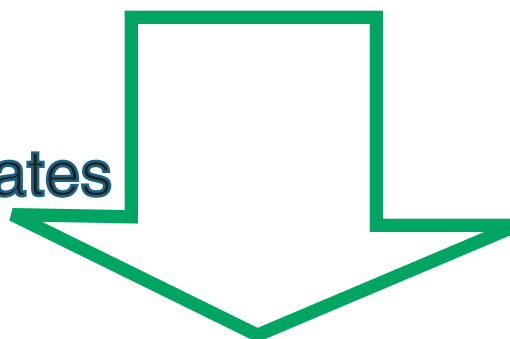


When Point Estimates



Miss the Point:
Stochastic Modeling
of WTO Restrictions

Patrick Westhoff, Scott Brown, and Chad Hart

FAPRI

**Food and Agricultural
Policy Research Institute**

University of Missouri/Iowa State University

FAPRI Policy Working Paper #01-05 — December 2005

Paper presented at a meeting of the International Agricultural Trade Research Consortium held in San Diego, CA, December 4-6, 2005. The authors would like to thank John Kruse, Seth Meyer, and Daniel Madison of the University of Missouri, and Gary Adams, formerly of the University of Missouri and now with the National Cotton Council for their work in developing the model used for the analysis, and William Meyers, Joseph Glauber, and Wyatt Thompson for useful comments on an earlier draft.

Abstract

Point estimates of agricultural and trade policy impacts often paint an incomplete or even misleading picture. For many purposes it is important to estimate a distribution of outcomes. Stochastic modeling can be especially important when policies have asymmetric effects or when there is interest in the tails of distributions. Both of these factors are important in evaluating World Trade Organization (WTO) commitments on internal support measures. Point estimates based on a continuation of 2005 U.S. agricultural policies and average values for external factors indicate that U.S. support would remain well below agreed commitments under the Uruguay Round Agreement on Agriculture (URAA). Stochastic estimates indicate that the mean value of the U.S. Aggregate Measure of Support (AMS) is substantially greater than the deterministic point estimate. In 41.8 percent of 500 stochastic outcomes, the URAA AMS limit is exceeded at least once between 2006 and 2014.

Key words: Agricultural policy, World Trade Organization, stochastic modeling, Aggregate Measure of Support, Doha Development Agenda

Contact author:

Patrick Westhoff
Food and Agricultural Policy Research Institute
University of Missouri
101 Park DeVill Drive, Suite E
Columbia, Missouri 65203 USA
Phone +1 573 882 4647
Fax +1 573 884 4688
westhoffp@missouri.edu

A traditional deterministic model of agricultural markets is not always the right tool to use in examining policy issues. Point estimates of policy impacts often fail to tell the whole story and sometimes may lead to inappropriate conclusions. At least for some questions, a stochastic model can be a more useful tool. Stochastic analysis can be particularly useful when policies have asymmetric consequences or when there is intrinsic interest in the tails of distributions.

U.S. agricultural policies provide many examples of asymmetries that increase the value of stochastic analysis. Consider, for example, the operation of the marketing loan program for U.S. grains, oilseeds, and cotton. Producers qualify for loan program benefits when market price indicators (posted county prices in the case of grains and soybeans, adjusted world prices for cotton and rice) fall below the government-specified loan rate.

Suppose that deterministic analysis generates point estimates of future prices that slightly exceed the levels that would trigger marketing loan benefits. Estimated government expenditures on the marketing loan program would be zero. Stochastic analysis, in contrast, would recognize that supply and demand uncertainty makes it more appropriate to consider a distribution of market prices rather than just a point estimate. In most of the possible market outcomes, prices would exceed the level triggering loan program benefits and marketing loan expenditures would be zero, but in some outcomes, prices would be low enough to result in marketing loan benefits. The average value of marketing loan benefits over all the stochastic outcomes, therefore, can be greater than zero even when marketing loan benefits at the average value of market prices would be zero.

The asymmetry of U.S. government farm programs has important implications when estimating taxpayer costs. Projections prepared in early 2005 by the Food and Agricultural Policy Research Institute (FAPRI) indicate that the deterministic estimate for U.S. government farm program expenditures is more than \$3 billion per year lower than the mean of 500 possible outcomes from stochastic analysis of the same baseline (FAPRI 2005b). The deterministic and stochastic estimates differ primarily because of large differences in the estimated cost of the marketing loan program, and not because of any significant difference between deterministic point estimates of prices and the mean prices estimated in the stochastic analysis.

From a policy perspective, sometimes the interesting part of a distribution is not the mean, median, or mode, but rather one of the tails. Policy makers may be more concerned with how a policy impacts farm income or government spending in a “bad” year than they are with effects under “normal” conditions. For example, analysis that considers the effects of crop insurance programs assuming average levels of yields and prices is likely to miss the true market and policy significance of the program.

Current World Trade Organization (WTO) rules also create a situation where it is important to focus on tails of distributions. Under the Uruguay Round Agreement on Agriculture (URAA), countries agreed to limit their total current Aggregate Measure of Support (AMS), an indicator of government support that is coupled to production decisions (WTO 1994). In the case of the United States, marketing loan expenditures account for much of the AMS. Because marketing loan expenditures depend on market prices, they are inherently variable. As a result, a given set of farm policies may leave the United States in compliance with its WTO commitments when prices are at average

or above-average levels, but might put the country out of compliance when prices are sufficiently low.

The paper will discuss the development of stochastic estimates of the U.S. current AMS. Both deterministic and stochastic analyses will indicate that U.S. support to producers is expected to be considerably below the current AMS limit established by the URAA under the reporting practices that have been followed by the U.S. government. However, examination of the stochastic results indicates that there is some non-zero probability that the United States could breach the URAA limits.

These analytical issues have important implications for evaluation of a possible Doha Development Agenda (DDA) agreement. Anderson, Martin, and van der Mensbrugge (2005) indicated that they generally had to assume large reductions in bound levels of AMS before the hypothetical commitments would become binding and affect estimated market outcomes. Such an assumption was necessary because their deterministic analysis started from a baseline where actual AMS levels in the United States and most other countries were well within their URAA obligations. This paper will show that even when point estimates suggest that existing limits are not binding, reductions in AMS limits increase the probability that limits will be reached or exceeded. The remaining sections of the paper provide a brief description of the stochastic model equations, the process used to generate stochastic estimates, a discussion of the results, and some concluding remarks.

The Stochastic Model

The FAPRI stochastic model of the U.S. agricultural economy represents an outgrowth of FAPRI's deterministic model of world agricultural markets. The FAPRI deterministic world model is a multimarket, nonspatial, partial equilibrium model that has increased in scope and complexity since the early 1980s. The deterministic model covers markets for major grains (wheat, corn, rice, sorghum, barley, and oats), oilseeds, (soybeans, rapeseed, sunflowerseed, peanuts, and palm oil), cotton, sugar, beef, pork, poultry, and dairy products. Country coverage varies by commodity, but generally includes the United States, the European Union, China, India, Japan, Brazil, Argentina, Canada, Australia, and other major exporters and importers of each commodity. The deterministic model is used to generate annual 10-year baseline projections (e.g., FAPRI 2005a) and analyze a wide range of domestic and trade policy questions (e.g., Fabiosa et al. 2005).

As it became clear that a deterministic model was inadequate for addressing some of the questions posed by policy makers, work began in 2000 on a stochastic version of the model. To keep the scale of the effort manageable, the stochastic model focuses on U.S. markets and is less detailed than its deterministic counterpart. World markets are represented by single reduced form equations, and some of the regional detail included in the U.S. portion of the deterministic model is replaced by national supply equations. Even so, the stochastic model has approximately 1,000 equations representing U.S. crop and livestock supply, demand, trade, and prices, as well as aggregate indicators such as government farm program costs, net farm income, agricultural land values, and consumer food price indices (FAPRI 2005e).

The crop portion of the model includes behavioral equations that determine crop acreage planted, domestic feed, food and industrial uses, trade, and ending stocks. On the livestock side of the model, behavioral equations determine animal inventories, meat, milk and dairy product production, consumption, and, where appropriate, ending stocks and trade. The model solves for the set of prices that brings annual supply and demand into balance in all markets.

Of particular interest to the present study are the equations that determine crop supply. The national planted area equations in the stochastic model approximate the aggregate behavior of the regional crop supply equations in the deterministic model. Planted area (APL) for each crop depends on per-acre expected supply-inducing net returns (ESINR) for the crop in question and competing crops, a weighted average of per-acre decoupled payments for all crops (DECP) and conservation reserve program acreage (CRP):

$$APL_i = f(ESINR_1, ESINR_2, ESINR_3 \dots ESINR_{10}, DECP, CRP). \quad (1)$$

The synthetic parameters of the model reflect standard relationships between supply and expected returns. Acreage increases with own expected returns, declines when there is an increase in expected competing crop returns, and the own-return elasticity is generally slightly larger than the absolute value of the sum of competing crop return elasticities. Given model parameters, a 1 percent increase in expected supply-inducing net returns for all modeled crops would increase the total land planted to modeled crops by 0.06 percent. Decoupled payments, defined as the weighted sum of direct payments and expected counter-cyclical payments (CCPs) for all crops, have only a small effect on planted area, with elasticities less than 0.02. In a survey of empirical work, Abler and Blandford (2004) found that estimated acreage impacts of production flexibility contract payments and market loss assistance payments (the precursors to direct payments and CCPs) were generally modest. The coefficients on the CRP variable in each equation suggest that a 1 acre increase in CRP area would reduce the area planted to the modeled crops by less than half an acre.

Expected supply-inducing net returns are a function of trend yields (TYLD), expected prices (EPR), expected variable production expenses per acre (VEX), expected marketing loan program benefits (EMLB), and expected CCPs (ECCP):

$$ESINR = EPR * TYLD - VEX + EMLB + 0.25 * ECCP. \quad (2)$$

The specification includes both market returns and marketing loan benefits that can only be earned by producing a crop, and assumes that producers value a dollar of expected returns from the market the same as a dollar of expected marketing loan benefits. Also included are 25 percent of expected CCPs. Because CCPs are made on a fixed base, they can be considered at least partially decoupled from production decisions (thus their inclusion in the decoupled payment term in the area equations). However, CCPs do depend on prices, and risk-averse producers may have a positive supply response to the price insurance offered by the program. The 0.25 parameter is based on analyst judgment, reflecting the notion that the crop-specific effect of CCPs on production is likely to be positive, but modest. Because expected CCPs are included in

the definition of expected supply-inducing net returns for all crops, an across-the-board increase or decrease in CCPs would have only a small impact on production, given both the 0.25 parameter and the small response of total crop area to proportional changes in all crop returns. A disproportionate decrease in expected CCPs for any one crop, however, would have more noticeable impacts, decreasing acreage for the crop in question but generally increasing acreage for competing crops, given model parameters.

Expected prices depend on the lagged price (PR_{t-1}) and the ratio of lagged yields (YLD_{t-1}) to the trend yield:

$$EPR = f(PR_{t-1}, YLD_{t-1}/TYLD). \quad (3)$$

The equation parameters are based on an estimation of the proportional year-over-year change in prices as a function of the change in yields. When yields in t-1 were unusually high (low), farmers are assumed to expect that prices in t will be higher (lower) than they were in t-1. While this is only a minor step toward a model assuming more rational expectations, it has important implications for how the model behaves in abnormal years. For example, in 2003 corn yields were at then-record levels while soybean yields were well below normal. Relative to 2002/03 levels, soybean prices increased sharply in 2003/04, while corn prices remained near the previous year's level. A naïve expectations approach would have generated a large increase in soybean acreage in 2004 at the expense of corn, given the change in relative prices in 2003/04. However, given the expected price formulation used in the model, the below-average soybean yield in 2003 offset part of the increase in 2003/04 prices, so the model expected soybean price for 2004/05 was noticeably lower than the 2003/04 actual price. The net result was a model estimate that both corn and soybean acreage would increase in 2004, consistent with observed market results.

Expected marketing loan benefits depend on the loan rate (LR), expected prices, an assumed wedge (MLBW), and the trend yield:

$$EMLB = \max(0, LR - EPR + MLBW) * TYLD. \quad (4)$$

The wedge variable reflects observed historical differences in per-unit marketing loan benefits (loan deficiency payments and marketing loan gains divided by production) and a simple comparison of loan rates and market prices. For example, corn marketing loan benefits averaged \$0.20 per bushel more than the difference between the corn loan rate and the corn market price between 1998/99 and 2001/02, the last extended period when loan program benefits were available (calculations based on USDA reported production and loan program data). The corn EMLB equation, therefore, assumes MLBW is equal to \$0.20 per bushel. Two factors contributing to the positive wedge are seasonality in prices (producers may take their marketing loan benefits when prices are below season average levels and payment rates are high), and the observed fact that the average of posted county prices used to calculate loan program benefits tends to be lower than the national average market price. While the actual relationship between marketing loan benefits and market prices may be more complicated than suggested by the model specification, it is clear that marketing loan benefits can and do occur when season-average market prices exceed the loan rate.

Finally, the expected CCP depends on the target price (TP), the direct payment rate (DP), expected price, loan rate, fixed CCP program yield (CCPY), and a 0.85 factor established by law:

$$ECCP = \max(0, TP - DP - \max(EPR, LR)) * CCPY * 0.85. \quad (5)$$

Considering the set of model supply equations, supply response can be very different depending on the level of market prices. Model supply elasticities with respect to expected market prices are zero when prices are below the loan rate, and they reach their maximum value only when expected market prices exceed the target price minus the direct payment rate (i.e., the level where an increase in prices no longer has a negative effect on government payments).

Asymmetries of government policies and the resulting differences in model supply response at different prices have proven important in analyses of various policy scenarios. Tighter limitations on payments available to any one producer were found to have little effect on crop supplies, government costs, or farm income when prices were above average, but much larger impacts at lower price levels (FAPRI 2003). Likewise, the limitation on marketing loan program benefits proposed in the President's budget for fiscal year 2006 was found to have much larger effects on production, government costs, and farm income when prices were low than when prices were high (FAPRI 2005c). Finally, an analysis of the impacts of increased ethanol production indicated that at low baseline levels of U.S. corn prices, increased corn demand would increase prices and reduce government payments to corn producers, but would have little impact on corn production or farm income. At higher baseline corn prices, there would be no government payment offset when increased demand results in higher market prices, and the result would be increased corn producer income and a much larger increase in corn production (FAPRI 2005d).

Space constraints do not permit a full description of the other behavioral equations in the model. Per-capita human consumption equations are generally functions of prices and income levels. Processing industry demand for raw commodities (e.g., soybean crush, corn processing for ethanol and high-fructose corn syrup) depends on endogenous processing margins. Derived demand for feed is a function of livestock sector indicators and feed prices. Beef and pork production depends in part on animal inventories, which in turn depend on dynamic investment behavior. Productivity measures such as milk per cow and livestock slaughter weights depend on output prices, production costs, and technological change. Stock demand equations reflect speculative and other motives for holding stocks, and incorporate provisions of government price support programs as appropriate.

The representation of U.S. agricultural commodity trade in the stochastic model is greatly simplified relative to the large non-spatial model FAPRI utilizes to generate deterministic projections. Single reduced-form equations take the place of the thousands of equations underlying the world models. For example, U.S. corn exports (COREX) are a function of a lagged dependent variable, current prices of corn (CORPR), wheat (WHEPR), sorghum (SORPR), barley (BARPR), and soybean meal (SOMPR), lagged prices of soybeans (SOYPR), and the level of oats net imports (OATIM):

$$\text{COREX} = f(\text{lag}(\text{COREX}), \text{CORPR}, \text{WHEPR}, \text{SORPR}, \text{BARPR}, \text{SOMPR}, \text{lag}(\text{SOYPR}), \text{OATIM}). \quad (6)$$

Coefficients for the reduced form trade equations are set so that the equations generally mimic the behavior of a global system. In the case of corn, for example, the reduced form equation suggests an own-price elasticity of U.S. export demand of about -1.03 in the short run and about -2.58 in the long run, with positive elasticities with respect to the other crop prices. This approach to modeling trade may be satisfactory when modeling U.S. policy changes, but it does not lend itself to analysis of multilateral policy changes. For example, the current U.S. stochastic framework would require significant modification before it could be used to analyze the impact of an international trade agreement that might systematically change the price responsiveness of export demand.

The model includes a large set of equations that permit estimation of fiscal year government farm program outlays and calendar year net farm income. While it is easy to dismiss these portions of the model as mere accounting, a number of challenges are faced in reconciling crop, calendar, and fiscal year data and in reproducing the detail expected by policy makers in the appropriate format.

Added to the model for the present analysis is a series of equations to estimate the current AMS and other indicators related to WTO internal support issues. The equations are intended to reflect the accounting practices used by the United States in preparing its WTO submissions (the most recent available at the time of this writing covers the 2001 marketing year), but can easily be modified to reflect other rules and practices. Because the focus is on amber box support subject to limitation under the WTO agreement, no effort is made to estimate support the United States has treated as green box support in its submissions. For example, the current AMS estimates do not include payments made under the U.S. direct payment program, even though the WTO status of those payments is in question at the time of this writing because of the WTO appellate body report on the Brazilian cotton case (WTO Appellate Body 2005).

Most of the accounting to generate AMS estimates is straightforward, given estimates generated by other model equations. For example, the main components of the calculated AMS for most major field crops are various benefits available under the marketing loan program. For most crops, the calculated AMS (CALCAMS) is simply the sum of crop year LDPs (CYLDP) and marketing loan gains (CYMLG) and a proxy for interest rate subsidies on commodity loans (an assumed subsidy rate multiplied by the value of loans made, (LOANSUB*VALLOAN):

$$\text{CALCAMS} = \text{CYLDP} + \text{CYMLG} + (\text{LOANSUB} * \text{VALLOAN}). \quad (7)$$

A different set of calculations are required for sugar and dairy, where the calculated AMS is primarily comprised of the calculated value to producers of a price support program that maintains domestic prices above those that prevailed in world markets between 1986 and 1988. The price support component of the AMS for these two commodities is equal to the product of the quantity produced (PROD) and the difference between the price support level (PRISUP) and the fixed 1986-1988 world reference price

(PRIREF). The calculated AMS also includes any coupled direct payments (COUPAY), such as those under the Milk Income Loss Contract (MILC) program:

$$\text{CALCAMS} = (\text{PRISUP}-\text{PRIREF}) * \text{PROD} + \text{COUPAY}. \quad (8)$$

The current AMS for each commodity (CURRAMS) is equal to the calculated AMS unless the calculated AMS is less than 5 percent of the value of production (price multiplied by production). If the calculated AMS for a given commodity is less than 5 percent of its value of production, the current AMS for that commodity is set equal to zero, as allowed by the *de minimis* rule in the URAA.

In its WTO submissions through crop year 2001, the United States classified crop insurance and market loss assistance payments as nonproduct-specific support (Economic Research Service 2005). Although the Brazilian cotton case raises questions about the appropriate classification of these programs, the analysis here assumes that crop insurance and counter-cyclical payments (which some consider a successor to market loss assistance payments, although the payment rules differ in several aspects) are classified as nonproduct-specific amber box support measures.

Estimates of counter-cyclical payments are generated by existing model equations. New to the system are equations used to estimate the contribution of crop insurance to AMS measures. Crop insurance net indemnities depend on the mix of crop insurance policies in force, actual and projected market prices, and crop yields at the unit level (farms are often divided into multiple units for crop insurance purposes). As such, it is very difficult to project crop insurance activity based solely on the aggregate U.S. variables estimated in other components of the stochastic model.

The crop insurance stochastic estimates are derived from the results of the FAPRI deterministic crop insurance baseline and the ratios of stochastic draws to the deterministic FAPRI baseline figures for crop acreage, crop yields, and crop prices. For the analysis, estimates for both yield and revenue insurance policies are developed for corn, soybeans, wheat, cotton, rice, sorghum, barley, and oats, and all other commodities are handled as a single aggregate.

Insurance premiums and premium subsidies vary with crop acreage. Loss ratios (the ratio of insurance indemnities to insurance premiums) are computed for the various crops and insurance policies. For yield insurance, the loss ratios depend on the ratio of the stochastic yield draw to the deterministic yield; low stochastic yield draws translate into high yield insurance loss ratios and higher than average yield insurance indemnities. For revenue insurance, the loss ratios depend on the ratio of the stochastic yield draw to the deterministic yield and the ratio of the stochastic price draw to the expected price. For the crop insurance simulations, the expected price is defined as the average of the stochastic price draw for the previous year and the deterministic price for the current year. The combination of low stochastic yield and/or price draws translates into higher revenue insurance loss ratios. As with actual revenue insurance, the simulation structure for revenue insurance allows the impact of a low yield (price) draw to be offset by a higher than average price (yield) draw, mitigating the size of any potential crop insurance payment.

The loss ratio for crop insurance on the commodities not explicitly included in the analysis is derived from its historical relationship with the combined loss ratio for crop

insurance on corn, soybeans, wheat, cotton, rice, sorghum, barley, and oats. Indemnities are then calculated as the product of the premiums and the loss ratios. Crop insurance net indemnities equal the sum of indemnities and premium subsidies less insurance premiums.

Nonproduct-specific support is only included in the total current AMS if the sum of all nonproduct-specific support is greater than the *de minimis* level of 5 percent of the value of total agricultural production. For most of the commodities included in the model, the value of production is simply defined as price multiplied by production. For beef and pork, the indicator prices in the model are multiplied by carcass-weight meat production and then by a calibration factor that generates 2001 estimates equal to those reported in the U.S. submission. For many other commodities, the model follows the practice used in the U.S. submission, where calendar year cash receipts for products such as fruits, vegetables, and nursery products are used in lieu of a true value of production measure. One case where this choice is particularly important is hay, where only a small portion of total production is marketed. The hay cash receipts used in the value of production calculation are therefore much less than the result of multiplying the USDA-reported levels of hay production and prices.

The total current AMS includes a number of minor components not endogenous in the stochastic model. For example, the U.S. submission indicates the value of irrigation subsidies in 2001 was \$300 million, and this was considered part of nonproduct-specific support. The model treats these components as exogenous variables that are included in the AMS calculations.

The Stochastic Process

The stochastic baseline process begins with the generation of a deterministic baseline. Each November, FAPRI analysts construct a set of preliminary global baseline projections using the deterministic model. Based on reviewer comments and other new information, a revised deterministic baseline is prepared in January.

As discussed, some of the equations in the stochastic model are different than the corresponding equations in the deterministic model. The stochastic model is calibrated so that it generates precisely the deterministic estimates when all exogenous variables are set at the levels assumed for the deterministic baseline. Thus, when the means of the stochastic baseline differ from the deterministic results, it is because there are non-linearities in the models, asymmetries in the policies, or because of the luck of the random draws, not because the models generate different results for the same set of baseline assumptions.

Considering all the factors that make commodity market outcomes uncertain, there is a very large set of variables one could draw from in conducting stochastic analysis. The FAPRI stochastic model draws from a relatively narrow set of exogenous variables. The process involves both “science” and “art.” Rather than sampling all possible sources of uncertainty, an attempt is made to draw from a sufficient number of factors to reflect both supply- and demand-side uncertainty so that resulting price and quantity distributions appear reasonably consistent with historical observations and analyst judgments.

In general, the approach is to make correlated random draws from empirical distributions of selected exogenous variables and solve the model for each of the 500 sets of exogenous variables to generate 500 alternative outcomes for the endogenous variables. Each of the exogenous sets of assumptions and endogenous sets of results are preserved, so that it is possible to decompose any given solution, and so that alternative policy scenarios can effectively be run against 500 different, but related, baselines.

Supply-side exogenous variables used to drive the stochastic analysis include crop yields, the share of planted area which is harvested, production expenses, and error terms from state milk production per cow equations. Demand-side variables include error terms from key domestic consumption, stock, and trade equations. While it is possible to imagine a wide range of other sources of variability (macroeconomic variables, model coefficients, etc.), experience has shown that this subset of factors is sufficient to generate plausible distributions of prices and quantities.

In general, the statistical distributions of exogenous variables are based on about 22 years of annual time series data. Crop yield distributions, for example, are based on deviations from trend yields during the 1983-2004 period. These deviations and corresponding deviations from trend shares of planted area that is harvested are correlated across all modeled crops. For example, drawing a positive deviation from trend corn yields means one is likely, but not certain, to also draw a positive deviation from trend soybean yields. Likewise, error terms from demand equations are also correlated. Results indicate, for example, that error terms from the reduced-form export demand equations for major crops are positively correlated with one another.

The stochastic draws of exogenous variables are made with SIMETAR, software developed by Dr. James Richardson at Texas A&M University. SIMETAR is capable of handling large matrices, but with limited historical observations it is not possible to develop reliable estimates of the correlations of all the selected exogenous variables together. Instead, the exogenous variables are grouped on the basis of similarity or observed correlation, and the correlation across groups is assumed to be zero; e.g., no correlation is assumed between the group containing all crop yield deviations and the group of error terms from meat consumer demand equations.

Given 500 sets of correlated random draws of the selected exogenous variables, the stochastic solution is derived by solving the model for each of the 500 sets. The model simulates in SAS, and results are maintained in SAS data sets and written to an Excel spreadsheet. With 500 solutions for 10 years for approximately 1,000 variables, the file size of the solution spreadsheet exceeds 100 megabytes.

It should be stressed that the stochastic process involves significant analyst judgment in deciding what variables to consider, methods used to detrend or otherwise adjust data, etc. To get a model to generate 500 sets of “reasonable” outcomes requires a robust model and frequent model upkeep and revision. While many of the model parameters are based strictly on econometric results of time series estimations, other parameters are based at least in part on analyst judgment. As argued by Just (2001), it is not reasonable to expect time series data to provide all the information needed to build models appropriate for policy analysis.

Results and Discussion

Baseline projections prepared in early 2005 indicated modest increases in nominal prices for major U.S. field crops between 2006 and 2014 (Table 1). For all the major crops, deterministic baseline prices rise to levels where marketing loan program benefits would be small or non-existent, and even CCPs would disappear for many crops. The mean results from the 500 stochastic outcomes suggest similar levels of crop prices. Only in the case of rice is the mean of stochastic prices noticeably lower than the deterministic estimate.

Given the asymmetric nature of U.S. farm programs, the estimated variation in stochastic results takes on special significance. For example, even though mean corn prices from the stochastic analysis are well above the \$1.95 loan rate, the \$0.33-\$0.38 per bushel standard deviation in corn prices is large enough that some of the 500 outcomes for corn prices are low enough to generate considerable marketing loan benefits. It is precisely this asymmetry that accounts for some of the differences between deterministic baseline prices and the mean prices of the stochastic analysis. In the case of rice, large average stochastic loan program benefits increase average coupled producer returns relative to the deterministic estimates, and result in a higher mean level of rice production. The higher mean level of rice production, in turn, contributes to a lower mean level of rice prices than in the deterministic baseline.

For the major field crops, the bulk of the estimated product-specific AMS can be attributed to marketing loan program benefits. The means reported in Table 2 mask a wide range of stochastic outcomes. In most of the 500 stochastic outcomes, for example, corn marketing loan benefits are zero in every year after 2006. In some of the outcomes, however, prices are low enough to generate very large marketing loan benefits. For example, in 2010, corn LDPs exceed \$3.6 billion in 10 percent of the outcomes.

At the mean of the stochastic outcomes, dairy and sugar account for more than half of the total product-specific AMS. Once the dairy MILC program expires in 2005, the AMS for those two commodities is simply equal to production multiplied by the gap between a legislatively-fixed support price and a WTO-fixed world reference price (based on 1986-1988 world market prices). Thus, for dairy and sugar under current U.S. policies, the only source of variation in the AMS is production uncertainty.

In the case of product-specific support, the difference between the calculated AMS and the current AMS used to determine compliance with the WTO agreement is modest, generally a little over \$200 million per year. The difference is due to the effect of the product-specific *de minimis* rule that excludes from the current AMS product-specific support that is less than 5 percent of the value of production of the commodity in question.

In contrast, there is a very large difference between the mean calculated nonproduct-specific support (primarily CCPs and crop insurance benefits) and the proportion included in the mean estimate of the current AMS. In the vast majority of outcomes (over 90 percent of outcomes in 2006 and over 98 percent of outcomes in 2014), total nonproduct-specific support is less than the *de minimis* level of 5 percent of the value of total agricultural production. As a result, none of the nonproduct-specific support counts toward the current AMS in the majority of possible outcomes. However, in the few cases when nonproduct-specific support exceeds the *de minimis* level, it is a

major component of the estimate of total current AMS. The mean contribution of less than \$1 billion in every year after 2006 reflects a very low probability of a very large contribution.

At the mean of the 500 outcomes, the total current AMS declines from about \$12 billion in 2006 to less than \$10 billion by 2014. This estimate is far below the URAA limit of \$19.1 billion, and would seem to suggest that the United States would face little difficulty complying with its URAA commitments, or even with a hypothetical DDA agreement that would require significant reductions in the permitted current AMS.

The means, however, do not tell the whole story. In 6.0 percent of the outcomes for 2006, for example, the product-specific current AMS exceeds the WTO limit, even before considering nonproduct-specific support measures. That share declines to 2.8 percent by 2014, primarily because projected increases in mean commodity prices reduce the likelihood of large marketing loan expenditures.

In addition to the effects of product-specific support, in 9.6 percent of the 2006 outcomes, nonproduct-specific support exceeds the *de minimis* level, and in 12.6 percent, the 2006 total current AMS (including both product-specific and nonproduct-specific support) exceeds the WTO limit. The proportion of cases of product-specific and nonproduct-specific support exceeding respective triggers cannot always be simply added to estimate the proportion of cases where the total current AMS will exceed the WTO limit, because some of the outcomes with high levels of product-specific AMS also have high levels of nonproduct-specific support. The share of outcomes where the total current AMS exceeds the WTO limit declines from 12.6 percent in 2006 to 4.6 percent by 2014, under current U.S. policies and URAA commitments.

The framework also makes it possible to estimate the proportion of outcomes where the total current AMS exceeds the URAA commitment levels at least once over the nine-year period. In 41.8 percent of the 500 outcomes, the URAA commitments are exceeded at least once between 2006 and 2014. If the results for individual years were independent of one another, the probability of at least one violation of the AMS commitments would be 51.8 percent. The difference suggests that AMS estimates are correlated positively across time. For example, suppose a high stochastic yield draw results in low market prices and a large AMS in year t . High yields in year t are also likely to result in large carry-out stocks that increase the likelihood of lower prices and a large AMS in year $t+1$.

These stochastic results tell a very different story than suggested by deterministic analysis (Table 3). Product-specific current AMS is more than \$2 billion per year lower in the deterministic analysis than the mean of the 500 stochastic outcomes. Two crops account for most of the difference. For both corn and soybeans, deterministic baseline prices are high enough that marketing loan benefits are small or non-existent, and what little support is provided by loan interest rate subsidies is less than the crop-specific *de minimis* level. In contrast, many of the stochastic outcomes yield sizable marketing loan benefits and, consequently, sizable current AMS.

Nonproduct-specific support is also significantly smaller in the deterministic analysis than the mean of the stochastic analysis. CCPs account for most of the difference, but crop insurance benefits also contribute. The relationship between deterministic and stochastic estimates of CCPs depends on baseline prices, and there are cases where deterministic estimates of CCPs can be greater than the mean of stochastic

outcomes, specifically, where deterministic baseline CCPs are near their maximum levels, there will be some stochastic outcomes where CCPs are at less than maximum levels. However, on balance, CCPs are smaller in the deterministic baseline than the mean of the stochastic outcomes.

The deterministic estimate of the total current AMS is actually closer to the 10th percentile of the stochastic outcomes than to the mean (Figure 1). In the deterministic analysis, the current AMS for several crops is zero in most or all years, so the total current AMS is only slightly larger than the AMS for dairy and sugar. The same occurs in most of the stochastic outcomes as well. In a substantial minority of the stochastic outcomes, however, marketing loan benefits, CCPs, and/or crop insurance benefits are large, contributing to a skewed distribution of total current AMS.

Sorting the stochastic results for 2006 illustrates the factors that contribute to the cases where WTO triggers are exceeded (Table 4). In the 6.0 percent of outcomes where product-specific support exceeds the AMS limit, the average corn and cotton prices are far lower than in the other 94.0 percent of outcomes, and these low prices can largely be attributed to above-average yields. In one-third of the cases where product-specific support exceeds the AMS limit, nonproduct-specific support also exceeds the *de minimis* level, as above-average CCPs and below-average value of production more than offset the impact of below average crop insurance benefits.

The 9.6 percent of 2006 outcomes where nonproduct-specific support exceeds the *de minimis* level suggests a very different pattern. In particular, crop insurance benefits far exceed their average levels, as corn and cotton yields and corn and cotton prices are all below their mean values. Normally, one would expect prices and yields to be inversely related, and that is indeed the more common relationship in the stochastic outcomes. However, there can be cases where large carry-in stocks and/or weak demand can result in below-average prices in spite of below-average yields. Such cases are relatively rare, but they do occur often enough to play a major factor in determining the share of outcomes that exceed AMS commitments.

To the extent these results are plausible, it illustrates the importance of drawing on both supply and demand side exogenous variables in doing stochastic analysis. If only supply side variables were drawn, downward-sloping demand curves would ensure a negative relationship between price and yields would hold in almost all cases (carry-in stocks could cause a few exceptions). Many of the cases where the nonproduct-specific support level exceeds the *de minimis* level could never have occurred if only supply side variables were considered, as there would be very few outcomes where production and prices would simultaneously be below mean levels.

When aggregating across all the outcomes where AMS commitments are exceeded, corn and cotton yields are near mean levels. The outcomes where high yields result in low prices, large marketing loan benefits, and a large product-specific AMS are offset by the cases where below-average yields and low prices result in high crop insurance expenditures and a large level of non-commodity specific support.

The value of agricultural production is systematically lower in the outcomes where the various WTO triggers are exceeded than in other outcomes. This suggests that in estimating the critical level of nonproduct-specific support it is not adequate to take 5 percent of the deterministic value of production or even 5 percent of the stochastic mean of the value of production.

As this is written, the shape of any eventual DDA agreement remains unclear. For purposes of illustration, consider a hypothetical agreement that would reduce the AMS limit in 10 percent increments until the 2011 limit equals 50 percent of the limit in 2006 but keep all other accounting rules the same as assumed in generating the other estimates (Table 5). Under current U.S. farm policies, the proportion of outcomes exceeding the hypothetical AMS limit would increase quickly, reaching almost 38 percent in 2011 before declining slightly in later years. The relationship between these estimates and U.S. policy changes remains uncertain, but the probability of policy change seems much higher at the lower AMS limit.

Results from assuming alternative levels of hypothetical reductions in AMS limits demonstrate the nonlinearity of the estimates. For example, 23 percent of outcomes exceed a 2011 AMS limit set 40 percent lower than the current limit, but 100 percent exceed a 2011 limit that is set 70 percent lower than the current limit. This occurs primarily because the AMS for dairy and sugar are largely predetermined under current policy. Dairy and sugar account for more than \$6 billion in AMS at the mean, and only production variability can change the estimate unless policies are altered.

If CCPs are included in measures of nonproduct-specific support, the likelihood of exceeding the *de minimis* trigger increases dramatically when the trigger is reduced below the current 5 percent. If, on the other hand, CCPs are excluded from the nonproduct-specific category, the share of outcomes where crop insurance and the other minor components of nonproduct-specific support exceed the *de minimis* level is low unless the trigger is lowered below 3 percent of the value of production.

Under one interpretation of the 2004 WTO framework agreement (WTO 2004), CCPs would be shifted out of the amber box to a redefined blue box that would be limited to 5 percent of the value of production. Given current program provisions, it is mathematically impossible for CCPs to exceed \$8 billion, and in none of the stochastic results does the value of agricultural production fall below \$160 billion. Only if the proposed blue box limit were reduced to less than 4 percent of the value of production does the stochastic model estimate any probability of exceeding the limit under current U.S. policies. Note that these estimates are contingent on the value of production being based on current market outcomes; if the value of production is based on some historical level, the results could be significantly different (in general, the value of production has increased over time, so using an historical value of production would tend to increase the proportion of outcomes exceeding hypothetical limits, all else equal).

Finally, the framework agreement and recent negotiations suggest the possibility of limits on AMS for particular products. How any such limits would be set is uncertain at this writing, but suppose the limits were set at some percentage of 1999-2001 average levels of reported current AMS for each commodity. Stochastic model results suggest that almost any plausible limit would have a significant chance of being exceeded under current U.S. policies (Table 6). For example, even if a commodity-specific limit were set at 150 percent of the 1999-2001 current AMS level, in 20.4 percent of outcomes the limit would be exceeded for corn in 2006 and in 13.0 percent in 2014. At lower commodity-specific limits, the proportion of outcomes exceeding the limit increases, but perhaps less than might have been anticipated. This occurs because in any given year, the most likely outcome is that prices will be high enough that marketing loan benefits and thus the product-specific AMS will be near zero.

The consequences of the hypothetical product-specific limits are very different for different commodities. For example, the hypothetical limits are especially large for soybeans, in part because special oilseed payments made in the 1999-2001 period were classified as product-specific support, while market loss assistance payments made to grain and cotton producers were classified as nonproduct-specific. With a higher base, the proportion of outcomes where the soybean AMS would exceed the hypothetical limit is much smaller than the corresponding proportions for corn.

Given the nature of the AMS calculations for dairy, in almost all outcomes even a modest reduction in a product-specific limit would be exceeded without a change in policy. With rising milk production over time, even setting the limit at 100 percent of the 1999-2001 current AMS would be almost certain to require a policy change.

Concluding Remarks

For many policy questions, traditional point estimates often miss the point. Many government policies have asymmetric features, so a deterministic point estimate may differ systematically from the mean of possible outcomes. Furthermore, there are many times where there is interest in the tails of distributions, such as policies that provide support only when abnormal events occur. Both of these concerns are important in examining the potential impacts of any agreement to establish new WTO disciplines on internal support measures.

The stochastic results detailed here illustrate the value of a model that can generate a range of possible outcomes rather than a single set of point estimates. Deterministic analysis suggests that projected U.S. support to producers as measured by the current AMS is well below the levels permitted under the URAA. Stochastic analysis reveals that the mean of possible AMS outcomes exceeds the deterministic level by several billion dollars per year, and that in 41.8 percent of the outcomes, the URAA limits would be exceeded at least once over the period between 2006 and 2014 if current rules and policies remained in place. While deterministic analysis would suggest that even a large reduction in AMS limits need have no effect on U.S. farm policy, stochastic analysis suggests that even a modest reduction in AMS limits could significantly increase the probability that limits will be exceeded in any given year. Commodity-specific limits are particularly likely to prove an issue for current U.S. farm policy.

The estimates reported here should be treated with caution. Stochastic analysis remains as much an art as a science, and future model developments will yield different results. Furthermore, stochastic analysis does not eliminate the problem of baseline dependence of scenario results. If deterministic baseline prices were higher (lower) than reported here, the proportion of outcomes that exceed various WTO limits would be lower (higher) than indicated in the tables. The results should be used to identify potential issues, but should not be considered definitive to the third (or even first) decimal place.

References

- Abler, D, and D. Blandford. "A Review of Empirical Studies on the Production Impacts of PFC and MLA Payments under the U.S. FAIR Act." Presentation at the USDA Economic Research Service workshop, "Modeling U.S. and EU Agricultural Policy: Focus on Decoupled Payments," Washington, D.C. October 4, 2004
- Anderson, K., W. Martin, and D. van der Mensbrugghe. "Doha Agricultural and Other Merchandise Trade Reform: What's at Stake." AAEA organized session paper, Providence, Rhode Island, July 2005.
- Economic Research Service, USDA. 2005. "United States Support and Support Reduction Commitments by Policy Category." Table on ERS WTO briefing room website, <http://www.ers.usda.gov/briefing/farmpolicy/data/totalusa.xls>.
- Fabiosa, J., J. Beghin, S. de Cara, A. Elobeid, C. Fang, M. Isik, H. Matthey, A. Saak, P. Westhoff, D.S. Brown, B. Willott, D. Madison, S. Meyer, and J. Kruse. 2005. "The Doha Round of the World Trade Organization and Agricultural Markets Liberalization: Impacts on Developing Economies." *Review of Agricultural Economics* 27(3):317-335.
- Food and Agricultural Policy Research Institute (FAPRI). 2003. "FAPRI Analysis of Stricter Payment Limitations." FAPRI-UMC Staff Report #05-03. Columbia, Missouri: FAPRI, June.
- . 2005a. "FAPRI 2005 U.S. and World Agricultural Outlook." FAPRI Staff Report 1-05. Ames, Iowa: FAPRI, January.
- . 2005b. "FAPRI 2005 U.S. Briefing Book." FAPRI-UMC Report #02-05. Columbia, Missouri: FAPRI, March.
- . 2005c. "The President's Budget: Implications of Selected Proposals for U.S. Agriculture." FAPRI-UMC Staff Report #03-05. Columbia, Missouri: FAPRI, March.
- . 2005d. "Implications of Increased Ethanol Production for U.S. Agriculture." FAPRI-UMC Staff Report #10-05. Columbia, Missouri: FAPRI, August.
- . 2005e. "FAPRI Stochastic Model Documentation." FAPRI-UMC Staff Report. Columbia, Missouri: FAPRI, forthcoming.
- Just, R. 2001. "Addressing the Changing Nature of Uncertainty in Agriculture." *American Journal of Agricultural Economics* 83(5):1131-1153.
- World Trade Organization (WTO). 1994. "Agreement on Agriculture." http://www.wto.org/english/docs_e/legal_e/14-ag.pdf.
- . 2004. "Text of the 'July Package'—the General Council's post-Cancun Decision." http://www.wto.org/english/tratop_e/dda_e/draft_text_gc_dg_31july04_e.htm.
- WTO Appellate Body. 2005. "United States—Subsidies on Upland Cotton." Report of the Appellate Body. Document #05-0884. <http://docsonline.wto.org>.

Table 1. Deterministic and stochastic baseline crop price projections

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn									
									(dollars per bushel)
Deterministic	2.19	2.22	2.23	2.26	2.28	2.30	2.32	2.32	2.33
Stochastic mean	2.18	2.21	2.22	2.25	2.27	2.29	2.31	2.32	2.32
Stochastic standard deviation	0.33	0.36	0.36	0.36	0.37	0.37	0.38	0.38	0.38
Soybeans									
Deterministic	4.99	5.27	5.41	5.42	5.43	5.44	5.44	5.44	5.43
Stochastic mean	5.01	5.24	5.37	5.41	5.42	5.42	5.41	5.41	5.43
Stochastic standard deviation	0.89	0.92	0.96	0.88	0.89	0.91	0.91	0.85	0.88
Wheat									
Deterministic	3.24	3.31	3.36	3.42	3.47	3.51	3.56	3.60	3.63
Stochastic mean	3.24	3.30	3.35	3.41	3.46	3.50	3.55	3.60	3.63
Stochastic standard deviation	0.38	0.37	0.41	0.42	0.43	0.41	0.42	0.42	0.42
Upland cotton									
									(dollars per pound)
Deterministic	0.45	0.46	0.46	0.48	0.50	0.51	0.52	0.53	0.55
Stochastic mean	0.46	0.46	0.46	0.48	0.50	0.51	0.51	0.53	0.54
Stochastic standard deviation	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07
Rice									
									(dollars per hundredweight)
Deterministic	6.98	7.26	7.42	7.58	7.73	7.89	8.09	8.27	8.41
Stochastic mean	6.98	7.25	7.34	7.46	7.58	7.69	7.84	7.95	8.06
Stochastic standard deviation	1.36	1.42	1.50	1.51	1.46	1.62	1.64	1.72	1.77

Note: Projections were prepared in January-February 2005 based on available market information and an assumed continuation of existing agricultural policies.

Table 2. AMS calculations, mean of 500 stochastic outcomes

	2006	2007	2008	2009	2010	2011	2012	2013	2014
	(million dollars)								
Product-specific calculated AMS	11,228	10,863	10,705	10,200	9,979	9,949	9,925	9,790	9,790
Product-specific current AMS	11,018	10,660	10,483	9,983	9,746	9,724	9,703	9,555	9,581
Barley	42	41	46	43	44	41	40	37	34
Corn	1,340	1,351	1,361	1,190	1,067	993	936	915	951
Cotton (upland)	1,452	1,474	1,409	1,253	1,162	1,167	1,151	1,086	1,014
Dairy	4,740	4,788	4,832	4,870	4,909	4,947	4,986	5,030	5,074
Minor oilseeds	14	12	13	11	9	11	14	12	14
Oats	13	11	12	9	8	8	7	7	7
Peanuts	21	23	24	25	22	25	25	26	23
Rice	341	295	288	271	248	257	239	230	209
Sorghum	104	97	94	83	72	60	50	44	41
Soybeans	1,407	1,037	910	740	739	775	825	739	770
Sugar	1,285	1,311	1,275	1,290	1,285	1,288	1,291	1,298	1,307
Wheat	158	120	117	99	82	53	40	32	37
All other	100	100	100	100	100	100	100	100	100
Nonproduct-specific calc. AMS	7,436	7,275	7,299	7,049	6,992	6,812	6,720	6,561	6,474
Countercyclical payments	4,254	4,019	3,905	3,639	3,481	3,282	3,147	2,942	2,822
Crop insurance	2,764	2,839	2,977	2,993	3,093	3,112	3,155	3,201	3,234
All other	418	418	418	418	418	418	418	418	418
Value of agricultural production (5% de minimis trigger)	210,633 10,532	214,229 10,711	218,115 10,906	222,249 11,112	225,124 11,256	227,876 11,394	231,139 11,557	235,995 11,800	240,833 12,042
Nonproduct-specific support included in current AMS	1,056	958	696	594	487	432	272	282	221
Total current AMS	12,073	11,618	11,179	10,578	10,234	10,156	9,975	9,838	9,802
URAA current AMS limit	19,103	19,103	19,103	19,103	19,103	19,103	19,103	19,103	19,103
Proportion of outcomes where:									
Product-specific current AMS exceeds AMS limit	6.0%	4.0%	4.2%	3.8%	2.2%	1.8%	3.4%	2.8%	2.8%
Nonproduct-specific calculated AMS exceeds de minimis 5%	9.6%	8.4%	6.2%	5.2%	4.0%	3.6%	2.4%	2.4%	1.8%
Total current AMS exceeds AMS limit	12.6%	12.0%	10.0%	8.4%	6.0%	5.4%	5.6%	5.0%	4.6%

Table 3. Deterministic and stochastic AMS calculations

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Product-specific calculated AMS	(million dollars)								
Deterministic	8,626	8,094	7,979	7,796	7,682	7,673	7,645	7,563	7,414
Stochastic mean	11,228	10,863	10,705	10,200	9,979	9,949	9,925	9,790	9,790
Difference	2,602	2,769	2,726	2,403	2,298	2,276	2,279	2,227	2,375
Product-specific current AMS									
Deterministic	7,937	7,950	7,798	7,628	7,522	7,523	7,500	7,354	7,268
Stochastic mean	11,018	10,660	10,483	9,983	9,746	9,724	9,703	9,555	9,581
Difference	3,081	2,710	2,686	2,356	2,225	2,201	2,202	2,201	2,314
(Corn current AMS)									
Deterministic	0	0	0	0	0	0	0	0	0
Stochastic mean	1,340	1,351	1,361	1,190	1,067	993	936	915	951
Difference	1,340	1,351	1,361	1,190	1,067	993	936	915	951
(Soybean current AMS)									
Deterministic	0	0	0	0	0	0	0	0	0
Stochastic mean	1,407	1,037	910	740	739	775	825	739	770
Difference	1,407	1,037	910	740	739	775	825	739	770
(Other product-spec. current AMS)									
Deterministic	7,937	7,950	7,798	7,628	7,522	7,523	7,500	7,354	7,268
Stochastic mean	8,270	8,272	8,211	8,054	7,941	7,956	7,942	7,902	7,860
Difference	334	322	414	426	419	433	442	547	592
Nonproduct-specific calc. AMS									
Deterministic	6,732	5,920	5,605	5,264	5,106	4,872	4,719	4,574	4,406
Stochastic mean	7,436	7,275	7,299	7,049	6,992	6,812	6,720	6,561	6,474
Difference	704	1,355	1,694	1,785	1,885	1,940	2,001	1,987	2,067
(Countercyclical payments)									
Deterministic	4,104	3,222	2,856	2,463	2,267	1,993	1,794	1,613	1,414
Stochastic mean	4,254	4,019	3,905	3,639	3,481	3,282	3,147	2,942	2,822
Difference	151	797	1,049	1,175	1,214	1,289	1,353	1,329	1,408
Nonproduct-specific support included in current AMS									
Deterministic	0	0	0	0	0	0	0	0	0
Stochastic mean	1,056	958	696	594	487	432	272	282	221
Difference	1,056	958	696	594	487	432	272	282	221
Total current AMS									
Deterministic	7,937	7,950	7,798	7,628	7,522	7,523	7,500	7,354	7,268
Stochastic mean	12,073	11,618	11,179	10,578	10,234	10,156	9,975	9,838	9,802
Difference	4,137	3,668	3,382	2,950	2,712	2,633	2,474	2,483	2,534

Table 4. Sorted stochastic results for 2006

	Mean of 500 outcomes	Product-spec. current AMS > AMS limit		Non-product-specific support > de minimis		Total current AMS > AMS limit	
		No	Yes	No	Yes	No	Yes
				(million dollars)			
Product-specific current AMS	11,018	10,338	21,589	10,670	14,238	10,140	17,069
Calculated nonproduct-specific	7,436	7,343	8,879	7,057	10,997	7,053	10,085
Total current AMS	12,073	11,234	25,121	10,670	25,235	10,261	24,608
Counter-cyclical payments	4,254	4,073	7,103	4,041	6,262	3,909	6,656
Crop insurance contribution	2,764	2,852	1,358	2,598	4,318	2,727	3,011
Value of agricultural production	210,633	211,267	200,684	211,514	202,322	211,929	201,629
				(bushels per acre)			
Corn yield	148.0	147.3	159.1	148.7	142.0	147.8	149.4
				(pounds per acre)			
Upland cotton yield	714	711	754	716	697	713	722
				(dollars per bushel)			
Corn price	2.18	2.22	1.65	2.21	1.90	2.24	1.80
				(dollars per pound)			
Upland cotton price	0.456	0.461	0.378	0.461	0.406	0.464	0.395
Proportion where product-specific support exceeds AMS limit	6.0%	0.0%	100.0%	4.4%	20.8%	0.0%	47.6%
Proportion where nonproduct-specific support exceeds de minimis	9.6%	8.1%	33.3%	0.0%	100.0%	1.1%	68.3%
Proportion where total current AMS exceeds AMS limit	12.6%	7.0%	100.0%	4.4%	89.6%	0.0%	100.0%

Table 5. Proportion of outcomes exceeding alternative AMS limits

	2006	2007	2008	2009	2010	2011	2012	2013	2014
	(million dollars)								
URAA Current AMS limit	19,103	19,103	19,103	19,103	19,103	19,103	19,103	19,103	19,103
Proportion where:									
Product-specific > AMS limit	6.0%	4.0%	4.2%	3.8%	2.2%	1.8%	3.4%	2.8%	2.8%
Nonproduct-specific > de minimis	9.6%	8.4%	6.2%	5.2%	4.0%	3.6%	2.4%	2.4%	1.8%
Total current AMS > AMS limit	12.6%	12.0%	10.0%	8.4%	6.0%	5.4%	5.6%	5.0%	4.6%
	(million dollars)								
Hypothetical AMS limit: 50% lower by 2011, keeping other rules	19,103	17,193	15,283	13,372	11,462	9,552	9,552	9,552	9,552
Proportion where:									
Product-specific > AMS limit	6.0%	8.2%	14.6%	17.0%	23.0%	37.6%	33.8%	31.2%	31.6%
Nonproduct-specific > de minimis	9.6%	8.4%	6.2%	5.2%	4.0%	3.6%	2.4%	2.4%	1.8%
Total current AMS > AMS limit	12.6%	15.4%	18.4%	20.0%	24.0%	37.8%	33.8%	31.8%	31.6%
Proportion where product-specific current AMS > AMS limit if:									
Limit unchanged (\$19.103 bil.)	6.0%	4.0%	4.2%	3.8%	2.2%	1.8%	3.4%	2.8%	2.8%
Limit reduced 10% (\$17.193 bil.)	10.6%	8.2%	7.8%	6.2%	5.8%	4.2%	5.2%	5.4%	5.2%
Limit reduced 20% (\$15.283 bil.)	18.2%	13.4%	14.6%	8.8%	9.2%	8.0%	7.6%	8.8%	8.0%
Limit reduced 30% (\$13.372 bil.)	24.8%	22.6%	21.4%	17.0%	14.8%	14.2%	13.4%	13.0%	13.4%
Limit reduced 40% (\$11.462 bil.)	33.2%	35.2%	29.4%	26.6%	23.0%	23.0%	22.4%	21.0%	20.0%
Limit reduced 50% (\$9.552 bil.)	49.0%	45.8%	43.8%	39.4%	36.2%	37.6%	33.8%	31.2%	31.6%
Limit reduced 60% (\$7.641 bil.)	77.6%	74.2%	72.2%	67.2%	63.0%	67.0%	66.4%	60.8%	61.8%
Limit reduced 70% (\$5.731 bil.)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Proportion where nonproduct- specific support > de minimis if:									
CCPs included; de minimis=5%	9.6%	8.4%	6.2%	5.2%	4.0%	3.6%	2.4%	2.4%	1.8%
CCPs included; de minimis=4%	33.2%	30.6%	27.6%	23.4%	20.8%	18.6%	13.8%	12.2%	11.4%
CCPs included; de minimis=3%	70.8%	64.0%	63.4%	58.0%	54.4%	48.6%	49.4%	43.0%	38.4%
CCPs included; de minimis=2%	92.6%	89.4%	90.4%	83.6%	85.8%	81.0%	81.6%	77.2%	72.4%
CCPs excluded; de minimis=5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CCPs excluded; de minimis=4%	0.2%	0.4%	0.0%	0.2%	0.4%	0.2%	0.0%	0.2%	0.0%
CCPs excluded; de minimis=3%	9.0%	8.0%	8.6%	8.0%	8.4%	9.4%	8.2%	8.6%	6.6%
CCPs excluded; de minimis=2%	28.0%	29.0%	29.2%	28.8%	30.2%	28.4%	30.0%	29.0%	28.0%
Proportion where CCPs exceed hypothetical blue box limit if limit is:									
5% of value of production	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4% of value of production	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3% of value of production	25.4%	20.8%	18.2%	13.6%	11.2%	8.4%	6.0%	4.0%	3.8%
2% of value of production	50.6%	45.6%	42.0%	37.2%	35.6%	32.6%	28.0%	23.8%	22.6%

Table 6. Proportion of outcomes exceeding hypothetical product-specific AMS limits

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Corn									
150% of 1999-2001 avg. (\$3,291 mil.)	20.4%	18.4%	18.4%	16.0%	14.0%	13.2%	12.2%	13.4%	13.0%
100% of 1999-2001 avg. (\$2,194 mil.)	28.2%	28.6%	27.4%	24.0%	21.2%	20.6%	19.0%	17.0%	18.6%
75% of 1999-2001 avg. (\$1,646 mil.)	31.4%	34.0%	31.6%	27.8%	26.6%	25.2%	22.8%	20.4%	22.2%
50% of 1999-2001 avg. (\$1,097 mil.)	36.4%	39.0%	36.4%	32.4%	31.2%	29.2%	26.6%	23.0%	24.4%
25% of 1999-2001 avg. (\$549 mil.)	42.8%	43.0%	42.8%	37.2%	37.6%	32.0%	30.6%	29.4%	28.8%
Soybeans									
150% of 1999-2001 avg. (\$5,037 mil.)	4.0%	1.8%	2.2%	1.0%	0.6%	1.2%	1.4%	0.8%	2.4%
100% of 1999-2001 avg. (\$3,358 mil.)	15.4%	11.4%	8.4%	7.0%	6.6%	5.2%	7.4%	5.8%	6.2%
75% of 1999-2001 avg. (\$2,519 mil.)	22.6%	19.0%	14.6%	12.2%	11.8%	11.4%	15.0%	13.2%	12.2%
50% of 1999-2001 avg. (\$1,679 mil.)	38.0%	26.8%	25.0%	19.0%	20.6%	21.6%	23.0%	20.2%	20.6%
25% of 1999-2001 avg. (\$840 mil.)	50.8%	38.0%	33.4%	29.6%	28.8%	32.0%	31.4%	29.8%	31.2%
Wheat									
150% of 1999-2001 avg. (\$911 mil.)	7.0%	6.0%	5.6%	3.8%	3.8%	1.2%	0.8%	1.0%	1.8%
100% of 1999-2001 avg. (\$607 mil.)	12.2%	9.2%	9.0%	7.0%	6.4%	3.6%	3.4%	2.2%	2.4%
75% of 1999-2001 avg. (\$455 mil.)	15.2%	11.6%	11.8%	9.6%	8.2%	5.2%	5.0%	3.4%	3.8%
50% of 1999-2001 avg. (\$304 mil.)	18.6%	14.4%	13.8%	12.8%	9.4%	7.8%	6.0%	4.4%	4.4%
25% of 1999-2001 avg. (\$152 mil.)	24.2%	19.6%	18.6%	16.0%	13.6%	11.2%	8.6%	6.8%	6.8%
Cotton									
150% of 1999-2001 avg. (\$3,107 mil.)	1.0%	0.6%	0.8%	0.4%	0.4%	0.4%	0.4%	0.6%	0.6%
100% of 1999-2001 avg. (\$2,071 mil.)	18.8%	20.4%	20.0%	14.6%	12.4%	12.4%	11.6%	9.8%	10.2%
75% of 1999-2001 avg. (\$1,553 mil.)	41.4%	45.0%	41.8%	34.2%	28.4%	29.2%	26.6%	24.4%	22.2%
50% of 1999-2001 avg. (\$1,036 mil.)	68.0%	68.8%	65.4%	54.8%	49.6%	49.0%	48.8%	44.0%	39.2%
25% of 1999-2001 avg. (\$518 mil.)	94.2%	91.8%	88.0%	81.4%	73.8%	74.8%	77.2%	72.2%	63.4%
Rice									
150% of 1999-2001 avg. (\$911 mil.)	6.2%	5.0%	5.4%	4.6%	3.2%	5.2%	4.4%	4.2%	2.6%
100% of 1999-2001 avg. (\$607 mil.)	27.4%	23.4%	23.6%	21.8%	21.0%	20.6%	20.0%	19.2%	18.4%
75% of 1999-2001 avg. (\$455 mil.)	34.6%	30.0%	29.4%	27.6%	26.4%	26.6%	25.0%	23.4%	24.0%
50% of 1999-2001 avg. (\$304 mil.)	43.6%	39.4%	36.6%	33.6%	31.0%	32.2%	29.4%	29.4%	26.6%
25% of 1999-2001 avg. (\$152 mil.)	57.4%	51.0%	51.2%	49.0%	44.6%	45.0%	41.8%	39.6%	35.2%
Dairy									
150% of 1999-2001 avg. (\$7,107 mil.)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
100% of 1999-2001 avg. (\$4,738 mil.)	54.4%	69.8%	82.6%	90.2%	95.4%	97.8%	99.4%	99.6%	100.0%
75% of 1999-2001 avg. (\$3,554 mil.)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
50% of 1999-2001 avg. (\$2,369 mil.)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
25% of 1999-2001 avg. (\$1,185 mil.)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Figures assume the commodity-specific de minimis rule is eliminated. With the existing de minimis rule, the current AMS would be zero whenever the calculated AMS is less than 5% of the value of production.

Figure 1. Deterministic and stochastic estimates of total current AMS

