Measuring the Effects of Decoupled Payments on Indica Rice Production Under the 1996 and 2002 Farm Bills

Working Paper 12-01

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January 2012

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Abstract

As a heavily subsidized crop with significant exports, rice bears at least a superficial similarity to upland cotton, which causes some to speculate that current rice policy exposes the U.S. to the same WTO sanctions as were levied in 2005 against U.S. cotton subsidies. This paper examines the impact of decoupled payments on U.S. indica rice production in the southern states of Arkansas, Mississippi, Missouri, Louisiana and Texas, a region chosen because it accounts for nearly all U.S. rice exports to Central and South America. Using Arellano's and Bond's generalized method of moments (GMM) estimation technique for dynamic panel models on county-level data, we find that both direct and counter-cyclical payments exert significant, positive effects on acreage planted in indica rice. The estimated acreage price and cost elasticities are statistically significant and are within the ranges of values in previous studies.

Keywords: rice policy, farm commodity programs, acreage response

JEL Codes: Q12, Q18

Since the 1994 conclusion of the Uruguay Round negotiations of the World Trade Organization (WTO), U.S. farm policy has increasingly emphasized farm support based on historic, as opposed to current, crop acreage and yields, asserting that these payments meet the WTO (1994) criterion of having "no, or at least minimal, trade distorting effects or effects on production." While decoupled from current production levels, for some crops these payments are of such magnitude relative to producer costs and market price that it is at least theoretically possible that they distort production. However, data limitations have constrained empirical tests of the impact of these decoupled payments such that the question of the magnitude and significance of the effect of these decoupled payments on production remains open to debate.

In the case of rice produced in the United States, the debate is more than academic. The U.S. government offers generous support to its rice producers. As a heavily subsidized crop with significant exports, rice bears at least a superficial similarity to upland cotton. This similarity has caused some to speculate that current rice policy exposes the U.S. to the same WTO sanctions as were levied in 2005 against U.S. cotton subsidies (Sumner 2005; Powell and Schmitz 2005). While the WTO's ruling (2005) in the case of upland cotton cites *coupled* and *price-contingent* subsidies (i.e. marketing loan program payments, market loss assistance payments, counter-cyclical payments and payments to purchasers of domestic cotton) as responsible for significant price suppression, the fact that the WTO found that the U.S. program of direct, decoupled payments did not conform to the definition of non-distorting payments offered in Annex 2 of the Agreement on Agriculture means that U.S. government support of rice is vulnerable to WTO limits, and to potential sanctions if it is shown to distort trade (Wailes and Durand-Morat 2005).

This paper examines the impact of decoupled payments on U.S. indica rice production in the southern states of Arkansas, Mississippi, Missouri, Louisiana and Texas. It employs panel data in a generalized method of moments (GMM) estimator to measure the extent to which "decoupled" payments offered under the 1996 and 2002 farm bills affected rice acreage planted in these regions. While our data set does not allow us to explain *how* these decoupled payments affect acres planted in rice, it does allow us to consider, as an empirical question, *whether* decoupled payments affect rice acres planted at the margin, and the magnitude of the marginal acreage response to changes in these payments.

U.S. Indica Rice Production

While U.S. farm policy treats rice as an essentially homogenous crop, offering the same payments and programs to all rice producers, the global rice market is markedly segregated, with little substitution between buyers of the distinct varieties (Childs and Burdett 2000). California rice producers grow primarily japonica rice, which is exported to Asian markets, while producers in the southern states of Arkansas, Louisiana, Texas, Mississippi, and Missouri grow indica rice, which is exported primarily to other western hemisphere countries. Given the segregated nature of the market, world prices for the two varieties do not necessarily follow the same trends, and may even move in opposite directions (ibid). Thus, producers' response to a single, nationwide target price may well differ depending on price expectations in the particular world market (japonica or indica) they potentially supply. Following Song and Carter (1996), this study treats the indica rice produced in the southern states as distinct from California rice, and focuses its empirical analysis on this particular rice product.

The United States Department of Agriculture divides rice production in the southern states (i.e. indica rice production) into three distinct regions based on similarities in production and soil characteristics. The map in figure 1 shows the locations of these regions, which include the Arkansas Non-Delta region, the Mississippi River Delta, and the Gulf Coast region. As reflected in figure 2, production costs per hundred-weight of rice produced -- both fixed and variable -- vary across regions, with the Gulf Coast region exhibiting the highest costs. Its higher variable costs are in large part attributable to the fact that alone among indica rice producers, Gulf Coast region rice farmers must pay for their irrigation water (Livesey and Foreman 2004). The higher fixed costs incurred by Gulf Coast producers result from the region's lower yields and higher land rental rates (Baldwin et al. 2011). Figure 2 also testifies to the economic challenges facing rice producers in all three regions: market returns to indica rice production seldom exceed costs over the 12-year period governed by the 1996 and 2002 farm bills. Price is less than average total cost in 10 out of 12 years for the Gulf Coast region, and 9 out of 12 years in both the Arkansas Non-Delta region, and the Mississippi River Delta region. Despite these obvious challenges, U.S. indica rice production has increased at a relatively constant rate of 2 percent per year since 1972, the earliest date that the USDA's National Agricultural Statistics Service reports county-level data. As illustrated in figure 3, area planted in indica rice has increased at an annual rate of over 17,000 acres per year, or approximately 1.9 percent annually, during the same period. Only the Gulf Coast region, characterized by significantly higher costs than the other two indica-producing regions, has experienced decreases in both output and acres planted during this period. The continued expansion of indica rice production simply cannot be explained by market forces; it can only be explained by considering the support offered rice producers by the United States government in the form of decoupled and coupled payments to rice producers.

Government Support of Indica Rice Producers Under the 1996 and 2002 Farm Bills

Base acreage and historical yields form the foundation of the U.S. government's decoupled payments to rice producers under the 1996 and the 2002 farm bills. Rice producers received payments at a rate denoted in dollars per hundredweight of rice, on 85 percent of their "base acreage," which is the acreage enrolled in the government's commodity support program. Output per base acre was set by the government on a county-by-county basis, based on historical yields. Rice farmers therefore received payments equal to 0.85 times the product of base acres times historic yields per acre, regardless of the amount of rice actually planted or harvested. As such, these payments bore no direct relation to actual acreage planted in rice, or to rice yield, rather, these decoupled payments simply depended on the base acres enrolled in the government program and historic county-level yields. Base acreage was fixed under the 1996 farm bill at an amount equal to the average farm acreage planted, or considered planted, in rice between 1993 and 1995. Under the 2002 farm bill, land owners were given a one-time choice between maintaining the 1996 base acreage, or updating the base to reflect the average of actual plantings during the 1998-2001 period. Rice producers who chose to update their base acres were also given the opportunity to update their yields. Payments varied under the two farm bills. Under the 1996 farm bill, base acre direct payments, known as production flexibility contract payments, or PFCs, varied each year, and ranged from $2.10 to $2.92 per derived hundredweight of rice (calculated as the product of base acres and historic yields per acre). Under the 2002 farm bill, PFCs were replaced by direct payments, or DPs, which were held constant and equal to $2.35 per hundredweight throughout the six years the act was in force. Like the PFCs, DPs were again awarded on 85 percent of the base acreage. In addition to these payments, under the 1996 act, rice producers received emergency market loss assistance payments, MLAs, for the years 1998 through 2001; these payments ranged between $1.45 and $2.82 per hundredweight, calculated as the product of base acres and historical, county-level yields. Again, these payments were awarded on 85 percent of the base acres enrolled. The MLAs were replaced under the 2002 farm bill with counter-cyclical payments, CCPs, which were set equal to the difference between a target price of $10.50 per hundredweight and the "effective price" of rice. This effective price was calculated as the season average farm price plus direct payment price received by farmers. As in the case of direct payments, the total CCP awarded to rice producers was determined by multiplying this effective price times USDA-determined historic yields per acre, over 85 percent of producers' base acreage.

The basis for claiming that these payments are "decoupled" from production decisions is the immutability of the base acreage and the historic yields. Once enrolled as part of a farm's base acreage, a given acre continued to generate payments to its owner so long as it remained available for agricultural use, provided it was not planted in fruits, vegetables, or wild rice. Thus, a putative rice farmer could plant exclusively soybeans or not plant at all, yet still receive these decoupled payments on all the base acres enrolled in the rice base acreage; the payments were received independent the number of acres planted. This decoupling created its own political backlash, as base acres were sold to developers, transformed into suburban hobby farms (a.k.a. "cowboy starter kits"), yet were still eligible to receive these transfer payments (Morgan, Gaul and Cohen 2006).

In addition to these decoupled payments, U.S. rice farmers received payments under both the 1996 and the 2002 farm bills linked directly to current production in the form of marketing loan gains, loan deficiency payments, and commodity certificate coupons. Marketing loans allowed producers to borrow an amount equal to $6.50 per hundredweight for current production until the crop was sold. If the world price fell below $6.50, producers were allowed to repay the loan at the adjusted world price, thus pocketing as a subsidy the difference between $6.50 and the world price. Alternatively, producers were free to keep the loan and forfeit their crops to the government, which they would presumably do if world price fell below $6.50. Producers who decided not to borrow against their crops were eligible for a similar subsidy in the form of a loan deficiency payment equal to the difference between the adjusted world price and the $6.50 floor. In the case of loan deficiency payments, producers retained their crops; they did not forfeit their harvest to the government. Finally, producers could purchase commodity certificates at the adjusted world price, and use them to pay off marketing loans. These three government programs are recognized as distorting market signals by setting an effective price floor on rice.

Both coupled and decoupled government payments were critical to the overall viability of indica rice production during the period governed by the two farm bills. Indeed, there would probably have been significant exit from the industry were it not for these payments. Figure 4 shows how, across all three indica producing regions, and for nearly every year of the 12-year period examined in this study, government payments were necessary to cover the costs of rice production. Furthermore, with the exception of the years 2001 and 2002 for the Arkansas Non-Delta region, and 2002 for the Mississippi River Delta region, between 1997 and 2008 decoupled payments contributed more to farm income than coupled ones, measured as returns per acre planted in rice. Most importantly, without decoupled payments, indica acreage would have generated losses in 8 of the 12 years governed by the 1996 and 2002 farm bills. With direct payments, the average indica producer was able to receive a profit from farming throughout most of the years between 1997 and 2008.

Literature review

The theoretical possibility that marginal differences in decoupled payments affect production has been established in the literature. Decoupled payments increase farm income, and with it, producers' access to credit and their ability to make investments that increase farm productivity (Tielu and Roberts 1998; Young and Westcott 2000; Roberts and Jotzo 2002; Sumner 2003b). Assuming that producers' risk aversion decreases with increases in wealth, decoupled payments encourage farmers to take on riskier investments (Hennessy 1998; Roberts and Jotzo 2002; Young and Westcott 2000; Sumner 2003a), and can therefore increase output of crops if expansions in output are associated with increased risk. When receipt of decoupled payments is tied to a requirement that land remain in agriculture, decoupled payments raise the opportunity cost associated with industry exit, and therefore keep land in production that would otherwise be devoted to another use (Sumner 2003a). Furthermore, by contributing to farm receipts, decoupled payments increase the number of farm operations capable of producing an income stream from farming sufficient to cover fixed and opportunity costs associated with agriculture, thereby increasing industry output (Chau and DeGorter 2005). Finally, by allowing producers to update their base acres (the land area that forms the basis for the payment) with each farm bill, and by allowing the update to reflect planting practices of the antecedent period (as was the case for rice in the 1996, the 2002 and the 2008 farm bills), current planting practices take on the character of investments capable of generating significant returns to farm income. This asset value of current farm production decisions increases the returns to current production, therefore distorts the market signals (Sumner 2003a, 2003b).

Empirical estimations of the acreage response associated with decoupled payments have found evidence of some distortionary effect, but results vary with respect to significance and magnitude. The body of work shows marked variation with respect to the degree of aggregation used to describe the acres receiving and responding to decoupled payments. While some studies measure acreage response at the farm level (Goodwin and Mishra 2005; Goodwin and Mishra 2006; Girante, Goodwin and Featherstone 2008; O'Donoghue and Whitaker 2010), others measure acreage response at the county level (Goodwin and Mishra 2006), state (Adams et al. 2001) or even national level (Burfisher, Robinson and Thierfelder 2000). Some studies look at acreage response across groups or cohorts of crops (Adams et al. 2001; O'Donoghue and Whitaker 2010), while others focus on individual crop acreage responses (Burfisher, Robinson and Thierfelder 2000; Goodwin and Mishra 2005; Goodwin and Mishra 2006; Girante, Goodwin and Featherstone 2008). Payments are treated as farm income (Burfisher, Robinson and Thierfelder 2000; Goodwin and Mishra 2005; Goodwin and Mishra 2006; O'Donoghue and Whitaker 2010) or as receipts per acre planted in one crop or a cohort of crops (Adams et al. 2001; Goodwin and Mishra 2006; Girante, Goodwin and Featherstone 2008). Table 1 summarizes these critical differences, as well as the estimated acreage responses generated by these studies.

The results of a decade's worth of research on the acreage response to decoupled payments highlight the sensitivity of the results to the level of aggregation as well as to the crop planted. Direct payments do not appear to have a significant effect on acres planted when evaluated at the state level over a composite of crops, but show significance for some crops when evaluated at both the national and the county level. At the farm level, the results are mixed. Farm-level decisions on corn and soybean acreage have been found to respond to decoupled payments, while wheat acreage appears insensitive to changes in direct payments. Problems with the overall robustness of the empirical estimations generated by these studies keep the question of the acreage response to decoupled payments alive and intriguing. Many of the studies published thus far fail to find significant acreage responses to own-price or to profits; others find counter-intuitive (negative) own-price responses. Clearly, this is an area in which further research is likely to be productive.

Study design

To estimate the acreage response of decoupled payments, we follow the examples of Reed and Riggins (1981), Duffy, *et al*. (1987), Druska and Horrace (2004), and Tronstad and Bool (2010) and develop a Nerlove (1958) inspired panel model of rice acreage planted. For each of the three indica rice-growing regions, we model county acreage planted in rice as a function of previous-year (or lagged) values of acres planted, the supply-inducing price, regional variable cost, direct payments,[1] counter-cyclical payments (if any), and a trend to capture technological and systematic changes over time. In our models, we use three different measures of direct and counter-cyclical payments: payments per planted acre, payments per base acre, and total county payments. As we are concerned with determining whether, and not how, decoupled payments affect indica output, we do not need individual operator-level information on risk preference, debt-to-asset ratios, or wealth. We chose to construct a panel of county-level acreage response over time as panel data are better suited to study dynamic processes, provide more information, minimize bias from aggregation, and give both more variability and more degrees of freedom (Gujarati 2003).

We estimate the amount of direct and counter-cyclical payments on a county basis using program acreages, county-level program yields, and payment rates. For the supply-inducing price in each county, we use the season average state farm price plus the loan gain (i.e. the difference between the loan rate of $6.50 and the adjusted world price published by USDA).[2] The addition of the farm price and loan gain represents the gross amount per hundredweight received by farmers. Sumner (2003b) notes that the effects of domestic price and loan gain are identical under the marketing loan program. Variables and their sources are described in table 2, below. Summary statistics by region for variables used in the models are reported in table 3.

Our econometric model is estimated in logarithmic form to allow most coefficients to be interpreted as elasticities. For each of the three indica rice producing regions, our model is

(1) $$\ln(A_{it}) = \beta_1 + \beta_2 \ln(P_{i,t-1}) + \beta_3 \ln(V_{t-1}) + \beta_4 \ln(D_{i,t-1}) + \beta_5 \ln(C_{i,t-1} + 1) + \rho \ln(A_{i,t-1}) + \delta_i + \varepsilon_{it}$$

or

(2) $$a_{it} = \beta_1 + \beta_2 p_{i,t-1} + \beta_3 v_{t-1} + \beta_4 d_{i,t-1} + \beta_5 c_{i,t-1} + \rho a_{i,t-1} + \delta_i + \varepsilon_{it}$$

where A_{it} is acres of rice planted in county i (i = 1, 2 … N) in year t (t = 1998, 1999 … 2008), V_{t-1} is prior-year per acre variable cost in that region, $P_{i,t-1}$ is the prior-year supply-inducing price, $D_{i,t-1}$ is the prior-year measure of direct payments in county i, $C_{i,t-1}$ is the prior-year measure of counter-cyclical,[3] δ_i is an effect for county i, and ε_{it} is an i.i.d. error.

Rewriting (2) so that the predetermined variables are a vector x_{it} and then differencing the result eliminates the individual effects:

(3) $$a_{it} = \beta' x_{it} + \rho a_{i,t-1} + \delta_i + \varepsilon_{it}$$

(4) $$\Delta a_{it} = \beta' \Delta x_{it} + \rho \Delta a_{i,t-1} + \Delta \varepsilon_{it}$$

We estimate (4) using the generalized method of moments (GMM) estimator of Arellano and Bond (1991). The use of this technique is justified as OLS fails to generate consistent estimators owing to the correlation between the error term ($\delta_i + \varepsilon_{it}$) and the lagged dependent variable. Within-groups (differenced) estimates and least-square dummy variables estimates (LSDV) similarly fail to address this correlation for samples, like ours, in which the time period included in the sample (T=11) is small relative to the number of cross-sections (N = 19 in Arkansas Non-Delta; N = 33 in Mississippi River Delta; and N = 29 in Gulf Coast).

The Arellano-Bond GMM differenced estimator (hereafter GMM-DIF) uses a set of instruments for the transformed lagged dependent variable that includes past values of the dependent variable. Other instruments include differenced exogenous and predetermined right-hand-side variables. That is, for $\Delta a_{i3} = a_{i3} - a_{i2}$, the instruments are a_{i1} and Δx_{i3}; for Δa_{i4}, instruments are a_{i2}, a_{i1}, and Δx_{i4}; *etc*. Assuming ε_{it} is i.i.d. $(0,\sigma^2)$ for $t = 1,2 \ldots T$, autocorrelation in $\Delta\varepsilon_{it}$ can be dealt with by constructing a weighting matrix H with 2 as the diagonal elements, -1 as the elements of the first sub-diagonals, and zeros elsewhere. H is proportional to the variance-covariance matrix of the errors in (4) and is used to compute a preliminary set of coefficient estimates that are used to estimate a variance covariance matrix of the residuals, H*. H* is used as the weighting matrix to compute the final coefficient estimates. Windmeijer (2005) shows that the coefficient standard errors in this two-step estimation are biased downward and provides a correction. We will report Windmeijer's corrected standard errors.[4]

There are two tests common to GMM-DIF models. First, to evaluate the validity of the instruments, a Sargan test is used. This a standard GMM test for valid over-identifying restrictions. Under the null hypothesis that the instrument matrix is orthogonal to the differenced errors (valid instruments), the panel Sargan *J* statistic, which is *N* times the usual *J* statistic, has an asymptotic χ^2 distribution with degrees of freedom equal to the rank of the instrument matrix minus the number of estimated coefficients. Second, rather than the Durbin-Watson statistic or another familiar test, two test statistics, *m1* and *m2* for autocorrelation are computed to test for first-order and second-order autocorrelation, respectively, in the residuals of (4). The null hypotheses are that there is no autocorrelation and in a well formulated model. If so, *m1* should show significant, negative first-order autocorrelation and *m2* should show no second-order autocorrelation. If *m2* shows autocorrelation, an additional lag of the dependent variable may be added. Both *m1* and *m2* are asymptotically normally distributed under their null hypotheses. Greater detail is found in Bond (2002) and in Arellano and Bond (1991).

GMM estimation routines do not usually report a goodness-of-fit measure such as the R^2 because in GMM estimation the mean of the residuals need not be exactly zero. Consequently, the sum of squares, total (SST) may not partition into the sum of the sum of squares, regression (SSR) and the sum of squares, error (SSE). In our results, we rely on Kvalseth (1985) and report a good-of-fit statistic, R_1^2 , which is equal to one minus the ratio of SSE to SST (R_1^2 = 1 - SSE/SST) for each model. Though the formula is familiar, the R_1^2 from GMM does not have precisely the same properties as R^2 in OLS. It is presented only as a general guide to help interpret the model's fit.

GMM-DIF estimators have become common when estimating small *T* dynamic panels. Zhang and Fan (2004) use GMM-DIF to examine the relationship between total factor productivity (TFP) and infrastructure in India, Mickiewicz et al. (2004) investigate the extent of investment constraints on domestic firms in Estonia, Skripnitchenko and Koo (2005) examine U.S. foreign direct investment in Latin American food industries, and Esposito (2007) reports GMM-DIF results in his examination EU agricultural policies. Di Liberto, et al. (2008) use GMM-DIF to examine regional TFP convergence in Italy.

Results

We estimate acreage response to decoupled payments for each indica region separately using the three different aggregations of the decoupled payments: payments per county acre planted in rice, payments per county base acre, and total decoupled payments received by producers in the county. Tables 4a, 4b, and 4c summarize the results of these estimations. In none of the nine models did the Sargan test reject the hypothesis of valid instruments. Further, in all nine models, the *m1* test statistic indicated significant first-order autocorrelation while the *m2* did not indicate second-order autocorrelation at 95% significance.[5] The Wald test of the joint significance of the coefficients had p-values less than 0.001 in all cases.

Decoupled payments

As highlighted in table 5, direct payments (PFCs, MLAs, and DPs) exert a significant and marked effect on county acreage planted in one of the three regions and show significant yet more muted effects in the others. In the Arkansas Non-Delta region, direct payments were significant at the 99% level regardless of the measurement used (payment per planted acre, payment per base acre, or total payments to county producers). The elasticity of acreage planted to direct payments ranges from 0.151 to 0.195 in the Arkansas Non-Delta region. In the Mississippi River Delta region, total direct payments received within a county and direct payments per base acre were significant determinants of county acreage planted with elasticities of approximately 0.108. In the Gulf Coast region, direct payments per planted acre were statistically significant with an estimated elasticity of 0.092. These numbers fall easily within the rather large range of acreage response estimates in the published literature on decoupled payments, as reflected in table 1.

Counter-cyclical payments are found to be significant in all three Arkansas Non-Delta models at the 99% level and in all three Mississippi River Delta models at the 95% level or better. In the Gulf Coast model, counter-cyclical payments are significant at the 99% level when measured as payments per planted acre. In each case, the estimated coefficients are much smaller than the coefficients on direct payments. This may be because direct payments can be known at planting time with much more certainty than can the counter-cyclical payments, causing farmers to rely on or react to direct payments more strongly.

Price elasticities

The coefficients on our measure of supply-inducing price, highlighted in table 6 were positive and significant at the 99% level in all nine models. In each case, the acreage response was price-inelastic. The inelastic supply response is consistent with previous studies, and the range of our estimates (between 0.332 and 0.858) is well within the range of elasticity estimates generated by previous studies. Chowdhury (2002) found rice acreage price elasticities of 0.67 to 0.81 in indica rice-growing states during the period 1959 to 1973, while Song and Carter (1996) estimated a rice acreage response elasticity for the indica producing region of 1.50 during what they call the "relatively free market period" of 1974 to 1981, and 0.11 during the more restrictive, "farm bill" period of 1982 to 1991. Chen and Ito (1992) estimate an elasticity for the 1981 rice crop of 0.29, and Salassi (1995) found a short-run, national acreage price elasticity for rice in 1992 of 0.18, with a long-run estimate of 0.43. McDonald and Sumner (2003) estimate a structural elasticity of the acreage supply function for rice ranging from 0.847 to 1.135.

Cost elasticities

Our results show that acreage in the Gulf Coast region is most sensitive to changes in variable costs. The cost elasticities are statistically significant in the models using total payments in all zones and are significant for all measures in the Gulf Coast. Even when not statistically significant, the coefficients have the correct sign. Our cost elasticities for the Gulf Coast are similar to Salassi's (1995) national estimates for 1992. Table 7 summarizes our estimated cost elasticities.

Conclusions and policy implications

Numerous authors have asserted that PFCs and DCs are likely to exert an effect on acreage that is small, or modest, relative to those sources of farm income directly linked to production (see, for example, Young and Westcott 2000; Westcott and Young 2004; and Gardner 2009) Insofar as we find that the acreage response elasticity with respect to supply-inducing price is significantly larger than the acreage response elasticity with respect to direct payments, our results confirm this. However, given that the supply-inducing price is and has been significantly greater than the direct payment rate, the percent change in acreage resulting from any given change in the supply-inducing price will be much smaller than the effect of an identical change in the direct payment rate, potentially compensating for the differences in elasticity estimates. In some regions, an attempt to offset future market losses through an increase in direct payment rates could have a greater impact on output, dollar-for-dollar, than those admittedly distortionary payments targeted at price. As reflected in table 8, our results indicate that in 2008, with respect to rice acreage in the Arkansas Non-Delta region, a $0.34 increase in direct payments would fully offset a $1 decrease in the supply-inducing price.

While rice producers are currently enjoying record-high farm prices, the history of price volatility characterizing the world rice market, combined with pressure from the WTO to limit the use of coupled payments, increases the likelihood that in the future the U.S. will rely more on direct payments as a means to support its rice producers. Our results caution against this. The current US program of decoupled payments to indica rice producers might well be vulnerable to WTO sanction, or at least to inclusion in its amber box of capped, support measures considered to exert distortionary effects on world trade. The threat of WTO sanction is particularly acute given that the majority of indica rice exports originate in the Arkansas Non-Delta region, which exhibits the highest acreage response elasticity to decoupled payments.[6] The authors of the next farm bill will do well to consider alternatives to the present system of decoupled payments as means of farm income support.

References

Adams, G., P. Westhoff, B. Willott, and R.E. Young II. 2001. "Do 'Decoupled' Payments Affect U.S. Crop Area? Preliminary Evidence from 1997–2000." *American Journal of Agricultural Economics* 83(5):1190–95.

Arellano, M., and S. Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies* 58(2):277–297.

Arellano, M., and O. Bover. 1995. "Another Look at the Instrumental Variable Estimation of Error-Components Models," *Journal of Econometrics* 68(1):29-51.

Baldwin, K., E. Dohlman, N. Childs, and L. Foreman. 2011. *Consolidation and Structural Change in the U.S. Rice Sector.* Outlook Report No. RCS-11D-01. http://www.ers.usda.gov/Publications/RCS/2011/ 04Apr/RCS11D01/ accessed 30 June 2011.

Blundell, R., and S. Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* 87(1):. 115-143.

Bond, S. R. 2002. "Dynamic Panel Data Models: a guide to micro data methods and practice." *Portuguese Economic Journal* 1(2):141-162.

Burfisher, M.E., S. Robinson, and K. Thierfelder. 2000. "North American Farm Programs and the WTO." *American Journal of Agricultural Economics* 82(3):768–74.

Childs N., and A. Burdett. 2000. *Rice Situation and Outlook: The U.S. Rice Export Market*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, pp. 48–54.

Chau, N., and H. DeGorter. 2005. “Disentangling the Consequences of Direct Payment Schemes in Agriculture on Fixed Costs, Exit Decisions, and Output.” *American Journal of Agricultural Economics* 87 (5):1174-1181.

Chen, D.T., and S. Ito. 1992. “Modeling Supply Response with Implicit Revenue Functions: A Policy-Switching Procedure for Rice.” *American Journal of Agricultural Economics* 74(1):186-196.

Chowdhury, A.A. F. 2002. “The Impact of the Acreage Allotment Program on Rice Farming.” *International Advances in Economic Research* 8(1):49-57.

Di Liberto, A., F. Pigliaruy, and R. Muraz. 2008. “How to Measure the Unobservable: A Panel Technique for the Analysis of TFP Convergence.” *Oxford Economic Papers* 60:343–368.

Druska, V., and W. C. Horrace. 2004. “Generalized Moments Estimation for Spatial Panel Data: Indonesian Rice Farming,” *American Journal of Agricultural Economics* 86(1):185-198.

Duffy, P. A., J. W. Richardson, and M. K. Wohlgenant. 1987. “Regional Cotton Acreage Response,” *Southern Journal of Agricultural Economics* 19(1):99-110.

Espostio, R. 2007. “Regional Growth and Policies in the European Union: Does the Common Agricultural Policy Have a Counter-Treatment Effect?” *American Journal of Agricultural Economics* 89(1):116–134.

Gardner, B. 2009. “Distortions to Agricultural Incentives in the United States and Canada,” In K. Anderson, ed., *Distortions to Agricultural Incentives: A Global Perspective 1955 – 2007*. Washington, D.C.: The World Bank and Palgrave MacMillian, pp.177-220.

Girante, M. J., B. K. Goodwin, and A. Featherstone. 2008. “Farmers’ Crop Acreage Decisions in the Presence of Credit Constraints: Do Decoupled Payments Matter?” Paper presented at the American Agricultural Economics Association Meetings, Orlando, FL, 27-29 July.

Goodwin, B. K., and A. K. Mishra. 2005. “Another Look at Decoupling: Additional Evidence on the Production Effects of Direct Payments.” *American Journal of Agricultural Economics* 87(5):1200–10.

———. 2006. “Are ‘Decoupled’ Farm Program Payments Really Decoupled? An Empirical Evaluation.” *American Journal of Agricultural Economics* 88(1):73–89.

Gujarati, D. N. 2003. *Basic Econometrics* 4th ed. New York: McGraw-Hill.

Hennessy, D.A. 1998. “The Production Effects of Agricultural Income Support Policies Under Uncertainty.” *American Journal of Agricultural Economics* 80 (1):46-57.

Kvalseth, T. O. 1985. “Cautionary Note about R^2,” *The American Statistician* 39(4):279-285.

Livezey, J., and L. Foreman. 2004. *Characteristics and Production Costs of U.S. Rice Farms*. Washington, DC: U.S. Department of Agriculture, Economic Research Service Statistical Bulletin No. 974-7.

Mickiewicz, T., K. Bishop, and U. Varblane. 2004. “Financial Constraints in Investment: Panel Data Results From Estonia, 1995-1999.” *Acta Oeconomica* 54(4):425-449.

Morgan, D., G. M. Gaul, and S. Cohen. July 2, 2006. “Farm Program Pays $1.3 Billion to People Who Don’t Farm.” *Washington Post*, www.washingtonpost.com/wp-dyn/content/article/2006/07/01/AR2006070100962.html.

Nerlove, M. 1958. *The Dynamics of Supply: Estimation of Farmers' Response to Price*. Baltimore: The Johns Hopkins Press.

O'Donoghue, E., and J. B. Whitaker. 2010. "Do Direct Payments Distort Producers' Decisions? An Examination of the Farm Security and Rural Investment Act of 2002." *Applied Economic Perspectives and Policy* 32(1):170-193.

O'Donoghue, E. 2011. Personal communication. U.S. Department of Agriculture, 27 July.

Powell, S. J., and A. Schmitz. 2005. "The Cotton and Sugar Subsidies Decisions: WTO's Dispute Settlement System Rebalances the Agreement on Agriculture." *Drake Journal of Agricultural Law* 10 (2):287-330.

Reed, M. R., and S. K. Riggins. 1981. "A Disaggregated Analysis of Corn Acreage Response in Kentucky," *American Journal of Agricultural Economics* 63(4):708-711.

Roberts, I., and F. Jotzo. 2002. US Farm Bill: Support and Agricultural Trade. *ABARE Research Report* 1.13, Canberra, 2001.

Salassi, M. E. 1995. "The Responsiveness of U.S. Rice Acreage to Price and Production Costs." *Journal of Agricultural and Applied Economics* 27(2):386-399.

Skripnitchenko, A., and W. W. Koo. 2005. "U.S. Foreign Direct Investment in Food Processing Industries of Latin American Countries: A Dynamic Approach." *Review of Agricultural Economics* 27(3):394-401.

Song, J.H., and C. Carter. 1996. "Rice Trade Liberalization and Implications for U.S. Policy." *American Journal of Agricultural Economics* 78(4):891-905.

Sumner, D.A. 2003a. "Implications of the USA Farm Bill of 2002 for Agricultural Trade and Trade Negotiations." *Australian Journal of Agricultural and Resource Economics* 46(3):117–40.

_____ 2003b. *A Quantitative Simulation Analysis of the Impacts of U.S. Cotton Subsidies on Cotton Prices and Quantities*, Mimeo. Accessed 7/6/11. http://www.fao.org/es/esc/common/ecg/306/en/Sumner.pdf

_____. 2005. "Boxed In: Conflicts between U.S. Farm Policies and WTO Obligations", *CATO Institute Trade Policy Analysis* No. 32. www.freetrade.org/pubs/pas/pas.html, accessed 19 June 2011.

Tielu, A., and I. Roberts. 1998. "Farm Income Support: Implications for Gains from Trade of Changes in Methods of Support Overseas." ABARE Current Issues 98(4):4–5.

Tronstad, R., and R. Bool. 2010."U.S. Cotton Acreage Response Due to Subsidized Crop Insurance," Paper presented at the Agricultural and Applied Economics Association Annual Meeting, Denver, CO, 25-27 July.

Wailes, E..J., and A. Durand-Morat. 2005. "Impacts of WTO Policy on U.S. Rice Policy." Paper presented at the World Trade Organization Impacts on U.S. Farm Policy Conference. New Orleans, LA, 1-3 June. http://cnas.tamu.edu/NOP6Wailes.pdf, accessed 20 June 2011.

Westcott, P. C., and C. E.Young. 2004. "Farm Program Effects on Agricultural Production: Coupled and Decoupled Payments." In M.E. Burfisher and J. Hopkins, eds., *Decoupled Payments in a Changing Policy Setting*. Washington D.C.: US Department of Agriculture, Agricultural Economic Report 838, pp. 7-17.

Windmeijer, F. 2005 "A Finite Sample Correction for the Variance of Linear Efficient Two-Step GMM Estimators." *Journal of Econometrics* 126(1):25-51.

World Trade Organization. 1994. *Uruguay Round Agreement on Agriculture, Annex 2: Domestic Support: The Basis for Exemption from the Reduction Commitments*. http://www.wto.org/english/docs_e/legal_e/14-ag_02_e.htm, accessed 17 July 2011.

_____ . 2005. *United States – Subsidies on Upland Cotton AB 2004-5, Report of the Appellate Body. WT/DS267/AB/R.* http://www.wto.org/english/tratop_e/dispu_e/267**abr**_e.doc*, accessed 17 July 2001.*

Young, C. E., and P. C. Westcott. 2000. "How Decoupled is U.S. Agricultural Support for Major Crops?" *American Journal of Agricultural Economics* 82(3):762-767.

Zhang, X., and S. Fan. 2004. "How Productive Is Infrastructure? A New Approach and Evidence from Rural India." *American Journal of Agricultural Economics* 86(2):492-50

Footnotes

[1] Under the 1996 farm bill, direct payments for 1997-2002 are program flexibility credit (PFC) payments and the emergency market loss assistance (or supplemental AMTA) payments.

[2] Loan gain includes loan deficiency payments, marketing loan gains, and certificate exchange gains and is computed as the difference between the loan rate and USDA's published adjusted work price.

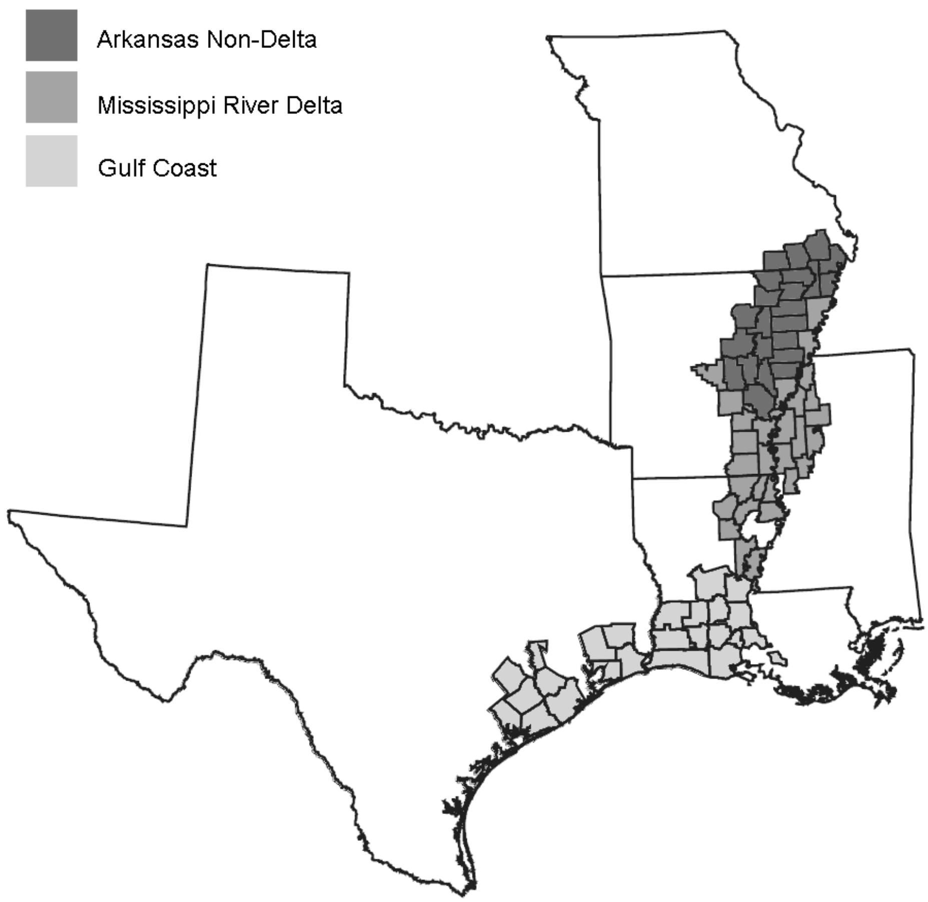
[3] Because counter-cyclical payments are zero in most years, we use the natural log of counter-cyclical payments per acre plus one in the model following Gujarati's advice (pg. 422, note 38). However, we do not interpret the coefficient on this variable as an elasticity.

[4] An extension of GMM-DIF is the system GMM estimator (GMM-SYS) of Arellano and Bover (1995) and Blundell and Bond (1998). They show that when the dependent variable is highly persistent, GMM-DIF may not be efficient. In our context, this would occur if acreage from year-to-year adjusted slowly, that is, if ρ is close to one in equation (4). The GMM-SYS estimator augments the instruments with differences of the dependent variable and levels of the exogenous variables. However, our GMM-DIF results did not show that acreage was highly persistent so we do not present GMM-SYS results.

[5] In the model using payments per base acre for Mississippi River Delta, a second lag of the dependent variable was needed to eliminate autocorrelation in the residuals.

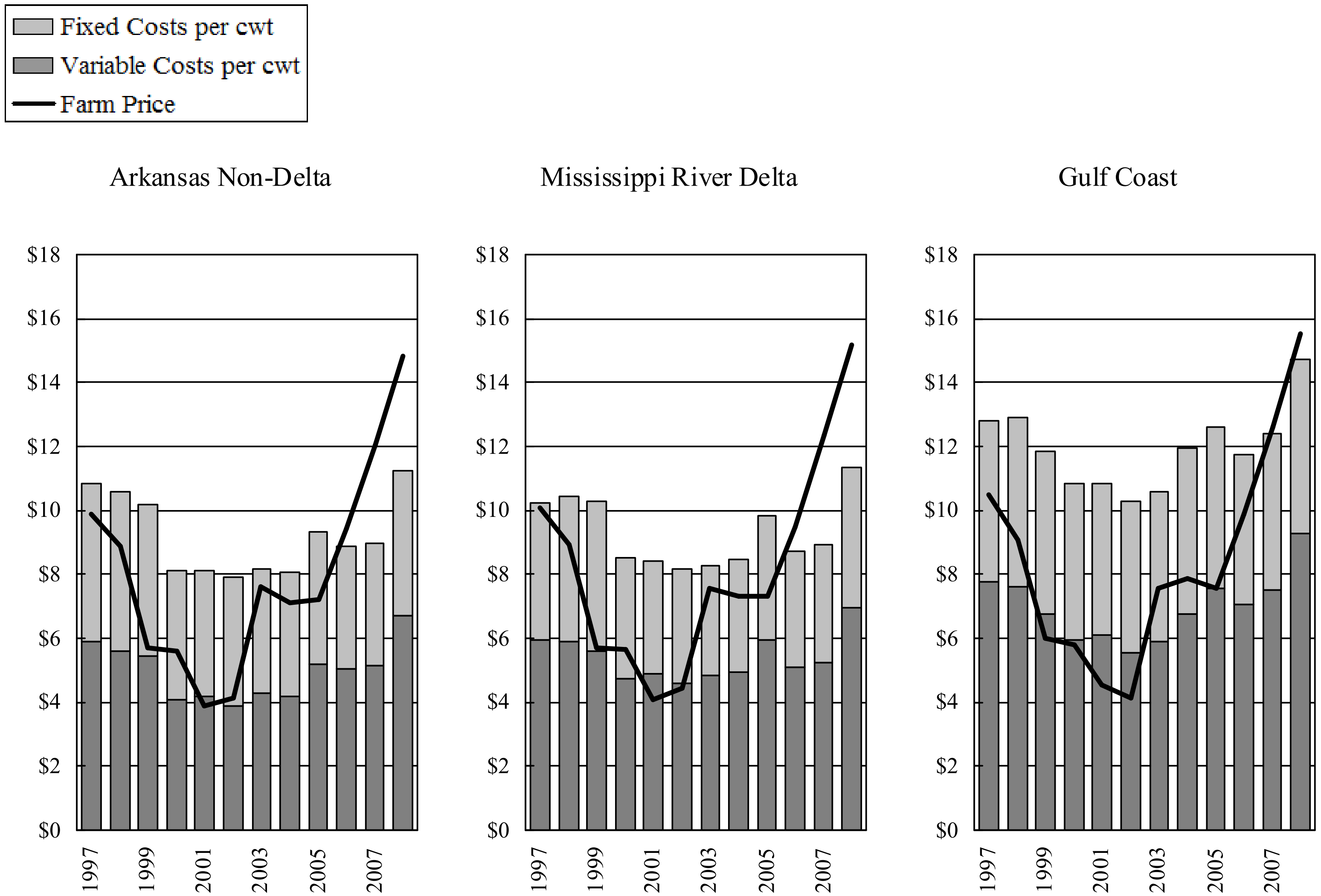
[6] According to the USDA Economic Research Service, Arkansas provided about 60 percent of the indica rice exports between 2001 and 2010 (http://www.ers.usda.gov/Data/StateExports/).

Figure 1. Indica Rice Producing Regions



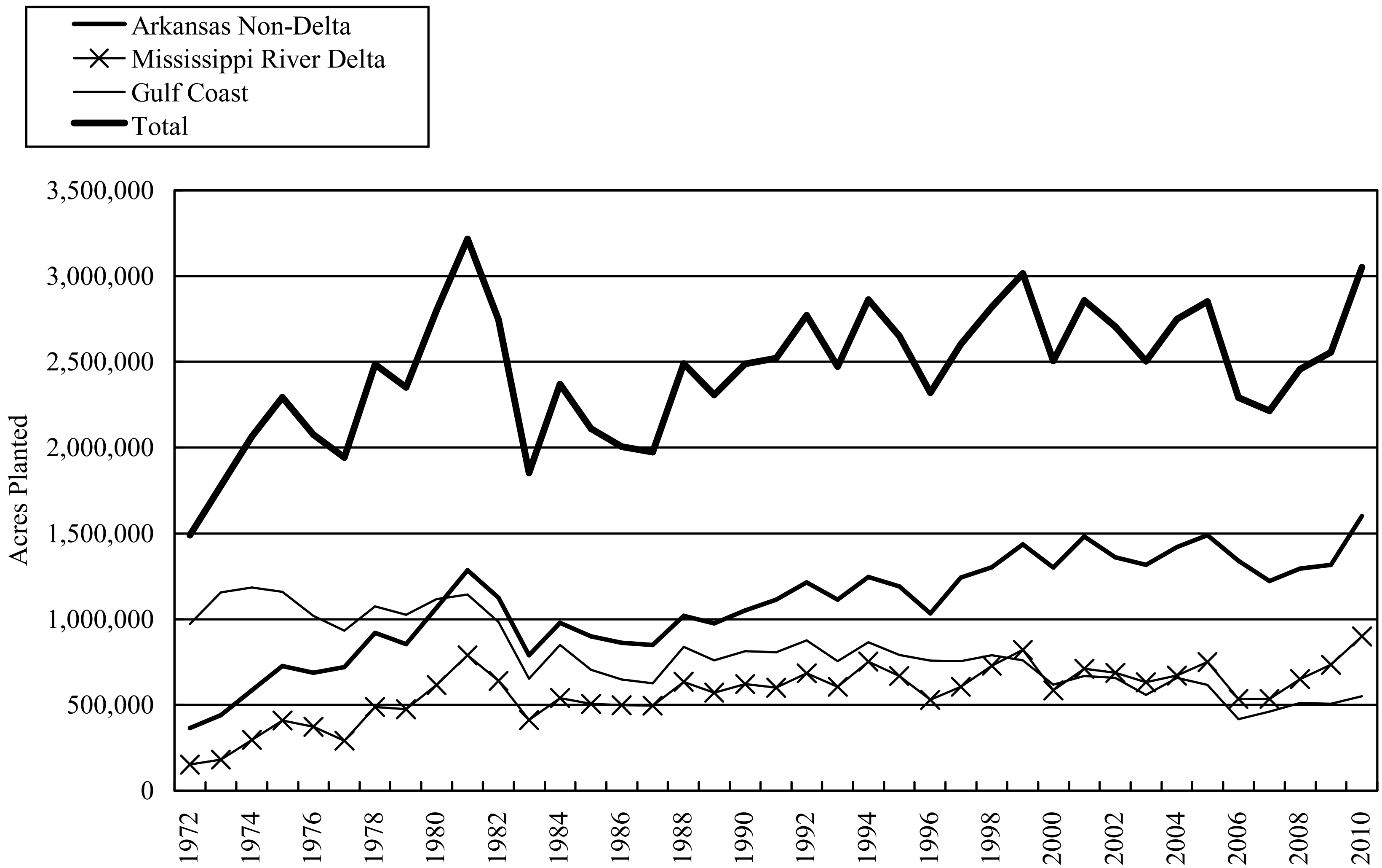
Source: Livezey and Foreman 2004

Figure 2. Price and Production Costs per Hundredweight (cwt) by Region



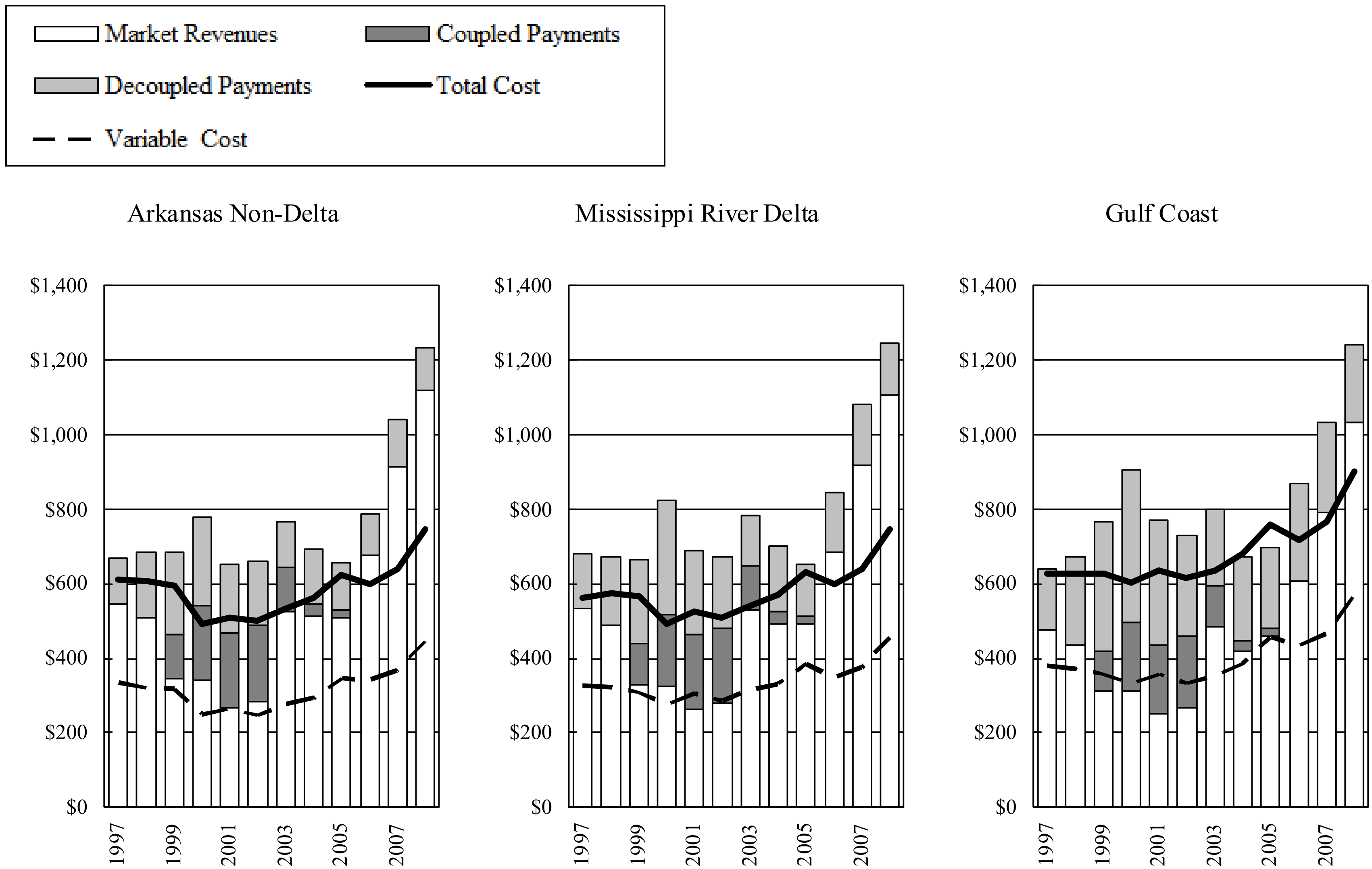
Source: Authors' calculations from USDA ERS and NASS data

Figure 3. Indica Rice Acres Planted by Region and Total



Source: Authors' calculations from NASS data

Figure 4. Revenues (by Source) per Acre Planted and Costs per Acre Planted, by Region



Source: Authors' calculations from USDA ERS and NASS data

Table 1. Empirical Estimations of Acreage Response to Decoupled Payments: Results and Aggregations

Authors (Year)	Method of analysis	Aggregation level of response variable	Crops	Payment Metric	Stat. signif. of estimated acreage effect of decoupled payments	Acreage response elasticity, ε_A
Burfisher, Sherman and Thierfelder (2000)	Computable general equilibrium model	Acres of crop *j* planted in country *i*, (*i* =U.S., Mexico, Canada)	Wheat, corn, feedgrains, oilseeds	Total transfer payments to farmers in country *i*	n.a.	$0.010 \leq \varepsilon_A \leq 0.022$ for US depending on the crop

Authors (Year)	Method of analysis	Aggregation level of response variable	Crops	Payment Metric	Stat. signif. of estimated acreage effect of decoupled payments	Acreage response elasticity, ε_A
Adams, Westhoff, Willott, and Young (2001)	Mixed estimation, 1997 to 2000, for 11 states.	Total acres planted in combined studied crops in state *i*	Summation of wheat, corn, sorghum, barley, oats, cotton, rice and soy	Expected real decoupled payments per acre planted in state *i*	significant at 90%	$\varepsilon_A = 0.026$
Goodwin and Mishra (2005)	Two-step estimation for censored system	Acres of crop *j* planted on farm *i*	Corn, soybeans, wheat	Decoupled payments received on farm *i*	Insignificant	n.a.

Authors (Year)	**Method of analysis**	**Aggregation level of response variable**	**Crops**	**Payment Metric**	**Stat. signif. of estimated acreage effect of decoupled payments**	**Acreage response elasticity, ε_A**
Goodwin and Mishra (2006)	Two-step estimation for censored system	Acres of crop *j* planted on farm *i*	Corn, soybeans, wheat	Decoupled payments per acre received on farm *i*	Significant for corn at 99% and soybeans at 95%; insignificant for wheat	ε_A(corn) = 0.0317 ε_A(soy) = 0.0204

Authors (Year)	**Method of analysis**	**Aggregation level of response variable**	**Crops**	**Payment Metric**	**Stat. signif. of estimated acreage effect of decoupled payments**	**Acreage response elasticity, ε_A**
Goodwin and Mishra (2006) *continued*	Not explicitly stated (SUR?)	Acres of crop *j* in county *i*	Corn, soybeans, wheat	Average PFC payments per farm acre in county *i* and average MLA payments per farm in county *i*	PFC decoupled payments significant for soybeans and MLA decoupled payments significant for corn and soybeans all at 99%	soy ε_A(PFC) = 0.018 soy ε_A(MLA) <0.01 corn ε_A(MLA) < 0.01

Authors (Year)	Method of analysis	Aggregation level of response variable	Crops	Payment Metric	Stat. signif. of estimated acreage effect of decoupled payments	Acreage response elasticity, ε_A
Girante, Goodwin, and Featherstone (2008)	OLS and fixed effects	Total planted acres (owned and rented) for farm *i*	n.a.	Total decoupled payments received on farm *i*	significant at 99% in both OLS and FE	OLS: ε_A = 0.055 Fixed Effects: ε_A = 0.366

Authors (Year)	**Method of analysis**	**Aggregation level of response variable**	**Crops**	**Payment Metric**	**Stat. signif. of estimated acreage effect of decoupled payments**	**Acreage response elasticity, ε_A**
Girante, Goodwin, and Featherstone (2008)	OLS and fixed effects	Acres planted of crop *j* on farm *i*	Corn, soybeans, wheat, sorghum	Total decoupled payments received on farm *i*	Significant for corn and wheat at 99% in OLS and corn and soybeans at 95% and 99% in FE	OLS: ε_A(corn) = 0.4182 ε_A(wheat) = 0.6282 Fixed Effects: ε_A(corn) = 0.1582 ε_A(soy) = 0.1173

Authors (Year)	Method of analysis	Aggregation level of response variable	Crops	Payment Metric	Stat. signif. of estimated acreage effect of decoupled payments	Acreage response elasticity, ε_A
O'Donoghue and Whittaker (2010)	Differences-in-differences (DiD)	Acres of crop cohort *j* harvested on farm *i*	3 crop cohorts: (1) barley, and oats; (2) wheat, corn, soybeans, and sorghum; (3) hay and "misc. other crops"	Change in total decoupled payments to farm *i* as a result of the base acreage change allowed by the 2002 farm bill.	Change in decoupled payments to farm *i* has significant effect at 95% or more for all 3 cohorts.	ε_A ranged from 0.23 to 0.40 [a]

[a] These values are not published in the article but are from personal communication with O'Donoghue (2011).

Table 2. Variables and Their Sources

Variable	Units	Description and Source
Acres planted	acres	county acreage planted in rice; USDA NASS Quick Stats
Price	dollars/cwt	state season average price for rough rice; USDA 2011 Rice Yearbook data tables
Loan gain	dollars/cwt	marketing loan gain when the adjusted world price (AWP) is below the loan rate ($6.50) = $6.50-AWP; AWP and loan rate; USDA 2011 Rice Yearbook data tables
Supply-inducing price	dollars/cwt	supply-inducing price = price + loan gain
Variable cost	dollars/acre	variable cost[a], USDA Commodity Costs and Returns.
Base acres	acres	County base acreage for production flexibility credits (PFC, 1996 farm bill) or for direct payments (2002 farm bill); USDA ERS
Direct payment rate	dollars/cwt	PFC or direct payment rate including supplemental AMTA payments; USDA 2011 Rice Yearbook data tables
Program yield	cwt/acre	yield for PFC or direct payment program; USDA ERS

[a] For 1997-1999, we calculated variable cost by adding "Operating capital "to the reported "Total, variable cash expenses." This accommodates changes made in the reporting format used by the USDA in its "Commodity Costs and Returns" data set (http://www.ers.usda.gov/Data/CostsAndReturns/testpick.htm). For the same reason, for 2000-2008 we calculated variable costs by adding "Hired labor" to the reported "Total, operating costs."

Variable	Units	Description and Source
Direct payments	dollars	= 0.85(county base acres)(direct payment rate)(program yield)
Direct payments per planted acre	dollars/acre	= (direct payments)/(county acres planted)
Direct payments per base acre	dollars/acre	= (direct payments)/(county base acres)
Counter-cyclical payment rate	dollars/cwt	counter-cyclical payment rate; USDA 2011 Rice Yearbook data tables
Counter-cyclical program yield	cwt/acre	yield for counter-cyclical payments; USDA ERS
Counter-cyclical payments	dollars/cwt	0.85(county base acres)(cc payment rate)(cc program yield)
Counter-cyclical payments per planted acre	dollars/acre	(counter-cyclical payments)/(county acres planted)
Counter-cyclical payments per base acre	dollars/acre	(counter-cyclical payments)/(county base acres)

Table 3. Summary Statistics

	Indica Rice Region					
	Arkansas Non-Delta		Mississippi River Delta		Gulf Coast	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Acres planted	67,961	34,433	23,651	18,011	21,574	24,110
Farm price	7.5798	3.2195	7.8419	3.3489	7.8003	3.2332
Loan gain	1.4859	1.3636	1.4872	1.3641	1.5397	1.3514
Supply-inducing price	9.0657	2.2778	9.3291	2.4047	9.3400	2.2828
Variable cost	314.906	54.709	338.301	48.605	404.192	68.113
Direct payments per planted acre	148.34	58.277	198.04	110.99	328.67	239.08
Direct payments per base acre	127.22	56.733	121.14	55.7	126.93	59.582
Total direct payments	9,861,500	6,461,100	3,972,200	3,392,400	5,366,000	5,303,900
Counter-cyclical payments per planted acre	17.134	29.627	19.078	34.674	32.257	67.185
Counter-cyclical payments per base acre	14.55	26.01	13.118	24.840	13.524	23.860
Total counter-cyclical payments	1,095,700	2,155,200	421,180	913,030	538,320	1,285,400
n	179		301		265	

Table 4a. GMM-DIF Two-Step Estimation Results Using Direct and Counter-cyclical per Planted Acre

Dependent Variable: Ln(Acres planted$_t$)

Region:	Arkansas Non-Delta	Mississippi River Delta	Gulf Coast
Constant	-0.0248312	0.105407***	0.0269482
	(0.0622101)	(0.0256403)	(0.082745)
ln(Acres planted$_{t-1}$)	0.377408***	0.0139539	0.0870192
	(0.141922)	(0.208789)	(0.0948237)
ln(Acres planted$_{t-2}$)		-0.226998***	
		(0.0687406)	
ln(Supply-inducing price$_{t-1}$)	0.422813***	0.541361***	0.787270***
	(0.0990411)	(0.150817)	(0.115442)
ln(Variable cost$_{t-1}$)	-0.115892*	-0.202133	-0.365439*
	(0.0604524)	(0.237626)	(0.207708)
ln(Direct payments per planted acre$_{t-1}$)	0.194756***	0.0799989	0.0924878**
	(0.042129)	(0.062349)	(0.0371648)
ln(1+counter cyclical payments per planted acre$_{t-1}$)	0.045873***	0.0394425**	0.0276927***
	(0.00837784)	(0.0162488)	(0.0105959)
Time	0.015156	-0.151124***	-0.056524
	(0.0616687)	(0.0335369)	(0.0778155)

Region:	Arkansas Non-Delta	Mississippi River Delta	Gulf Coast
Sum of squared errors	2.233538	15.99472	12.35150
Std. error of regression	0.113955	0.248988	0.218801
m1 test for AR(1) errors	-2.53243**	-1.86773*	-2.42131**
m2 test for AR(2) errors	-0.621024	-0.570724	-1.43883
Sargan test	$\chi^2(54)=18.7051$	$\chi^2(52)=30.1319$	$\chi^2(54)=26.0387$
Wald joint test	$\chi^2(6)=44.9397$***	$\chi^2(7)=2018.68$	$\chi^2(6)=67.7998$***
R_1^2	0.9845	0.9290	0.9640
Dimensions	N=19, T=10, 179 obs.	N=33, T=9, 266 obs.	N=29, T=10, 265 obs.

Table 4b. GMM-DIF Two-Step Estimation Results Using Direct and Counter-cyclical Payments per Base Acre

Dependent Variable: ln(Acres planted$_t$)

Region:	Arkansas Non-Delta	Mississippi River Delta	Gulf Coast
Constant	-0.0176203	0.124999***	0.0326723
	(0.0648182)	(0.0322913)	(0.0721878)
ln(Acres planted$_{t-1}$)	0.305914	0.0717472	0.350974***
	(0.197699)	(0.0932628)	(0.117127)
ln(Supply-inducing price$_{t-1}$)	0.463187***	0.588124***	0.695835***
	(0.119848)	(0.133592)	(0.113275)
ln(Variable cost$_{t-1}$)	-0.115347*	-0.254778*	-0.728568***
	(0.0640047)	(0.132989)	(0.21757)
ln(Direct payments per base acre$_{t-1}$)	0.168915***	0.107586*	-0.0331535
	(0.0399096)	(0.0619477)	(0.0450359)
ln(1+counter cyclical payments per base acre$_{t-1}$)	0.044249***	0.0417027***	-0.00935767
	(0.0084657)	(0.0152339)	(0.0151684)
Time	0.0105876	-0.153856***	-0.0377557
	(0.0643891)	(0.0314536)	(0.0710492)
Sum of squared errors	2.567693	22.57770	14.52736
Std. error of regression	0.122182	0.277119	0.237292
m1 test for AR(1) errors	-2.46709**	-2.94274	-2.48645**

Region:	Arkansas Non-Delta	Mississippi River Delta	Gulf Coast
m2 test for AR(2) errors	-0.590285	-1.82693*	-0.456431
Sargan test	χ^2(54)=18.3745	χ^2(54)=31.3652	χ^2(54)=28.0244
Wald joint test	χ^2(6)=43.9932***	χ^2(6)=116.786***	χ^2(6)=62.9625***
R_1^2	0.9822	0.9134	0.9576
Dimensions	N=19, T=10, 179 obs.	N=33, T=10, 301 obs.	N=29, T=10, 265 obs.

Table 4c. GMM-DIF Two-Step Estimation Results Using Direct and Counter-cyclical Payments

Dependent Variable: ln(Acres planted$_t$)

Region:	Arkansas Non-Delta	Mississippi River Delta	Gulf Coast
Constant	-0.0201385	0.118411***	0.016113
	(0.0505833)	(0.0323274)	(0.0650742)
ln(Acres planted$_{t-1}$)	0.196604	0.0741784	0.312531***
	(0.200814)	(0.118993)	(0.0984697)
ln(Supply-inducing price$_{t-1}$)	0.331732***	0.562722***	0.857727***
	(0.0932412)	(0.135297)	(0.117638)
ln(Variable cost$_{t-1}$)	-0.135414**	-0.295706***	-0.566516***
	(0.0600577)	(0.114454)	(0.218545)
ln(Direct payments$_{t-1}$)	0.151175***	0.107741**	0.0616372
	(0.0285358)	(0.045582)	(0.0457826)
ln(1 + counter cyclical payments$_{t-1}$)	0.0088281***	0.0107354***	0.005232
	(0.0012416)	(0.00348768)	(0.0034210)
Time	0.010582	-0.149537***	-0.0276323
	(0.0502186)	(0.031108)	(0.0639291)
Sum of squared errors	2.431710	22.45036	14.17639
Std. error of regression	0.118903	0.276336	0.234408
m1 test for AR(1) errors	-2.27124**	-2.90263***	-2.5728**
m2 test for AR(2) errors	0.313973	-1.94478*	-0.328349

Region:	Arkansas Non-Delta	Mississippi River Delta	Gulf Coast
Sargan test	$\chi^2(54)=18.2417$	$\chi^2(54)= 31.7593$	$\chi^2(54)=27.2485$***
Wald joint test	$\chi^2(6)=62.0152$***	$\chi^2(6)= 128.843$***	$\chi^2(6)=73.3941$***
R_1^2	0.9832	0.9139	0.9587
Dimensions	N=19, T=10, 179 obs.	N=33, T=10, 301 obs.	N=29, T=10, 265 obs.

Table 5. Estimated Acreage Responses to Changes in Decoupled Payments

		Region		
		Arkansas non-Delta	Mississippi River Delta	Gulf Coast
Direct Payments	per planted acre	0.194756***	0.0799989+	0.0924878**
	per base acre	0.168915***	0.107586*	-0.0331535
	total	0.151175***	0.107741**	0.0616372+
Counter-cyclical payments	per planted acre	0.045873***	0.0394425**	0.0276927***
	per base acre	0.044249***	0.0417027***	-0.00935767
	total	0.008828***	0.0107354***	0.005232+

Asterisks identify significance at the 90% (*), 95% (**), or 99% (***) levels.

Pluses identify significance at 90% (+) in one-tailed tests.

Table 6. Estimated Price Elasticities

		Region		
		Arkansas non-Delta	Mississippi River Delta	Gulf Coast
Decoupled	per planted acre	0.422813***	0.541361***	0.787270***
Payments	per base acre	0.463187***	0.588124***	0.695835***
Measure	total	0.331732***	0.562722***	0.857727***

Asterisks identify significance at the 99% (***) level.

Table 7. Estimated Cost Elasticities

		Region		
		Arkansas non-Delta	Mississippi River Delta	Gulf Coast
Decoupled	per planted acre	-0.115892*	-0.202133	-0.365439*
Payments	per base acre	-0.115347*	-0.254778*	-0.728568***
Measure	total	-0.135414**	-0.295706***	-0.566516***

Asterisks identify significance at the 90% (*), 95% (**), or 99% (***) levels.

Table 8. Increase the Direct Payment Rate with an Acreage Response Equivalent to a $1 Supply-Inducing Price Increase, 2008 Farm Prices[a].

	Arkansas Non-Delta	Mississippi River Delta	Gulf Coast
Model with payments per base acre	$0.43	$0.83	([b])
Model with total payments	$0.34	$0.80	$2.08[c]

Notes: [a] Payments per planted acre not included in estimates due to dynamic effects.

[b]Model coefficient is not significant.

[c] Model coefficient is significant at 90% in a one-tailed test.