# Are "Decoupled" Farm Program Payments Really Decoupled? An Empirical Evaluation*

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**Abstract**

This analysis utilizes farm-level data to evaluate the extent to which U.S. farm program benefits, particularly the Agricultural Market Transition Act (AMTA) and market loss assistance payments, bring about distortions in production. The issue is important in light of the upcoming WTO negotiations and debate over the distortionary effects of such decoupled ("green-box") payments. We consider a variety of empirical models intended to evaluate various aspects of the distortion question. Our results generally suggest that the distortions brought about by AMTA payments, though statistically significant, are quite modest. However, market loss assistance payments do bring about larger statistically significant effects and may have resulted in more production of corn. Models of land idling suggest that AMTA payments may decrease idling, though the effects are again relatively modest. Probit models of the land acquisition decision suggest that AMTA payments do not influence the likelihood that agents will acquire more land. Our results are reinforced using an aggregate county level acreage model.

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## 1 Introduction

U.S. agricultural policy underwent significant changes with the 1996 Federal Agriculture Improvement and Reform (FAIR) Act. In principle at least, the FAIR Act was meant to signal a transition toward a new policy environment characterized by diminished government involvement in agricultural markets. Market price supports and deficiency payment programs were replaced by a program with fixed payments (called “production flexibility contract” or “Agricultural Market Transition Act” (AMTA) payments) and a loan deficiency payment program intended to establish minimum support prices for program crops, including soybeans. AMTA payments were based upon historical program benefits which, in turn, were determined by a farmer’s historical production (base yields and acreages) of program crops (i.e., corn, wheat, cotton, grain sorghum, etc.). In principle, AMTA payments were intended to decline each year until the FAIR Act expired in 2002.

The FAIR Act was also known as the “Freedom to Farm” Act, a name that reflected the fact that program benefits, at least those delivered in the form of AMTA payments, are not tied to the production of specific crops or even to active production at all. AMTA payments are instead based upon historical production (i.e., base acreage in program crops) over the period preceding the FAIR legislation. In this vein, AMTA payments are considered to be “decoupled” from production decisions and thus are not expected to distort production and marketing decisions.

Of course, the extent to which the FAIR Act actually constituted a change in U.S. farm policy is a topic of substantial debate, especially in light of the 2002 Farm Bill which was signed into law on May 13, 2002. The 2002 Bill provided generous increases in support and extended the fixed, decoupled AMTA-type payments for another six years. Not only were the payments extended under the 2002 Act, producers were also given the opportunity to update their base acreages and yields which determine the payments and, perhaps more important, to include historical soybean acreage in their base. This substantially increased payments for many growers, especially in the Corn Belt. Provisions for updating this historical base, especially if such provisions are anticipated by growers, may bring into question the extent to which the payments are actually decoupled. Anticipation of future opportunities for updating base acreage may influence current production decisions, thus breaking the "decoupled" nature of the programs.

Although it has long been recognized that domestic farm programs that distort production or price have the potential to affect international markets and thus foreign competitors, the distortionary effects of domestic farm programs became an important issue in the Uruguay Round of the General Agreement on Tariffs and Trade / World Trade Organization (GATT/WTO) negotiations in the 1980s and 1990s. Along with the conventional focus on export subsidies and market access, domestic farm programs were targeted for reductions in support and other reforms. A philosophy underlying the Uruguay Round Agreement on Agriculture (URAA) involved a classification scheme whereby domestic policies were characterized by the extent to which they were considered to be "trade-distorting." Policies that were considered to be minimally trade distorting, such as conservation programs, domestic food aid, and research and extension expenditures were termed to be "Green Box" policies and not subject to limits on overall expenditures. An important fact is that, because they are presumed to be decoupled from production, AMTA payments are considered to be a "green-box" policy and thus are not subject to the negotiated reductions in support. Those policies that were judged to have more serious implications for market distortions were grouped into an "Amber Box." The URAA included mandated reductions in Amber Box policies of 20% relative to a 1986-88 base period for developed countries.[1] Finally, "Blue Box" policies included those Amber Box policies that involved supply management provisions and were based on fixed areas and yields.

[1] It is interesting to note that the base period was characterized by low prices and corresponding high levels of support, thus making it easier for WTO parties to meet their obligations without major changes in support. The very low prices experienced recently have raised concerns regarding the extent to which recent support may have brought the U.S. close to its negotiated maximum.

A point of contention underlying this classification system involves the lack of a precise definition of "minimally trade-distorting." Clearly, absent such a definition, policies that may actually have effects on production and thus international markets may not be subject the the disciplines of the WTO. For example, ad-hoc disaster relief payments, a factor characterizing U.S. agricultural policy both before and after the 1996 FAIR Act, are considered to be green box policies. However, intuition clearly suggests that agents will alter their production behavior with the knowledge that widespread crop losses will trigger disaster payments. The argument is often made that, because disaster payments arrive after harvest and thus after production decisions are made, they cannot have an impact on production decisions and thus will not have distortionary effects. Such an argument has some merit—but only if producers are surprised by the payments.

A complicating factor in this view is that agents are forward-looking and are certainly cognizant of the potential for such payments to be forthcoming should market conditions dictate. For example, no one can argue that ad hoc disaster payments, which have been a feature of U.S. agricultural policy for the last twenty years (or longer) are truly decoupled, even though they are received ex-post to planting decisions. Producer behavior throughout the 1980s and 1990s demonstrated that these policies were quickly incorporated into producers' expectations, such that the likelihood that disaster payments would be received during periods of low yields most certainly affected producers' planting decisions. One piece of anecdotal evidence can be found in the crop insurance demand literature. It is widely accepted by researchers and policymakers alike that ad hoc disaster payments have served as a disincentive for producers to purchase crop insurance, in spite of the fact that these payments are of an ad hoc nature and thus are not guaranteed by policy.[2] A similar argument can be made for the emergency market loss payments experienced between 1998 and 2001. After large payments were made in 1999, is there any doubt that producers conditioned 2000 production decisions on the expectation that such payments might again have been realized

[2]See, for example, the results of Goodwin and Kastens (1993), who found that expectations regarding the provision of ad hoc disaster relief diminished incentives for agents to purchase crop insurance.

if market prices were low? [3]

In the case of decoupled income support payments, such as those provided under the AMTA provisions of the FAIR Act, it is less clear that agents will alter their production decisions as a result of the payments. In the case of risk-neutral producers with perfect capital markets, decoupled payments should not have an effect on production. However, recent research by Hennessy (1998) pointed out that agents with declining absolute risk aversion (DARA) preferences will be willing to assume more risk as wealth increases (i.e., because of decoupled farm payments), since such an increase lowers their aversion to risk. Their willingness to accept more risk may result in expanded production or may otherwise alter their production techniques. These "second-order" effects might be expected to be small, though their existence and magnitude is essentially an issue to be sorted out through an examination of the empirical evidence.[4] Of course, although production patterns and program payments may be relatively straightforward to measure, modeling producers' risk preferences is notoriously difficult. Conclusions regarding payment-induced distortions through the effects of decoupled payments on risk preferences are dependent upon a particular form of risk aversion which may not adequately describe producers' responses to risk.

Provisions of the 2002 Farm Bill also lead one to question how decoupled the fixed AMTA payments actually were. As noted above, producers were given the option to update their base and program yields—parameters that determine the actual AMTA payments received. The choice is optional—producers can keep their current base and program yield if it is optimal for them—but are also able to update these parameters to reflect production patterns in recent years. It is impossible to empirically gauge the extent to which producers might have anticipated this opportunity. It certainly is possible, however, that expectations regarding

[3]Apparently U.S. policymakers believe there is. In touting the safety-net and counter-cyclical payment provisions of the $170 billion House version of the 2002 Farm Bill (H.R. 2646), Agriculture Committee Chairman Combest stated that there "...is nothing in the House farm bill that artificially drives production, and nothing that takes away from our trading capabilities" (October 12, 2001 House Agricultural Committee News Release).

[4]Indeed, Hennessey's simulation results suggested the wealth effects were likely to be modest. Skeptics argue that existing research has been unable to reach strong consensus opinions regarding the nature of farmers' risk preferences. Anecdotal evidence would lead one to believe that farmers are not strongly averse to moderate increases in the risk that they face, given the array of risk management tools and techniques available to them. Consider, for example, the widespread failure of actuarially-fair crop insurance.

the opportunity to update program parameters on the basis of production during the latter years of the FAIR Act may have had an important effect on acreage and production decisions. In this light, AMTA payments may have been tied to production decisions in spite of their decoupled nature.

It has been noted that behavior that is often interpreted to be a response to risk by risk-averse agents may actually reflect liquidity and borrowing constraints. Stylized models of expected utility maximization by risk-averse agents often neglect to consider the liquidity and borrowing constraints that may be faced by agents with imperfect or incomplete capital markets. Thus, in addition to the effects of policy-induced changes in wealth on DARA agents and the anticipation of future policy changes, it is conceivable that changes in current or guaranteed future wealth (as in the case of AMTA payments) would have important impacts on capital constrained agents. In light of the difficulties associated with identifying parameters of agents' risk preferences, this is essentially an empirical question.[5]

This raises a semantical issue—how does one define "decoupled" payments? In our view, a *fully decoupled payment* is one for which the level of payment is fixed and guaranteed and thus is not influenced by ex-post realizations of market conditions (e.g. low prices or area yields). In Hennessy's (1998) analysis, decoupled payments include those that may be triggered by ex-post market or production conditions, although the actual payment level is not conditioned on an individual's specific level of production. Thus, policies such as the emergency market loss payments and other disaster relief measures are considered to be decoupled.[6] Distinctions are often made between the "wealth" and "risk" or "insurance" effects of policies. These are essentially distinctions made on the basis of which moment of the price or revenue distribution is affected—the first (wealth effects) or the second (risk effects). Most payments affect both and payments clearly may have different effects in this regard. We would also argue, however, that the distinction becomes less clear when one is interested in

[5]Indeed, it may be a question that cannot be directly answered using the available data. Behavior reflecting risk preferences may be observationally equivalent to that representing responses to imperfect capital markets. Rarely is one able to make direct inferences about agents' risk preferences.

[6]Hennessy makes a distinction between wealth and risk effects of payments. We argue here that a truly decoupled payment really only involves wealth effects. Cahill (1997) presents definitions of varying rates of decoupling and considers the extent to which E.U. policies are decoupled.

empirically assessing how payments affect production. As we note below, an empirical model generally relates observed policy outcomes and program parameters to observed behavior. Though it may be straightforward to relate payment receipts to production responses, it may be difficult to decompose the production response into risk and wealth components.

In light of the recent deliberations over the 2002 Farm Bill and the upcoming WTO negotiations, the extent to which domestic support programs are trade- and market-distorting is an especially important issue. The issues are controversial and the debate is contentious. De Gorter (2000) argued that some trade-distorting green box policies, such as production flexibility contract (AMTA) payments should be placed in a "flashing amber box" because of their trade distortions. Chau and de Gorter (2000) argue that AMTA payments allow producers to cover fixed costs and thus may result in marginal farmers that would otherwise be forced to shut down being able to remain in production. In a more general way, this is essentially an expression of the incomplete capital markets argument presented above.

The objective of this analysis is to evaluate the effects of decoupled farm program benefit payments on the production decisions of producers. To this end, we utilize a set of detailed farm-level data, collected under the USDA's Agricultural Resource Management Survey (ARMS) program. The focus is on farms in the Corn Belt, the major agricultural production region of the U.S. We consider acreage devoted to the production of the three principal crops in this region—corn, soybeans, and wheat.[7] Individual farm data are used in conjunction with county and crop reporting district aggregates to evaluate the extent to which AMTA payments may appear to have been linked to production decisions in the period that has followed the implementation of the 1996 FAIR Act.

The plan of our paper is as follows. The next section discusses conceptual issues that underlie our empirical models. The third section discusses an empirical framework and econometric procedures for evaluating the effects of decoupled farm programs using individual farm survey data. The fourth section presents an empirical analysis of the effects of decoupled farm payments on production decisions using farm-level data. This analysis

[7] We note at the outset that corn and soybeans are the main crops and that wheat is primarily grown for crop rotation reasons in this region.

is conducted in two segments. In the first, individual farm-level data are used to evaluate the acreage distortions caused by decoupled farm payments. We also consider the effects of market loss assistance payments, seemingly ad hoc payments made to producers in compensation for low market prices in 1998-2001. In a second segment of the analysis, we consider an aggregate analysis of data at the crop reporting district level. As we discuss in some detail below, this is an attempt to address the limitation of not having repeated observations on individual farms. The final section of our paper offers a brief summary and contains some concluding remarks.

# 2 Conceptual Issues

The appropriate conceptual framework for evaluating the effects of farm policies on producers' actions must consider a number of factors. Central to the issue of how producers will react to policy options is the fact that agricultural production involves a degree of risk. Yields are uncertain, as are prices, and the two random factors are highly correlated. Likewise, farms generally have multiple outputs and inputs and face nonindependent risks from each source. Although this observation really involves stating the obvious, theoretical models typically abstract from the richer dimensions that characterize risk and thus may oversimplify in an effort to provide tractable descriptions of policy responses. In light of the central role of risk and uncertainty, producers' risk preferences play a key role in evaluations of policy effects. Indeed, risk management and the provision of "safety nets" has been a major factor in recent farm policy debates.

A large literature has evaluated the implications of risk averse behavior for agricultural production and supply analysis. Considerable evidence supports the view that agents are risk averse (see, for example, Hansen and Singleton (1983), Wolf and Pohlman (1983), and Chavas and Pope (1985)). As we noted above, however, the actual effects of a policy change, such as the provision of AMTA payments under the 1996 FAIR Act, must be considered within the overall risk management and wealth situation of individual producers. For example, the empirical literature has generally concluded that agents do not have a strong demand for for actuarially-fair crop insurance.[8] However, theory predicts that risk-averse agents will fully insure if rates are actuarially fair. Pope and Just (1991) evaluated a class of risk preferences where risk aversion may be affected by wealth. Their empirical results confirmed that wealth was an important factor influencing acreage decisions of Idaho potato producers.

Hennessy's (1998) conceptual model and simulation results demonstrated that agents with declining absolute risk aversion (DARA) preferences may respond to decoupled payments in a manner that distorts markets. Again, decoupled payments that have important wealth effects may distort production by making producers less averse to risk. His simulation results indicated that this wealth effect is likely to be quite small when compared to the risk/insurance effects of programs that are tied to market variables, such as prices and yields. A key question underlying arguments regarding the risk preference effects of decoupled payments involves the extent to which payments actually shift the wealth of farmers. What may appear to be "large" payments may not be so substantial when compared against a farmer's overall wealth, which tends to be quite large for the average U.S. farmer.

Our interest in this analysis lies in an empirical evaluation of farm-level data and thus we make no pretense as to the development of a detailed theoretical model capable of incorporating all aspects of policy and production choice under risk. However, it is useful to consider the fundamental framework in which agents make production decisions. Agents are forward looking, and thus maximize a long-run stream of the expected utility of wealth. To the extent that production decisions from season to season are unrelated, this is equivalent to assuming that agents maximize the expected utility of wealth in each period. However, such an assumption is indeed strong and the fact that agents may choose to remain in production even when current expected revenues do not cover fixed costs—if future expected profits are sufficiently high—may imply that the problem involves expectations over multiple periods. Indeed, the importance of crop rotation and fallow requirements for many crops as well as

[8] See Goodwin and Smith (1996) for a summary of this literature. Just, Calvin, and Quiggin (1999) found that the wealth (direct income) effects of crop insurance programs were much more important to explaining insurance demand than the risk-reducing effects.

the adjustment costs associated with changing crops and production levels suggests that the problem of modeling supply must consider the effects of actions over several periods.

Agents will act to maximize the expected utility of wealth, including changes brought about by discounted future expected profits. In each period, wealth is given by initial wealth, plus profits derived from production, direct government payments, and non-farm activities. The agent's problem can thus be characterized as maximizing the expected value of:

$$V_t = \sum_{t=0}^{T} U\{\delta^t(\sum_i P_{it}Q_{it}(A_{it}, X_{it}, A_{it-1}, \epsilon_t) - w'X - C(A_{it-1}) + G_t + PS(P_{it}) + W_{t-1})\}, \quad (1)$$

where $W_t$ is wealth, $P_{it}$ is the price received for output i, $Q(\cdot)$ is output of product i, which is assumed to be a function of lagged acreage ($A_{t-1}$, representing rotational issues), acreage, and an exogenous shock, given by $\epsilon_t$, $X_t$ represents a vector of variable inputs, purchased at price $w_t$, and $C(\cdot)$ represents fixed costs, which also are influenced by lagged acreage. Government policies affect the producer's problem in several ways. First, prices received $P_{it}$ may reflect support mechanisms such as loan deficiency payments. Second, payments based upon market conditions, such as market loss assistance payments (also known as "double-AMTA" payments) may be received at harvest, and thus expectations regarding such payments will play a key role in production decisions. Such payments are represented by $PS(P_{it})$, which represents the fact that such payments may be conditioned on market prices. Finally, direct decoupled payments $G_t$ will be important for their effects on wealth.

A number of restrictions are relevant to the producer's problem, including capacity constraints and those constraints describing the availability and cost of borrowed capital. If capital markets are perfect, wealth can be adjusted to accommodate situations where revenues are not sufficient to cover costs. However, borrowers are likely to face credit constraints, determined by their credit-worthiness. In such cases, decoupled payments may indeed be relevant to production. Agents select acreage and other inputs to maximize the expected value of the utility function. This yields reduced form acreage equations of the form:

$$A_t = f(A_{t-1}, P_t, w_t, G_t, PS_t, W_{t-1}). \quad (2)$$

Output prices and payments based upon market conditions at harvest ($PS_t$) are unknown at the time planting decisions are made and thus actions will reflect agents' expectation of the harvest-time values of these variables. Thus, an estimable, reduced-form acreage response equation will assume the form:

$$A_t = f(A_{t-1}, P_t^*, w_t, G_t, PS_t^*, W_{t-1}), \tag{3}$$

where asterisks correspond to expected harvest-time values, conditional on information available to agents at planting.

In cases where an agent's risk preferences are influenced by their level of wealth (such as Constant Relative Risk Aversion (CRRA) or Decreasing Absolute Risk Aversion (DARA)), their production decisions may be influenced by their level of wealth. In this way, decoupled payments $G_t$ as well as initial levels of wealth will be important. Of course, as we have noted and discuss in greater detail below, for the typical commercial farm in the U.S., the support provided by AMTA and other decoupled programs is likely to be small relative to a farm's overall wealth level.

# 3 Empirical Framework and Econometric Methods

Our analysis is conducted using individual farm data collected under the Agricultural Resource Management Survey (ARMS) project by the National Agricultural Statistics Service of the USDA. We focus on data taken from four years of the NASS survey—1998-2001. These years were chosen as representative of the FAIR Act policy environment. In addition, the survey collected detailed policy information for these four years. County data from a variety of other sources were matched to the ARMS survey data. In particular, county data for crop acreages were taken from the USDA-NASS database and county-level program payments were summarized from unpublished USDA data.

Although the ARMS data provide a rich and valuable set of detailed farm household data, the database does have an important limitation—the lack of repeated sampling on individual farms. That is, the sample is taken randomly each year and it is thus impossible to observe the same farm in more than a single year.[9] This implies an important reliance on cross-sectional variability and prevents one from conditioning observed events on the preceding year's experience or on fixed farm effects. For example, though it is possible to observe an individual grower's corn acreage in a given year, it is not possible to examine how this acreage compares to the preceding year's acreage. The potential for confounding effects to complicate the identification of policy responses certainly exists. For example, those farms receiving large AMTA payments had a large base in program crops prior to the FAIR Act. To the extent that fixities make producers slow to adjust acreage, correlation between AMTA payments and current acreage may reflect correlation of both variables with historical acreage.[10] To address this issue, we consider an alternative evaluation of policy effects at the county level. This essentially involves treating each county as a farm. In this case, we are able to condition current production on lagged production. Our reliance on cross-sectional data also raises important concerns regarding simultaneity biases. Many production decisions are made jointly and thus the inability to measure predetermined (i.e., lagged) values of certain variables may make addressing this concern difficult. We attempt to adjust for this issue by relying on exogenous variables to the extent possible. For example, AMTA payment receipts are certainly exogenous to an individual in any given year. Likewise, we utilize county-level farm average market loss assistance payments for the preceding year to represent expectations regarding market loss assistance support. However, one could potentially question the extent to which some explanatory variables, such as insurance purchases and the ratio of debts to assets, may be endogenous to production decisions. Although we partially address this issue below, it remains an important caveat that merits additional research.

Unpublished data on season-average loan rates were obtained from the Farm Service Agency (FSA) of the USDA. Chicago Board of Trade (CBOT) futures market prices for corn, soybeans, and wheat were taken from the Bridge database. An expected price for each

[9] This limitation will be addressed in future versions of the ARMS surveys in that surveys will revisit a subsample of farms.

[10] It should be noted that we can intuitively assign a direction that such a bias might be expected to take. If both AMTA payments and current acreage is strongly correlated with historical production, we would expect to see a stronger effect of AMTA payments on current acreage than what might be expected in the absence of such correlation. The results that follow should be interpreted with this caveat in mind.

county was taken by calculating a state average basis for each state using season average prices collected from USDA-NASS and then adjusting the planting time price for the harvest time contract for the annual, state average basis charge. This yielded a state average expected harvest-time market price.[11] The greater of the expected cash price or the county loan rate was taken to represent the expected commodity price. Unpublished county level data describing farm program payment receipts in each farm program category were obtained from the USDA. These data were used to measure county-level aggregates of farm program receipts in the form of AMTA payments and market loss assistance (MLA) payments. These were placed on a per-farm and per-acre basis using county level data on the number of farms and number of farm acres in each county, taken from the 1997 *Agricultural Census*.

Our analysis is intended to focus on mainstream, commercial farms. Thus, we eliminated any farm from the ARMS survey that was defined (using the ERS farm typology index) as a limited resource, lifestyle, or retirement farm. In addition, any farm with less than 50 acres of total land was dropped from our sample. In light of the considerable heterogeneity of crop types, production practices, and policy types across different regions, it is important that a relatively homogeneous group of farms be evaluated. Thus, our analysis is focused on the Corn Belt region of the U.S.—which we define using the USDA-ERS farm resource region designation of the "Heartland." This region is comprised of a homogeneous grouping of counties in Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota. Our focus in on acreage of corn, soybeans, and wheat—overwhelmingly the primary crops in this region.

We have emphasized the important role of risk preferences as a factor determining planted acreage of crops and the potential effects of decoupled payments. The measurement of risk preferences in empirical models is difficult, since preferences are not directly observable and available survey data generally do not collect information about such preferences. We represent risk preferences in our empirical models by using a proxy variable, constructed as the ratio of total expenditures on insurance over total farm expenses. We hypothesize that

[11]We utilized the average daily close prices in February for December corn and November soybean futures and the average daily price in September for the July wheat futures on the CBOT.

more risk averse farms will tend to devote more of their total production expenditures to insurance. We are able to directly measure a farm's wealth. Our measure of wealth is given by total assets less total debts. In order to prevent double-counting of AMTA payments, we subtract AMTA payment receipts from total wealth. All financial values are converted to real terms by dividing by the producer price index.

A number of important econometric issues underlie our empirical analysis. An important characteristic of the ARMS data relates to the stratified nature of the sampling used to collect the data. Two estimation approaches have been suggested for problems such as this involving stratification. The simplest involves a jacknife procedure, where the estimation data are split into a fixed number of subsamples and the estimation is repeated with each subsample omitted. Under the jacknife approach, the sample is divided into $m$ subsamples.[12] The model of interest is estimated $m$ times using weighted regression procedures with each of the respective subsamples omitted from the estimation data. A simple expression for the variance is then taken by considering the variability of the estimates across each of the replicated estimates. Although this approach has been clearly shown to be appropriate in simple regression applications, its suitability for more complex estimation problems is unclear (at least to us in our analysis).[13] In addition, it is unclear how our focus on a subsample of the overall ARMS sample would be affected by using the pre-defined jacknife groupings, since one could be left with very different numbers of observations in each of the jacknifed groups.

An alternative approach involves repeated sampling from the estimation data in a bootstrapping scheme. Ideally, rather than random sampling from the entire estimation sample, an appropriate approach to obtaining unbiased and efficient estimation results involves random sampling from individual strata (see, for example, Deaton (1997)). In the ARMS data, however, this is not possible since the strata are not identified. The database does, however, contain a population weighting factor, representing the number of farms in the population

[12]Estimation programs created by ERS use 15 subsamples.

[13]In particular, it is unclear that the stratification scheme would not alter likelihood functions beyond simple weights, though this remains an important topic for future research. Our bootstrapping approach, though analytically simple, is computationally burdensome.

(i.e., all U.S. farms) represented by each individual observation. This can be used in a probability-weighted sampling scheme whereby the likelihood of being selected in any given replication is proportional to the number of observations in the population represented by each individual AMRS observation. We utilize a probability-weighted bootstrapping procedure The specific estimation approach involves selecting $N$ observations (where $N$ is the size of the survey sample) from the sample data. The data are sampled with replacement according to the probability rule described above.[14] The models are estimated using the pseudo sample of data. This process is repeated a large number of times and estimates of the parameters and their variances are given by the mean and variance of the replicated estimates.[15]

An important econometric problem also involves the fact that a censoring issue underlies our empirical acreage models. Not every farm produces every crop in each year. In particular, 90.32% of farms in our sample produced corn, 89.41% produced soybeans, and 37.44% produced wheat. This may reflect specialization issues for individual farmers or crop rotation patterns. To address this censoring issue, we utilize the recently introduced modeling procedures of Shonkwiler and Yen (1999).

Consider a system of censored variables, $y_{it}$, related to a set of explanatory variables through:

$$y_{it} = f(X_{it}, \beta_i). \tag{4}$$

Shonkwiler and Yen propose a two-step estimation procedure, whereby the discrete variable indicating a noncensored observation of $y_{it}$ $(d(y_{it} > 0))$ is evaluated using a probit model of the form:

$$d_{it} = g(z_{it}, \alpha_i). \tag{5}$$

[14] To be precise, if observation $i$ represents $n_i$ farms out of the total of $M$ farms in the population, the likelihood that observation $i$ is drawn on any given draw is $n_i/M$. It should be acknowledged that our approach may result in less efficient estimates than would be the case were sampling from individual strata possible. This could occur in cases where inferences are being made about variables used in designing the stratification scheme in that such information is being ignored by not drawing from individual strata. To the extent that this is relevant to our analysis, the t-ratios reported below represent conservative estimates.

[15] We utilize 2,000 replications in the applications which follow.

These estimates are then used to construct correction terms in the system of the form:

$$y_{it} = \Phi(z_{it}, \hat{\alpha}_i) f(X_{it}, \beta_i) + \delta_i \phi(z_{it}, \hat{\alpha}_i) + \xi_{it}, \tag{6}$$

where $\Phi(\cdot)$ represents the normal cumulative distribution function (cdf) and $\phi(\cdot)$ represents the normal probability density function (pdf). Shonkwiler and Yen (1997) note that the error term $\xi_{it}$ is heteroscedastic. Thus, a heteroscedasticity-consistent method must be used in estimation. In our case, we apply a general correction in the form of White's heteroscedasticity-consistent covariance matrix.[16]

# 4 Empirical Results

Our empirical analysis is conducted in three segments. In the first, a large sample of data drawn from individual farms is used to consider three acreage equations—for corn, soybeans, and wheat. In a second segment of the analysis, we consider an evaluation of several alternative measures of farm land usage. In particular, we consider factors, including farm program payments, affecting the ratio of non-harvested to harvested farm acres. The 1999 ARMS survey contained two additional measures of farm land usage pertinent to our analysis. The first considered the extent to which owned farm land was placed in uses other than crop production and orchards (e.g., pasture, conservation reserve, fallow, etc.). The second involved a query of producers regarding whether they had acquired ownership of new land over the year. Production distortions from decoupled programs may manifest themselves through the acquisition of new productive resources—i.e., land. Thus, we consider the extent to which new land acquisitions were associated with farm program payments by using a probit model to evaluate the probability than an agent acquired land in 1999.

Finally, a third segment of our investigation expands our empirical analysis to a consideration of acreage allocations at the crop reporting district and county levels. In our analysis

[16]It should be noted that a definite form of the heteroscedasticity is implied by the two-step procedure and thus more efficient estimates may be feasible from directly incorporating this form of heteroscedasticity in the estimates. Our reliance on cross-sectional variability in a heterogeneous sample leads us to suspect that other, unknown forms of heteroscedasticity may also be relevant. Thus, we use a more general correction.

of county-level data, the sampling undertaken in the ARMS survey is not dense enough to permit the construction of reliable county aggregates.[17]

Variable definitions and summary statistics for our sample of "Heartland" region farms are presented in Table 1. Our sample consists of 4,121 farm-level observations. The average farm planted 373 acres of corn, 386 acres of soybeans, and 41 acres of wheat. Of course, these averages reflect the substantial proportion of farms that did not grow wheat in a given year, such that the average acreage for farms growing wheat was much higher (115 acres). Aggregate price risk and other factors that are likely to be constant across all farms in a given year are likely to be important factors affecting acreage decisions. We include annual dummy variables to capture such fixed annual effects. These factors represent price risk (assumed to be constant across all farms in the region in a given year) and other unobservable factors that may be relevant to production.[18]

The first segment of our empirical analysis considers acreage response equations for individual farms in the "Heartland" region. Equations for corn, soybeans, and wheat, the dominant crops in the region, were estimated. Parameter estimates and summary statistics are presented in Table 2.[19] Parameters representing price effects are generally of the correct sign, though the price coefficient is negative (though essentially zero) for corn and is quite large for wheat. However, the estimated price coefficient for corn is not statistically significant. The estimates correspond to acreage elasticities of 0 and 0.53 for corn and soybeans, respectively. A large elasticity (3.43) is implied for wheat, though when the elasticity is evaluated using acreage for only those farms growing wheat, a more reasonable estimate of 1.23 is implied.

The role of AMTA payments is central to our analysis of the production effects of direct

[17] In particular, the ARMS survey consists of approximately 10,000 farm observations per year. With 3,142 counties in the U.S., this implies an average of about 3 farms per county. Of course, stratified sampling and the geographic concentration of agriculture affects this count. However, we do not believe sufficient observations exist to permit county-level aggregation of the ARMS data. In addition, the stratification scheme makes it difficult to adequately weight observations to construct county averages, since strata extend over multiple counties.

[18] We also considered models that omitted these fixed effects. Results were similar and the overall implications of the analysis were robust to the inclusion of fixed annual effects.

[19] First stage probit models (not presented here) included lagged county level yields, acreage, operator age, farm machinery assets, and assets associated with irrigation equipment.

farm payments. Recall that our conceptual considerations identified three different avenues through which decoupled payments might operate to influence production. In the first, risk averse agents may find that the additional wealth provided by AMTA payments lowers their aversion to risk and thus encourages greater production of risky commodities. We represent individuals' risk aversion by including the proportion of total expenses accounted for by insurance purchases (which includes all forms of insurance purchased by the farm).[20] We allow the response to AMTA payments to vary according to this effect by including an interaction term. Following Pope and Just (1991), we also include the farm's level of wealth (total assets, less total debts and AMTA payment receipts). We adjust for AMTA payments to prevent double-counting, although for the typical farm such payments represent small changes to overall wealth. We also have hypothesized that agents that are capital constrained may respond to AMTA payments by increasing production (acreage). We represent the likely degree of financial leverage for an individual farm by considering the ratio of total debts to total assets. Again, we include an interaction term with the AMTA payments variable to permit farms to have variable responses to the payments according to their degree of financial leverage. Finally, we have hypothesized that any anticipation of the opportunity afforded producers to update program parameters under the 2002 Farm Bill may have affected acreage decisions. Such an effect is impossible to directly measure, though AMTA payments should convey an important signal regarding the expected benefits of future farm policy for an individual farm. Thus, the overall effect of AMTA payments depends on parameters involving a direct effect plus the interaction effects with insurance and leverage.

The direct effect of AMTA payments on acreage decisions is statistically significant in each of the three equations, though the estimated coefficients are quite small. In the case of corn, the coefficient implies that an additional $1.00 per acre in AMTA payments would increase corn acreage by 1.14 acres. In the case of soybeans, the direct effect of such an increase is 0.81 acres. Finally, for wheat, an additional $1.00 of AMTA payments raises

[20]We acknowledge the potential limitations associated with this measure of risk aversion, including possible distortions brought about by actuarially-unfair crop insurance. This measure is used in lieu of any direct or indirect representation of risk preferences.

wheat acreage by 0.63 acres. In elasticity terms, the corresponding elasticities (not including the interaction terms) are 0.0420 for corn, 0.0291 for soybeans, and 0.2096 for wheat. Note that the larger wheat effect may be somewhat misleading in light of the relatively small number of farms that produce wheat. The corner solutions implied by the large number of farms that grow no wheat is accounted for by the $\delta_i$ correction term, which is significant only in the case of the wheat acreage equation.[21]

Of course, these direct effects only apply to farms with no insurance and no debt. The debt to asset interaction terms are not statistically significant in any of the equations. This may suggest that the capital constraints discussed above and identified in other work (e.g., DeGorter (2000)) do not have an important effect on acreage decisions, at least for this sample of farms. A different result is implied in the case of the insurance-AMTA interaction terms, which are negative in every case and statistically significant for both corn and soybeans. The interaction term narrowly misses statistical significance in the wheat equation. It is important to note that, even if such a crude measure captures the relative degree of risk aversion for producers, it is impossible to determine exactly how this degree of risk aversion changes with AMTA payments. In every case, the results suggest that more risk averse producers are less likely to expand production in response to increases in AMTA payment receipts. When the AMTA acreage elasticities are calculated at the average values of the insurance proportion term, values of 0.0314, 0.0232, and 0.1303 are obtained for corn, soybeans, and wheat, respectively. The overall elasticities, including both the insurance and debts to assets ratio interaction effects, are 0.0391, 0.0278, and 0.1287 for corn, soybeans, and wheat, respectively.

The overall implication for a representative farmer (i.e., at the data means) is that a doubling of AMTA payments would raise corn, soybean, and wheat acreage by 3.9%, 2.8% and 12.9%, respectively. These effects imply very small, though statistically significant, responses to increased AMTA payments. The exact mechanism by which AMTA payments are affecting acreage response—wealth effects, changes in risk preferences, capital constraints,

[21] This is not surprising in light of the prevalence of corner solutions for wheat as compared to corn and soybeans.

or changes related to the anticipation of future benefits—is impossible to identify. It is however clear that allegations regarding the substantial production effects ("flashing amber box" effects) are not supported, at least for these data. This is not to say that there is limited potential for distortions to arise as a result of the provision of decoupled AMTA payments. We have examined only one dimension of production distortions—acreage allocation effects. It is possible that, although acreage is unchanged, agents change their production and marketing techniques in a manner that produces distortions. For example, the risk effects discussed above could assert themselves through changes that involved the adoption of riskier production practices (e.g., decreased application of fertilizer and chemicals) rather than a simple expansion or reallocation of crop acreage.

A second important dimension of farm program support in the post-FAIR environment involves the provision of ad hoc disaster assistance, including market loss assistance payments. In the case of the ARMS survey data, information regarding market loss assistance payments is grouped with overall disaster relief. It is important to note that these payments are generally based upon market conditions at harvest and thus cannot be anticipated with certainty when acreage decisions are made. In this light, we are interested in obtaining a proxy measure of producers' expectations regarding the market loss assistance payments. Again, the fact that we are unable to observe an individual farm over time limits our analysis. Ideally, we would prefer to have information about the payment receipts of producers in the year preceding the period in which planting decisions are made. As an alternative, we utilize the county average of market loss assistance payments per farm acre in the preceding year $MLA_{t-1}$). It is important to note that MLA payments were based upon base acreages, and thus would be expected to be more highly associated with events in traditional program crop markets (i.e., corn and wheat). This is not to say that MLA payments are not expected to affect soybean production, since many payment recipients produced soybeans in their crop mix.

A somewhat stronger effect seems to be implied for expected market loss assistance payments than was the case for AMTA payments, at least for corn. The coefficient on the preceding year's MLA payments is highly significant for corn, though it does not appear that MLA payments had a significant effect on wheat or soybean acreage. In addition, the effect for corn is quite strong, implying that an additional dollar of MLA payments in the preceding year tends to raise corn acreage, other things constant, by 6.22 acres. The corn MLA elasticity is 0.12, suggesting that a doubling of MLA payments would be expected to raise corn production by 12%. In that large acreage responses are not implied for wheat or soybeans, one would assume that such an increase would involve a reallocation of land away from other crops or the introduction of uncultivated land (e.g., pasture or fallow land) into corn production. Of course, these are changes at the margin and thus large shifts in program payments could conceivably have different effects. Implications that MLA payments affected corn but not wheat or soybeans are not really surprising. Recall that market loss assistance payments were paid on those crops that had base acreage under the old farm programs and thus did not pertain to soybeans. The fact that wheat acreage is not strongly affected is also not a surprise. Wheat is not a major crop in the Corn Belt states evaluated in this study and is generally grown for crop rotation purposes.

Provision of the MLA payments may have served as a signal to producers that income shortfalls for such crops that are based upon low market prices may be offset to a degree by ad-hoc MLA payments. However, the conceptual link is somewhat tenuous since the MLA payments, though indirectly based upon market conditions for an individual crop, are not based upon a producer's specific level of production of that crop (or on production of any crop for that matter). In particular, an individual producer may have received market loss assistance payments for a crop regardless of whether that particular crop was grown in the relevant year. The determining factor involved base acreage, which is reflected in AMTA payments. The link with market conditions may also be subject to challenge, since the statutory authority underlying the market loss assistance payments does not tie their provision to prices or conditions in a particular market. However, by definition, the payments are intended to assist producers because of poor market conditions. Thus, in spite of such ambiguity, the link between market conditions and market loss assistance payments seems to exist, though the exact connection is certainly subject to debate.

Using aggregate data, Pope and Just (1991) found that wealth tended to be positively correlated with the acreage of potatoes in Idaho. They interpreted this finding to represent differences in risk preferences that result from constant relative risk aversion preferences. We included total farm wealth in each of the acreage models. In every case, total wealth does not appear to be significantly correlated with acreage of the three crops. It should be acknowledged, however, that we control for the scale of a farm by including total acreage. One would certainly expect that total acreage of a farm operation would be highly correlated with wealth, such that the effects of wealth on acreage may be captured in the effect of total acreage. In every case, as would be expected, total farm acreage is positively correlated with acreage of each crop. This raises a concern as to whether AMTA payments may provide an incentive for producers to acquire additional farm land, thus making total farm size heavily correlated with the decoupled payments. We address this possibility below in a consideration of factors influencing the acquisition of new land in 1999.[22] Certainly, this possibility raises concerns regarding the potential endogeneity of total farm acres to individual crop acreages or other variables in the model. While acknowledging this possibility and the fact that we have assumed total acreage to be fixed for a farm, we would argue that crop acreages are more likely to respond to the total scale of a farm that would be the opposite case.[23]

We have included the proportion of total farm sales accounted for by livestock farms.[24] It is not surprising that farms with livestock production have fewer acres of corn, soybeans, and wheat. As expected, the scale of a farm, represented by total size, is highly correlated with the total number of acres grown for any of the crops. The coefficients correspond to crop mixes that are similar to what is realized for the region. For example, the average allocation of farm acreage to each of the three crops in the region was 32% for corn, 33%

[22]It is important, however, that acreage of individual crops be conditioned on farm scale since larger farms will, by definition, have more acreage in individual crops. Our inclusion of both AMTA payments and farm size allows us to evaluate the extent to which AMTA payments affect acreage, conditional on holding farm size constant.

[23]Consideration of various instruments for evaluating the extent of any such endogeneity concerns remains a topic of current research. The lack of repeated sampling in the ARMS survey is an impediment to the identification of appropriate instruments.

[24]We are grateful to Matt Holt for this suggestion.

for soybeans, and 5% for wheat. An interesting result lies in the response to fertilizer price changes. Regions with higher fertilizer costs tend to grow more soybeans and less corn. This is expected since corn is much more demanding in terms of fertilizer requirements.

In all, our analysis of farm-level data suggests that decoupled AMTA payments had a relatively modest though statistically significant effect on acreage of corn, soybeans, and wheat in the "Heartland" region of the U.S. The acreage responses are, however, very modest, with elasticities for corn and soybeans (the major crops) being about 0.03-0.04. However, it does appear that the provision of market loss assistance payments may have resulted in a more substantial increase in corn acreage. Our results suggest that acreage is not affected by wealth, thus perhaps implying that any risk preference shifts caused by different levels of wealth do not appear to affect crop acreage.

An alternative and more general evaluation of the effects of decoupled payments on production practices involves measures of the extent to which farm land is placed in alternative practices other than crop production. Such alternatives might include conservation reserves, pasture, forest, set-asides, fallow, and other idling practices. Two alternative measures of land idling/waste were constructed. In the first, we considered the ratio of total harvested acres to total farm acres to represent crop land usage. Thus, one minus this ratio yields a measure of the proportion of farm acres idled *(Not Harvested)*.

The 1999 ARMS survey collected detailed data relating to land ownership and land acquisition. Detailed information about the usage of owned land was elicited. For this single year, we constructed an alternative measure (*Not Cropped*) reflecting the idling and waste of owned farm land resources. This measure is slightly different in that it pertains only to owned resources and thus omits production on leased acreage. It thus may provide a less accurate view of overall production/acreage effects of program payments.

For our data, the alternative waste/idling measures ranged from 16.7% for *Not Harvested* to 23.2% for *Not Cropped.* Table 3 contains parameter estimates for each of the alternative measures of land usage. In both cases, the results suggest that higher AMTA payments do tend to be associated with more intensive use of land. This is not unexpected, since farms with more productive land are more likely to have less waste and are also more likely to have a crop base.[25] In elasticity terms, the elasticity of the proportion of total farm acres idled with respect to AMTA payments is -0.33 for the first model and -0.16 for the second model. The AMTA interaction terms are significant in the first model but are not statistically significant in the second model. When the elasticities are evaluated at the mean values of the insurance and relative debt variables, AMTA elasticities are -0.31 and -0.22, respectively. These results suggest that increasing AMTA payments does indeed lead to less land being put in fallow or set-aside, though the extent to which this reflects the fact that farms with more crop land naturally are those that have higher historical base and thus higher AMTA payments is unclear. The preceding results would tend to suggest that this does not occur through substantial increases in corn, soybean, or wheat acreage.

Other factors affecting land usage have the expected signs. The average of the normalized yield across all crops grown on a farm has the expected negative effect, implying that farms with higher relative yields tend to have less land idled.[26] Higher soybean and wheat prices are associated with less land being idled, though a negative effect is indicated for corn prices, though the corn price effect is statistically significant only in the first model. Higher market loss assistance payments (for the county in the previous year) imply less waste or idling of land in the first model, but do not have a statistically significant effect in the second model. The elasticity for market loss payments is again quite large at -0.39, though this effect is statistically significant only in the first model. Thus, expectations regarding the provision of market loss assistance payments appear to have a significant effect in reducing the idling and waste of farm acreage. In general, higher input prices, fertilizer and labor in particular, lead to more idling of land resources. Finally, wealth does not appear to be significantly related to land idling in the overall farm acreage measure, though wealth does reduce idling when only owned acreage is considered.

[25]That is, farms with AMTA payments are those farms that were producing program crops when base acres were assigned. Such farms would certainly be expected to have had a comparative advantage in crop production and thus are less likely to have idled acres.

[26]The normalized yield is calculated by taking the farm's yield and dividing by the NASS county-average yield for the year in question. This removes the effects of county-wide yield shocks and thus places yields in relative terms.

In general, the two alternative models suggest that the provision of direct government payments, even in cases where the payments are not tied to production of a particular crop, may lead to less idling of land and thus may result in more land being in production. The larger sample which includes a consideration of the entire land operated by a farm suggests that the greatest effect is likely to be realized from market loss assistance payments. This is as would be expected, since such payments are seemingly more tied to the market place, since they are triggered (at least in theory) by market events, which motivate legislators to offer support. In the case of our analysis of owned land usage in 1999, the results suggest that AMTA payments may be associated with less idling of land. This may reflect either the wealth or risk effects noted above. However, the result is smaller than what is implied for all land operated by the farm. In all, although AMTA and MLA payments appear to exert a statistically significant effect in reducing idling of farm acreage, the elasticities are quite inelastic, ranging from -0.16 to -0.39 for AMTA and MLA payments.

Finally, the 1999 ARMS survey data allowed us to consider the acquisition of new owned land resources by farms in that year. A relatively small proportion of the farms (4.94%) actually acquired land in 1999. We were interested in evaluating whether the provision of decoupled payments might have been associated with the acquisition of new land—yet another indication of potential production distortions. Of course, for every agent buying land, another is selling and thus it is not clear that such transactions actually lead to more production. Parameter estimates and summary statistics for a probit model of the land acquisition decision are presented in Table 4. An interesting result is that the direct effect of AMTA payments on the decision to purchase land is not statistically significant. The effect does not appear to vary with the ratio of debts to assets though it does vary significantly with insurance purchases. The results suggest that farms that are strong insurers are less likely to be acquiring new land. The overall marginal effect of AMTA payments, which is largely driven by the insurance interaction term, is given by $f(X\beta)\beta_i$, where $f(\cdot)$ represents the normal pdf. The overall marginal effect, incorporating the insurance and leverage ratio interaction effects, is -0.0007, implying that raising AMTA payments $1 per acre would lower the probability of acquiring new land by 0.07%. If we consider the direct effect, for farms with no insurance and no debts, the marginal effect implies that increasing AMTA payments by $1 per acre raises the likelihood of acquiring new land by 0.01%.

Thus, the estimates suggest that the provision of AMTA payments may lead to more land ownership transactions, though the effect is not significant for the average farm in our sample and is very small even for farms that have no insurance or debts. Even if a larger effect were indicated, one could not necessarily conclude that this will involve the introduction of new land into production, since this may merely involve the exchange of ownership of land that was already in production.[27]

Although the preceding empirical analysis provides rich inference by using farm-level data, our analysis is clearly limited by its reliance on cross-sectional variation—individual farms are not observed over time. This limits our ability to condition on historical values of key variables and thus may complicate the identification of causal effects of policy variables. For example, AMTA payments are based upon historical base acreage for program crops. It is likely that farms that planted a large number of acres to corn in the post-FAIR policy environment also had considerable acreage in corn during the pre-FAIR regimes, and thus are also receiving large AMTA payments. Thus, a large acreage of corn may be correlated with large AMTA payment receipts, although it is not necessarily the case that AMTA payments are "causing" producers to plant corn. As we have noted, to the extent that such an effect is present, one would expect the overall effect would be to infer a larger influence of AMTA payments on acreage than actually exists.

Ideally, in cases where adjustment is costly or occurs with a lag, one will condition on the outcomes of prior planting decisions (i.e., in the preceding year or perhaps under the previous policy regime). As we have previously noted, the ARMS data are too sparsely sampled to permit one to derive meaningful county-level aggregates or averages.[28] Thus,

[27] We were concerned that, to the extent that land purchased may be debt financed, the debt to asset ratio may be endogenous to land purchases. To address this concern, we estimated an alternative two-stage probit model in which the debt to asset ratio was allowed to be endogenous. The resulting estimates (not presented here) were very similar.

[28] The stratification scheme used in collecting the ARMS data also complicates aggregation.

our county-level analysis does not include the basic measures of risk aversion (i.e., insurance purchases), financial leverage (the ratio of debts to assets), and wealth. However, we are able to observe other basic factors typically associated with planting decisions, including measures of AMTA payment receipts (per farm acre in the county) and average market loss assistance (MLA) payments (per farm) in each county.

Table 5 presents parameter estimates and summary statistics for county-level acreage equations for corn, soybeans, and wheat. The aggregate results suggest that, except in the case of soybeans, acreage responses are not significantly related to prices in that the own-price acreage responses are not statistically significant. The price effect for soybeans is significantly negative, which is of course contrary to expectations. This may reflect a high degree of correlation between corn and soybean prices.[29]. It is also important to note that the fixed annual effects likely capture much of the price variation that is relevant to acreage decisions. Thus, it is likely to be difficult to precisely identify price effects that are manifest in cross-sectional variation and fixed annual market effects. In the case of corn and wheat, fixed annual effects appear to be highly significant in influencing acreage. Lagged acreage of each respective crop exerts a strong influence on acreage, representing the conventional partial adjustment process that is universally found to be relevant to planted acreage.

Probably of greatest interest is the finding that AMTA payments again appear to have a positive relationship with crop acreages at the county level, though once again the effect is very small. The AMTA effects on acreage are statistically significant for soybeans and wheat. In the case of soybeans, the results imply that an additional dollar per acre of AMTA payments will add 98 acres of soybeans and an additional 71 acres of wheat. Such small marginal effects imply very modest elasticities. In particular, the AMTA acreage elasticity is essentially zero for corn, 0.01 for soybeans, and 0.06 for wheat. These results are largely in agreement with those presented at the disaggregated level. In the case of MLA payments, a significant relationship with acreage is implied only in the case of corn, where an additional dollar per acre of MLA payments appears to raise county acreages by 131

[29]The correlation coefficient has a value of 0.9143.

acres. Again, this corresponds to a very small elasticity estimate of 0.006, which although statistically significant, is very close to zero. Thus, at the county level, the results do not imply large effects from AMTA payments or the market loss assistance payments. It should be acknowledged that our county-level models rely on aggregated data for which much of the variation in explanatory factors has been removed. Indeed, the fixed-effects parameters may account for much of the variation, especially in policy, that affected production in the post-FAIR years.

Results for the other factors hypothesized to be relevant to acreage shifts are very similar to what was obtained for the disaggregated, producer-level data. A large effect is implied for input prices. Again, higher fertilizer prices appear to have large effects on acreage, with shifts being implied from corn and wheat to soybeans. Finally, we wanted to determine the extent to which farm financial risk might have had important acreage effects. Recall that it is difficult to obtain such a measure for individual farms in the ARMS sample since we do not observe the farms over time. However, such a measure can be constructed at the county level. We considered a measure of risk at the county level—the ten-year coefficient of variation on net farm income for the county, calculated from the U.S. Department of Commerce's Regional Economic Information System database. This measure was not statistically significant in any of the equations. Whether this reflects weaknesses in our measure of risk or rather implies that acreage decisions are not especially sensitive to income risk is unclear.

We repeated the county-level acreage response analysis using the level of acreage produced in each county in 1995, immediately before the FAIR Act was implemented. Our goal was to condition on acreage prior to the implementation of the FAIR Act and the beginning of AMTA payments. The results were very similar to those included in Table 5 and thus are not presented here.[30]

[30] These results are available from the authors on request.

# 5 Concluding Comments

The objective of our analysis was to utilize farm-level data to consider the extent to which U.S. farm program benefits, particularly the AMTA and market loss assistance payments, may bring about distortions in production. Previous research has pointed out that wealth effects operating through risk preferences or the effects of payments on capital-constrained borrowers may result in distortions, in spite of the fact that the benefits of these programs are not directly tied to production of a particular crop. The issue is important in light of the recent U.S. Farm Bill, which expanded these decoupled payments, as well as the upcoming WTO negotiations and the debate over the distortionary effects of such decoupled ("green-box") payments on markets. To address this question, we consider a variety of empirical models intended to evaluate various aspects of the distortion question.

Our analysis is admittedly somewhat broad in its focus and as such produces results that are sometimes ambiguous. However, we do believe some important findings emerge from our analysis. First, there is modest evidence that AMTA payments may lead to increased production of corn, soybeans, and wheat. However, the acreage effects are very modest. Acreage elasticities for the major crops, corn and soybeans, are about 0.03 to 0.04. This suggests that even a very large increase in these decoupled payments would not be expected to significantly increase acreage. A somewhat different implication is implied for market loss assistance payments which, at least for corn, appear to have a more significant effect on acreage. In particular, the elasticity of corn acreage with respect to MLA payments was 0.12, suggesting that such payments may indeed lead to more corn production. Thus, evidence suggesting production distortions is much stronger in the case of market loss assistance payments. The fact that these payments primarily affect corn acreage is entirely in line with expectations since the market loss assistance payments are based upon AMTA payments and thus apply only to historical program crops, thus omitting soybeans. However, the link with market conditions is not a direct one since eligibility for these payments does not depend on current production of any particular crop but rather is based upon historical production at the time that base acreage was determined. Suffice it to say that corn growers produce corn with the expectation that poor market conditions for corn will lead legislators to consider emergency market loss assistance payments, which will then be based upon that individual's base acreage. Our analysis does not imply important wealth effects, at least for our sample of Corn Belt farms.

We also considered how decoupled payments may affect the acreage idling decisions of producers. AMTA payments appear to evoke modest though generally significant effects, leading to less idling of land. A larger effect is implied by market loss assistance payments, at least in the case of the models of the entire farm. Increasing market loss assistance payments tends to make producers less likely to idle or waste land.

Finally, we considered probit models of the acquisition of new owned land for 1999. In this case, our results suggest that AMTA payment benefits did not appear to lead to strong incentives for agents to acquire new farm land assets. Likewise, market loss assistance payments do not appear to be correlated with incentives to acquire ownership of new farm land.

Overall, our results would seem to imply that decoupled farm program payments are nearly production-neutral. In particular, although these payments do have a statistically significant effect on acreage of the major crops in the U.S. Corn Belt, the effects are very modest, with elasticities on the order of 0.02-0.03. Thus, very large expansions in AMTA payments would have only modest effects on the acreage of corn and soybeans in the U.S. Corn Belt. This result is not surprising given the fact that such payments, though often large, represent relatively modest changes in the overall wealth of the typical Corn Belt farm. In particular, AMTA payments over these years averaged 1.8% of the typical farm's overall net worth. The conclusions are not as favorable for the neutral position of the ad hoc market loss assistance payments. Our results implied an acreage elasticity of 0.12 for corn in response to market loss assistance payments. These payments likely have a stronger link to market events and thus are more likely to bring about distortionary effects. Of course, producers' expectations regarding such payments, which are received after production decisions are made, are unobservable and thus our results are conditional on our proxy measurement of such expectations.

A number of research questions remain unanswered by our analysis. Our cross-sectional analysis is limited by our inability to observe an individual farm over time. As we discuss above, this limits our ability to condition our analysis on certain factors and thus may make it difficult to identify those effects we are evaluating. For example, farms that grow corn today also grew corn prior to the FAIR Act. On the basis of this historic production, such farms receive AMTA payments. This could lead one to the faulty conclusion that AMTA payments cause farmers to grow corn when in fact, production reflects certain fixities and gradual adjustments. Having noted this possibility, it should also be pointed out that one would expect that this would lead to biases that would tend to overstate the importance of AMTA payment benefits on acreage decisions. Thus, even in light of the potential for such effects, our results do not imply large acreage effects as a result of AMTA payments.

Anecdotal evidence suggests another important effect neglected by our analysis. When asked, many farmers stated that they are producing certain crops with the expectation that future policy changes would result in updated base acreages and yields. Farmers do not want to move to nontraditional crops or to idling land because they would not want to lose the opportunity to secure an updated base. The 2002 Farm Bill certainly supports such a suspicion. The 2002 Act provided a number of generous provisions for farmers to update their program base and yields that determine the fixed, decoupled payments. In light of this fact, farmers may have been slow to adjust to market conditions or other factors outside of policy because they are anticipating that base acreages will be updated. This may complicate an analysis of the production effects of farm program payments since AMTA payments are based upon historic base acreages and farmers may have anticipated having the opportunity to update base in the near future.

This raises an interesting question. Were farmers surprised by the generous provisions of the 2002 Farm Bill and did this legislation affect their expectations for future farm policy benefits? Allowing producers to update their base acreage and yields which form the basis for decoupled payments certainly must be interpreted as making the programs “less decoupled.”

To the extent that farmers expect that current production will be an important determinant of future program benefits, their production decisions may be altered by policy, even when such policy is administered through decoupled payments. This is, of course, a research question that must await future policy developments. It will be important to evaluate acreage decisions under the new farm legislation to determine whether the 2002 provision to allow updating of program yields and base had an important effect on the relationship between decoupled payments and acreage decisions.

Our analysis has been based upon the ARMS survey data. In the future, repeated sampling of individual farms may allow much richer inferences to be drawn from these data. In addition, potentially important endogeneity concerns that we have largely ignored are certainly an important area for future research. Finally, we have only scratched the surface of a very important research question. Recent policy events, the most significant of which are to be found in the provisions of the 2002 U.S. Farm Bill, may have had very important effects on how producers view decoupled payments. This research must be updated as new data on production patterns and policy benefits under the new Farm Bill become available.

Table 1. Variable Definitions and Summary Statistics

| Variable | Definition | Mean | Std. Dev. |
|---|---|---|---|
| Corn Acres | Corn acreage | 372.9658 | 478.7375 |
| Soybean Acres | Soybean acreage | 385.8964 | 493.2744 |
| Wheat Acres | Wheat acreage | 41.2196 | 133.3294 |
| Corn Price | Max(basis adjusted futures price, county loan rate) | 2.4478 | 0.2726 |
| Soybean Price | Max(basis adjusted futures price, county loan rate) | 5.6130 | 0.7059 |
| Wheat Price | Max(basis adjusted futures price, county loan rate) | 3.3085 | 0.5355 |
| Farm Size | Total farm size | 1007.6800 | 1131.7800 |
| Disaster | Disaster payments received per acre ($/acre) | 5.2782 | 8.8549 |
| MLA | County average market loss payments (t-1) | 7.1427 | 6.8702 |
| AMTA | AMTA payments received ($/acre) | 13.7438 | 12.9069 |
| Debts/Assets | Debt to asset ratio | 0.1907 | 0.2213 |
| Insurance | Ratio of insurance expenses to total expenses | 0.0420 | 0.0361 |
| Wage | State average farm wage rate ($/hr.) | 8.0227 | 0.5741 |
| Fertilizer Price | State average nitrogen price ($/lb.) | 0.2020 | 0.0439 |
| Gas Price | State average gasoline price ($/gallon) | 0.9032 | 0.1559 |
| Not harvested | Proportion of farm acres not harvested | 0.1671 | 0.1888 |
| Mean yield | Average normalized yield (farm yield / county yield) | 0.9947 | 0.1762 |
| Not cropped | Proportion of owned acres not in crops or orchards | 0.2323 | 0.2545 |
| Acquire Land | 1 if farm acquired owned land in 1999, 0 otherwise | 0.0494 | 0.2167 |
| Livestock | Ratio of livestock sales to total sales | 0.3032 | 0.3645 |

[a] Numbers of observations are 2,615 for all variables except for *Not Harvested*, which had 2,263 observations and *Not Cropped* and *Acquire Land*, which each had 806 observations.

Table 2. Parameter Estimates and Summary Statistics:

Farm-Level Acreage Equations[a]

| Variable | Corn | Soybeans | Wheat |
|---|---|---|---|
| Intercept | −100.8545 | −469.2999 | 102.4263 |
| | (139.0267) | (124.6880)* | (272.8356) |
| Corn Price | −19.3730 | −3.1929 | −22.1629 |
| | (33.6055) | (28.0293) | (37.6518) |
| Soybean Price | 27.6723 | 36.6562 | −23.4637 |
| | (28.4936) | (25.4647) | (39.0912) |
| Wheat Price | 8.9690 | 4.6828 | 42.6033 |
| | (5.5987) | (5.0772) | (11.5756)* |
| Farm Size | 0.3567 | 0.4000 | 0.0722 |
| | (0.0170)* | (0.0128)* | (0.0247)* |
| MLA/Acre$_{t-1}$ | 6.2169 | 0.8852 | −0.6103 |
| | (0.8253)* | (0.6234) | (0.8440) |
| AMTA/acre | 1.1362 | 0.8144 | 0.6288 |
| | (0.2667)* | (0.2384)* | (0.3781)* |
| AMTA*Debts/Assets | 1.0836 | 0.6829 | −0.0252 |
| | (0.7201) | (0.6087) | (1.5022) |
| AMTA*Insurance | −6.7718 | −3.9429 | −5.6635 |
| | (2.8452)* | (2.3580)* | (3.4983) |
| Wage | 7.6514 | 14.2717 | 7.1522 |
| | (5.9096) | (4.7640)* | (7.6931) |
| Fertilizer Price | −462.3489 | 597.1776 | −40.9231 |
| | (186.6615)* | (152.2171)* | (248.4924) |
| Gas Price | −28.9693 | 6.8248 | −29.0928 |
| | (47.2342) | (38.8972) | (88.6076) |
| Wealth | 1.4902 | −1.2421 | −1.2071 |
| | (1.1553) | (1.3039) | (1.8784) |
| $D_{99}$ | −31.5660 | 51.3995 | −12.5301 |
| | (30.9730) | (24.1196)* | (50.5132) |
| $D_{00}$ | −41.4478 | 64.2401 | 1.0845 |
| | (47.5475) | (36.7160) | (74.9867) |
| $D_{01}$ | −1.8756 | −3.9833 | −7.2065 |
| | (54.7396) | (43.5154) | (82.9128) |
| Livestock | −57.6096 | −96.2826 | −15.1671 |
| | (5.8221)* | (5.9667)* | (6.0364)* |
| $\delta_i$ | −28.9062 | −0.0212 | −42.0279 |
| | (24.0324) | (18.0800) | (7.0276)* |
| $R^2$ | 0.7822 | 0.8051 | 0.3488 |

[a] Numbers in parentheses are standard errors. An asterisk indicates statistical significance at the $\alpha = .10$ or smaller level. Note that $\delta_i$ is the correction term from equation (6).

Table 3. Parameter Estimates and Summary Statistics:

Crop Land Idle/Waste Equations[a]

| Variable | Not Harvested | Not Cropped |
|---|---|---|
| Intercept | 1.5511 | 0.6571 |
| | (0.1908)* | (0.6017) |
| Mean yield | −0.2121 | −0.1244 |
| | (0.0180)* | (0.0369)* |
| Corn Price | 0.1333 | 0.2761 |
| | (0.0446)* | (0.2763) |
| Soybean Price | −0.0766 | 0.0441 |
| | (0.0421)* | (0.1174) |
| Wheat Price | −0.0318 | 0.0765 |
| | (0.0092)* | (0.0995) |
| Farm Size | 0.0000 | 0.0000 |
| | (0.0000)* | (0.0000) |
| AMTA | −0.0040 | −0.0027 |
| | (0.0004)* | (0.0012)* |
| County Corn Acres$_{t-1}$ | 0.0000 | 0.0000 |
| | (0.0000)* | (0.0000)* |
| MLA | −0.0093 | −0.0027 |
| | (0.0010)* | (0.0042) |
| AMTA*Debts/Assets | −0.0024 | −0.0025 |
| | (0.0006)* | (0.0040) |
| Wage | −0.0359 | −0.0286 |
| | (0.0071)* | (0.0305) |
| Fertilizer Price | −2.8792 | −2.1879 |
| | (0.3001)* | (1.6046) |
| Gas Price | 0.1084 | −0.7287 |
| | (0.0721) | (0.4898) |
| AMTA*Insurance | 0.0152 | −0.0134 |
| | (0.0039)* | (0.0181) |
| Wealth | −0.0001 | −0.0062 |
| | (0.0006) | (0.0032)* |
| Livestock | 0.1793 | 0.0910 |
| | (0.0100)* | (0.0276)* |
| $D_{99}$ | −0.0632 | |
| | (0.0426) | |
| $D_{00}$ | −0.0780 | |
| | (0.0680) | |
| $D_{01}$ | 0.2578 | |
| | (0.0821)* | |
| Number of Observations | 4121 | 884 |
| $R^2$ | 0.2701 | 0.1500 |

[a] Numbers in parentheses are standard errors. An asterisk indicates statistical significance at the $\alpha = .10$ or smaller level.

Table 4. Probit Parameter Estimates and Summary Statistics: Discrete Land Acquisition Equations[a]

| Variable | Parameter |
|---|---|
| Intercept | 3.7702 |
| | (7.1982) |
| Mean yield | 0.5316 |
| | (0.4903) |
| Corn Price | −3.4708 |
| | (3.8613) |
| Soybean Price | −1.1195 |
| | (1.3964) |
| Wheat Price | −1.4277 |
| | (1.7280) |
| Farm Size | 0.0002 |
| | (0.0001)* |
| AMTA | 0.0126 |
| | (0.0126) |
| County Corn $\text{Acres}_{t-1}$ | 0.0000 |
| | (0.0000)* |
| MLA | −0.0137 |
| | (0.0509) |
| AMTA*Debts/Assets | 0.0213 |
| | (0.0243) |
| Wage | 0.1596 |
| | (0.3423) |
| Fertilizer Price | 33.9825 |
| | (23.9202) |
| Gas Price | 5.4278 |
| | (7.5721) |
| AMTA*Insurance | −0.5701 |
| | (0.2272)* |
| Wealth | 0.0062 |
| | (0.0150) |
| Livestock | −0.3837 |
| | (0.3420) |
| McFadden's $R^2$ | 0.1403 |

[a] Numbers in parentheses are standard errors. An asterisk indicates statistical significance at the $\alpha = .10$ or smaller level.

Table 5. Parameter Estimates and Summary Statistics:

County-Level Acreage Equations[a]

| Variable | Corn | Soybeans | Wheat |
|---|---|---|---|
| Intercept | −235.8030 | −17144.5000 | −1556.9800 |
| | (4269.0000) | (4230.5000)* | (2444.4000) |
| Corn Price | −2854.8700 | 7297.9630 | −9048.2500 |
| | (1765.0000) | (1888.4000)* | (1482.2000)* |
| Soybean Price | 1670.0960 | −2082.9100 | 5433.0430 |
| | (840.7000)* | (950.5000)* | (726.5000)* |
| Wheat Price | −1022.6700 | 1677.8250 | −67.2777 |
| | (528.7000)* | (466.4000)* | (329.6000) |
| Farm Size | 0.0093 | 0.0156 | −0.0023 |
| | (0.0025)* | (0.0027)* | (0.0009)* |
| $\text{Acres}_{t-1}$ | 0.9633 | 0.9594 | 0.9635 |
| | (0.0066)* | (0.0073)* | (0.0163)* |
| AMTA/acre | 14.4440 | 98.4449 | 70.6200 |
| | (50.0391) | (47.0538)* | (35.3224)* |
| $\text{MLA}_{t-1}$ | 131.4639 | 71.6577 | 24.8099 |
| | (57.3470)* | (51.2490) | (34.1845) |
| $\text{Disaster}_{t-1}$ | 112.4279 | −106.2860 | −188.7110 |
| | (131.3000) | (123.3000) | (93.1989)* |
| Gas Price | 3955.7880 | −7054.7800 | 7355.6010 |
| | (1704.8000)* | (1735.8000)* | (1275.1000)* |
| Fertilizer Price | −32236.4000 | 11971.5100 | −9495.2200 |
| | (4218.3000)* | (4200.8000)* | (2675.1000)* |
| Wage | 417.9300 | 1025.1150 | −1447.5600 |
| | (308.2000) | (282.1000)* | (186.1000)* |
| Income CV | 24.7461 | 27.3505 | −0.2151 |
| | (24.7461) | (17.5131) | (10.5349) |
| $D_{98}$ | 185.0549 | −181.2660 | −470.3420 |
| | (481.9000) | (441.1000) | (276.0000)* |
| $D_{99}$ | −896.3420 | 41.3731 | −229.8590 |
| | (430.7000)* | (440.3000) | (252.9000) |
| $D_{00}$ | 657.1753 | −297.1100 | −588.4040 |
| | (440.0000) | (398.6000) | (276.2000)* |
| $R^2$ | 0.9917 | 0.9900 | 0.9553 |

[a] Numbers in parentheses are standard errors. An asterisk indicates statistical significance at the $\alpha = .10$ or smaller level.

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