The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates

Barrett E. Kirwan*

Massachusetts Institute of Technology
Cornell University

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ABSTRACT

This paper investigates the effects of U.S. agricultural subsidies on farmland rental rates. The analysis is conducted with data from the 1992 and 1997 Censuses of Agriculture micro-files and exploits the variation in subsidies introduced by the 1996 Federal Agriculture Improvement and Reform Act. The estimation employs models that include farm and county by time fixed effects to control for unobserved sources of bias (e.g., soil quality and weather). Instrumental variables methods are used to resolve expectation errors that would otherwise bias the estimates. The primary finding is that landlords capture one-fifth of the marginal subsidy dollar per acre. This finding stands in contrast to the standard assumption that landlords immediately capture the entire subsidy. There is some evidence that the share of the subsidy captured by landlords increases as the farmland rental market becomes more competitive. The analysis also indicates that the lower effective price of land induces tenants to rent more land such that they gain roughly $1 per dollar of subsidy. Taken together, the results suggest that agricultural subsidies benefit farmers, as well as individuals that own agricultural land.

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1 Introduction

The primary goal of U.S. agricultural policy over the past century has been to increase farmers' income. Since 1973, direct payments to agricultural producers have been a vital instrument for supporting that goal[1]. Whether agricultural subsidies actually benefit farmers, however, is an open question. Nearly half of all farmland in the United States is rented, almost all of it from non-farmers. Agricultural subsidies may not benefit farmers if non-farmer landlords are able to adjust rental rates to capture the subsidies paid to agricultural producers.

In the United States, agricultural subsidies are a significant transfer payment to farmers. Among income support policies, subsidies rank among the highest in expenditures per recipient. In 1999, the average subsidy was $17,561 per recipient household. Compare this to $2,052 annually per recipient household in food stamps; an average total unemployment compensation claim of $3,118; or $4,460 per recipient in annual benefits from SSI, an income support for the needy aged, blind, and disabled. The total amount spent on farm payments in 1999, $22.7 billion, rivals the spending of one of the largest transfer programs, the earned income tax credit, which allocated $30.5 billion in credits to low-income tax filers. The size of the farm subsidy program alone emphasizes the importance of understanding whether the stated policy goals are being met.

Recent increased scrutiny of U.S. agricultural policy highlights the importance and urgency of this issue. Media stories about Congressmen and sports and movie stars receiving agricultural subsidies have focused the domestic debate on agricultural policy[2]. The international debate has also focused on U.S. domestic agricultural policy due to record subsidy payments from 1999 through 2001. This topic is playing a key role in the current Doha round of World Trade Organization negotiations.

[1] See Orden, Paarlberg, and Roe (1997) for a history of agricultural policy.

Despite the prevalence of rental agreements, and the importance of subsidies as a policy measure, there is little empirical work examining the relationship between subsidies and farmland rental rates. Without a clear understanding of the connection between subsidies and rental rates farm policy might be severely misguided. Rented farmland is almost entirely owned by non-farmers. In 1999 alone, 94 percent of landlords were non-farmers. Policy aimed at benefiting farmers fails if non-farmer landlords extract the entire subsidy dollar. This paper estimates the extent to which the marginal subsidy dollar is reflected in rental rates. In an effort to inform both the public debate and the academic literature, I quantify the effectiveness of government subsidies as a policy instrument used to benefit farmers, and I utilize an incidence measure to inform various assumptions in the literature surrounding farmland value determination.

This paper investigates the relationship between farmland rental rates and agricultural subsidies by analyzing a panel of farm-level production data. The data are from confidential United States Department of Agriculture (USDA) – National Agricultural Statistical Service (NASS) *Census of Agriculture* micro files from 1992 and 1997. The nature of these data provides two identifying sources of variation. The first comes from the differential acreage enrollment in the subsidy program across farms. To illustrate, consider two otherwise identical fields, one is completely enrolled in the subsidy program, while the other is not. Under this scenario any difference in rental rates will be due to differences in subsidies. The second source of variation is due to a policy change in 1996, the Federal Agricultural Improvement and Reform (FAIR) act, which exogenously changed subsidy rates. This provides a quasi-experimental design that allows me to examine a change in subsidy rates that is plausibly uncorrelated with other behavioral changes.

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[2] For example, Elizabeth Becker. "Some Who Vote on Farm Subsidies Get Them as Well." *The New York Times* Sept.1, 2001, and Billy Heller. "$24M Baseballer Reaps Farm Aid." *The New York Post* Mar. 27, 2002.

I employ several techniques to exploit these sources of variation and identify the effect of subsidies on farmland rental rates. I use farm fixed effects and time-varying county fixed effects to control for unobserved farm heterogeneity and regional shocks, and I exploit the exogeneity imposed on subsidy payments by the 1996 legislation to overcome bias due to simultaneity. I use instrumental variables techniques to overcome possible expectation error that could bias the estimated effect of subsidies on farmland rental rates by using the legislated, pre-determined 1997 subsidy payments as an instrumental variable to address expectation error in the 1992 subsidies.

The analysis finds that between 18 and 20 percent of the marginal subsidy dollar is reflected in increased rental rates. This implies that of the $5.5 billion in farm subsidies in 1997, at most $1.1 billion may have gone to non-farmers. Although the literature typically assumes that every subsidy dollar is captured by landowners, i.e., full incidence (e.g., Chambers 1995), these findings suggest that the standard assumptions may need to be re-evaluated to more accurately reflect the factor market for land.

Based on these findings, economic theory suggests that subsidies may have effects beyond the farmland rental market. Because farm subsidies are factor-specific subsidies to land, the marginal subsidy dollar effectively lowers the rental rate by 80 cents. The lower rental price of land induces substitution away from other variable inputs toward rental land, while the lower marginal cost might result in greater output and increased variable input use. The ultimate effect on other variable factors of production is an empirical question. The analysis finds a significant, positive response of expenditure on nearly all variable inputs. Overall, the marginal per-acre subsidy dollar increases per-acre expenditure by 35 cents.

The increased output ultimately results in a gain to tenant farmers. The analysis shows that the net returns of tenant farmers increase one-for-one with the marginal subsidy dollar, supporting the notion that ultimately the farm operator benefits from the marginal subsidy dollar.

The paper proceeds as follows. Section 2 reviews the existing literature, noting the lack of empirical work on subsidy incidence. Section 3 details the institutional facts about the farmland rental market and subsidy policy. Section 4 describes the data. Section 5 lays out the empirical strategy employed in this investigation, emphasizing the identifying assumptions. Section 6 presents the incidence on landlords and provides evidence of the robustness of the estimated incidence. Section 7 provides a plausible explanation of the results. Section 8 examines the subsidy's effect on non-land factors of production. Section 9 provides evidence that the incidence on tenants is complementary to the incidence on landlords. Finally, section 10 interprets the findings in light of existing assumptions and policy objectives and suggests directions for future research.

2 Literature Review

This paper is one of the first to examine the incidence of subsidies on farmland rental rates, but it has a foundation in a much broader literature on the determinants of farmland values. Alston (1986) and Robison,et al. (1985), among others, examined the asset value of land as the present discounted value of the stream of returns to land, which they represented with the cash rental rate. Melichar (1979) noted that the discount rate in such models is comprised of a discount rate and the expected growth rate of the stream of returns. More recently Weersink, et al. (1999) disaggregated the stream of returns to farmland into the return from farming and the subsidies to land. They

estimated separate discount rates for each stream, finding that subsidies are discounted less heavily than the returns to production.

Virtually all of the research on subsidy incidence has examined the relationship between subsidies and land values. This investigation has taken many approaches. Morehart, et al. (2001) and Weersink, et al. (1999) are characteristic of those who use a present discounted value of the stream of subsidies in their analysis. Shoemaker, et al. (1989) approach the problem by using a computable general equilibrium model in order to ascertain the extent to which subsidies are capitalized into land values. Both of these approaches suffer from assuming perfect incidence and essentially examine only the process of capitalization. Barnard, et al. (1996) represent a separate approach using pooled cross-sections in order to assess the degree of capitalization. Although this approach does not assume perfect incidence, the findings cannot be separated into an incidence estimate and discount and expected growth rate estimates.

The approach taken in this paper contributes to the discussion by explicitly separating the incidence estimate from the discount rate. By focusing on farmland rental rates, rather than land value, I disentangle the incidence question from the question of expectations over future policy. This not only contributes to the current knowledge about who benefits from current subsidies and to what degree, but it also lays the groundwork to more carefully address the questions concerning the expected growth rate of government subsidies.

Researchers have recently begun examining the effects of subsidies on rental rates (Lence and Mishra 2003; Goodwin, et al. 2004). A prominent feature of this research is the implicit assumption that once one controls for observable characteristics, no unobservables remain that are correlated with government payments. This assumption is the 'selection on observables' assumption. To illustrate the hazard of relying on this assumption, consider the confounding effect

of the inherent productivity of land due to complex interactions among soil characteristics and climate. This characteristic is an unobserved determinant of land values that is correlated with subsidies because subsidies are a function of historic yield. In the presence of this unobservable characteristic, the coefficient on government payments will capture both the effect of subsidies *and* the effect of unobserved productivity. Since both effects are positively related to land values, the parameter of interest will be larger than it would be if it identified the true effect of subsidies. This paper overcomes the problem by using a farm fixed effect to purge permanent, unobserved characteristics that determine rental rates.[3]

In contrast, this study uses disaggregated panel data to control for unobserved heterogeneity and county-specific secular trends. The timing of the data allows me to exploit exogenous variation in subsidies from the mid-1990s policy change. The policy change acts as a 'quasi-experiment' by changing the subsidy in a way that was unanticipated and uncorrelated with the farmer's behavior, thereby reinforcing the identification of the true effect of subsidies on farmland rental rates.

3 Institutional Background

3.1 Overview of the farmland rental market

Renting farmland is a common practice in U.S. agriculture, where more than 45 percent of the 917-million farmland acres are rented (USDA 2001b). A typical tenant rents 65 percent of the land he farms, paying either in cash or in shares of production. Sixty percent of rented farmland is paid for with cash, 24 percent with shares of production, and 11 percent with a cash/share combination. Those who cash lease pay $60 per acre on average. The average rental rate among those who grow subsidized crops is slightly below the national average at $50 per acre.

[3] Interestingly, Hoch (1958 and 1962) and Mundlak (1961) developed the fixed effects model to account for unobserved

The rental market is characterized by short-term contracts in long-term relationships. Rental contracts commonly take the form of year-to-year "handshake" agreements. When formal, written rental contracts exist they also generally last one year. In spite of frequent renewal, these arrangements are typically found in long-term landlord-tenant relationships. Allen and Lueck (1992) report an average landlord-tenant relationship length of 11.5 years in Nebraska and South Dakota, and Sotomeyer, et al. (2000) report 11.3-year landlord-tenant relationships in Illinois. The parties enter into the rental agreements early in the year, typically by March 1st. A rental rate negotiated in the spring is based on the expected returns from farming during the upcoming year. Among the expected returns are government payments, which typically are made after the harvest. The mistiming between the setting of the rental rate and the realization of government payments results in forecast error. The forecast error involved in the agreed upon rental rate may serve to confound the relationship between subsidies and rental rates if not adequately addressed. Below I detail the instrumental variables (IV) strategy used to address the issue.

The incidence measures the division of subsidy benefits between the tenant and the landowner. Whenever a land-owning farmer rents out land, the incidence question asks whether the tenant or land-owning farmer benefits from the policy. To the extent that rented land is owned by a non-farmer, the incidence denotes how much of each dollar leaves agriculture. In the United States, non-farmers own 94 percent of the rented land, or 340 million acres—twice the size of Texas (USDA, NASS 2001b). This makes the issue of subsidy incidence a particularly poignant one if agricultural subsidies are meant to benefit farmers. In effect, one can view the incidence as describing the portion of each subsidy dollar *not* going to a farmer.

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heterogeneity in estimating agricultural production functions.

3.2 Agricultural Subsidy Policy

A key component of domestic agricultural policy is the support of farmers' income. The U.S. farmers' income is supported by a two-tier system: 1) price supports and 2) income supports, i.e., subsidies. Price supports have existed since the farm program began in the 1930s. For most of the century, they were the chief mechanism for transferring money to the agricultural sector. Prices are supported by the government's promise to purchase the commodity at a predetermined price. Although the government once took direct possession of these purchases, today it generally augments the price the farmer receives from sales to a third party.

Income supports became a distinct objective with the introduction of production subsidies in 1973. Since their inception, subsidies have been calculated in a consistent way. An acre of land used to grow one of seven crops—wheat, corn, sorghum, barley, oats, rice, and cotton—could qualify to be subsidized. A qualifying acre receives a subsidy equal to a national subsidy rate times an output yield assigned to that acre. Between 1985 and 2002 the assigned yield, called a *program yield*, approximately equaled the farm-average yield between 1980 and 1985[4]. An acre that qualifies for a subsidy is called a *base acre*. A farm's total crop-specific subsidy is the product of the subsidy rate, the program yield, and the total number of base acres for that crop. That is,

subsidy = subsidy rate * program yield * base acres.

Prior to 1996, the subsidy rate was designed in a way that made subsidy payments counter-cyclical. This was done by calculating the crop-specific deficiency rate as the difference between a legislated *target price* and the national average price received. As the national average price fell, the difference between it and the target price increased, causing the subsidy to increase.

[4] Prior to 1985 the program yield was the 5-year Olympic average of the farm's annual yield. The current program yield is the average of the 1980 – 1985 program yields.

It is important to note that program yield and base acreage are specifically tied to a qualifying acre of land. As an acre changes ownership, these parameters are transferred with the land. As such, agricultural subsidies are factor-specific subsidies to land. However, not all land planted to a subsidized crop qualified for the subsidy because subsidies were closely associated with supply control measures through the base acreage allotment. Prior to 1996, total subsidized acres could not be greater than an average of the number of acres planted to that crop over the previous five years. If a farmer's planted acreage exceeded his base, he was disqualified from receiving subsidies for that year, although his increased planting would enter into a five-year moving average when calculating the farm's total base acres in subsequent years. This feature provided farmers with some means to affect current and future subsidies through current behavior. (See Duffy, et al. (1995) for an analysis of the effect of base acres on land values.)

As an additional supply control measure, farmers were required to remove a designated proportion of their base acres from production each year and leave it fallow. This program was called the Acreage Reduction Program (ARP), but it was commonly referred to as the "set-aside" program. The Department of Agriculture annually established the set-aside proportion, which could be as high as 25 percent. In 1992, producers were required to leave 5 percent of their wheat, corn, sorghum, and barley base acres fallow; 10 percent of their cotton base acres fallow; and none of their rice or oats base acres fallow.

These planting constraints and supply control measures imposed costs that kept many producers from participating in the subsidy program. Before 1996, participation rates usually ranged from 60 to 80 percent of qualified acres[5]. After the 1996 policy change, which removed the

[5] Land qualified to receive subsidies for oats is the single exception, where the participation has been between 20 and 40 percent of qualified acres

costly constraints, nearly all qualified acres were enrolled in the farm program.[6] The identification strategy relies, in part, on the cross-sectional variation in acres participating in the subsidy program.

3.2.1 The Federal Agricultural Improvement and Reform Act

The 1990s saw an end to the supply control measures and the completion of the process to decouple subsidies from contemporaneous production. In a dramatic move, the Federal Agricultural Improvement and Reform (FAIR) Act froze base acres at their 1995 level and removed all planting restrictions, including set-aside requirements. With the exception of certain fruits and vegetables, producers were given complete planting flexibility, while they still received subsidies based on their 1985 program yield and their 1995 acreage base. At the same time, the subsidy rate was no longer conditioned on the commodity's price, as it was before 1996, but it was exogenously determined by the policy. I exploit this innovation to identify the effect of subsidies on farmland rental rates.

Two aspects of this reform are significant to the analysis below. First, by freezing the farm-specific program parameters (program yield and base acres), the policy divorced farmer behavior from the subsidy. As described below, this unique feature of the legislation allows me to control for simultaneity that would otherwise serve to confound the incidence estimates. Second, the 1996 legislation removed the uncertainty of subsidy payments by establishing a schedule of annual payments from 1996 to 2002. I exploit the post-1995 known subsidy payments as an IV for pre-1995 *ex ante* uncertain subsidy payments. Failure to address this issue would result in attenuation bias of the incidence estimate.

[6] This variation will be used in future work by the author to measure the costs of program participation.

4 Data

The primary source of data used in the analysis described below is the U.S. Census of Agriculture, a quinquennial census of those who produce at least $1,000 of agricultural goods. These data are confidential micro files accessed under an agreement with the USDA Economic Research Service and the USDA National Agricultural Statistics Service (NASS). The data are available at NASS in Washington, DC[7].

The Census of Agriculture contains farm-level information such as total acres farmed, total acres rented, and total government payments received. It also contains detailed information on the number of acres harvested and the total production of each crop. The value of production is reported for 13 crop groups and for all livestock. The census also collects information on the corporate structure of the operation as well as demographic information on the primary operator.

Additionally, approximately one in three farms receives the census's long form which requests further information on the production and financial structure of the operation[8]. Recipients are asked to report production expenses in 15 cost groups, including cash rent paid on land and buildings. Recipients are further asked to report the estimated value of the farm's land and buildings. The long form also collects information on the type and amount of equipment used, the number of workers hired, and the use of agricultural chemicals and fertilizers.

4.1 Sample Selection

Two years of the Census of Agriculture, 1992 and 1997, are used to create a balanced panel of farming operations. Each year has roughly 1.6 million respondents. Although the total number

[7] Any interpretations and conclusions derived from the data represent the author's views and not necessarily those of NASS.

of respondents remains roughly equal over the two years, this masks a great deal of turnover (see Hoppe & Korb, 2001). There are 1,040,305 farm operations observed in both years of the data[9]. The population of interest is all farms that could potentially receive subsidies in the base year. I approximate that population by focusing on the 437,979 farms that grew any one of the seven program crops in the base year. The first column of Table 1 contains the summary statistics for this population. Because I am concerned with the financial structure of farming, I limit the sample to those who returned the long-form in both years, yielding 100,936 observations in each year. Since rental rates are the outcome of primary interest, I include only those who report paying cash rent in both years. I remove farms that are primarily renting structures by dropping those with imputed rental rates greater than two standard deviations above the mean[10]. The cutoff is $470, which is conservative considering the highest response to the 1997 June Agricultural Survey, a nationwide survey that specifically asked for cropland cash rental rates was $448. The final analysis sample consists of 58,302 farms observed over two years.

Table 1 contains the summary statistics of the estimation sample and the population of farms growing subsidized crops. The median farmer in this sample has operated a farm for 23 years, compared to 22 years in the population. The average net returns per acre to a farmer in the analysis are $92.50, a bit less than the average in the full sample of those reporting net returns. Of those receiving subsidies in the sample the average total government payment is $16,614. The median is $10,000. This suggests that a few farms receive large subsidies. The sample statistics of key variables can be found in Table 1.

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[8] The Census attempts to collect financial information from all farms with sales over $500,000, and randomly samples from the remaining farms.

[9] This is not indicative of the failure rate of farms, but rather the incomplete response rate to the census. About 85% of farm operations respond.

4.2 Variable Creation

4.2.1 Dependent Variable

The Census of Agriculture does not report the per-acre rental rate, however respondents do report the total amount paid in cash rent. The total acres rented on a cash, share, or free basis also are reported. From these two variables, I create the per-acre rental rate by dividing total cash rent by total acres rented. Admittedly, the resulting rental rate will be too small for farms that cash rent part of the land and share rent another part. This introduction of measurement error[11] into the dependent variable is of no concern unless the coincidence of cash and share rental arrangements is correlated with government payments. A look at more recent data (Agricultural Resource Management Survey, 2001) suggests that average per-acre subsidies are the same for farms that exclusively cash rent and those that both cash and share rent, which suggests that the induced measurement error does not bias the coefficient estimates.

4.2.2 Independent Variables

The subsidy variable is constructed from the reported government payments variables. Every agricultural producer is asked to report non-price support payments received from the government. Producers are asked to report both total payments received and payments received from the Conservation Reserve Program (CRP). By subtracting CRP payments from the reported total payments, I construct an approximate measure of subsidy receipts. In 1992, subsidies accounted for 68 percent of direct government payments net of Conservation Reserve Program payments. The remaining 32 percent are from disaster relief (17 percent) and other programs

[10] This drops less than 1% of the sample.
[11] The induced error is not classical measurement error, but rather a potential downward bias of the dependent variable. This results in a non-zero mean error, confounding the intercept but leaving the other coefficients unaffected.

(USDA, NASS, 1996). In 1997, even fewer total payments are attributable to non-subsidy sources, with only 4 percent of direct government payments going to neither subsidies nor CRP payments (USDA, NASS, 2001).

The remaining covariates are constructed directly from variables contained in the Census of Agriculture. All regressors are measured on a per-acre basis, using total farmland acres in the denominator.

5 Empirical Strategy – Identification

Here I lay out the obstacles that must be overcome in order to identify the effect of government subsidies on farmland rental rates. I begin by specifying a simple rental rate equation that, under ideal circumstances, yields the incidence measure. In the face of a less than ideal experiment, I lay out the modifications necessary to identify the parameters of the conditional expectation function. After setting out a fixed-effect estimation equation, I detail the instrumental variables procedure necessary to overcome attenuation bias in the econometric model. The resulting IV model overcomes the obstacles separating the real-world situation from the econometric ideal.

5.1 Econometric Ideal

If subsidies were randomly assigned, then the parameter identified by a regression of the rental rate on subsidy per acre would be the proportion of each extra subsidy dollar per acre reflected in higher rental rates. Denote the rent on acre i at time t by $r_{it,}$ and let g_{it} be the amount of subsidy payments associated with acre i. Then we may write

(1) $$r_{it} = \alpha + g_{it}\gamma^{*} + \eta_{it}$$

where η_{it} is the residual. Random assignment identifies γ^{*} as the incidence of agricultural subsidies on farmland rental rates.

However, subsidies are not randomly assigned, g_{it} is most likely correlated with η_{it}, and the resulting OLS estimate of γ in equation (1) will be biased. The subsidy is a function of yield and crop choice; hence, it is an endogenous variable reflecting the characteristics of the land and the producer's behavior. This endogeneity problem can be overcome by addressing three issues: unobserved heterogeneity, simultaneity, and farmer's expectation error due to the mistiming of rental contracts and subsidy payments[12]. The innovation of my analysis is to address all three problems and identify the parameter of interest in the conditional expectation function. First, I use farm fixed effects to control for unobserved heterogeneity, such as different land characteristics and entrepreneurial skill. Second, I control for simultaneity by exploiting a unique aspect of the policy change that divorced producer behavior from subsidy payments. Finally, I am able to overcome the expectation error by using an IV strategy.

The best instrumental variables for agricultural subsidies are the program parameters (program yield and base acres) underlying the subsidies. These parameters fulfill the requirements of instrumental variables because, as detailed below, within the fixed effects model they are highly correlated with the subsidy and plausibly uncorrelated with the error term. Data on the program parameters are unavailable at the farm level, but two farm level variables closely reflect the program parameters. They are the 1992 set-aside acres and the 1997 subsidy level. The 1992 acres that were set aside as part of the ARP are a linear function of the base acres, and the 1997 subsidy is a known, deterministic function of the underlying program parameters. These features allow me to

use the 1992 set-aside acres and the 1997 level of government payments as instrumental variables for the 1992-1997 change in government payments.

5.2 Unobserved Heterogeneity

Many farm characteristics cannot be observed by the econometrician, yet they are influential to both subsidies and farmland rental rates. Among these are farm-level soil properties and farmer human capital and entrepreneurial skill. Transient shocks, such as drought or pests, also may affect rental rates and government subsidies. Typical analyses are performed at the county or regional level, under the assumption of farm homogeneity within the geographic unit of observation. However, differences in farm size, structure, and productivity within a county serve to confound the conventional analysis[13].

The unique nature of the data allows me to control for permanent farm-level characteristics that cause γ to be inconsistent. One source of bias comes through the unobserved characteristics, such as farm productivity, that positively influence both subsidies and rental rates. This positive correlation between government payments and the unobserved factors that influence productivity will result in an upward bias to incidence estimates and confound γ as a measure of the effect of subsidies on rental rates. Including farm and time-varying county fixed effects allows me to overcome this source of bias. Rewriting equation (1) using f_{it} as the fixed effect for farm i in year t yields:

$$r_{it} = \alpha + g_{it}\gamma + \delta X_{it} + f_i + C_t + \varepsilon_{it} \quad (2)$$

[12] Measurement error will also be a problem as only 68% of government payments in 1992 were subsidies. This is much less of a problem in 1997 when 98% of government payments were subsidies. Instrumental variables techniques will address this issue.

[13] Current work by the author examines the information lost due to aggregation.

The parameter C_t is the time-varying county effect which allows for shocks, such as weather or pests, that impact everyone within a localized region. X_{it} is a vector of observable covariates such as yield, selection and production of crops, occurrence of irrigation, farm size, sales, and costs.

Controlling for unobserved heterogeneity in this way has the advantage of avoiding the inherently nonlinear relationships between soil characteristics and productivity. Because of this nonlinear relationship, even explicitly using soil characteristics as controls cannot overcome the omitted variable bias—a problem other researchers have faced (e.g. Moss, et al. 2002). This method of conditioning on unobserved farm-level characteristics also overcomes the bias inherent in studies on more aggregate units of observation (Lence and Mishra 2003).

The estimating equation used in this study is obtained from equation (2) by first differencing the data to absorb the farm effect, resulting in

$$\Delta r_i = C + \Delta g_i \gamma + \delta X_{i92} + \Delta \varepsilon_i \,. \tag{3}$$

The first difference of the control variables is not included because the 1997 level of these variables are potential outcomes influenced by the exogenous subsidy change. Instead, the 1992 values of these variables are included in the estimating equation. In a panel with t=2, the coefficients estimated from first difference data will be identical to those obtained by including the individual fixed effects.

5.3 Simultaneity Bias

Simultaneity bias arises when at least one of the explanatory variables is determined simultaneously along with the response variable. Prior to the 1996 FAIR Act, output prices played a role in determining both subsidies and rental rates. When expected prices were high, rental rates

were high and expected subsidies were low. Thus, simultaneity caused a negative relationship between the subsidy and the rental rate.

A unique feature of the 1996 FAIR Act allows me to exploit the policy change itself to overcome the simultaneity problem. The 1996 legislation was titled the "Freedom to Farm Act" because it lifted planting restrictions and divorced the subsidy from prices and producers' behavior. Such a divorce meant that prices no longer determined the subsidy rate, and simultaneity bias ceased to be a problem for the incidence estimates. Hence, the policy provides an exogenous change in subsidy rates, and its structure eliminates the obstacle to identification caused by simultaneity bias.

5.4 Expectation Error

Without the obstacle of simultaneity bias, the remaining problem to be addressed is expectation error, which causes attenuation bias. As detailed earlier (see Section 3.1), rental rates are set according to *expected* receipts, including expected subsidy payments. Prior to the 1996 FAIR Act, subsidy payments were conditioned on the market price and thus were unknown until after the harvest, while rental rates were agreed upon before planting in the spring. To see the effects of this mistiming on the incidence parameter, rewrite equation (2) using the *expected* government payments, g_{it}^{*},

$$r_{it} = \alpha + g_{it}^{*}\gamma + f_i + C_t + \varepsilon_{it}. \tag{4}$$

Actual government payments will equal the expected government payment and an expectation error,

$$g_{it} = g_{it}^{*} + \varepsilon_{it}^{g}. \tag{5}$$

Substituting for expected subsidy receipts in equation (4) yields

$$r_{it} = \alpha + g_{it}\gamma + f_i + C_t + \varepsilon_{it} - \varepsilon_{it}^{g}. \tag{6}$$

The expectation error becomes part of the error term in the estimating equation. Assuming the expected subsidy and the expectation error are uncorrelated, i.e. $Cov\left(g_{it}^{*}, \varepsilon_{is}^{g}\right) = 0 \forall t, s$, implies that realized government payments, g_{it}, are correlated with the error term in equation (6). The effect on the coefficient of interest is the same as classical errors in variables, namely attenuation bias.

The 1996 FAIR Act reduces the complexity of the problem by eliminating expectation error in 1997. Recall that in 1996 the subsidy rates were exogenously predetermined for the next seven years. Because of this feature of the legislation, there was no expectation error in 1997. The expected government payments for 1997 and 1992, respectively, are:

(7) $$g_{i97}^{*} = g_{i97},$$

(8) $$g_{i92}^{*} = g_{i92} - \varepsilon_{i92}^{g}.$$

Substituting (7) and (8) into equation (2) and first differencing results in

(9) $$\Delta r_i = C + \Delta g_i \gamma + \Delta \varepsilon_i - \varepsilon_{i92}^{g}.$$

An adequate instrument is correlated with the change in government subsidies and uncorrelated with the composite error term in equation (9). Two variables meet these requirements, the 1992 set-aside acres, denoted as sa_{i92}, and the 1997 subsidy level. Both variables are assumed to be strictly exogenous. That is, conditional on the fixed effects, sa_{i92} and g_{i97} are uncorrelated with both ε_{i92} and ε_{i97}. Thus, they are uncorrelated with $\Delta\varepsilon_i$. Furthermore, both variables are uncorrelated with the second error term, ε_{i92}^{g}. The 1992 set-aside acres are proportional to the base acres, and are known when rental rates are set. Thus, under rational expectations, the 1992 set-aside acreage is uncorrelated with the expectation error. The 1997 subsidy level is uncorrelated with the second error term due to the absence of expectation error in 1997 which allows one to write the

orthogonality condition as $E\left(\varepsilon_{i92}^{g} g_{i97}^{*}\right) = 0$. This condition holds if the subsidy shock in 1992 contained no information for the expected subsidy in 1997, a reasonable assumption.

Since the 1997 level of government payments is uncorrelated with the composite error, it is therefore a good instrumental variable insofar as it is correlated with the 1992-1997 change in government payments. The top panel of Table 4 contains the results of the following first stage equation of a two-stage least squares estimation strategy:

(10) $$\Delta g_i = C + g_{i97}\delta + sa_{i92}\zeta + u_i .$$

The coefficient of variation and the F-statistics are very high for both instruments, satisfying the requirement that the instruments are correlated with the endogenous variable.

6 Estimation and Results

6.1 Ordinary Least Squares

6.1.1 A Cross-Sectional Approach

The approach taken by this paper has the advantage of controlling for unobserved characteristics of the farm, such as the operators entrepreneurial skill and the productivity of the land. Estimates that fail to account for these characteristics likely suffer an upward bias as productivity and skill are probably positively correlated with the subsidy. Subsidies are a direct function of the productivity of the land, and more skillful farm operators may better understand the complexities involved in maximizing subsidy payments. Estimation methods that fail to adequately control for these variables will attribute rental rate variation to the subsidy that should be attributed to productivity and skill.

I explore the consequences of unobserved heterogeneity by ignoring the panel nature of the data and estimating the incidence in each year separately and in the pooled cross-section. Table 2 contains the results of this exercise. Panel A reports the estimates for 1992, panel B reports the estimates for 1997, and panel C reports the estimates obtained by pooling the two cross-sections. Column one contains the results of a bivariate regression of the rental rate on the per-acre subsidy, while column two includes as covariates the proportion of the farm planted to 13 different crop groups, the output yield of 8 crops, sales, variable factor expenditures, farm size, and the proportion irrigated. It is noteworthy that in 1992, the incidence estimate found from the simple bivariate relationship is far below perfect incidence. In fact, the estimate in column one suggests that only 46 cents of the marginal subsidy dollar is reflected in rental rates. As controls are added, the incidence estimates change dramatically, falling nearly fifty percent in panels B and C, with a 30 percent drop in panel A.

In such a setting, county fixed effects may adequately control for unobserved heterogeneity if farms within a county are sufficiently homogeneous. Columns three and four present the incidence estimates when a county fixed effect is included. The specification reported in column three includes no covariates, and it yields incidence estimates very similar to those in column 2. Column four includes covariates, and the incidence estimate declines even more to 0.23 in the 1992 cross-section, 0.39 in the 1997 cross-section, and 0.26 in the pooled cross-sections.

A notable feature of Table 2 is the extensive change in the incidence estimate as more controls are added. This parameter instability causes one to wonder how much bias continues to exist because of other unobservable and excluded covariates.

6.1.2 A New Approach

Table 3 contains the incidence estimates when I control for unobserved heterogeneity, as delineated in equation (3) above. Columns one and two report the coefficient from a random and fixed effects regression respectively. The random effects regression will be consistent and efficient if the unobserved qualities of the farm are uncorrelated with the regressor (here per-acre government payments). However, the random effects model will be inconsistent if the farm effects are correlated with the regressors. Performing a Hausman test on the appropriateness of the random effects model effectively tests whether the unobserved farm characteristics are in fact biasing the estimate. The Hausman test statistic is reported at the bottom of columns one and two in Table 3. It soundly rejects the random effects model, suggesting that one should be concerned with unobserved heterogeneity when seeking a consistent estimate of the incidence parameter.

Columns two and three of Table 3 report the results of the fixed effects model including farm and time-varying county effects. Column two contains no covariates, while column three includes the 1992 level of the covariates listed above. As noted earlier, the 1997 values of these covariates are potential outcomes affected by the changing subsidy and their inclusion in this specification would serve to confound the incidence estimate. Compared to the estimates in Table 2, the incidence estimate is lower once one accounts for unobserved farm characteristics, signifying a decrease in the upward bias. Another important feature of columns two and three is the stability of the incidence estimates. Once farm fixed effects are included, additional covariates do little to change the estimate, suggesting that farm fixed effects account well for potential sources of bias.

The most notable characteristic of Table 3 is the low incidence estimate; the estimated incidence is only 0.18. In other words, 18 cents of the marginal subsidy dollar is reflected in higher rental rates. As discussed earlier, conventional wisdom and economic theory suggest that the land owner should capture all of the Ricardian rents, including the subsidy. The evidence presented here

suggests that the truth lies far from perfect incidence; the landlord is only able to capture 18 cents of the marginal subsidy dollar.

One may be concerned that this estimate suffers from attenuation bias caused by measurement error or expectation error. The next section details the instrumental variables strategy used to account for these sources of bias and demonstrates that the conclusions reached above are essentially unchanged.

6.2 Instrumental Variables

As discussed earlier, the measurement error and expectation error concerns apply to the 1992 government payments and can be addressed with instrumental variables. The ideal instruments for 1992 government payments would be the farm-specific subsidy parameters: program yield and base acres. These parameters are known in advance, are highly correlated with actual subsidy payments, and are uncorrelated with the idiosyncratic shocks to prices that ultimately determine subsidy payments. Thus, program yield and base acres are good instruments because they are correlated with the realized subsidy payment and uncorrelated with shocks that contribute to the expectation error.

Unfortunately, data on program yields and base acres are unavailable. In order to closely approximate the ideal instruments and stay within the constraints on data availability one must look to linear functions of these variables, such as set-aside acres and 1997 government payments.

Since set-aside acres are an exogenously determined proportion of base acres they provide a good instrument for the 1992 subsidy level. As noted earlier, base acres are known when the rental contracts are agreed upon, thus they are highly correlated with the expected subsidy. The 1997 subsidy payments are a potentially good instrument because in 1997 the subsidy on an acre of

qualified land equaled the 1992 program yield multiplied by the 1997 subsidy rate. The 1997 subsidy should thus be highly correlated with the ideal instrument, the 1992 program parameters.

The first panel of Table 4 reports the first stage of a two-stage least squares estimation strategy. Column one reports the coefficients and the F-statistic when no covariates are included in the fixed effects specification. Both instruments are significant predictors of the change in subsidies. The F-statistic is 20,011. Stock and Staiger (1997) have suggested that strong instruments have an F-statistic greater than five. These instruments easily meet the criteria.

The second panel of Table 4 reports the IV estimates. The IV estimates, 0.186 and 0.214, are slightly higher than the OLS estimates, revealing some attenuation. However, the small difference between the OLS and IV estimates suggests that expectation error is not a large concern in this investigation.

By accounting for the potential sources of bias, namely unobserved heterogeneity, simultaneity bias, and expectation error, I have found that the landlord captures only 20 cents of the marginal subsidy dollar. Economic theory predicts that if land is the only specific factor of production and if markets are perfectly competitive then the landlord will capture the entire marginal subsidy dollar. These findings call into question the validity of these assumptions in the short run.

6.3 The Heterogeneity of Rental Rate Incidence across Region and Farm Size

One might be concerned that the results presented mask variation in response across region or the size of the farm operation. Regions within the U.S. differ substantially in the crops grown and the predominant lease contract type. Noting that each crop is subsidized separately, one might worry that the incidence differs according to crop and subsidy regime. Farm size might also

influence the size of the incidence. For instance, perhaps large farms are better able to negotiate for lower rental rates, and they are driving the relatively low incidence. I explore the robustness of the results by estimating the incidence separately for different regions and different farm sizes.

6.3.1 Resource Regions

Table 5 reports the regional[14] mean and median rental rates and per-acre subsidies for 1992 and 1997. This Table highlights the heterogeneity in both the levels and in the 1992-1997 changes of these variables. Five of the nine regions experienced a decline in mean and median rental rates. While the average per-acre subsidy almost uniformly declined, five of the regions experience an increase in the median per-acre subsidy.

Table 6 presents the OLS and IV incidence estimates by resource region. A prominent feature across resource regions is the stability of the incidence estimate, which generally ranges from 0.17 to 0.30 with a couple of zeros. The incidence is somewhat higher in the Heartland region, where subsidized crops are a significant share of output. Regions with fewer farms and less subsidized crop production generally have lower incidence, sometimes not significantly different than zero, but nearly always significantly different than one. In spite of regional differences highlighted in Table 5, the incidence estimates are all relatively similar; no one region seems to be driving the results.

6.3.2 Sales Class

Another concern could be that the incidence differs by farm size. Large farms might be able to negotiate lower rental rates and thereby keep a larger share of the subsidy. Alternatively, small farms might be better acquainted with the landlord and hence receive a more favorable rental rate.

In the analysis below I define farm size to be gross sales, and I adopt the classification system espoused by the USDA.[15]

Table 7 reports the summary statistics for rental rates and per-acre subsidies by sales class. Interestingly, both rental rates and subsidies monotonically increase with sales class, presumably reflecting the higher productivity of the land farmed by larger farms.

Columns one and two of Table 7 report the estimated subsidy incidence when the data are treated as pooled cross-sections and the panel nature of the data is ignored. These columns reveal a significant degree of variation in the estimated incidence across farm size when one fails to control for the unobserved characteristics of the farm. Notably, the incidence estimates are smallest for the smallest and largest farms, suggesting that the unobserved characteristics are more highly correlated with size for these two sales classes than for the others. The change in the estimate once controls are added is also noteworthy. The relative instability of these estimates supports the position that the unobserved farm characteristics may play a role in biasing the incidence estimate.

Columns three through six report the OLS and IV estimates once unobserved heterogeneity is accounted for. The incidence estimates do not significantly differ across farm sizes, ultimately settling around 0.2. These results give further confidence in the twenty percent incidence reported above.

7 Interpretation

Economic theory predicts, and economists have long held, that under competitive markets, incidence is perfect and landlords are able to extract the entire marginal subsidy dollar. Intuitively, a subsidized parcel of farmland should result in competition among renters to secure the subsidy.

[14] The USDA has established 9 resource regions corresponding to predominant crop mix and farming practices.

Such competition will result in an increased rental rate as potential tenants bid against each other until ultimately the price of that parcel of land fully reflects the return from the subsidy. The evidence presented here suggests that this does not always happen. In the short-run, competition only serves to increase the rental rate by 20 cents. A possible explanation of this fact is imperfect rental markets. In a market with many landlords and few renters, the landlords may implicitly share the subsidy dollar in an attempt to attract tenants.

In order to examine this hypothesis I create five measures of rental market concentration. The first measure is the proportion of farmers in a county who rent some land, and the second is the proportion of farmland in a county that is rented. The next measure is an approximation of the tenant-landlord ratio within a county. This measure is an approximation because each farmer reports the number of landlords from whom they rent land, but there is no way to tell whether a single landlord rents to multiple tenants. This approximate tenant-landlord ratio will be lower than the actual ratio. Finally, I calculate two Herfindahl indexes to measure rental market concentration. One Herfindahl defines market share over total county rental expenditure, the other defines market share over the total number of rented acres. I interact these measures with the change in government payments in order to determine whether the marginal effect of subsidies changes as rental markets become less concentrated.

The results from this exercise are found in Table 9. If rental market imperfections do not play a role, I should see no relationship between the incidence and rental market concentration. These results suggest that I can safely reject the null hypothesis that the subsidy incidence is not related to rental market concentration. Nearly every measure of concentration returns a sign and magnitude that is consistent with the alternative hypothesis that subsidy incidence decreases with rental market concentration. For instance, the first row of Table 9 indicates that if all farms in a

[15] For example, see http://www.ers.usda.gov/Briefing/FarmStructure/Gallery/farmsbyconstantdollars.htm

county rented land the incidence would increase to about 25 percent. These findings suggest that rental market imperfection is a plausible explanation for the incidence finding reported above.

8 Variable Factors of Production

Agricultural subsidies are *de facto* specific subsidies to land. As such, they serve to reduce the rental price of land. A 20 percent subsidy incidence on landlords, as found above, implies that the marginal per-acre subsidy dollar lowers the rental rate by 80 cents.

By lowering the rental rate of land, the subsidy changes the relative prices of the factors of production. The altered relative prices will have an indeterminate impact on the use of non-land inputs. Because the relative price of non-land inputs has increased, producers will substitute away from them toward the relatively cheaper land. At the same time, since total costs are lower, the farmer may expand output and demand more non-land variable inputs. The net result on the non-land factors of production is theoretically ambiguous.

The subsidy will directly affect the demand for land. Facing a lower rental rate, farmers will rent more acres. The first row of Table 10 supports this implication. Since the number of rented acres will have a mechanical, negative relationship with the subsidy *per acre*, the rented acres are regressed on the total subsidy. One should thus interpret the coefficient as the change in rented acres due to the marginal subsidy dollar rather than the marginal subsidy dollar per acre. The results of this estimation suggest that increasing the subsidy by one dollar per acre (a total increase of $1,040 for the median farm) leads to between one and three more acres rented. This result supports the theoretical prediction about the direct effect of subsidies.

I measure the indirect effect of subsidies on non-land variable factors of production by applying the empirical strategy developed above to expenditures on 13 variable factors of

production. The data on variable input expenditures are reported by those returning the census long form. Using the same sample of cash renters as above, I treat the expenditure on each input as the dependent variable and estimate the effect of subsidies using equation (9).

The appropriate specification in this setting differs slightly from that used above in order to adequately account for the trend in expenditures. The time-varying county effect not only captures local shocks, but also accounts for the county-specific trend in expenditure. If the expenditure trend is proportional to the farm size then the per-acre transformation is sufficient for the county effect to capture the change. However, if the trend is proportional to total expenditures and not to farm size then a log-log specification would be preferred. It stands to reason that factor expenditure growth for livestock and feed, for instance, will not be proportional to the acres farmed. Therefore, a more appropriate specification is the log-log model.

Table 10 reports the OLS coefficient on government payments for each of the 13 factor expenditure regressions and for a total expenditure regression. All of the regressions include a complete set of covariates as specified earlier. For comparison purposes, column one reports the results from the per-acre specification. The largest response comes from expenditures that are least likely to grow in proportion to farm size, such as livestock and feed. Column two of Table 10 reports the elasticity estimates from a log-log specification. Columns three and four report the incidence which is calculated by evaluating each elasticity at the mean and median of the dependent and independent variables. Using OLS, I estimate that the marginal subsidy dollar result in a 35 cent increase of total variable factor expenditures.

Expenditures might also suffer from expectation error in much the same way as rental rates. To account for this, I instrument for the change in government payments using the 1992 set-aside

acres and the 1997 government payments. Table 11 reports the IV estimates. The estimate is essentially unchanged from the OLS.

The indirect effect of the subsidy increases expenditure on variable factors by about 35 cents, revealing a positive production response to the factor-specific subsidy. This response is consistent with the cost of farming an additional acre of land. As noted above, increasing the subsidy payment by one dollar per acre for the median farm would increase the total subsidy payment by $1,040 and result in about one more acre rented. The average cost of farming an acre of land, according to the summary statistics in Table 1, is about $385. The expenditure results imply that an extra $1,040 subsidy results in $365 more dollars spent on other variable factors of production, an amount consistent with the cost of farming one additional acre. This result is noteworthy since under WTO rules subsidies are allowed if they are nondistortionary. The evidence presented here suggests that these subsidies might not meet that criterion.

9 Tenant's Incidence

The above analysis found landlords capturing 20 cents of the marginal subsidy dollar, and tenants increasing expenditures on variable inputs by 35 cents. Yet the question of how the subsidy ultimately affects the tenant remains. If variable inputs are perfectly elastically supplied, and the farmer is a risk-neutral profit maximizer, then one would expect the farmer's net returns to increase by at least 80 cents. The production response should not dissipate the subsidy incidence on the tenant. Using the same empirical strategy as the one detailed in section 5, I measure the tenant's incidence by regressing net returns on government payments. Here the instrumental variable strategy is slightly different. There is no expectation error associated with the dependent variable in this specification; net returns are calculated as the total revenue (including government payments)

less total variable costs. However, measurement error in the 1992 subsidy measure remains. Fortunately, for the same economic reasons as above, the 1997 subsidy level is an appropriate instrument for the change. Namely, the cross-sectional variation in 1997 subsidy payments accurately reflects the variation in program yield and base acres, and these parameters are independent of the component of 1992 subsidies that suffers from measurement error.

Table 12 reports the ultimate effect of the marginal subsidy dollar on the farmer's net returns. As with the other estimates, the IV in columns three and four results are slightly larger the OLS results in columns one and two, but the result is consistent. Tenants ultimately benefit one for one from the marginal subsidy dollar. The production response outlined above seems to be sufficient to make up for the 20 cents extracted by the landlord.

10 Conclusion

This paper has investigated the direct effect of agricultural subsidies on farmland rental rates, the indirect effect on other factors of production, and the ultimate effect on the farm operator. In the investigation, I have overcome three significant obstacles: unobserved heterogeneity, simultaneity, and expectation errors. Using a nationally representative dataset of individual farms, I have controlled for unobserved heterogeneity with fixed effects. I exploited the 1996 FAIR Act to account for any concern about simultaneity bias, and I used IV techniques to overcome measurement and expectation error, thereby identifying the effect of subsidies on rental rates. The analyses are based on individual-level data from 1992 and 1997, years that bracket the 1996 policy change.

The evidence on the incidence of agricultural subsidies demonstrates that some, but not all, of the subsidy is passed to landlords. The point estimates suggest that, on average, about 20 cents

of the marginal subsidy dollar per acre are passed to landowners in the form of higher rents. Considering that 94 percent of landlords are not farmers, this incidence implies that if all subsidy recipients were tenant farmers, then non-farmer landlords would have received about $1.1 billion of the $5.5 billion in agricultural subsidies paid to farmers in 1997, signifying a "leakage" of 20 percent. Of course, not all subsidy recipients are tenants, and the distribution of subsidy payments between tenants and owners will result in a lower leakage. Overall, a vast majority of the aid to farmers stays in the farm sector. Evidence was presented indicating that tenants ultimately benefit one-for-one from the marginal subsidy dollar. Farm policy appears to accomplish its stated purpose to increase farmers' income.

The evidence presented in this paper also demonstrates the production effects caused by agricultural subsidies. Because incidence is incomplete and the subsidy is factor-specific, the marginal subsidy dollar effectively reduces the farmland rental rate by 80 cents. In response, farmers rent more land and purchase more variable inputs in order to produce a crop on the extra acreage. Overall, the marginal subsidy dollar increases variable factor expenditures by 35 cents. As a result of the production response, farmers ultimately benefit one-for-one from the marginal subsidy dollar.

These results provide a first step in accurately characterizing the farmland rental market. The body of literature that has investigated the effect of government payments on land values has typically assumed full incidence because land has a zero elasticity of supply while all other factor inputs are supplied with infinite elasticity. However, this paper's results show that in the short-run such an assumption is untenable.

Future work should investigate the role played by market imperfections or sticky prices in the farmland rental market. Imperfect rental markets provide a plausible explanation; the evidence

presented suggests that the incidence may increase to twenty-five percent if all farmers within a county were tenants. A large presence of long-term tenant-landlord relationships might cause rental rates to adjust slowly. Incidence may be higher in the long run as rents adjust when new tenant-landlord relationships are formed, but the time frame of this analysis could be too short to capture this occurrence.

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Table 1
Summary Statistics: U.S. Census of Agriculture Micro Files

		Program Crop Producers *N=437,979*		Sampled Renters *N=58,302*	
		Mean	Median	Mean	Median
Variable	Year	(1)	(2)	(3)	(4)
Size (Acres)	1992	762.299	393.493	1,638.330	1,040.000
	1997	773.972	378.046	1,743.750	1,116.000
Sales ($/Acre)	1992	323.821	168.514	465.250	299.546
	1997	660.872	173.555	483.460	303.898
Expenditures ($/Acre)	1992	155.941	3.370	369.717	233.362
	1997	329.403	0.369	385.997	230.172
Irrigated Acres	1992	386.035	223.562	138.924	0.000
	1997	437.385	244.905	161.452	0.000
Proportion in Pasture	1992	0.102	0.000	0.135	0.015
	1997	0.111	0.000	0.133	0.008
Proportion Irrigated	1992	0.443	0.394	0.100	0.000
	1997	0.463	0.416	0.106	0.000
Proportion in Cropland	1992	0.803	0.900	0.821	0.912
	1997	0.771	0.883	0.824	0.921
Subsidies ($)	1992	6,677.59	1,548.71	17,234.20	10,393.93
(including zeros)	1997	5,556.14	1,595.33	14,287.55	9,919.00
Subsidies ($)	1992	11,173.13	5,886.43	22,643.12	15,447.56
(exluding zeros)	1997	8,507.25	4,549.02	17,918.44	13,900.00
Subsidies ($/ Acre)	1992	8.760	3.936	12.947	9.514
(including zeros)	1997	7.179	4.220	11.085	9.000
Subsidies ($/ Acre)	1992	14.657	14.959	17.011	13.541
(exluding zeros)	1997	10.992	12.033	13.902	11.687
Rental Rate ($/ Acre)	1992	n/a	n/a	47.605	34.468
	1997	n/a	n/a	50.123	36.543

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. All monetary values have been adjusted to 1997 dollars.

Table 2 - Annual Cross Sections
Effect of Subsidies on Farmland Rental Rates
Dep Var: Farm Average Rental Rate ($/acre)
Farm Level Analysis

	No Controls (1)	Covariates (2)	County Fixed Effects (3)	County Fixed Effects and Covariates (4)
	A. 1992 Cross Section			
Government Payments	0.463 **	0.309 **	0.261 **	0.199 **
	(0.013)	(0.015)	(0.012)	(0.013)
Sales		0.033 **		0.021 **
		(0.009)		(0.001)
Costs		-0.029 **		-0.019 **
		(0.010)		(0.001)
Farm Size (Acres)		-0.452		-0.200
		(0.095)		(0.064)
Proportion Irrigated		22.282 **		29.985 **
		(1.073)		(1.377)
Proportion Pasture		-33.222 **		-14.006 **
		(1.168)		(1.463)
	B. 1997 Cross Section			
Government Payments	0.946 **	0.493 **	0.424 **	0.320 **
	(0.022)	(0.022)	(0.017)	(0.017)
Sales		0.019 **		0.011 **
		(0.004)		(0.001)
Costs		-0.013 **		-0.008 **
		(0.003)		(0.001)
Farm Size (Acres)		-0.295 **		-0.086
		(0.052)		(0.064)
Proportion Irrigated		23.441 **		27.648 **
		(1.072)		(1.422)
Proportion Pasture		-33.341 **		-16.732 **
		(1.343)		(1.553)
	C. Pooled Cross Sections			
Government Payments	0.645 **	0.371 **	0.303 **	0.230 **
	(0.000)	(0.012)	(0.010)	(0.010)
Sales		0.022 **		0.014 **
		(0.004)		(0.000)
Costs		-0.017 **		-0.011 **
		(0.004)		(0.000)
Farm Size (Acres)		-0.372 **		-0.141 **
		(0.050)		(0.045)
Proportion Irrigated		23.284 **		29.251 **
		(0.762)		(0.978)
Proportion Pasture		-33.097 **		-14.888 **
		(0.907)		(1.052)

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. Heteroskedasticity-robust standard errors are shown in parentheses. The dependent variable is cash rental rate. When included, the covariates are the 1992 values; the 1997 values are not included because they are potential outcomes. The controls are the 1992 values of per-acre sales, per-acre variable costs excluding rent, farm size (1,000s of acres), proportion of farmland that is irrigated, proportion of farmland in pasture or range, proportion of total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, fruits & nuts, and other crops. All monetary values have been adjusted to 1997 dollars. ** indicates significance at 99th percentile.

Table 3 - Individual Farm Effects Estimates
Dependent Variable: 1992 - 1997 Change in the Cash Rental Rate

	Random Effects (1)	Farm Fixed Effects (2)	County x Time Effects (3)	Time Effect (4)
Government Payments	0.408 **	0.183 **	0.183 **	0.172 **
	(0.009)	(0.061)	(0.018)	(0.018)
Sales			-0.008	-0.007
			(0.005)	(0.006)
Costs			0.007	0.006
			(0.006)	(0.007)
Farm Size (Acres)			0.099	0.109
			(0.055)	(0.051)
Proportion Irrigated			-5.269 **	1.038
			(1.958)	(1.321)
Proportion Pasture			-4.678 **	-1.790
			(1.845)	(1.564)
Hausman Test	1033.100			
p -value	(0.000)			

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. Heteroskedasticity-robust standard errors are shown in parentheses. The dependent variable is the change in the cash rental rate, except in the random effects model where the dependent variable is the cash rental rate. When included, the covariates are the 1992 values; the 1997 values are not included because they are potential outcomes. The controls are the 1992 values of per-acre sales, per-acre variable costs excluding rent, farm size (1,000s of acres), proportion of farmland that is irrigated, proportion of farmland in pasture or range, proportion of total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, fruits & nuts, and other crops. All dollars have been inflated to 1997 dollars. ** indicates significance at 99th percentile.

Table 4 - Farm Effects IV Estimates
1992 Set-aside and 1997 Subsidy as Instruments

	No Covariates (1)		Covariates (2)	
	A. First Stage			
1997 Government	0.830	**	0.902	**
Payments	(0.005)		(0.004)	
1992 Set-Aside	-327.517	**	-323.647	**
Acres	(2.771)		(2.636)	
Sales			0.0005	**
			(0.0002)	
Costs			-0.0007	**
			(0.0003)	
Farm Size			0.1527	**
			(0.0183)	
Proportion Irrigated			-3.112	**
			(0.3941)	
Proportion Pasture			3.644	**
			(0.4185)	
First Stage *F* -stat	20,011		2,057	
R^2	0.31		0.51	
	B. IV Estimates			
Government	0.186	**	0.214	**
Payments	(0.020)		(0.019)	
Sales			-0.0075	**
			(0.0011)	
Costs			0.0065	**
			(0.0013)	
Farm Size			0.098	**
			(0.0808)	
Proportion Irrigated			-4.953	**
			(1.7449)	
Proportion Pasture			-4.778	
			(1.8513)	
Overidentification Test	20.77		21.25	
p -value	0.00		0.38	

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. Standard errors are shown in parentheses. The dependent variable is the change in the cash rental rate. All specifications include a farm fixed effect and a time-varying county fixed effect. The instruments are the proportion of the farm enrolled in set-aside in 1992 and the per-acre subsidies in 1997. When included, the covariates are the 1992 values of the variable; the 1997 values are not included because they are potential outcomes. The controls are the 1992 values of per-acre sales, per-acre variable costs excluding rent, farm size (1,000s of acres), proportion of farmland that is irrigated, proportion of farmland in pasture or range, proportion of total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, fruits & nuts, and other crops. All dollars have been inflated to 1997 dollars. In panel A, the F-statistic is for the test of whether the coefficients on the instruments are jointly equal to zero. In panel B, the F-statistic is for the test of overidentifying restrictions. **indicates significance at the 99th percentile.

Table 5 - Region Summary Statistics

Region		Rental Rate Mean (1)	Rental Rate Median (2)	Subsidy per Acre Mean (3)	Subsidy per Acre Median (4)
Heartland	1992	55.28	48.84	13.62	12.51
N=18,920	1997	60.28	53.92	13.79	12.77
Northern	1992	49.75	39.43	9.11	5.04
Crescent	1997	50.06	38.87	8.83	6.87
N=10,280					
Northern	1992	25.85	16.83	9.01	7.66
Great Plains	1997	25.08	18.07	6.53	5.54
N=6,198					
Prarie	1992	19.50	10.79	10.84	7.87
Gateway	1997	19.68	10.81	7.94	5.98
N=7,049					
Eastern	1992	28.48	19.45	6.85	0.00
Uplands	1997	25.40	17.05	5.49	2.11
N=1,921					
Southern	1992	53.24	38.99	8.69	2.00
Seaboard	1997	51.55	37.50	8.40	5.19
N=6,250					
Fruitful Rim	1992	70.75	53.45	22.15	7.77
N=3,358	1997	73.45	55.56	14.01	7.18
Basin and	1992	42.80	24.00	6.90	1.59
Range	1997	42.62	20.71	5.43	2.00
N=1,263					
Mississippi	1992	35.88	28.48	27.29	20.46
Portal	1997	34.75	26.43	16.74	13.68
N=3,063					

Notes: Data are from the confidential microfiles of the Census of Agriculture. Regions are as defined by the USDA's Economic Research Service as Farm Resource Regions.

Table 6 - Regional Incidence Estimates

	OLS				IV			
Region	No Covariates (1)		Covariates (2)		No Covariates (3)		Covariates (4)	
Heartland	0.274	**	0.288	**	0.270	**	0.294	**
	(0.051)		(0.050)		(0.030)		(0.030)	
Northern Crescent	0.137	**	0.148	**	0.150	**	0.173	**
	(0.056)		(0.056)		(0.053)		(0.053)	
Northern Great Plains	0.063		0.065		0.063		0.146	**
	(0.074)		(0.073)		(0.068)		(0.068)	
Prarie Gateway	0.222	**	0.190	**	0.121	**	0.171	**
	(0.044)		(0.042)		(0.049)		(0.047)	
Eastern Uplands	0.033		0.041		0.003		0.074	
	(0.066)		(0.072)		(0.113)		(0.114)	
Southern Seaboard	0.194	**	0.216	**	0.255	**	0.315	**
	(0.051)		(0.055)		(0.064)		(0.064)	
Fruitful Rim	0.221	**	0.235	**	0.240	**	0.259	**
	(0.055)		(0.055)		(0.082)		(0.064)	
Basin and Range	0.040		0.006		0.082		0.087	
	(0.134)		(0.116)		(0.142)		(0.155)	
Mississippi Portal	0.137	**	0.107	**	0.164	**	0.166	**
	(0.028)		(0.028)		(0.043)		(0.039)	

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. Heteroskedasticity-robust standard errors are shown in parentheses. The dependent variable is cash rental rate. When included, the covariates are the 1992 values; the 1997 values are not included because they are potential outcomes. The controls are the 1992 values of per-acre sales, per-acre variable costs excluding rent, farm size (1,000s of acres), proportion of farmland that is irrigated, proportion of farmland in pasture or range, proportion of total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, fruits & nuts, and other crops. All monetary values have been adjusted to 1997 dollars. ** indicates significance at 99th percentile.

Table 7 - Summary Statistics by Sales Class

1992 Sales		Rental Rate Mean (1)	Rental Rate Median (2)	Subsidy per Acre Mean (3)	Subsidy per Acre Median (4)
< $10,000	1992	24.56	16.41	3.01	0.00
N= 2,597	1997	27.65	17.05	4.94	0.00
$10,000 - $100,000	1992	35.45	23.71	8.87	4.15
N= 31,587	1997	32.97	20.63	7.53	4.37
$100,000 - $250,000	1992	41.86	30.09	12.17	8.59
N= 57,091	1997	44.48	32.01	10.57	8.54
$250,000 - $500,000	1992	49.03	37.61	13.38	10.83
N= 49,222	1997	50.01	38.76	12.16	10.51
$500,000 +	1992	60.43	47.74	15.06	11.29
N= 26,562	1997	64.35	50.46	12.45	10.69

Notes: Data are from confidential U.S. Census of Agriculture microfiles. Sale class taxonomy as used by the USDA Economic Research Service. Statistics weighted by sample weights developed by the USDA National Agricultural Statistical Service. Observations per sales class represent weighted totals.

Table 8 - Sales Class Incidence Estimates

	OLS No Fixed Effects		OLS Fixed Effects		IV Fixed Effects	
1992 Sales	No Covariates (1)	Covariates (2)	No Covariates (3)	Covariates (4)	No Covariates (3)	Covariates (4)
< $10,000	0.411 **	0.195	-0.360	-1.027	-0.207	-4.644
	(0.098)	(0.110)	(0.852)	(1.826)	(1.707)	(11.708)
$10,000 - $100,000	0.615 **	0.334 **	0.221 **	0.227 **	0.100	0.192 **
	(0.021)	(0.021)	(0.055)	(0.055)	(0.083)	(0.079)
$100,000 - $250,000	0.671 **	0.463 **	0.190 **	0.173 **	0.152 **	0.211 **
	(0.018)	(0.021)	(0.024)	(0.024)	(0.041)	(0.038)
$250,000 - $500,000	0.541 **	0.429 **	0.171 **	0.180 **	0.177 **	0.211 **
	(0.020)	(0.022)	(0.022)	(0.023)	(0.032)	(0.031)
$500,000 +	0.425 **	0.294 **	0.184 **	0.208 **	0.222 **	0.244 **
	(0.026)	(0.027)	(0.031)	(0.032)	(0.046)	(0.045)

Notes: Dependent variable is the rental rate. Columns three through six are estimated in first differences; there the dependent variable is the change in farmland rental rates. Controls, when included, are the 1992 values; the 1997 values are not included because they are potential outcomes. The controls are the 1992 values of per-acre sales; per-acre variable costs, excluding rent; farm size (1,000s of acres); proportion of farmland that is irrigated; proportion of farmland in pasture or range; proportion of total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, fruits & nuts, and other crops; and 1992 yield of corn, wheat, oats, barley, sorghum, cotton, rice, and soybeans. All dollars have been inflated to 1997 dollars. ** indicates significance at 99th percentile. Sales class taxonomy defined by the USDA Economic Research Service.

Table 9 - The Effect of Rental Market Concentration on the Subsidy Incidence
Coefficient on Government Payments & the Interaction Term Reported

	OLS				IV			
	Main Effect		Interaction		Main Effect		Interaction	
Interaction Term	(1)		(2)		(3)		(4)	
Proportion of Farmers who are Tenants	-0.090		0.400	**	0.009		0.246	**
	(0.097)		(0.140)		(0.020)		(0.026)	
Tenant-Landlord Ratio	0.213	**	-0.242		0.048	**	0.338	**
	(0.044)		(0.122)		(0.021)		(0.052)	
Proportion of Farm Land that is Rented	-0.042		0.368	**	0.019		0.275	**
	(0.065)		(0.114)		(0.019)		(0.027)	
Herfindahl	0.147	**	-0.077		0.135	**	0.148	*
Market Share = Rental Expenditures	(0.034)		(0.112)		(0.016)		(0.075)	
Herfindahl	0.220	**	-0.162	**	0.170	**	-0.050	*
Market Share = Acres Rented	(0.026)		(0.038)		(0.021)		(0.025)	

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. Heteroskedasticity-robust standard errors are shown in parentheses. The dependent variable is change in the cash rental rate. The interaction terms are county level measures of rental market concentration. The Herfindahl indexes treat market share as a farm's proportion of total rental expenditure in the county, and a farms proportion of the total acres rented in the county. The instruments are the per-acre subsidies in 1997 and the per-acre subsidies in 1997 interacted with the measure of rental market concentration . All monetary values have been adjusted to 1997 dollars. ** indicates significance at 99th percentile.

Table 10
Effect of Subsidies on Variable Factor Expenditures - OLS Regressions
Coefficient on Government Payments Reported

	OLS		Log-log Specification			
					Incidence at the Mean	Incidence at the Median
Dependent Variable	(1)		(2)		(3)	(4)
Acres	0.003	**	0.011	**	0.001	0.001
	(0.000)		(0.000)			
Livestock	0.218	**	0.010		0.026	0.000
	(0.099)		(0.004)			
Feed	0.571	**	0.027		0.077	0.009
	(0.131)		(0.003)			
Seed	0.035	**	0.020	**	0.022	0.023
	(0.005)		(0.002)			
Fertilizer	0.075	**	0.024	**	0.051	0.053
	(0.007)		(0.002)			
Chemicals	0.078	**	0.044	**	0.079	0.068
	(0.006)		(0.003)			
Fuel	0.043	**	0.014	**	0.016	0.018
	(0.005)		(0.001)			
Electricity	0.014	**	0.020	**	0.008	0.006
	(0.004)		(0.002)			
Labor	0.074	**	0.030	**	0.072	0.042
	(0.022)		(0.004)			
Repair	0.061	**	0.021	**	0.031	0.033
	(0.009)		(0.002)			
Machine	0.016		0.041	**	0.022	0.008
Rental	(0.012)		(0.005)			
Interest	0.092	**	0.042	**	0.066	0.066
	(0.015)		(0.003)			
Property Taxes	0.004		0.015	**	0.006	0.005
	(0.004)		(0.002)			
Other	0.098	**	0.016	**	0.033	0.027
Expenditures	(0.040)		(0.001)			
Total Variable	1.289	**	0.016	**	0.339	0.349
Factors	(0.251)		(0.001)			

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. Standard errors are shown in parentheses. All specifications include covariates from 1992; the 1997 values are not included because they are potential outcomes. The controls are the 1992 values of per-acre sales, per-acre variable costs excluding the dependent variable; farm size (1,000s of acres), proportion of farmland that is irrigated, proportion of farmland in pasture or range, proportion of total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, fruits & nuts, and other crops. Due to computational constratints, the robust regressions do not include the time-varying county effect. The log-log specification reports the elasticity estimates, which are evaluated at the mean and median of the subsidy and the dependent variable to obtain the incidence estimates. All monetary values have been adjusted to 1997 dollars. ** indicates significance at 99th percentile.

Table 11 - Effect of Subsidies on Variable Factor Expenditures
IV Results - 1992 Log Set-aside and 1997 Log Subsidies Instruments
Coefficient on Log Government Payments Reported
Log-log Specification

Dependent Variable	No Covariates (1)		Incidence at the Mean (2)	Incidence at the Median (3)	Covariates (4)		Incidence at the Mean (5)	Incidence at the Median (6)
Acres	0.015		0.002	0.002	0.020		0.002	0.002
	(0.001)				(0.001)			
Livestock	0.009		0.025	0.025	0.008		0.020	0.000
	(0.005)				(0.005)			
Feed	0.033	**	0.095	0.095	0.030	**	0.088	0.010
	(0.004)				(0.004)			
Seed	0.027	**	0.030	0.030	0.025	**	0.029	0.029
	(0.002)				(0.002)			
Fertilizer	0.032	**	0.069	0.069	0.029	**	0.063	0.064
	(0.002)				(0.002)			
Chemicals	0.046	**	0.083	0.083	0.047	**	0.085	0.074
	(0.004)				(0.004)			
Fuel	0.019	**	0.021	0.021	0.016	**	0.018	0.021
	(0.001)				(0.001)			
Electricity	0.023	**	0.009	0.009	0.019	**	0.008	0.005
	(0.003)				(0.003)			
Labor	0.039	**	0.095	0.095	0.033	**	0.081	0.047
	(0.004)				(0.004)			
Repair	0.026	**	0.037	0.037	0.022	**	0.032	0.034
	(0.002)				(0.002)			
Machine Rental	0.047	**	0.025	0.025	0.045	**	0.024	0.009
	(0.006)				(0.006)			
Interest	0.044	**	0.070	0.070	0.039	**	0.061	0.062
	(0.004)				(0.004)			
Property Taxes	0.021	**	0.008	0.008	0.017	**	0.007	0.006
	(0.003)				(0.003)			
Other Expenditures	0.021	**	0.044	0.044	0.018	**	0.038	0.031
	(0.002)				(0.002)			
Total Variable Factors	0.019	**	0.399	0.399	0.017	**	0.351	0.362
	(0.001)				(0.001)			

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997, payed cash rent in both years, and reported growing program crops in 1992. There are 58,302 farms in each year of the sample. Standard errors are shown in parentheses. Farm and time-varying county effects are included in all specifications. The instruments are the log of acres in the farm enrolled in set-aside in 1992 and the log of subsidies in 1997. When included, the covariates are from 1992; the 1997 values are not included because they are potential outcomes. The controls are the 1992 values of per-acre sales, per-acre variable costs excluding the dependent variable; farm size (1,000s of acres), proportion of farmland that is irrigated, proportion of farmland in pasture or range, proportion of total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, fruits & nuts, and other crops. All monetary values have been adjusted to 1997 dollars. ** indicates significance at 99th percentile.

Table 12
Effect of Subsidies on Net Returns
Dependent Variable: Net Returns ($/Acre)

	OLS				IV			
	(1)		(2)		(3)		(4)	
Government Payments	0.959	**	0.976	**	1.076	**	1.080	**
	(0.086)		(0.089)		(0.128)		(0.124)	
Farm Size			0.656				0.660	
			(0.576)				(0.576)	
Irrigated			27.500	**			27.647	**
			(11.494)				(11.494)	
Pasture			-22.202	**			-22.462	**
			(11.240)				(11.242)	
Acreage Controls	No		Yes		No		Yes	

Notes: Net returns here are total sales plus subsidies minus total variable costs. The instruments are the 1992 proportion of the farm enrolled in set-aside and the 1997 per-acre subsidy. The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997 and reported growing program crops and paying cash rent in both years. There are 58,302 farms in the sample. Acreage controls are the 1992 total farm acres planted to corn, wheat, oats, barley, sorghum, cotton, rice, soybeans, other grains & beans, hay and seeds, vegetables, and fruits & nuts. A farm fixed effect, year effect, and time-varying county fixed effect are included. Standard errors are shown in parentheses. ** indicates significance at 99th percentile.