Chapter 4

Decoupled Payments and Farmers' Production Decisions Under Risk

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When decoupled payments were enacted in 1996, some identified ways that decoupled payments might indirectly influence production decisions (Hennessy, 1998; Tielu and Roberts, 1998; and Antón, 2000). Such indirect links include easing farmers' credit constraints, raising farmers' wealth and thus their tolerance for risk, instilling expectations of future payments, and affecting farmers' labor-leisure decisions. In this chapter, we are concerned primarily with farmers' wealth, risk attitudes, and production decisions. Decoupled payments increase producers' wealth, and this enhanced wealth, in turn, could increase their tolerance to risk. This willingness to assume more risk could lead to shifts toward more acreage for riskier crops or changes in use of risk-reducing (or increasing) inputs, leading to changes in total plantings. If such decisions at the farm level are significant, aggregate U.S. production could change, which could affect world markets.

Decoupled Payments and U. S. Farmer Income and Wealth

The size of decoupled payments since 1996 raises the question of whether they might still induce additional production indirectly. Specifically, do farmers' income and wealth increase to the point where they become willing to assume more risk and alter their production decisions?[20]

Like other government payments, decoupled payments represent an immediate supplement to farm household income and can be used for current needs, including paying for farm expenses and meeting family living costs. Decoupled payments also affect farm household wealth – the value of assets less liabilities – when they are used for purposes such as reducing debt, investing in the farm, or nonfarm investments. For landowners, decoupled payments also influence wealth by increasing farmland values. The value of agricultural land should largely reflect its current and future earnings potential. Because PFCs become a part of returns to farmland, they become capitalized into its price, changing the wealth of land-owners. Using a dynamic model, Roe et al. (chapter 2) estimated that PFC payments increased aggregate land values by about 8 percent. Goodwin et al. (2003a, 2003b) found that decoupled payments have increased land values, ranging anywhere from 2 to 6 percent in the Northern Great Plains and Corn Belt regions. Barnard et al. (2001) found that the gap between aggregate land values with and without government payments was about 13 percent during 1990-97, increasing to about 25 percent during 1998-2001 when payments included MLA and marketing loan benefits in addition to PFC payments. Note that farmers who buy land after the payments have already been capitalized into

[20] The remaining discussion will focus on payments having characteristics similar to the PFC payments and not the Market Loss Assistance emergency payments made in 1998 to 2001. Also, we do not address the issue of updating and expectations related to the direct payments created under the 2002 FSRI Act.

the land price do not benefit, since the capitalized value of the payments was, in effect, paid to the previous owner.

However, not all PFC payments benefit farm operators since not all farmland is owned by operators. Tenant farmers may pass these payments through to landlords through higher farmland rental payments and as a result do not benefit from the entire direct payment or its capitalization into land values. An ERS report indicates that about 60 percent of the acreage enrolled in the PFC program was rented in 1996 (USDA, ERS, 2003). Roberts (chapter 6) reports a one-third pass-through rate from farmers to landowners on cash-rented land in 1997. These values suggest nonfarm landlords received at least 20 percent of the payments (60 percent of land times 33 percent pass-through rate). After adjusting for payment pass-through, Roberts estimates that the total (coupled plus decoupled) payments in 1999 represented an average of 3 percent of overall farm household wealth for households receiving payments. Decoupled payments in 1999 accounted for 24 percent of total direct payments to these farm households.

Risk and Risk Management in Farming

Does greater wealth make producers more willing to accept risk in their production decisions? Risk is a fundamental component of the farm business and farm household, and it influences production choices and farm management decisions. The many sources of risk in agriculture range from price and yield risk to income/financial risk to personal injury/health risk (Harwood et al., 1999). Farmers who have borrowed money are at risk of default if income falls short. Because prices, yield, and other outcomes are contingent on markets and weather, the consequences of production decisions are not known until long after those decisions are made.

Several surveys have asked farmers to rank the risks they confront. The 1996 ARMS data indicate that producers of field crops—such as wheat, corn, soybean, tobacco, and cotton—were concerned more about yield and price variability than about other categories of risk, while producers of vegetables, greenhouse crops, cattle, and poultry were most concerned about changes in government laws and regulations. Across all farms, ARMS data clearly indicate that producers are most concerned about changes in government laws and regulations (institutional risk), variability in crop yields or livestock output (production risk), and uncertainty in commodity prices (market risk) (Harwood et al., 1999). Concerns about risk also vary across types of producers and by farm type and size groupings (Musser and Patrick, 2002).

Farmers generally use a combination of risk management tools to mitigate risk. Risk management strategies include diversification, production contracting, maintaining liquid assets, and crop insurance. In crop production, farmers may reduce risk by using more drought-tolerant varieties, varying tillage practices, or irrigating if possible. To transfer the risk of falling crop prices, farmers may use forward contracting, futures, or options. Government payments also provide support during periods of low commodity prices and in the event of natural disasters.

The farming household has additional means for coping with risk. Off-farm employment is a significant source of income for many farm households, and this source is usually more stable than farm income. Most farmers have some life insurance, health insurance, and insurance on major property such as their home, automobiles, and farm equipment. Investments can be shifted between farming and nonfarming uses. Household consumption may be tightened if income drops.

Even so, all of these strategies do not completely mitigate the risk of low incomes. For example, farmers with crop insurance must still absorb the deductibles, and price-hedging strategies often maintain some basis risk.[21] Government emergency payments usually do not cover all yield shortfalls. Even off-farm employment may be uncertain. So farming decisions will always be made in the face of at least some risk. Consequently, understanding farmers' attitudes toward risk is critical to ascertain how they may make use of decoupled payments.

[21] Basis risk is the risk that the producer's local cash price does not track perfectly with the price of the hedging instrument, such as a futures contract.

Farmers' Attitudes Toward Risk

Farmers allocate their assets and engage in production activities to maximize the utility of their income or wealth, rather than to simply maximize expected profits (see box, "Measures of Risk Aversion"). This implies that farmers use decision rules that account for not only expected profits but also the risks associated with their production and management decisions. When a decisionmaker prefers a particular amount of income generated with certainty from an economic activity or adoption of technology over an alternative that, on average, provides the same expected return but also has uncertainty in its outcome, the individual is said to be *risk averse*. A risk-averse person still prefers more income to less, but would be willing to give up some income in exchange for a more stable stream, while a *risk-neutral* person is interested only in expected or average profits and would not be dissuaded by any uncertainties in prices or output. The trade-off may depend on the level of wealth.

An individual's preference now and into the future for a certain outcome over an uncertain one with equal expected value can be measured by the risk aversion coefficient. Empirical studies have generally found evidence of risk aversion for most U.S. farmers, but with a wide range of risk attitudes (table 4-1). These studies date back 30 years and have examined the risk attitudes of many groups of farmers by using a variety of approaches to measure these attitudes.[22]

[22] Young (1979) categorizes these methods as direct elicitation of utility functions (DEU), experimental methods (EM), and observed economic behavior (OEB). The DEU process consists of interviewing farmers to determine their preferences among risky alternatives for hypothetical gains and losses. The EM process consists of presenting farmers with real risky prospects (that is, significant monetary payoffs instead of simply hypothetical choices) and observing their decisions. The OEB method consists of estimating risk attitude parameters reflected in observed farming decisions, such as input levels and crop acreage mix.

Some studies have examined whether the agricultural sector as a whole exhibits risk-averse behavior. In studies of the U.S. corn and soybean sectors, Chavas and Holt (1990 and 1996) found evidence of risk aversion as well as decreasing aversion to risk as wealth increases. Lence (2000) found mild risk aversion for the U.S. agricultural sector but also found that relative risk aversion among U.S. farmers appeared to decrease over time since the mid-1930s.

Just and Pope (2002) summarized research on risk preferences as generally supporting the "stylized fact" that utility (see box, "Measures of Risk Aversion") is increasing at a decreasing rate with wealth and profit; that is,

Table 4-1--Risk attitudes of U.S. farmers: Results of empirical studies

Source	Description of producers	Measurement method[1]	Sample size	Risk attitudes	Effect of wealth
Bard and Barry	Illinois farmers	DEU-interval method	81 farmers	>50 percent averse	Not evaluated
Brink and McCarl	Midwest grain farmers	OEB-compared profit max. vs. utility max. in QP model	38 farmers	66 percent averse, 34 percent neutral, 0 percent loving	Not evaluated
Chavas and Holt, 1990	U.S. corn and soybean sectors	OEB-model based on acreage allocations	Aggregate-used national data	Averse	Decreases aversion
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Collins, Musser, and Mason	Oregon grass seed growers	DEU-estimated utility functions	37 farmers	16-32 percent averse 38-52 percent neutral, 30-32 percent loving	Not evaluated
Halter and Mason	Oregon grass seed growers	DEU-estimated utility functions	44 farmers	About equal across averse, neutral, loving	Not evaluated
Hildreth and Knowles	Minnesota cattle producers	DEU-estimated various utility functions	13 farmers	85 percent to 8 percent averse, varies by functional form;	Generally decreases aversion
King and Oamek	Eastern Colorado wheat farmers	DEU - interval approach	10 farmers	30 percent averse, 70 percent mixed	No clear relationship
Lence	U.S. agricultural sector	OEB-model based on asset allocations	Aggregate-used national data	Averse	Not evaluated
Lin, Dean, and Moore	California crop farmers	OEB-compared utility max and profit max	6 farmers	50 percent averse, 33 percent neutral, 17 percent mixed	Not evaluated
Love and Buccola	Iowa corn and soybean farmers	OEB-estimated using FOC for input choices in utility max model	264 farmers in 3 counties-data aggregated by county	Averse for all 3 counties	No change (imposed by functional form)
Ramaratnam, Rister, Bessler, and Novak	Texas grain sorghum farmers	DEU-estimated various utility functions	26 farmers	100 percent to 73 percent averse, varies by functional form;	Varies by functional form
Saha, Shumway, and Talpaz	Kansas wheat farmers in utility max model	OEB-estimated using FOC for input choices	15 farmers (observations aggregated)	Averse	Decreases aversion
Schurle and Tierney	Kansas crop and livestock farmers	DEU-interval method	90 farmers	80 percent averse, 2 percent neutral, 18 percent loving	Not evaluated
Tauer	New York dairy farmers	DEU - interval method	72 farmers	34 percent averse, 39 percent neutral, 26 percent loving	Group test: decreases aversion
Thomas	Kansas crop and livestock farmers	DEU - interval method	30 farmers	20 percent averse, 13 percent loving, 67 percent mixed	Generally decreases aversion
Wilson and Eidman	Minnesota swine producers	DEU - interval method	45 farmers	42 percent averse, 36 percent neutral, 22 percent loving	33 percent decreases, 21 percent constant, 18 percent increases, 28 percent mixed

[1]DEU = direct elicitation of utility, OEB = observed economic behavior, FOC = first order conditions, and QP = quadratic programming.

Measures of Risk Aversion

Economists have theorized that individuals use decision rules that account for not only expected profits but also the risks associated with their management decisions. That is, individuals allocate their assets and engage in production activities that maximize the "utility" of their income or wealth, rather than simply maximize expected profits. "Utility" in this sense accounts not only for the mean or average level of income or wealth but also for its variability or riskiness.

A decisionmaker is said to be "risk averse" when he or she prefers a particular amount of income received with certainty over an alternative that, on average, provides the same expected return but also has uncertainty in its outcomes. Put another way, a risk-averse person still prefers more income to less, but prefers less variability over greater variability. A more risk-averse person is willing to accept a smaller income with certainty, relative to the expected value of the risky prospect. A person who cares only about expected profit and is indifferent to its variability is said to be "risk neutral," while a person who prefers more variability for a given level of expected profits is said to be "risk loving."

Risk aversion is indicated by a utility function that shows decreasing marginal utility as the level of income or wealth (w) is increased. Indifference to risk is represented by a linear utility function. More formally, risk attitude is defined by the second derivative of the utility function: $U''(w) < 0$ implies risk aversion, $U''(w) = 0$ implies risk indifference or neutrality, and $U''(w) > 0$ implies risk preference.

An individual's preference for a certain outcome over an uncertain outcome with equal expected value is measured by the risk aversion coefficient, and this measure is suitable for comparisons across individuals or comparisons across income or wealth levels for a single decisionmaker.

The degree of risk aversion is measured by coefficient of absolute risk aversion, coefficient of relative risk aversion, and coefficient of partial (relative) risk aversion. The "coefficient of absolute risk aversion" is defined as: $\rho^a = - U''(w)/U''(w)$; while the "coefficient of relative risk aversion" is defined as: $\rho^r = - w\, U''(w)/U''(w)$. A third measure of risk aversion is the "coefficient of partial (relative) risk aversion," defined as: $\rho^p = -x\, U''(x)/U''(x)$, where x is gain or loss or operating income. Partial risk aversion is the same as relative risk aversion, except that it is defined in terms of loss or gain, rather than wealth (Robison and Barry, 1987; Newberry and Stiglitz, 1981).

Constant Absolute Risk Aversion (CARA) implies that the preferred option in a risky choice situation is unaffected by the addition or subtraction of a constant amount to all payoffs. In other words, a person whose aversion to a particular level of risk is not affected by their level of wealth is said to display CARA. A negative exponential utility function such as $U = 1\text{-}\exp(-cW)$ exhibits CARA property. $\rho a = c$ for this utility function. CARA is not a desirable property because it fails to represent rational decisionmaking. Most empirical studies in agricultural economics reject the assumption of CARA (Pope and Just, 1991; Chavas and Holt, 1996).

Decreasing Absolute Risk Aversion (DARA) implies that an individual becomes more willing to accept a particular risk as his or her wealth increases. A log utility function such as $U = \ln(w)$ exhibits DARA property. $\rho^a = 1/w$, implying that an individual becomes less risk averse as his or her wealth increases. Chavas and Holt, 1996 and Saha et al. 1994, found agricultural decision maker preferences to be consistent with DARA.

Economists have theorized that most people probably become less averse to a particular level of risk as their wealth increases and, in this case, are said to display DARA. In a sense, a person with a million dollars would be less averse to a gamble with some probability of losing $100 than if this person had only $2,000 to start with.

Increasing Absolute Risk Aversion (IARA) implies that an individual is less willing to accept a particular level of risk as his or her wealth increases. A quadratic utility function such as: $U = w - bw^2$ exhibits IARA property. $\rho^a = 2b/(1-2bw)^2$ suggests that an individual becomes more risk averse as his or her wealth increases. Since IARA implies rarely observed response to risk, quadratic utility function is not generally assumed in the literature.

Constant Relative Risk Aversion (CRRA) implies that the preferred option among a set of risky alternatives would not be changed if all payoffs were multiplied by a constant amount. That is, an individual will have constant aversion to a proportional loss of wealth even though the absolute loss increases. A special form of the power utility function such as $U = \{1/(1-r)\}W^{(1-r)}$ exhibits CRRA property. $\rho^r = r$ for this utility function. CRRA is implicit in many risk analyses in which calculations are on a per-acre basis. CRRA is inappropriate for risk analysis in agriculture because farmers with different farm sizes are known to react differently to risky alternatives.

In sum, with CRRA, a person feels the same about losing 10 percent of $100 and losing 10 percent of $1,000. With increasing RRA (IRRA), a person is more averse to losing 10 percent of $1,000 than to losing 10 percent of $100, while with decreasing RRA (DRRA) a person is more averse to losing 10 percent of $100 than to losing 10 percent of $1,000.

producers are generally risk averse. But they also found decreasing absolute risk aversion to be common among producers, implying that as producers become wealthier over time they have more tolerance for risk. Although farmers who receive PFC payments likely display varying attitudes toward risk, it is certainly plausible that some such farmers are willing to assume more risk.

Decoupled Payments and Production Decisions

Decoupled payments may influence farmers' production decisions if changes in wealth alter their attitude toward risk. A farmer's level of risk aversion may affect production decisions and management choices in several ways. The most obvious is the mix of farm outputs. Like an investor trying to balance risk and returns in a securities portfolio, a producer may adjust the acreage mix of crops to reflect some tradeoff between risk and returns. Compared with a more risk-averse farmer, a less risk-averse farmer would plant more land to a riskier crop or plant on marginal land if it enabled greater returns (Hardaker et al.).

Aversion to risk may also affect total output and input use. A more risk-averse producer, who dislikes income variability, may prefer slightly lower output and expected returns if variability of returns also declines (Sandmo, 1971). So if decoupled payments raise farmers' wealth and their tolerance for risk, they may take on more risk in their production choices in pursuit of higher returns. Risk aversion could also affect input decisions to the extent that the level of input use affects output variability. Other things equal, a risk-averse producer would prefer to use less of an input (such as fertilizers for corn production) that increases output variability, compared to input use for expected profit maximization (MacMinn and Holtman, 1983).

As mentioned, some have argued that decoupled payments encourage producers to increase their production and alter cropping patterns, with unintended aggregate effects. Many theoretical studies have described these possible links. For example, Tielu and Roberts (1998) examined how decoupled payments may boost production by increasing farm investment (increasing wealth and lowering risk), reducing farm exits (by raising land values), and increasing output in the long run (by creating expectations of future payments). They argued that the wealth and risk effects of decoupled payments on production are likely minimal.

Only a few empirical studies have examined the actual magnitude of such effects on crop production; these are simulations of the payments that suggest that decoupled payments have little effect on U.S. acreage allocation and production. Young and Westcott (2000) applied the acreage elasticities with respect to wealth from Chavas and Holt (1990) to U.S. crops receiving PFC payments. Because PFC payments are small (3 percent of total farm wealth) and because the impact of wealth on acreage is also small, Young and Westcott conclude that acreage shifts from PFC payments would be minimal.[23] Assuming that farmers receive the full value of PFC payments, the estimated acreage shift for the seven crops covered by PFC payments would range from 180,000 to 570,000 acres annually, on a base of about

[23] This elasticity shows the percentage change in crop acreage in response to a 1-percent change in farm wealth.

180 million acres. Accounting for the pass-through of PFC payments to nonfarming landlords would reduce this effect even further.

Burfisher et al. (2000) used a computable general equilibrium model of the United States, Canada, and Mexico to show the effects of decoupled payments on agricultural production, prices, and trade. They incorporated risk premiums reflecting the variability of net returns for four major crops into their model. Here, risk premiums work like a tax or added cost, resulting in lower overall production. By reducing risk premiums, decoupled payments lead to higher production. Their model suggests that a 50-percent increase in decoupled payments would boost U.S. crop production slightly, ranging from 0.5 percent for wheat to 1.1 percent for oilseeds. Burfisher et al. used a relative risk aversion coefficient of 2.0 for the U.S.; using Lence's (2000) value of 1.13 would reduce the risk premiums by roughly half, resulting in an even smaller acreage shift.

Conclusions

The effects of decoupled payments have become prominent as governments consider how to fulfill their WTO obligations to limit payments that influence production, prices, and trade. The notion that decoupled payments might influence production through "risk effects" presumes that such payments increase farmers' income and wealth such that they become less risk averse. This change in attitude could then be manifested through changes in input use, a new output mix, and changes in overall production.

The effects of payments on risk attitudes and production are likely small for several reasons. While many farmers are likely to alter their response to risk as they become wealthier, decoupled payments are small compared with participating farmers' net wealth—after adjusting for pass-through to nonfarming landowners. More important, while empirical studies of farmers' risk attitudes indicate some evidence of risk aversion, producers do not respond to risk solely through adjustments to production or inputs. Surveys find that producers already use various tools—such as insurance, hedging, and management strategies—to mitigate risks. And, farm households can respond to changes in their risk attitudes with adjustments throughout their portfolio, such as off-farm employment and investing in nonfarm real estate or financial assets.