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How Coupled Are Decoupled Farm Payments? A Review of the Evidence

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This survey paper explores the literature on decoupling of farm programs that has emerged in the last 10 years. The paper identifies and assesses the various channels of potential coupling of decoupled farm payments and provides a taxonomy of coupling mechanisms found in theoretical and empirical papers. Coupling of decoupled payments is pervasive but effects when measurable are small, with the exception of the impact on land values. The paper points to unresolved issues on potential coupling mechanisms for further research.

Key words: agricultural policy, decoupled, decoupling, farm payment programs, program subsidies, support

Introduction

Domestic subsidies to agriculture were brought under the discipline of global trade rules for the first time in the Uruguay Round Agreement on Agriculture (URAA) of the World Trade Organization (WTO) in 1994. Member countries of the WTO decided to reduce the distortions that were caused by current levels of domestic farm subsidies. Under the URAA, domestic support is classified into three categories or "boxes" according to their impact on international trade. The amber box contains the most distorting subsidies, which are therefore required to be limited in use. The blue-box payments also cause some distortion but are required to be production limiting. The green box contains subsidies that cause no or minimal distortion. The subsidies in the blue and green boxes are excluded from all WTO disciplines. To reduce trade distortions caused by these farm subsidies, members were required to shift toward decoupled income support while reducing coupled support. Decoupled support policies are categorized as green-box payments. They are defined as payments that are financed by taxpayers and are not related to current production, factor use, or prices, and for which eligibility criteria are defined by a fixed, historical base period. Since they are exempt from WTO disciplines, decoupled payments have become an important part of income support provided to agriculture, especially in industrialized countries.

Developing countries and natural exporters of agricultural goods have "resisted" the established leadership of the EU and United States in WTO negotiations. New coalitions

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such as the Cairns group and the various Gs groups are questioning farm subsidies in many industrialized countries.[1] All subsidies will eventually be scrutinized. Beyond amber- and blue-box payments, green-box payments have been discussed during negotiations, although no limits have been set on the table. The 2003 Common Agricultural Policy (CAP) reforms with their new decoupled Single Farm Payment (SFP) and the attempts by the United States to boost green-box payments to offset expected reductions in amber- and blue-box support are viewed suspiciously by many developing countries as a more hidden way to foster agricultural production and trade.

Green-box payments are likely to be central to the round following the Doha round. This evolution of the WTO agricultural negotiations is occurring in the context of recent WTO rulings against Canadian dairy, EU sugar, and U.S. cotton policies, all three shown to be distorting and inconsistent with WTO obligations. The U.S. cotton dispute also put the U.S. direct payments inclusion in the green box into question, although the latter were not initially a focus of the dispute. Many countries with large farm programs are pushing their own interest groups to consider less coupled policies or decoupled policies fitting under generously defined blue and green boxes under a new WTO agreement at the conclusion of the Doha round. The policy debate has led to various claims and conjectures to explain the link between decoupled payments and production decisions and market outcomes (Aksoy and Beghin, 2004). The economics profession has recently addressed and delineated many of these potential links, both with analytical conceptualizations and empirical investigations. This large body of work, accumulated in the last 10 years, motivates taking stock and evaluating what has been settled and what is left to elucidate.

Our survey paper distills the recent literature on decoupling of farm programs in the last 10 years, building on a previous survey by Abler and Blandford (2005). We first describe the ambiguity surrounding "decoupling," then assess the various channels of potential coupling of decoupled farm payments and provide a taxonomy of coupling mechanisms found in theoretical and empirical papers. The majority of the papers reviewed find that decoupled payments affect the decision-making process of farmers, though most effects are small in magnitude. This paper identifies unresolved issues on "coupling mechanisms" for further research. The following programs have been considered here: the production flexibility contract (PFC) payments from the 1996 Federal Agriculture Improvement and Reform (FAIR) Act which have been continued as direct payments in the 2002 Farm Security and Rural Investment (FSRI) Act and the counter-cyclical payments (CCPs) in the United States, and the CAP area payments in the EU.

The remainder of the paper is organized as follows. The section below provides two important definitions of decoupled payments and identifies the coupling mechanisms of decoupled payments. The next six sections are devoted to a review of the recent literature, classifying papers by the specific mechanism. The final section offers our findings and conclusions. An appendix presents tables providing summary highlights of the papers reviewed in each of the six literature discussion sections.

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[1] The Group of 20 or G20, with variations of G21, G22, and G20+, represents a coalition of developing economies established in 2003 just before the 5th Ministerial WTO conference, held in Cancún, Mexico. The Group seeks to break the US-EU dominance on WTO negotiations. It currently includes: in Africa—Egypt, Nigeria, South Africa, Tanzania, and Zimbabwe; in Asia—China, India, Indonesia, Pakistan, Philippines, and Thailand; and in Latin America—Argentina, Bolivia, Brazil, Chile, Cuba, Ecuador, Guatemala, Mexico, Paraguay, Peru, Uruguay, and Venezuela.

Definition of Decoupled Payments and Coupling Mechanisms

Two prominent definitions of "decoupled" payments are based on the URAA (as defined in Annex 2.6) and the Organization for Economic Cooperation and Development (OECD). The URAA defines decoupling in terms of policy design as taxpayer-financed payments satisfying the following criteria:

- Eligibility for such payments shall be determined by clearly defined criteria such as income, status as a producer or landowner, factor use or production level in a defined and fixed base period.
- The amount of such payments in any given year shall not be related to, or based on, the type or volume of production (including livestock units) undertaken by the producer in any year after the base period.
- The amount of such payments in any given year shall not be related to, or based on, the prices, domestic or international, applying to any production undertaken in any year after the base period.
- The amount of such payments in any given year shall not be related to, or based on, the factors of production employed in any year after the base period.
- No production shall be required in order to receive such payments.

The OECD defines decoupling in terms of policy effects (Cahill, 1997). A policy is "fully decoupled" if "it does not influence production decisions of farmers receiving payments." Beyond unchanged market equilibrium, market adjustment to any exogenous shocks should not be affected either. Both the shape and the position of supply and demand curves are unchanged. A less restrictive concept, "effectively fully decoupled," means that equilibrium levels of production and trade are unchanged but the shape of the demand and supply curves can change.

While some payments may narrowly satisfy the URAA definition, they potentially have some allocative ("coupling") effects, which arise with uncertainty, imperfect credit, land and labor markets, and farmer expectations about future payments. In the presence of uncertainty, decoupled payments reduce risk aversion and the degree of risk. If credit markets are imperfect, decoupled payments have the potential to increase the liquidity of credit-constrained farmers. The payments also increase land values and rents, which also improves the creditworthiness of credit-constrained farmers and provides incentives to retain land in agriculture. Decoupled payments affect labor markets by influencing the on- and off-farm labor supply decisions. Decoupled payments affect farmer expectations by linking current decisions to future payments. Next, we review each coupling mechanism. Appendix tables A1–A6 summarize the results from the literature according to the coupling mechanisms, the evidence of their magnitude when available, and associated authors.

Coupling Through Risk

If farmers' preferences display decreasing absolute risk aversion (DARA), increases in wealth imply a reduction in the coefficient of absolute risk aversion (wealth effect).

Decoupled payments also reduce the degree of risk faced by farmers by reducing income variability (insurance effect) (Hennessy, 1998). Hennessy models a risk-averse farmer, maximizing expected utility from profit. The farmer earns stochastic profit from the market, which is augmented by a decoupled payment. The farmer's objective function is given by:

$$\max_{\alpha} \int_{a}^{b} U\big(\hat{\pi}(\alpha, \varphi, \varepsilon)\big)\, dJ(\varepsilon), \tag{1}$$

where α is the farmer's choice variable, $\hat{\pi}(\alpha, \varphi, \varepsilon)$ is the sum of stochastic market returns $\tilde{\pi}(\alpha, \varepsilon)$ and decoupled support payment $DP(\varphi, \varepsilon)$. Under the conditions that (*a*) the farmer's preferences display DARA, (*b*) the risk faced by the farmer reduces his optimal level of the choice variable ($\tilde{\pi}_{\alpha\varepsilon} > 0$), (*c*) support-augmented income increases with risk ($(\hat{\pi}_{\varepsilon}(\alpha, \varphi, \varepsilon) > 0$), and (*d*) the decoupled payment reduces the risk faced by the farmer ($DP_{\varphi\varepsilon}(\varphi, \varepsilon) \leq 0$), the optimal choice of the farmer increases with the magnitude of support. Hennessy also shows that under constant absolute risk aversion (CARA) and conditions (*b*), (*c*), and (*d*), the optimal choice of the farmer increases with the magnitude of support. In this case, wealth effects are absent; the optimal choice is influenced only by insurance effects due to the reduced income variability induced by the increase in support. Hennessy conducts a numerical analysis for a continuous corn producer in the Midwest to obtain some measure of the magnitudes of the wealth and insurance effects of a target price program based on fixed yield. Monte Carlo simulations indicate that an increase in the magnitude of support could increase nitrogen use by a maximum of 15%, while the increase in output is small (a maximum of 2.75%). Insurance effects are much larger than wealth effects. To ensure that decoupled payments do not have any insurance effects, Hennessy suggests these payments should not vary with the source of uncertainty.

Sckokai and Moro (2006) report findings similar to those of Hennessy (1998). Using data from the Italian Farm Accounting Data Network, they empirically evaluate the risk effects of the recent CAP reforms in the EU. It is assumed that risk arises due to uncertain prices and that farmers display constant relative risk aversion (CRRA) preferences. The estimated model is then used to simulate the effects of recent CAP reforms (reduced intervention prices compensated by an increase in cereal area payments and eventually SFP). Supplies of all arable crops are positively influenced by own-area payments. The elasticity of crop acreage with respect to area payments is positive for all arable crops. The introduction of the nonstochastic SFP reduces income variability and offsets the impact of the increased price variability. Risk effects are decomposed into insurance and wealth effects. Additionally, the policy change has price and payment effects which offset each other; while the wealth effects are positive but small, insurance effects are more important in determining the direction of the output effect of the policy change.

Burfisher, Robinson, and Thierfelder (2000) study the linkage between decoupled payments and production in the United States, Canada, and Mexico under uncertainty. They apply a three-country computable general equilibrium (CGE) model in which the effect of the decoupled payment on production is captured through a change in the risk premium. Using 1997 data, the authors look at PFC in the United States, National Income Stabilization Accounts (NISAs) in Canada (an effectively coupled payment), and Procampo in Mexico, and analyze risk in returns for corn, wheat, feed grains, and oilseeds. They abstract from risk management such as hedging or off-farm employment. Farmers in the United States and Canada are assumed to tolerate loss twice as often compared to farmers in Mexico. The study examines the effect of a 50% increase in decoupled payments on risk premia. Risk premia decrease, though the effects on output via the decreased risk premia are small. U.S. output of oilseeds rises by 1.1%, and output of wheat rises by 0.5%. Mexican output of wheat and feed grains increases by 0.7%, while the output of oilseeds falls by 0.3%, reflecting the shift in resources into more risky crops.

Young and Westcott (2000) examine U.S. PFC payments, crop and revenue insurance, marketing loans, and disaster assistance payments and their effect on production. Assuming wealth elasticities of acreage between 0.087 and 0.270 (from Chavas and Holt, 1990), the authors calculate the production impact of PFC payments on program crops (corn, barley, oats, sorghum, rice, wheat, and upland cotton). PFC payments increased aggregate acreage by 0.18 to 0.57 million acres annually, translating into a maximum increase in acreage of 2% over the period 1996–2002. A shift of acreage toward riskier crops and regions also occurred.

Antón and Le Mouël (2004) employ a mean-variance approach to compute the magnitude of the risk effects of CCP. They model a risk-averse farmer producing a single output facing stochastic prices. Her income, M, is given by the sum of stochastic profits, CCP, and off-farm income. The farmer maximizes the certainty equivalent income with respect to output y. The first-order condition yields the price risk premium:

$$(2) \qquad E\left[\max(LR,\tilde{p})\right] * \left(1 - \frac{\dfrac{\partial V(M)}{\partial y}}{E\left[\max(LR,\tilde{p})\right] * \left[\dfrac{2E(M)}{R_r} + \dfrac{V(M)}{E(M)} \right]} \right) = C',$$

where LR is the commodity loan rate, $\tilde{p}$ is the stochastic output price, $E(M)$ is expected income, $V(M)$ is the variance of income, R_r is the coefficient of relative risk aversion, and C' is marginal cost. The second term in brackets captures the price risk premium. The incentive price is defined as the expected price given the truncation of the price distribution at the loan rate less the price risk premium. A policy that decreases the price risk premium increases the incentive price and has a positive effect on production. Computing the price risk premium under normally distributed prices, Antón and Le Mouël evaluate the risk-related incentives for major commodities expressed as a percentage of the market price of the commodity. The assumed value of R_r matters but effects are overall small. The CCP program created risk-related effects in the magnitude of 0.9% for sorghum, 1.5% for corn, and 1.9% for wheat.

Serra et al. (2005a) analyze the impact of decoupled payments on production decisions taken at both the intensive and extensive levels in the presence of price uncertainty. The model assumes that farmers have two sources of income: market revenue from sales of a single output and decoupled payments (DP). The farmer maximizes expected utility from wealth. The analysis is based on the assumption of DARA. The authors derive expressions for the elasticity of output with respect to DP and the elasticity of output with respect to (stochastic) price. Both the elasticities are found to be analytically positive, indicating that increases in both DP and price increase output. While DP increases output only by reducing risk, a higher price raises output by increasing marginal income and by reducing risk. The authors specify a single aggregate output produced using two variable inputs, chemical inputs and fertilizers, and use farm-level data for the years 1998–2001 from Kansas, and national-level aggregate data. Results indicate that the DP elasticity is near zero and smaller than the price elasticity, with the former equal to 0.006. Further, a reduction in price support, compensated exactly by an increase in decoupled payments, leads to a small reduction in output. Finally, the elimination of PFC payments would cause 6% of the farmers to exit.

In a related paper, Serra et al. (2006) analyze the impact of decoupled payments on production by explicitly considering the effect that inputs have on output variability when farmers face both output and price risk. For the single output/single input model, an increase in DP increases (decreases) the demand for the input if the farmer's preferences display DARA (increasing absolute risk aversion) and the input is risk increasing. This occurs because the impact of DP on input use is determined by an interaction between the wealth effect (caused by the change in the coefficient of risk aversion brought about by a change in wealth) and the effect of the input on output variability. If the input is risk decreasing, the effect of DP on input use is indeterminate. The effect of an increase in price on input demand is also indeterminate. Using a model with three inputs (pesticides, fertilizers, and seeds and fuel oil) and the data of Serra et al. (2005a), the authors find that all inputs are risk increasing and that farmers in the sample exhibit DARA preferences. DP elasticities for the three inputs are positive, but statistically insignificant. Price elasticities for the inputs are positive, though only the elasticities for pesticide and fertilizer are statistically significant. A reduction in price support which is compensated by a decoupled payment may lead to a decrease in output mean and variance by reducing the use of risk-increasing inputs.

Makki, Johnson, and Somwaru (2005) analyze the effects of CCPs on farm-level income variability, crop choice, and acreage allocation decisions by simulating an expected utility maximization model for a risk-averse representative Minnesota farmer facing price and output uncertainty. The farmer is assumed to buy revenue or yield insurance. The authors compare the certainty equivalent of the terminal period wealth under different assumptions about programs, acreage allocations, and market conditions. The simulation exercise is conducted for the years 2002–04. Results indicate that CCPs increase farm welfare considerably, especially in low price years. Farmers may increase acreage of crops with higher CCP rates, especially if base updating is allowed, as it was under the 2002 FSRI Act.

Goodwin and Mishra (2006) econometrically evaluate the effect of PFC and market loss assistance (MLA) payments on farm-level decisions using farm-level data from USDA's Agricultural Resource Management Survey (ARMS) for the period 1998–2001. They investigate the impact of current PFC and MLA payments on current acreage decisions of farmers. The empirical model is based on expected utility maximization of wealth (initial wealth plus market returns, government payments, and nonfarm activities). The following reduced-form acreage response equation is estimated:

$$A_t = f\left(A_{t-1}, \tilde{p}_t, w_t, DP_t, \widetilde{CP}_t, W_{t-1}\right), \tag{3}$$

where A_t is current acreage, A_{t-1} is lagged acreage, $\tilde{p}_t$ is stochastic output price for the commodity, w_t is input price, and W_{t-1} is wealth. $\widetilde{CP}_t$ represents government payments which are conditioned on market conditions (LDP and MLA payments), and DP_t denotes fixed payments received by the producer. The estimation equations include PFC and MLA payments and also the indirect effects that PFC payments can have on farmers' decisions via the farmers' risk aversion. A farmer's level of risk aversion is represented by the proportion of his insurance bill as compared to his total expenditure. The PFC-insurance interaction term captures the effect that PFC payments can have on risk aversion. The empirical model also includes the farm's wealth, calculated as total assets less total debts, and PFC payments. The authors estimate acreage equations for corn, soybeans, and wheat. They find that the direct effects of PFC payments on acreage decisions are positive and significant, except in the wheat acreage decision, though the magnitude of the impact is small. The coefficient of the PFC-insurance term in all three acreage equations is negative though insignificant. Wealth effects are also insignificant.

The overall effect of a dollar increase in PFC payments is to increase corn, soybean, and wheat acreage by 0.92, 0.61, and 0.36 acres respectively corresponding to acreage elasticities of 0.0317 for corn, 0.0204 for soybeans, and 0.0428 for wheat. MLA effects on corn acreage are found to be stronger as compared to the effect of PFC payments, though the effect on soybeans and wheat are not significant. Appendix table A1 summarizes the papers discussed in this section.

Coupling via Credit Constraints

Decoupled payments can influence the investment decisions of farmers by adding to their wealth, which might enable farmers to save more and therefore increase their investment. For capital-constrained farmers, decoupled payments improve their creditworthiness and make credit more accessible. Roe, Somwaru, and Diao (2003) examine the economy-wide effect of decoupled payments on consumption and savings patterns. First, the paper explores the link between PFC payments and land values using data from statistical reporting districts in Minnesota from 1994 to 2000. Results indicate a positive correlation between government payments and land values; between 1994 and 2000, a 10% change in government payments led to a 3.24% change in land values. The appreciation in land values can affect investment by increasing the access to credit, as land is used as collateral. Next, the authors examine the effects of PFC payments on investment under perfect and segmented capital markets using an intertemporal three-sector general equilibrium (GE) model. PFC payments are incorporated into the model as a lump-sum transfer from urban households to the rural households who undertake agricultural production. The model is calibrated to 1997 U.S. data. PFC payments are assumed to be \$6.11 billion in 1997, and are paid in every period in perpetuity. The steady-state solutions of the model with and without (defined as the benchmark) the PFC payments are compared. With perfectly integrated capital markets, the sole effect of PFC payments is on land values, which exceeds the benchmark by 9% in the short run and by about 8% in the long run. With imperfect capital markets, the rental rate of capital in agriculture declines by 0.1% in the first 10 years as compared to the benchmark. The effect on rental rate of capital outside agriculture is negligible. The price of land and hence the value of land rises. Farmers increase their level of capital stock, and as they do so, also employ more labor. Thus, higher labor hours are employed in agriculture over the benchmark. Aggregate agricultural production increases by a maximum of 0.18% over the benchmark, a very small effect. All of these effects occur in the short run. In the long run, the differences in the rental rates of capital in agriculture and outside agriculture are arbitraged away and there is convergence to the benchmark. Hence, PFC payments do not have any effects in the long run.

Goodwin and Mishra (2006), earlier discussed in the previous section, also empirically estimate the impact of PFC payments on easing credit constraints faced by farmers. Credit constraints are represented by the debt-to-asset ratio of the farm. The PFC-(debt-to-asset ratio) interaction term captures the effect that PFC payments might have on the farm's financial leverage. However, the interaction term is not statistically significant in the corn, soybean, and wheat acreage equations. Appendix table A2 recapitulates this section's information.

Coupling Through Labor Allocation

Decoupled payments can have a significant effect on farmers' on-farm and off-farm labor supply decisions. Farmers do not view on-farm and off-farm work as having similar characteristics. As Key and Roberts (2009) note, farmers can derive nonpecuniary benefits from farming, and the receipt of decoupled payments leads to an increase in on-farm labor supply. Another explanation could be that the receipt of decoupled payments increases farmers' liquidity and hence reduces their reliance on off-farm work. Ahearn, El-Osta, and Dewbre (2006) investigate the effect of government payments on the off-farm labor participation decision of farm operator households using ARMS data for the years 1996 and 1999 and a bivariate probit approach. They find that PFC, LDP, and MLA payments, individually and in aggregate, reduce the probability that the farmer works off the farm. The estimation results for the spouse are more ambiguous.

In an investigation also based on recent ARMS data, Dewbre and Mishra (2002) estimate the effect that PFC, MLA, LDP, and disaster assistance payments have on the leisure time and on-farm hours of operators and spouses. The impact of the PFC payments on on-farm labor hours is negative yet statistically insignificant. PFC payments have a positive and significant impact on leisure hours though the effect is very small in magnitude. The authors conclude that PFC payments are decoupled. The authors also focus on transfer efficiency losses arising from reallocation of farm resources caused by the government payments and leakages of benefits to nonfarming landowners. Transfer efficiency is measured as the impact of the payments on the total income of households. PFC has the lowest transfer efficiency (0.29) for households with some off-farm income among the payments considered and also the highest transfer efficiency (0.55) for households with no off-farm income.

Using 2001 ARMS data, El-Osta, Mishra, and Ahearn (2004) estimate the effect of PFC, LDP, and disaster assistance payments on on- and off-farm labor and total labor supply. They find that combined payments have a positive effect on on-farm and total labor hours supplied and a negative effect on off-farm labor supply. Operators increased their on-farm labor hours while cutting down on both off-farm labor as well as leisure time. When each government payment is considered individually, PFC payments have a positive significant impact on on-farm labor hours and a negative significant impact on off-farm labor hours. No significant effect is found on total labor supply.

Key and Roberts (2009) develop a household model where farmers make labor allocation decisions to maximize utility. It is assumed that farmers derive utility from consumption, leisure, and nonpecuniary benefits from farming. The authors employ an additive utility function. Under the assumption of decreasing marginal utility of income, they find that an increase in DP leads to a reallocation of labor toward on-farm work and away from off-farm work. The explanation for this result is based on the nonpecuniary benefits that farmers receive from farming. Because of the nonpecuniary benefits, farmers prefer on-farm work to off-farm work for the same wage rate. Using 2002–04 ARMS data, Key and Roberts find evidence of nonpecuniary benefits by empirically estimating the wage differential between on-farm and off-farm work. For the entire sample, their findings show the off-farm hourly wage rate to be $24 higher than the on-farm wage rate. Appendix table A3 sums up the points made by the papers cited in this section.

Coupling via Land Markets

Decoupled payments are passed on to landowners via higher land rents and land values. This can lead to land remaining in agriculture and also, as mentioned earlier, can make credit more accessible to farmers. Roe, Somwaru, and Diao (2003) assert that PFC payments lead to an increase in land values, even in the long run. One of the earliest articles to raise this issue was Schertz and Johnston (1998). The authors conduct a study in four major agricultural regions: the Great Plains, the Corn Belt, the South, and California. The study is based on the responses of farm managers or operators to the 1996 FAIR Act. Based on their discussions with the farm managers, the authors conclude that owing to their nonstochastic nature, PFC payments inflate land prices and land rents. PFC payments increase land values as they are attached to the land. In the case of cash leases, much of the payments pass on to the landowner via increased rents. In the case of crop share leases, payments create incentives for the landowner to adjust the lease to take advantage of the PFC payments (e.g., in some cases landowners shifted to cash leases).

Gohin, Guyomard, and Le Mouël (2000) analyze the impact of direct payments on land and production. They evaluate them in terms of their eligibility to qualify as green-box payments. The authors use a static partial equilibrium model with two perfectly competitive agricultural sectors, each producing a single output, with a constant returns-to-scale production technology. Production in the two sectors depends on the use of three inputs: an aggregate variable input, a specific primary factor, and a fixed allocable factor such as land, which is used in both sectors and is in fixed supply. The domestic support instruments considered include output subsidies, variable input subsidies, and DP based on the specific factor, and on land. Optimal output supply and derived input demands are determined by a two-stage profit-maximization process. Land prices are determined endogenously by the market-clearing condition for land. Land prices are computed under two alternative assumptions: land homogeneity and heterogeneity. Comparative-static analysis indicates that the land use and output supply in each sector depend on both sectors' DP and output subsidy. The effect of the DP depends on the use of other support measures and the production technology. Two countries with different production technologies or different factor movements across sectors will have different impacts from using the same direct support instrument.

Barnard et al. (2001) analyze the effects of commodity program payments on cropland values using 2000 county-level farmland value data from ARMS. They estimate hedonic land price equations with all government payments (which include PFC, LDP, MLA, and disaster assistance payments) grouped together as a single variable. Results suggest that the commodity program payments have a significant effect on cropland values. The highest proportional effect was in the Heartland region (includes Iowa, Illinois, Indiana, and parts of Ohio, Minnesota, Missouri, Kentucky, South Dakota, and Nebraska) where farm commodity programs accounted for 24% of the market value of farmland. Farm commodity programs also had a similar effect in the Prairie Gateway region (includes Kansas, and parts of Texas, Oklahoma, New Mexico, Nebraska, and Colorado) (23% of the market value of farmland) and in the Northern Great Plains region (includes North Dakota, most of South Dakota, and parts of Montana, Minnesota, Wyoming, Colorado, and Nebraska) (22% of the market value of farmland). Even though all payments have been grouped together, the authors note that PFC payments are expected to have a larger impact on land values as compared to the coupled LDP and disaster assistance payments. This is because the coupled payments can increase production and therefore increase the demand for other non-land inputs. Consequently, benefits from the coupled payments may be transferred to other inputs, and not all benefits are capitalized into higher land values. PFC payments are paid on land, and being lump-sum in nature, they are not expected to influence production. Hence, all benefits from the PFC payments are expected to be capitalized into higher land values. In contrast, Goodwin, Mishra, and Ortalo-Magné (2003a,b) found LDP and disaster assistance payments have a larger impact on land values as compared to the PFC payments.

Dewbre, Antón, and Thompson (2001) employ the policy evaluation matrix (PEM) model to study the effects that direct payments (based on land use) have on trade and their efficiency in providing income support. Since they are based on land use, these DPs are considered as area payments and are further classified into two types: one requiring production for eligibility, and the other that land be kept in arable use. The authors also compare the area payments with market price support, input subsidies, and output payments. Their paper focuses on the impacts of the support measures through their incidence on relative prices. The impact of area payments on production, trade, and farm income arises because of their impact on land prices. The results from model simulation reveal that the area payments have the smallest effect on trade as compared to the other three forms of support. Within the area payments, the one requiring no active production has a smaller effect on trade than the one which requires mandatory production. Market price supports have a smaller impact on trade as compared to the input subsidies. In fact, input subsidies prove to be the most inefficient form of support in terms of providing income support, while area payments prove to be the most efficient.

Roberts, Kirwan, and Hopkins (2003) examine the incidence of government payments on land rents using micro data from the 1992 and 1997 *U.S. Census of Agriculture*. Results indicate that government payments had a significant impact on land rents. For 1997, rents increased between \$0.33 and \$1.55 for each government payment dollar (in 1997 the major component of government payments consisted of payments made under the PFC program). For 1992, the effect on land rents is smaller, reflecting the temporary nature of government payments in that year.

Goodwin, Mishra, and Ortalo-Magné (2003a,b) use farm-level data from ARMS to estimate the determinants of farmland values. While the first study (2003a) uses data for the years 1998–2001, the second study (2003b) uses data for the years 1998–2000. The current value of farmland is affected by the sum of the expected future cash flows discounted according to the risk of these cash flows. Cash flows from the same source have the same discount factor. The authors consider three sources of future cash flows:

market returns, government payments (PFC, LDP, and disaster assistance), and the nonagricultural returns to land. Each government program has been considered separately in the analysis since programs differ according to support provided. The uncertainty associated with each program differs. They find that PFC payments have a positive and significant effect on farmland values; a dollar increase in PFC payments leads to an increase in per acre land values of $4.94 in the first study, and $4.06 in the second study.

Frandsen, Gersfelt, and Jensen (2003) employ a computable general equilibrium (CGE) model to analyze the production and trade impacts of decoupling income support in the EU. The model accounts for the support measures in the CAP and the Agenda 2000 reforms. The model baseline is constructed for the period 1997–2013, and captures the structure of the domestic support in the EU. The baseline is compared with three scenarios. Of interest to us is the scenario where all domestic support is converted into a single region-specific decoupled payment to land. Under this scenario, there is a substantial increase of 75.1% in land prices for the EU15 as a whole. All individual EU countries also display increases in land prices. Other results are a decrease in the production of wheat, other grains, oilseeds, and bovine animals by 6.9%, 5.6%, 8.9%, and 11%, respectively. Most affected are plant-based fibers, such as cotton whose production decreases by 63%. These decreases are reflective of the high level of domestic support enjoyed by these commodities under Agenda 2000.

Gohin (2006) analyzes the impact of the 2003 CAP Mid-Term Review (MTR) under two different assumptions about the modeling of Agenda 2000 direct payments. The first is based on the standard approach employed in other studies that have examined the effect of CAP MTR reforms, under which there is full capitalization of the arable crop direct payments by 2008, and beef premia are not limited by any maximum limit. Under the second assumption, there is a 50% capitalization of the arable crop direct payments by 2008, and beef premia are paid on a limited number of animals. Under both assumptions, direct payments are based on land use and therefore increase land rents (by 164% under the first assumption and 38.5% under the second). A static, single-country, multisector GE model of the EU15 economy with perfect competition in all markets and constant-returns-to-scale technology is employed. Gohin focuses on the soft wheat sector for the analysis. The model is calibrated to 1995 data from Eurostat. Policy variables were calibrated using FEOGA/WTO notifications. Under the CAP MTR scenario, Agenda 2000 arable crop direct payments are reduced by 90%, the slaughter premium on adult animals is reduced by 80%, and the suckler cow premium and the special beef premium are reduced by 50% and 90%, respectively. It is also assumed that the SFP has no market effects. The simulation results indicate that under both assumptions, land rents decrease by at least 80%.

There are also negative impacts on arable crop and beef production. The results with the first assumption are similar to findings reported by the other studies: soft wheat and beef production decrease by 1.6% and 3.6%, respectively. The results with the second assumption are in the same direction but the magnitude of the impact differs, with a decrease of 7.3% in soft wheat production and a 1.2% decrease in beef production. The varying results suggest that the impacts of the CAP MTR are sensitive to the modeling of the Agenda 2000 direct payments. Another conclusion that can be drawn from the results of the alternative modeling of the Agenda 2000 arable crop direct payments is that the payments seem to have a moderate degree of coupling.

Goodwin and Mishra (2006) (discussed in earlier sections) also assess the impact of PFC payments on the allocation of land across alternate practices such as conservation reserves, pasture, fallow, and other idling practices. They find that PFC payments lead to less idling of land. Further, the authors investigate whether PFC payments led to the acquisition of new land. Their findings show that PFC payments may lead to more land ownership transactions, though the effect is not significant. Appendix table A4 recaps these papers on coupling through land markets.

Coupling from Farmer Expectations on Future Policy Changes

Farmers form expectations on future decoupled payments. The latter are often based on historical behavior which then "couples" current production decisions to these expected future payments. Lagerkvist and Olson (2002) analyze anticipatory adjustments made by farmers to the 1996 FAIR Act using a sample of Minnesota farmers. Both the timing and the size of the support are considered to be stochastic. The farmer has well-defined probability distribution functions for the timing and the size of the reform. The farmer maximizes net receipts subject to a binding dividend constraint derived from the budget constraint of the farm business. Assuming the farmer continuously updates his information, the authors convert the dynamic stochastic problem into two deterministic control problems for the pre-reform and post-reform periods. The solution indicates that the pre-reform debt-to-asset ratio differs from the post-reform ratio. The former includes an additional term which captures the anticipatory optimal debt adjustment to a future reform of farm policy. The adjustment is comprised of the expectation effect (relating to the uncertainty in the size of the reform) and the timing effect (relating to the uncertainty in the timing of the reform). The authors estimate the pre-reform and post-reform debt-to-asset ratios for an anticipated reduction in support using data from the Southwestern Minnesota Farm Business Management Association records for 1989–1998 using the generalized method of moments estimator. The empirical results indicate the presence of anticipatory adjustments in the debt-to-asset ratio due to the expected change in the post-reform support.

In a related investigation, Lagerkvist (2005) applies the framework in Lagerkvist and Olson (2002) to analyze the impacts of the CAP MTR reform of the area payments on the incentives for farmland investment among Swedish farmers. The paper provides an explanation for the fluctuations in farmland investment based on agricultural policy uncertainty. The required rate of return (ROR) for farmland investment is used to capture farmland investment incentives. The short-term ROR includes the impact of incentive adjustment to a future reform in the area payments. Numerical analysis based on survey data from a sample of Swedish farmers shows that the pre-reform ROR under timing uncertainty is less than the ROR with complete certainty. Further, the pre-reform ROR under both timing and post-reform area payment uncertainty is less than the ROR under only timing uncertainty under a nonpositive correlation between the timing of the reform and the post-reform payment.

Sumner (2003) analyzes the impact of an expected base update on the supply response of program crops by constructing the degree of linkage between future payments that might involve base updating and current production, and then evaluating how this is affected by a current update. The degree of linkage depends among other factors on the probability that the program remains operative in the future, the probability that an update occurs, and how the new base affects future payments relative to the current program. The degree of linkage is sensitive to the probabilities and discount factor used. Under a high degree of linkage, payments such as the direct payments or CCP, which are affected by base updating in the future, strongly influence current production.

McIntosh, Shogren, and Dohlman (2007) use experimental economics to study the effects of CCP and base acre updating on supply response under price and policy uncertainty. Each participant is endowed with "tokens," representing base acres to be invested in either a "Blue" option (denoting a program crop) or a "Red" option (representing a nonprogram crop or a crop that has not been planted earlier), or a combination of the two. These allocation decisions are made under three situations: (*a*) participants face only price uncertainty (baseline case), (*b*) they face price uncertainty and receive CCP (CCP case), and (*c*) they face price and policy uncertainty and also receive CCP (policy risk case). The results indicate that CCP increased the investment in the program crop (Blue option). There was a 5.43% shift in base acres toward the program crop with the CCP case as compared to the baseline. Under the policy risk case there was a shift of 7.92% in base acres toward the program crop. These results provide evidence that both the CCP and the possibility of future base updating do create some incentives for farmers to plant more of the program crops than that indicated by market returns.

Coble, Miller, and Hudson (2008) use survey data from Iowa and Mississippi to analyze what expectations farmers have from future farm bills, including expectations regarding future base update. In the survey, they ask questions regarding the probability of base and program yield update for DP and CCP, whether payment rates will change or remain the same, and if farmers made any adjustments in acreage or input use to affect future program payments. On average, the surveyed farmers believed there was a 40% chance that base or yield updates would be allowed, though only 17% of those surveyed said they would make adjustments in acreage planted or input use. The authors also use a censored probit model with the dependent variable as the willingness to accept (WTA) a one-time payment in lieu of an opportunity to update base. The WTA captures the value placed by farmers on the opportunity to update base. Greater expectation of an update and a higher percentage of farm income were found to increase the WTA. The mean WTA across the two states was $48.16 per acre.

Using a stochastic dynamic programming approach, Bhaskar and Beghin (2008) analyze the impact of farmer expectations about the possibility to update base acreage and program yield on a farmer's acreage and fertilizer use decision under price, yield, and policy uncertainty. They consider a risk-averse farmer producing corn, earning income from the sale of his crop and government payments. There is policy uncertainty about the possibility of base acreage and program yield update in the 2007 Farm Bill. The farmer's subjective probability about the expected updates is discretized into five values, between 0 and 1 in increments of 0.25. The farmer maximizes the present value of expected utility by choosing acreage and fertilizer use during 2003–11, taking into account the possibility of a base acreage and program yield update. The choice variables, the acreage planted and fertilizer use, are discretized into four values each. Price and yield shocks are the state variables which are discretized into eight and two states each. There are two possible income streams in 2007–2011—one when updates are allowed and the other when no updates are allowed. The farmer weighs the two possible future income streams with their prior subjective probability of updates. In this way, the latter affects the acreage and fertilizer use decisions in the 2003–06 period. The results are presented in terms of the average of the optimal planted acreage over 2003–06, and the average yield resulting from optimal fertilizer use over 2003–06. The authors find that optimal acreage and yield in 2003–06 are weakly increasing in the subjective probability of the updates. They also find that the maximum percentage increase in acreage is 6.25% and the maximum percentage increase in yield is 0.134%. In sum, the effects through expectations appear tangible although small. The summary for these papers on expectations is presented in appendix table A5.

Other Coupling Linkages and Allocative Effects

A few papers do not fit within the conceptual underpinnings of the previous taxonomy. Using some reduced forms, Adams et al. (2001) econometrically estimate the effect of PFC and MLA payments on the total area planted in 11 states for wheat, corn, sorghum, barley, oats, cotton, rice, and soybeans, using annual state-level data for the years 1997–2001. The authors test two hypotheses: first, whether PFC and MLA payments affect the total area planted, and second, whether PFC and MLA payments have the same effect as market returns and marketing loans on the total area planted. Based on the empirical results, PFC and MLA payments do have some effect on the area planted. Empirical results for testing the second hypothesis do not provide a clear indication whether PFC and MLA payments have different effects on area planted than market returns and marketing loans. The authors conclude that their results provide only weak evidence that PFC and MLA payments have some effect on the total area planted. The results in the study are based on the assumptions that the elasticities are the same across states and on naïve expectations on the part of the farmers in the computation of expected market returns and expected MLA payments. A similar analysis is conducted by Beckman and Wailes (2005) who assess the impact of direct payments and CCP in the 2002 FSRI Act on acreage supply response for rice. They find that DPs are decoupled while a $1 increase in CCP per year increases rice area harvested by 956.29 thousand acres for the six major U.S. rice-producing states.

Guyomard, Le Mouël, and Gohin (2004) compare the effectiveness of four support mechanisms (an output subsidy, a land subsidy, and decoupled payments with and without mandatory production, DPm and DP, respectively) on achieving four policy objectives: providing income support, increasing the number of farmers, reducing the negative externalities from non-land input usage, and keeping trade effects at a minimum. A support mechanism is considered to be more efficient than the other support mechanisms if, for the same budgetary costs, it has a higher impact on the four policy objectives identified above. The analytical model is based on three equilibrium equations representing equilibrium in the output and land markets and an entry-exit condition. DP does not appear in any of the three equations. It only achieves the policy objective of providing income support. DPm, on the other hand, has a positive effect on the number of farmers, though its effect on output price and land price is ambiguous. The authors find that none of the four policy instruments dominate in terms of efficiency in all four policy goals. DP is most efficient when it comes to supporting farmers' income with the least distortion of trade. Land subsidies are the most efficient in reducing the negative externalities from non-land input use, while decoupled payments with mandatory production are the most efficient in maintaining or increasing the number of farmers.

Chau and de Gorter (2005) examine the effects of decoupled payments on exit decisions of farmers. It is their contention that decoupled payments subsidize production and at times cross-subsidize exports. In the model constructed by the authors, producers receive both coupled and decoupled support. The coupled payment is modeled as an ad valorem subsidy, which is incorporated in the price they receive for exports. The decoupled payment is a lump-sum payment, DP. The producers incur fixed and variable costs. The fixed costs are assumed to be firm specific. The model results indicate that DP allows producers to cover fixed costs, thereby permitting those with higher fixed costs, who would have exited otherwise, to remain in production. Thus, direct payments do not affect an individual producer's output; rather, they affect aggregate output and exports by influencing the exit decision of producers. The model is calibrated to 1998 U.S. wheat production to compare the effects of PFC and LDP payments. Fixed costs are assumed to be normally distributed. In the long run when it is possible to exit, the removal of PFC payments causes 3% of the producers to exit, leading to a reduction in output and exports.

Serra et al. (2005b) examine the effect of decoupling of support on the environment by analyzing the effect of post-MacSharry CAP reforms on the use of pest control inputs in the cereal, oilseed, and protein (COP) crop sector. The model specifies damage abatement functions to capture the contribution of the pest control inputs in reducing crop damage. The authors derive expressions for the elasticity of the demand of pest control inputs with respect to price support measures and per hectare compensatory payments. They hypothesize and find that the input response to DP is less than the response to price, using a sample of French farms from the Farm Accounting Data Network for the period 1994–1999. The model is then shocked with CAP reforms (decrease in cereal intervention prices, and increase in area payments). Area payments for oilseeds and protein crops are reduced. These policy changes result in a reduction in the use of crop protection inputs by a little more than 3%, and a shift away from oilseed/protein crop acreage toward cereal acreage. When area payments are combined into the SFP, the use of crop protection inputs is reduced by 11%. Cereal acreage falls while oilseed and protein crop acreage remains almost constant. Appendix table A6 summarizes these last papers.

Conclusion

There has been a move toward decoupled support away from coupled support consistent with the 1994 URAA. However, as seen above, decoupled payments do influence farmers' decisions. Our review identifies five major coupling channels of decoupled payments: (*a*) they affect the risk faced by farmers, either by reducing their level of risk aversion (wealth effects) or by reducing the risk they face (insurance effects); (*b*) they ease credit constraints faced by farmers; (*c*) they affect the labor allocation decisions of farm households; (*d*) they alter land values, rents, and land prices; and (*e*) they influence farmers' decisions through expectations about future payments. Less often mentioned, decoupled payments can also influence the entry and exit decisions of farmers and have some effect on the environment by influencing input usage.

Although decoupled payments are not fully "decoupled," as the research suggests that they influence farmers' decisions through the channels identified above, the magnitude of these impacts was found to be small in most cases. One exception is with respect to land markets. Since most decoupled payments (be it the PFC, direct payments, or the CAP area payments) are land based and nonstochastic, they tend to be capitalized into higher land values which increase land rents and prices. This feature could lead to land remaining in agricultural use rather than being converted into nonagrarian alternate uses. Wealth effects, though positive, are small in magnitude, and insurance effects are more important than wealth effects in determining the impact of decoupled payments. Decoupled payments also influence crop choice, since the payments vary by crops, and some crops are not eligible to receive payments.

An important and unresolved issue is to identify the cumulative impact of these individually small effects coming from each coupling mechanism. Could it be that when combined together, risk aversion, wealth effects, credit constraints, expectations, base update, and linkages through input markets have a substantial impact on production? Goodwin and Mishra (2006) have econometrically analyzed the cumulative effects of risk aversion, wealth effects, and credit constraints. They left out expectations of future decoupled payments, base update, and labor market linkages, and captured risk aversion in a roundabout way without explicit parameterization. Numerical methods would allow a more explicit characterization of risk aversion and account for expectations and base and yield updates.

Decoupled payments have been a step toward reducing the distortions caused by domestic farm subsidies, but there is scope for further decoupling. This can be achieved by changing eligibility requirements in some cases (e.g., removing the restriction that fruits and vegetables are not eligible for payments in the case of direct payments in the United States), by requiring eligibility to be satisfied at the farm level (e.g., area payments in the CAP have base acreage restriction at the national or regional level, which still creates incentives at the farm level to increase acreage), and by ensuring that the eligibility to receive payments does not change after the inception of the decoupled payment program.

The implementation of decoupled programs calls into question the current definition of the green-box payments in the WTO. There is a need for reevaluating the eligibility criteria of the green-box payments. Right now, eligibility criteria do not take into account the farmer's response under uncertainty, or the fact that the impact of similarly designed programs can differ across countries, and even across sectors within a country (Gohin, Guyomard, and Le Mouël, 2000). Also, some eligibility criteria are ambiguous (e.g., it is not specified if eligibility criteria should be satisfied at the farm level, at the sub-sectoral level, or at the sectoral level).

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References

Abler, D., and D. Blandford. "A Review of Empirical Studies of the Acreage and Production Response to U.S. Production Flexibility Contract Payments Under the FAIR Act and Related Payments Under Supplementary Legislation." Paper prepared for the Organization for Economic Cooperation and Development, Paris, 2005.

Adams, G., P. Westhoff, B. Willott, and R. Young, II. "Do Decoupled Payments Affect U.S. Crop Area? Preliminary Evidence from 1997–2000." *Amer. J. Agr. Econ.* 83,5(2001):1190–1195.

Ahearn, M., H. El-Osta, and J. Dewbre. "The Impact of Coupled and Decoupled Government Subsidies on Off-Farm Labor Participation of U.S. Farm Operators." *Amer. J. Agr. Econ.* 88,2(2006): 393–408.

Aksoy, A., and J. Beghin, eds. *Global Agriculture Trade and Developing Countries.* Washington, DC: World Bank, 2004.

Antón, J., and C. Le Mouël. "Do Counter-Cyclical Payments in the 2002 U.S. Farm Act Create Incentives to Produce?" *Agr. Econ.* 31,2-3(2004):277–284.

Barnard, C., R. Nehring, J. Ryan, and R. Collender. "Higher Cropland Value from Farm Payments: Who Gains?" *Agr. Outlook* (November 2001):26–30.

Beckman, J., and E. Wailes. "The Supply Response of U.S. Rice: How Decoupled Are Income Payments?" Paper presented at annual meetings of the American Agricultural Economics Association, Providence, RI, 2005.

Bhaskar, A., and J. Beghin. "Decoupled Payments and the Role of Base Acreage and Yield Updating Under Uncertainty." Work. paper, Dept. of Econ., Iowa State University, 2008.

Burfisher, M., S. Robinson, and K. Thierfelder. "North American Farm Programs and the WTO." *Amer. J. Agr. Econ.* 82,3(2000):768–774.

Cahill, S. "Calculating the Rate of Decoupling for Crops Under CAP/Oilseeds Reform." *J. Agr. Econ.* 48,3(1997):349–378.

Chau, N., and H. de Gorter. "Disentangling the Consequences of Direct Payment Schemes in Agriculture on Fixed Costs, Exit Decisions, and Output." *Amer. J. Agr. Econ.* 87,5(2005):1174–1181.

Chavas, J.-P., and M. T. Holt. "Acreage Decisions Under Risk: The Case of Corn and Soybeans." *Amer. J. Agr. Econ.* 72,3(1990)529–538.

Coble, K., J. Miller, and M. Hudson. "Decoupled Farm Payments and Expectations for Base Updating." *Rev. Agr. Econ.* 30,1(2008):27–42.

Dewbre, J., J. Antón, and W. Thompson. "The Transfer Efficiency and Trade Effects of Direct Payments." *Amer. J. Agr. Econ.* 83,5(2001):1204–1214.

Dewbre, J., and A. Mishra. "Farm Household Incomes and U.S. Government Program Payments." Paper presented at annual meetings of the American Agricultural Economics Association, Long Beach, CA, 2002.

El-Osta, H., A. Mishra, and M. Ahearn. "Labor Supply by Farm Operators Under 'Decoupled' Farm Program Payments." *Rev. Econ. of the Household* 2(2004):367–385.

Frandsen, S., B. Gersfelt, and H. Jensen. "The Impacts of Redesigning European Agricultural Support." *Rev. Urban and Regional Develop. Stud.* 15,2(2003):106–131.

Gohin, A. "Assessing CAP Reform: Sensitivity of Modeling Decoupled Policies." *J. Agr. Econ.* 57,3(2006): 415–440.

Gohin, A., H. Guyomard, and C. Le Mouël. "Measuring the Degree of Decoupling of Alternative Internal Support Policy Instruments: The Green Box Issue." Work. paper, INRA–ESR, Rennes, 2000.

Goodwin, B., and A. Mishra. "Are 'Decoupled' Farm Program Payments Really Decoupled? An Empirical Evaluation." *Amer. J. Agr. Econ.* 88,1(2006):73–89.

Goodwin, B., A. Mishra, and F. Ortalo-Magné. "Explaining Regional Differences in the Capitalization of Policy Benefits into Agricultural Land Values." In *Government Policy and Farmland Markets*, eds., C. B. Moss and A. Schmitz, pp. 97–114. Ames, IA: Iowa State University Press, 2003a.

———. "What's Wrong with Our Models of Agricultural Land Values?" *Amer. J. Agr. Econ.* 85,3(2003b): 744–752.

Guyomard, H., C. Le Mouël, and A. Gohin. "Impacts of Alternative Agricultural Income Support Schemes on Multiple Policy Goals." *Eur. Rev. Agr. Econ.* 31,2(2004):125–148.

Hennessy, D. "The Production Effects of Agricultural Income Support Policies Under Uncertainty." *Amer. J. Agr. Econ.* 80,1(1998):46–57.

Key, N., and R. Roberts. "Nonpecuniary Benefits to Farming: Implications for Supply Response to Decoupled Payments." *Amer. J. Agr. Econ.* 91,1(2009):1–18.

Lagerkvist, C. "Agricultural Policy Uncertainty and Farm-Level Adjustments—The Case of Direct Payments and Incentives for Farmland Investment." *Eur. Rev. Agr. Econ.* 32,1(2005):1–23.

Lagerkvist, C., and K. Olson. "Optimal Capital Structure and Income Support Reform Uncertainty." Paper presented at annual meetings of the American Agricultural Economics Association, Long Beach, CA, 2002.

Makki, S., D. Johnson, and A. Somwaru. "Farm-Level Effects of Counter-Cyclical Payments." Paper presented at annual meetings of the American Agricultural Economics Association, Providence, RI, 2005.

McIntosh, C., J. Shogren, and E. Dohlman. "Supply Response to Counter-Cyclical Payments and Base Acre Updating Under Uncertainty: An Experimental Study." *Amer. J. Agr. Econ.* 89,4(2007): 1046–1057.

Roberts, M., B. Kirwan, and J. Hopkins. "Incidence of Government Program Payments on Land Rents: The Challenges of Identification." *Amer. J. Agr. Econ.* 85,3(2003):762–769.

Roe, T., A. Somwaru, and X. Diao. "Do Direct Payments Have Intertemporal Effects on U.S. Agriculture?" In *Government Policy and Farmland Markets*, eds., C. B. Moss and A. Schmitz, pp. 115–139. Ames, IA: Iowa State University Press, 2003.

Schertz, L., and W. Johnston. "Landowners: They Get the 1996 Farm Act Benefits." *Choices* 13,1(1998): 4–7.

Sckokai, P., and D. Moro. "Modelling the Reforms of the Common Agricultural Policy for Arable Crops Under Uncertainty." *Amer. J. Agr. Econ.* 88,1(2006):43–56.

Serra, T., D. Zilberman, B. Goodwin, and A. Featherstone. "Decoupling Farm Policies: How Does This Affect Production?" Paper presented at annual meetings of the American Agricultural Economics Association, Providence, RI, 2005a.

———. "Effects of Decoupling on the Mean and Variability of Output." *Eur. Rev. Agr. Econ.* 33,3(2006): 269–288.

Serra, T., D. Zilberman, B. Goodwin, and K. Hyvonen. "Replacement of Agricultural Price Supports by Area Payments in the European Union and the Effects on Pesticide Use." *Amer. J. Agr. Econ.* 87,4(2005b):870–884.

Shonkwiler, J., and S. Yen. "Two-Step Estimation of a Censored System of Equations." *Amer. J. Agr. Econ.* 81,4(1999):972–982.

Sumner, D. "Implications of the U.S. Farm Bill of 2002 for Agricultural Trade and Trade Negotiations." *Austral. J. Agr. and Resour. Econ.* 47,1(2003):99–122.

Young, C., and P. Westcott. "How Decoupled Is U.S. Agricultural Support for Major Crops?" *Amer. J. Agr. Econ.* 82,3(2000):762–767.

Table A1. Wealth and Insurance Effects of Decoupled Payments

Papers [a]	Methodology: Modeling Approach	Methodology: Empirical/Numerical	Elasticity Otherwise Noted [b]	
Hennessy (1998) [price-contingent payments on fixed yield]	Expected utility maximization under DARA	Model calibrated to a single 400-acre continuous corn farm	Output: Corn Input: Nitrogen	0.012 0.071
Burfisher, Robinson & Thierfelder (2000) [PFC in U.S.] [Procampo in Mexico]	CGE model of the U.S., Mexico & Canada with risk premium	Simulations used to measure the effect of a 50% ↑ in payments over 1997 levels	Output: U.S. wheat U.S. oilseeds Mexico wheat & feedgrains Mexico oilseeds	 0.010 0.022 0.014 –0.006
Young & Westcott (2000) [PFC]	N/A	N/A	Acreage: [c] ↑ in DP of $36 billion over 1996–2002 ⇒ ↑ by 0.64% to 2% over 1996–2002	
Antón & Le Mouël (2004) [CCP]	Mean-variance approach	Numerical analysis based on 1999 OECD data, 2001–03 loan rates, and 2002–03 CCP rates	Incentive price: [d] Corn Wheat Sorghum	↑ by 1.5% by 1.9% by 0.9%
Serra et al. (2005a) [PFC]	Expected utility maximization under DARA	Econometric estimation using full information maximum-likelihood and farm-level data	Output [e] Elimination of DP ⇒ Input: Chemical input Fertilizer	0.006 6% farms exit 0.0064 0.0064
Serra et al. (2006) [PFC]	Expected utility maximization under DARA	Econometric estimation using nonlinear 3-stage least squares, 3-stage generalized least squares, and farm-level data	Input: Pesticides Fertilizer Other variable inputs (seed, fuel, oil, etc.)	 *3.46E-6* *3.90E-6* *5.79E-6*
Goodwin & Mishra (2006) [PFC]	Expected utility maximization	Econometric estimation using the 2-step estimation procedure and farm-level data	Acreage: [f] Corn Soybeans Wheat	 *0.0344* *0.0246* *0.0333*

(continued . . .)

Table A1. Continued

Papers	Methodology: Modeling Approach	Methodology: Empirical/Numerical	Elasticity Otherwise Noted		
Sckokai & Moro (2006) [area payments]	Dual expected utility model under CRRA	Econometric estimation using the 2-step estimation procedure[g] and farm-level data	Output:	Corn	0.014
				Durum wheat	0.072
				Other cereals	0.087
				Oilseeds	0.015
			Acreage:	Corn	0.014
				Durum wheat	0.056
				Other cereals	0.088
				Oilseeds	0.005

[a] The specific decoupled payment is identified below in brackets.
[b] Italicized elasticities reflect statistical insignificance.
[c] Acreage is aggregate U.S. acreage of seven crops receiving PFC payments: corn, grain sorghum, oats, barley, wheat, upland cotton, and rice.
[d] The incentive price is defined as the truncated expected price (truncation of the price distribution at the loan rate) less the price risk premium. The CCP payments reduce the risk premium which increases the incentive price of commodities.
[e] Output is a quantity index that includes wheat, corn, grain sorghum, and soybeans. This definition of output also applies to Serra et al. (2006).
[f] The acreage elasticities here include the effect of the PFC payments on the level of risk aversion and on the financial leverage of the farm. In the paper, the coefficients on the PFC-insurance and PFC-(debt-to-asset ratio) interaction terms are found to be statistically insignificant.
[g] Following Shonkwiler and Yen (1999).

Table A2. Imperfect Capital Market/Credit Constraint Effects of Decoupled Payments

Papers[a]	Methodology: Modeling Approach	Methodology: Empirical/Numerical	Elasticity Otherwise Noted[b]		
Roe, Somwaru & Diao (2003) [PFC]	Intertemporal 3-sector CGE model	Model is calibrated to 1997 U.S. data	↑ in DP by \$6.11 billion[c] ⇒ Ag'l production in the U.S. ↑ by a maximum of 0.18%; Rental rate on ag'l capital ↓ by 0.1%; Land price, labor hours & capital-labor ratio in ag ↑		
Goodwin & Mishra (2006) [PFC]	Expected utility maximization	Econometric estimation using the 2-step estimation procedure and farm-level data	Acreage:[d]	Corn	*0.0344*
				Soybeans	*0.0246*
				Wheat	*0.0333*

[a] The specific decoupled payment is identified below in brackets.
[b] Italicized elasticities reflect statistical insignificance.
[c] The paper assumes that \$6.11 billion is paid to farmers as PFC payments in 1997, and that these payments are made in each period of time from 1997 in perpetuity. These effects occur in the short run and are compared to the baseline model (without PFC payments).
[d] See footnote f to table A1 above.

Table A3. Labor Market Effects of Decoupled Payments

	Methodology			
Papers [a]	Modeling Approach	Empirical/Numerical	Elasticity Otherwise Noted [b]	
Ahearn, El Osta & Dewbre (2006) [PFC]	Labor-leisure model	Econometric estimation using maximum likelihood for off-farm labor participation model and farm household data	Probability of off-farm participation ↓:	
			Operator	–0.016
			Spouse	–0.003
Dewbre & Mishra (2002) [PFC]	Farm household resource allocation model	Econometric estimation using ordinary least squares for leisure demand and on-farm labor supply models and farm household data	Leisure hours_Off-farm: [c]	
			Operator	0.0019
			Spouse	0.0011
			Leisure hours: [d]	
			Operator	0.0007
			Spouse	0.0009
			On-farm labor hours: [e]	
			Operator	*–0.0013*
			Spouse	*–0.0109*
El-Osta, Mishra & Ahearn (2004) [PFC]	Labor-leisure model	Econometric estimation using weighted least squares for on-farm and total labor supply models, weighted maximum likelihood for off-farm labor supply model, and farm household data	On-farm labor hours	0.0172
			Total labor hours	*0.0122*
			Off-farm labor hours	–0.05 [f]
Key & Roberts (2009) [direct payments]	Labor-leisure model with nonpecuniary benefits from farming	Comparative statics	↑ DP ⇒ ↑ on-farm labor supply and ↓ off-farm labor supply	

[a] The specific decoupled payment is identified below in brackets.
[b] Italicized elasticities reflect statistical insignificance.
[c] The elasticity was calculated for farmers who had some off-farm work.
[d] The elasticity was calculated for farmers who had no off-farm work.
[e] The on-farm work hours model was estimated for farmers who had some off-farm work.
[f] The elasticity has been taken from Abler and Blandford (2005).

Table A4. Land Market Effects of Decoupled Payments

Papers [a]	Methodology: Modeling Approach	Methodology: Empirical/Numerical	Elasticity Otherwise Noted	
Gohin, Guyomard & Le Mouël (2000) [direct payments based on land]	Two-sector partial equilibrium model	N/A	↑ DP ⇒ ↑ in land allocation ⇒ ↑ in output supply	
Dewbre, Antón & Thompson (2001) [area payments] [b]	PEM crop model [c]	Policy simulation experiments based on 1998 data	Production impact ratio: [d]	
			EU	0.06
			U.S.	0.09
			Mexico	0.15
			Trade impact ratio:	
			EU	0.04
			U.S.	0.07
			Mexico	0.14
Goodwin, Mishra & Ortalo-Magné (2003a) [e] [PFC]	Net present value model which includes individual government payments and farm location	Econometric estimation using probability-weighted bootstrapping procedure and farm-level data	Land values: ↑ $1 in DP per acre ⇒	↑ by $4.06 per acre
Goodwin, Mishra & Ortalo-Magné (2003b) [e] [PFC]	" " " "	" " " "	" " " "	↑ by $4.94 per acre
Roberts, Kirwan & Hopkins (2003) [PFC, LDP, and other payments]	Model of land rents equal to expected returns less payments to factors other than land and including government payments	Econometric estimation using ordinary least squares and farm-level data	Land rents: ↑ $1 in G [f] per acre ⇒	↑ by $0.33 to $1.55 per acre
Roe, Somwaru & Diao (2003) [PFC]	Intertemporal 3-sector CGE model	Model is calibrated to 1997 U.S. data	↑ in DP by $6.11 billion [g] ⇒ land values ↑ by 8.3% in the long run and by 9% in the short run	
Frandsen, Gersfelt & Jensen (2003) [single uniform payment based on land]	Multi-regional, static CGE model under certainty	Calibrated to Global Trade Analysis Project database with adjustments made to capture the features of the Agenda 2000 reforms	Land price ↑ by 75%	
Goodwin & Mishra (2006) [PFC]	Expected utility maximization	Econometric estimation using the 2-step estimation procedure and farm-level data	Land idling [h]	–0.330

(continued . . .)

Table A4. Continued

Papers	Methodology: Modeling Approach	Methodology: Empirical/Numerical	Elasticity Otherwise Noted
Gohin (2006) [Agenda 2000 arable crop direct payment]	Multi-sector static CGE model	Calibrated to 1995 Eurostat data and FEOGA/WTO notifications	Land rent: ↓ DP by 90% ⇒ ↓ by ≅ 80%

[a] The specific decoupled payment is identified below in brackets.
[b] The area payment requires that land be in arable use. The paper also considers area payments which require mandatory production. The results here provide a lower bound.
[c] The PEM model stands for Policy Evaluation Matrix model, and was developed by the OECD.
[d] The production and trade impact ratios measure the effect on production and trade of a given change in support provided by area payments relative to the estimated impact on production and trade of the same monetary change in market price support.
[e] The Goodwin, Mishra & Ortalo-Magné (2003a) study uses data for the years 1998–2000, while their 2003b study uses data for the years 1998–2001. The explanatory variables used in the two studies also differ.
[f] G includes, among others, PFC and LDP payments.
[g] The paper assumes that $6.11 billion is paid to farmers as PFC payments in 1997, and that these payments are made in each period of time from 1997 in perpetuity.
[h] Land idling refers to the number of acres not harvested; an alternative measure used was the number of acres not cropped. The elasticity for this measure was –0.16.

Table A5. Expectation Effects of Decoupled Payments

Papers [a]	Methodology: Modeling Approach	Methodology: Empirical/Numerical	Effects and Magnitude When Available
Sumner (2003) [direct payments]	Present value calculation	Parameterization of subjective probabilities	Degree of linkage between future DP and current production = 0.27 [b]
Lagerkvist (2005) [area payments]	Investment decision model under timing and support uncertainty	Numerical analysis of the model using a survey of Swedish farmers	Expected ↓ in DP ⇒ farmers become more inclined to overinvest
McIntosh, Shogren & Dohlman (2007) [CCP]	Random-effects model under price and policy uncertainty and DARA preferences	Estimation using data obtained from an experiment	Shift in base acres toward program crop of 7.92% [c]
Coble, Miller & Hudson (2008) [direct payments and CCP]	Censored probit model	Estimation using survey data from Iowa and Mississippi farmers	Willingness to accept a one-time payment in lieu of an opportunity to update = $48.16/acre
Bhaskar & Beghin (2008) [direct payments and CCP]	Acreage and nitrogen application choice under price, yield, and policy uncertainty	Numerical analysis using discrete state and choice sets	Maximum increase in acreage of 6.25% Maximum increase in yield of 0.134%

[a] The specific decoupled payment is identified below in brackets.
[b] The value of the degree of linkage is sensitive to the assumptions made while constructing it. (See "Coupling from Farmer Expectations on Future Policy Changes" section in text for details.
[c] Each participant is endowed with "tokens," representing base acres. The participant has to invest the tokens in either a "Blue" option or a "Red" option, or a combination of the two. Blue tokens represent a program crop, while a red token represents a nonprogram crop or a program crop which the farmer has not planted earlier.

Table A6. Other Effects of Decoupled Payments

Papers [a]	Methodology: Modeling Approach/Mechanism [b]	Methodology: Empirical/Numerical	Elasticity Otherwise Noted [c]	
Adams et al. (2001) [PFC and MLA]	(see footnote b)	Econometric estimation using mixed estimation methods and state-level data	Acreage [d]	*0.026*
Guyomad, Le Mouël & Gohin (2004) [lump-sum payments]	One-sector static model under certainty (DPm influences the entry-exit decision of farmers by requiring production for eligibility; DP is fully decoupled) [e]	N/A	↑ in DP ⇒ ↑ in total profit ↑ in DPm ⇒ ↑ in number of farmers	
Serra et al. (2005b) [area payments]	Dual model of technology (the optimal use of pesticides depends on land allocation which is affected by area payments)	Econometric estimation using Zellner's seemingly unrelated regression (SUR) and farm-level data	Pesticide use in: Cereals Oilseeds & protein crops	 0.3549 0.3919
Chau & de Gorter (2005) [PFC]	One-sector static model under certainty (DP influences entry-exit decision by enabling farmers to cover fixed costs)	Model calibrated to 1998 U.S. wheat sector	Output Exports	0.034 0.106
Beckman & Wailes (2005) [CCP]	Nerlove model of supply response (see footnote b)	Econometric estimation using ordinary least squares and state-level data	Acreage: [f] Rice	0.197 [g]
Goodwin & Mishra (2006) [h] [PFC]	Expected utility maximization (see footnote b)	Econometric estimation using the 2-step estimation procedure and farm-level data	Acreage: Corn Soybeans Wheat	0.0317 0.0204 *0.0428*

[a] The specific decoupled payment is identified below in brackets.

[b] The mechanism by which the particular DP affects the different variables is identified. In the cases of Adams et al. (2001), Beckman and Wailes (2005), and Goodwin and Mishra (2006), the exact mechanism is not identified; only the effects of DP are measured.

[c] Italicized elasticities reflect statistical insignificance.

[d] Acreage is the aggregate acreage of 7 crops across 11 states.

[e] DP is decoupled payment without mandatory production, and DPm is decoupled payment with mandatory production.

[f] Acreage harvested in Arkansas, California, Louisiana, Mississippi, Texas, and Missouri for long- and medium-grain rice.

[g] Short-run elasticity.

[h] The elasticity derived here does not include the effect of PFC payments on the risk-averse nature of farmers or on credit constraints faced by farmers. In the paper, these effects are defined to be the "direct" effects of the PFC payments.