stocks, and appropriate domestic use categories such as food, feed and seed. All of these demands except government stocks and seed are a function of current prices. Finally, supply and total demand are brought together to determine the equilibrium price.

Because government farm programs do not apply to hay, the hay model is fairly simple. Harvested acreage is a function of lagged harvested acreage, lagged price, beginning stocks and animal numbers (the combined indices for beef and dairy cattle from the index of grain-consuming animal units). Yield is estimated as a function of harvested acreage, weather and trend. Hay demand is a function of hay price, corn price

[3] Under the 1990 Farm Bill, farmers could "flex," or change cropping patterns on up to 25 percent of their base acres to a more restricted set of program crops (Knutson, Penn, and Flinchbaugh, 1998).
[4] Under the 1985 and 1990 Farm Bills, participating wheat, feed grain, cotton, and rice producers between zero and 92 percent their maximum program payment acreage while continuing to receive deficiency payments on 92 percent of their maximum program payment acreage (Knutson et al., 2006).

and animal numbers. Ending stocks are a function of price, supply and future production.

FAPRI Missouri Model

To project net farm income for crop producers in a particular state, a state-level model of crop production, costs, prices and net returns is necessary. A state-level model suitable for projecting net farm income must be linked to a sector-level model that provides projections of national prices, yields and costs of production. One such model is the FAPRI Missouri crop and livestock model (FAPRI, 2005a). Its crops sector estimates state prices, state yields and regional production costs for corn, upland cotton, oats, rice, soybeans, grain sorghum, wheat and hay as linear relationships to corresponding national variables in the FAPRI U.S. crop model.

Projected yield is estimated as a function of trend to account for technology-driven yield increases. Projected yield, price, production costs and loan deficiency payments are used to calculate expected net returns for each crop. Planted acreage for every crop except hay is estimated as function of per acre expected net returns for these crops. Harvested acreage for each of these seven crops is estimated as a function of planted acreage and is multiplied by yield to calculate production. For hay, harvested acreage is a function of harvested acreage and price in the previous year, and total acreage planted to the other crops in the model or enrolled in the Conservation Reserve Program.

Cash receipts for each crop are estimated as a function of the value of production for the current year and the previous year. Expenses are divided into fifteen production cost categories. Per acre cost for each of these categories is multiplied by planted acres for each crop to calculate total expenditures in each category. Receipts and expenses from the livestock sector are then incorporated, with agriculture sector output being the sum of crop and livestock receipts. Net farm income for the state is calculated by adding government payments to agriculture sector output, then subtracting the combined crop and livestock production expenses.

The Missouri model makes point-estimate projections of combined net farm income for the state's crop and livestock sectors, which do not account for the variability in prices, yields and production costs. The Texas crop model will project farm income for seven major crops in the state on a per-crop basis. Projected prices, yields and costs of production will be made stochastic to incorporate the risk associated with these variables. Stochastic net farm income projections will be simulated to develop probabilistic projections of NFI that can be compared under alternative policy scenarios.

Summary

Economic crop models have been developed for a wide range of purposes. The crops sub-sector of FAPSIM was used by ERS for policy analysis and to estimate economic indicators for crops. The AG-GEM model was developed by Davis (1992) to estimate the impacts of the 1990 Farm Bill on agriculture and to separate government costs into fiscal, calendar and marketing years. The FAPRI U.S. crop model is used to estimate the impact of exogenous shocks on crops, analyze farm policy options, and make baseline projections for agricultural markets, farm program spending and farm income. The crops sector of the FAPRI Missouri crop and livestock model estimates crop production, costs, prices and net returns for the state, and is linked to the national FAPRI model.

The FAPSIM, AG-GEM, and FAPRI models illustrate the variety of uses for crop models. The Texas crop model will follow the format of the Missouri crop and livestock model, using baseline projections from the FAPRI U.S. crop model as exogenous variables. While the Missouri model's projections are deterministic, endogenous variables projected in the Texas crop model will be simulated stochastically to account for the risk associated with prices, yields and production costs.

CHAPTER III

METHODOLOGY

The Texas crop model was developed to project farm income for the state's crop producers. The model includes corn, upland cotton, peanuts, rice, grain sorghum, wheat and hay. This chapter describes the procedures and data used in formulating the model, as well as the tests used for its validation. Ordinary least squares (OLS) regression is used to estimate the model's equations, and Monte Carlo simulation is used to simulate its key output variables.

OLS regression and Monte Carlo simulation are described first. The theoretical model is then outlined from the top down, and the empirical model is built from the bottom up. Finally, the data and tests used to validate the model are described.

OLS Regression

Ordinary least squares (OLS) regression is used to estimate the relationships between a dependent variable and the explanatory variables in the Texas crop model. Simple regression can be used to explain the relationship between two variables, while multiple regression estimates how multiple explanatory variables are related to a dependent variable (Woolridge, 2003). OLS is used to estimate the Texas crop model because it is the simplest estimation procedure and because it minimizes the sum of squared residuals, which most researchers believe to be an appropriate goal for an estimation technique

(Davis, 1992). Other economic models have used OLS over more sophisticated econometric methods because it simulates more reliably (Davis, 1992; Adams, 1994).

The basis of econometric analysis is explaining a dependent variable (Y) in terms of at least one independent variable (X). This relationship can be explained in the following equation:

$$Y = \beta_0 + \beta_1 X + u$$

where:

β_0 = Intercept parameter,

β_1 = Slope parameter(s), and

u = Error term.

The intercept parameter represents the expected value of Y when X is zero, but is not extremely useful in this analysis. Of greater significance is the slope parameter, which shows the relationship between Y and X when the factors contained in the error term are held constant. The error term, or residual, accounts for factors other than X that affect Y. The residual is the difference between the actual value and the predicted value of Y (Woolridge, 2003).

OLS can be applied to cross-sectional or time series data; the Texas crop model uses time series data. The Gauss-Markov Theorem states that when the five assumptions for time series data hold, OLS estimators result in the smallest variance and therefore are the best linear unbiased estimators (Woolridge, 2003). These five assumptions and a brief explanation of each are as follows:

1. Linear in parameters: the time series process follows a linear model

2. Zero conditional mean: for each observation, the error term is expected to be zero

3. No perfect collinearity: no independent variable is constant or a perfect linear combination of the others

4. Homoskedasticity: conditional on the independent variable(s), the variance of the error term is the same for all time periods

5. No serial correlation: conditional on the independent variable(s), the errors in two different time periods are uncorrelated

Monte Carlo Simulation

The intercept and slope parameters from an OLS estimation can be used to make a deterministic, or point-estimate, projection of a dependent variable for one or more future periods. A deterministic projection is the value of the dependent variable when there is no risk in the projection. Residuals represent the unexplained portion of each endogenous variable and as such represent the uncertainty regarding the point estimate. Letting the residuals from the OLS regression equations represent the risk for a variable, one can simulate a probabilistic forecast assuming the residuals are distributed normal as $\tilde{Y} = Y\text{-}hat + Std\ Dev * SND$, where SND is a standard normal deviate ~N(0,1). This process is known as Monte Carlo simulation. The Texas crop model will use simulation rather than the distributive properties for OLS regression because it can incorporate the stochastic variability in national prices and yields from FAPRI's stochastic baseline.

Multivariate probability distributions occur when two or more random variables are correlated. If the random variables are correlated and normally distributed, they should be simulated as a multivariate normal (MVN) distribution. If a MVN distribution is not used, the correlation will be ignored in simulation and the model will either overstate or understate the mean and variance for the key output variables (Richardson, Schumann, and Feldman, 2006b). Residuals from the OLS equations in the Texas crop model will be tested for normality prior to using a MVN distribution to simulate the uncertainty about the point estimates.

Because the Texas crop model will use OLS, the residuals for its endogenous variables are assumed to be normally distributed. The OLS residuals will be used to develop the parameters for simulating the stochastic variables assuming a MVN distribution. A MVN distribution has three components. The deterministic component is the mean, or predicted value from the econometric equation, the stochastic component is the standard error of prediction, and the multivariate component is the correlation matrix of residuals (Richardson, Schumann, and Feldman, 2006b). Stochastic values for an endogenous variable in a MVN distribution can be simulated as:

$$\tilde{Y}_{it} = Y\text{-}hat_{it} + \sigma\text{-}hat_i * CSND_{it}$$

where:

$\tilde{Y}_{it}$ = Stochastic value for variable i in period t,

$Y\text{-}hat_{it}$ = Deterministic value for variable i in period t,

$\sigma\text{-}hat_i$ = Standard error of prediction for variable i, and

$CSND_{it}$ = A correlated standard normal deviate for variable i in period t.

The CSND vector is the product of multiplying the factored correlation matrix by a vector of independent standard normal deviates (Richardson, Klose and Gray, 2000).

Theoretical Model

The theoretical model begins with net farm income, the key output variable in the Texas crop model. Net farm income for crop producers is the difference between total receipts and total production expenditures. Net farm income for a crop can be modeled as:

NFI = TR – TC

where:

NFI = Net farm income,[5]

TR = Total revenue, and

TC = Total costs of production.

Total revenue includes returns from the market as well as government farm program payments, and can be modeled as:

TR = P * Q + GP

where:

P = Marketing year average price,

Q = Quantity of production, and

GP = Government farm program payments.

Marketing year average price is estimated as a linear relationship to the U.S. marketing year average price. Quantity of production is calculated by multiplying harvested acreage by average yield. Harvested acreage is estimated as a function of

[5] All variables are for Texas unless otherwise noted.

planted acreage. State average yield is estimated as a linear relationship to national average yield. These relationships can be modeled as:

$P = f(P_{us})$,

$Q = HA * Y$,

$HA = f(PA)$, and

$Y = f(Y_{us})$

where:

P_{us} = U.S. marketing year average price,

HA = Harvested acreage,

Y = Average yield,

PA = Planted acreage, and

Y_{us} = U.S. average yield.

Planted acreage is a function of expected net returns from each program crop in the model. Expected net returns consist of returns from the market and the expected loan deficiency payment[6], less total costs of production. Planted acreage for a crop can be modeled as:

$PA = f(ENR_{CR}, ENR_{CT}, ENR_{PN}, ENR_{RC}, ENR_{SG}, ENR_{WH})$ and

$ENR_t = ((P_{t-1} + E(LDP)) * E(Y) – VC) / PPI$

where:

ENR_{CR} = Per acre expected net returns for corn,

[6] Direct and counter-cyclical payments are not included because they are decoupled from current production.

ENR_{CT} = Per acre expected net returns for cotton,

ENR_{PN} = Per acre expected net returns for peanuts,

ENR_{RC} = Per acre expected net returns for rice,

ENR_{SG} = Per acre expected net returns for sorghum,

ENR_{WH}= Per acre expected net returns for wheat,

ENR_t = Per acre expected net returns for a given crop in period t,

P_{t-1} = Marketing year average price in the previous year,

E(LDP)= Expected loan deficiency payment rate,

E(Y) = Expected yield,

VC = Regional per acre variable costs of production, and

PPI = Producer Price Index.

Expected loan deficiency payments (LDPs) are determined by the marketing loan rate, the previous year's U.S. marketing year average price, and an LDP adjustment factor to the make the U.S. price equivalent to a posted county price. An LDP adjustment factor of .95 is used for corn, peanuts, sorghum and wheat, and .925 is used for cotton and rice. Adjusted world price in the previous year replaces the previous year's market price in the expected LDP calculation for cotton and rice. Expected LDPs can be modeled as:

$$E(LDP) = Max(0, LR - AF * P_{USt-1})$$

where:

LR = U.S. marketing loan rate,

AF = Adjustment factor, and

P_{USt-1} = U.S. marketing year average price in the previous year.

Expected yield (Y) is estimated as a function of trend to account for technology-driven yield improvements. Per acre variable costs of production (COP) for each type of expense are estimated at the regional level as a linear relationship to corresponding national costs of production. The one exception to this is short-term interest cost, which is the sum of all other production costs multiplied by the interest rate. Interest cost is added to all other production costs to calculate per acre variable costs of production. Per acre variable costs are multiplied by planted acreage to calculate total costs of production. These relationships can be modeled as:

$E(Y) = f(\text{Trend})$,

$COP = f(COP_{US})$,

$COP_{IN} = \Sigma\,(COP) * r$,

$VC = \Sigma\,(COP) + COP_{IN}$, and

$TC = VC * PA$

where:

Trend = Year,

COP = Regional per acre cost of production for each cost except interest,

COP_{US} = U.S. per acre cost of production for each cost except interest,

COP_{IN} = Regional per acre interest cost, and

r = Interest rate.

Total government payments are the sum of direct payments, counter-cyclical payments and LDPs. Direct and counter-cyclical payment calculations include base acreage, program yields and payment rates. Harvested acreage, yield and the LDP rate are used to determine LDPs. These payments for each crop can be modeled as:

$GP = DP + CCP + LDP,$

$DP = BA * .85 * Y_{DP} * R_{DP},$

$CCP = BA * .85 * Y_{CCP} * R_{CCP},$

$R_{CCP} = Max(0, TP – R_{DP} – Max(P_{US}, LR)),$

$LDP = HA * Y * R_{LDP}$, and

$R_{LDP} = Max(0, LR – P_{US} – AF)$

where:

DP = Direct payments,

CCP = Counter-cyclical payments,

LDP = Loan deficiency payments,

BA = Base acreage,

Y_{DP} = Average direct payment yield,

R_{DP} = U.S. direct payment rate,

Y_{CCP} = Average counter-cyclical payment yield,

R_{CCP} = Counter-cyclical payment rate,

TP = U.S. target price, and

R_{LDP} = Loan deficiency payment rate.

Variables in the model were then classified as exogenous or endogenous, and those intended to be stochastic were identified. Table 1 lists the exogenous and endogenous variables in order of their initial appearance in the theoretical model and indicates which of them will be made stochastic. While most of the model's endogenous variables are stochastic, only those made stochastic with a multivariate or univariate probability distribution are noted as such. Other endogenous variables are random because their calculation includes one or more stochastic variables.

Empirical Model

Once the theoretical model was outlined from the top down, the empirical model was built from the bottom up. An individual sector for each crop in the model was developed. The relationships proposed in the empirical model were followed for the six program crops with two key exceptions.

The first exception was in estimating regional peanut production costs, where regional projections were directly used as the deterministic component of stochastic projections. This was necessary because projections for national peanut production costs, the explanatory variable in the theoretical model, were not available. The second exception was in the harvested acreage estimation for wheat. A significant portion of wheat planted in Texas is used for cattle grazing, so a producer's decision whether to use planted wheat acreage for grazing or wheat production is largely based on expected returns for each alternative. To account for this, harvested acreage for wheat was estimated as a function of planted wheat acreage and the ratio of the beef cattle price to

Table 1. Exogenous and Endogenous Variables in the Texas Crop Model

Exogenous Variables	Endogenous Variables
*U.S. Price (marketing year average)	Net Farm Income
*U.S. Average Yield	Total Revenue
Producer Price Index	Total Costs of Production
U.S. Marketing Loan Rate	Price (marketing year average)
U.S. Seed Costs	Quantity of Production
U.S. Fertilizer Costs	Government Farm Program Payments
U.S. Chemicals Costs	*Harvested Acreage
U.S. Custom Operations Costs	*Average Yield
U.S. Fuel, Lube & Electricity Costs	*Planted Acreage
U.S. Repairs Costs	Per Acre Expected Net Returns
U.S. Hired Labor Costs	Expected Loan Deficiency Payment Rate
U.S. Irrigation Water Costs	*Expected Yield
U.S. Ginning Costs	Regional Per Acre Variable Costs of Production
U.S. Drying Costs	*Regional Seed Costs
U.S. Farm Overhead Costs	*Regional Fertilizer Costs
U.S. Taxes & Insurance Costs	*Regional Chemicals Costs
Interest Rate	*Regional Custom Operations Costs
Base Acreage	*Regional Fuel, Lube & Electricity Costs
Average Direct Payment Yield	*Regional Repairs Costs
U.S. Direct Payment Rate	*Regional Hired Labor Costs
Average Counter-cyclical Payment Yield	*Regional Irrigation Water Costs
U.S. Target Price	*Regional Ginning Costs
	*Regional Drying Costs
	*Regional Farm Overhead Costs
	*Regional Taxes & Insurance Costs
	Regional Short-term Interest Costs
	Direct Payments
	Counter-cyclical Payments
	Loan Deficiency Payments
	Counter-cyclical Payment Rate
	Loan Deficiency Payment Rate
	*Beef Cattle Price
	*Conservation Reserve Program Acreage
	Hay Costs of Production

Note: All variables are for Texas unless otherwise noted. An asterisk (*) indicates a stochastic variable.

expected net returns from wheat. Beef cattle price was estimated as a function of the Oklahoma City 600-650 pound feeder steer price.

Table 2 lists the production cost categories, as well as the ERS regions from which production cost data were used for each crop and their corresponding years. Prior to 1995, production regions were groups of states with similar production methods and costs. New farm resource regions that do not necessarily follow state boundaries were implemented in 1995 to more accurately represent the geographic distribution of U.S. farm production (USDA/ERS, 2005a). Three of these regions include areas of Texas, so production cost data from the current region containing the majority of the state's planted acreage was used. Since ERS conducts cost of production surveys for a particular crop only once every three to eight years, data for the new regions begins in different year for almost every crop.

The hay sector model is much simpler than those for the six program crops for two reasons. First, perennial or biannual hay crops are grown on a large portion of hay acreage, so those crops are not planted every year. The second reason is that there are no government farm programs covering hay. Because most hay crops are not planted every year, the hay model begins with harvested acreage.

Harvested acreage is estimated as a function of harvested acreage in the previous year, price in the previous year, and the sum of acreage planted to the six program crops plus Conservation Reserve Program (CRP) acreage. Hay price is estimated as a function of national hay price, while CRP acreage is estimated as a function of CRP in the previous year. Hay yield is estimated as a function of national hay yield, and is

Table 2. Cost of Production Categories and ERS Regions for Six Crops in Texas

	Corn	Cotton	Peanuts	Rice	Sorghum	Wheat
Seed	X	X	X	X	X	X
Fertilizer	X	X	X	X	X	X
Chemicals	X	X	X	X	X	X
Custom Operations	X	X	X	X	X	X
Fuel, Lube & Electricity	X	X	X	X	X	X
Repairs	X	X	X	X	X	X
Hired Labor	X	X	X	X	X	X
Irrigation Water	X			X		
Ginning		X				
Drying			X			
Farm Overhead	X	X	X	X	X	X
Taxes & Insurance	X	X	X	X	X	X
Short-term Interest	X	X	X	X	X	X
Previous Region	Great Plains	Southern Plains	Southern Plains	Delta: Gulf Coast	Southern Plains	Central & Southern Plains
Years	1978-1995	1978-1996	1978-1994	1978-1999	1978-1994	1978-1997
Current Region	Prairie Gateway	Prairie Gateway	Prairie Gateway	Fruitful Rim:Gulf Coast	Prairie Gateway	Prairie Gateway
Years	1996-2003	1997-2003	1995-2003	2000-2003	1995-2003	1998-2003

multiplied by harvested acreage to calculate total production. Hay price is estimated as a function of national hay price, and is multiplied by production to calculate total revenue. Production cost budgets from Texas Cooperative Extension (2006) were used to calculate total production costs for 2005. FAPRI's projected Producer Price Index was used to project future costs of production based on costs in 2005. Total production costs were subtracted from total revenue to calculate net farm income for hay. NFI for hay calculated with this formula assumes all hay is sold at the market price, but most hay is fed on the farm where it was harvested. As a result, this formula tends to overstate total receipts and NFI for hay.

Simetar (Richardson, Schumann and Feldman, 2006a) was used to estimate the model's OLS equations and to simulate the key output variables stochastically. Simetar is a simulation language for risk analysis to provide a transparent method for analyzing data, simulating the effects of risk, and presenting results in the user-friendly environment of Microsoft Excel. Simetar can be used to perform all of the steps for developing, simulating and applying a stochastic model in Excel. These steps include estimating parameters for random variables, simulating stochastic variables, testing the validity of the random variables, presenting the results graphically, and ranking risky alternatives (Richardson, Schumann and Feldman, 2006b).

In addition to the independent variables in the theoretical model, dummy variable parameters were used to explain variations in the model's endogenous variables. The first dummy variable series accounted for adjustments in crop sectors caused by policy changes.

Simetar's observational diagnostics (DF betas) were used to identify observations that could be removed from each variable's estimation to significantly improve the overall fit. The DFBeta Restriction column of the observational diagnostics output contains a 1 for each observation when the model is unrestricted and all observed data points are used. If an observation's Studentized Residual is greater than 2, the observation is a candidate for exclusion from the model based on an alpha of 0.05 (Richardson, Feldman, and Schumann, 2006b). Observations can be excluded by changing the 1 to a 0 in the DFBeta Restriction column. This adjustment was done for program crop prices, yields, expected yields and planted acres in years corresponding to the implementation of a new farm bill to account for the adjustment to a farm bill change. Dummy variables were also used in 1983, when the PIK program[7] was used to control production. Table 3 lists the years for which these dummy variables were used. The resulting series of 0s and 1s was used as an explanatory variable labeled D1, where 0 = outlier, 1 = included. In the cost of production equations, the D1 series accounted for the change in ERS production cost regions. Years under the current regional definitions were represented with a 0, and years under the previous regions were represented with a 1.

Additional dummy variables were used to account for considerable shifts in regional production costs. It was assumed that a significant movement in reported regional production costs lasting several years was caused by a difference in data collection methods rather than an actual shift in costs. A line graph of each production

[7] The Payment-in-kind (PIK) program paid farmers 80 to 95 percent of their farm program yield in return for retiring acreage from production for one year (Knutson, Penn, and Flinchbaugh, 1998).

Table 3. Years Using Dummy Variables for Farm Policy Adjustments in Texas Yield, Expected Yield, Price and Planted Acres Equations

	Corn	Cotton	Peanuts	Rice	Sorghum	Wheat
Yield	1990, 1997	--	--	1986, 1997	1996	2003
Expected Yield	1990, 1997	1987	--	1986	--	1983
Price	1996	--	1990	--	1996	1996, 2002
Planted Acres	1987	1986	1986, 2003	1986	1997	--

cost data series was used to identify these shifts. A 1 was assigned to observations assumed to correspond to a change in data collection, and the series of 0s and 1s was denoted as D2, where 1 = original method, 0 = alternate method. While the D1 series was used as an explanatory variable throughout the model, the D2 series was only used in cost of production equations. A third dummy variable (D3) was used in the planted acres equations to represent years since 1996, when planting restrictions that existed in previous farm programs were eliminated.

Once the model's equations were estimated using OLS regression, the endogenous variables were projected for 2006-2014. The deterministic projections were calculated as:

$$\text{Y-hat} = \beta_0 + \beta_1 X + ADJ$$

where:

Y-hat = Deterministic projection,

β_0 = Intercept parameter,

β_1 = Slope parameter(s),

X = Explanatory variable(s), and

ADJ = Adjustment factor, the last three observations' average residual.

"If" statements were used to ensure projections of planted acres could not fall below zero, and that harvested acreage projections could not exceed planted acres. It was assumed that taxes and insurance costs would not decrease from one year to the next. “If” statements were used to make taxes and insurance costs equal to those in the previous year if they were projected to decrease.

Residuals from the regression equations were then used to make the projections stochastic. A correlation matrix of the residuals for groups of correlated variables was generated. The seven groups are:

1. Texas prices
2. Texas yields
3. Texas planted acres and harvested acres
4. Regional seed costs
5. Regional fertilizer, chemical and fuel costs
6. Regional repairs, custom operations, labor and overhead costs
7. Regional tax & insurance costs and Texas cash receipts

A correlated standard normal deviate (CSND), or random number, for each stochastic variable in each projected year was developed from the appropriate factored correlation matrix. The stochastic projections were then simulated for variable i as:

$\tilde{Y}_{it} = Y\text{-}hat_{it} + \sigma\text{-}hat_i * CSND_{it}$

where:

$\tilde{Y}_{it}$ = Stochastic projection for variable i in period t,

$Y\text{-}hat_{it}$ = Deterministic projection for variable i in period t,

$\sigma\text{-}hat_i$ = Standard error of prediction for variable i, and

$CSND_{it}$= A correlated standard normal deviate for variable i in period t.

A univariate distribution was assumed in projecting irrigation costs for corn and rice, ginning costs for cotton, and drying costs for peanuts. These costs were simulated univariate because they were only relevant for one or two crops in the model. Beef cattle price and CRP acreage were also simulated with a univariate distribution.

Stochastic values for these six variables were calculated as they were for all other variables, except the CSNDs were replaced with independent standard normal deviates.

Five hundred iterations of net farm income for each Texas crop in the model were simulated under the January 2005 FAPRI Baseline projections for national costs of production, prices and yields. The experiment was repeated with the January 2006 FAPRI Baseline projections. FAPRI Baseline projections were used because they come from one of the most comprehensive models of the agricultural industry. FAPRI explicitly models all crops included in the Texas crop model, and assumes continuation of current farm policy programs in making the baseline. Five hundred iterations of simulated values for national prices and yields from the FAPRI Baseline, along with the means of simulated production costs, were used as input to the Texas crop model. Probabilistic projections of net farm income for each crop and for all seven crops were compared under the two sets of baseline projections to show the impact of updating the baseline projections for prices, yields and production costs. The differences between these two baselines reflect higher production costs driven by rising energy prices, and increasing export demands that resulted from a weakening dollar from 2004 to 2005.

Data

Historical data from 1978-2004 were used in the Texas crop model.[8] Data from the Economic Research Service (USDA/ERS, 2005b & 2005c) were used for national and regional costs of production as well as government payments. National Agricultural

[8] Cost of production data were only available through 2003.

Statistics Service (USDA/NASS, 2005) data were used for price, yield, planted acres and harvested acres for each crop at the national and Texas levels.

National costs of production, prices, yields and the interest rate projected in the January 2005 and 2006 FAPRI Baselines were used as exogenous variables for the Texas crop model. FAPRI projections of national prices and yields were stochastic, while those for costs of production were the means from FAPRI's stochastic baseline. Marketing loan rates, target prices, direct payment rates, direct and counter-cyclical payment yields, as well as base acreages were obtained from the Farm Service Agency (USDA/FSA, 2005). Although these policy variables are only set through 2007 in the current Farm Bill, they were assumed to remain unchanged in the future.

Validation

The OLS regression and stochastic simulation results were statistically validated to verify that the appropriate parameters were used in the estimations and that the historical distributions of residuals were replicated in the stochastic simulation.

Several measures were used to validate the OLS model. A t-test was used to test the statistical significance of each explanatory variable. A variable's t-statistic is used to generate its p-value, which represents the smallest significance level at which the null hypothesis of statistically significance can be rejected. R^2, R-bar^2 and an F-test were used to evaluate the overall fit of each estimated equation. The Durbin-Watson (D-W) statistic was used to test for first order serial correlation in the residuals. The forecasting error of each regression was measured with Theil's U2 statistic. The Theil U2 statistic is the square root of the sum of squared residuals from the forecast divided by the sum of squared observational values (Richardson, Schumann and Feldman, 2006b). The Shapiro-Wilks, Anderson Darling, and Cramer von Mesis test statistics were used to test whether the residuals from the OLS equations were normally distributed. This was necessary because correlation matrices for these residuals were used in generating the random numbers to make the model stochastic.

Once the OLS model was validated, results of the stochastic simulation were tested. A Student's t-test was used to test whether means of the simulated variables were statistically different from their deterministic values. To validate the standard deviations, each variable's simulated standard deviation was compared to its assumed standard deviation with a Chi-squared test. For variables simulated with a multivariate distribution, the correlation of simulated data was tested against the correlation matrix of historical residuals to determine whether the simulated variables were appropriately correlated. This was done with a Student's t-test for each correlation coefficient.

Summary

The Texas crop model was developed to project net farm income for the state's crop producers in 2006-2014. The theoretical model was outlined from the top down beginning with the net farm income, the key output variable. The empirical model was then constructed from the bottom up. Historical data from the Economic Research Service, National Agricultural Statistics Service and Farm Service Agency were used along with FAPRI projections of national costs of production, prices and yields.

OLS regression was used to estimate the model's econometric equations. Projections for stochastic variables assumed to be correlated with other variables were simulated with a MVN distribution. Monte Carlo simulation was used to simulate 500 iterations of the key output variables under January 2005 and January 2006 FAPRI Baseline projections. The OLS model equations and the stochastic simulation results were validated using statistical tests.

CHAPTER IV

RESULTS

As stated in Chapter I, the objective of this study is to develop a model to project net farm income (NFI) for Texas crop producers. The Texas crop model was developed to achieve this objective. OLS regression was used to estimate the model's equations and stochastic simulation was used to develop probabilistic projections of NFI. This chapter presents the model's regression results, the results of testing the residuals from the OLS equations for normality, deterministic and probabilistic NFI projections, and statistical validation of stochastic variables in the model.

OLS Regression Results

The results of estimating the econometric equations for yields, expected yields, prices, planted acres and harvested acres are reported in Tables 4-8. A good regression model has the expected sign on the coefficient and a low p-value for each explanatory variable. The overall fit of each regression equation can be verified with high R^2 and R-bar^2, and an F-statistic greater than the critical value given the degrees of freedom (which depends on the number of observations and explanatory variables). A D-W statistic close to 2.0 indicates the residuals are not auto correlated, and a low Theil U2 statistic supports the model's forecasting ability.

Each Texas crop's annual yield was estimated as a function of national yield because technology used to improve yields throughout the U.S. is utilized in Texas as well. The R^2 and R-bar^2 values for these equations were between 0.54 and 0.91 for cotton, rice, and wheat, but were between 0.23 and 0.47 for corn, peanuts and sorghum, and less than .11 for hay (Table 4). The F-statistic was significant at the 99 percent confidence level for each program crop, but was not significant at the 90 percent confidence level for hay. The D-W statistics were within ±0.6 of 2.0 for all crops except peanuts and hay. The Theil U2 statistic was higher than 0.11 for cotton, peanuts and hay, but lower than .10 for the other four crops.

Although some of the regression equations did not have a good fit in terms of their R^2, R-bar^2 and F-statistic or showed autocorrelation in the residuals, they were used in the model. This is because estimating state or regional variables as a function of their national values is the best available model useful for policy analysis or to compare net farm income projections for Texas crops under alternative FAPRI baseline projections of national prices, yields and production costs. High autocorrelation causes the confidence level of the Student-t and F tests to increase because the power of the test increases, and can cause a null hypothesis test to not be rejected when it should be rejected.

The Texas crop model requires a variable for expected yield, which is used to calculate expected net returns for the planted acres equations. Expected yields were estimated separately from yields because producers are assumed to expect yields to change each year based on technology and assuming normal planting conditions and weather patterns. Historical yield was the independent variable and the year was the independent variable in the expected yield equations (Table 5). The R^2 and R-bar^2 values for expected yield were at least 0.63 for cotton, peanuts and rice, but below 0.43

Table 4. Multiple Regression Results for Explaining Yields for Seven Crops in Texas

		Intercept	US Yield	D1	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
	Beta	52.0576	0.5053	-0.9313	0.439	0.392	9.374	2.547	0.0837
	P-value	0.0036	0.0003	0.9022					
Cotton									
	Beta	-90.4340	0.8561	--	0.558	0.541	31.605	1.839	0.1379
	P-value	0.3436	0.0000	--					
Peanuts									
	Beta	-2.5599	0.9437	--	0.262	0.232	8.868	0.530	0.2285
	P-value	0.7553	0.0065	--					
Rice									
	Beta	-7.8933	1.1542	0.1626	0.907	0.899	116.629	1.506	0.0425
	P-value	0.1095	0.0000	0.9327					
Sorghum									
	Beta	15.4648	0.4832	10.8693	0.469	0.425	10.603	2.167	0.0704
	P-value	0.0917	0.0003	0.0191					
Wheat									
	Beta	-17.8080	1.0359	8.2451	0.622	0.591	19.784	2.391	0.0853
	P-value	0.0312	0.0000	0.0099					
Hay									
	Beta	0.6026	0.6685	--	0.100	0.064	2.767	2.677	0.1138
	P-value	0.5436	0.1092	--					

Note: US Yield is the respective national yield for the crop. D1 is a dummy variable to identify outliers resulting from a policy change.

Table 5. Multiple Regression Results for Explaining Expected Yields for Six Crops in Texas

		Intercept	Trend	D1	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
	Beta	-2005.7734	1.0633	-0.4490	0.420	0.372	8.690	2.369	0.0873
	P-value	0.0007	0.0004	0.9536					
Cotton									
	Beta	-18150.9477	9.3895	-116.5026	0.658	0.630	23.096	2.446	0.1213
	P-value	0.0000	0.0000	0.0569					
Peanuts									
	Beta	-1373.3036	0.7005	--	0.852	0.846	143.419	1.605	0.1025
	P-value	0.0000	0.0000	--					
Rice									
	Beta	-1713.3999	0.8942	-10.6430	0.772	0.753	40.606	1.160	0.0665
	P-value	0.0000	0.0000	0.0173					
Sorghum									
	Beta	-112.0733	0.0842	--	0.015	0.000	0.374	2.000	0.0959
	P-value	0.6863	0.5464	--					
Wheat									
	Beta	-436.7269	0.2379	-8.2070	0.283	0.223	4.742	1.887	0.1175
	P-value	0.0253	0.0166	0.0413					

Note: Trend represents the year. D1 is a dummy variable to identify outliers resulting from a policy change.

for corn, sorghum and wheat. The F-statistic was not significant at the 90 percent confidence level for sorghum, but was significant at the 95 percent level for wheat and at the 99 percent level for the other four crops. The D-W statistics were within ±0.6 of 2.0 for all crops except rice. Theil's U2 statistic was significantly higher than 0.10 only for cotton and wheat.

Marketing year average prices for Texas crops were estimated as a linear relationship to national prices, because prices in most areas of the country follow national prices. The R^2 and R-bar^2 were greater than 0.81 for the six program crops, but were .385 and .361, respectively, for hay (Table 6). The F-statistics were significant at the 99 percent confidence level for all crops, and Theil's U2 statistic was less than 0.07 for the program crops. However, the D-W statistics for cotton and peanuts were less than 1.1, suggesting the residuals for prices of these crops were auto correlated.

Planted acreage for each program crop was estimated as a function of expected net returns for all of the crops with the expectation that planted acres for a crop would be positively related to its own expected net returns and negatively related to expected net returns of the other crops (Table 7). The dummy variable D3 was also used as an explanatory variable to account for years under the 1996 and 2002 Farm Bills, which eliminated planting restrictions present in previous farm programs.

The OLS equations estimated for planted acres of the Texas crops resulted in unexpected signs and high p-values for several explanatory variables. The positive signs on the coefficients of the D3 variable for corn, cotton, peanuts and sorghum indicate that planted acreage for these crops relative to their expected net returns has increased since

Table 6. Multiple Regression Results for Explaining Prices for Seven Crops in Texas

		Intercept	US Price	D1	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
	Beta	0.7282	0.9084	-0.2394	0.936	0.931	175.691	1.496	0.0366
	P-value	0.0003	0.0000	0.0355					
Cotton									
	Beta	-0.0471	1.0056	--	0.937	0.934	371.409	1.075	0.0451
	P-value	0.1434	0.0000	--					
Peanuts									
	Beta	13.8144	0.8094	-9.9291	0.889	0.878	79.895	0.914	0.0584
	P-value	0.0023	0.0000	0.0000					
Rice									
	Beta	0.2505	1.0528	--	0.943	0.941	417.145	1.554	0.0605
	P-value	0.5374	0.0000	--					
Sorghum									
	Beta	1.1613	0.7952	-0.5964	0.832	0.818	59.415	1.957	0.0657
	P-value	0.0001	0.0000	0.0016					
Wheat									
	Beta	0.0846	0.9963	-0.1977	0.869	0.858	79.484	2.185	0.0667
	P-value	0.8248	0.0000	0.2799					
Hay									
	Beta	30.2571	0.5276	0.0000	0.385	0.361	15.663	1.844	0.1115
	P-value	0.0086	0.0006	0.0000					

Note: US Price is the respective national price for the crop. D1 is a dummy variable to identify outliers resulting from a policy change.

Table 7. Multiple Regression Results for Explaining Planted Acres for Six Crops in Texas

	Intercept	CRENR	CTENR	PNENR	RCENR	SGENR	WHENR	D1	D3	R^2	R-bar^2	F-test	D-W	Theil U2
Corn														
Beta	1305.137	-322.236	415.868	27.832	-81.976	234.609	-529.674	632.146	182.757	0.621	0.443	3.482	1.802	0.1176
P-value	0.0007	0.2076	0.0472	0.6988	0.3126	0.6077	0.1903	0.0366	0.1940					
Cotton														
Beta	4607.976	-882.058	913.718	-343.201	325.753	1873.307	-838.124	1405.173	195.831	0.287	0.000	0.854	0.763	0.1294
P-value	0.0011	0.3481	0.2222	0.2099	0.2816	0.2774	0.5687	0.1917	0.7012					
Peanuts														
Beta	182.542	-7.090	-2.416	7.321	19.617	-75.963	5.364	82.130	77.641	0.738	0.614	5.972	1.363	0.0902
P-value	0.0002	0.8289	0.9244	0.4460	0.0881	0.2176	0.9169	0.0095	0.0006					
Rice														
Beta	-110.885	25.188	-53.162	-23.519	90.484	76.390	90.392	360.348	-114.773	0.804	0.712	8.713	1.465	0.1385
P-value	0.3998	0.6834	0.3225	0.2129	0.0027	0.5022	0.3610	0.0012	0.0031					
Sorghum														
Beta	134.464	1747.969	-439.418	-40.791	28.606	297.633	137.616	2168.842	207.661	0.575	0.375	2.875	2.116	0.1597
P-value	0.9258	0.0427	0.4478	0.8515	0.9096	0.8291	0.9062	0.0553	0.6459					
Wheat														
Beta	6465.479	-412.349	-1109.942	-162.837	143.740	2062.293	1832.922	--	-81.666	0.554	0.381	3.196	0.994	0.0796
P-value	0.0000	0.5095	0.0295	0.3693	0.4755	0.0837	0.0716	--	0.8088					

Note: CRENR, CTENR, PNENR, RCENR, SGENR and WHENR are deflated per acre expected net returns for corn, cotton, peanuts, rice, sorghum and wheat, respectively. D1 is a dummy variable to identify outliers resulting from a policy change. D3 is a dummy variable to account for years of production since 1996, when planting restrictions were removed.

the 1996 Farm Bill was passed. The R^2 and R-bar^2 values ranged from 0.287 and 0.0, respectively, for cotton to 0.804 and 0.712 for rice (Table 7). The F-statistic was not significant at the 90 percent confidence level for cotton, but was significant at the 95 percent level for corn, sorghum and wheat, and at the 99 percent level for peanuts and rice. The D-W statistic was less than 1.4 for cotton, peanuts and wheat, signaling autocorrelation in their residuals. The Theil U2 statistic was higher than 0.10 for corn, cotton, rice and sorghum.

One possible explanation for the performance of the planted acreage estimations is that farmers do not shift crop acreage to the most profitable crop each year due to fixed assets and resource constraints. Most farmers do not have the experience or equipment necessary to produce every crop in the model, and much of the cropland in Texas is not suitable for growing all of these crops. Prior to 1997, farm programs also limited flexibility in planting decisions.

Harvested acreage was estimated as a linear relationship to planted acreage for the six program crops because a portion of planted crops is not harvested in most years due to poor growing conditions and other factors (Table 8). The ratio of the beef cattle price to expected net returns for wheat was also used as an explanatory variable for harvested wheat acreage because a considerable amount of wheat planted in Texas is used for cattle grazing. Harvested hay acreage was estimated as a function of both harvested acreage and price in the previous year, and the sum of acreage planted to the six program crops plus CRP acreage. The R^2 and R-bar^2 values were higher than .79 for corn, rice, sorghum and hay, and were between .52 and .67 for cotton, peanuts and

Table 8. Multiple Regression Results for Explaining Harvested Acres for Seven Crops in Texas

	Intercept	Planted Acres			R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	207.6601	0.7780	--	--	0.930	0.927	329.748	1.474	0.0454
P-value	0.0105	0.0000	--	--					
Cotton									
Beta	-605.1465	0.9419	--	--	0.669	0.655	50.461	2.186	0.1178
P-value	0.4455	0.0000	--	--					
Peanuts									
Beta	132.9425	0.4696	--	--	0.539	0.521	29.272	0.996	0.0841
P-value	0.0000	0.0000	--	--					
Rice									
Beta	-0.4951	0.9966	--	--	1.000	1.000	448208	1.492	0.0024
P-value	0.3684	0.0000	--	--					
Sorghum									
Beta	-7.9324	0.8840	--	--	0.911	0.908	256.205	1.720	0.0796
P-value	0.9704	0.0000	--	--					
Wheat			BFPR:WHENR						
Beta	-3460.7465	1.1169	-2.9313	--	0.623	0.590	19.002	1.543	0.1699
P-value	0.0088	0.0000	0.7672	--					
Hay		HayHA t-1	HayPR t-1	ProgPA + CRP					
Beta	-1820.4290	0.7415	20.3749	0.0690	0.819	0.795	34.675	2.586	0.0912
P-value	0.1681	0.0000	0.0121	0.2558					

Note: Planted Acres is the respective number of acres planted to the crop. BFPR:WHENR is the ratio of the beef cattle price to deflated per acre expected net returns for wheat. HayHA t-1 is harvested hay acreage in the previous year. HayPR is the hay price in the previous year. ProgPA + CRP is the sum of acres planted to the six program crops and CRP acreage.

wheat. The F-statistics were significant at the 99 percent confidence level for all harvested acreage equations. The D-W statistics were within ±0.6 of 2.0 for all crops except peanuts, and Theil's U2 statistic was significantly higher than 0.10 only for cotton and wheat.

Each program crop's regional costs of production were estimated as a function of its corresponding national production costs, assuming costs in most parts of the U.S. follow national averages. Production cost regression results are reported in Tables A-1 through A-10. For seed costs, the R^2 and R-bar^2 values were at least 0.83 for all crops except rice, which had an R^2 of .395 and an R-bar^2 of .342 (Table A-1). The F-statistic for each crop was significant at the 99 percent confidence level and the D-W statistics were within ±0.6 of 2.0 for all crops except peanuts. Theil's U2 statistic was less than 0.09 for all crops except cotton.

In the fertilizer cost regressions, the R^2 and R-bar^2 were above 0.87 for all crops except corn, which had an R^2 of .398 and an R-bar^2 of .346 (Table A-2). All F-statistics were significant at the 99 percent confidence level, and Theil's U2 statistic was greater than .10 only for corn (Table A-2). However, the D-W statistic was below 1.4 for corn, cotton, peanuts and rice, signifying autocorrelation in the residuals for these crops' fertilizer costs. The R^2 and R-bar^2 for chemicals costs were above 0.82 for all crops except peanuts, which had an R^2 of .331 and an R-bar^2 of .273 (Table A-3). The F-statistic was significant at the 99 percent level for each crop. The Theil U2 statistic was significantly higher than 0.10 only for peanuts, but the D-W statistics were less than 1.3 for all six crops, again suggesting autocorrelation.

In the custom operations cost equations, the R^2 and R-bar^2 values were at least .81 for corn, rice, sorghum and wheat, but were between .24 and .50 for cotton and peanuts (Table A-4). The F-statistic was significant at the 95 percent confidence level for cotton, and significant at the 99 percent level for the other five crops. The D-W statistics were less than 0.9 for all crops except sorghum, and Theil's U2 statistic was greater than 0.10 for all crops except rice and sorghum. The custom operations equations for cotton and peanuts had low R^2 and R-bar^2 values and high Theil U2 statistics, which can be explained by the fact that expenditures for custom work are highly variable over time and by location, depending on yields and weather conditions. If a farmer has a poor crop or has plenty of time to harvest his crop, he is less likely to hire a custom harvester than he does if the crop is good and he needs it harvested in a short period of time.

The OLS equations for costs of fuel, lube and electricity had R^2 and R-bar^2 values of at least .64 for all crops except cotton, which had an R^2 of .489 and an R-bar^2 of .444 (Table A-5). All F-statistics were significant at the 99 percent level. However, D-W statistics were below 1.4 for all crops except sorghum, and Theil U2 statistics were above 0.10 for cotton, peanuts and wheat.

In the repair cost equations, the R^2 and R-bar^2 were above 0.86, the F-statistics were significant at the 99 percent confidence level, and Theil U2 statistics were less than 0.10 for all crops (Table A-6). However, the D-W statistics were less than 1.4 for corn, peanuts and rice. The R^2 and R-bar^2 in the hired labor cost equations were greater than 0.88 for all crops except cotton, which had an R^2 of .648 and an R-bar^2 of .600 (Table A-

7). The F-statistics were significant at the 99 percent confidence level for all six crops, and Theil's U2 statistic was above 0.10 only for cotton. However, the D-W statistics were less than 1.4 for all six crops.

In the overhead cost regressions, the R^2 and R-bar^2 were at least .59 for corn, peanuts, sorghum and wheat, but were less than .43 for cotton and rice (Table A-8). The F-statistic for cotton was not significant at the 90 percent confidence level, but those for the other five crops were significant at the 99 percent level. Theil's U2 statistic was above 0.10 only for corn and cotton, but the D-W statistics were less than 1.3 for all crops except sorghum and wheat. OLS equations for taxes and insurance costs had R^2 and R-bar^2 values greater than 0.81 and F-statistics that were significant at the 99 percent level for all six crops (Table A-9). Theil's U2 statistic was higher than 0.10 only for corn, but D-W statistics were less than 1.4 for corn, cotton, rice and sorghum.

Results for estimating irrigation costs for corn and rice, ginning costs for cotton, and drying costs for peanuts are reported in Table A-10. The R^2 and R-bar^2 values ranged from 0.518 to 0.991 and F-statistics were significant at the 99 percent confidence level for all four costs. However, the D-W statistics were less than 1.4 for all but cotton ginning costs, and Theil's U2 statistic was less than 0.10 only for rice irrigation water costs. Table A-11 reports the results of estimating the beef cattle price as a function of the Oklahoma City 600-650 pound feeder steer price; and an equation to estimate CRP acreage as a linear relationship to CRP in the previous year. Both equations had R^2 and R-bar^2 values above 0.84, F-statistics significant at the 99 percent level, and Theil U2 statistics less than 0.05. However, the D-W statistic was less than 1.0 for both equations.

Normality Tests

The residuals from the OLS equations for prices, yields, planted acres and harvested acres were tested for normality using the Shapiro-Wilks, Anderson Darling, and Cramer von Mesis tests. The results of these tests at the 95 percent confidence level are reported in Table 9. In all three tests, the null hypothesis that the residuals from the OLS equations for prices were normally distributed was rejected for cotton and hay, but was not rejected for the other five crops. The Shapiro-Wilks test rejected the null hypothesis for cotton and sorghum yields, but the Anderson Darling and Cramer von Mesis tests found residuals for all yield equations to have a normal distribution. For the planted acres equations, the null hypothesis for corn was rejected by the Anderson Darling and Cramer von Mesis tests, but all three tests found the residuals for acres planted to the other five crops to be normally distributed. All three tests rejected the null hypothesis for the cotton and sorghum harvested acres equations, and the Shapiro-Wilks test also rejected the null hypothesis for rice harvested acres. However, all three tests failed to reject the null hypothesis that the OLS residuals were normally distributed for harvested acres of corn, peanuts, wheat and hay.

Net Farm Income Projections

The Texas crop model's key output variables are annual net farm income (NFI) (2006-2014) for corn, cotton, peanuts, rice, sorghum, wheat and hay. Statistics for these variables were calculated after simulating the stochastic model for the January 2005 and January 2006 FAPRI Baseline projections of national production costs, prices and yields.

Table 9. Results of Three Tests for Normality in Historical Residuals for Texas Prices, Yields, Planted Acres and Harvested Acres at the 95 Percent Confidence Level

Variable	Test	Test Value	P-value	Result
Corn Price				
	Shapiro-Wilks	0.958	0.328	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.537	0.153	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.093	0.132	Fail to Reject the Ho that the Distribution is Normally Distributed
Cotton Price				
	Shapiro-Wilks	0.764	0.000	Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	1.509	0.001	Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.228	0.002	Reject the Ho that the Distribution is Normally Distributed
Peanuts Price				
	Shapiro-Wilks	0.935	0.138	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.514	0.173	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.082	0.815	Fail to Reject the Ho that the Distribution is Normally Distributed
Rice Price				
	Shapiro-Wilks	0.978	0.831	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.169	0.931	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.018	0.982	Fail to Reject the Ho that the Distribution is Normally Distributed
Sorghum Price				
	Shapiro-Wilks	0.944	0.167	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.485	0.208	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.079	0.796	Fail to Reject the Ho that the Distribution is Normally Distributed
Wheat Price				
	Shapiro-Wilks	0.943	0.158	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.513	0.176	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.067	0.709	Fail to Reject the Ho that the Distribution is Normally Distributed
Hay Price				
	Shapiro-Wilks	0.833	0.001	Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	1.545	0.000	Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.278	0.001	Reject the Ho that the Distribution is Normally Distributed
Corn Yield				
	Shapiro-Wilks	0.968	0.547	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.458	0.243	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.083	0.821	Fail to Reject the Ho that the Distribution is Normally Distributed
Cotton Yield				
	Shapiro-Wilks	0.900	0.013	Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.711	0.056	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.105	0.090	Fail to Reject the Ho that the Distribution is Normally Distributed
Peanuts Yield				
	Shapiro-Wilks	0.974	0.711	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.177	0.918	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.020	0.967	Fail to Reject the Ho that the Distribution is Normally Distributed
Rice Yield				
	Shapiro-Wilks	0.964	0.450	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.512	0.179	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.099	0.110	Fail to Reject the Ho that the Distribution is Normally Distributed
Sorghum Yield				
	Shapiro-Wilks	0.923	0.048	Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.485	0.209	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.070	0.731	Fail to Reject the Ho that the Distribution is Normally Distributed
Wheat Yield				
	Shapiro-Wilks	0.957	0.312	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.364	0.414	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.058	0.615	Fail to Reject the Ho that the Distribution is Normally Distributed
Hay Yield				
	Shapiro-Wilks	0.940	0.124	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.469	0.228	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.060	0.636	Fail to Reject the Ho that the Distribution is Normally Distributed

Table 9. Continued

Variable	Test	Test Value	P-value	Result
Corn Planted Acres				
	Shapiro-Wilks	0.926	0.062	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.766	0.040	Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.136	0.034	Reject the Ho that the Distribution is Normally Distributed
Cotton Planted Acres				
	Shapiro-Wilks	0.956	0.314	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.372	0.394	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.050	0.498	Fail to Reject the Ho that the Distribution is Normally Distributed
Peanuts Planted Acres				
	Shapiro-Wilks	0.979	0.859	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.291	0.581	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.052	0.537	Fail to Reject the Ho that the Distribution is Normally Distributed
Rice Planted Acres				
	Shapiro-Wilks	0.963	0.445	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.500	0.190	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.091	0.141	Fail to Reject the Ho that the Distribution is Normally Distributed
Sorghum Planted Acres				
	Shapiro-Wilks	0.955	0.296	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.328	0.503	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.049	0.512	Fail to Reject the Ho that the Distribution is Normally Distributed
Wheat Planted Acres				
	Shapiro-Wilks	0.966	0.524	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.311	0.531	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.049	0.506	Fail to Reject the Ho that the Distribution is Normally Distributed
Corn Harvested Acres				
	Shapiro-Wilks	0.934	0.085	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.542	0.149	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.075	0.766	Fail to Reject the Ho that the Distribution is Normally Distributed
Cotton Harvested Acres				
	Shapiro-Wilks	0.916	0.031	Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.807	0.032	Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.135	0.035	Reject the Ho that the Distribution is Normally Distributed
Peanuts Harvested Acres				
	Shapiro-Wilks	0.968	0.547	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.261	0.682	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.032	0.807	Fail to Reject the Ho that the Distribution is Normally Distributed
Rice Harvested Acres				
	Shapiro-Wilks	0.914	0.028	Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.686	0.065	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.101	0.104	Fail to Reject the Ho that the Distribution is Normally Distributed
Sorghum Harvested Acres				
	Shapiro-Wilks	0.834	0.001	Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	1.739	0.000	Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.335	0.000	Reject the Ho that the Distribution is Normally Distributed
Wheat Harvested Acres				
	Shapiro-Wilks	0.961	0.415	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.289	0.589	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.040	0.669	Fail to Reject the Ho that the Distribution is Normally Distributed
Hay Harvested Acres				
	Shapiro-Wilks	0.964	0.445	Fail to Reject the Ho that the Distribution is Normally Distributed
	Anderson Darling	0.550	0.142	Fail to Reject the Ho that the Distribution is Normally Distributed
	Cramer von Mesis	0.109	0.079	Fail to Reject the Ho that the Distribution is Normally Distributed

FAPRI Stochastic Baseline projections were used because the FAPRI modeling system is one of the most thorough representations of the agricultural industry. Continuation of current farm policy programs is assumed in making the baseline, which is a 500-iteration Monte Carlo simulation of FAPRI's U.S. crop model. The 500 iterations of simulated values for national prices and yields from FAPRI were used as input to the Texas crop model. This, along with the correlated risk from the Texas model's regression equations made the Texas crop model stochastic. Means of the 500 iterations of national production costs from FAPRI were used in the Texas crop model, and the correlated risk from the regression equations made the Texas cost projections stochastic.

Deterministic NFI projections for Texas crops under the two sets of baseline projections are reported in Table 10. Compared to NFIs under the January 2005 FAPRI Baseline, total NFI projections decreased for each year in the analysis by an average of 11.7 percent under the January 2006 Baseline with the most significant reductions coming in 2006-2008. NFI projections for all six program crops declined, with sorghum and wheat impacted the most on a percentage basis. Exceptions were cotton NFI in 2009-2011 and rice NFI in 2014. Increases in projected hay prices due to low rainfall in many areas caused NFI projections for hay to increase under the January 2006 Baseline.

National price and yield projections from FAPRI enter the Texas crop model as stochastic variables. To account for the additional risk in state prices, state yields and regional costs of production, these variables were made stochastic with a multivariate normal distribution using correlation matrices of residuals from the OLS equations. The

Table 10. Deterministic Projections of Texas Crop Net Farm Income (NFI) under January 2005 and January 2006 FAPRI Baselines, 2006-2014

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn NFI ($1,000)									
January 2005	199,084	196,070	193,005	185,218	182,155	182,271	179,986	177,342	174,040
January 2006	102,646	117,614	117,620	130,939	145,057	150,889	150,548	152,864	153,365
Change	-96,438	-78,456	-75,386	-54,279	-37,098	-31,383	-29,437	-24,478	-20,675
% Change	-48.4%	-40.0%	-39.1%	-29.3%	-20.4%	-17.2%	-16.4%	-13.8%	-11.9%
Cotton NFI									
January 2005	778,327	789,377	777,134	765,334	761,148	751,229	735,062	701,725	642,048
January 2006	652,199	739,582	772,299	778,558	779,757	768,682	725,343	672,974	630,948
Change	-126,128	-49,794	-4,836	13,224	18,609	17,453	-9,719	-28,751	-11,100
% Change	-16.2%	-6.3%	-0.6%	1.7%	2.4%	2.3%	-1.3%	-4.1%	-1.7%
Peanuts NFI									
January 2005	98,571	100,126	101,263	100,825	100,309	100,395	99,915	100,148	99,246
January 2006	73,762	82,401	84,612	87,281	89,063	88,916	88,289	87,020	86,529
Change	-24,808	-17,725	-16,650	-13,544	-11,245	-11,479	-11,627	-13,128	-12,718
% Change	-25.2%	-17.7%	-16.4%	-13.4%	-11.2%	-11.4%	-11.6%	-13.1%	-12.8%
Rice NFI									
January 2005	124,909	128,111	122,825	120,396	120,963	118,927	116,000	112,800	109,479
January 2006	93,889	103,429	108,218	106,052	106,645	104,225	103,303	105,685	109,531
Change	-31,021	-24,682	-14,607	-14,344	-14,317	-14,702	-12,697	-7,114	52
% Change	-24.8%	-19.3%	-11.9%	-11.9%	-11.8%	-12.4%	-10.9%	-6.3%	0.0%
Sorghum NFI									
January 2005	138,344	132,119	124,343	112,540	103,978	92,610	78,551	65,119	53,711
January 2006	34,148	33,422	27,459	17,173	10,420	9,671	6,972	6,419	5,051
Change	-104,195	-98,697	-96,884	-95,367	-93,559	-82,938	-71,579	-58,700	-48,660
% Change	-75.3%	-74.7%	-77.9%	-84.7%	-90.0%	-89.6%	-91.1%	-90.1%	-90.6%
Wheat NFI									
January 2005	3,758	-3,812	-16,676	-24,979	-24,867	-27,294	-29,874	-34,791	-42,714
January 2006	-226,489	-138,138	-124,032	-109,053	-98,172	-92,996	-92,467	-94,679	-96,993
Change	-230,247	-134,325	-107,356	-84,074	-73,305	-65,701	-62,593	-59,888	-54,280
% Change	-6127%	-3523%	-643.8%	-336.6%	-294.8%	-240.7%	-209.5%	-172.1%	-127.1%
Hay NFI									
January 2005	479,905	500,045	518,476	531,882	550,567	564,093	578,943	584,706	590,248
January 2006	531,556	552,784	578,092	600,676	624,517	645,362	660,169	664,644	666,026
Change	51,651	52,739	59,616	68,794	73,950	81,269	81,226	79,938	75,778
% Change	10.8%	10.5%	11.5%	12.9%	13.4%	14.4%	14.0%	13.7%	12.8%
Total									
January 2005	1822898	1842035	1820371	1791217	1794252	1782232	1758583	1707049	1626059
January 2006	1261711	1491095	1564268	1611627	1657287	1674750	1642158	1594927	1554456
Change	-561,187	-350,941	-256,102	-179,590	-136,965	-107,481	-116,425	-112,121	-71,603
% Change	-30.8%	-19.1%	-14.1%	-10.0%	-7.6%	-6.0%	-6.6%	-6.6%	-4.4%

Note: Wheat NFI does not include returns to livestock sector from wheat grazing.

annual NFI projections for 2006-2014 were simulated for 500 iterations under the January 2005 FAPRI Baseline, and again under the January 2006 Baseline.

Statistical summaries of stochastic projections for national prices, yields and costs of production from the January 2005 and January 2006 FAPRI Baselines are summarized in Tables A-12 to A-14. Compared to the January 2005 Baseline, projected mean prices in the January 2006 Baseline were 1 to 6 percent lower for peanuts, but 2 to 10 percent higher for all other crops in most years (Table A-12). Although large supplies from record production in recent years put downward pressure on prices, increasing export demand caused by a weakening dollar boosted price projections for all program crops except peanuts (FAPRI, 2006). Increasing cattle numbers combined with reduced hay yields due to low rainfall in many areas in 2005 led to higher hay price projections (FAPRI, 2006). Yield projections in the January 2006 Baseline were 6 to 9 percent higher for cotton because of the record yields seen in 2004 and 2005, and unchanged to 2 percent lower for all other crops for most years (Table A-13). Cost of production projections increased for all crops, especially corn, sorghum and wheat (Table A-14). The significant increases in energy prices from 2004 to 2005 led to much higher fuel and fertilizer cost projections, while seed, repairs and interest costs also increased significantly (FAPRI, 2006).

Summary statistics for the Texas NFI projections are reported in Table 11. With the exception of cotton in 2010-2014, each program crop's 2006-2014 annual mean income was less under the January 2006 Baseline than the January 2005 Baseline. This occurred due to higher costs of production led by fuel price increases offsetting the gains in crop prices.

Although the risk in multiple scenarios can be compared using any of the five statistics shown in Table 11, coefficient of variation (CV) is the best measure of risk for comparing scenarios. The CV is the ratio of the standard deviation to the mean as a percentage, and it measures the relative risk associated with a scenario. When comparing scenarios, CV is preferred to the standard deviation, which ignores the level of returns. Because they represent only the best or worst outcome, minimum and maximum values are not good measures of risk, either (Richardson, Schumann, and Feldman, 2006b).

With the means decreasing significantly and the standard deviations only changing slightly, the coefficient of variation for projected NFI for corn increased from the 2005 Baseline to the 2006 Baseline for each year, especially 2006-2009 (Table 11). The CV of projected NFI for cotton increased or was unchanged for each year except 2010 and 2014, and the CV for NFI increased every year for peanuts. Although the means of 2006-2014 projected NFI for rice fell, the CV declined for each year due to decreases in the standard deviations. Relative risk associated with NFI for sorghum rose due to the means decreasing considerably.

Coefficient of variation is not a reliable measure of risk when the range of variables includes zero, but the relative risk for wheat appeared to increase under the January 2006 Baseline because NFI projections fell significantly while the standard deviations either decreased slightly or increased for each year. The CV for hay NFI

Table 11. Statistical Summary of Texas Crop Net Farm Income (NFI) Projections under January 2005 and January 2006 FAPRI Baselines, 2006-2014

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn NFI, January 2005 Baseline ($1,000)									
Mean	220,113	223,575	221,912	220,356	220,891	219,055	219,299	215,805	210,323
Standard Deviation	69,895	76,656	73,702	72,700	72,089	76,135	73,973	73,740	72,153
Coefficient of Variation (%)	32	34	33	33	33	35	34	34	34
Minimum	18,802	-38,066	-38,092	-8,484	16,919	-61,247	24,926	-44,028	-2,893
Maximum	457,525	474,099	488,332	485,301	450,580	486,502	478,535	520,132	444,810
Corn NFI, January 2006 Baseline									
Mean	110,679	142,572	153,211	165,206	170,534	170,097	166,259	166,901	167,118
Standard Deviation	74,772	74,372	70,154	75,972	70,335	76,456	70,641	71,382	76,335
Coefficient of Variation (%)	68	52	46	46	41	45	42	43	46
Minimum	-161,652	-96,647	-101,331	-84,047	-44,575	-60,198	-25,638	-52,515	-94,627
Maximum	374,201	388,370	379,423	395,528	406,790	416,559	483,486	482,518	475,207
Cotton NFI, January 2005 Baseline									
Mean	770,404	774,230	756,873	734,081	715,086	693,576	677,486	641,904	608,910
Standard Deviation	323,846	336,834	341,879	333,634	338,294	333,215	334,868	323,372	333,205
Coefficient of Variation (%)	42	44	45	45	47	48	49	50	55
Minimum	-86,622	-104,616	-6,675	-137,764	-126,906	-189,449	-271,633	-290,257	-243,815
Maximum	1,917,306	1,899,327	2,044,803	1,892,093	1,742,951	1,738,408	2,117,290	2,119,015	1,919,850
Cotton NFI, January 2006 Baseline									
Mean	619,673	691,983	718,390	724,963	725,998	705,165	678,448	657,900	639,620
Standard Deviation	323,551	351,667	359,121	358,263	343,347	347,716	368,678	341,679	347,774
Coefficient of Variation (%)	52	51	50	49	47	49	54	52	54
Minimum	-232,416	-142,461	-242,166	-192,922	-102,542	-88,633	-142,671	-181,334	-360,027
Maximum	1,571,428	2,124,635	2,009,017	1,937,398	2,044,911	1,854,577	1,943,289	1,757,092	2,442,200
Peanuts NFI, January 2005 Baseline									
Mean	92,943	94,565	95,028	95,398	94,854	94,690	94,152	94,276	94,993
Standard Deviation	40,930	40,154	41,066	42,672	41,107	42,978	43,144	39,238	39,499
Coefficient of Variation (%)	44	42	43	45	43	45	46	42	42
Minimum	-30,834	-30,725	-21,299	-20,992	-10,210	-27,907	-10,143	-30,435	-9,869
Maximum	226,694	256,525	211,605	297,398	225,346	234,956	286,159	214,910	268,485
Peanuts NFI, January 2006 Baseline									
Mean	62,476	73,221	77,466	80,381	81,143	80,816	80,848	79,559	79,389
Standard Deviation	38,973	39,206	41,633	41,460	40,229	41,652	41,880	38,187	40,268
Coefficient of Variation (%)	62	54	54	52	50	52	52	48	51
Minimum	-47,335	-24,858	-51,160	-59,602	-28,059	-40,424	-50,839	-30,784	-85,711
Maximum	184,176	257,143	190,335	243,561	211,986	231,175	264,450	192,849	243,404

Table 11. Continued

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Rice NFI, January 2005 Baseline ($1,000)									
Mean	126,526	133,007	128,959	127,311	128,883	130,267	129,501	126,997	127,378
Standard Deviation	21,396	24,537	26,943	29,308	30,469	30,943	31,247	34,471	34,976
Coefficient of Variation (%)	17	18	21	23	24	24	24	27	27
Minimum	60,987	71,012	68,989	62,923	58,326	64,872	58,326	58,326	58,326
Maximum	213,822	247,167	246,601	292,795	253,574	302,686	253,751	279,047	289,066
Rice NFI, January 2006 Baseline									
Mean	94,361	105,690	109,655	109,034	112,454	111,508	114,366	114,694	117,237
Standard Deviation	13,920	18,283	18,579	19,724	24,081	22,078	26,287	26,445	29,097
Coefficient of Variation (%)	15	17	17	18	21	20	23	23	25
Minimum	62,598	60,384	64,838	58,326	58,326	58,326	58,326	58,326	58,047
Maximum	141,508	182,643	185,040	177,959	228,693	202,356	216,402	218,608	230,923
Sorghum NFI, January 2005 Baseline									
Mean	130,140	125,905	122,197	113,812	111,902	105,584	98,416	91,601	82,589
Standard Deviation	66,176	68,167	65,407	64,742	68,573	64,229	65,085	64,213	61,163
Coefficient of Variation (%)	51	54	54	57	61	61	66	70	74
Minimum	-36,908	-38,847	-43,919	-49,912	-73,282	-65,378	-47,115	-88,937	-88,044
Maximum	348,635	384,607	323,620	381,809	446,854	301,683	450,721	373,955	338,221
Sorghum NFI, January 2006 Baseline									
Mean	25,544	34,598	39,271	38,595	38,423	31,801	27,183	23,347	21,106
Standard Deviation	57,094	58,301	60,980	63,284	64,216	61,622	62,919	60,150	67,074
Coefficient of Variation (%)	224	169	155	164	167	194	231	258	318
Minimum	-145,756	-153,060	-147,080	-187,952	-145,840	-133,579	-196,628	-167,775	-180,600
Maximum	173,023	184,241	218,019	222,604	230,069	225,516	209,215	194,335	383,806
Wheat NFI, January 2005 Baseline									
Mean	30,651	23,416	13,806	6,908	2,441	-5,522	-9,370	-20,665	-28,856
Standard Deviation	99,790	102,664	108,634	106,756	108,846	111,463	113,290	113,369	119,859
Coefficient of Variation (%)	326	438	787	1,545	4,459	-2,019	-1,209	-549	-415
Minimum	-235,394	-506,981	-335,336	-259,799	-389,006	-355,200	-323,423	-305,825	-291,580
Maximum	380,843	386,741	596,327	377,157	403,696	328,424	470,936	310,687	461,021
Wheat NFI, January 2006 Baseline									
Mean	-152,044	-104,300	-97,536	-88,474	-84,265	-85,106	-86,871	-92,049	-94,068
Standard Deviation	94,952	101,787	105,717	102,785	111,956	112,085	109,165	112,368	121,427
Coefficient of Variation (%)	-62	-98	-108	-116	-133	-132	-126	-122	-129
Minimum	-430,481	-355,675	-606,190	-367,365	-453,152	-529,838	-416,151	-375,026	-505,889
Maximum	216,592	395,999	334,153	326,870	289,748	308,520	332,430	272,317	345,025

Table 11. Continued

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Hay NFI, January 2005 Baseline ($1,000)									
Mean	478,966	501,231	524,941	533,521	552,862	568,854	583,543	586,258	593,192
Standard Deviation	177,444	188,335	216,887	190,593	200,198	212,557	211,303	199,184	213,243
Coefficient of Variation (%)	37	38	41	36	36	37	36	34	36
Minimum	19,319	-39,190	30,947	-35,045	33,997	28,998	102,007	110,510	101,226
Maximum	1,070,195	1,089,019	1,233,956	1,141,015	1,370,693	1,484,943	1,488,730	1,271,168	1,562,890
Hay NFI, January 2006 Baseline									
Mean	529,369	553,366	583,863	601,244	627,039	648,635	663,714	665,300	668,208
Standard Deviation	171,780	190,253	220,047	193,583	208,324	224,781	232,072	219,795	229,198
Coefficient of Variation (%)	32	34	38	32	33	35	35	33	34
Minimum	64,919	103,709	54,674	100,099	83,283	57,282	143,774	172,363	152,672
Maximum	1,056,077	1,183,519	1,387,972	1,279,748	1,338,986	1,674,555	1,594,673	1,398,384	1,542,209
Total NFI, January 2005 Baseline									
Mean	1,849,744	1,875,929	1,863,717	1,831,386	1,826,919	1,806,506	1,793,028	1,736,177	1,688,528
Standard Deviation	432,467	466,565	487,769	447,454	465,739	457,028	477,778	437,696	469,059
Coefficient of Variation (%)	23	25	26	24	25	25	27	25	28
Minimum	738,043	478,934	613,853	490,333	592,567	618,463	479,553	398,114	307,003
Maximum	3,350,523	3,239,659	3,524,173	3,477,369	3,124,167	3,220,725	3,354,157	3,253,714	3,162,801
Total NFI, January 2006 Baseline									
Mean	1,290,058	1,497,131	1,584,319	1,630,950	1,671,324	1,662,916	1,643,948	1,615,650	1,598,610
Standard Deviation	429,929	464,333	486,785	465,355	468,118	469,537	508,844	446,855	492,929
Coefficient of Variation (%)	33	31	31	29	28	28	31	28	31
Minimum	-44,637	79,962	256,004	334,333	199,329	329,662	356,275	421,433	306,034
Maximum	2,859,999	3,131,758	3,043,550	3,059,766	3,115,886	3,009,766	3,358,947	3,142,422	3,301,965

Note: Wheat NFI does not include returns to livestock sector from wheat grazing.

slightly decreased for each year. The CV for total NFI for all seven crops increased for each year of the analysis, especially 2006-2009 (Table 11).

Charts of the probabilistic projections of Texas crop NFI for 2006-2014 under the two sets of baseline projections were developed from the simulation results. The projected NFI for corn, cotton and hay are shown as fan graphs in Figures 1-3. A fan graph plots the mean and user-specified percentiles of a random variable, say 5, 25, 75 and 95 percentiles to show the 90 percent and 50 percent confidence intervals. Each percentile in a fan graph shows the probability that NFI will fall within certain ranges.

The January 2006 FAPRI Baseline projections decreased the entire probability distributions for NFI for corn in each year, especially in the first three years (Figure 1). The range of the 90 percent confidence interval for corn NFI was larger for 2006, 2007 and 2009, but smaller in the other years. The probability distributions of NFI for cotton were decreased in the short term, but increased slightly for later years (Figure 2). The 90 percent confidence interval was a larger range under the January 2006 Baseline for all years except 2010. Hay price increases caused the probability distributions of NFI projections for hay to increase (Figure 3). The range of the 90 percent confidence interval for hay NFI was smaller under the January 2006 Baseline for all years except 2007, 2008 and 2014.

The probability distributions of total annual NFI for the seven crops in the Texas crop model are shown in Figure 4. Large increases in fuel and fertilizer prices for 2006-2008 reflected in the January 2006 Baseline significantly shifted the probability distributions of total NFI downward for these years. With energy cost inflation

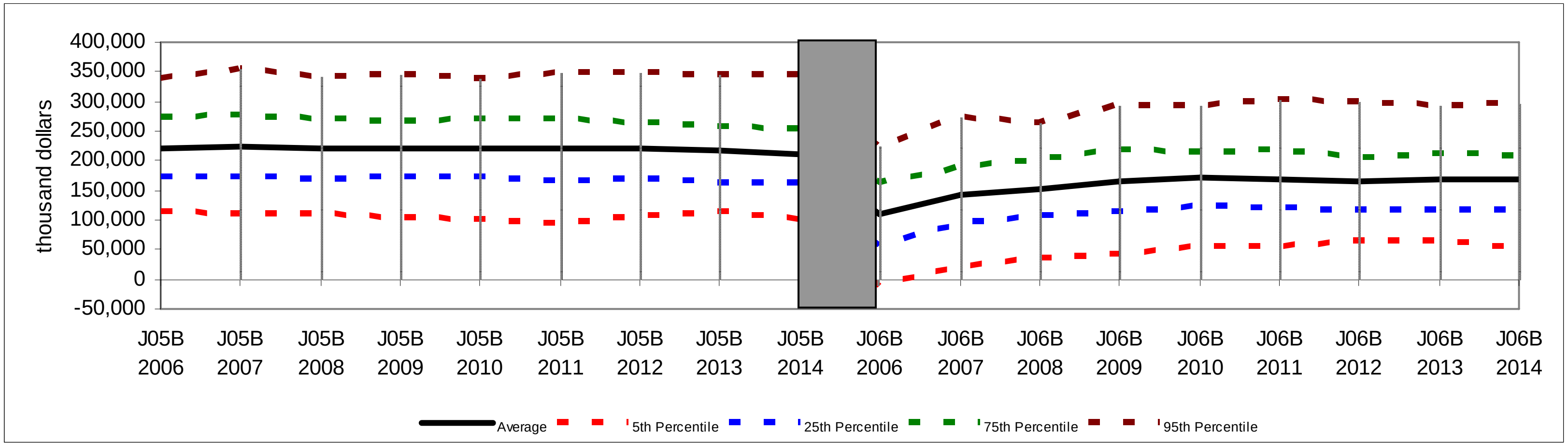

Figure 1. Fan Graph of Net Farm Income Projections for Texas Corn under January 2005 and January 2006 FAPRI Baselines, 2006-2014

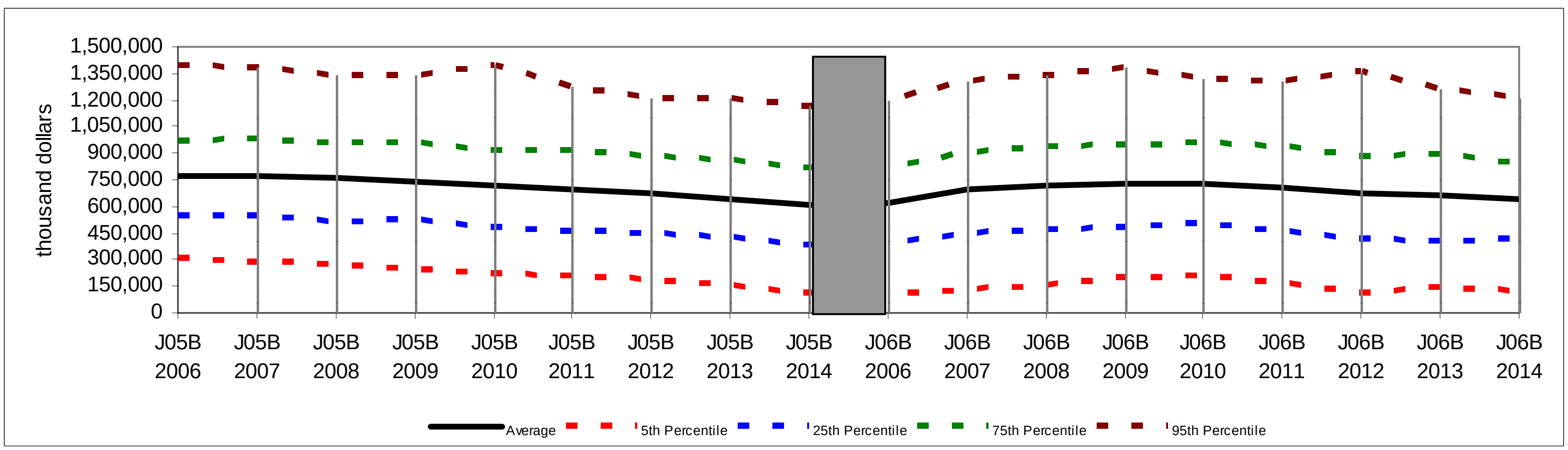

Figure 2. Fan Graph of Net Farm Income Projections for Texas Cotton under January 2005 and January 2006 FAPRI Baselines, 2006-2014

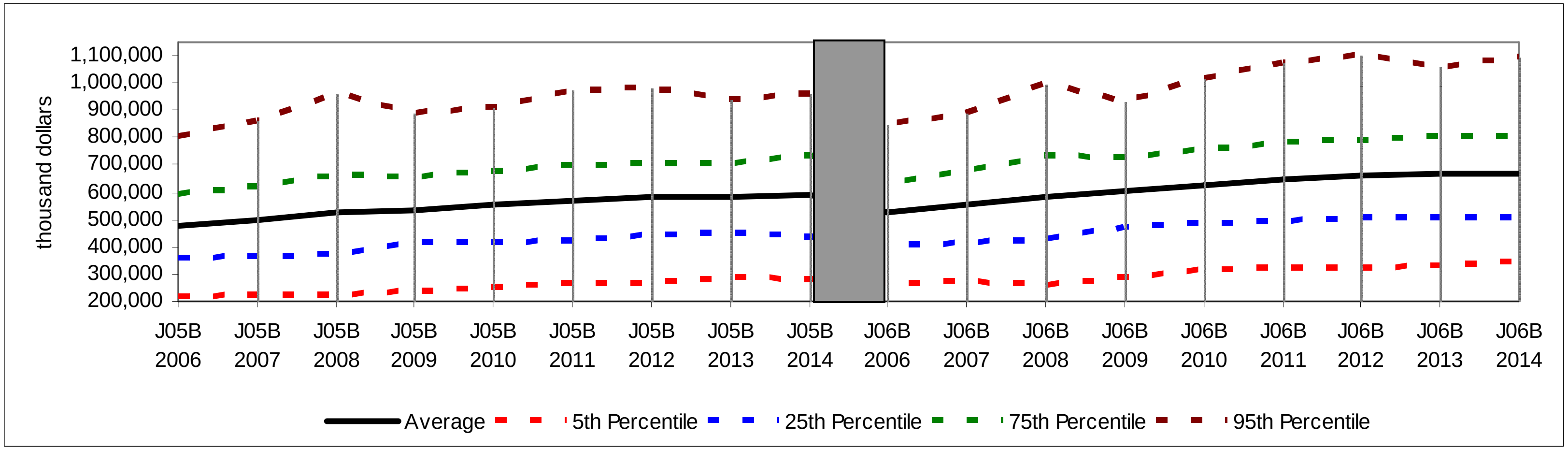

Figure 3. Fan Graph of Net Farm Income Projections for Texas Hay under January 2005 and January 2006 FAPRI Baselines, 2006-2014

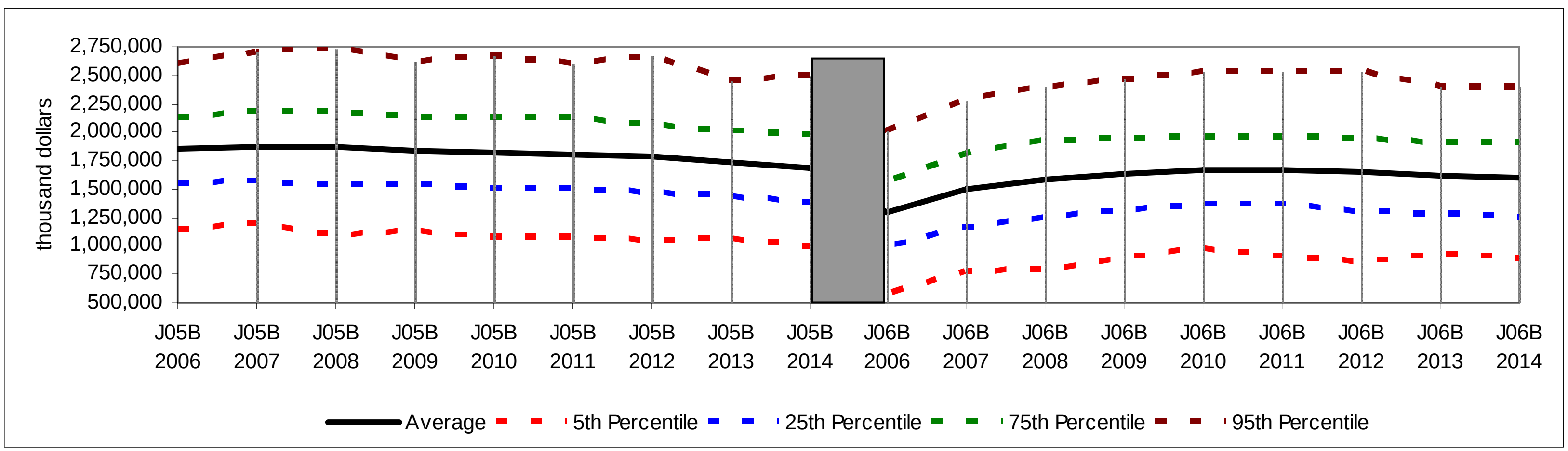

Figure 4. Fan Graph of Total Net Farm Income Projections for Seven Crops in Texas under January 2005 and January 2006 FAPRI Baselines, 2006-2014

projected to slow down beyond 2008, changes in the probability distributions of total NFI projections were smaller for these years. Under the January 2006 Baseline, the range of the 90 percent confidence interval for total NFI was larger for 2009, as well as 2011-2013.

Fan graphs of projected NFI for peanuts, rice, sorghum and wheat are presented in Figures A-1 to A-4. The probability distributions of annual NFI projections for peanuts decreased under the January 2006 FAPRI Baseline, with the most significant reductions being for 2006 and 2007 (Figure A-1). The range of the 90 percent confidence interval of NFI for peanuts was smaller for all years except 2007, 2008 and 2014. The probability distributions of NFI for rice fell and the range of the 90 percent confidence interval decreased significantly under the January 2006 Baseline (Figure A-2). The probability distributions of NFI projections for sorghum decreased considerably under the January 2006 Baseline, with the likelihood of a negative NFI increasing from less than 5 percent to roughly 25 percent for most years (Figure A-3). The 90 percent confidence interval was a smaller range for all years except 2014. The probability distributions for annual wheat NFI also declined, with the probability of negative NFI for most years increasing from about 50 percent under the January 2005 Baseline to more than 75 percent under the January 2006 Baseline (Figure A-4). The 90 percent confidence interval was a smaller range for all years except 2013 and 2014.

Validation

The statistical validation tests described in Chapter III were used to validate the simulated projections of prices, yields and planted acres for 2006 under the January 2005 FAPRI Baseline. Prices, yields and planted acres are the stochastic variables driving the Texas crop model and the results of the Student t-tests for these variables are reported in Table 12. Student t-tests showed that simulated means of these variables were not statistically different than their deterministic values at the 95 percent confidence level.

Due to the large number of stochastic variables in the Texas crop model, it may seem necessary to use a higher confidence alpha level or the Bonferroni correction[9] to decrease the chance of failing to reject a null hypothesis that is false. However, the Bonferroni correction was not used because the primary goal of validating the stochastic variables was to test the ability of each variable to independently project its own mean and standard deviation, rather than a simultaneous projection of all equations in the model.

A Chi-squared test was used to compare the standard deviation of simulated Texas prices, yields and planted acres to their implied standard deviation. The implied standard deviation for Texas prices and yields is a combination of the standard deviation for the national variable (price or yield) and the standard deviation for the residuals of the OLS equation relating Texas price and yield to their national counterparts. The formula for calculating the implied standard deviation is:

[9] The Bonferroni correction is multiple-comparison correction used when several dependent or independent statistical tests are being performed simultaneously (Weisstein, 2006).

Table 12. Student t-Tests of 2006 Simulated Means vs. Deterministic Values for Texas Prices, Yields and Planted Acres at the 95 Percent Confidence Level

Variable	t-Test	Critical Value	P-value	Result
Prices				
Corn	0.00	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Cotton	0.00	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Peanuts	0.02	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Rice	0.00	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Sorghum	0.00	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Wheat	0.00	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Hay	0.02	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Yields				
Corn	0.00	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Cotton	-0.01	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Peanuts	0.00	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Rice	-0.05	2.25	0.96	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Sorghum	-0.02	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Wheat	0.01	2.25	0.99	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Hay	0.03	2.25	0.98	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Planted Acres				
Corn	0.53	2.25	0.59	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Cotton	0.89	2.25	0.37	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Peanuts	-0.76	2.25	0.45	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Rice	0.31	2.25	0.76	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Sorghum	-0.08	2.25	0.93	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean
Wheat	1.13	2.25	0.26	Fail to Reject the Ho that the Mean is Equal to the Assumed Mean

$$S = \sqrt{(\beta * StDevFAPRI)^2 + SEP^2}$$

where:

β = U.S. price or yield coefficient for the OLS equation,

StDevFAPRI = Standard deviation of 500 iterations of national price or yield in the FAPRI Baseline, and

SEP = Standard error of prediction for the OLS equation.

Results of the Chi-squared tests for prices, yields and planted acres are reported in Table 13. For each Texas price and yield, the simulated and implied standard deviation test statistics were not statistically different. Simulated standard deviations for corn, rice, sorghum and wheat planted acreage were statistically different from their standard error from the regression equations because of the increased variability in prices and yields.

Results of comparing the correlation of simulated variables with that of historical residuals for prices, yields and planted acres are shown in Table 14. Student t-tests showed that the simulated and historical correlations coefficients were statistically different at the 95 percent confidence level for most prices, but were not statistically different for roughly half of the yields and planted acres.

Summary

Multiple regression equations were used to explain and project yields, expected yields, prices, planted acres, harvested acres and costs of production for major crops in Texas. Most of the OLS regression equations had the expected signs on the coefficients, high R^2

Table 13. Chi-squared Tests of 2006 Simulated Standard Deviations vs. Assumed Standard Deviations for Texas Prices, Yields and Planted Acres at the 95 Percent Confidence Level

Variable	Chi-squared Test	Lower Bound	Upper Bound	P-value	Result
Prices					
Corn	509.82	439.00	562.79	0.72	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Cotton	512.96	439.00	562.79	0.65	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Peanuts	492.86	439.00	562.79	0.86	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Rice	462.54	439.00	562.79	0.25	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Sorghum	486.37	439.00	562.79	0.70	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Wheat	466.62	439.00	562.79	0.30	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Hay	478.62	439.00	562.79	0.53	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Yields					
Corn	495.92	439.00	562.79	0.94	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Cotton	526.31	439.00	562.79	0.38	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Peanuts	506.82	439.00	562.79	0.79	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Rice	471.12	439.00	562.79	0.38	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Sorghum	453.53	439.00	562.79	0.14	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Wheat	519.09	439.00	562.79	0.52	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Hay	501.07	439.00	562.79	0.93	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Planted Acres					
Corn	574.41	439.00	562.79	0.02	Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Cotton	507.98	439.00	562.79	0.76	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Peanuts	492.62	439.00	562.79	0.86	Fail to Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Rice	628.54	439.00	562.79	0.00	Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Sorghum	613.05	439.00	562.79	0.00	Reject the Ho that the Simulated and Assumed Standard Deviations are Equal
Wheat	637.64	439.00	562.79	0.00	Reject the Ho that the Simulated and Assumed Standard Deviations are Equal

Table 14. Student t-Tests of 2006 Simulated Correlation Coefficients vs. Historical Correlation Coefficients for Texas Prices, Yields and Planted Acres

Prices

Confidence Level		0.95				
Critical Value		1.96				

	Cotton	Peanuts	Rice	Sorghum	Wheat	Hay
Corn	14.42	3.48	2.26	20.01	9.26	0.22
Cotton		3.41	19.00	13.78	9.85	1.68
Peanuts			4.71	1.64	3.65	2.63
Rice				5.13	0.19	0.85
Sorghum					8.04	1.28
Wheat						2.20

Yields

Confidence Level		0.95				
Critical Value		1.96				

	Cotton	Peanuts	Rice	Sorghum	Wheat	Hay
Corn	2.62	2.75	4.93	1.05	1.35	1.13
Cotton		0.59	5.36	3.50	0.43	1.43
Peanuts			5.08	0.22	3.16	0.01
Rice				2.66	0.12	2.04
Sorghum					1.49	2.46
Wheat						1.42

Planted Acres

Confidence Level		0.95			
Critical Value		1.96			

	Cotton	Peanuts	Rice	Sorghum	Wheat
Corn	0.88	1.27	2.86	1.32	1.14
Cotton		0.74	2.46	2.79	2.64
Peanuts			1.44	1.71	2.17
Rice				1.01	5.88
Sorghum					0.22

and R-bar^2 values, F-statistics significant at the 99% confidence level, and a Theil U2 statistic lower than 0.10. Some of the yield and planted acres equations had low R^2 and R-bar^2, and the D-W statistics showed serial correlation in the residuals for many of the production cost equations. However, these equations were still used because estimating state or regional variables as a function of their national values is the best available model for comparing net farm income projections for Texas crops under alternative FAPRI baseline projections.

Simulating the Texas crop model with the January 2006 FAPRI Baseline decreased 2006-2014 NFI projections for the six program crops (especially sorghum and wheat) compared to the January 2005 Baseline, but increased NFI projections for hay. Total NFI for all seven crops decreased for each year by an average of 11.7 percent between the January 2005 Baseline and the January 2006 Baseline.

The Texas crop model is capable of simulating NFI for Texas crops under alternative sets of baseline projections from FAPRI. The model shows the impact of baseline changes on the probability distributions of NFI for each crop and for the state as a whole. The model can be used as a farm policy analysis tool to show the impacts of sector changes, which affect prices, yields and costs of production for crops. This can be done by changing policy variables such as loan rates, target prices or payment fractions in the model, and using a FAPRI Baseline consistent with the new policy values. In addition, the model can compare net farm income projections under alternative sets of macroeconomic policy variables or energy prices.

CHAPTER V

CONCLUSIONS

Agricultural policy directly affects the economic viability of Texas crop producers because government payments make up a significant portion of their net farm income (NFI). Net farm income projections are helpful to producers, agribusinesses and policy makers, but an economic model using prices, yields, planted acres, harvested acres, production costs, and policy variables to make these projections for Texas did not previously exist.

The objective of this study was to develop a model to project annual NFI for corn, upland cotton, peanuts, rice, grain sorghum, wheat and hay producers in Texas. The Texas crop model was developed to achieve this objective, estimating price, yield and costs of production for each crop as a function of corresponding variables at the national level. A stochastic baseline of projections for national prices and yields from FAPRI, along with the means of FAPRI's projected production costs, were used as input to the Texas crop model. The stochastic FAPRI Baseline used as input into the Texas model and the residuals for OLS equations that relate Texas variables to national variables were used to incorporate the Texas and U.S. risk left unexplained by the OLS equations. Multivariate normal distributions were assumed in simulating the residuals.

Deterministic and probabilistic NFI projections for Texas crops were compared under the January 2005 and January 2006 FAPRI Baseline projections of national prices, yields and production costs. With production costs increasing considerably and prices rising moderately in the January 2006 Baseline, deterministic projections of total NFI for Texas crops decreased for each year in the analysis by an average of 11.7 percent. Probability distributions of projected Texas NFI fell for all program crops, especially sorghum and wheat. The impacts of recent droughts on both the supply and demand for hay have led to higher prices, causing Texas NFI projections for hay to rise. Large increases in projected fuel and fertilizer prices for 2006-2008 significantly decreased the probability distributions of Texas total NFI for these years. With energy cost inflation projected to slow down beyond 2008, probability distributions of total NFI projections changed less for these years.

The Texas crop model can be used to simulate NFI for Texas crop producers under alternative FAPRI baselines. The model shows the impact of baseline changes on the probability distributions of NFI for each crop and for Texas as a whole. It can also be useful as a policy analysis tool to show the impacts of sector changes on prices, yields and costs of production for crops. In addition, the model can compare NFI projections under alternative farm policy, macroeconomic policy, and input price scenarios.

Although the Texas crop model has many potential uses, it also has several limitations. Some of these involve cost of production data and estimations. National production costs projections for peanuts were not available from FAPRI, so regional estimates were used as the deterministic component of the stochastic projections. Cost of production projections for hay were developed using one base year of actual costs, and PPI projections from FAPRI. Using more years of historical data for hay production costs would be a better method for developing those projections. Although most equations relating regional production costs for program crops to their national values resulted in a good fit, using state production cost data rather than regional data may improve the model's NFI projections. Additionally, methods to correct for the autocorrelation detected in the residuals from many of the production cost estimations could be applied to the model.

Calculations of NFI for wheat and hay are somewhat misleading and could be changed to better reflect the outlook for these crops. As previously stated, NFI for wheat is underestimated as it does not include returns from wheat used for cattle grazing. Because most hay is fed on the farm where it was grown, assuming all harvested hay is sold overestimates NFI for hay. Additionally, alfalfa could also be separated from other hay in the hay model because prices and yields for various types of hay are significantly different.

The Texas crop model could also be divided into geographical regions of the state. This would improve the model because several crops are grown in multiple regions of the state where growing seasons, costs of production, and weather conditions are much different.

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APPENDIX A

Table A-1. Multiple Regression Results for Explaining Seed Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	-4.2521	1.1645	0.9977	--	0.983	0.982	670.738	1.790	0.0387
P-value	0.0350	0.0000	0.2433	--					
Cotton									
Beta	7.1907	0.3511	-1.5612	8.1712	0.909	0.896	73.096	1.455	0.1219
P-value	0.0010	0.0000	0.3361	0.0000					
Peanuts									
Beta	-12.3826	0.9978	-4.6326	--	0.913	0.905	120.267	0.827	0.0576
P-value	0.0275	0.0000	0.0045	--					
Rice									
Beta	15.8477	0.4987	-3.3485	--	0.395	0.342	7.495	1.439	0.0828
P-value	0.0001	0.0032	0.0118	--					
Sorghum									
Beta	-1.5080	1.1597	1.3471	--	0.938	0.933	174.822	1.767	0.0611
P-value	0.0023	0.0000	0.0000	--					
Wheat									
Beta	-0.1837	0.7145	--	--	0.852	0.839	66.300	1.743	0.0637
P-value	0.6952	0.0000	--	--					

Note: US Costs are the respective national seed costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-2. Multiple Regression Results for Explaining Fertilizer Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	0.9432	0.8746	-8.5599	--	0.398	0.346	7.617	0.594	0.1902
P-value	0.9350	0.0027	0.0125	--					
Cotton									
Beta	0.9390	0.5156	-2.3431	5.9689	0.943	0.935	121.528	1.287	0.0903
P-value	0.7342	0.0000	0.0456	0.0011					
Peanuts									
Beta	18.4760	0.1054	-3.6514	18.5297	0.894	0.879	61.688	0.868	0.0966
P-value	0.0033	0.4383	0.0233	0.0000					
Rice									
Beta	16.9955	0.9202	-9.3648	--	0.937	0.932	171.121	1.372	0.0514
P-value	0.0001	0.0000	0.0000	--					
Sorghum									
Beta	-1.5729	1.0251	0.7929	--	0.899	0.891	102.812	1.818	0.0508
P-value	0.2520	0.0000	0.0584	--					
Wheat									
Beta	-0.1224	0.8334	-0.2723	--	0.887	0.878	90.589	1.648	0.0716
P-value	0.9292	0.0000	0.6128	--					

Note: US Costs are the respective national fertilizer costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-3. Multiple Regression Results for Explaining Chemicals Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	-3.6644	1.1263	-2.6290	--	0.900	0.892	103.860	0.852	0.0995
P-value	0.3300	0.0000	0.0605	--					
Cotton									
Beta	1.2313	0.3294	-1.9849	5.6724	0.919	0.908	83.201	0.671	0.0598
P-value	0.8258	0.0114	0.1510	0.0038					
Peanuts									
Beta	-0.9328	0.4181	7.4702	--	0.331	0.273	5.688	0.386	0.1173
P-value	0.9396	0.0029	0.0168	--					
Rice									
Beta	1.9065	0.8765	1.3942	-3.7240	0.995	0.994	1364.64	0.998	0.0280
P-value	0.1093	0.0000	0.0744	0.0057					
Sorghum									
Beta	0.7830	0.8989	-1.4850	--	0.843	0.829	61.541	0.677	0.1022
P-value	0.5553	0.0000	0.0042	--					
Wheat									
Beta	0.3374	0.3962	0.4187	--	0.990	0.989	734.394	1.241	0.0357
P-value	0.0366	0.0000	0.0001	--					

Note: US Costs are the respective national chemicals costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-4. Multiple Regression Results for Explaining Custom Operations Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	17.2674	-0.2193	-4.6044	-4.1419	0.887	0.872	57.519	0.675	0.1213
P-value	0.0000	0.1929	0.0000	0.0000					
Cotton									
Beta	2.8597	0.2932	0.6674	--	0.303	0.243	5.011	0.732	0.1895
P-value	0.1517	0.0052	0.4308	--					
Peanuts									
Beta	1.2619	1.0043	-0.5236	--	0.493	0.449	11.176	0.843	0.1883
P-value	0.6311	0.0009	0.5751	--					
Rice									
Beta	14.5788	0.7688	-8.6502	9.7828	0.994	0.993	1136.82	0.962	0.0240
P-value	0.0000	0.0000	0.0000	0.0000					
Sorghum									
Beta	-1.9230	1.2380	2.5103	--	0.902	0.894	106.443	1.907	0.0553
P-value	0.0009	0.0000	0.0000	--					
Wheat									
Beta	-3.4629	1.7529	1.4229	-0.3175	0.836	0.814	37.483	0.670	0.1235
P-value	0.0146	0.0000	0.0209	0.6279					

Note: US Costs are the respective national custom operations costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-5. Multiple Regression Results for Explaining Fuel, Lube and Electricity Costs for Six Crops in Texas

	Intercept	US Costs	D1	R^2	R-bar^2	F-test	D-W	Theil U2
Corn								
Beta	16.7678	1.1509	-1.6064	0.780	0.761	40.719	1.315	0.0935
P-value	0.0014	0.0000	0.4587					
Cotton								
Beta	-1.5342	0.9672	--	0.489	0.444	10.997	0.788	0.1554
P-value	0.8270	0.0001	--					
Peanuts								
Beta	16.9567	1.0072	-8.9215	0.770	0.751	38.604	0.789	0.1076
P-value	0.0751	0.0001	0.0050					
Rice								
Beta	22.2599	0.7853	-12.2440	0.910	0.902	116.324	1.166	0.0665
P-value	0.0001	0.0000	0.0000					
Sorghum								
Beta	2.9082	0.9272	--	0.947	0.942	205.106	1.792	0.0515
P-value	0.0317	0.0000	--					
Wheat								
Beta	0.3448	1.1858	-0.1599	0.673	0.645	23.689	0.532	0.1251
P-value	0.8271	0.0000	0.8189					

Note: US Costs are the respective national fuel, lube and electricity costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions.

Table A-6. Multiple Regression Results for Explaining Repairs Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	9.6108	0.8246	-3.3222	1.4308	0.901	0.887	66.438	1.002	0.0766
P-value	0.0001	0.0000	0.0037	0.2409					
Cotton									
Beta	9.8433	0.5569	-5.7094	12.9788	0.898	0.884	64.321	1.426	0.0944
P-value	0.0540	0.0043	0.0009	0.0000					
Peanuts									
Beta	8.6442	0.7839	-0.6704	4.5086	0.938	0.930	111.801	0.859	0.0434
P-value	0.0498	0.0000	0.6407	0.0060					
Rice									
Beta	8.1269	0.6701	-0.5215	-3.2780	0.907	0.894	71.304	0.934	0.0451
P-value	0.0000	0.0000	0.4701	0.0013					
Sorghum									
Beta	1.7470	0.8644	0.3430	--	0.879	0.868	83.381	1.480	0.0765
P-value	0.3894	0.0000	0.6834	--					
Wheat									
Beta	-0.3230	0.9993	--	0.3167	0.963	0.958	192.266	1.868	0.0464
P-value	0.8211	0.0000	--	0.5048					

Note: US Costs are the respective national repairs costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-7. Multiple Regression Results for Explaining Hired Labor Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	0.7729	1.5882	--	-2.1111	0.995	0.994	1407.887	1.202	0.0244
P-value	0.0460	0.0000	--	0.0000					
Cotton									
Beta	24.4731	-0.1806	--	-1.7575	0.648	0.600	13.498	1.085	0.1221
P-value	0.0000	0.3156	--	0.2452					
Peanuts									
Beta	22.2928	0.6616	--	-13.9082	0.948	0.940	132.571	0.547	0.0721
P-value	0.0000	0.0000	--	0.0000					
Rice									
Beta	2.4909	0.9044	0.3719	3.1516	0.901	0.887	66.693	1.322	0.0781
P-value	0.3020	0.0000	0.8022	0.1446					
Sorghum									
Beta	0.7587	0.8905	--	0.0411	0.995	0.994	1474.249	1.230	0.0324
P-value	0.0837	0.0000	--	0.8787					
Wheat									
Beta	0.4986	0.6094	0.5816	0.7184	0.963	0.958	193.243	1.088	0.0648
P-value	0.1280	0.0001	0.0003	0.0197					

Note: US Costs are the respective national hired labor costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-8. Multiple Regression Results for Explaining Overhead Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	4.3098	0.6531	--	2.1376	0.758	0.725	22.964	1.118	0.1186
P-value	0.0777	0.0031	--	0.0226					
Cotton									
Beta	9.5400	0.0850	0.6871	--	0.068	0.000	0.839	0.596	0.1704
P-value	0.0000	0.4370	0.5017	--					
Peanuts									
Beta	17.2304	0.3478	-5.5695	--	0.645	0.597	13.333	1.226	0.0989
P-value	0.0000	0.0259	0.0114	--					
Rice									
Beta	10.1162	0.4597	-0.3207	--	0.429	0.379	8.625	1.012	0.0814
P-value	0.0013	0.0005	0.7604	--					
Sorghum									
Beta	0.9241	0.8239	0.3234	--	0.922	0.915	135.865	1.930	0.0801
P-value	0.0246	0.0000	0.3787	--					
Wheat									
Beta	0.0865	0.5897	0.4925	1.7815	0.795	0.768	28.509	1.583	0.1000
P-value	0.9238	0.0000	0.1933	0.0000					

Note: US Costs are the respective national overhead costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-9. Multiple Regression Results for Explaining Taxes and Insurance Costs for Six Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn									
Beta	3.4352	0.8255	-2.2836	3.2394	0.835	0.812	37.064	0.416	0.1429
P-value	0.0194	0.0001	0.1632	0.0382					
Cotton									
Beta	0.5282	0.9233	--	-2.7244	0.986	0.984	518.128	1.237	0.0419
P-value	0.2763	0.0000	--	0.0000					
Peanuts									
Beta	5.9212	0.4798	-1.3498	--	0.973	0.971	416.924	1.416	0.0367
P-value	0.0000	0.0000	0.0004	--					
Rice									
Beta	-0.5094	0.8814	0.4361	--	0.993	0.992	1649.05	0.983	0.0373
P-value	0.2312	0.0000	0.2418	--					
Sorghum									
Beta	2.2953	0.4765	-0.0227	2.3744	0.904	0.890	68.729	1.364	0.0931
P-value	0.0076	0.0011	0.9546	0.0004					
Wheat									
Beta	2.2732	0.2185	--	0.7596	0.952	0.945	144.75	1.556	0.0796
P-value	0.0006	0.1202	--	0.1694					

Note: US Costs are the respective national taxes and insurance costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-10. Multiple Regression Results for Explaining Miscellaneous Costs for Four Crops in Texas

	Intercept	US Costs	D1	D2	R^2	R-bar^2	F-test	D-W	Theil U2
Corn Irrigation Water Costs									
Beta	0.7402	0.6304	-0.6674	1.2271	0.879	0.862	53.131	0.464	0.1537
P-value	0.0000	0.2448	0.0000	0.0000					
Cotton Ginning Costs									
Beta	-4.7104	0.7970	-1.1336	--	0.695	0.669	26.243	1.840	0.1217
P-value	0.4945	0.0000	0.6053	--					
Peanuts Drying Costs									
Beta	19.9675	-0.0033	-1.7606	10.0855	0.575	0.518	9.938	1.352	0.1520
P-value	0.0000	0.9719	0.3535	0.0000					
Rice Irrigation Water Costs									
Beta	0.1374	1.4363	--	3.9858	0.991	0.990	795.139	0.513	0.0484
P-value	0.9469	0.0000	--	0.0001					

Note: US Costs are the respective national irrigation water, ginning and drying costs for the crop. D1 is a dummy variable to account for the change in ERS production cost region definitions. D2 is a dummy variable to account for assumed changes in data collection methods.

Table A-11. Multiple Regression Results for Explaining Beef Cattle Price and Conservation Reserve Program (CRP) Acreage in Texas

	Intercept	OKC BFPR	R^2	R-bar^2	F-test	D-W	Theil U2
Beef Cattle Price							
Beta	18.8613	0.5936	0.848	0.841	133.562	0.885	0.0448
P-value	0.0001	0.0000					
CRP Acreage		CRP t-1					
Beta	1920.7856	0.5177	0.961	0.959	420.631	0.999	0.0259
P-value	0.0000	0.0000					

Note: OKC BFPR is the Oklahoma City 600-650 pound feeder steer price. CRP t-1 is CRP acreage in the previous year.

Table A-12. Statistical Summary of National Price Projections under January 2005 and January 2006 FAPRI Baselines, 2006-2014

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn Price, January 2005 Baseline ($/bushel)									
Mean	2.18	2.21	2.22	2.25	2.27	2.29	2.31	2.32	2.32
Standard Deviation	0.33	0.36	0.36	0.36	0.37	0.37	0.38	0.38	0.37
Minimum	1.39	1.24	1.46	1.45	1.38	1.41	1.50	1.43	1.39
Maximum	3.37	3.70	3.47	3.58	3.64	3.95	3.97	3.74	3.92
Corn Price, January 2006 Baseline ($/bushel)									
Mean	2.10	2.20	2.30	2.37	2.43	2.46	2.46	2.48	2.49
Standard Deviation	0.30	0.33	0.35	0.37	0.36	0.36	0.34	0.36	0.37
Minimum	1.45	1.48	1.45	1.50	1.45	1.57	1.64	1.71	1.65
Maximum	3.06	3.34	3.48	3.70	3.73	3.82	3.58	4.18	3.81
Change in Mean	-3.9%	-0.3%	3.4%	5.4%	6.4%	6.8%	6.1%	6.5%	7.1%
Cotton Price, January 2005 Baseline ($/pound)									
Mean	0.46	0.46	0.46	0.48	0.50	0.51	0.51	0.53	0.54
Standard Deviation	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07
Minimum	0.27	0.29	0.29	0.30	0.31	0.31	0.33	0.33	0.34
Maximum	0.61	0.61	0.65	0.64	0.67	0.68	0.71	0.71	0.73
Cotton Price, January 2006 Baseline ($/pound)									
Mean	0.48	0.51	0.51	0.51	0.51	0.52	0.53	0.55	0.56
Standard Deviation	0.06	0.06	0.06	0.07	0.06	0.07	0.07	0.07	0.07
Minimum	0.34	0.34	0.33	0.35	0.35	0.34	0.37	0.38	0.38
Maximum	0.63	0.67	0.66	0.70	0.66	0.69	0.69	0.73	0.73
Change in Mean	5.8%	9.8%	9.2%	5.7%	2.5%	2.1%	3.2%	3.6%	3.1%
Peanuts Price, January 2005 Baseline ($/ton)									
Mean	386.37	389.08	390.29	390.26	392.35	394.30	395.92	396.45	399.39
Standard Deviation	51.66	55.94	58.84	59.92	58.23	62.23	63.66	64.24	65.42
Minimum	248.57	247.72	225.40	246.26	232.08	230.60	213.59	233.51	217.21
Maximum	530.35	519.96	549.99	558.82	569.04	571.28	557.60	573.26	572.24
Peanuts Price, January 2006 Baseline ($/ton)									
Mean	365.02	372.27	383.58	385.14	381.06	381.94	383.65	388.38	388.11
Standard Deviation	60.45	63.18	63.70	65.79	66.07	65.85	64.76	71.35	72.76
Minimum	222.50	204.85	212.00	224.20	216.67	194.09	216.69	199.68	210.01
Maximum	528.15	534.39	551.74	569.29	544.46	565.98	533.14	597.24	582.29
Change in Mean	-5.8%	-4.5%	-1.8%	-1.3%	-3.0%	-3.2%	-3.2%	-2.1%	-2.9%
Rice Price, January 2005 Baseline ($/cwt.)									
Mean	6.98	7.25	7.34	7.46	7.58	7.69	7.84	7.95	8.06
Standard Deviation	1.35	1.42	1.50	1.51	1.46	1.62	1.64	1.72	1.76
Minimum	3.59	3.90	3.53	3.79	3.89	4.01	3.59	3.71	4.04
Maximum	9.85	10.03	10.40	10.71	11.04	11.04	11.23	11.60	12.21

Table A-12. Continued

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Rice Price, January 2006 Baseline ($/cwt.)									
Mean	7.33	7.43	7.25	7.52	7.76	7.90	8.11	8.32	8.57
Standard Deviation	0.79	0.84	0.80	0.88	0.92	0.97	0.98	1.02	1.10
Minimum	5.59	5.45	5.32	5.40	5.77	5.60	5.76	6.05	6.20
Maximum	9.07	9.24	9.10	9.35	9.77	10.00	10.14	10.32	10.89
Change in Mean	4.8%	2.4%	-1.2%	0.8%	2.3%	2.7%	3.3%	4.4%	5.9%
Sorghum Price, January 2005 Baseline ($/bushel)									
Mean	1.96	1.98	2.00	2.03	2.06	2.10	2.15	2.18	2.20
Standard Deviation	0.31	0.32	0.33	0.33	0.34	0.32	0.33	0.35	0.34
Minimum	1.05	1.11	1.18	1.25	1.18	1.24	1.24	1.33	1.28
Maximum	2.84	3.28	3.01	3.09	3.40	3.29	3.61	3.49	3.56
Sorghum Price, January 2006 Baseline ($/bushel)									
Mean	1.97	2.05	2.11	2.17	2.22	2.26	2.28	2.32	2.35
Standard Deviation	0.26	0.30	0.32	0.34	0.33	0.32	0.31	0.32	0.33
Minimum	1.32	1.32	1.25	1.33	1.33	1.29	1.52	1.52	1.41
Maximum	2.79	3.08	3.17	3.29	3.39	3.50	3.34	3.74	3.56
Change in Mean	0.7%	3.2%	5.3%	6.4%	7.1%	7.0%	5.9%	6.0%	6.3%
Wheat Price, January 2005 Baseline ($/bushel)									
Mean	3.24	3.30	3.35	3.41	3.46	3.50	3.55	3.60	3.63
Standard Deviation	0.38	0.37	0.41	0.42	0.43	0.41	0.42	0.42	0.42
Minimum	2.26	2.23	2.17	2.36	2.40	2.54	2.45	2.40	2.36
Maximum	4.34	4.51	4.52	4.77	4.83	4.73	4.97	4.80	5.23
Wheat Price, January 2006 Baseline ($/bushel)									
Mean	3.32	3.40	3.45	3.55	3.60	3.66	3.70	3.73	3.76
Standard Deviation	0.34	0.38	0.41	0.42	0.42	0.42	0.41	0.42	0.43
Minimum	2.54	2.46	2.41	2.46	2.44	2.46	2.62	2.66	2.63
Maximum	4.22	4.87	4.78	4.97	5.05	4.92	5.29	5.20	5.36
Change in Mean	2.3%	3.1%	3.0%	4.1%	4.1%	4.4%	3.8%	3.5%	3.5%
Hay Price, January 2005 Baseline ($/ton)									
Mean	88.92	90.13	91.62	92.33	93.42	94.24	95.81	96.50	97.22
Standard Deviation	8.75	8.78	9.77	9.24	9.53	9.06	9.89	9.41	9.79
Minimum	73.37	72.51	71.37	71.98	74.20	74.18	76.81	74.92	72.27
Maximum	122.84	124.09	131.90	140.73	138.76	144.17	133.21	148.71	135.47
Hay Price, January 2006 Baseline ($/ton)									
Mean	97.46	98.03	99.65	101.00	102.09	103.31	104.32	104.51	104.47
Standard Deviation	8.89	8.65	9.78	9.17	9.11	9.64	10.54	9.93	10.22
Minimum	79.37	81.22	82.63	82.12	83.06	79.72	83.65	82.79	84.84
Maximum	129.78	135.92	147.79	137.19	150.22	143.24	171.96	155.21	148.62
Change in Mean	8.8%	8.1%	8.1%	8.6%	8.5%	8.8%	8.2%	7.7%	6.9%

Table A-13. Statistical Summary of National Yield Projections under January 2005 and January 2006 FAPRI Baselines, 2006-2014

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn Yield, January 2005 Baseline (bushels/acre)									
Mean	148.0	150.3	152.1	154.2	156.0	158.4	160.4	162.4	164.5
Standard Deviation	11.4	11.3	11.7	11.3	11.4	11.5	11.5	11.9	11.5
Minimum	122.8	125.7	127.0	129.0	131.0	133.2	135.2	137.1	139.4
Maximum	164.4	166.4	168.5	170.5	172.5	174.6	176.7	178.7	180.8
Corn Yield, January 2006 Baseline (bushels/acre)									
Mean	147.0	149.1	150.8	152.8	154.6	156.4	158.6	160.4	162.3
Standard Deviation	11.5	11.1	11.6	11.7	11.4	11.7	11.0	11.3	11.6
Minimum	122.0	124.3	125.7	127.5	129.3	131.3	133.1	135.1	137.0
Maximum	163.3	165.3	167.1	169.0	170.9	172.7	174.6	176.6	178.5
Change in Mean	-0.7%	-0.8%	-0.8%	-0.9%	-0.9%	-1.3%	-1.1%	-1.2%	-1.3%
Cotton Yield, January 2005 Baseline (pounds/acre)									
Mean	713.8	718.8	724.5	730.1	734.9	740.3	745.2	751.5	756.1
Standard Deviation	57.6	57.4	59.5	57.9	59.9	58.0	58.3	59.6	57.8
Minimum	595.5	602.6	607.9	612.0	617.1	622.2	627.7	634.1	638.1
Maximum	846.7	853.2	855.9	864.2	868.2	871.9	875.3	884.8	888.5
Cotton Yield, January 2006 Baseline (pounds/acre)									
Mean	766.0	774.4	781.1	789.1	796.1	804.9	810.7	818.0	826.4
Standard Deviation	55.9	55.0	55.9	57.5	59.1	55.9	58.1	57.5	56.4
Minimum	661.3	669.6	677.1	683.8	691.5	699.1	706.4	713.7	721.3
Maximum	869.2	876.5	883.1	892.0	899.6	906.7	914.6	920.9	927.4
Change in Mean	6.8%	7.2%	7.2%	7.5%	7.7%	8.0%	8.1%	8.1%	8.5%
Peanuts Yield, January 2005 Baseline (pounds/acre)									
Mean	2926.9	2956.0	2978.9	3007.0	3029.9	3064.0	3091.2	3123.7	3144.8
Standard Deviation	254.9	266.5	266.3	264.5	250.5	273.9	262.7	261.2	261.0
Minimum	2381.4	2408.1	2435.4	2463.1	2488.3	2515.6	2542.3	2570.3	2595.7
Maximum	3458.8	3481.3	3512.4	3536.8	3566.6	3591.0	3617.9	3642.3	3668.7
Peanuts Yield, January 2006 Baseline (pounds/acre)									
Mean	2894.2	2921.4	2946.2	2971.8	3001.3	3024.4	3054.2	3078.5	3106.6
Standard Deviation	264.9	264.7	267.4	264.3	260.9	254.6	258.0	264.9	271.2
Minimum	2345.2	2373.1	2399.1	2426.1	2452.5	2479.7	2509.4	2535.3	2560.0
Maximum	3440.1	3466.6	3492.1	3516.3	3549.3	3567.0	3598.4	3628.2	3653.7
Change in Mean	-1.1%	-1.2%	-1.1%	-1.2%	-1.0%	-1.3%	-1.2%	-1.5%	-1.2%

Table A-13. Continued

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Rice Yield, January 2005 Baseline (pounds/acre)									
Mean	6908.8	6974.8	7037.1	7098.7	7161.2	7223.2	7285.3	7347.2	7410.8
Standard Deviation	218.5	218.9	216.5	218.5	220.1	216.6	221.2	213.2	216.4
Minimum	6428.1	6491.2	6553.7	6614.7	6675.8	6738.3	6797.6	6859.1	6933.7
Maximum	7333.8	7400.6	7461.3	7520.0	7587.9	7638.6	7710.0	7770.9	7835.0
Rice Yield, January 2006 Baseline (pounds/acre)									
Mean	6897.4	6949.3	7011.1	7073.0	7129.7	7191.0	7252.6	7311.4	7372.0
Standard Deviation	159.1	157.8	156.7	155.5	162.3	161.5	159.8	157.0	158.1
Minimum	6616.4	6671.9	6731.7	6791.0	6850.4	6910.7	6970.0	7031.2	7091.9
Maximum	7180.0	7237.2	7297.6	7356.7	7413.9	7478.0	7538.0	7597.4	7657.6
Change in Mean	-0.2%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.5%	-0.5%	-0.5%
Sorghum Yield, January 2005 Baseline (bushels/acre)									
Mean	63.7	64.1	64.5	64.9	65.6	65.9	66.3	66.8	67.2
Standard Deviation	6.9	6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Minimum	50.3	50.7	51.2	51.5	52.1	52.6	53.0	53.5	53.9
Maximum	74.1	74.5	74.9	75.4	76.0	76.4	76.8	77.3	77.6
Sorghum Yield, January 2006 Baseline (bushels/acre)									
Mean	64.03	64.22	64.45	64.58	64.93	65.02	65.26	65.42	65.61
Standard Deviation	6.83	6.81	6.80	6.99	6.97	7.03	6.80	6.83	6.92
Minimum	51.16	51.30	51.56	51.66	51.94	52.06	52.23	52.45	52.68
Maximum	74.55	74.81	74.99	75.16	75.38	75.42	75.67	75.99	76.18
Change in Mean	0.6%	0.1%	-0.1%	-0.5%	-1.0%	-1.4%	-1.7%	-2.1%	-2.5%
Wheat Yield, January 2005 Baseline (bushels/acre)									
Mean	42.1	42.4	42.7	43.0	43.4	43.7	44.0	44.3	44.6
Standard Deviation	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Minimum	36.4	36.8	37.1	37.4	37.8	38.1	38.4	38.7	39.0
Maximum	46.0	46.4	46.7	47.0	47.3	47.6	47.9	48.2	48.5
Wheat Yield, January 2006 Baseline (bushels/acre)									
Mean	41.74	41.98	42.29	42.60	42.91	43.21	43.54	43.84	44.15
Standard Deviation	2.72	2.71	2.71	2.71	2.72	2.70	2.70	2.70	2.71
Minimum	36.11	36.31	36.63	36.94	37.25	37.56	37.90	38.19	38.49
Maximum	45.74	46.01	46.30	46.63	46.93	47.23	47.54	47.86	48.16
Change in Mean	-0.8%	-1.0%	-1.0%	-1.0%	-1.1%	-1.1%	-1.0%	-1.0%	-1.0%
Hay Yield, January 2005 Baseline (tons/acre)									
	2.55	2.56	2.57	2.58	2.59	2.61	2.62	2.64	2.65
Hay Yield, January 2005 Baseline (tons/acre)									
	2.52	2.54	2.55	2.56	2.57	2.59	2.60	2.61	2.62
Change	-0.8%	-0.8%	-0.7%	-0.7%	-0.8%	-0.8%	-0.9%	-1.0%	-1.0%

Note: Stochastic hay yield projections were not available from FAPRI.

Table A-14. Means of National Cost of Production Projections under January 2005 and January 2006 FAPRI Baselines, 2006-2014 ($/acre)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn									
January 2005	171.92	174.30	177.03	179.66	182.21	185.53	189.17	193.38	197.95
January 2006	229.48	214.44	209.84	207.59	207.01	209.64	212.79	216.08	219.47
Change	33.5%	23.0%	18.5%	15.5%	13.6%	13.0%	12.5%	11.7%	10.9%
Cotton									
January 2005	357.24	363.37	369.30	375.28	381.56	389.02	397.01	406.19	415.77
January 2006	409.96	394.17	390.82	390.66	392.05	397.78	404.40	410.94	417.89
Change	14.8%	8.5%	5.8%	4.1%	2.8%	2.3%	1.9%	1.2%	0.5%
Peanuts									
January 2005	381.11	379.93	379.84	384.35	389.34	395.24	401.19	406.74	412.70
January 2006	451.92	423.83	415.93	412.92	412.83	418.42	424.66	431.21	437.72
Change	18.6%	11.6%	9.5%	7.4%	6.0%	5.9%	5.9%	6.0%	6.1%
Rice									
January 2005	369.65	376.41	382.69	389.08	395.73	404.15	413.42	424.42	435.86
January 2006	480.44	449.30	441.00	438.30	438.23	444.55	451.75	459.23	466.63
Change	30.0%	19.4%	15.2%	12.7%	10.7%	10.0%	9.3%	8.2%	7.1%
Sorghum									
January 2005	107.77	109.55	111.38	113.28	115.01	117.23	119.74	122.73	125.85
January 2006	154.08	143.24	140.07	138.63	138.28	140.13	142.32	144.65	147.01
Change	43.0%	30.7%	25.8%	22.4%	20.2%	19.5%	18.9%	17.9%	16.8%
Wheat									
January 2005	73.91	75.13	76.31	77.51	78.60	80.07	81.83	83.85	85.97
January 2006	97.34	91.88	90.47	90.10	90.14	91.24	92.59	94.00	95.44
Change	31.7%	22.3%	18.6%	16.2%	14.7%	14.0%	13.2%	12.1%	11.0%

Note: Costs of production for peanuts are at the regional level.

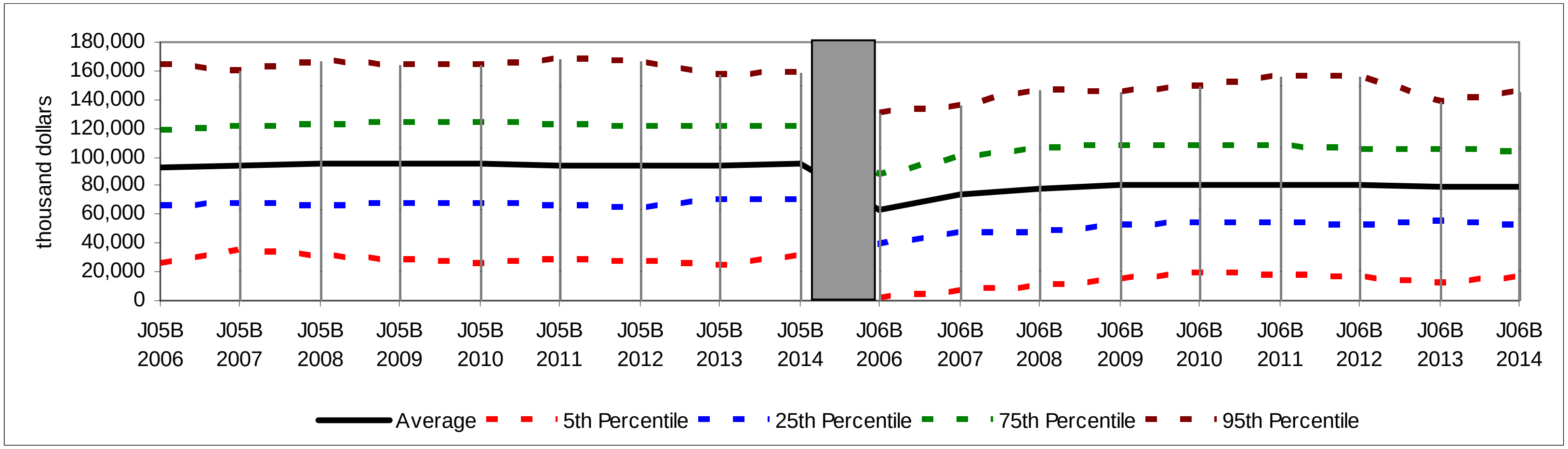

Figure A-1. Fan Graph of Net Farm Income Projections for Texas Peanuts under January 2005 and January 2006 FAPRI Baselines, 2006-2014

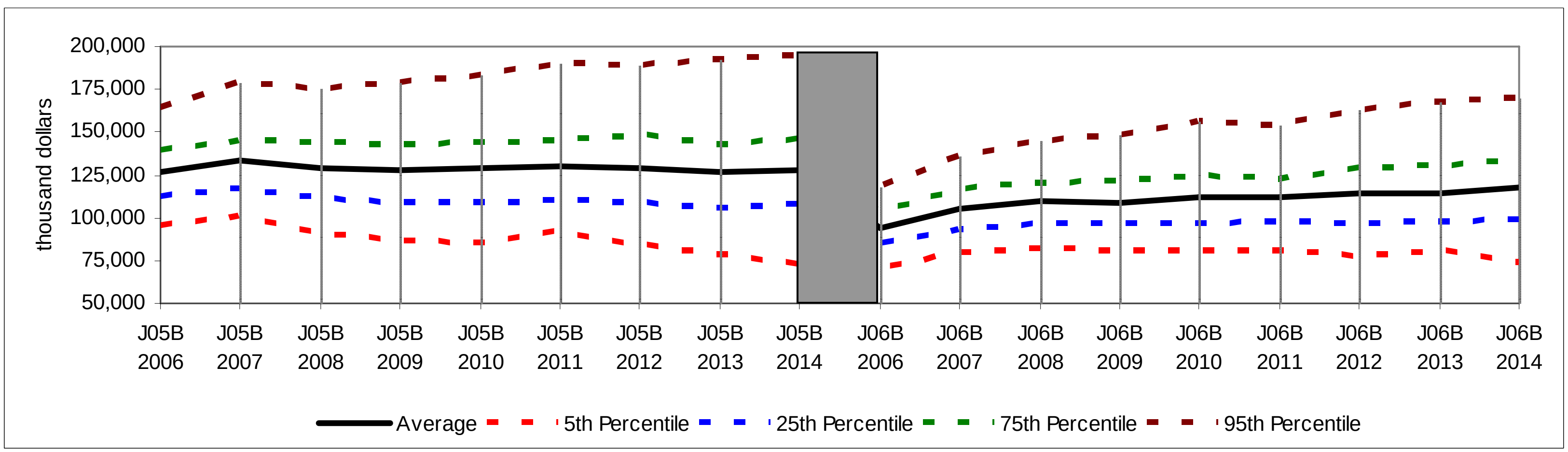

Figure A-2. Fan Graph of Net Farm Income Projections for Texas Rice under January 2005 and January 2006 FAPRI Baselines, 2006-2014

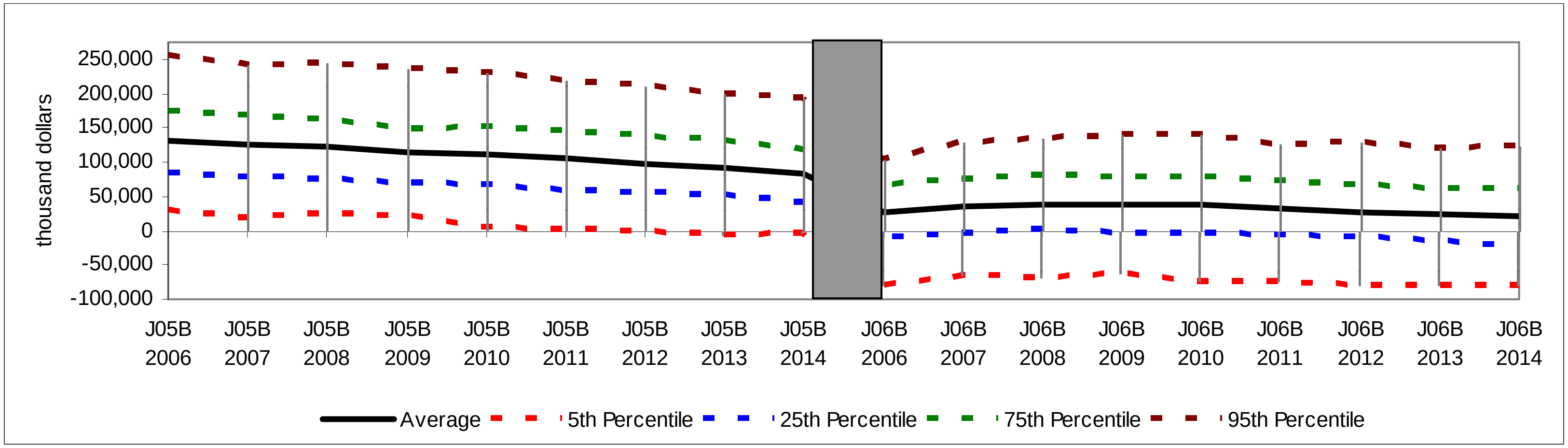

Figure A-3. Fan Graph of Net Farm Income Projections for Texas Sorghum under January 2005 and January 2006 FAPRI Baselines, 2006-2014

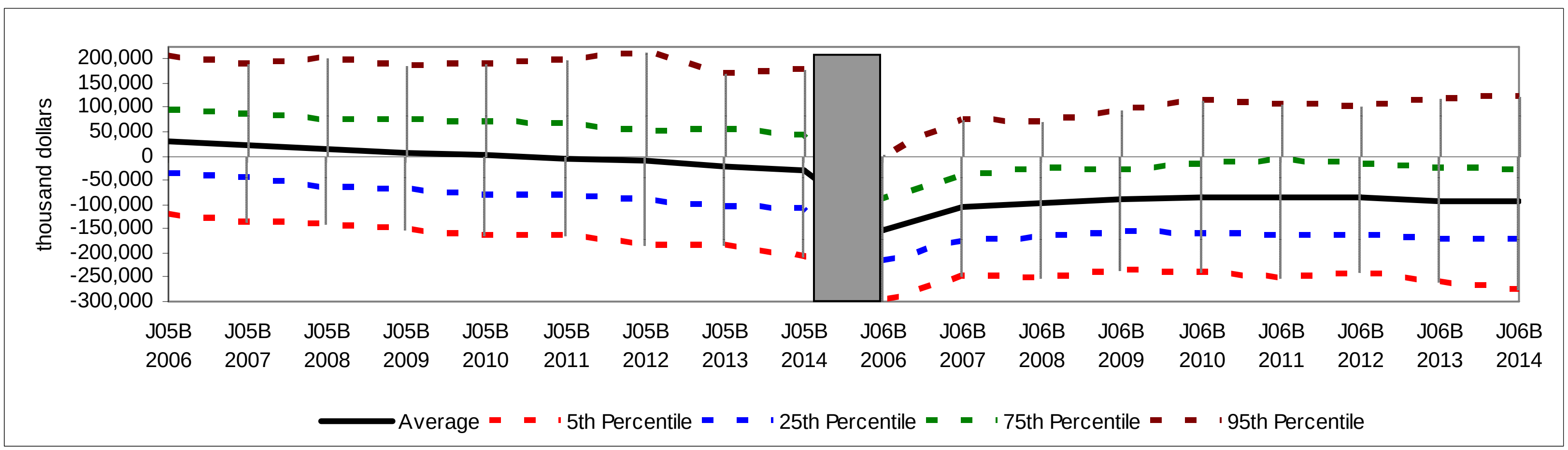

Figure A-4. Fan Graph of Net Farm Income Projections for Texas Wheat under January 2005 and January 2006 FAPRI Baselines, 2006-2014

APPENDIX B

Appendix B is an explanation of how to use the Texas crop model. Here, the steps necessary to incorporate the FAPRI Baseline projections, update the model, and simulate the model's key output variables are described.

How to Update FAPRI Baseline Projections

To update FAPRI Baseline projections in the Texas crop model, projections for four groups of variables need to be obtained from FAPRI – prices, yields, costs of production, and miscellaneous variables.

Prices and Yields

The Texas crop model uses 500 annual iterations of stochastic national prices and yields from the FAPRI Baseline. Create a worksheet for prices and one for yields, and incorporate them into the model by following these steps:

1. Obtain the 500 annual iterations of national price and yield projections from FAPRI's Stochastic Baseline.
2. Open the "Stochastic" worksheet of the file containing FAPRI's baseline projections.
3. Open FAPRI Developer by selecting "FAPRIEx," "Generate Matrix" on the menu bar. FAPRI Developer may need to be installed if it is not already on your computer.
4. Select "Price" from the search variable dropdown list in the FAPRI Baseline Sorter dialog box.
5. Select the crops to include by highlighting "Barley, Corn, Cotton, Oats, Rice, Soybean, Sorghum, Wheat, Sunflowers, Peanuts, Hay and Ctseed."
6. Select the columns to include for each appropriate year: J=2006, K=2007, etc.

7. Enter “1” for the Header Row Number and click “OK.”

8. Rename the new sheet to indicate the variable and baseline year. Ex: “Prices 2006”

9. Repeat Steps 4-8, substituting Yields for Prices.

10. Open the “500USPr” worksheet of the Texas crop model.

11. Check that column headings in the new Prices and Yields worksheets match those in the “500USPr” and “500USYld” worksheets of the Texas crop model.

12. Copy and paste the matrix of prices from FAPRI into the “500USPr” worksheet of the Texas crop model. Check that Iteration 501 (Line 504) contains a formula to calculate the average of Iterations 1-500.

13. Copy and paste the matrix of yields from FAPRI into the “500USYld” worksheet of the Texas crop model. Check that Iteration 501 (Line 504) contains a formula to calculate the average of Iterations 1-500.

14. Check that prices and yields in the “~USPr&Yld” worksheet of the Texas crop model match those in the “500USPr” and “500USYld” worksheets.

Costs of Production and Miscellaneous Variables

FAPRI’s national costs of production projections for corn, cotton, rice, sorghum and wheat, as well as their regional production cost projections for peanuts, are used in the Texas crop model. These can be incorporated using the following steps:

1. Obtain baseline projections from FAPRI for national costs of production and miscellaneous variables listed in Column C of the file named “Blank COP & Misc.”

2. Rename the file containing the projections to indicate the baseline month and year. Ex: “Jan 2006 COP & Misc”

3. Copy and paste projections for these variables into the appropriate rows in the “SASData-fi” and SASData-cr” worksheets of the Texas crop model, as specified in the first two columns of the “COP & Misc” worksheet.

How to Update the Texas Crop Model

The Texas crop model uses historical data for regional costs of production and Texas planted acres, harvested acres, yields and prices. Beef cattle price, Conservation Reserve Program (CRP), and government payment data are also included. The model can be updated by incorporating data for these variables from recent years.

Regional Costs of Production

The Texas crop model can be updated with recent data for regional costs of production by following these steps:

1. Open the “ERSdata” worksheet of the Texas crop model.
2. Go to the Economic Research Service Commodity Cost and Returns website: http://www.ers.usda.gov/Data/CostsAndReturns/testpick.htm .
3. Under “Recent historic costs and returns, U.S. and ERS Farm Resource Regions, New Format and Regions,” select “Corn” and “Prairie Gateway” and click “Submit.”
4. Click “OK” to open the data file with Microsoft Excel.
5. Select cell B5 in the data worksheet and click “Window, Freeze Panes” on the Excel toolbar.
6. Copy and paste the data for each cost category into the “ERSdata” worksheet.
7. Check that data in the “ERSdata” worksheet from previous years matches that in the data file, as some cost data from recent observations may have been updated in the USDA-ERS system.
8. Repeat steps 3-7 for cotton, rice, sorghum and wheat, with their corresponding regions. The Prairie Gateway region is used for each of these crops except rice, which is in the Fruitful Rim region. The Fruitful Rim data file for rice includes separate worksheets for California and the Gulf Coast; use the Gulf Coast sheet.

Texas Planted Acres, Harvested Acres, Yields and Prices

State-level data in the Texas crop model can be updated by following these steps:

1. Open the "NASSdata" worksheet of the Texas crop model.

2. Go to the USDA-NASS homepage: http://www.nass.usda.gov/index.asp.

3. Under "Quick Stats: U.S. and State Data," select "US and State - Crops" from the dropdown list and click "Go."

4. Select "Planted, Harvested, Yield, Production, Price (MYA), Value of Production" from the "select data type" list.

5. Select the following crops from the "select data items" list: Corn for Grain
Cotton Upland
Hay All (Dry)
Peanuts for Nuts
Rice All
Sorghum for Grain
Wheat All

6. Select the appropriate range of years and leave the interval as "1."

7. Select Texas from the location list and click "Add."

8. Click "Get Data - Download Only," "Download CSV (Units as separate column within CSV)."

9. Copy and paste the data into the appropriate rows of the "NASSdata" worksheet.

Other Data

The steps for updating beef cattle price are as follows:

1. Open the "NASSdata" worksheet of the Texas crop model.

2. Go to the USDA-NASS homepage: http://www.nass.usda.gov/index.asp.

3. Under "Statistics by State" on the left margin, select "Texas" from the dropdown list.

4. Under “Texas Publications,” select “Annual Statistical Bulletin” from the dropdown list and click “Go.”

5. Select “Average Prices Received for Livestock” from the list of reports.

6. Enter the data for marketing year average price for beef cattle into the “BFPCFTX” row of the “NASSdata” worksheet.

The steps for updating CRP acreage and rental payments are as follows:

1. Open the “NASSdata” worksheet of the Texas crop model.

2. Go to the USDA-FSA homepage: http://www.fsa.usda.gov/pas/.

3. Click “News Releases” on the left margin.

4. CRP acreage and rental payments are normally announced in a news release in early October that has “Conservation Reserve Program” in the headline.

5. Enter the CRP acreage data into the “CRPTX” row and the CRP rental payments data into the “CRPEXPTX” row of the “NASSdata” worksheet.

6. Hay harvested acreage “HASHARTX-1”and price “HAPFRMTX-1” in the previous year can be updated by dragging their formulas to the right.

Once data for variables in the “ERSdata” and “NASSdata” worksheets are updated, they need to be incorporated into calculations for the model’s projections. This can be done in the following steps:

1. Open the “CRdata” worksheet of the Texas crop model.

2. Bold text indicates the data is projected. Drag the VLOOKUP formula for the last observation that is not bold to the right so all historical data for a particular variable comes from the same worksheet, and is not bold.

3. Repeat Step 2 for each set of variables (excluding dummy variables) in each crop’s data sheet, “CRdata” through “HAdata.”

4. Drag all formulas in the last year of projected values to the right to include projections for the appropriate years.

5. Open the “CRest” worksheet.

6. Click inside cell A3. Run a regression on observed data with CPCRSDSP as the dependent variable and CPCRSEED, D1 and D2 (if applicable) as the independent variables, and put a check in the boxes next to “Predictions & Residuals” and “Observational Confidence & Prediction Intervals” under Optional Output.

7. Repeat Step 6 for all costs of production (except short-term interest costs), harvested acres and cash receipts for each program crop, as well as each variable in the hay model.

8. Click inside cell L1102 of the “CRest” worksheet. Run a regression on observed data with CRSYLDTX as the dependent variable and YEAR as the independent variable (Rows 79 and 80 in the “CRdata” worksheet), and put a check in the box next to “Observational Diagnostics” under Optional Output.

9. In the first column of the output under the Observational Diagnostics, replace the 1 with a 0 in each row with a significant (bold) Studentized Residual <u>only</u> for observations within the first two years of a farm bill change.

10. In Row 75 of the “CRdata” worksheet, highlight the D1 row for all years used in the regression and enter the formula: =TRANS(CRest!$L$1122:$L$11_ _) and press Ctrl + Shift + Enter to enter the array of dummy variables.

11. Click inside cell A1102 of the “CRest” worksheet. Run another regression with CRSYLDTX as the dependent variable, and YEAR and D1 as the independent variables, and check the boxes next to “Predictions & Residuals” and “Observational Confidence & Prediction Intervals.”

12. Repeat Steps 8-11 for expected yield, yield, price, and planted acres for each program crop. For the planted acres equations, include the dummy variable D3 for both regressions.

13. Open the “Stochastic” worksheet.

14. Drag the cell references for historical residuals from the estimated equations (at the top of the worksheet) down to include residuals for all years of historical data.

15. Below the correlation matrix for prices (in cells A42:I50), generate a new correlation matrix from the residuals for prices (with labels), including all years of residuals.

16. Copy and paste the numbers from the new correlation matrix (without labels) into cells C44:I50. Delete the lower correlation matrix.

17. Cells D70:D76 should still contain the the formula: =CSND($C$44:$I$50), so it generates CSNDs from the correlation matrix.

18. Repeat Steps 15-17 for each group of variables.

19. Open the "CReq" worksheet.

20. Update the formula for SE Predicted in cell A17 to show that from the last observation from the regression in the "CRest" worksheet.

21. Drag the formulas for "Estimate" (row 12) and "Observation" (row 13) to the right so each year with observed data has a non-bold number in both of these rows.

22. Drag all formulas for the last year of projections to the right to include projections for the appropriate years.

23. Repeat steps 19-22 for each variable for every crop.

The steps for updating government payment data are as follows:

1. Open the "GovPmts" worksheet of the Texas crop model.

2. Go to the USDA-ERS homepage: http://www.ers.usda.gov/.

3. Click "Data Sets."

4. Under "Data Products by Title," click the letter F.

5. Choose "Farm Income Data" from the list of titles.

6. Under "Data Files," select "See all data files."

7. Under "Government Payments, by State and Program," select the year for which data is needed and click "Submit."

8. Copy and paste the data for Texas government payments into the appropriate cells in Rows 2-11 of the "GovPmts" worksheet.

9. If necessary, payment fractions for direct and counter-cyclical payments can be updated in Rows 32 and 53 of the "GovPmts" worksheet.

How to Simulate the Texas Crop Model's Key Output Variables

The Texas crop model's key output variables are net farm income (NFI) for corn, upland cotton, peanuts, rice, grain sorghum, wheat and hay. Projections of these variables can be simulated by following these steps:

1. Open the "~USPr&Yld" worksheet and enter a 0 into cell A4 so the 500 annual iterations of national prices and yields from FAPRI will be used in the simulation.
2. Open the "ToSimulate" worksheet of the Texas crop model.
3. Drag the NFI projections (rows 25-32) to the right to include the appropriate years.
4. Check that the model is in deterministic mode (not expected value).
5. Open Simetar's Simulation Engine dialog box.
6. In the "Select Output Variables for Analysis" box, click the button and highlight NFI projections in rows 25-32 for the appropriate years.
7. Check the appropriate boxes under "Location of Output Variable Names."
8. Enter a name for the worksheet of simulated data in the "Output Worksheet" box.
9. Select the appropriate number of iterations and click "SIMULATE."

VITA

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