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A REVIEW OF EMPIRICAL STUDIES OF THE ACREAGE AND PRODUCTION RESPONSE TO US PRODUCTION FLEXIBILITY CONTRACT PAYMENTS UNDER THE FAIR ACT AND RELATED PAYMENTS UNDER SUPPLEMENTARY LEGISLATION

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NOTE BY THE SECRETARIAT

This paper was prepared by Professors David Abler and David Blandford, both from Pennsylvania State University. It contains a literature review of empirical studies on land allocation and production response to direct payments under the United States 1996 FAIR Act and subsequent Marketing Loss Assistance (MLA) payments.

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A Review of Empirical Studies of the Acreage and Production Response to US Production Flexibility Contract Payments Under the Fair Act and Related Payments Under Supplementary Legislation[1]

1. This paper provides a review of the literature relating to empirical studies of the acreage and/or production response to the direct payments made to US farmers of wheat, feed grains, cotton and rice under the Federal Agriculture Improvement and Reform Act of 1996 and related payments made under additional legislation during the period 1999-2002.

1. Direct Payments under the FAIR Act and Related Legislation

2. Prior to the passage of the FAIR Act in 1996 direct payments were provided to US producers of wheat, feed grains, cotton and rice (referred to in this paper as "program crops") through a target price/deficiency payment system. Payments were triggered when average farm prices fell below a predetermined target price for an eligible commodity. The size of the payment was determined by multiplying the payment rate per unit of production by a program payment yield per acre and the number of acres eligible for payments. The deficiency payment was based on the difference between the target price and either the market price during a specified period, or the price support loan rate, whichever was higher. The area eligible for payments was determined from an average of plantings in previous years. Farmers were allowed limited flexibility on what crops to plant on the land and plantings of supported crops could be limited through an acreage reduction program.

Production Flexibility Contract (PFC) Payments

3. The FAIR Act changed the system used for making direct payments to US producers of program crops. The previous system was replaced by predetermined annual payments for the duration of the legislation (1996-2002). Also eliminated were production adjustment ("set-aside") provisions and most of the restrictions on what crops could be grown on land enrolled in commodity programs. The previous system of price support (commodity and marketing loans) was continued for the crops concerned.

4. Under the FAIR Act, the Secretary of Agriculture was required to offer Production Flexibility Contracts (PFCs) for the crop years 1996-2002 for wheat, corn, sorghum, barley, oats, cotton and rice — the so-called "contract commodities"— to eligible landowners or producers with eligible cropland. Land eligible for enrolment was that which had previously been eligible for deficiency payments (*i.e.* had a payment base) or land enrolled in the Conservation Reserve Program (CRP), which had previously had a payment base and whose CRP contract would expire during the life of the FAIR Act.[2]

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[2] Under the Conservation Reserve Program, which was originally introduced under the Food Security Act of 1985, the owners of environmentally sensitive farmland can sign a contract to convert their land to approved permanent conserving uses for 10-15 years. In exchange, landowners receive an annual payment plus cash or payments in kind for up to 50% of the cost of establishing permanent vegetative cover. The 1996 Act provided for a maximum CRP enrollment of 36.4 million acres.

5. The amount of payments allocated per commodity per year was predetermined; total payments were set at USD 36.6 billion for the 7-year life of the Act or an average of just under USD 5.1 billion per year.[3] The annual payment rate for each commodity was determined by dividing the total amount allocated for that commodity by the total quantity of national production eligible for payments.[4]

6. Those who chose to enrol their land in the PFC program received an annual payment equal to the product of their contract payment quantity and the national annual payment rate. The contract payment quantity was the product of 85% of the contract payment acreage and the farm program payment yield. The contract payment acreage was the crop acreage base that would have been in effect for the 1996 crop under Title V of the Agricultural Act of 1949, if it had been in force. The farm program payment yield was that established for the 1995 crop. In order to receive payments, participants in the program who operate highly erodible land had to agree to manage that land under approved conservation practices; those whose properties contained wetlands had to satisfy restrictions on the use of such wetlands for agricultural use. Finally, contract acreage could not be used for non-agricultural commercial or industrial purposes, and there were restrictions on the use of the land for the production of fruit and vegetables.

Marketing Loss Assistance (MLA) Payments

7. MLA payments were introduced as part of "emergency assistance" provided to US agriculture in 1999. As part of an appropriations act signed into law in October 1998, USD 2.857 billion in additional payments were made to farmers to compensate them for the loss of markets for 1998 crops. Subsequent acts provided additional MLA payments of USD 5.5 billion for 1999 crops, USD 5.465 billion for 2000 crops, and USD 4.6 billion for 2001 crops.[5] For the crops eligible for PFC payments, the MLA payments were proportional to the PFC payments made in that year, with a maximum payment per person of USD 19 888. Hence, the MLA payments can be viewed to be supplementary or "top-up" PFC payments.[6]

2. Potential Impact of PFC and MLA Payments on Production Decisions

8. The impact of any type of government financial support for agriculture on production depends crucially on the exact nature of the program through which support is provided, the incentives that it creates and the behaviour of producers in response to those incentives. Even if US farmers do not correspond exactly to the profit-maximizing agents that lie at the centre of neoclassical economic theory, there is ample evidence that they are responsive to changes in relative prices and returns that are created by government programs.

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3 The allocation percentages were: corn 46.22%, wheat 26.26%, cotton 11.63%, rice 8.47%, sorghum 5.11%, barley 2.16%, and oats 0.15%. The actual amount available each year was adjusted for refunds to/from the Commodity Credit Corporation (CCC) and to reflect payment limits to individual recipients. Rice was allocated an additional USD 8.5 million per year from 1997 to 2002.

4 PFC payments are sometimes referred to as AMTA payments. AMTA refers to Title I, the Agricultural Market Transition Act, of the FAIR Act. It is that part of the legislation that contains the commodity provisions, including PFC, but also commodity loans and other forms of price support, *e.g.* for dairy, peanuts and sugar. To avoid potential confusion, we shall refer to the payments as PFC payments. Actual PFC payment amounts under the FAIR Act were adjusted for deficiency payments still owed to farmers, and repayments owed by farmers to the government, under the 1990 Farm Act.

5 The amounts for the 1999 and 2000 crops were both disbursed in federal fiscal year 2000 (*i.e.* October 1999 – September 2000).

6 MLA payments have sometimes been referred to as "double AMTA" payments (Goodwin and Mishra, 2002).

9. Producers are likely to adjust their production plans in response to government payments if such payments affect the relative profitability of alternative crops. In the short-run, such response is likely to be reflected in the amount of land allocated to alternative crops and amounts of variable inputs, such as fertilizer and labour, used in production. In the longer-run, response may be reflected in the level of investment in machinery and other quasi-fixed assets, and possibly in the total amount of land in production. In order for such effects to be apparent, the amount of payment received from the government must increase with the volume of production and the additional revenue obtained from expanding production (the returns derived from selling the crop plus government payments) must exceed the additional costs of that production. In the case of the PFC and MLA payments, although these were determined on the basis of figures for the production of individual commodities, actual production in the current year did not affect the level of payments to the producer. The figures used to determine payments related to historical data for area and yields. Thus PFC and MLA payments to an individual program participant did not depend on current production on the land upon which the calculation of payments were made, or on actual market prices.

10. Given this, it might seem that it would be unlikely *a priori* to find evidence of an effect of PFC and MLA payments on production. However, there are several mechanisms through which such an effect might be created (OECD, 2001; OECD, 2004). These are as follows:

1. The additional income generated by payments may enhance the ability of producers to cover fixed and variable production costs. Payments may serve to keep production higher in the short-run, if that production would otherwise be unprofitable at prevailing market prices. For this to apply, those who receive the payment must choose to use it to cover production costs, rather than to increase their consumption or savings.[7] Producers may also choose to use some of the increased income generated by payments to make longer-term investments in their farm operations. They may do this simply because they have a preference for investing in agriculture rather than in other sectors of the economy or seek to take advantage of their specialized skills, particularly if there are imperfections in labour, information, and capital markets. Alternatively, producers may be operating on the downward portion of their average total cost curve, *i.e.* under increasing returns to scale. In such a case, it would be economically rational to use some or all of the additional revenue from direct payments to expand output. It should be noted that since the prices of fixed assets in farming, particularly land, may change when farmers' revenues change, the revenue-enhancing effect of payments may be translated into changes in land rental rates and values, rather than changes in production.[8]
2. If producers face a capital constraint, *i.e.* limitations in their ability to secure capital from traditional lenders, then the additional income generated by payments may permit them to relax that constraint by investing more heavily in their operations out of earnings generated by the farm business. For this to apply, there would have to be a market failure due to imperfect or incomplete capital markets resulting in an insufficient supply of capital to otherwise suitably qualified agricultural borrowers, or a supply of capital at a price (rate of interest) which exceeds its opportunity cost in other uses, adjusted for any premium reflecting the relative risk of agricultural investments. In addition, producers would have to use the funds provided by

[7] In an unpublished conference paper, Chau and de Gorter (2000, p. 6) argue that a producer may decide to do this rather to exit the industry, under the expectation that adjustments by others will eventually cause market prices to rise. If a large number of producers behave in this way, there will only be a short-run effect on production.

[8] A key issue is the speed with which land prices change in response to changes in revenue. In the United States, a highly active rental market for land plays a key role in this regard, as is discussed subsequently in the paper.

payments for production-enhancing investments, rather than for any other purposes. We might also note that payments may relax capital constraints by influencing the supply of loans to agricultural producers. Lenders may be more willing to lend to producers if the risk of non-repayment is viewed to be lowered through the additional income provided through a known stream of future payments, rather than having to rely on the uncertain stream of producers' market returns. To the extent that payments increase the value of fixed assets, particularly land, an increase in farmers' equity may also enhance the ability of farmers to secure loans.

3. If producers are risk averse, the increase in wealth created by the payments may make producers less risk averse than otherwise, causing them to expand production by planting crops on land that would otherwise be viewed to be too risky.[9] Such an effect might be strengthened if payments vary inversely with market prices (as was the case with the earlier deficiency payments), since this would reduce income variability and provide an insurance effect.[10] Such an effect would not be expected to apply to PFC payments, which were invariant to changes in market prices. However, it might apply to MLA payments, which were explicitly provided to provide an *ex post* increase in income to offset the effects of "loss of markets," *i.e.* weaker demand and lower prices.[11]

4. Even if producers are not risk averse, expectations about the conditions attached to future payments might influence production decisions. The most relevant case is one in which producers have reason to believe that their might be a future updating of the area upon which payments are based (the payment base). In such a case, producers might be reluctant to reallocate acreage from program crops to other crops or to idle marginal land when prices fall in order to protect their future eligibility for payments. For there to be a link between current payments and these production decisions, producers would have to believe that the existence of payments today is a predictor of payments in the future, or that current levels of payments provide an indication of what future payment levels might be.

5. The existence of payments may prompt some producers to remain in agriculture, rather than exiting the industry. If exit would result in land abandonment or the conversion of land to other crops, the provision of payments would unequivocally result in the production of supported crops being maintained at a higher level than would otherwise be the case. In contrast, the exit of less efficient farmers may result in the land being acquired by more efficient farmers — those with superior managerial skills — who are able to produce profitably at prevailing market prices. The amalgamation of land parcels may permit economies of scale to be realized, leading to increased production efficiency and lower average costs of production. Larger scale farms may be in a better position to obtain financing from lenders to fund purchases of variable inputs or to make output-enhancing investments, due to their higher income-earning capacity or greater equity to provide security for loans. Any or all of these effects associated with the exit of farmers and resulting structural changes might lead to an increase in production in the absence of payments.

11. In analyzing ways in which policies can affect production, OECD (2001) classifies these as static effects, effects under uncertainty, and dynamic effects. Static effects are those that occur when policies

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9 This is the "wealth" effect of support identified by Hennessy (1998) and OECD (2001; 2004). The existence of a wealth effect requires that producers exhibit decreasing absolute risk aversion (DARA), which occurs when the Arrow-Pratt coefficient of absolute risk aversion declines as wealth increases.

10 This is the "insurance" effect of support identified by Hennessy (1998) and OECD (2001; 2004).

11 Some analysts, *e.g.* Chau and de Gorter (2001), have assumed *a priori* that the effects of PFC and MLA payments on producer decision-making are equivalent. Others, *e.g.* Goodwin and Mishra (2002) and Young and Westcott (2000), note the possibility that producers' expectations and their production decisions may have been altered after MLA payments were introduced.

affect the incentive prices of agricultural inputs or outputs. Income effects when production decisions are constrained and the effects of quantitative restrictions are also static effects. Effects under uncertainty arise if farmers are risk averse and if a policy reduces risk or increases farm income. Dynamic effects are those arising out of changes in investment decisions by producers or out of expectations concerning government behaviour that influence producer decision-making. Within this classification of effects, the first mechanism identified above (covering fixed and variable production costs) would be considered a static effect. The third mechanism (risk aversion) would be an effect under uncertainty, while the other three mechanisms (capital constraints, producer expectations, and producer entry/exit) would be dynamic effects.

3. Impact Studies by Methodology

12. We have chosen to group the studies in this review by methodology, rather than by the issues identified above. There are two principal reasons for this. First, many studies examine several of the issues identified and it is therefore difficult to achieve a neat breakdown of studies by issue area. Second, some studies use approaches that might be viewed to be less robust in terms of the evidence that they generate on the impact of the payments. Consequently, in this section of the paper, we present our review in a sequence that begins with largely descriptive analyses based on survey data, through synthetic economic models, to econometric impact studies. This ordering reflects a prior expectation on the weight that might be attached to the evidence provided by various approaches, our view being that econometric impact studies carry the greater weight. We recognize, however, that our judgment on this issue may not be universally shared.

Survey Studies

13. Following the implementation of the FAIR Act, data were gathered under the auspices of the Economic Research Service of the US Department of Agriculture from eight panels of professional farm managers and farm operators in order to assess the potential impact of the new legislation on management decisions (Schertz and Johnson 1998a, 1998b; Ryan *et al*., 2001). Panel participants, who were drawn from regions that were historically important in previous commodity programs, were asked to provide information on their management decisions in 1996 (including crop selection, risk management strategies, and land rental arrangements), and on future plans, particularly in the light of the PFC payments they were scheduled to receive. On the basis of the information provided, Schertz and Johnson concluded that the introduction of the PFC payments "quickly affected the price of land and cash rental rates for land" (1998a, p. 5). They note that the high degree of certainty associated with the stream of payments, and their linkage to land resulted in a rapid upward adjustment in the price of land and in cash land rental rates. The terms of crop share leases were also adjusted to take account of the value of the PFC payments. Longer term changes in share lease arrangements were also recorded (conversion to cash lease, or cessation of leasing) as landowners sought to capture a greater share of the PFC payments.

14. Subsequent analysis of survey data collected by USDA lent support to the expectations of the panellists by finding an increase in cash lease income and a shift from share rental to cash leasing (Ryan *et al*., 2001, p. 24).[12] It is important to note that the renting of farmland plays a significant role in US agriculture. Ryan *et al*. (2001) note that roughly 42% of farmers rented land in 1999 and that rented farmland accounted for an average of 45% of the total land operated per farm. The authors observe "depending on the extent that government payments lead to higher rental rates and higher land values, operators farming mostly rented acreage may receive little benefit" (p. 23). The implication may be that

[12] Using USDA data for farm sector accounts and an income capitalization approach, Ryan *et al.* (2001) estimate that total US government payments increased US farmland values by an average of 25% for the years 1998-2001.

payments that are directly tied to the ownership of land, such as PFC payments, may rapidly be reflected in changes in land values and rental rates, rather than in the use of inputs or the level of production.

15. From the information provided by the 1997 panel study, Schertz and Johnson (1998b) concluded that the PFC payments had not influenced short-run crop management decisions. Any changes in crop mix or input applications indicated by the panel participants were associated with the planting flexibility provisions of the legislation, together with producer expectations about expected yields, product prices and input costs. However, the panel data did indicate that the payments might have an effect on production decisions over the longer term by stimulating increased use of non-land inputs, such as machinery and chemicals, due to changes in the relative prices of these inputs with respect to the price of land. Furthermore, while panellists indicated that the proceeds from PFC payments were being used for widely divergent purposes, some of the farm managers indicated that they were encouraging their land-owning clients to use some of the proceeds from payments to make productivity-enhancing investments in such things as irrigation and land drainage.

Synthetic Studies

16. Several studies employ synthetic economic models to evaluate the impact of government payments. The models are derived from economic theory and incorporate specific assumptions about the impact of payments on farmers' production decisions. The models are calibrated using micro (farm) or aggregate (sectoral) data.

17. In two unpublished papers[13], Chau and de Gorter (2000; 2001) use a model of the US wheat sector calibrated on data for 1998 to examine the impact of PFC/MLA payments and to compare this to the impact of loan deficiency payments (LDPs). In their model LDPs are assumed to have an impact on production, while PFC payments have an impact on production only when the possibility of farm exit is included. When that is the case, they estimate that the removal of PFC payments in 1998 would have resulted in an exit of 3.4% of wheat farms and a decline in wheat production of 3.4%. They note that "whereas removal of decoupled payments can have a relatively large impact on the exit decision of low-profit farm units, its aggregate output impact can remain quite limited so long as the output level of the marginal farm is relatively small. Clearly, these results are sensitive to the distribution of PFC payments across farm size, along with the reservation profit of the individual farm" (2001, p. 30). The authors do not consider the possibility that land and machinery owned by exiting farmers could be rented or sold to other farmers, which would diminish the impact of the payments on production.

18. Mullen *et al.* (2001), in an unpublished conference paper, use a similar type of approach to examine the risk reduction effects of PFCs, MLAs and LDPs for Kansas wheat production.[14] Producers are assumed to face output price uncertainty and to seek to maximize the expected utility of initial wealth and profit under decreasing absolute risk aversion. The degree to which payments influence output depends on their subsidy effect (direct relationship to output); insurance effect (reduction in the variance of income); and wealth effect (reduction in farmers' aversion to risk). PFC payments are assumed to have an effect on production decisions only through the wealth effect. Alternative assumptions about MLAs are employed, ranging from the same effect as PFCs (wealth effect only) to those of LDPs (insurance, subsidy, and wealth effects). The model is calibrated using data for 1998. The results obtained suggest that the PFCs had only a

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13 Here and throughout this paper, the term unpublished refers to work that has not been published formally in books or in referenced, academic journals. The research in question will normally have been presented at conferences or issued in working paper series by universities or research institutes.

14 Mullen's (2001) unpublished M.S. thesis uses somewhat lower supply elasticities than Mullen *et al.* (2001) for the model's two inputs, land and a composite non-land input, which generates somewhat smaller impacts on production, but the qualitative conclusions are unchanged.

minor effect on production in the year examined, as did MLAs providing that these create only a wealth effect. Their impact is far more pronounced if their impact on decision-making is similar to LDPs, because the average payment under MLAs exceeded that from LDPs in the year considered. While the results of the analysis are sensitive to several key assumptions, in particular the degree of aversion to risk and the exact impact of MLAs on producer decisions, the qualitative implications are of interest. These are that: (1) the wealth effect on production may be relatively modest—their model yields a 12% share for this effect in the total change in production generated by support; and (2) the insurance effect of payments may be relatively large, accounting for an estimated 61% of the total change in production in their model, compared to 27% for the subsidy effect.

19. Lamb and Henderson (2000) use a representative farm approach to examine the impact of the FAIR Act on farmland values in the Corn Belt. Their approach assumes that current and future payments under farm programs are capitalized directly into the value of land. They use state-level cost and returns data for corn obtained from the USDA to estimate the impact of payments on land values for 1996-98 on a state-by-state basis and to project future trends under various assumptions about corn prices. By comparing the estimated land values derived from their model to actual values, they conclude that "the recent run-up in farmland values is rational given increased government subsidy payments between 1996-98 (when compared with the level of government support that would have prevailed under the 1990 farm bill) and higher commodity prices" (p. 110). Their model predicted declining land values by 2002 in response to lower PFC payments and lower commodity prices, particularly in more marginal corn producing areas. This conclusion did not take into account the various emergency measures that were taken to support producers' incomes after 1998, including the MLA payments. Their analytical framework would presumably predict that such payments would have helped to moderate the projected decline in farmland values.

20. Gray *et al.* (2004) develop a stochastic model for a representative Northwest Indiana corn/soybean farm to determine how the probability distribution of returns to land in 2001 were affected by market returns and various government policy tools (PFC, MLA, and LDP) and crop revenue coverage insurance (CRC). Uncertainty is reflected in the model through distributions of prices and yields for corn and soybeans, and for aggregate farm income which is assumed to trigger MLA payments. The model calculates the certainty equivalent (CE) return to land under various levels of relative risk aversion. Scenarios are examined based on stochastic simulations involving 2 000 iterations. The first scenario compares the returns to land when PFC, MLA, and LDPs are used to augment returns to land. The second scenario evaluates the same effects when producers are assumed to purchase CRC insurance. Under scenario 1, the returns to land are increased by each type of government support instrument; the standard deviation of returns is reduced by MLA payments and LDPs. These measures also decrease the skewness of the distribution of returns by truncating the lower end of the price or returns distribution. The coefficient of variation of returns falls with PFC payments due to their mean-enhancing effect. The authors note that when considered together "these are all favourable results from the farmer's perspective, since the mean goes up, variability goes down, and upside potential is increased" (p. 247). The authors conclude that the risk reducing characteristics of price supports (LDPs) make this a relatively more valuable form of support for risk-averse farmers, but that PFC and MLA payments are also valuable to risk-averse producers with constant relative risk aversion. They also note that the increase in CE returns may have significant implications for farmers' willingness to bid higher land rents, with the effect being relatively more pronounced for more risk-averse producers.

21. Roe *et al.* (2003) use an inter-temporal multi-sector model based primarily on data for 1997 to examine the market effects of PFC payments. Under the assumption that agricultural capital markets are perfectly integrated with capital markets in the rest of the economy, and that those who are taxed to provide the funds for PFC payments and the recipients of the payments have the same consumption preferences, the payments serve primarily to increase the value of land (by an estimated 8%). If on the

other hand farmers have a bias towards investing in agriculture then there is a small effect on output but this only persists in the short run. The model indicates an increase in output of 0.2%, but the long-term effect is to increase land values and rental rates.

Econometric Studies of Land Allocation

22. Principal results from econometric studies of land allocation are summarized in Annex Table 1. Adams *et al.* (2001) use four years of state-level data (1997-2000) for 11 states that account for a significant proportion of total US crop production.[15] The study analyzes the relationship between a state's total crop area and the sum of PFC and MLA payments using a variety of econometric models. The authors ran one model to test whether PFC and MLA payments help explain total crop area and found that the PFC/MLA payment variable was not statistically significant. The authors also ran a second model to test whether PFC and MLA payments have a different impact on total area than market returns and marketing loans. This model included the sum of four income sources (gross market returns, marketing loans, PFC payments, and MLA payments) as a single variable and the sum of PFC and MLA payments as a second variable. In this model, the PFC/MLA payment variable was statistically insignificant while the variable representing the sum of the four income sources was statistically significant. When the PFC/MLA payment variable was removed from the model, the variable representing the sum of the four income sources became statistically insignificant.

23. Adams *et al.* (2001) conclude that their results provide weak evidence that PFC and MLA payments affect total crop area. However, a statistically significant effect is found only when PFC and MLA payments are lumped together with gross market returns and marketing loans into a single variable, and even then only when a separate PFC/MLA payment variable that turns out to be statistically insignificant is also included in the model. Chavas (2001), commenting on this work, notes the weakness of the empirical results, including the assumption that area planted elasticities are the same across all 11 states in the analysis and limitations in capturing farmers' responses created by the short time period analyzed.

24. In an unpublished conference paper using farm-level panel data from the US Census of Agriculture, Key *et al.* (2004) compare farm-level changes between 1992 and 1997 in program crop plantings for farms that participated in government programs with those that did not participate. Because farms choose whether or not to participate in farm programs, the authors faced the challenge of controlling for unobserved factors that could influence both program participation and plantings of program crops. By examining farm-specific changes between 1992 and 1997 in program crop acreage, they were able to control for time-invariant unobserved factors at the farm level. They also controlled for fixed effects associated with farm type, scale, location, and operator age. They found that the growth rate of program crop acreage among participants was about 19 percentage points greater than that of non-participants, other things equal. However, this result could be biased if the authors' controls on unobserved factors affecting program participation were inadequate. For example, if participants had superior managerial abilities not captured by the control variables, then total acreage on participating farms could have been growing faster than on non-participating farms, and along with it the acreage in program crops. Limiting their sample to farms with the same amount of land in 1997 as in 1992, the authors found that the growth rate of program crop acreage among participants was about 8 percentage points greater than that of non-participants.

25. The authors suggest two possible explanations for their results. One is that program participation rules associated with pre-1996 programs effectively acted to limit program acreage in 1992. When these rules were relaxed under the FAIR Act, acreage in program crops increased. Other research has found that

[15] The 11 states are Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin. These states encompass nearly all of the Corn Belt and much of the Wheat Belt.

traditional commodity programs in the United States have limited acreage and output supply response (McDonald and Sumner, 2003) and that the FAIR Act led to an increase in acreage supply elasticities (Lin *et al*., 2000). An alternative explanation is that payments under the FAIR Act were distortionary, and led farmers to produce more than they would have without the payments. The authors note that additional research would be needed to examine these two explanations.

26. In an unpublished working paper, Goodwin and Mishra (2002) use farm-level data for more than 4 000 commercial farms for 1998-2001 to evaluate the effects of payments on decisions at the farm level.[16] The data are drawn primarily from the USDA's Agricultural Resource Management Survey (ARMS). Their analysis centres on the USDA's Heartland region and on the three most important crops in that region (corn, soybeans, and wheat).[17] They estimate acreage equations for the three crops that incorporate market prices, PFC and MLA payments per acre, and variables that attempt to capture the indirect effects of PFC payments on area response through farmers' aversion to risk and capital constraints. The key results from their analysis are as follows:

1. A statistically significant impact of PFC payments is found in each of the three crop area equations, although the coefficients and resulting elasticities are relatively small for the two most important crops in terms of area planted—corn and soybeans. A variable that seeks to capture how capital constraints may moderate the impact of PFC payments is not significant in any of the equations. However, a variable that attempts to capture how risk aversion may moderate the impact of PFC payments is statistically significant for corn and soybeans, suggesting that producers who are more risk averse are more likely to increase the planted area of those crops in response to PFC payments. When the direct and indirect effects of the PFC payments are combined the resulting elasticities are approximately 0.04 for corn, 0.03 for soybeans, and 0.13 for wheat. This implies that PFC payments increased crop acreage by about 4% for corn, 3% for soybeans, and 13% for wheat.[18] The figure for wheat may be larger than the other two crops because the wheat area is substantially smaller than that of the other two crops in the region.
2. The authors were unable to obtain MLA payments for each individual farm and were forced to use average MLA payments at the county level in their analyses.[19] They found a statistically significant impact of MLA payments on corn area, with a larger elasticity (0.12) than the PFC elasticity (0.04). This implies that MLA payments increased corn acreage by about 12%. MLA payments did not have a statistically significant impact on soybean or wheat area.
3. The authors examined the impact of PFC and MLA payments on the extent to which farmland is placed in alternative uses to crop production (*e.g.* pasture, fallow, Conservation Reserve Program, set-asides, etc.). Their results indicate that PFC payments have a statistically significant, negative impact on the proportion of a farm's total area in alternative uses. MLA payments also had a statistically significant and negative impact in one of the authors' models.

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16 Commercial farms are those with annual sales of USD 250 000 or more. Commercial farms accounted for more than one-half of all PFC payments and about two-thirds of agricultural production among farms receiving PFC payments in 2001 (Burfisher and Hopkins, 2003).

17 The Heartland region, also known as the Corn Belt, is comprised of a relatively homogeneous grouping of counties in the states of Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and South Dakota.

18 These figures and similar figures elsewhere in this paper assume that the estimated magnitudes of the marginal effects of payments hold over the entire range of payments. This assumption may be questioned but we lack empirical evidence on whether marginal effects would be greater or smaller at lower payment levels.

19 MLA payments are grouped with other disaster relief payments in the ARMS data.

However, as the authors indicate, the causal link between PFC/MLA payments and alternative land uses may run in both directions. Farms with payments are those that were producing program crops when base acres were assigned. Such farms would be expected to have had a comparative advantage in crop production and thus less likely to have allocated their land to alternative uses.

4. The authors also examined the impact of PFC and MLA payments on the acquisition of new farmland, which is potentially another route through which these payments may affect production decisions. PFC payments had a very weak impact on the probability of acquiring new farmland, and the impact of MLA payments was not statistically significant.

5. A comparison of the magnitude of the impacts of PFC and MLA payments with the impacts of market price support is difficult. The authors include corn, soybean, and wheat price/loan rate variables that in each case are equal to either the basis adjusted futures price or the county loan rate, whichever is greater in a given year in a county. However, these variables are generally not statistically significant in the farm-level acreage equations. Their finding, that PFC and MLA payments should affect acreage while market prices/loan rates do not, is puzzling.

27. In the second part of their analysis, Goodwin and Mishra (2002) use county-level data for the Heartland region for 1998-2001 to examine the impact of PFC and MLA payments on corn, soybean, and wheat acreage. As the authors indicate, a limitation of their farm-level analysis is that individual farms are not observed over time in the ARMS data. This makes it difficult to control for historical values of key variables and complicates the identification of causal effects of policy variables. PFC and MLA payments depend on historical base acreage for program crops. Farms that planted a large number of acres to program crops during the period covered by the FAIR Act may have also had significant acreage in program crops prior to the FAIR Act, and thus received large payments. In this case acres devoted to program crops are correlated with payments, but the payments do not necessarily have a causal influence on acreage decisions. In their county-level analysis the authors control on lagged crop acreage in order to mitigate this causal identification problem.

28. The results of Goodwin and Mishra's (2002) county-level analysis parallel their farm-level analysis. They find that the impacts of PFC payments on crop area are statistically significant but small in magnitude. Area elasticities are approximately zero for corn, 0.01 for soybeans, and 0.06 for wheat. MLA payments have a statistically significant impact on crop area only in the case of corn, and for corn the elasticity is approximately zero. As a caveat, the authors note that the control variables in their county-level analysis, particularly the annual dummy variables, may have removed some of the policy variation that affected production under the FAIR Act.

29. As with their farm-level analysis, a comparison of the magnitude of the impacts of PFC and MLA payments with those of market price support is difficult in their county-level analysis. The corn, soybean, and wheat price/loan rate variables in the county-level analysis are generally statistically significant but of the "wrong" sign — the own-price acreage supply parameters are negative and statistically significant for corn and soybeans (wheat is not statistically significant), while most of the cross-price acreage supply parameters are positive and statistically significant. Once again, it seems puzzling that PFC and MLA payments should affect acreage while market prices/loan rates do not have any effect or actually have a negative effect.

30. In an unpublished conference paper, Goodwin and Mishra (2003) repeat their earlier (2002) farm-level analysis, but this time focusing on wheat and barley acreage on commercial farms in the Northern Great Plains region.[20] Wheat and barley are the two crops most likely to be grown on marginal agricultural

[20] The Northern Great Plains region is comprised of a relatively homogeneous grouping of counties in the states of Colorado, Minnesota, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

land in the region, with barley being a minor crop and wheat a more important crop. The authors again find that the impacts of payments are generally statistically significant but relatively small in magnitude. Area elasticities with respect to PFC payments are approximately 0.08 for wheat and 0.13 for barley. MLA payments have a statistically significant impact on barley acreage but not on wheat acreage. For barley, the area elasticity with respect to MLA payments is approximately 0.15.

31. As in their earlier (2002) study, the authors examined the impact of payments on the extent to which farmland is placed in alternative uses to crop production. Their results indicate that PFC payments have a statistically significant, negative impact on the proportion of a farm's total area in alternative uses, but the impact is small in magnitude.

32. Goodwin and Mishra (2003) include barley and wheat price/loan rate variables that, like their earlier study, are equal to either the basis adjusted futures price or the county loan rate, whichever is greater in a given year in a county. The barley price/loan rate variable is not statistically significant but the wheat price/loan rate variable is positive and statistically significant in the wheat acreage equation. The estimated wheat area elasticity with respect to the wheat price/loan rate is 0.74, or about nine times greater than the wheat area elasticity with respect to PFC payments.

Econometric Studies of Time Allocation

33. Econometric studies of the impacts of PFC and MLA payments on farm household time allocation between on-farm work, off-farm work, and leisure are relevant because of the ability of farm households to change their time allocation to agricultural activities with a consequent effect on agricultural production, in response to changing incentives. More than one-half of all US farm operators work off the farm, and 80% of those who work off the farm do so at a full-time job (Mishra *et al*., 2002). About 95% of total US farm household income in 2002 originated off the farm, and among commercial farms about one-third of total farm household income in 2002 came from off the farm (McElroy *et al*., 2003). Approximately two-thirds of farm households receiving PFC payments in 2001 worked both on and off the farm in varying amounts (Burfisher and Hopkins, 2003). In addition to changing the allocation of time between on-farm and off-farm work, farm households can also change the total amount of time allocated to leisure. A fully decoupled payment that had no effect on production incentives would change time allocation only through an income effect on the demand for leisure, increasing leisure time and reducing both on-farm and off-farm work (Singh *et al.* 1986).

34. Principal results from econometric studies of time allocation are summarized in Annex Table 2. In an unpublished conference paper, Ahearn *et al.* (2002) analyze the impact of government payments on off-farm labour force participation decisions and hours worked off the farm by farm operators. They used 1991 farm household data from the Farm Costs and Returns Survey, and 1996 and 1999 farm household data from the Agricultural Resource Management Survey (ARMS). Government payments analyzed for 1996 and 1999 included PFC and disaster-relief payments.[21] Their results for all three years indicated that government payments reduced the probability of working off the farm, but the estimated impact for 1999 was substantially smaller than the estimated impacts for 1991 and 1996. The authors note that that the decline in the impact of 1999 payments on off-farm participation might have been a result of the introduction of PFC payments in 1996, but which had a delayed impact on labour supply until sometime after 1996, or it could have been due to the significantly greater payments in 1999, thereby lessening the impact per dollar of payments on off-farm participation. They did not find a difference in impact on off-farm participation for 1999 among the various types of government payments they analyzed. Their results for hours worked off the farm indicate that the impacts of government payments were small during all three years. For 1999, the authors' results indicate that the elasticity of hours worked off the farm by the

[21] As noted above, MLA payments are grouped with other disaster-relief payments in the ARMS data.

farm operator with respect to PFC payments was about -0.01, and the elasticity of hours worked off the farm with respect to disaster-relief payments was also approximately -0.01. The authors did not analyze changes in on-farm work hours or leisure time.

35. In an unpublished conference paper, El-Osta *et al.* (2003) used 2001 farm household data from ARMS to analyze the impacts of government payments on on-farm, off-farm work hours, and total work hours among farm operators. They found that the impact of PFC payments on on-farm work hours was statistically significant but small in magnitude. Their results indicate that the elasticity of on-farm work hours by the farm operator with respect to PFC payments was about 0.02. They obtained similar results with respect to disaster-relief payments—statistically significant but small in magnitude. Their results indicate that the elasticity of off-farm work hours by the farm operator with respect to disaster-relief payments was about 0.01. The authors found a statistically significant and negative impact of PFC payments on off-farm work hours by the farm operator, with an elasticity of -0.05. The impact of MLA payments on off-farm work hours was statistically insignificant. The impacts of PFC and MLA payments on total work hours were also statistically insignificant.

36. In an unpublished conference paper, Dewbre and Mishra (2002) used 1998-2000 ARMS data to analyze the impacts of government payments on leisure hours and on-farm work hours by farm operators and their spouses. The impacts of PFC payments on on-farm work hours were statistically insignificant for farm operators or spouses. The impacts of PFC payments on leisure hours were statistically significant and positive but very small in magnitude, with an elasticity of approximately zero for both farm operators and spouses. For disaster-relief payments, the authors found that the impacts on on-farm work hours were positive but uniformly small, with an elasticity of approximately zero for farm operators and 0.02 for spouses. The estimated impacts of disaster-relief payments on leisure hours were statistically insignificant. One methodological difference between Dewbre and Mishra (2002) and the studies by Ahearn *et al.* (2002) and El-Osta *et al.* (2003) is that the former focused solely on commercial farms, whereas the latter two included not only commercial farms but also retirement and leisure/lifestyle farms. On-farm labour may have non-pecuniary attributes for retirement and leisure/lifestyle farms that are not captured in these studies.

37. Ahearn *et al.* (2002), El-Osta *et al.* (2003), and Dewbre and Mishra (2002) also include loan deficiency payments (LDPs) in their analysis. LDPs were not statistically significant in the on-farm or total work hours equations in El-Osta *et al.* (2003). They were negative and statistically significant in the off-farm work hours equations in both Ahearn *et al.* (2002) and El-Osta *et al.* (2003), with estimated coefficients similar to those of PFC payments. In Dewbre and Mishra (2002), LDPs had a positive and statistically significant on on-farm work hours by farm operators and no statistically significant effect on on-farm work hours by spouses.

38. Goodwin and Mishra (2004) use 2001 farm household data from ARMS to analyze the impacts of PFC payments and other variables on off-farm work by farm operators. They find that PFC payments have a negative and statistically significant impact on off-farm work hours. Among farm operators working off the farm, their results imply an elasticity of off-farm work hours with respect to PFC payments of approximately -0.51. This elasticity seems quite large, and it is possible that the PFC payments variable was serving as a proxy for other government payments or the scale of the farming operation. The authors did not analyze changes in on-farm work hours or leisure time.

Econometric Studies of Land Rents and Land Values

39. A common presumption among economists is that in the long run the benefits of government farm programs accrue entirely, or almost entirely, to landowners as benefits are capitalized into land values (Floyd, 1965). The supply of land to agriculture as a whole is inelastic, while in the long run other inputs

are often assumed to be perfectly elastic in supply. Even if the supply of other inputs is not perfectly elastic in supply but more elastic than land, landowners still capture a disproportionate share of the benefits of support.

40. If PFC and MLA payments were captured largely by landowners through higher land values and land rents, then the scope for these payments to influence agricultural production would be narrowed. Farmers renting land would not be able to use payments associated with their rented land to cover fixed or variable costs.[22] These farmers would be no more able to secure capital from traditional lenders than in the absence of the payments. They would see no increase in wealth, at least on the land that they rent, ruling out a risk-related wealth effect. Expectations of future payments associated with rented land would not affect decisions by renters because they would not capture these payments. The payments would not affect a renter's decision to remain in or to exit from agriculture, although they could affect a landlord's decision to keep land in agriculture. If PFC and MLA payments were partially retained by renters, then the mechanisms identified above through which these payments might influence production would come into play in proportion to the degree that renters retained the payments.

41. In 2002, about 38% of all land in farms in the United States was rented or leased from others (US Department of Agriculture, 2004). Among commercial farms, the corresponding figure was 43%. For farms receiving PFC payments in 1996, 59% of base acreage was rented in, while commercial farms receiving PFC payments rented in approximately two-thirds of their base acreage (Burfisher and Hopkins, 2003). Statistics for 1999 indicate that only about 12% of rental acres were owned by landlords who operate farms (US Department of Agriculture, 2001). The remaining rental acres were owned by non-farm landlords.

42. Principal results from econometric studies of land rents and land values are summarized in Annex Table 3. Goodwin *et al.* (2003a; 2003b) use farm-level data drawn primarily from ARMS to estimate the determinants of farmland values. The first study (2003a) uses ARMS data for 1998-2000, while the second (2003b) uses data for 1998-2001. The two studies differ somewhat in explanatory variables employed but both include PFC payments and disaster-relief payments (which include MLA payments).[23] They find that PFC payments have a statistically significant impact on farmland values, with the impact of an additional dollar of payments ranging from about USD 4.10 (2003a) to about USD 4.90 per acre (2003b). They also find that disaster-relief payments have a statistically significant impact on farmland values, with the impact of an additional dollar of payments ranging from about USD 4.70 (2003b) to about USD 5.50 per acre (2003a). These results suggest that PFC and disaster-relief payments are captured at least partially by landowners, and that landowners were anticipating a continuance of payments beyond the life of the FAIR Act. As the authors note, one caveat to their results is that year-to-year fluctuations in government payments may not capture changes in long-run cash flow expectations that drive land values. When the authors modified their model to allow the effects of government payments on land values to differ from one year to another, they found substantial differences in payment impacts across years.

43. Goodwin *et al.* (2003a; 2003b) also included LDPs in their models. The impact of an additional dollar of LDP payments on land values ranged from about USD 6.60 (2003b) to about USD 7.80 per acre (2003a). The impacts of LDPs are somewhat larger than those estimated for PFC or MLA payments, but the authors do not indicate whether these differences are statistically significant.

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22 Farmers who both own and rent land would still realize gains on the land that they own, possibly leading them to increase production as a result of payments associated with the land they own.

23 In the Goodwin *et al.* (2003a) dataset, MLA payments account for about 90% of total disaster-relief payments.

44. In an unpublished working paper using 1992 and 1997 farm-level panel data from the US Census of Agriculture for a sample of over 113 000 farmers who reported paying cash rent in both years, Kirwan (2004) analyzes how government payments were divided between landlords and renters. The author lumps all government payments together and does not break out PFC or MLA payments from other payments. Controlling for farm, county, and time fixed effects that may affect cash rents, he found that about 40% of each additional dollar of government payments was reflected in increased rental rates. The remaining 60% represented a net gain to the renter. A caveat noted by the author is that rental rates may adjust slowly in the presence of long-term rental contracts. Landlords might capture all or nearly all gains from government payments in the long run, but a 5-year time frame could be too short to capture this.

45. Roberts *et al.* (2003) use 1992 and 1997 farm-level panel data from the US Census of Agriculture with a similar methodology as Kirwan (2004) but a smaller sample of about 58 500 farmers. They also lump all government payments together into a single variable. They derive results for 1997, when approximately USD 6.1 billion of the total payments to farmers was derived from PFCs and the balance of USD 1.7 billion was associated with conservation programs. Their most statistically robust estimates suggest an increase in cash land rents of between USD 0.34 and USD 0.41 per acre for each additional dollar of government payments.

46. In an unpublished conference paper, Janssen and Button (2004) used county-level data from the state of South Dakota for 1991-2001 to analyze the impact of government payments on cropland values and rental rates. The impact of the FAIR Act was assessed by including a dummy variable for the 1997-2001 period in regression models explaining cropland values and rental rates, and by permitting the coefficient on a government payments variable in the models to differ between the 1991-1996 and 1997-2001 periods. Their results indicated that the influence of government payments on cropland values did not change between the 1991-1996 and 1997-2001 periods, but that the influence of government payments on rental rates declined between 1991-1996 and 1997-2001. The authors combined commodity program payments, disaster-relief payments, and Conservation Reserve Program payments into a single variable. They did not attempt to distinguish among the impacts of different types of payments. It should also be noted that differences in cropland values and rental rates between the 1991-1996 and 1997-2001 periods could be due to other factors in addition to, or instead of, the FAIR Act.

47. In an unpublished conference paper, Lambert and Griffin (2004) used panel data for 470 farms in the state of Illinois between 1996 and 2001 to examine the influence of PFC payments and loan deficiency payments on farmland cash rents. They found a positive and statistically significant impact of PFC payments on cash rents. However, their results are difficult to interpret and may be called into question because their PFC payments variable is measured on a per farm basis, and they attempt to relate this variable to cash rents measured on a per acre basis.

48. Bierlen *et al.* (2000) used a November 1997 survey of farm operators in the state of Arkansas to analyze changes in leasing arrangements associated with the FAIR Act. Contrary to Schertz and Johnston (1998a; 1998b), they found little evidence that landlords changed leasing arrangements in an attempt to capture PFC payments. They concluded that, at least in their sample, PFC payments were shared between landlords and tenants. However, they note that landlords may not have fully adjusted leasing arrangements to the FAIR Act by the date of their survey.

49. Barnard *et al.* (2001) analyze county-level farmland value data from the 2000 Agricultural Resource Management Study. They ran hedonic land price regressions to calculate the effect of farm commodity program payments on farmland values, while controlling for soil quality, urban influence, availability of irrigation, and other factors. All payments were grouped together in a single variable. They found that payments have a significant effect on farmland values. Their results indicate that payments have

the highest proportional effect in the Heartland region, accounting for 24% of farmland value. The effect is similar in the Prairie Gateway region (23%) and the Northern Great Plains region (22%).[24]

50. Lence and Mishra (2003) examine the impact of PFC, MLA, and other government payments on cash rents using county-level panel data from the state of Iowa for 1997-2000. Unlike most other studies of land values and rents, they control for spatial autocorrelation (*i.e.* correlation across space in the random factors outside their model that influence cash rents). Their results indicate landowners capture most of the benefits from PFC and MLA payments — an additional dollar of PFC or MLA payments leads to an estimated increase in cash rents of approximately USD 0.85. Their statistical tests for spatial autocorrelation suggest that it is present and significant. For comparison purposes, when they ran their model assuming no spatial autocorrelation, the impact of an additional dollar of MLA payments on cash rents dropped to about USD 0.50 while the point estimate of the impact of an additional dollar of PFC payments was greater than USD 1, which is implausible.[25] Surprisingly, the authors' estimated impact of LDPs on cash rents was negative and statistically significant.

4. Related Studies

51. As noted above, capital constraints, risk aversion, and producer entry/exit decisions are three of the avenues through which PFC and MLA payments may influence agricultural production. This section reviews some recent studies on these three topics for the United States that, while not directly addressing PFC and MLA payments, have bearing on the degree to which such payments may affect production. On the whole, the studies indicate that some scepticism is warranted about the degree to which capital constraints or risk aversion could have served as avenues for PFC or MLA payments to affect production.

Studies of Capital Constraints

52. Barry *et al.* (2000) test the "pecking order" theory of firm investment, which predicts that firms initially prefer to use lower cost internal funds to finance investments, followed later by higher cost external funds as necessary. They use farm-level panel data for 1990-1994 from the state of Illinois. Their provide support for the pecking order theory, indicating that strong cash flow leads producers to increase investment while reducing debts or refraining from borrowing. For their full sample of farms, an additional dollar of cash flow leads to about USD 0.60 in additional investment. Splitting their sample into high credit risk farms and low credit risk farms, the authors find that an additional dollar of cash flow leads to about USD 0.70 in additional investment among high credit risk farms and about USD 0.50 in additional investment among low credit risk farms.

53. Bierlen and Featherstone (1998) use farm-level panel data for 1976-1992 from the state of Kansas to test whether farm machinery investment is subject to capital constraints. They divide their sample into three time periods based on the farm business cycle (1976-1980 boom, 1981-1986 bust, and 1987-1992 recovery) and, within each time period, split the sample into various sub-samples depending on farm size, farm debt-to-asset ratio, and age of the farm operator. They find that cash flow generally did not have a statistically significant effect on investment during the 1976-1980 boom. However, during the 1981-1986 bust and 1987-1992 recovery, cash flow did have statistically significant effects on investment. Among farms with a high debt-to-asset ratio, an additional dollar of cash flow led to an estimated USD 0.10-0.20 in additional investment during the bust and recovery periods. Among farms with a low debt-to-asset ratio, the impact of an additional dollar of cash flow on additional investment during these periods was much smaller (about USD 0.04-0.05).

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24 The Prairie Gateway region is comprised of a relatively homogeneous grouping of counties in the states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas.

25 The point estimate was 1.34 and was not statistically different from 1.

54. In an unpublished conference paper, Zhao *et al.* (2004) also test the pecking order theory, using farm-level panel data for 1995-2002 from Illinois. They regress investment on current-year cash flow, cash flow lagged one year, and other variables. Instead of a positive relationship, they find negative and statistically significant relationships between investment and current and lagged cash flows. However, their results are questionable because in calculating "cash flow" they apparently subtract investment expenditures, so that to some degree they are regressing investment on (minus one times) itself.

55. Given that the studies reviewed here suggest that capital constraints, if present, are more severe among high credit risk farms, one may ask what proportion of farms receiving direct payments fall into the high credit risk category. In 2001, about 60% of farms receiving PFC payments held debt that represented less than 40% of their debt repayment capacity, while only about one-fifth carried debt representing 80% or more of their capacity (Burfisher and Hopkins, 2003).

56. A challenge facing studies of capital constraints is to avoid confusing changes in a producer's internal ability to finance investments with changes in investment opportunities (Hubbard, 1998). A firm's cash flow may be correlated with investment not because the firm faces capital constraints but because cash flow is serving as an indicator of expected returns to investment. The studies reviewed here include measures of marginal q in their econometric models in order to control for this problem.[26] However, as Hubbard (1998) notes, marginal q is an unobservable variable and measures that are used are imperfect proxies.

57. Another challenge facing studies of capital constraints involves the use in many studies of cash flow as a proxy for changes in net worth. Economic theories of capital constraints predict that a firm's access to capital and the interest rate it pays on loans depend on net worth (Hubbard, 1998). In general, accounting decisions — especially those related to depreciation — can reduce the correlation between current-period cash flow and changes in net worth. In agriculture, an additional complication is that the cash flow of the farm business may have a limited correlation with the change in the net worth of the farm household. Farm households allocate wealth among competing investments that include not only farm business assets such as land, machinery, and farm equipment, but typically also off-farm financial assets such as stocks, bonds, retirement accounts, certificates of deposit, and mutual funds.

58. Farm households in the US have diversified significantly into off-farm investments in recent years. In 1993, off-farm assets accounted for only about 16% of total farm household assets; by 1999, this percentage had risen to about 31% (Mishra *et al*., 2002). Among farm households receiving PFC payments, off-farm assets accounted for about 30% of total assets in 1999 (Burfisher and Hopkins, 2003). Perhaps reflecting stock market declines after 1999, the percentage of total farm household assets accounted for by off-farm assets fell to about 22% in 2002 (McElroy *et al*. 2003).

Studies of Risk Response and Risk Aversion

59. Several econometric studies of acreage and output supply response have included measures of price variability and found that these measures are often statistically significant (Moschini and Hennessy, 2001; OECD, 2004). In a widely cited study, Chavas and Holt (1990) used annual time-series data for the US for 1954-1985 to examine the effects of variability in corn and soybean prices and producer wealth on corn and soybean acreage decisions. The price variability terms were generally statistically significant, which the authors interpret as evidence that corn and soybean producers do not exhibit constant absolute risk aversion. They also found that producer wealth had a positive and statistically significant impact on

[26] Marginal q, also known as fundamental q, is the expected discounted stream of marginal profits from an additional dollar of investment, *i.e.* the marginal value of capital to the producer.

corn and soybean acreages, which they interpreted as evidence that corn and soybean producers exhibit decreasing absolute risk aversion.[27]

60. Just and Pope (2003) maintain that studies which find that acreage or production responds to variability in prices or yields do not demonstrate that the reason behind this response is risk aversion. They argue that risk aversion can be overestimated if alternative explanations for seemingly risk-averse behaviour are not considered. These alternatives include stochastic disturbances to production (*e.g.* weather) when output is a concave function of inputs, constraints on producer decision-making (*e.g.* a fixed total amount of land to allocate among crops) that give rise to production decisions which mimic the decisions of a risk-averse producer, costs of adjustment in acreage or capital that also give rise to production decisions mimicking those of a risk-averse producer, and liquidity or solvency constraints that generate risk responsive behaviour even when producers are risk neutral. In an unpublished working paper, Goodwin and Mishra (2002) observe that existing research has been unable to reach a strong consensus regarding the nature of farmers' risk preferences.

61. US farm households have a wide array of risk management strategies that they can pursue to reduce income risks associated with farming (Harwood *et al*. 1999; Moschini and Hennessy, 2001). These include production responses to reduce the variability of yields (*e.g.* irrigation, pesticides), hedging to reduce price risks (use of forward contracts, futures, options), crop insurance (yield insurance, revenue insurance), diversification of the farm enterprise among commodities produced, and diversification of income sources beyond the farm itself (off-farm labour supply, off-farm investment). Moschini and Hennessy (2001) note that risk measures included in acreage and output supply response studies should be measures of the residual risk left over after one accounts for risk management strategies used by producers.

62. While farm business income in the United States exhibits considerable variability, total farm household income is much more stable. During 1960-1999, the coefficient of variation (CV) for net farm income was approximately 51%, while the CV for off-farm income was approximately 36% and the CV for total farm household income was about 27% (Mishra and Sandretto, 2002). During this period, the correlation coefficient between net farm income and off-farm income was about -0.3 (Mishra and Sandretto, 2002). This means that farm households partially offset years with low net farm income by increasing off-farm income, and vice versa.

63. In an unpublished conference paper, Serra *et al.* (2004) analyze the decisions of farm households to invest in non-farm assets, using data from a survey of Kansas farm households for 1994-2000. Their results indicate that higher farm income fluctuations increase the relevance of financial assets in the farm household portfolio, which suggests that these assets are used as farm risk management tools. Their findings also indicate farm households may use diversification of farm activities as a risk management tool. They found that households running highly diversified farms are less likely to have off-farm investments. In a study using 1996 ARMS data, Mishra and Morehart (2001) also found that farm diversification reduces the likelihood of off-farm investment by farm households.

64. OECD (2004) examines the impacts of PFC and MLA payments for coarse grains on the variability of revenues received by coarse grain producers. PFC payments reduced revenue variability to only a very small degree (4%), while MLA payments led to a larger reduction (17%). Neither PFC nor MLA payments alone had a statistically significant negative covariance with market revenues. However, the sum of PFC and MLA payments did have a statistically significant negative covariance with market

[27] Constant absolute risk aversion (CARA) occurs when the Arrow-Pratt coefficient of absolute risk aversion for an economic agent is the same regardless of agent's level of wealth. As noted earlier, decreasing absolute risk aversion (DARA) occurs when the Arrow-Pratt coefficient of absolute risk aversion declines as wealth increases.

revenues — in other words, the two types of payments when added together served to smooth out fluctuations in market revenues for coarse grain producers.

65. The potential effects of risk-reducing measures on agricultural production have also received attention in the literature on crop insurance. While a review of this literature is beyond the scope of this paper, recent reviews by Glauber (2004) and Moschini and Hennessy (2001) suggest that the production impacts of crop insurance are ambiguous. On the one hand, crop insurance has a risk sharing effect (between the producer and the insurer) that may encourage additional acreage or additional input usage per acre. On the other hand, crop insurance is subject to moral hazard problems that may lead producers to reduce input usage per acre.

Studies of Producer Entry/Exit and Structural Change

66. In an unpublished working paper, Chau and de Gorter (2001) provide a theoretical analysis of the potential impact of direct payments on producer decisions as to whether to remain in farming or to exit the industry. Their analysis suggests that an increase in direct payments, whether coupled or decoupled, widens the range of producers who are willing to commit to production and to incur the fixed costs necessary to do so. They argue that even though a fully decoupled transfer may not affect firm-level output decisions, it can influence aggregate output by changing incentives to exit the industry.

67. In an unpublished conference paper, Ahearn *et al*. (2004) use data from the Census of Agriculture to track the exit and entry of farmers. They point to the considerable turn-over in farm operators in the United States, noting that 38% of the farmers that were operating in 1992 were no longer in operation in 1997, while roughly the same number of new farmers entered the sector to take their place. The authors note that economic theory does not provide a clear prediction of the impact of government payments on farm structure. Their analysis uses state-level data to test a series of hypotheses, including the impact of payments, on productivity, average farm size, concentration of production, the likelihood of exit, and participation in off-farm employment. Unfortunately, the data relate to the period 1978-1996, and do not cover the policies that are the focus of this paper.

68. There has been little analysis of the linkage, if any, between PFC/MLA payments and structural change in US agriculture. It is unclear what impact such payments might be expected to have on structure and whether that impact would be different from other forms of government support. As noted, the United States has an actively functioning market for land, not least through the rental market, and the land assets of marginal production units that might exit the sector in the absence of government support may not necessarily be unprofitable if combined with the assets of other producers. To the extent that there are economies of scale that can only be realized through structural change, it is by no means clear that the exit of marginal production units prompted by the elimination of payments would result in a reduction of aggregate production.

5. Conclusions and Suggestions for Future Work

69. The empirical studies reviewed lend support to the view that PFC and MLA payments had some impact on production relative to the counterfactual case with no PFC or MLA payments. Although several mechanisms for this effect can be hypothesized, it is difficult to disentangle the relative importance of each of these empirically. Empirical studies indicate that the payments may have influenced planted area and possibly the use of variable inputs, particularly farm household labour. In general, the estimated impacts are modest. In the econometric studies reviewed, PFC and MLA payment variables are sometimes statistically insignificant, and when they are statistically significant they imply in most cases that each type of payment increased planted area and on-farm work hours by less than 5%. In no instance do the econometric results imply an increase in planted area or on-farm work hours due to PFC or MLA payments

of more than 15%. Some of the synthetic studies suggest larger impacts on production, but their results are sensitive to assumptions about the degree and nature of farmers' aversion to risk. The synthetic studies also do not consider the possibility that assets owned by farmers who would exit the industry in the absence of PFC or MLA payments, could be sold or rented to other farmers, which would diminish the impact of the payments on production.

70. Empirical evidence on the relative magnitude of PFC and MLA payment effects compared to market price support or other policy programs is inconclusive. Only one of the econometric studies of land allocation obtained satisfactory results for both a market price support variable and a PFC or MLA payment variable,[28] making comparisons within a given study difficult. Comparisons across studies—an estimate of the impact of market price support from one study weighed against an estimate of PFC or MLA payment impacts from another study—are problematic because of differences in methodology and data from one study to another. The synthetic studies reviewed suggest that the magnitudes of PFC and MLA payment effects relative to those of loan deficiency payments (LDPs) are sensitive to farm entry/exit and to the degree and nature of farmers' aversion to risk. None of the synthetic studies present any credible evidence that the impacts of PFC or MLA payments could be larger than the impacts of LDPs.

71. Empirical work suggests that PFC and MLA payments had a significant effect on land values and rental rates. Given the importance of the rental market for land in the United States, it appears that there was a relatively high "pass-through" of the additional income generated by the payments to landowners, many of whom are not the actual operators of the land. It appears that the payments primarily had the effect of increasing the value of the principal fixed asset in agriculture—land.

72. Additional work that could improve the empirical evidence on the impacts of direct payments would entail collecting and analyzing panel data for a nationally representative sample of farm households on their production, investment, and time allocation decisions. Panel data on production and investment decisions are available and have been analyzed for selected states (Illinois, Iowa, and Kansas). However, these are not nationally representative surveys. Panel data on production and investment decisions for the entire US are available from the Census of Agriculture, but the Census is conducted once every five years, making it very difficult to sort out the impacts of year-to-year variations in government payments. The Agricultural Resource Management Survey is a large, nationally representative survey of farm households that is conducted annually. However, ARMS at present has no panel component.[29]

73. Panel data make it possible to control statistically for farm-level fixed effects that can confound attempts to estimate the impacts of direct payments on farm decision-making. Farms with direct payments own or rent land that was producing program crops when base acres were assigned. Such farms would be expected to have characteristics associated with their land (soils, climate, irrigation, etc.) that give them a comparative advantage in the production of program crops. These characteristics would be positively correlated with both current production and historical production during the period used to calculate base acreage. Failing to control for farm-level fixed effects in an econometric analysis could cause the direct payment variables to serve, in part, as proxies for the omitted characteristics. As such, the impacts of direct payments on land allocation and production could be overestimated.

74. Panel data collected annually over a period of several years would also make it possible to assess longer run impacts of direct payments on farm decision-making. A limitation of some of the studies reviewed is that they are based partly or wholly on data from the first few years after the passage of the

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[28] This study is Goodwin and Mishra (2003). In studying the determinants of wheat acreage, they found that the impact of market price support was about nine times greater than the impact of PFC payments.

[29] Two pilot tests have been done to gauge the feasibility of adding a panel component to the ARMS, and there continues to be interest at USDA in adding a panel component.

FAIR Act in 1996. This may be too short of a time period in which to observe adjustments that may have ultimately occurred, particularly in agricultural capital stocks, farm entry/exit, and land rental contracts. Panel data would permit analysis of these longer run adjustments.

75. The FAIR Act was superseded by the 2002 Farm Act, which replaced PFC payments with similar direct payments, and replaced MLA payments with countercyclical payments (CCPs). Because the 2002 Farm Act has only been in place for three years, empirical evidence on the acreage and production impacts of this legislation is still being accumulated.

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ANNEX TABLES

Annex Table 1. Principal Results from Econometric Studies of Land Allocation

Study	Was Study Published?	Explanatory Variable	Dependent Variable	Unit of Analysis	Estimated Elasticity	
					Statistically Significant?	Value
Adams *et al.* (2001)	Yes	Sum of PFC and MLA Payments	Total Crop Area	State	No	—
Goodwin and Mishra (2002)	No	PFC Payments	Corn Area	Farm	Yes	0.04
				County	Yes	0.00
			Soybean Area	Farm	Yes	0.03
				County	Yes	0.01
			Wheat Area	Farm	Yes	0.13
				County	Yes	0.06
		MLA Payments	Corn Area	Farm	Yes	0.12
				County	Yes	0.00
			Soybean Area	Farm	No	—
				County	No	—
			Wheat Area	Farm	No	—
				County	No	—
Goodwin and Mishra (2003)	No	PFC Payments	Wheat Area	Farm	Yes	0.08
			Barley Area	Farm	Yes	0.13
		MLA Payments	Wheat Area	Farm	No	—
			Barley Area	Farm	Yes	0.15
Key *et al.* (2004)	No	Farm Program Participation (Yes or No)	Change in Total Area in Program Crops, 1992-1997	Farm	Yes	0.08*

* The change in total area in program crops between 1992 and 1997 was 8% higher for farms participating in government programs than those not participating, among farms with the same total amount of land in the two years.

Annex Table 2. Principal Results from Econometric Studies of Time Allocation

Study	Was Study Published?	Explanatory Variable	Dependent Variable	Unit of Analysis	Estimated Elasticity	
					Statistically Significant?	Value
Ahearn *et al.* (2002)	No	PFC Payments	Hours Worked Off Farm, Farm Operator	Farm	Yes	-0.01
		Disaster-Relief Payments*	Hours Worked Off Farm, Farm Operator	Farm	Yes	-0.01
Dewbre and Mishra (2002)	No	PFC Payments	Hours Worked on Farm, Farm Operator	Farm	No	—
			Hours Worked on Farm, Spouse	Farm	No	—
			Leisure Hours, Farm Operator	Farm	Yes	0.00
			Leisure Hours, Spouse	Farm	Yes	0.00
		Disaster-Relief Payments*	Hours Worked on Farm, Farm Operator	Farm	Yes	0.00
			Hours Worked on Farm, Spouse	Farm	Yes	0.02
			Leisure Hours, Farm Operator	Farm	No	—
			Leisure Hours, Spouse	Farm	No	—
El-Osta *et al.* (2003)	No	PFC Payments	Hours Worked on Farm, Farm Operator	Farm	Yes	0.02
			Hours Worked Off Farm, Farm Operator	Farm	Yes	-0.05
			Total Work Hours, Farm Operator	Farm	No	—
		Disaster-Relief Payments*	Hours Worked on Farm, Farm Operator	Farm	Yes	0.01
			Hours Worked Off Farm, Farm Operator	Farm	No	—
			Total Work Hours, Farm Operator	Farm	No	—
Goodwin and Mishra (2004)	Yes	PFC Payments	Hours Worked Off Farm, Farm Operator	Farm	Yes	-0.51*

* Disaster-relief payments include MLA payments.

Annex Table 3. Principal Results from Econometric Studies of Land Rents and Land Values*

Study	Was Study Published?	Explanatory Variable	Dependent Variable	Unit of Analysis	Estimated Effect of USD 1 Increase in Payments	
					Statistically Significant?	Value
Goodwin *et al.* (2003a)	Yes	PFC Payments	Land Value	Farm	Yes	4.10
		Disaster-Relief Payments**	Land Value	Farm	Yes	5.50
Goodwin *et al.* (2003b)	Yes	PFC Payments	Land Value	Farm	Yes	4.90
		Disaster-Relief Payments**	Land Value	Farm	Yes	4.70
Kirwan (2004)	No	All Government Payments	Land Rent	Farm	Yes	0.40
Lence and Mishra (2003)	Yes	PFC Payments	Land Rent	County	Yes	0.86
		MLA Payments	Land Rent	County	Yes	0.84
Roberts *et al.* (2003)	Yes	All Government Payments	Land Rent	Farm	Yes	0.34-0.41

* This table only includes studies reporting estimated impacts of government payments on land rents or land values. Other econometric studies of land markets are discussed in the text.

** Disaster-relief payments include MLA payments.