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

by

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ABSTRACT

This paper identifies the effect of agricultural subsidies on farmland rental rates in the United States. Rental agreements are primarily between farmers and non-farmer landlords, but no evidence exists concerning the incidence of subsidies on these two groups. By exploiting a unique policy change in 1996 and a nationally representative dataset of individual farms, I solve the endogeneity problem with fixed effects and instrumental variables techniques. I show that non-farmer landlords capture forty percent of the marginal subsidy dollar per acre. This finding is in sharp contrast to the basic assumptions in the literature that suggest full incidence on the landlords. I discuss possible characteristics of the farmland rental market that would result in less than perfect incidence.

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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, they 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

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

payments from 1999 through 2001. This topic will play a key role in the current Doha round of World Trade Organization negotiations.

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. This paper fills that gap by estimating the incidence of subsidies on farmland rental rates. By estimating the extent to which the marginal subsidy dollar is reflected in rental rates, I 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 has only 50 percent of its acres enrolled. Under this scenario the observed 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 uncorrelated with other behavior changes.

I employ several techniques to exploit these sources of variation and identify the effect of subsidies on farmland rental rates. I use county and farm fixed effects to control for regional shocks and unobserved farm heterogeneity, and I exploit the exogeneity imposed on subsidy payments by the 1996 legislation to overcome bias due to endogenous farm response. I use instrumental variables techniques to identify the 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 37 and 43 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, as much as $2 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.

I continue the investigation into the effects of subsidies by examining the response of per-acre expenditures on variable factors of production. The marginal subsidy dollar effectively lowers the rental rate by 60 cents. The lower rental price of land induces substitution away from other variable inputs, while the lower total cost results 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 $1.22.

The increased output ultimately results in a gain to tenant farmers. The analysis shows that the net returns of tenant farmers increase by 40 to 70 cents, supporting the notion of a 40-60 landlord-tenant split of 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. Section 7 examines the effect subsidy's effect on non-land factors of production. Section 8 provides evidence that the incidence on tenants is complementary to the incidence on landlords. Finally, section 9 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. Empirical investigation into the determinants of land values began in the 1960's using simultaneous equation models of supply and demand. However, the most recent wave of investigation has focused on the demand for agricultural land. Using present value models, researchers have sought to relate the stream of returns to farmland to the current land price (e.g., Melichar1979; Robison, et al. 1985). Typically, the rental rate is used to represent the returns to farmland in such analyses (e.g., Alston 1986; Burt 1986).

From this foundation the literature has branched out to include time varying discount rates (Hanson and Myers 1995), demand for alternative uses, e.g., urbanization (Hardie, et al. 2001), and different measures of the return to land. An example of this last branch in the literature can be found in Weersink, et al. (1999). They use the present value model in an effort to distinguish between the effects of returns to production and government subsidies on the price of land. They find that returns to production are discounted more heavily than subsidies.

The work by Weersink, et al. illustrates one of the many different techniques used to investigate the effect of government subsidies on farmland values. Barnard, et al. (1996) use an alternative source of variation by pooling three years of data and regressing land values on subsidies and other covariates. They repeat the analysis for twenty separate regions, yielding elasticities ranging from zero to 0.69, with an average elasticity of less than 0.16. Goodwin and Ortalo-Magne use an alternative method by investigating the effects of wheat price supports and subsidies over 10 years in wheat-producing regions in three countries (the United States, Canada, and France). They report a price elasticity of 0.38, but without reporting the mean land and support values this elasticity is difficult to interpret.

A prominent feature of this body of literature is the implicit reliance on the assumption that once observable characteristics are controlled for 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. This characteristic is an unobserved determinant of land values that is correlated with subsidies since 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.

Regardless of the data or method used, work to date on the role of government subsidies in the farmland question has emphasized the notion that the marginal effect of subsidies depends on the current expectation of future programs. The issue of current expectations over future subsidy payments is important when more broadly considering the influence of government programs on land values, but it clouds the issue when one wants to know how an extra dollar of subsidy today influences the current factor prices faced by an agricultural producer. If the dollar is perfectly reflected in increased rental rates, then the incidence of the subsidy is on the landowner. If rental rates for land are unaffected then the farmer enjoys the full incidence of the subsidy. By focusing on farmland rental rates, rather than land value, I can disentangle the incidence question from the question of expectations over future policy. This not only informs the debate about who benefits from current subsidies and to what degree, but it also lays the groundwork for more carefully addressing the questions the literature has examined concerning the expected growth rate of government subsidies.

In the literature, one question remains unanswered: to what degree are agricultural subsidies reflected in farmland rental rates? Recent work has begun to address this question (Lence and Mishra 2003) by using strictly cross-sectional variation and a selection on observables assumption, but the work is subject to the same criticism as above, namely the lack of a clearly identified estimate. In particular, failure to account for secular and county trends, and potentially mis-specified spatial correlation confound their estimate. In contrast, this study uses disaggregated panel data to control for unobserved heterogeneity, secular trends, and county-specific 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. In fact, more than 45 percent of the 917-million farmland acres in the United States is 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 land 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 $54 per acre.

Rental contracts commonly take the form of year-to-year "handshake" agreements. Formal, written rental contracts also generally last one year. In spite of frequent renewal, these arrangements are typically found in long-term landlord-tenant relationships. (Allen & Lueck 1992). 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 mis-timing 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 rented land is owned by a land-owning farmer, 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 (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.

3.2 Agricultural Subsidy Policy

A key component of domestic agricultural policy is the support of farmers' incomes. In the U.S., farmers' incomes are 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 delivery of these purchases, today it simply 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 introduction, subsidies have been calculated in a consistent way. Each of seven subsidized crops—wheat, corn, sorghum, barley, oats, rice, and cotton—receives a subsidy calculated as the product of a national payment rate (called a *deficiency rate*), a program yield, and the allotted acreage planted to that crop. That is,

$$\text{subsidy} = \text{deficiency rate} * \text{program yield} * \text{acreage allotment}.$$

The deficiency 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.

Program yield and acreage allotment are farm-specific parameters that initially were very closely associated with a farmer's production decisions. However, that connection gradually eroded until 1985 when program yield was frozen at that year's level. Subsequent yield enhancements by a producer had no effect on his subsidy receipts.[3]

By divorcing the yield component of the subsidy formula from actual yields, the production subsidy became a factor-specific subsidy to land. However, not all land planted to a subsidized crop qualified for the subsidy as subsidies were closely associated with supply control measures through the acreage allotment. After 1985, a producer received payment on and was constrained by an *acreage base* for each crop. A crop's acreage base was calculated as the five-year moving average of acres planted to that crop. 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 the five-year moving average when calculating the 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.)

Both program yields and base acres were assigned to individual plots of land. If a field was sold or rented, the program parameters were transferred with the land. In effect, this feature made the subsidy specific to the land.

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[3] In future work, I will exploit these exogenous policy changes to measure the distortionary effects of agricultural subsidies on production.

The identification strategy relies, in part, on the cross-sectional variation in acres participating in the subsidy program. Costly compliance measures, such as additional supply controls and documentation requirements, might explain why a farm did not participate in the subsidy program.

As an additional supply control measure, farmers were required to remove a designated proportion of their land 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[4]. After the 1996 policy change, which removed the costly constraints, nearly all qualified acres participated in the farm program.[5]

In addition to bearing the direct cost which the supply controls imposed on production, farmers had to submit and maintain documentation on yield (until 1985) and acres planted on each plot of land. They were required to submit the information to the county Farm Service Agency (FSA), the program implementation agency of the USDA. In order to establish base acres and receive subsidies, renters had to obtain verifiable documentation from previous tenants. This was a difficult task for land that was frequently rented to different producers. If a plot of land was sold, the new operator had to obtain verifiable documentation from the previous

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

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

operator(s) in order to establish base acres. Consequently, much farmland, especially rented land, did not have a base or program yield attached and therefore did not qualify for subsidy payments.

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 endogenous behavior 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.

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 only available at NASS in Washington, DC[6].

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. 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 of respondents remains roughly equal over the two years, this masks a great deal of

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

turnover (see Hoppe & Korb (2001)). I match 1,040,305 farm operations across the two years. 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 182,874 observations in each year. As I am interested in the relationship between subsidies and rental rates, I include only those who report paying cash rent in both years and who report growing any one of the seven program crops in the base year. I further limit the sample by dropping farms with imputed rental rates greater than two standard deviations above the mean. 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. Establishing these cutoffs allows me to account for average rental rates that clearly reflect rent paid on buildings. The final analysis sample consists of 59,948 farms observed over two years.

The median farmer in this sample has operated a farm for 23 years, compared to 22 years in the full sample. 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. This discrepancy reflects the relative profitability of fruit and vegetable producers, as well as that of livestock producers. Of those receiving subsidies in my sample the average total government payment is $16,614. The median is $10,000. This suggests that a few farms receive large subsidies. The full distribution of key variables can be found in Table 1.

4.2 Variable Creation

4.2.1 Dependent Variable

Although the Census of Agriculture does not report the per-acre rental rate, 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[7] 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 (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)).

[7] 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.

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

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

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. Subsidies are a function of yield and crop choice, hence they are endogenous variables reflecting the characteristics of the land and the producer's behavior. The endogeneity problem can be overcome by addressing three issues: unobserved heterogeneity, endogenous response to the subsidy change, and farmer's expectation error due to the mistiming of rental contracts and subsidy payments. The innovation of my analysis is to address all three problems and identify the parameter of 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 endogenous response 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 an instrumental variable 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[8].

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, county, and time fixed effects allows me to overcome this source of bias. Rewriting equation (1) using f_{it} and θ_t as the fixed effect for farm *i* and year *t* respectively yields:

(2) $$r_{it} = \alpha + g_{it}\gamma + f_i + C_{kt} + \theta_t + \varepsilon_{it}$$

The parameter C_{kt} is the time-varying county effect which allows for shocks, such as weather or pests, that impact everyone within a localized region.

Controlling for unobserved heterogeneity in this way has the advantage of avoiding the inherently nonlinear relationships between soil characteristics and productivity. Explicitly using

[8] 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.

soil characteristics as controls precludes identification—a problem other researchers have faced (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

$$\Delta r_i = \theta + \Delta g_i \gamma + C_k + \Delta \varepsilon_i . \qquad (3)$$

Such a transformation of the data is most efficient if the errors in equation (2) are serially correlated. 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 Endogenous Response to the Policy Change

A common concern when using an exogenous policy change to identify the parameter of interest is the bias induced by an agent's endogenous response to the policy change. A unique feature of the 1996 FAIR Act allows me to exploit the policy change itself to overcome the endogenous response problem. The 1996 legislation was titled the "Freedom to Farm Act" because it lifted planting restrictions and divorced the subsidy from the producer's behavior. Such a divorce made it impossible for producers to respond to the policy change in such a way as to influence their subsidy and simultaneously alter their land rental rate. Hence, the policy provides an exogenous change in subsidy rates, and its structure eliminates the obstacle to identification caused by endogenous response to the policy change.

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}^*,

(4) $$r_{it} = \alpha + g_{it}^*\gamma + f_i + C_{kt} + \theta_t + \varepsilon_{it} .$$

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

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

Substituting for expected subsidy receipts in equation (4) yields

(6) $$r_{it} = \alpha + g_{it}\gamma + f_i + C_{kt} + \theta_t + \varepsilon_{it} - \varepsilon_{it}^g .$$

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) $$g^*_{i92} = g_{i92} - \varepsilon^g_{i92}.$$

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

(9) $$\Delta r_i = \theta + \Delta g_i \gamma + C_k + \Delta\varepsilon_i - \varepsilon^g_{i92}.$$

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}^9. 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 $E(\varepsilon^g_{i92} g^*_{i97}) = 0$. 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. Table 2a contains the results of the following two first stage equations of a two-stage least squares estimation strategy:

(10) $$\Delta g_i = \theta + g_{i97}\delta + C_k + u_i,$$

(11) $$\Delta g_i = \theta + sa_{i92}\zeta + C_k + v_i..$$

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

The OLS estimates of equation (3) are reported in columns three and four of Table 2b. Columns one and two report the incidence obtained when the panel nature of the data are ignored. Unobserved heterogeneity clearly causes an upward bias to the estimate, as the coefficients in columns one and two are more than twice the size of those in columns three and four. Typically, controlling for other exogenous covariates will increase the precision of the estimates, and one may be concerned that other, time-varying farm characteristics are also necessary to identify the parameters of the conditional expectation function. For these reasons other covariates have been included in columns two and four of Table 2b.

The incidence estimates from Table 2b, columns three and four, suggest that nearly one-fifth of the marginal subsidy dollar is reflected in increased rental rates. Adding covariates to the specification in equation (3) does not significantly alter the estimate. This result stands in sharp contrast to the frequent assumption of full incidence in the literature (e.g., Morehart, et al. 2001).

6.2 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.

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 know 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 they are highly correlated with the 1992 program parameters. The 1997 subsidy payments are a scaling of the product of the 1995 program parameters (the scaling factor being the subsidy rate). Thus, insofar as the 1995 program parameters are similar to the 1992 parameters, the 1997 subsidy payments will be highly correlated with the ideal instrument, the 1992 program parameters.

The IV estimates are reported in columns five and six of Table 2b. The IV estimation identifies a marginal incidence of about 15 percent. That is, approximately 15 cents of each extra subsidy dollar is reflected in increased rental rates. Having two exogenous instruments for the single endogenous variable allows me to test for over-identifying restrictions. Performing the over-identification test yields an F-statistic of 1.67 with a p-value of 0.2. Therefore, one cannot reject the hypothesis that the instruments are exogenous. Notably, the OLS and IV coefficients are very similar, suggesting that expectation error is not a large concern.

7 Interpretation

Economic theory predicts, and economists have long held, that under competitive markets, there is perfect incidence and the landlords are able to extract the entire marginal subsidy dollar. As has been demonstrated, actual incidence is much less than perfect.

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 two measures are the proportion of farmers in a county who rent some land and 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. This will bias the results against the null hypothesis that renter concentration affects the subsidy incidence. 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 3. If rental market imperfections do play a role, I should see the incidence rising as the market becomes less concentrated. Nearly every measure of concentration returns a sign and magnitude that is consistent with the hypothesis that subsidy incidence decreases with rental market concentration. For instance, the first row of table 3 indicates that if all farms in a county rented land the incidence would double from 15 percent to about 30 percent.

8 Variable Factors of Production

Agricultural subsidies began in the 1970s as production subsidies, but by the 1990s, they were *de facto* specific subsidies to land. As such, they serve to reduce the rental price of land. A 15 percent subsidy incidence on landlords, as found above, implies that the marginal per-acre subsidy dollar lowers the rental rate by 85 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 will expand output and demand more non-land variable inputs. The net result on the non-land factors of production is theoretically ambiguous.

I measure the effect of subsidies on non-land variable factors of production by applying the empirical strategy developed above to per-acre 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 per-acre expenditure on each input as the dependent variable and estimate the effect of subsidies using equation (9). The IV strategy used above is not directly applicable, the 1997 subsidy is no longer assumed to be strictly exogenous The OLS coefficient from regressing the change in farm size on the 1997 level of government payments is 0.0045 with a robust standard error of 0.0027. Such a correlation suggests that the 1997 subsidy level may be correlated with time-varying, unobserved, farm-level characteristics that also determine total expenditures. The second instrument, the 1992 set-aside acres, is still assumed to be exogenous, influencing farm size and total expenditures only through its effect on subsidies.

Table 4a column one reports the OLS coefficient on government payments for each of the 14 regressions. Per-acre expenditure on nearly all variable inputs responds positively and significantly to the marginal subsidy dollar. Fertilizer and chemicals are among the largest responders, perhaps signifying increased intensity in order to expand output. Aggregating all of the non-land variable inputs, one can derive the total increase in production expenditure brought on by the marginal subsidy dollar. Focusing on the final row of column one, the cumulative effect is an increased expenditure of $2.27 per acre on variable inputs, a very large response to an 85 cent decrease in the rental rate. Such a response deserves scrutiny, as outliers may be driving these results.

In order to investigate the role of outliers in this estimate columns two through four report the results of various robust regressions. Column two simply trims the top and bottom 1% of the dependent variable. Column three provides a more sophisticated method of determining which observations are truly outliers using least trimmed squares (Rousseeuw, 1984). Column four presents the least absolute deviation, or median regression, estimate. All of these estimates are significantly lower than the OLS estimate, suggesting that the true effect of subsidies on total variable factor expenditures is between 51 and 83 cents.

Table 4b reports the IV estimates, using the 1992 set-aside acres as an instrument for the change in government payments. Columns one and two present the results for the entire sample, while columns three and four present the results after dropping the top and bottom 1% of the dependent variables. This estimate is somewhat sensitive to the inclusion of controls, but it also suggests that the true incidence on variable factor expenditures is less than the OLS estimate. The conclusions that can be drawn are that the output effect clearly dominates the substitution effect due to changing relative prices, expenditures on fertilizer and chemicals respond the most, and most likely about 50 cents of the subsidy dollar are spent on variable inputs.

9 Tenant's Incidence

The above analysis found landlords capturing 15 cents of the marginal subsidy dollar, and tenants increasing expenditures on variable inputs by $0.50. 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 85 cents. The production response should not dissipate the subsidy incidence on the tenant. Given the landlord's incidence, one should expect a subsidy incidence of 85 percent 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. Table 5a reports the OLS estimates. As with variable expenditures, the estimates change when the top and bottom one percent of the dependent variable are removed from the sample. Columns three and four present the coefficients from performing OLS on this "trimmed" sample. Columns five and six use the more sophisticated Least Trimmed Squares to account for outliers. Both sets of results provide similar estimates, namely that the marginal subsidy dollar increases net returns by about $1.12.

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. Now the concern is the simultaneity of sales and subsidies in 1992. Fortunately, for the same economic reasons as above, the 1992 set-aside acreage is an appropriate instrument for the change in government payments. Namely, the cross-sectional variation in 1992 set-aside acres accurately reflects the variation in base acres, and this parameter is independent of the component of 1992 subsidies that suffers from simultaneity. Columns one and two of Table 5b report the first stage of the two-stage least squares estimation strategy, using the 1992 set-aside acres as in instrumental variable for the change in government payments. Columns three and four present the final and most plausible relationship between subsidy payments and the tenant's net returns. About 90 cents of the subsidy dollar are reflected in the tenant's bottom line. Considering the confidence interval, this estimate is consistent with the rental rate incidence estimated above. Ultimately, on average landlords capture 15 cents of the marginal subsidy dollar, leaving the remaining 85 cents for the tenant.

10 Conclusion

This paper has investigated the effect of agricultural subsidies on farmland rental rates. In the investigation, I have overcome three significant obstacles: unobserved heterogeneity, endogenous response, 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 endogenous response, and I used IV techniques to identify 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 a portion—but not all—of subsidies is passed to landlords. The point estimates suggest that, on average, about 15 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 farmers were tenant farmers, then non-farmer landlords would have received about $776 million of the $5.5 billion in agricultural subsidies paid to farmers in 1997, signifying a "leakage" of 14.1 percent. Of course, not all subsidy recipients are tenants, and the distribution of subsidy payments among tenants and owners will result in a lower leakage estimate. However, contrary to assumptions in the literature about the farmland market, there is not perfect incidence on landlords; tenant farmers do benefit from agricultural subsidies. Evidence was presented that indicated about a 90 percent incidence on tenants.

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 either ignored or made assumptions concerning the pass-through of agricultural subsidies. The literature typically assumes that land has a zero elasticity of supply while all other factor inputs are supplied with infinite elasticity. However, this paper's results show that these assumptions are untenable. It will be necessary for future work to distinguish among several competing hypotheses concerning incidence under a perfect-markets assumption (see Feldstein (1977), Hertel (1991), Floyd (1965) for possible candidates).

Additionally, future work should investigate the role played by market imperfections or sticky prices in the farmland rental market. A large presence of long-term rental contracts might cause rental rates to adjust slowly. Incidence may be perfect in the long run, but the time frame of this analysis could be too short to capture this. Institutional factors also may be part of the explanation. Anecdotally, land is often rented from a neighbor or widow, and the rental rate is agreed upon with a handshake. Social norms in such arrangements may prevent complete extraction of Ricardian rents from tenants.

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Table 1

Summary Statistics: U.S. Census of Agriculture Micro Files[2.]

		Full Sample[3.]		Program Crop Producers		Program Crops Producers & Renters	
		N=182,863		*N=94,749*		*N=59,948*	
	Year	Mean	Median	Mean	Median	Mean	Median
Rental rate	1992	111.88[4.]	27.54	48.26[5.]	31.14	47.66	32.73
	1997	115.25[4.]	31.17	54.97[5.]	35.90	55.82	37.96
Total Government	1992	8,847.36	0.00	15,531.19	8,576.00	16,614.38	10,000.00
Payments	1997	7,656.53	3.00	13,559.12	8,500.00	15,043.22	10,696.50
Government	1992	10.69	0.00	11.82	8.00	12.32	9.24
Payments	1997	22.01	0.01	11.06	8.27	11.52	9.52
Sales	1992	7,176.18	278.51	466.35	253.48	429.50	273.00
	1997	7,337.84	295.87	501.08	284.98	474.26	304.59
Costs	1992	5,805.20	219.41	370.04	191.12	341.60	212.52
	1997	5,768.15	224.81	395.41	205.69	377.17	230.48
Farm size	1992	1.88	0.62	1.70	1.02	1.61	1.06
	1997	1.89	0.61	1.77	1.08	1.74	1.15
Proportion of a farmland planted to each crop.							
Wheat	1992	0.0607		0.1097		0.1094	
	1997	0.0611		0.1133		0.1118	
Corn	1992	0.1272		0.2304		0.2491	
	1997	0.1227		0.2280		0.2432	
Sorghum	1992	0.0120		0.0218		0.0167	
	1997	0.0086		0.0161		0.0132	
Barley	1992	0.0088		0.0157		0.0172	
	1997	0.0075		0.0137		0.0144	
Oats	1992	0.0055		0.0090		0.0086	
	1997	0.0036		0.0063		0.0057	
Rice	1992	0.0062		0.0114		0.0085	
	1997	0.0058		0.0111		0.0082	
Cotton	1992	0.0218		0.0394		0.0375	
	1997	0.0260		0.0489		0.0449	
Soybeans	1992	0.0946		0.1661		0.1839	
	1997	0.1093		0.1936		0.2154	
Other Grains	1992	0.0166		0.0290		0.0273	
and Beans	1997	0.0171		0.0307		0.0293	
Hay and Seeds	1992	0.1217		0.0972		0.1010	
	1997	0.1291		0.1001		0.1037	
Vegetables	1992	0.0145		0.0096		0.0114	
	1997	0.0134		0.0087		0.0104	
Fruit	1992	0.0254		0.0018		0.0016	
	1997	0.0258		0.0021		0.0018	
Pasture	1992	0.1417		0.0826		0.0737	
	1997	0.1441		0.0843		0.0751	
Other	1992	0.3594		0.2035		0.1814	
	1997	0.3421		0.1717		0.1514	

notes:

1. All variables, except Total Government Payments, are reported as per acre of farmland.
2. The U.S. Census of Agriculture micro files are confidential data whose use was secured by agreements with the USDA - Economic Research Service and the National Agricultural Statistical Service.
3. Sample consists of farms that received the "long form" in both 1992 and 1997 census.
4. Calculated over those who paid cash rent for land and buildings. In 1992 N=99,261, and in 1997 N=92,874.
5. Calculated over those who paid cash rent for land and buildings. In 1992 N=68,030, and in 1997 N=66,011.

Table 2a - The Effect of Subsidies on Farmland Rental Rates
IV First Stage
Dep Var: 1992 - 1997 Change in Government Payments
Farm Level Analysis[1.]

	(1)		(2)	
1997 Government	0.911	**	0.946	**
Payments	(0.003)		(0.003)	
1992 Set-Aside	-420.772	**	-419.987	**
Acres	(3.081)		(3.022)	
Total Sales			0.0006	**
			(0.0002)	
Costs			-0.0008	**
			(0.0003)	
Farm Size			0.130	**
			(0.0176)	
Irrigated			-2.431	**
			(0.3737)	
First Stage *F*-test[4.]	41,229		5,395	
R^2	0.58		0.64	
Acreage Controls[2.]			X	
Fixed Effects[3.]	X		X	
Observations	59,948		59,948	

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997 and reported growing program crops in 1992 and paying cash rent in both years. Standard errors are shown in parentheses. ** indicates significance at 99th percentile.
1. All variables are measured per farmland acre.

2. Acreage controls are the 1992 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.
3. A farm fixed effect, year effect, and time-varying county fixed effect are included.
4. The *F*-test tests whether the coefficients on the excluded instruments are jointly equal to zero.

Table 2b - Effect of Subsidies on Farmland Rental Rates
1992 - 1997 Panel of Cash Renters
Dependent Variable: 1992 - 1997 Change in the Cash Rental Rate
Farm Level Analysis[1.]

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS				IV Both 92 SA & 97 GP	
Government	0.451 **	0.291 **	0.141 **	0.141 **	0.147 **	0.152 **
Payments	(0.075)	(0.061)	(0.033)	(0.034)	(0.014)	(0.014)
Sales		0.026 **		-0.008		-0.008 **
		(0.005)		(0.005)		(0.001)
Costs		-0.024 **		0.007		0.007 **
		(0.005)		(0.006)		(0.001)
Farm Size (Acres)		-0.419 **		0.094		0.095
		(0.066)		(0.055)		(0.079)
Proportion		24.310 **		-4.808 **		-4.795 **
Irrigated		(0.855)		(1.928)		(1.666)
Proportion		-43.218 **		-4.274 **		-4.306 **
Pasture		(1.020)		(1.836)		(1.780)
Overid *F*-test					1.670	5.990
(*p*-value)					(0.197)	(0.014)
Sample Size	59,948	59,948	59,948	59,948	59,948	59,948
Acreage Controls[3.]		X		X		X
Fixed Effects[4.]			X	X	X	X

Notes: 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 59,393 farms in the sample. Standard errors are shown in parentheses. ** indicates significance at 99th percentile.

1. Because the rental rate is constructed as the total rental expenditures on land and buildings divided by total acres rented, all observations with rental rates greater than two standard deviations above the mean were dropped (cutoff = $470/acre). The highest reported cropland rental rate in the 1997 June Ag Survey was $448/acre, making the cutoff a conservative one.

2. Set aside instrument for the dollars per acre regressions is the proportion of total acres enrolled in the Acreage Reduction Program, a mandatory supply control component of the subsidy program. In 1992 most crops required that 5% of base acres be "set aside." The government payments instrument is the*level* of government payments per acre in 1997

3. Controls are the 1992 values of farm size (acres), proportion of farmland that is irrigated, 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.
4. A farm fixed effect, year effect, and time-varying county effect are included.

Table 3 - The Effect of Rental Market Concentration on the Subsidy Incidence

Regression of Rental Rates on Government Payments & Government Payments Interacted with a Measure of Tenant Supply

Coefficient on Government Payments & the Interaction Term Reported

Farm Level Analysis[1.]

	Mean		(1)	(2)	(3)	(4)
			OLS		IV[2.]	
Interaction Term	Change in Gov't Payments	Interaction	Main Effect	Interaction	Main Effect	Interaction
Proportion of Farmers who are Tenants	-1.91	-1.34	-0.090	0.400 **	0.009	0.246 **
			(0.097)	(0.140)	(0.020)	(0.026)
Tenant-Landlord Ratio	-1.91	-0.57	0.213 **	-0.242	0.048 **	0.338 **
			(0.044)	(0.122)	(0.021)	(0.052)
Proportion of Farm Land that is Rented	-1.91	-1.17	-0.042	0.368 **	0.019	0.275 **
			(0.065)	(0.114)	(0.019)	(0.027)
Herfindahl[3.]	-1.91	-140.67	0.147 **	-0.077	0.135 **	0.148 *
Market Share = Rental Expenditures			(0.034)	(0.112)	(0.016)	(0.075)
Herfindahl	-1.91	-598.15	0.220 **	-0.162 **	0.170 **	-0.050 *
Market Share = Acres Rented			(0.026)	(0.038)	(0.021)	(0.025)
Controls[4.]						
Fixed Effects[5.]			X		X	

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997 and reported growing program crops in 1992 and paying cash rent in both years. There are 59,948 farms in the sample. Standard errors are shown in parentheses. ** indicates significance at 99th percentile.

1. Because the rental rate is constructed as the total rental expenditures on land and buildings divided by total acres rented, all observations with rental rates greater than two standard deviations above the mean were dropped (cutoff = $470/acre). The highest reported cropland rental rate in the 1997 June Ag Survey was $448/acre, making the cutoff a conservative one.

2. The main effect is instrumented by the 1997 level of government payments and 1992 set-aside acres. The interaction is instrumented by the interaction of the 1997 level of government payments and the 1992 set-aside acres with the 1992 level of the interacting variable.

3. The coefficient and standard error on the Herfindahl interaction terms are multiplied by 1000.

4. Controls are the 1992 values of farm size (acres), proportion of farmland that is irrigated, 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.

5. A farm fixed effect, year effect, and time-varying county effect are included.

Table 4a
Effect of Subsidies on Farmland Rental Rates - OLS Regressions
Coefficient on Government Payments Reported
Farm Level Analysis[1]

	(1) OLS		(2) Trim Top & Bottom 1%		(3) Least Trimmed Squares[2]		(4) Median Regression	
Livestock	0.110		0.096	**	-0.003		0.000	
	(0.129)		(0.022)		(0.001)		(0.003)	
Feed	0.568	**	0.167	**	-0.002		0.000	
	(0.233)		(0.034)		(0.002)		(0.001)	
Seed	0.028	**	0.039	**	0.025	**	0.019	**
	(0.008)		(0.008)		(0.002)		(0.002)	
Fertilizer	0.061	**	0.075	**	0.055	**	0.051	**
	(0.015)		(0.010)		(0.004)		(0.003)	
Chemicals	0.071	**	0.092	**	0.061	**	0.062	**
	(0.016)		(0.011)		(0.004)		(0.003)	
Fuel	0.426		0.048	**	0.037	**	0.038	**
	(0.270)		(0.006)		(0.002)		(0.001)	
Electricity	0.038	**	0.017	**	0.004	**	0.005	**
	(0.018)		(0.006)		(0.001)		(0.000)	
Labor	0.043		0.073	**	0.029	**	0.000	
	(0.026)		(0.022)		(0.004)		(0.002)	
Repair	0.574		0.069	**	0.061	**	0.060	**
	(0.365)		(0.010)		(0.003)		(0.002)	
Machine	0.020		0.035	**	0.014	**	0.000	
Rental	(0.013)		(0.014)		(0.002)		(0.001)	
Interest	0.050	**	0.075	**	0.040	**	0.023	**
	(0.022)		(0.011)		(0.004)		(0.001)	
Property Taxes	0.032		0.007	**	0.005	**	0.005	**
	(0.019)		(0.003)		(0.001)		(0.000)	
Other	0.249		0.048	**	0.042	**	0.046	**
Expenditures	(0.196)		(0.022)		(0.005)		(0.003)	
Total Variable	2.267	**	0.832	**	0.512	**	0.619	**
Factors[3]	(0.996)		(0.069)		(0.026)		(0.016)	
Sample Size	59,948		58,750		59,948		59,948	
Fixed Effects[5]	X		X		X		X	

Notes: The sample consists of all farms that returned the Census of Agriculture's long form in both 1992 & 1997 and reported growing program crops in 1992 and paying cash rent in both years. There are 59,948 farms in the sample. Standard errors are shown in parentheses. ** indicates significance at 99th percentile.
1. Regression of total listed factor expenditures on total government payments.
2. Coefficients reported for LTS regression are from weighted least squares with weights based on LTS regression.
3. Total variable factors includes the of all factors listed, but excludes rental expenditures.
4. Acreage controls are the 1992 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
5. All models are run on first-differenced data, effectively including farm and year fixed effects. Columns (1) and (2) also include county fixed effects.

Table 4b
Effect of Subsidies on Farmland Rental Rates - 2SLS Regressions
Coefficient on Government Payments Reported
Farm Level Analysis[1]

	(1)		(2)		(3)		(4)	
	IV[2] Full Sample				IV Trim Top & Bottom 1%			
Livestock	-0.332		-0.048		0.121	**	0.143	**
	(0.291)		(0.285)		(0.044)		(0.043)	
Feed	-0.466		0.481		0.138	**	0.058	
	(0.429)		(0.412)		(0.060)		(0.060)	
Seed	0.002		-0.004		-0.007		-0.013	
	(0.015)		(0.015)		(0.008)		(0.008)	
Fertilizer	0.016		-0.022		0.002		-0.039	**
	(0.020)		(0.020)		(0.014)		(0.014)	
Chemicals	0.039	**	0.004		0.010		-0.006	
	(0.018)		(0.018)		(0.013)		(0.013)	
Fuel	0.011		-0.047	**	0.042	**	0.002	
	(0.020)		(0.020)		(0.008)		(0.008)	
Electricity	-0.017		-0.021		0.013		0.005	
	(0.011)		(0.011)		(0.008)		(0.008)	
Labor	-0.060		-0.024		0.039		0.036	
	(0.065)		(0.065)		(0.024)		(0.024)	
Repair	0.018		-0.013		0.052	**	0.032	**
	(0.029)		(0.029)		(0.013)		(0.013)	
Machine	-0.045		-0.058		0.019	**	0.007	
Rental	(0.032)		(0.032)		(0.009)		(0.009)	
Interest	-0.019		-0.011		0.109	**	0.103	**
	(0.051)		(0.051)		(0.017)		(0.017)	
Property Taxes	0.002		-0.011		0.008	**	0.005	
	(0.011)		(0.011)		(0.004)		(0.004)	
Other	-0.295	**	-0.031		0.017		0.016	
Expenditures	(0.122)		(0.116)		(0.027)		(0.027)	
Total Variable	-1.150		-0.178		0.536	**	0.299	**
Factors[3]	(0.818)		(0.787)		(0.148)		(0.146)	
Sample Size	59,948		59,948		58,750		58,750	
Acreage Controls[4]			X				X	
Fixed Effects[5]	X		X		X		X	

Notes: 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 59,948 farms in the sample. Standard errors are shown in parentheses. ** indicates significance at 99th percentile.

1. Regression of per-acre listed factor expenditures on per-acre government payments.
2. The 1992 proportion of farmland in the "set aside" program instruments for per-acre government payments.

3. Total variable factors includes the sum of all factors listed but excludes rental expenditures.
4. Acreage controls are the 1992 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.
5. A farm fixed effect, year effect, and time-varying county fixed effect are included. Note all robust regressions include year and farm effect, but not county effect.

Table 5a
Effect of Subsidies on Net Returns
Dependent Variable: Net Returns
Farm Level Analysis

	(1)		(2)		(3)		(4)		(5)		(6)	
	OLS Full Sample				OLS Trim Top & Bottom 1%				Least Trimmed Squares			
Government	1.377	**	1.321	**	1.086	**	1.168	**	1.143	**	1.119	**
Payments	(0.231)		(0.256)		(0.041)		(0.055)		(0.021)		(0.023)	
Farm Size			16.532				8.145	**			5.572	**
			(9.261)				(1.578)				(0.962)	
Irrigated			-56.297	**			7.404				17.416	**
			(21.188)				(3.982)				(1.554)	
Pasture			-12.970				-8.211	**			-6.251	**
			(9.778)				(1.649)				(1.001)	
Acreage Controls			X				X				X	
Fixed Effects	X		X		X		X		X		X	

Notes: 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 59,948 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.

Table 5b - IV Estimate of the Effect of Subsidies on Net Returns
Instrumental Variable: 1992 Set-Aside Acres
Dependent Variable: Net Returns
Farm Level Analysis

	(1)		(2)		(3)		(4)	
	IV First Stage				IV Set-Aside Acres			
1992 Set-Aside Acres	-244.098	**	-277.655	**				
	(2.618)		(3.383)					
Government Payments					0.521	**	0.898	**
					(0.065)		(0.076)	
Farm Size			-1.289	**			7.398	**
			(0.201)				(1.260)	
Irrigated			3.721	**			8.372	**
			(0.353)				(2.208)	
Pasture			1.188	**			-7.487	**
			(0.208)				(1.300)	
First Stage *F*-test	8,695		840					
First Stage R^2	0.13		0.19					
Acreage Controls			X				X	
Fixed Effects	X		X		X		X	

Notes: 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. The top and bottom one percent of the dependent variable has been dropped from the sample. There are 58,750 farms in this 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. The F-test tests whether the coefficients on the excluded instruments are jointly equal to zero. ** indicates significance at 99th percentile.