

THE INCIDENCE OF GOVERNMENT PROGRAM PAYMENTS ON AGRICULTURAL LAND RENTS: THE CHALLENGES OF IDENTIFICATION

MICHAEL J. ROBERTS, BARRETT KIRWAN, AND JEFFREY HOPKINS

Economic reasoning and some empirical evidence suggest that government payments increase rents on agricultural lands to which the payments are attached (Barnard et al., Floyd, Gardner, Kuchler and Tegene). The degree to which this occurs—the *incidence* of current expected government payments on current rent—is relevant for policy in two ways. First, it provides information about the distribution of payment benefits *vis-à-vis* landowners and farmers. For example, if payment benefits are intended for farmers rather than landowners, and the incidence is high, a share of the benefits may miss their target.¹ Because about 60% of U.S. farmland is owned by nonoperators, there is a real potential for this kind of misallocation (Hopkins, Morehart, and Bohman).

Second, the level of incidence may reflect the degree to which government programs that give rise to these payments alter production. A high incidence may reflect a low supply response to a government program, because a small share of the payments is dissipated via lower output prices (due to greater quantities supplied) and higher prices for input factors besides land (due to greater quantities demanded). A low incidence may reflect a large supply response and a greater appropriation of payment benefits to commodity consumers and suppliers of other input factors, such as machinery and human capital. Thus, reliable

estimates of incidence over time provide indirect evidence of the production response associated with changing government farm programs, in addition to information about the allocation of payment benefits. Of particular interest is the 1996 “decoupling” of certain government payments from farmers’ production decisions. Some hold that large decoupled payments induce a production response despite the basic theoretical reasoning that suggests otherwise. A relatively low incidence of decoupled payments may help to substantiate this claim.

In this paper we report some preliminary evidence on the incidence of government payments on land rents, using micro data from the 1992 and 1997 Agricultural Censuses. This unique dataset allows us to control for certain kinds of unobserved heterogeneity and time-varying stochastic factors that may bias previous incidence estimates, which were based on a smaller cross section of farms and used aggregated values for certain explanatory variables. Unlike previous research, which focuses mainly on the relationship between government payments and land values, we focus mainly on the relationship between payments and rents. We do this because land values, more than rents, encapsulate intangible beliefs about the future that are difficult to measure and may show misleading statistical associations, as explained below.

The unique structure of 1997 payments also aids in identification. In 1997, nearly all direct government payments to farmers came from Production Flexibility Contracts (PFCs). The amounts of these decoupled payments were scheduled by the Federal Agriculture Improvement and Reform Act of 1996 (FAIR) and were contingent neither on farmers’ 1997 production decisions nor on 1997 prices. In other words, the amounts of the payments were known more than a year prior to disbursement and planting decisions. This feature of PFCs implies that the cross-sectional variance

This paper was presented at the ASSA winter meetings (Washington D.C., January 2003). Papers in these sessions are not subjected to the journal’s standard refereeing process.

Michael Roberts and Jeffrey Hopkins are economists, Economic Research Service, United States Department of Agriculture; and Barrett Kirwan is graduate student, economics, Massachusetts Institutes of Technology.

The authors thank Nigel Key and Charles Barnard for helpful comments on an earlier draft of this manuscript. The views expressed are those of the authors and do not necessarily represent those of the U.S. Department of Agriculture.

¹ It is not clear that government payment benefits are targeted at farmers as opposed to landowners. We only point out that different incidences imply different allocations of benefits between tenant farmers and landlords, so the true incidence (and allocation of benefits) may be of interest to policymakers.

of direct payments in 1997 contains little or no expectation error, which, as explained below, provides a useful instrument for identifying the incidence of payments, both in 1997 and in 1992. Thus, we are able to estimate incidence both before and after the 1996 decoupling of farm programs.²

Before turning to statistical issues, we briefly review the theory that underlies the incidence of coupled and decoupled farm payments on agricultural land rents. In particular, we explain why one might expect the supply response associated with these payments to be inversely related to the incidence on rents.

The Incidence of Coupled and Decoupled Payments

The 1996 farm bill instituted a marked change in agricultural policy. Prior to 1996, direct payments to farmers were tied to commodity prices. If prices fell below target levels, farmers were compensated for the difference between the market price and the program target price, via direct payments. There were certain restrictions associated with participation in these programs, some of which limited farmers' flexibility with regard to the crops they were allowed to plant. In 1996, these programs were replaced with lump-sum PFC payments, the levels of which were determined by enrollment of agricultural land in pre-1996 governmental programs.³

Define $\mathbf{q}_i$ as a vector of commodity production quantities (indexed by k) produced on land units (indexed by i) as a function of profit-maximizing non-land inputs (the vector $\mathbf{x}_i$), $\mathbf{p}$ as a vector of commodity prices (also indexed by k), and $\mathbf{w}$ as a vector of input prices (indexed by j). The vectors $\mathbf{p}$ and $\mathbf{q}_i$ may also include certain nonagricultural benefits. In addition to the market price received, suppose the government provides additional payments in the amount $\mathbf{c}_i$ per unit of production and lump-sum PFC payments in the amount PFC_i . The rent on each producing land unit i is given by revenues net of variable costs:

$$(1) \quad r_i = E[(\mathbf{p} + \mathbf{c})^T \mathbf{q}_i - \mathbf{w}^T \mathbf{x}_i] + \text{PFC}_i.$$

² Although few payments besides PFC payments were actually paid in 1997, it is possible that farmers held expectations for other kinds of payments that were not subsequently realized. Our estimates for the 1997 cross section, reported below, assume that the 1997 expectation error (if it is real) is uncorrelated with the cross section of rents.

³ See Economic Research Service for more details on commodity programs both before and after the 1996 farm bill.

Further, assume that there exists an inverse demand function for each commodity produced and an inverse supply function for each input, defined respectively as $p_k(\sum_i \mathbf{q}_i)$ and $w_j(\sum_i \mathbf{x}_i)$.

If the commodity demand functions and input supply functions are perfectly elastic, and all land types earn positive rents, with all else being the same, rents will reflect the full value of government payments.⁴ If, however, the demand functions and input supply functions are not perfectly elastic, coupled payments ($\mathbf{c}$) may alter production quantities in a way that feeds back into commodity prices and input prices. Production quantities may change from new land brought into production (that which earned zero rent without government payments), from substitution of land from one crop to another, and from altered production levels within land units (through changes in $\mathbf{x}_i$).

If commodity production increases in general, one may expect commodity prices to decline and input prices to increase, offsetting some of the hypothetical increase in government payments. This price feedback offsets the incidence of coupled payments. Greater production induces lower commodity prices (movement along the demand curve for commodities), and induced increases in $\mathbf{w}$ shift the demand curve for land to the left. The incidence is therefore inversely related to the supply elasticity. If the supply curve were perfectly inelastic and prices for inputs besides land did not change, incidence would equal one, and rents would reflect the full value of government payments.

Decoupled payments (PFCs) affect land rents in a more straightforward manner. Because the payment level does not depend on farmers' current production decisions, they should not cause farmers to alter them, so the payment should be fully reflected in higher rents. In principle, these are lump-sum payments to fixed land units.

Some posit, however, that market imperfections and wealth effects cause these payments to induce a production response despite their decoupled nature (Adams et al., Hennessy). If this induced production response feeds back into lower commodity prices and higher input prices, these would also offset the level of

⁴ When $\mathbf{p}$ and $\mathbf{w}$ are unaffected by changes in $\mathbf{c}$, then $\Delta \mathbf{r} = \mathbf{q}^T \Delta \mathbf{c} + [(\mathbf{p} + \mathbf{c})^T \Delta \mathbf{q} / \Delta \mathbf{x} - \mathbf{w}^T \Delta \mathbf{x} / \Delta \mathbf{c}] \Delta \mathbf{c}$. For small induced changes in $\mathbf{q}$ and $\mathbf{x}$, profit maximization implies that the terms in parentheses are zero, so that the change in rent equals the change in government payments.

incidence, much like coupled payments. Thus, farm payments are ultimately reflected in rent increases, production distortions, or a balance of the two.

In practice, neither coupled nor decoupled payments assume the pure forms described above. In exchange for pre-1996 coupled payments, farmers were required to limit the planting of program crops to historical precedents as determined by their past plantings—so-called “base acres” in program crops. These limits were designed to mitigate induced overproduction but did not necessarily avert it entirely (Duffy et al.).

Production depends, in part, on farmers’ expectations about the structure of future payments. In the 2002 farm bill, farmers were permitted to “re-base” according to plantings during the post-1996 period, so in fact 1996–2002 plantings influenced post-2002 government payments. If forward-looking farmers had anticipated these changes, expectations about post-2002 payments could have influenced the 1996–2002 plantings, and, therefore, producer decisions may not have been made in a strictly decoupled environment.

A Regional Picture

Government payments tend to be countercyclical with net farm income less government payments, a phenomenon that is not surprising, given that payments are often conditional on prices. The countercyclical nature of the payments is especially evident at the regional level, as seen in figure 1. The figure shows per acre government payments (the solid line) and per acre net farm income less government payments (the dashed line). The countercyclical nature of the payments is evident in all regions—especially in the Heartland and the Northern Great Plains—regions where net farm income is the most variable and government payments are largest relative to net farm income (on average). Below, we explain how the stochastic properties of government payments and net farm income present certain statistical issues associated with identifying the incidence of payments on land rents.

Land values, like rents, should encapsulate government payments attached to the land. Relative to both government payments and net farm income, agricultural land values (the dotted line in figure 1) are relatively stable. Land values also (theoretically) reflect expectations about payments and returns further into the

future, which may be smoother than the realized values. The land value data, however, are interpolated between census years, so that apparent stability may be a spurious result of data construction (see the notes under the graph for more information about these data).

Figure 1 provides some evidence that payments are capitalized into land values over the cross section of regions but provides less evidence over the time series. In general, the smaller government payments are relative to net farm income, the greater net farm income is relative to land values. In particular, note that government payments are largest relative to net farm income in the Heartland and Great Plains regions—regions that also have the highest land values relative to net farm income. However, close inspection of the plots suggests that unobserved heterogeneity is also important to land values. For example, the relative values of net farm income and government payments appear similar in the Southern Seaboard and the Fruitful Rim; land values payments in the Fruitful Rim, however, are larger relative to both net farm income and government payments.

Over time, the large fluctuations of both payments and net farm income obscure the relationship between land values and government payments. A large component of land values (much like stock and bond values) includes the belief held by landowners and potential landowners in future net returns and government payments, which are uncertain and therefore intangible. If land market participants believe that government subsidies will continue indefinitely at current or higher levels, as opposed to believing that the payments will soon end, land values will be substantially higher. The stochastic variability of returns and government payments, coupled with the intangibility of expectations about the future, clouds the relationship between rents and land values over time. In our statistical analysis below, we focus on cash-lease rents, rather than on land values, so that we can focus squarely on current expectations, which are more tangible than the amalgamation of current and future expectations that land values encapsulate.

A Statistical Model

Economic theory implies that land rents should equal *expected* returns less payments for factors besides land. Let r_{it} denote per acre

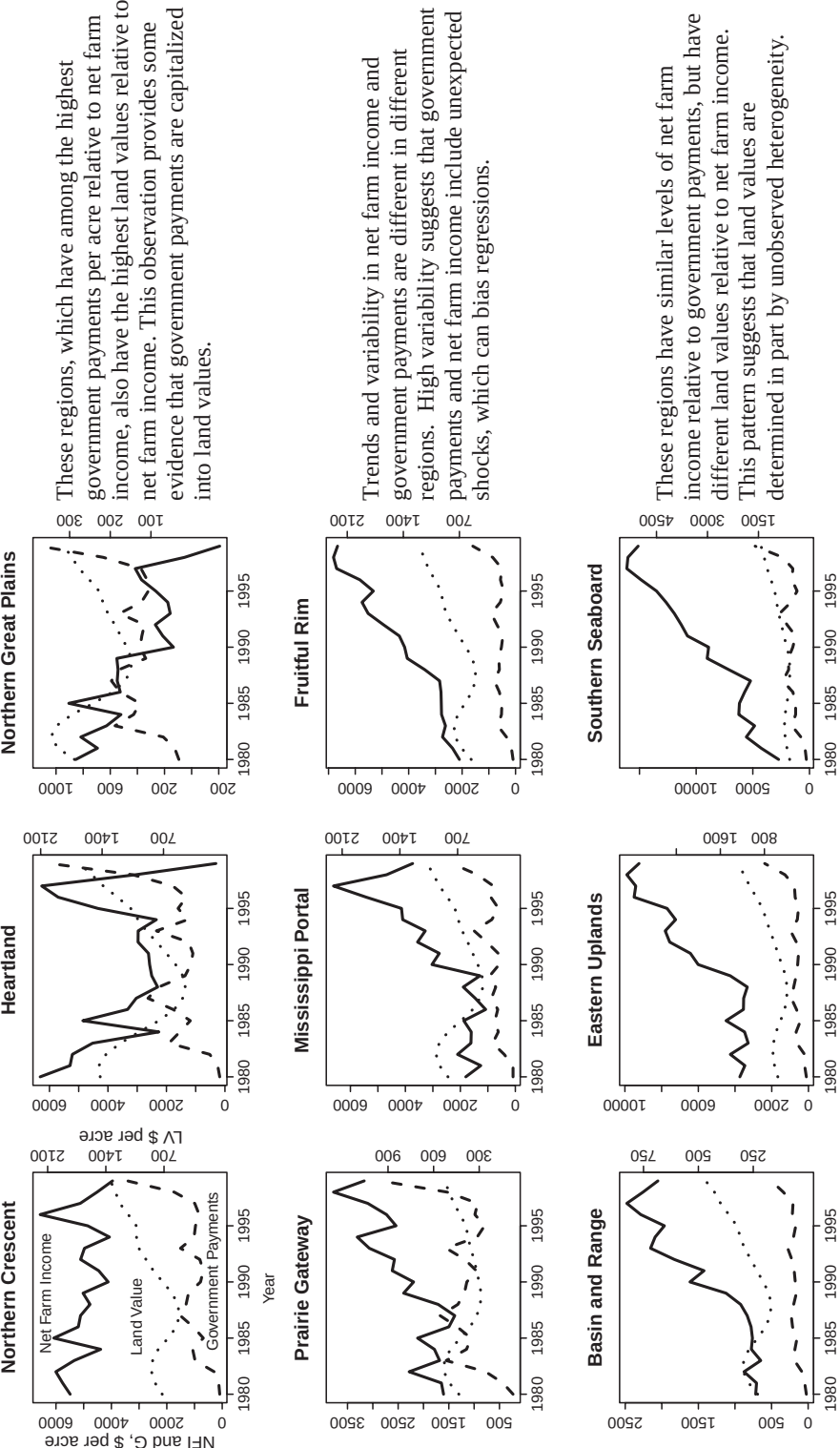


Figure 1. Government payments, net farm income, and land values

Notes: The solid line indicates net farm income (NFI) less government payments (G); the dashed line indicates direct government payments (G); the dotted line indicates agricultural land values (LV). Land values (the right-side axis) are on a scale equal to exactly three times that of government payments and net farm income (the left-side axis), so relative values can be visually compared across regions. All values are in 1996 dollars. Net income and government payments data were interpolated from annual state-level values reported by USDA-ERS. Agricultural land values, constructed by Eldon Ball, were interpolated from county-level census data on land and buildings with the value of buildings removed. See Heimlich for a more thorough description of the nine farm regions.

cash rent for tenant farmer i in period t , g_{it} denote per acre *observed* direct government payments, π_{it} denote observed per acre net returns (gross receipts less government payments and payments to factors besides land), β denote the incidence of expected government payments on rents, and u_{it} an error:

$$(2) \quad r_{it} = \pi_{it} + \beta g_{it} + u_{it}.$$

The error includes expectation error—the difference between expected and realized government payments plus net returns—plus other unobserved factors. Portions of both the expectation error and the unobserved factors may be aggregate or geographically localized in nature. We denote these components of the error by v_t and w_{Rt} , respectively, where R indexes local regions. For farmer i in period t the variables ε_{it}^π , ε_{it}^g , and ε_{it}^u denote, respectively, the portion of the net returns expectation error, the portion of the government payments expectation error, and the portion of unobserved factors, not encapsulated by v_t and w_{Rt} . Accounting for the aggregate and regional fixed effects and subtracting the expectation error, we can therefore write:

$$(3) \quad u_{it} = v_t + w_{Rt} - \varepsilon_{it}^\pi - \beta \varepsilon_{it}^g + \varepsilon_{it}^u.$$

In a simple linear regression of (r_{it}) against observed net returns (π_{it}) and government payments (g_{it}), the expectation errors affect the estimated coefficients much like measurement error—they bias the regression coefficients toward zero. Furthermore, in a single cross section, if a large component of the expectation error is aggregate in nature (encapsulated by v_t), the coefficients could be biased either upward or downward. The expectation error in net returns, which may be correlated with the expectation error in government payments (as suggested by the data plotted in figure 1), likely exacerbates these biases. Finally, because government payments tend to be regionally concentrated, government payments are likely correlated with w_{Rt} and perhaps with ε_{it}^u . That is, the estimates could be confounded by unobserved heterogeneity that is correlated with payment levels.

The unusual structure of payments in 1997 helps us overcome some of these statistical problems. Of the approximately \$8 billion in direct government payments paid in 1997, \$6.1 billion emanated from PFCs, \$1.7 billion were directed toward conservation, and just

\$257.3 million came from other sources (U.S. Department of Agriculture). After subtracting conservation payments, the cross-sectional variance in 1997 government payments therefore should include little expectation error. Thus, a regression that utilizes the 1997 cross section should provide more reliable incidence estimates than those based on the 1992 cross section. Furthermore, the cross section of 1997 payments is correlated with the 1992 cross section of payments but should not be correlated with the expectation error in 1992. We therefore use 1997 government payments as an instrument for identifying the incidence in 1992. To control for unobserved heterogeneity, and to test the robustness of our results, we include a number of control variables, in addition to using a fixed effect for each county to proxy for w_{Rt} .

Lastly, to take advantage of our panel, we assume that the incidence is the same in 1997 and 1992, and then we examine the changes in rents as compared with changes in instrumented government payments and controls. By examining the relationship between the difference in rents and the expected government payments, we control for a cross-sectional heterogeneity that is fixed over time as well as that which is time-varying but uncorrelated with growth in government payments.

Data

The data used in this analysis are drawn from the microfiles of the 1992 and 1997 Census of Agriculture. All statistical analyses were prepared on site at the U.S. Department of Agriculture to preserve the confidentiality of the survey respondents; the data are not publicly available. In order to look at changes between the two years, we limit the sample to farms that report in both years. We also limit the sample to those who received the Census “long form,” which asks about land values and expenditures, including rent. From this subsample we select those who indicate positive cash rents paid in both years. These criteria limit our sample size to 75,858 farms. To isolate the influence on land rental rates (as opposed to building rental rates) and to eliminate the influence of large outliers, we drop farms that report values of key variables (per acre rent, total sales, costs, and government payments) that are in the top 1% of values in one or more of the two years. Because most

government payments are associated with crop production, we further limit the sample to farms that report positive crop sales in either year. These criteria leave 61,873 farms in 1997 and 61,532 farms in 1992, with 58,504 farms used in the first difference estimation. All observations are weighted by the acreage size of the farm, so our analysis relates to the effects on the average cash-rented acre in our sample.⁵

Results

Table 1 gives a brief summary of the regression results. The first three rows report incidence estimates for the 1997 cross section, the next three rows report incidence estimates for the 1992 cross section, the following three rows report estimates for the 1992 cross section when 1992 payments are instrumented with 1997 payments, and the last three rows report estimates for farm-level differences between 1992 and 1997. The table includes ten estimates of the incidence of government payment for each identification strategy, so the stability of the coefficient estimates may be compared across different groups of control variables. In all regressions, the dependent variable is cash rent per acre rented. The first column includes government payments and total crop sales as explanatory variables, the second column adds total farm sales, the third column adds reported costs, the fourth column adds land in farms and the proportion of harvested cropland that is irrigated, the fifth column includes a series of acreage controls, and columns 6–10 use the same controls as columns 1–5, except that they also include county-level fixed effects. Although farm size, proportion of acres irrigated, and the acreage controls are not theoretically important once net returns are accounted for, these variables may capture some of the difference between observed and expected net returns. The coefficient estimates

and standard errors for the control variables are omitted due to limited space, but they are available from the authors upon request. The variance explained by the county fixed effects is not included in the R^2 for columns 6–10; the standard errors of the parameter estimates, however, do take into account the fixed effects.

All of the estimates suggest that government payments significantly influence rents; the estimates, however, are not stable across control groups. In general, the greater the number of controls, the less the estimated incidence, a pattern that is especially acute in the cross-section regressions. These results suggest that unobserved heterogeneity confounds incidence estimates based on the cross section of farms.

The estimates for the 1997 cross section imply that rents increase between \$0.33 and \$1.55 for each government payment dollar. The 1992 cross-section estimates are notably smaller. These estimates, however, are likely biased downward due to the transitory component of government payments. The instrumented estimates for the same year are markedly higher than the uninstrumented estimates and are roughly in line (though somewhat smaller) than those estimated for 1997. Estimates reported in columns 6–10 of the last three rows are based on within-county covariance between the growth in rent and the growth in expected government payments. Given an estimated standard error of almost 6 cents, these incidence estimates are more stable across controls than those implied by the cross-section estimates.

Conclusion

Our strongest estimates imply an incidence of government payments on land rents of between 34 and 41 cents for each government payment dollar. Our rich data, along with the unique structure of 1997 payments, allow us to control for expectation errors associated with payment levels and unobserved regional heterogeneity, errors that likely bias previous estimates.⁶ After accounting for expectation errors, unobserved heterogeneity may still confound parameter estimates based on the cross section. Estimates based on differences in rents and expected government payments are stronger because they control for more kinds of unobserved heterogeneity and because the estimated coefficients are

⁵ Our rent-per-acre estimate equals total cash rent divided by the number of acres rented for all farms that paid positive cash rent. If a farmer also share-leases a portion of his rented farm, our rent-per-acre estimate underestimates the true rate. If the rent paid includes the lease of buildings in addition to land, the true rent per acre is overestimated. These errors in the rent estimate will bias our capitalization estimate if the errors are correlated with government payments in a way that is not captured by our control variables. Summary statistics from a separate survey (the USDA Agricultural Resource Management Survey) imply that about 18% of farms that cash-lease land also share-lease land. Comparisons of government payments per acre across different tenancy arrangements and farm types imply that biases potentially caused by the joint dependency of the tenancy relationship and government payments are likely accounted for by the control variables and differences. Due to length restrictions, these statistics are omitted; however, they are available from the authors upon request.

⁶ Our incidence estimates cannot be compared with those of Barnard et al. because they examine land values rather than rents.

Table 1. Summary of Regressions

	Estimated incidence (and standard error) of government payments on land rent, no fixed effects				Estimated incidence (and standard error) of government payments on land rent, with county fixed effects					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1997 cross section, OLS	1.545	1.156	1.154	1.079	0.574	0.615	0.486	0.488	0.412	0.329
<i>N</i> = 61,873	(0.024)	(0.022)	(0.022)	(0.023)	(0.027)	(0.037)	(0.035)	(0.035)	(0.036)	(0.037)
<i>R</i> ²	0.12	0.23	0.23	0.24	0.28	0.03	0.11	0.11	0.12	0.13
1992 cross section, OLS	0.762	0.595	0.594	0.533	0.358	0.326	0.302	0.314	0.262	0.228
<i>N</i> = 61,532	(0.019)	(0.017)	(0.016)	(0.017)	(0.020)	(0.028)	(0.026)	(0.026)	(0.026)	(0.028)
<i>R</i> ²	0.04	0.25	0.26	0.27	0.30	0.01	0.14	0.15	0.16	0.17
1992 cross section, IV	2.314	1.645	1.611	1.507	0.840	0.524	0.391	0.383	0.259	0.211
<i>N</i> = 61,532	(0.045)	(0.040)	(0.040)	(0.041)	(0.047)	(0.040)	(0.037)	(0.037)	(0.037)	(0.038)
<i>R</i> ²	0.06	0.26	0.27	0.27	0.30	0.01	0.14	0.15	0.16	0.17
1992–97 difference, IV	0.768	0.641	0.638	0.612	0.550	0.520	0.413	0.407	0.392	0.336
<i>N</i> = 58,804	(0.048)	(0.047)	(0.047)	(0.048)	(0.048)	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
<i>R</i> ²	0.00	0.03	0.03	0.03	0.03	0.00	0.03	0.03	0.03	0.03

Notes: In all regressions, the dependent variable is cash rent per acre rented. See the "Results" section for column descriptions. *R*² values in columns 6–10 do not include variance explained by county-level fixed effects. The first column includes government payments and total crop sales as explanatory variables, the second column adds total farm sales, the third column adds reported costs, the fourth column adds land in farms and the proportion of harvested cropland that is irrigated, the fifth column includes a series of acreage controls, and columns 1–5, except that they also include county-level fixed effects.

more stable, depending on the sets of control variables used.

It may be that a substantive portion of government payments is captured by other input factors, such as human capital and machinery. Alternatively, it could be that, in the long run, incidence is larger than our estimates imply, but that it takes time for rental rates to reflect changes in expected government payments, perhaps due to long-term contracts and other rigidities in the land rental market. More research is needed to verify these incidence estimates, to ascertain the time it takes for rents to reflect changes in associated government payments, and to measure how incidence is ultimately capitalized into land values.

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