The Crowding Out Effects of the 2002 Farm Bill on Hedging: Evidence from Pacific Northwest Grain Farms

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Introduction

The 2002 Food Security and Rural Investment (FSRI) Act introduced a price protection program called Counter Cyclical Payments (CCP) to major grain producers in the US. The CCP program is an addition to the Loan Deficiency Payment (LDP) and Direct Payment (DP) programs from the previous 1996 Federal Agriculture Improvement and Reform (FAIR) Act. At the same time, US federally subsidized crop revenue insurance programs also protect farmers from market and production risks. These government policy programs may crowd out the traditional price risk management role of hedging in commodity futures markets.

Although the participation rate in futures markets has generally been considered low for US crop growers, the 1996 US Department of Agriculture (USAD)'s Agricultural Resource Management Study survey suggested use may be increasing. The survey also indicates hedging with futures for risk management being used on 40 to 50 percent of the larger farms (Harwood, et al, 1999). Therefore, it should be interesting to investigate what the optimal hedging level should be under current crop insurance programs after implementation of the new provisions of the 2002 FSRI Act.

Agricultural commodity futures markets have served as price risk management tools in the US grain sector for over 100 years. A vast amount of literature can be found on hedging demand and its risk management value (Holthausen, 1979; Lapan, et al, 1991). Literature also exists showing that hedging demand and its risk protection value may be strengthened in the presence of crop yield insurance (Dhuyvetter and Kastens, 1999; Coble, et al, 2000), but weakened in the presence of crop revenue insurance (Mahul, 2003; Wang, et al, 2003).

However, studies focused specifically on government programs and risk management are limited (Krause and Brorsen, 1995; Knutson, et al, 1998; Goodwin, 2001). From the studies that include government programs in risk analysis (Turvey and Baker, 1990; Hennessy, 1998; Hanson, et al, 1999; Ke and Wang 2002), none specifically investigate impacts of the new FSRI Act policies.

Additionally, most existing studies on futures hedging and crop insurance are based on a single crop, with a few that include two crops (Hennessy, et al, 1997; Ke and Wang, 2002). Lence (1996) included another investment opportunity in the portfolio which could capture a diversification effect, but such an effect was not explicitly examined. As a common practice, farmers often grow multiple crops in rotation for agronomic reasons. The inclusion of multiple crops may affect hedging demand due to a diversification effect. Additionally, cross hedging may occur since some crops do not have a futures market or access to a revenue insurance program.

The goal of this research is to use a farmer's expected utility maximization model to investigate the impact of the new 2002 FSRI Act on hedging demand in the presence of alternative crop insurance programs. Crop acreage is assumed to be exogenous because the new FSRI Act is similar to the 1996 FAIR Act in that both DP and CCP payments are decoupled from production. Specific objectives include: (1) to evaluate the risk management role of the new FSRI Act commodity payment programs in the presence of alternative insurance programs, (2) to examine the impact of these programs on hedging demand, and (3) to include multiple crops in the analysis and explore their impact on hedging demand.

The remainder of the paper is divided into four sections. The theoretical framework and model are explained in the next section. A description of the data and model calibration occur following the theoretical framework section. Empirical results are then presented and discussed. The final section presents the summary and conclusions.

Model

This analysis assumes a representative farmer selects a portfolio of risk management instruments at planting time each year, when yields and market prices are uncertain. The portfolio includes hedging with futures, insurance, and government programs.[1] At planting time, the farmer places a hedge by selling the futures contract that will mature at harvest time when the crop is sold on the cash market. The farmer also selects a coverage level for one of the available insurance products at planting time. Both the selected insurance products and the hedged positions are then settled at harvest.[2] The available insurance products include: (1) a yield insurance based on Actual Production History (APH), (2) a revenue insurance with a fixed price index based on Income Protection (IP), and (3) another revenue insurance having a price index with a replacement feature, based on Crop Revenue Coverage (CRC).[3] A decision by the farmer to participate in the government programs is assumed.

The decision maker's objective is to maximize his/her expected utility of wealth at harvest based on the information available at planting time.

$$\underset{x}{Max}\ E[U(w)]\text{, and } w = w_0 + \pi, \tag{1}$$

where x is a vector of choice variables including hedging and insurance coverage levels; $E(\ )$ is an expectation operator; $U(\ )$ is a von Neumann-Morgenstern utility function representing the risk attitude of the decision maker; w is the stochastic terminal wealth; w_0 is an initial wealth level; and π is the profit function from all farmland in the rotation. Profit is specified as revenue generated from cash sales, hedging, crop insurance indemnities, and government program payments less production costs, hedging transaction costs, and insurance premiums. That is:

$$\pi = NP + FI + (YI \text{ or } RI) + GP, \tag{2}$$

where:

$$NP = P_L Y - CY,$$

or revenue from selling crops in the cash market less production costs. P_L is the local cash price at harvest, Y is the corresponding realized production level, and CY is the cost of producing Y;

$$FI = x_1 E(Y)(F_0 - F - TC),$$

or net return from hedging. The choice variable x_1 is the hedging quantity chosen at planting time expressed as a ratio (positive for a short hedge) of expected production E(Y), F is the stochastic futures price at harvest, F_0 is the planting time futures price, and TC is the transaction cost of hedging, expressed as the rate per bushel hedge;

$$YI = P_b \max\,[0, x_2 E(Y) - Y] - PRE_y,$$

or net indemnity from yield insurance, a stylized APH program. P_b is the base price for insurance purposes, and x_2 is the insurance coverage level chosen at planting time. The yield insurance premium is PRE_y which is set at a specified level;

$$RI = \max\,[0, x_3 P_r E(Y) - P_P Y] - PRE_r,$$

or net indemnity from revenue insurance. x_3 represents the chosen coverage level. P_r is the price used to calculate revenue loss, which can be set at a specified level for IP, or as the higher of the local cash market price at harvest or the predetermined level for CRC. The latter can be expressed as $P_r = \max[P_P, P_b]$. P_P is a terminal cash market price which differs from the local cash price P_L by a constant transportation cost. The revenue insurance premium is PRE_r; and

$$GP = DP + LDP + CCP,$$

or total government payments. Direct Payments (*DP)* is a constant payment to farmers and is equal to 85 percent of a legislated direct payment rate (P_D) times the base yield of 0.9*E(Y)*. The loan deficiency payment (*LDP)* is equal to $Y max[0, LR-P_L]$, where *LR* is the local loan rate, a set price. The Counter Cyclical Payment (CCP) is set at 85 percent of $0.935E(Y) \max[0; P_T - P_D - \max(P_{SA}, LR_N)]$, where P_T is a set target price, P_{SA} is the US season average price, and LR_N is the national loan rate. These parameters are set according to current US farm policy.[4]

The farmer is assumed to have constant relative risk aversion, with the utility function as:

$$U(w) = (1-\theta)^{-1} w^{(1-\theta)} \quad (3)$$

where θ is the Arrow-Pratt relative risk aversion coefficient. This risk preference approach represents decreasing absolute risk aversion, is justified in Wang, et al (1998), and has been adopted in analyses with a similar focus (Coble, et al, 2000; Mahul, 2003).

Because government programs have complicated functional forms, a numerical approach is applied based on simulated price and yield distributions. Per acre based production is used so that all production parameters are yield based.

Empirical Analysis and Data

The Pacific Northwest (PNW) region of the US, represented by the states of Washington, Oregon, and Idaho, provides a unique environment to assess risk management strategies for non-irrigated crop producers. This region accounts for 15 percent of US wheat production, and dominates the US production of soft white wheat, a variety that targets Asian markets. Within the PNW, the Palouse region covers eastern Washington and northern Idaho and has the highest non-irrigated winter wheat yields in the US. The region's 18 or more inches (460 mm) of annual precipitation allows farmers to use a continuous three-crop rotation. Winter wheat is the primary cash crop, with barley and dry peas in rotation to accomplish economic and agronomic goals.

Several portfolios of risk management instruments are analyzed in this research. Based on currently available instruments for this region, the portfolios include several combinations of: 1) wheat futures markets; 2) APH for all crops; 3) IP for wheat and barley; 4) CRC for wheat; and 5) all applicable government programs including DP and CCP for wheat and barley, and the LDP for wheat, barley, and peas. Specific portfolios are summarized in Table 1. To assess the risk environment, joint distributions of prices and yields relevant to farms in the Palouse region are simulated for the 2002 crop year.

Farm-level yields are obtained from the USDA's Risk Management Agency.[5] This data set keeps a maximum of ten years of yield observations (2001 is the most recent year), although the ten observed yields may not cover the most recent ten years due to rotation. These actual on-farm yield data include 543 observations for wheat, 311 observations for barley, and 258 observations for peas.

Because a short period of historical data may not be able to capture disasters that occur infrequently, a longer period (64 years) of county-level yield data is used to determine the trend and distributional form. No structural change is detected over this period, and a linear trend (with an autoregressive term in the case of wheat) is estimated for each crop. Farm-level yields are assumed to follow the same trend and distributional form as county yields except the variance level, which is estimated from the de-trended farm-level yield data.

Distributional form of crop yield data continues to be a debated issue (Just and Weninger, 1999; Ker and Coble, 2003; Ramirez, et al, 2003). Although non-normal distributional forms have been used in many yield studies (Mahul, 2003; Moss and Shonkwiler, 1993; Nelson and

Preckel, 1989), normal distributions have some distinct advantages. The normal possesses a well-defined multivariate joint distribution, and provides the convenience of constructing a joint distribution from independently simulated marginal distributions by a linear transformation. Several normality tests (Shapiro-Wilk; Kolmogorov-Smirnov; Cramer-von Mises; Anderson-Darlin) conducted on county yield residuals after adjusting for trend indicate normality cannot be rejected for wheat. Barley and pea yields also passed the normality tests after removal of one severe drought year (1977). The final estimated models used for simulating yields are normal for wheat, and a mixture distribution of two normal components for barley and peas. The second normal component has a very low mean and standard deviation to represent a single disaster year with a probability of one in 64. The probability density function of this mixture distribution looks like a bell-shaped normal curve with a small hump on its left tail.

Local cash prices are the Portland Grain Exchange (PGE) price less $0.50 per bushel (/bu) for wheat, and less $0.43/bu for barley. The pea cash price is the local cash price. Since the PNW region produces soft white wheat (which has no actively traded futures contact), the Chicago Board of Trade (CBT) futures market is used for hedging. These data are provided by the USDA's Agricultural Marketing Service and the Chicago Board of Trade.

Generalized Autoregressive Conditional Heteroskedastic (GARCH) models have been commonly used for the logarithm of commodity cash and futures prices. For this analysis, wheat cash and futures log prices are estimated with a bivariate GARCH model. Barley and dry pea log prices are estimated separately using a univariate GARCH model. Price models are estimated from weekly price data covering the four years prior to the expected planting date for the 2002 crop (September 1998 to August 2001 for wheat futures and cash prices, and April 1998 to March 2002 for barley and pea cash prices). Then, 2002 harvest price distributions are simulated based on the initial planting time prices. Wheat planting time prices for the first week of September 2001 are \$3.69/bu and \$2.96/bu for cash and futures, respectively. The barley and pea planting time prices for the first week of April 2002 are \$2.22/bu and \$7.39 per hundredweight (/cwt), respectively. The mean of the simulated futures price is then adjusted to equal its planting level of \$2.96/bu in order to avoid any speculating effect from the decision model.

An empirical distribution with 2,000 realizations is simulated for each crop's price and yield. The independently simulated distributions (wheat cash and futures prices are simulated jointly) are converted into a joint distribution by imposing the estimated correlation structure. The correlation structure is estimated based on historical yields and harvest prices, and imposed by a simple linear transformation because all variables are normally distributed. Summary statistics for the simulated price and yield data are presented in Table 2, along with correlation values for the simulated joint distributions.

The value of the risk aversion coefficient is set at $\theta = 2$, which is based on previous research (Wang, et al, 2003; Coble, et al, 2000; Mahul, 2003). Sensitivity analysis on θ has been conducted, and the impact on hedging is small. Although not reported here, results of these sensitivity analyses are available from the authors. The initial per acre farm wealth is set at \$550 based on the average farm equity in Whitman County which covers the majority acreage in Palouse. Production cost is determined by total rotation budgeted cost of \$707 over three acres for the three crop rotation, \$465 over two acres for the two crop rotation, and \$230 per acre for winter wheat only (Painter, et al, 1995).

Transaction costs associated with hedging are set at \$0.017/bu, based on a \$50 commission per contract, a margin of \$745, and an interest rate of 5 percent. The prices used to indemnify crop loss in the insurance programs are the CBT September (Sep) wheat futures price plus a Portland basis of $0.45/bu for wheat ($3.41/bu); 85 percent of the Sep corn futures price during February for barley ($1.90/bu); and the expected local cash price for peas ($7.49/cwt). The insurance coverage levels are restricted to be either zero or from 0.50 to 0.85 for wheat and barley, and from 0.50 to 0.75 for peas based on currently available insurance policies. The insurance premium is set as the expected indemnity (actuarially fair premium level) multiplied by one minus the subsidy rate. Premium subsidies represent 2002 levels,[6] and no load is assumed because the current USDA base premium has a very small load and the administrative cost is directly subsidized.

The DP is set at $0.52/bu for wheat, and $0.24/bu for barley. The base yield used to calculate the per acre payment is set at 90 percent of the expected 2002 yield (see endnote 4). The local loan rate for the LDP is $2.90/bu for wheat, $2.14/bu for barley, and $6.33/cwt for peas. The target prices in the CCP are $3.86/bu and $2.21/bu for wheat and barley, respectively. The national loan rates for wheat and barley are $2.80 and $1.88, respectively. The US season average wheat price is unknown at planting and therefore a random variable. The Portland wheat (barley) cash price less 50 (43) cents per bushel is used as a proxy for the national season average price.[7]

Results

The optimization choices suggested by decision model (1) are solved numerically using GAUSS. Certainty equivalent (CE) is utilized to evaluate alternative risk management portfolios (relative to cash sales) under specified conditions and restrictions. CE is defined here as the amount of money (per acre in this case) that would have to be provided to the farmer to keep him or her as well off as providing the farmer with the specified risk management portfolio. CE can be calculated by solving:

$$E[U(w_0 + \pi^*)] = E[U(w_0 + \pi_0 + CE)] \quad (4)$$

where π^* is the net return from using a specific risk management portfolio at the optimum level, and π_0 is the net return from selling in the cash market which is defined as *NP* in equation (2).

Role of Government Programs, Hedging, and Insurance

The alternative portfolios include futures contracts, government programs, and each type of crop insurance (Table 3). The alternative risk management portfolios are assessed under several different scenarios. The base scenario is designed to represent the current situation (upper left block in Table 3), which includes all government program payments, no insurance premium loading, and a futures transaction cost of $0.017/bu.

Seven alternative risk management portfolios are analyzed for the base scenario. The maximum insurance coverage for wheat CRC, barley APH, and pea APH at 0.85, 0.85, and 0.75, respectively, with a zero hedge ratio is identified as the optimum strategy. Any risk averse decision maker should insure for the maximum amount when the insurance is actuarially fair. Since the maximum level is always selected, these coverage levels are not reported in the table. The futures hedge ratio is zero for all portfolios in the base scenario. This outcome is different compared to earlier results in Coble, et al (2000) or Ke and Wang (2002) when government programs did not include the CCP. The base scenario result is also quite different from results in Mahul's (2003) study, where no government program is included. Hedging played a significant risk management role in these previous studies. These differing results suggest the CCP protects farmers from price risk at no cost, leaving little room for the futures market with the assumed transaction cost of $0.017/bu.

CRC protects both price and yield risks (relative to APH that protects yield risk only), has the price replacement feature (relative to IP), and tends to have the largest amount of premium subsidy. The fact that IP does not consistently have a higher value than APH is also different relative to previous research (Wang, et al, 2003; Ke and Wang, 2002). The likely explanation is again the inclusion of the CCP program, which protects against price risk at no cost. Therefore, the price risk protection of IP is not valued as much.

The CE values ranging from \$36.34 (government programs only) to \$39.83 (the optimum portfolio) are primarily contributed by government program payments. The expected income transfer from government programs is \$35.73. The \$0.61 difference between the CE for government programs and this expected income transfer is the farmer's valuation for the price risk protection feature of the government programs. The values of the alternative crop insurance products (measured by subtracting total CE from the CE associated with government payments only) are between \$2.73 and \$3.49. These values include both the expected income transfer from the premium subsidy, and the risk management value.

Some sensitivity analyses are conducted to reveal the risk management value of each instrument when the risk preference parameter, the insurance premium loading factor, and the premium subsidy are set at different levels. These results are not reported in the tables, but are discussed briefly. An increased risk aversion scenario looks at the impact of assuming a more risk-averse farmer by raising the risk aversion coefficient (θ) from 2 to 3. Results show that the more risk-averse producer has a higher CE for all risk management portfolios as expected. However, the increase in CE is quite small (less than \$0.50 per acre). The rank order of the portfolios is similar to the base scenario, and all hedge ratios remain at zero.

More sensitivity analysis on the crop insurance premium subsidy and loading factors reveal that the hedging results are not sensitive to these parameters, but the insurance coverage selections are.

Impact of Government Programs on Hedging and Insurance

Several scenarios evaluating the impact of each government payment on hedging (with a futures transaction cost) are analyzed and reported in the upper portion of Table 3. The CCP is designed to provide extra price risk protection in conjunction with the LDP, as indicated by the payment structure in equation (2). Therefore, the first scenario removes the CCP, the subsequent scenario eliminates both the CCP and LDP, and finally all three government payment programs are eliminated.

When the CCP is removed from government payments, just over $7 in CE value is lost for each portfolio. This is primarily caused by a reduction in the income transfer. The relative rank of the portfolios also remains the same. The CE value for each insurance program (CE-G) increases slightly, which is caused by the wealth effect. The farmer is now more risk averse at the lower wealth level, and values the risk protection higher. However, there is still no hedging. Evidently, the remaining LDP provides farmers with free price risk protection, and the futures transaction cost along with the basis risk give farmers little incentive to hedge.

When the LDP is also removed from the farmer's portfolio, the CE value is reduced by about an additional $13. Even with a transaction cost, hedge ratios become non-zero and vary from 13 to 19 percent of expected wheat production. Under the DP only scenario, the farmer does not receive any price risk protection from government programs and has to rely on the futures market. The highest hedge ratios are in the portfolios with yield-based insurance (APH) or no insurance. The lowest hedge ratios are in the portfolios with IP. Hedge ratios are in the middle of the range for those portfolios with CRC. With the reduced income from no government program payments, all instruments are valued higher (CE-G) from the wealth effect. IP provides the best protection from price risk, while APH or no insurance provides no price risk protection. CRC also provides price risk protection, but the replacement feature in CRC puts it somewhere between IP and APH. This is because CRC resembles IP when market prices are low, and behaves like APH when prices are high.

When the CCP and LDP payments are both removed, the "Gov. Only" portfolio provides only the value of the DP program ($16.30) in the absence of the futures market. When the "No Ins." portfolio (which includes both futures and the DP program) is compared to the "Gov. Only" portfolio, the CE increases by three cents reflecting the value of the futures market. When the DP only scenario results are compared to the corresponding portfolios in the scenario where the LDP is available, both the insurance and futures values increase but only by a few cents (note the CE value differences in the "CE-G" column). The lower wealth level makes the farmer more risk averse, and the risk management instruments are valued at a higher level.

In the final scenario (no government programs), futures are utilized with hedge ratios ranging from 14 to 20 percent when transaction costs are included. This is a very small increase from the previous scenario where the DP program is available. The DP program has no risk protection function but increases the mean level of wealth, thereby reducing risk preference. In going from the DP only scenario to no government program, more than $16 in CE is lost. The more risk averse farmer now hedges slightly more and values the instruments slightly higher.

Hedge ratio changes across the four scenarios show that both the LDP and the CCP provide price risk protection free of charge. The futures market could have played a role in price risk management under the current transaction cost, but its potential contribution is replaced by these government programs.

Impacts of Futures Transaction Costs on Hedging

To assess the impact of transaction costs on hedging, the same scenarios are analyzed after eliminating the $0.017/bu futures transaction cost. The results are reported on the lower portion of Table 3. All hedge ratios are shown increased. When all government programs are included, the hedge ratios change from zero to a low level between 8 and 14 percent. The one or two cents more in the CE measures the risk reducing value of the hedging. Futures transaction costs are not the primary impediment to using futures when the CCP program fills the need for price insurance at no cost and no basis risk, however, these costs are still a relevant parameter when farmers consider hedging.

When the CCP is eliminated from government program payments, between 19 and 25 percent of the expected wheat production will be hedged in the futures market assuming no transaction costs. Introducing transaction-free futures without insurance ("No-Ins." portfolio), increases the CE value by five cents. When alternative crop insurance products are included in the portfolio, CE values increase by four to six cents relative to the scenario when futures transaction costs are present. The net values after accounting for government programs (CE-G value) also increase by four to nine cents from the scenario that includes CCP (the base scenario). This value increase is a joint effect from two sources. First, increased use of hedging provides a higher risk protection value. Second, a lower wealth level from eliminating the CCP program means higher risk aversion and the farmer values any risk protection higher. Again, the hedge ratio is higher when yield insurance is used relative to when revenue insurance is used. However, the difference is quite small because the revenue insurance coverage is restricted to be

85 percent of the mean revenue or less, leaving some potential price variation unprotected. Given the high basis risk (the wheat cash and futures price correlation is around 0.5), the hedge ratio seems reasonable.

When the transaction cost is eliminated from the scenario with neither CCP nor LDP, hedge ratios increase to a range from 39 to 45 percent, which is about 26 percent higher than the case with transaction cost. Additionally, the net values (CE-G) of the futures and insurance portfolios are about 16 cents higher than the "with-transaction" cost scenario. The scenario that eliminates all government programs results in the same hedge ratios as the scenario with only a DP program. The lower CE values are caused purely by the income effect of losing about $16.30 from the DP program.

All the scenarios previously analyzed include results with and without a futures transaction cost. Results generally suggest that hedging levels are sensitive to hedging costs. Figure 1 illustrates this impact by plotting hedging levels of the optimum portfolio under alternative transaction cost levels. The two curves represent outcomes without the CCP program (DP only and DP combined with the LDP) because there is almost no need for hedging when CCP are available irrespective of transaction cost levels. The hedging level decreases almost linearly as the transaction cost increases. The hedging level reaches zero at $0.014 per bushel when the LDP is included. Without the LDP, the hedge ratio is still about 12 percent at a hedge cost of $0.020. The results between zero and the current transaction cost level of $0.017 are consistent with those in Table 3. Although it is difficult to see due to scale, the slopes of the two curves are neither identical nor constant necessarily.

Impacts of relative levels of government program protection to market price

The impact of each government program is assessed in the previous section. However, price risk protection for farmers is also influenced by the level of the government program parameters relative to prices, such as the target price and loan rate relative to the expected market price. This impact is now explored using two approaches. First, the market price distribution is fixed as previously simulated, but government program parameters are changed hypothetically. Second, government program parameters are fixed at current levels, while the market price distributions (mean levels) are changed.

The impact based on the first approach is illustrated in Figure 2. Figure 2 shows the hedging levels under alternative protection levels from the government programs with and without a transaction cost for the optimal portfolio (CRC for wheat and APH for barley and peas). As the target price for the wheat CCP program moves from its current level of $3.86 down to $2.90, the loan rate is maintained at $2.90. Therefore, the price range from $3.86 to $2.90 on the horizontal axis represents impacts from reducing the CCP target price. When the target price drops below $2.90, the CCP program has a zero value and does not impact the hedging decision anymore. Thereafter, the wheat loan rate is allowed to decrease without the CCP program from $2.90 to 0 reflecting reduced protection from the LDP program. When the loan rate is zero, government payments reflect only the DP.

The top curve represents hedge ratios when futures transaction costs are eliminated. When the loan rate is below $2 per bushel, the hedge ratio remains constant at 33 percent. This constant rate is because the probability that wheat prices will fall below $2 is low, so growers will rarely receive any payment, and they have to hedge in the futures market to manage price risk. When the loan rate increases beyond $2, the hedge ratio drops sharply, until the loan rate reaches its current level of $2.90. Then, the CCP program still won't start to make payments until the DP program amount is repaid at the target price of $3.42, ($2.90 + the $0.52 direct payment). This $0.52 interval is represented by the flat section of the curve, after which the hedge curve starts a new concave decreasing pattern.

The bottom curve in Figure 2 represents the situation where futures transaction costs are present. The same pattern is observed when government programs provide a loan rate of about $1.80, but the hedge ratios are lower when hedging has a cost. The hedge ratio drops when the loan rate increases, and becomes zero when the loan rate reaches $2.50. However, the transaction cost hedge curve is not monotonic like the no transaction cost curve. When the government programs provide very low protection, the hedge ratio is also zero. This is because the grower's income level is much lower without the income transfer from government programs, and the futures transaction cost is weighed more heavily than its price risk protection. Therefore, at the assumed $0.017/bu transaction cost level, hedging occurs only when the government loan rate for wheat is set around $2.00.

The effects of government programs on hedging based on changes in market price levels are illustrated in Figure 3. Six additional joint price-yield distributions are simulated. All other attributes remain the same except for the expected wheat cash and futures prices, which deviate from the base distribution by -$0.50, -$0.25, $0.25, $0.50, $0.75, and $1 per bushel.

With a futures transaction cost of $0.017/bu, the hedging level remains at zero until the price expectations are $0.75 higher than the base price of $2.96 cash and $3.69 futures. However, when the transaction cost is eliminated, the hedging level increases from about zero to 33 percent as the expected prices rise. As the expected market prices go up, growers expect to receive lower payments from the government programs given the fixed target price and loan rate.

Thus, they will depend more on futures hedging to protect their price risks. The curve is concave and converges to a maximum level when the CCP and LDP eventually could make no payments.

The two approaches have similar results in that when the government program protection levels are high relative to expected price levels, futures are not used, and vise versa. They both confirm that government programs “crowd out” hedging in the futures market. Over the price range where the CCP program provides protection from price risk, hedging levels are zero under the transaction cost. If government program parameters remain unchanged, farmers tend to hedge more during years with high expected price levels than in the low years. Or, at the fixed expected price level for the base scenario, hedging takes place only when CCP’s are eliminated and the loan rate drops to relatively low levels under the same transaction cost.

Impacts of Multiple Crops in the Rotation

In order to explore the phenomena of multiple crops, two hypothetical scenarios are investigated; a rotation with wheat and barley only and another for wheat alone.[8] Hedging is not used when the CCP and LDP are both present at the transaction cost level of $0.017, and the DP program does not substantially impact hedging levels as discussed previously. Therefore, the focus is on cases when the CCP is removed (LDP and DP only) and transaction cost is either at $0.017 per bushel or eliminated. Results reported in Table 4 should be compared with the scenarios that include wheat, barley, and peas in Table 3.

Table 4 results suggest there is no difference in the insurance coverage levels relative to previous results where all three crops are included. With zero futures transaction cost, the hedge ratios are also similar across the scenarios with different numbers of crops. However, this is driven by the actuarially fair nature of the premium and “free” nature of hedging, and does not mean a lack of any diversification effect.

The hedge ratio increases from zero to about 10 percent when wheat is the only crop and a futures transaction cost is included. The risk protection benefit of the futures is not large enough to cover its transaction cost when three crops are grown on the farm, while the benefit is higher when only one crop is grown. The CE for the futures market alone (CE-G for the "No. Ins." Portfolio) is zero for three crops, one cent for two crops, and nine cents for one crop. This result suggests that a diversification effect for price risk exists when growing multiple crops. A transaction cost enhances the need to replace the risk reduction role of hedging with diversification.

Summary and Conclusions

An expected utility maximization model is used to analyze risk management behavior for non-irrigated crop producers under provisions of the 2002 FSRI Act programs. Representative farms growing winter wheat, spring barley, and peas from Whitman County, Washington are used to model risk management behavior. Risk management portfolios that include hedging with wheat futures, yield insurance, revenue insurance, government programs, and several plausible combinations are analyzed. The optimum portfolio includes the government programs, and revenue insurance (CRC is preferred over IP) combined with APH for those crops not covered by the CRC product. This optimum portfolio is very robust to scenario changes.

Results generally suggest that government programs account for the primary value of the risk management portfolios available to non-irrigated PNW crop producers. This reflects both the price risk protection associated with the loan deficiency payments (LDP) and counter cyclical payments (CCP), and the general increase in certain income. However, the high income transfer from government programs clearly dominates total risk protection values. Contrary to previous studies when CCP program payments were not available, hedging or combining hedging with insurance products plays a very limited role in risk management. Futures are used only when the CCP program is removed from the portfolio and LDP has a very low loan rate, when a futures transaction cost is not present, or when the market prices are at a very high level compared to the current target price. Such results suggest that the observed behavior of using little hedging is likely rational under both the new 2002 FSRI Act and the 1996 FAIR Act.

The dominant role of government program income transfers in risk management value certainly has relevant policy implications. Current farm policy programs have a clear and unfavorable impact on the use of market-based instruments (futures) for risk management purpose. Only when the target price is reduced enough to eliminate CCP's, and the Loan Rate is significantly reduced (below $2.50/.bu for wheat) will futures be used if faced with a reasonable transaction cost. Additionally, crop insurance programs play a role in risk management only if the current premium subsidy scheme remains. Adding a normal 30 percent load to the actuarially fair premium structure essentially eliminates the use of crop insurance for risk management if not subsidized. Additional policy efforts to encourage the use of market-based instruments or crop insurance for risk management should recognize the importance of the "crowding out" role of current farm programs.

When futures are used, hedging levels are positively affected by the inclusion of APH, and negatively affected by CRC and IP. This inverse relationship is more pronounced with IP than with CRC. This result suggests the replacement feature of CRC allows more potential price variability to be unprotected. Futures transaction costs also have a negative impact on hedging.

Diversification impacts on hedging and insurance from multiple crop rotations commonly used in the PNW region are not identifiable under the current government program and crop insurance structure. However, if the CCP is removed, a diversification impact is demonstrated by more hedging when the number of crops decreases from three to one.

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Table 1. Summary of Scenarios Considered in the Empirical Analysis

	Instruments Included							
Portfolio	Government Programs	Wheat Futures	Pea APH	Barley		Wheat		
				APH	IP	APH	IP	CRC
Gov. Only[1]	U							
No Ins.[2]	U	U						
A_W&B&P[3, 4]	U	U	U	U		U		
I_W&B+A_P	U	U	U		U		U	
C_W+A_B&P	U	U	U	U				U
C_W+I_B+A_P	U	U	U		U			U
A_W&P+I_B	U	U	U		U	U		
I_W+A_B&P	U	U	U	U			U	
A_W&B	U	U		U		U		
I_W&B	U	U			U		U	
C_W+A_B	U	U		U				U
C_W+I_B	U	U			U			U
A_W+I_B	U	U			U	U		
I_W+A_B	U	U		U			U	
A_W	U	U				U		
C_W	U	U						U
I_W	U	U					U	

1 "Gov. Only" means the portfolio includes government programs only.
2 "No Ins." means no insurance is included, but futures and government programs are included.
3 "W" represents wheat, "B" represents barley, and "P" represents peas.
4 "C", "I", and "A" represent the available insurance products, CRC, IP, and APH. CRC is revenue insurance with price replacement, IP is revenue insurance without price replacement, and APH is yield insurance.

Table 2. Descriptive Statistics of the Simulated Joint Distribution of Prices and Yields for the Representative Farms in Whitman County, Washington

					Correlation Coefficients						
Variable	Unit	Mean	Standard Deviation	Skew-ness	Wheat F	Wheat P	Wheat Y	Barley P	Barley Y	Pea P	Pea Y
Wheat F	$/Bu.	2.96	0.75	0.70	1.00						
Wheat P	$/Bu.	3.69	0.61	0.52	0.48	1.00					
Wheat Y	Bu.	89.16	14.97	-0.04	0.00	-0.03	1.00				
Barley P	$/Bu.	2.22	0.21	0.23	0.31	0.63	-0.02	1.00			
Barley Y	Bu.	73.17	18.69	-0.43	0.02	0.00	0.11	0.03	1.00		
Pea P	$/cwt	7.39	0.63	0.16	0.05	0.02	-0.01	0.04	0.01	1.00	
Pea Y	Cwt	19.85	5.64	-0.20	-0.02	-0.02	0.38	0.03	0.21	-0.04	1.00

Note: "F" is futures price, "P" is cash price, and "Y" is yield.

Table 3. Impacts of Government Programs on Hedge Ratios, Insurance Coverage and CE

	Base Scenario			No CCP - only DP and LDP			No CCP and LDP - DP only			No Government Program	
Insurance Alternative	Hedge Ratio	CE ($)	CE-G[1] ($)	Hedge Ratio	CE ($)	CE-G ($)	Hedge Ratio	CE ($)	CE-G ($)	Hedge Ratio	CE ($)
	With Futures Transaction Cost										
Gov. Only[2]	na	36.34	0	na	29.19	0	na	16.30	0	0.19	0.04
No Ins.[3]	0	36.34	0	0	29.19	0	0.18	16.33	0.03	0.19	0.04
A_W&B&P[4,5]	0	39.34	3.00	0	32.20	3.01	0.19	19.31	3.01	0.20	3.04
I_W&B+A_P	0	39.15	2.81	0	32.07	2.88	0.13	19.29	2.99	0.13	3.02
C_W+A_B&P	**0**	**39.83**	**3.49**	**0**	**32.72**	**3.53**	**0.16**	**19.89**	**3.59**	**0.17**	**3.63**
C_W+I_B+A_P	0	39.55	3.21	0	32.45	3.26	0.15	19.66	3.36	0.16	3.39
A_W&P+I_B	0	39.07	2.73	0	31.94	2.75	0.18	19.08	2.78	0.19	2.81
I_W+A_B&P	0	39.43	3.09	0	32.34	3.15	0.14	19.53	3.23	0.14	3.26
	Without Futures Transaction Cost										
No Ins.	0.13	36.35	0.01	0.24	29.24	0.05	0.43	16.49	0.19	0.43	0.19
A_W&B&P	0.14	39.36	3.02	0.25	32.27	3.08	0.45	19.47	3.17	0.45	3.20
I_W&B+A_P	0.08	39.15	2.81	0.19	32.10	2.91	0.39	19.42	3.12	0.39	3.15
C_W+A_B&P	**0.11**	**39.84**	**3.50**	**0.23**	**32.77**	**3.58**	**0.42**	**20.04**	**3.74**	**0.42**	**3.78**
C_W+I_B+A_P	0.10	39.56	3.22	0.22	32.50	3.31	0.41	19.80	3.50	0.41	3.54
A_W&P+I_B	0.13	39.08	2.74	0.24	32.00	2.81	0.44	19.24	2.94	0.44	2.97
I_W+A_B&P	0.09	39.43	3.09	0.20	32.37	3.18	0.40	19.66	3.36	0.40	3.40

Note: [1] The column labeled "CE-G" reflects the value of the portfolio after the CE from government programs is removed.

[2] "Gov. Only" means the portfolio includes government programs only.

[3] "No Ins." means no insurance is included, but futures and government programs are included.

[4] "W" represents wheat, "B" represents barley, and "P" represents peas.

[5] "C", "I", and "A" represent the available insurance products, CRC, IP, and APH. CRC is revenue insurance with price replacement, IP is revenue insurance without price replacement, and APH is yield insurance.

Table 4. Impacts of Multiple Crops on Hedge Ratios, Insurance Coverage, and CE in the Presence of LDP and DP

	With Futures Transaction Cost					No Futures Transaction Cost				
Insurance Alternative	Hedge Ratio	Ins. Coverage Wheat	Ins. Coverage Barley	CE ($)	CE-G[1] ($)	Hedge Ratio	Ins. Coverage Wheat	Ins. Coverage Barley	CE ($)	CE - G ($)
	Wheat and Barley					**Wheat and Barley**				
Gov. Only[2]	na	na	na	44.01	0	na	na	na	44.01	0
No Ins.[3]	0.06	na	na	44.02	0.01	0.24	na	na	44.13	0.12
A_W&B[4,5]	0.06	0.85	0.85	46.98	2.97	0.25	0.85	0.85	47.10	3.09
I_W&B	0.00	0.85	0.85	46.78	2.77	0.19	0.85	0.85	46.85	2.84
C_W+A_B	**0.03**	**0.85**	**0.85**	**47.77**	**3.76**	**0.22**	**0.85**	**0.85**	**47.87**	**3.86**
C_W+I_B	0.02	0.85	0.85	47.36	3.35	0.21	0.85	0.85	47.45	3.44
A_W+I_B	0.05	0.85	0.85	46.58	2.57	0.24	0.85	0.85	46.68	2.67
I_W+A_B	0.00	0.85	0.85	47.20	3.19	0.20	0.85	0.85	47.28	3.27
	Wheat Only					**Wheat Only**				
Gov. Only	na	na	na	46.88	0	na	na	na	46.88	0
No Ins.	0.12	na	na	46.97	0.09	0.22	na	na	47.23	0.35
A_W	0.12	0.85	na	50.26	3.38	0.23	0.85	na	50.53	3.65
C_W	**0.10**	**0.85**	na	**51.97**	**5.09**	**0.21**	**0.85**	na	**52.20**	**5.32**
I_W	0.07	0.85	na	50.69	3.81	0.18	0.85	na	50.88	4.00

Note: [1]The column labeled "CE - G" reflects the value of the portfolio after the CE from government programs is removed.

[2] "Gov. Only " means the portfolio includes government programs only.

[3] "No Ins." means no insurance is included, but futures and government programs are included.

[4] "W" means wheat, and "B" means barley.

[5] "C", "I", and "A" represent the available insurance products, CRC, IP, and APH. CRC is revenue insurance with price replacement, IP is revenue insurance without price replacement, and APH is yield insurance.

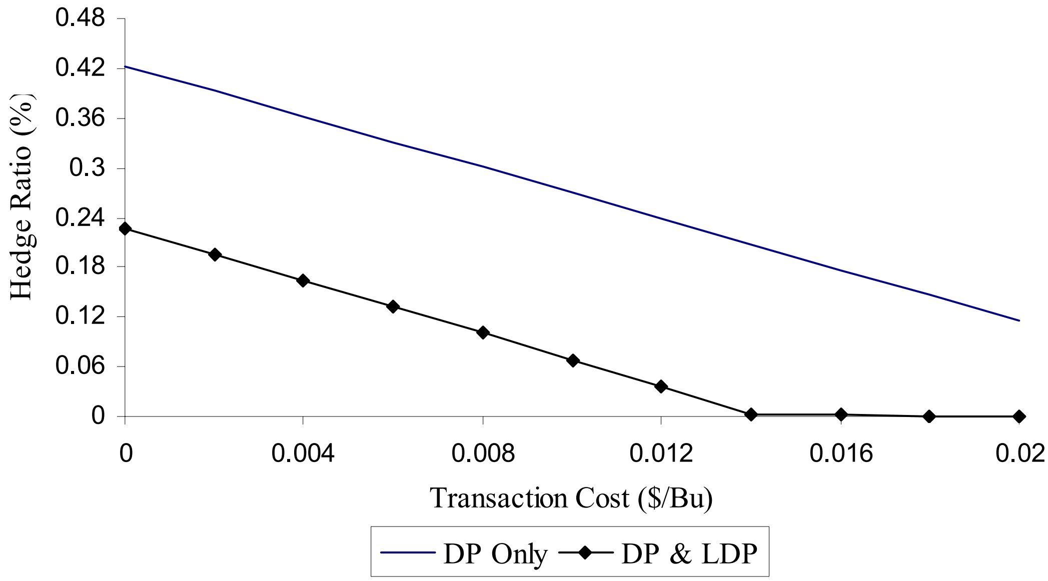

Figure 1. Impact of Futures Transaction Cost on Hedging for the Optimum Risk Management Portfolio under the Base Scenario without the CCP Program

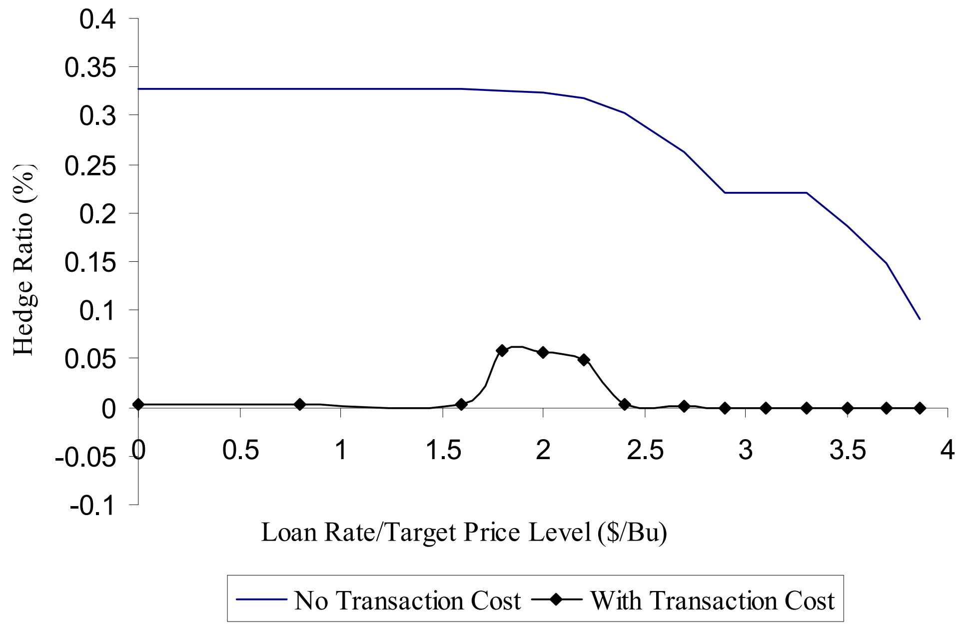

Figure 2. Impact of Loan Rate and Target Price Levels on Hedging for the Optimum Risk Management Portfolio under the Base Scenario

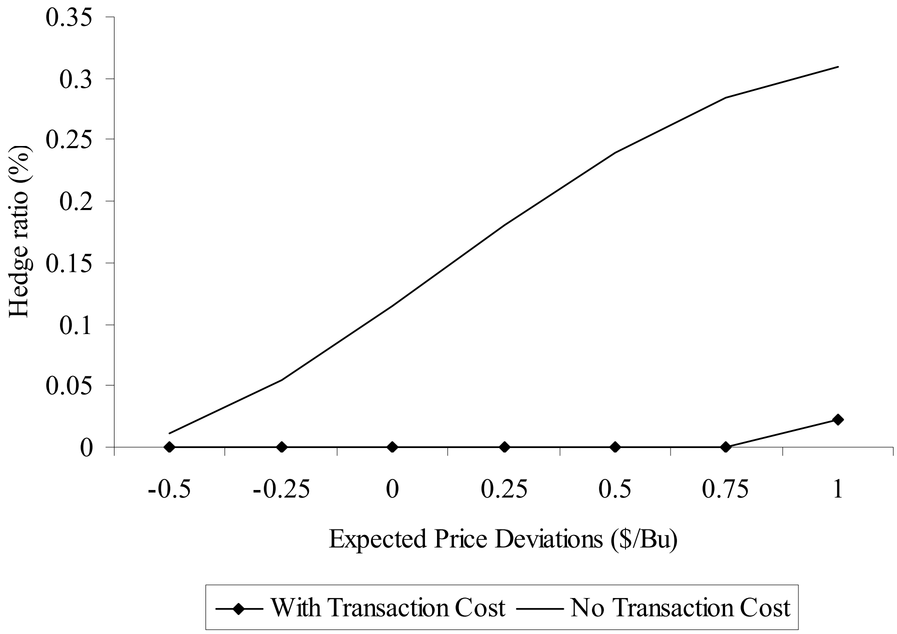

Figure 3. Impact of Expected Wheat Prices on Hedging for the Optimum Risk Management Portfolio under the Base Scenario

Endnotes:

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[1] Options are not considered in this research for three reasons. First, the focus is on farmers' risk management behavior and the futures market is assumed to be unbiased to rule out speculating. Options have limited value compared to futures when unbiased futures are used (Mahul, 2003). Second, even if options are used when the futures are biased, the impact of government programs (which are free to farmers) on futures and on options should be similar. Third, adding options adds significant complexity to the analysis and adds little information.

[2] Only one hedge is assumed, and no early trading is allowed. This assumption precludes the speculative motive (together with the unbiased market assumption) from hedging, and keeps the model in the simple two-period framework.

[3] All insurance programs considered here are individual farm based programs. The group insurance program is not considered because it is not available in many regions of the US including the area used in the empirical analysis.

[4] The DP program yield is carried over from the 1996 FAIR Act and assumed to be 0.90 of the expected current yield. The CCP program yield is updated per Base option 4 in the 2002 FSRI Act and equal to 0.935 of current yield. The payment scheme of the CCP provides an additional payment so that the grower will receive a price no lower than the target price. However, because the grower receives the DP first and then receives the higher of the loan rate or the market price, the DP, market payment and LDP are removed from the CCP program payment.

[5] Yield histories for each crop are identified by a policy number, have a county identifier, and also include location descriptors of the insured unit. Thus, it is possible to segregate Whitman County high precipitation area farm-level actual yields from other farm locations that constitute a majority of the Palouse area. Farms having less than six actual yield observations are deleted.

[6] The current subsidy regime is regressive relative to the chosen coverage levels. The corresponding subsidy rate for each of the coverage levels from 50% to 85% with a 5% incremental is: 67%, 64%, 64%, 59%, 59%, 55%, 48%, and 38%. In the analysis, the coverage level is allowed to be selected on a continuous basis to identify slight differences by using a fitted continuous function of subsidy rates.

[7] Historically, the US season (12-month) average wheat price is highly correlated with the adjusted harvest (September) Portland price ($\rho = 0.92$ from 1982 to 2001). They also have very close means, \$3.21 versus \$3.26, and standard deviations, \$0.59 versus \$0.71. Therefore, using the adjusted Portland price provides a very close approximation of the US season average price for calculating the CCP payment. The same reason holds for barley.

[8] From an agronomic point of view, these two rotations are not ideal in the high precipitation region. However, these cropping patterns with fallow in the rotations exist in the PNW for the intermediate rainfall area (annual precipitation of 14 to 18 inches), and the dry area (annual precipitation of 9 to 13 inches).