Acreage Effects of Decoupled Programs at the Extensive Margin

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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 for wheat and barley production in the Northern Great Plains. The issue is important in light of the upcoming WTO negotiations and debate over the distortionary effects of such decoupled ("green-box") payments. Our results suggest that a modest, though statistically significant effect on acreage may have been evoked by AMTA payments. In particular, if the over $45 billion allocated to AMTA payments and market loss assistance had been doubled, wheat acreage may have been 7% greater and barley acreage may have been 12.8% higher. Models of land idling suggest that AMTA payments have a very modest effect on land idling in this region. We note that the nature of our data may result in an upward bias in AMTA and MLA payment effects, such that our analysis provides conservative estimates.

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1 Introduction

A fundamental change in U.S. agricultural policy occurred with the 1996 Federal Agriculture Improvement and Reform (FAIR) Act. The Act signaled a move away from production controls and acreage base requirements by allowing planting flexibility. Instead of the traditional target price (deficiency payment) programs that had been a fixture of U.S. policy for many years, support would be conveyed to farmers through loan deficiency payments and fixed, decoupled payments. These decoupled payments were based upon a producer's historical base acreage for program crops, though they were not tied to current production or market conditions. Under the 1996 FAIR Act, these payments were known as production flexibility contract (PFC) or AMTA payments. The notion of decoupling has been relevant to U.S. agricultural policy for some time. Prior to the 1996 Act, farmers were allowed a degree of planting flexibility on program acres and thus policies of the time were often considered to be "partially decoupled."

The extent of decoupling of domestic support programs plays a critical role in international trade negotiations. The Uruguay Round Agreement on Agriculture (URAA) classifies domestic support policies by the extent to which they are trade-and market-distorting. Those policies that are deemed by the WTO to be "minimally trade distorting" are called "Green Box" policies and are exempt from the negotiated restrictions on domestic support.[1] Decoupled payments, such as the AMTA payments of the U.S., are considered to be green box policies and thus are exempted from the negotiated reductions in support. In principle, since these simple lump-sum transfers are not tied to current production and are made according to historical base acreages (most of which were established in the 1980s), the programs

[1] The URAA instituted a "traffic-light" analogy for classifying domestic programs in terms of the extent to which they distort markets. Green box policies are the most innocuous. Amber box policies refers to those programs that are considered to be trade distorting and thus subject to the constrains imposed by the agreement.

should be production-neutral and thus non-trade distorting.

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 to 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.

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 substantial degree of ad hoc support that followed the Act and the generous provisions of the 2002 Farm Security and Rural Investment Act (FSIRA) which was signed into law on May 13, 2002.[2] Low prices and localized yield shortfalls resulted in disaster payments and "market loss assistance" (MLA) payments. The MLA payments are especially pertinent in that, although the payments were not tied to production, they clearly were triggered by low market prices. Is a payment that is not tied to production but is triggered by low prices truly decoupled? Valid arguments could be made in both directions, though the U.S. did report MLA payments as amber box support provisions, thus implicitly admitting that the payments were tied to production. The 2002 Act provided substantial increases in support and, perhaps of greatest consequence, extended the fixed, decoupled AMTA-type payments for another six years. In addition, producers were given the opportunity to update their base acreages and yields which determine the payments (using 1998-2001 yields and acreage) and to include historical soybean acreage

[2] The 1996 Act was known as the "Freedom to Farm" Bill in light of its planting flexibility. However, in the late 1990s, policy rhetoric often referred to the Act as the "Freedom to Fail" Bill. Such rhetoric was generally accompanied by strident calls for additional ad hoc support, which was freely forthcoming from Congress during the late 1990s.

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 were 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.

Undoubtedly, the yield and base updating provisions will be the focus of much debate and consternation in the upcoming WTO negotiations. Agents are forward-looking and certainly anticipate many future policy benefits, even if such policies are of an ad hoc nature. For example, it is difficult to 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. Producers' 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 almost certainly affected producers' planting decisions. 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 if market prices were low? The updating provisions are 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 or might, in future policy deliberations, anticipate the policy outcomes. It certainly is possible, however, that expectations regarding 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.

The production neutrality of such decoupled programs has recently been brought into question, both in academic research and in policy discussions. Perhaps of greatest relevance is the yield and base updating provisions of the 2002 FSIRA Act, which many consider to have provided a precedent for linking future benefits to current production. Aside from this obvious concern, recent research has argued that fully decoupled payments may have production effects by changing an individual's aversion to risk by increasing their wealth. 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.[3] Skeptics argue that existing research has been unable to reach strong consensus opinions regarding the nature of farmers' risk preferences. 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.

Perhaps a more pertinent possibility relates to the capital constraints that most certainly influence producers but are often omitted from theoretical and empirical models. In particular, 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.

[3]Indeed, Hennessy's simulation results suggested the wealth effects were likely to be modest.

In spite of its importance, this empirical question has received relatively limited attention. In recent work, we examined the extent to which decoupled payments may have influenced corn, soybean, and wheat acreage in the U.S. Corn Belt during the FAIR policy years. Our empirical results confirmed that AMTA payments had a statistically significant, positive effect on corn acreage. However the effects of these payments were very modest, suggesting that a doubling of the $35.6 billion allocated to AMTA payments between 1996 and 2001 may have increased corn and soybean acreage by 2-4%. It is important to note that characteristics of our data may result in an upward bias on this effect and thus that our results place an "upper-bound" on the expected acreage effects arising from these programs. An important question pertaining to these results involves the extent to which these effects might differ for alternative crops and areas outside of the Corn Belt. In particular, one would expect that the largest effects of such programs should be realized for the most "marginal" crops and regions.[4]

The objective of this analysis is to consider the acreage effects of AMTA payments in a context that is closer to the extensive margin of production. We extend our earlier analysis of corn and soybeans in the Corn Belt to consider wheat and barley acreage in the Northern Great Plains region of the U.S. We only consider farms in counties that produce a significant level of wheat and barley (at least 10,000 county acres). Our analysis is based upon the USDA Agricultural Resource Management Survey (ARMS) data.

The plan of our paper is as follows. The next section briefly 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. We also consider the effects of market loss assistance payments, seemingly ad hoc payments made to producers

[4]We use the term "marginal" rather loosely, since most producers in the Northern Great Plains, which is the focus of our research, would object to being termed "marginal." However, it is the case that yields and net returns are lower in such regions and that yield risk tends to be substantially higher than one would find in the Corn Belt. We are grateful to David Zilberman for pointing out the importance of considering regions that are closer to the margin than what one anticipates to be the case for the Corn Belt.

in compensation for low market prices in 1998-2001. 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.[5] 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

[5] 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.

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 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 ϵ_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:

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

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 CCC government payment outlays were taken from unpublished USDA-FSA sources.

Our focus is on production effects of decoupled programs. We model this through a consideration of harvested crop acreage for wheat and barley. It should be acknowledged that acreage response models most typically use planted acreage and thus that any abandonment is not included in our model. Two points underlie our reliance upon harvested acres. First, these are the only acreage statistics that are collected in the ARMS surveys. Perhaps more important is the fact that we are most concerned with the effects of policies on markets. Acreage that is not harvested certainly has no effect on output markets and thus is not relevant to market distortions. Thus, reliance on harvested acreage is justified by the overall objectives of our study.

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.[6] 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 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.[7] To address this issue, we considered an alternative alternative evaluation of policy effects at the county level in our analysis of corn and soybeans. This allowed us to condition on county production patterns prior to the 1996 FAIR Act. Our results there suggested that the effects of such bias were modest at most.

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 insur-

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

[7]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. That is, our results should place an upper bound on the effects of payments on production. The results that follow should be interpreted with this caveat in mind.

ance 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 wheat were taken from the Bridge database. Expected barley prices are calculated using February state average prices. An expected wheat price for each 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.[8] 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-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 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 upper plains region of the U.S.—which we define using the USDA-ERS farm resource region designation of the "Northern Great Plains." We focus our analysis on the two crops that are most likely to be grown on marginal land—wheat and barley. Thus, we eliminate any county that did not have at least 10,000 acres of both crops planted.

[8]We utilized the average daily close prices in February for September

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 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.[9] 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).[10] 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.

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

[10] 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.

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 (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[11] 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.[12] 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.[13]

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, 97% of farms in our sample produced wheat while only about 38% of the farms in our sample produced barley. 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

[11] We utilize the *Surveyselect* procedure of SAS in our estimation, though alternative approaches are also possible.

[12] 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.

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

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:

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

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 ξ_{it} is heteroscedastic. Our bootstrapping procedures are robust to unknown forms of heteroscedasticity in that they are of a nonparametric nature, involving resampling from the estimation data.

4 Empirical Results

Our empirical analysis is conducted in two segments. In the first, a large sample of data drawn from individual farms is used to consider two acreage equations—for wheat and barley. In a second segment of the analysis, we consider an evaluation of an alternative measure of farm land usage—the extent to which crop land is not harvested on an individual farm. In particular, we consider factors, including farm program payments, affecting the ratio of non-harvested to harvested farm acres.

Variable definitions and summary statistics for our sample of the "Northern Great Plains" region farms are presented in Table 1. Our sample consists of 1,198 farm-level observations. The average farm planted 113 acres of barley and 869 acres of of wheat. Of course, these averages reflect the substantial proportion of farms that did not grow barley in a given year, such that the average acreage for farms growing wheat was much higher (299 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.[14]

The first segment of our empirical analysis considers acreage response equations for individual farms in the region. Equations for barley and wheat, the dominant crops on what is generally considered to be "marginal land" in the region, were estimated. Parameter estimates and summary statistics are presented in Table 2.[15] Parameters representing price effects are of the correct sign, though the price coefficient is not significant for barley. For wheat, the estimates correspond to an acreage response elasticity of 0.74.

The role of AMTA payments is central to our analysis of the production effects of direct farm payments. Recall that our conceptual considerations identified three different avenues through which decoupled payments might operate to influence production. 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).[16] 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

[14]It should be noted that factors that are highly correlated in a cross section from year to year will be correlated with such fixed annual effects, thus making identification of the individual effects problematic. 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.

[15]First stage probit models (not presented here) included lagged county level yields, acreage, operator age, farm machinery assets, and assets associated with irrigation equipment. Note that the parameters do not directly correspond to marginal effects. For those variables that are not included in the first stage probit models, marginal effects are given by $F(g(z_{it}, \alpha_i)\beta$. The mean values of $F(\cdot)$ are 0.38 for barley and 0.96 for wheat, respectively. These roughly correspond to the proportion of farms producing the commodities in question.

[16]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.

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 Act 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.

In both the barley and wheat acreage equations, the direct effect of AMTA payments on acreage is statistically significant. The coefficients suggest that an additional dollar per acre average of AMTA payments would raise the typical grower's acreage by about 4 acres for barley and about 8 acres for wheat. The interaction effect with leverage (the debt to assets ratio) is not statistically significant in either case. The interaction effect with insurance is statistically significant for barley, but not for wheat. The results suggest that, to the extent that insurance purchases reflect an agent's risk aversion, more risk averse agents are less responsive to AMTA payments in terms of expanding their acreage. At the means of the data, acreage elasticities with respect to AMTA payments are 0.1287 for barley and 0.0797 for wheat. These effects are relatively strong, especially for barley. A doubling of the $36 billion spent on AMTA payments in the last several years might be expected to increase barley acreage by about 13% and wheat acreage by about 8%. These effects, though not extremely large, certainly are economically significant. It should be noted that we have assumed prices to be exogenous for individual agents. However, any such large scale policy change would certainly have a negative effect on prices, thus moderating this effect. In comparison, the elasticities representing the effects of AMTA payments on corn, wheat, and soybean acreage obtained in other work were on the order of 0.02 to 0.04. Thus, the effects in marginal growing areas are likely to be substantially larger than what was revealed for the Corn Belt.

As we have noted, an upward bias in these effects may exist. In particular, land that is currently engaged in production, especially in marginal growing areas, is likely to have been in production during the 1980s when acreage bases were established. One would expect production patterns to reflect natural conditions of comparative advantage. Put differently, land that was good for growing wheat and barley in the 1980s is likely to still be good for the same uses. Since AMTA payment levels are based upon historical base acreages, correlation between AMTA payments and current production may exist, even with a lack of causality between the payments and acreages. Were it possible to condition acreage on acreages in earlier years, this effect could potentially be controlled for. However, as noted above, a limitation of the ARMS data exists in the fact that there is no repeated sampling and thus that the same farm is not observed more than once (at least in an identifiable form). The results for barley are less of a concern in light of its relatively low importance as a major internationally traded crop. However, the results do suggest an effect for wheat that is roughly double that revealed for corn and soybeans. This is not surprising in that one would certainly expect that more marginal crops and areas might have much greater potential for expansions. Land that was suitable for production of more intensively grown crops like corn and soybeans may not have had the same potential for expansion as the more marginal lands considered here.

In addition to the support provided through AMTA payments, considerable support was directed to growers through market loss assistance payments. We also included market loss assistance (MLA) payments in the acreage equations. In contrast to AMTA payments, MLA payments are ad hoc and thus are not known with certainty in the same way that as AMTA payments, whose level can be anticipated. Thus, we construct a measure of expected MLA payments by taking the preceding year's county-wide average (on a per-farm-acre basis). In the case of barley acreage, an additional dollar of expected MLA payments results in about four additional acres of barley. However, in the case of wheat, no acreage effect is apparent from market loss assistance. This is in considerable contrast to the results obtained for corn and soybeans in other work. In that case, acreage effects from MLA payments were substantially higher than was the case for AMTA payments. Of course, the manner in which MLA payment levels were determined may make it quite difficult to separately identify the effects of the two. In particular, MLA payments were paid on the basis of a producer's AMTA payments. This does not, however, imply that the two were perfectly correlated in our sample since the payment rates (per base acre) were not the same for the two different programs over time or across crops. To the extent that AMTA payments and market loss assistance were correlated, separate identification of their independent effects may be difficult.

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.

The exact mechanism by which AMTA payments are affecting acreage response—wealth effects, changes in risk preferences, capital constraints, or changes related to the anticipation of future benefits—is impossible to identify. The effects are relatively modest, though this is not to say that there is limited potential for distortions to arise as a result of the provision of decoupled AMTA payments. Our results suggest that increasing AMTA payments by 10% might raise wheat acreage by 0.7%, a small though not trivial amount. Larger increases are implied for barley. Any interpretation of such effects should recognize that we are measuring payment benefits *per farm acre*. Such a modeling approach is necessary because AMTA payments are not tied to any specific crop. We should acknowledge that 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.

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 net farm wealth in each of the acreage models. In every case, total wealth does not appear to be significantly correlated with acreage of the two 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 (buy or rent) additional farm land, thus making total farm size heavily correlated with the decoupled payments. In other research, we have explicitly considered factors influencing the acquisition of new land in 1999. Our results suggested that no apparent link existed between AMTA payments and the probability that a farm acquired more farm land in 1999. This serves to temper concerns that total farm size might be endogenous to the levels of particular crops that were grown. In the present analysis, though we acknowledge 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.[17]

We have included the proportion of total farm sales accounted for by livestock farms. It is not surprising that farms with livestock production have fewer acres of wheat and barley. 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. Regions with higher fertilizer costs tend to grow less wheat, though there is no apparent effect on barley acreage decisions.

In all, our analysis of farm-level data suggests that decoupled AMTA payments appear to have moderate though statistically significant positive effects on acreage of wheat and barley in the Northern Great Plains. Our results suggest that a doubling of AMTA payments might be expected to trigger increases of 7% in the acreage of wheat, and perhaps even larger increases in the relatively minor crop of barley. Interestingly, market loss assistance payments do not appear to have evoked large acreage responses. This may reflect the substantially correlated nature of AMTA and MLA payments and the AMTA effect may represent combined influences of AMTA and the ad hoc assistance provided by market loss assistance.

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. 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.

For our data, waste/idling measure averaged about 34% for Northern Great Plains farms in out sample. Table 3 contains parameter estimates for each of the alternative measures of land usage. Not surprisingly, 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

[17] 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.

more productive land are more likely to have less waste and are also more likely to have a crop base.[18] In elasticity terms, the elasticity of the proportion of total farm acres idled with respect to AMTA payments is -0.0004. The AMTA interaction terms are significant in both cases, with more highly leveraged farms being more likely to farm intensively and more risk averse producers being likely to set aside more land. These results suggest that increasing AMTA payments does indeed lead to less land being put in fallow or set-aside, though the effect is very small and 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.

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.[19] Prices do not seem to affect land idling. Higher market loss assistance payments (for the county in the previous year) do not have a statistically significant effect on waste or idling of land. Higher fuel prices lead to more idling of land resources though other factor prices do not have a significant effect on land idling. Finally, wealthier producers tend to have less idling of land resources. This may reflect risk preferences associated with wealth or, conversely, may simply reflect the fact that wealthier producers may be expected to possess higher quality farm land.

In general, the model suggests 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 slightly less idling of land and thus may result in more land being in production. This effect is only asserted through the AMTA payment variable, with no statistically significant effect being implied for MLA payments.

[18] 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.

[19] 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.

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 current production of a particular crop. The issue is important in light of the recent U.S. Farm Act, 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. Our analysis pursues this empirical question for relatively marginal land and crops—wheat and barley production in the Northern Great Plains.

Our results find more moderate acreage responses, especially for barley, which is a relatively minor crop. It appears difficult to separate the effects of AMTA and MLA payments and our analysis suggests that a doubling of both payments might lead to 7% more land being brought into wheat production. 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 wheat and barley 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.

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 Act, 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 legislation become available.

Table 1. Variable Definitions and Summary Statistics

Variable	Definition	Mean	Std. Dev.
Barley Acres	Barley acreage (harvested)	112.6995	239.7407
Wheat Acres	Wheat acreage (harvested)	868.8957	858.7022
Wheat Price	Max(basis adjusted futures price, county loan rate)	3.9583	0.5717
Barley Price	Max(basis adjusted futures price, county loan rate)	2.0095	0.3489
Farm Size	Total farm size	2,784.3200	2,546.4200
Disaster	Disaster payments received per acre ($/acre)	6.6100	23.5011
MLA	County average market loss payments (t-1)	4.0801	4.2190
AMTA	AMTA payments received ($/acre)	9.1712	10.5027
Debts/Assets	Debt to asset ratio	0.2473	0.6773
Insurance	Ratio of insurance expenses to total expenses	0.0703	0.0435
Wage	State average farm wage rate ($/hr.)	7.8457	0.6833
Fertilizer Price	State average nitrogen price ($/lb.)	0.1807	0.0380
Gas Price	State average gasoline price ($/gallon)	0.9090	0.1501
Not harvested	Proportion of farm acres not harvested	0.3367	0.2702
Mean yield	Average normalized yield (farm yield / county yield)	1.0332	0.3487

[a] Number of observations is 1,198.

Table 2. Parameter Estimates and Summary Statistics:

Farm-Level Acreage Equations[a]

Variable	Barley	Wheat
Intercept	375.3308	−271.4593
	(748.9621)	(749.7691)
Barley Price	41.5699	145.4715
	(117.5930)	(117.1564)
Wheat Price	26.5251	161.6532
	(129.5923)	(95.8160)*
Farm Size	31.7959	265.9214
	(12.9073)*	(22.8506)*
MLA/Acre$_{t-1}$	12.6254	−6.7506
	(6.9478)*	(6.0380)
AMTA/acre	11.0267	8.3965
	(4.4139)*	(3.4796)*
AMTA*Debts/Assets	−7.0350	−2.2646
	(7.7072)	(4.3985)
AMTA*Insurance	−72.9358	0.5114
	(34.8393)*	(32.8571)
Wage	−13.8538	35.7710
	(46.9478)	(48.8058)
Fertilizer Price	−1395.9000	−4941.2800
	(1030.2800)	(985.6470)*
Gas Price	105.6809	−80.1471
	(573.6282)	(517.2749)
Wealth	0.3107	2.4953
	(2.7210)	(2.9976)
D_{99}	−146.5295	−12.8045
	(115.3755)	(93.8023)
D_{00}	−75.5178	136.5783
	(210.7890)	(164.0743)
D_{01}	−3.6100	683.7180
	(259.6588)	(198.9321)*
Livestock	−100.9353	−525.8343
	(30.2888)*	(47.6923)*
δ_i	−144.6128	218.6965
	(41.6646)*	(195.2483)
R^2	0.1982	0.5428

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

Table 3. Parameter Estimates and Summary Statistics:

Crop Land Idle/Waste Equation[a]

Variable	Estimate
Intercept	1.3654
	(0.4049)*
Mean yield	−0.1717
	(0.0216)*
Wheat Price	0.0360
	(0.0602)
Barley Price	0.0221
	(0.0750)
Farm Size	0.0100
	(0.0036)*
AMTA	−0.0125
	(0.0023)*
County Wheat Acres$_{t-1}$	−0.0013
	(0.0019)
County Barley Acres$_{t-1}$	−0.0055
	(0.0019)*
MLA$_{t-1}$	−0.0131
	(0.0028)*
AMTA*Debts/Assets	−0.0015
	(0.0036)
Wage	−0.1268
	(0.0260)*
Fertilizer Price	0.5721
	(0.8323)
Gas Price	−0.0353
	(0.2518)
AMTA*Insurance	0.0398
	(0.0176)*
Wealth	−0.0023
	(0.0010)*
D_{99}	0.1148
	(0.0721)
D_{99}	0.2179
	(0.0767)*
D_{00}	0.2071
	(0.1087)*
Number of Observations	1198
R^2	0.4362

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

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