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Decoupled farm payments and the role of base updating under uncertainty*

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Abstract

In the context of the U.S farm policy, this paper analyzes the effect that expectations about base updating in future policies have on a farmer's acreage decision in the presence of price, yield and policy uncertainty. We consider a risk neutral farmer producing a single crop whose income consists of market revenue and government payments. We consider two policy regimes. Decisions made in the current policy regime are linked to government payments in the future policy regime through the possibility of a base update in the future regime. There is policy uncertainty about the possibility of a base update being allowed in the future. We combine stochastic dynamic programming with present value calculations to link current acreage decisions to future program payments. The average optimal planted acreage is weakly increasing in the subjective probability of the future base update. The maximum percentage increase in the average optimal planted acreage is 6%.

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The Uruguay Round Agreement on Agriculture (URAA) of the World Trade Organization (WTO) in 1994 was the first time that a major step was taken towards reducing the trade distortions caused by domestic agricultural subsidies. Domestic subsidies were classified into three categories or "boxes" according to the level of distortion that they caused. The amber-box contains the most distorting subsidies and 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 the subsidies that cause no or minimal distortion. The subsidies in the blue- and green-boxes are currently excluded from all WTO disciplines. Decoupled payments fall under the green-box. They are defined as payments that are (i) financed by taxpayers, (ii) not related to current production, factor use, or prices and, (iii) the eligibility criteria are defined by a fixed, historical base period. Furthermore, no production is required to receive these payments. Since there are no restrictions on their use, they have come to play an important role in providing support to farmers, especially in industrialized countries.

In the United States, decoupled payments were first introduced in the 1996 Federal Agriculture Improvement and Reform (FAIR) Act in the form of production flexibility contract (PFC) payments. These were continued as direct payments (DP) in the 2002 Farm Security and Rural Investment (FSRI) Act. The EU too has been moving towards decoupled support with the 1992 MacSharry reforms, Agenda 2000 and CAP Mid-Term Review (MTR) in 2003 with a Single Farm Payment (SFP). The trend has been to cut support prices while compensating farmers with decoupled payments.

Recently though, green-box subsidies, especially decoupled payments, have come under scrutiny. The WTO rulings against the United States in the cotton dispute (WTO 2004, WTO 2005) has brought the U.S. direct payments under the spotlight. There is an ongoing debate over the impact that decoupled payments have on farmer decisions. The literature on decoupled payments has identified five major "coupling" mechanisms of decoupled payments[1]. First, under decreasing absolute risk aversion preferences, decoupled payments reduce the coefficient of absolute risk aversion (wealth effect) and income variability (insurance effect) (Hennessy 1998, Sckokai and Moro 2006). Second, in the presence of imperfect credit markets, decoupled payments can ease the credit constraints faced by farmers (Roe et al. 2003, Goodwin and Mishra 2006). Third, decoupled payments can influence the labor supply decisions of farmers, by affecting the choice between leisure and total labor supply or between on- and off-farm labor supply (El-Osta et al. 2004, Ahearn et al. 2006). Fourth, decoupled payments increase land values and rents since they are non-stochastic and are paid on historical acreage (Goodwin et al. 2003a, Goodwin et al. 2003b, Roberts et al. 2003). Fifth, expectations about future decoupled payments can influence current decisions of farmers (Sumner 2003, McIntosh et al. 2007, Coble et al. 2007). Our article formally explores this fifth mechanism. The case of base acreage updating of the DPs allowed in the 2002 FSRI Act in the United States illustrates the relevance of exploring the mechanisms linking current acreage and future payments. Sumner 2003 develops a degree of linkage between payments that might involve base updating and current production. The degree of linkage measures the contribution of current production to the present value of

[1]For a detailed review of the literature on decoupled payments, see Bhaskar and Beghin 2007.

future payments. A high value of the degree of linkage implies that DPs have a strong link to current production. McIntosh et al. 2007 conduct an experiment to study the effect of expectations about a future possibility of base acreage updating on allocation decisions of the participants between a program and non-program crop. They find that the possibility of a future base acreage update increases the allocation towards the program crop by around 8%. Using a survey of Iowa and Mississippi farmers, Coble et al. 2007 observe that farmers believe there is a 40% chance that base acreage or yield updates will be allowed in the 2007 Farm Bill. They also find that the willingness to accept a one time payment in-lieu of an opportunity to update base is positively affected by a greater expectation of an update.

Complementary to Sumner 2003, McIntosh et al. 2007 and Coble et al. 2007, our approach formalizes and quantifies the influence of expected payments under future policy which might allow a base update on acreage decisions under current policy. We account for the stochastic and dynamic environment in which farmers operate. We analyze the impact of base updating on a risk neutral farmer's acreage decision in the presence of price, yield and policy uncertainty. The farmer makes acreage planting decisions in the current policy regime, (2002-2006), not knowing the policies that will be in place in the future policy regime (the duration of the 2007 Farm Bill). If base updating is allowed in the future regime, then the new base acreage for DPs, is considered to be the average of the planted acreage in the current regime. The subjective beliefs of the farmer formed under the current Farm Bill, regarding a future base update occurring is discretized into five values, starting from 0 (no update) to 1 (certain update) in increments of 0.25. The farmer's problem is to maximize the present value of expected profits by choosing acreage during 2002-2006 while taking into account the possibility of a future base update. Thus the farmer cares not only about her current income but also about her future stream of income.

The solution to the model provides the optimal planted acreage for each of the years 2002-2006, and for each value of the subjective probability about the future base update. The results are presented in terms of the average of the optimal planted acreage, $\bar{A}$, over 2002-2006. Under certainty that there is no future base update, this value is driven entirely by market conditions and current government programs, and establishes a “business as usual” baseline. Under certainty that there will be an opportunity to update base, this value is driven by market conditions and the expectation that base updating will be allowed for sure. $\bar{A}$ is then the new base acreage for DPs. The stronger the belief that there will be a future opportunity to update base, the stronger is the link between current acreage and future payments. $\bar{A}$ is weakly increasing in δ. We then compute the percentage increase in $\bar{A}$ relative to the baseline, to quantify the supply expansion effect of an expected base update. The results indicate that the maximum percentage increase in $\bar{A}$ is 6%. We also look into alternate assumptions to investigate the robustness of our main result. The paper is organized as follows. The model is discussed in the next section. Section 3 describes the numerical analysis. Section 4 presents the results and Section 5 concludes.

Model

We follow Duffy and Taylor 1994 in formulating the acreage optimization problem for a risk neutral farmer. The farmer produces a single crop, corn[2], and faces price and yield uncertainty, with price and yield being negatively correlated. She earns income from the sale of her crop and government payments. Three government payments are considered. The DPs, the countercyclical payments (CCP) and the loan deficiency payments (LDP). The DPs and CCPs are paid on fixed base acres and program yield, though the CCPs are triggered by low prices. The LDPs are also triggered by low prices, though these payments are paid on current production. The CCPs were introduced in the 2002 FSRI Act. These payments were given to farmers in 1998-2001 as the Market Loss Assistance (MLA) payments because of low prices. These ad hoc payments were made permanent as the CCPs. Thus updating base acreage would affect the DPs and CCPs. The per-period profit of the farmer can be written as:

$$\pi_t = \tilde{P}_t\tilde{Y}_tA_t + max(LR - (\tilde{P}_t - 0.26), 0)\tilde{Y}_tA_t + 0.85D * BA * Y_d \quad (1)$$

$$+0.85 * max(CR, 0) * BA * Y_c - TC(A_t),$$

where $\tilde{P}_t$ is the stochastic price, $\tilde{Y}_t$ is the stochastic yield, A_t is the current acreage, LR is the loan rate, $\tilde{P}_t - 0.26$ represents the posted county average price[3], D is the DP rate, CR is the CCP rate which equals $TP - D - max(\tilde{P}_t, LR)$, where TP is the target price and

[2]This simplifying assumption is made to reduce the dimensionality of computations and can be rationalized as representing a stylized aggregate agricultural crop supply, especially for low values of acreage responses. As explained later, our cost of production specification indicates the ability to bring land into production but does not stipulate where the new land comes from (competing crops or idled land).

[3]Babcock and Hart 2005 find that on average the posted county average price (used for computing the LDP rate) is less than the season average price by 26 cents in the case of corn.

TC is the total cost of production, which is a function of current acreage. BA is the base acreage for the duration of the 2002 FSRI Act, and Y_d and Y_c are program yields for the DPs and CCPs respectively. Thus profit, π_t, is a function of $\tilde{P}_t$, $\tilde{Y}_t$ and A_t.

The farmer faces policy uncertainty, in that she doesn't know the policies that will be in place for 2007-2011. Specifically, we consider the policy uncertainty about a future opportunity to update base acreage. The farmer forms expectations about the possibility of a future base update. This is captured by the farmer's subjective probability about the future base update, $\delta \in [0, 1]$. Five values of δ are considered to capture the varying degree of conviction that the farmer has regarding the future base update. $\delta = 0$ implies that the farmer is certain that base updating will not be allowed in the 2007 Farm Bill. On the other hand, $\delta = 1$ implies that the farmer is certain that base updating will be allowed in the 2007 Farm Bill. The farmer takes into account the possibility of a future base update, while maximizing the present value of expected profits.

The farmer maximizes the present value of expected profits with respect to acreage over the period 2002-11. The farmer's problem can be expressed as:

$$\max_{A_t} E\left[\sum_{t=0}^{4} \beta^t \pi_t(A_t, \tilde{P}_t, \tilde{Y}_t) + \beta^5(\delta VB + (1-\delta)VNB)\right], \tag{2}$$

where β is the discount factor and E is the expectations operator, over price and yield. The first term of (2) represents the maximization problem for 2002-2006. The terminal value for this problem is specified by the possible future income stream from 2007-2011. There are two possible income streams in 2007-2011; one associated with base updating, VB, and the second, associated with no base updating, VNB.

VB is the value function for the stochastic dynamic programming (SDP) problem associated with base updating (SDP_{VB}) and VNB is the value function for the SDP problem associated with no base updating (SDP_{VNB}). The farmer weighs the future income stream with δ. As the farmer's beliefs about the expected base update changes, land allocation decisions in 2002-2006 are affected. Equation (2) also provides the link between acreage decisions in 2002-2006 with future farm payments. This is because under base updating, the new base (which is the average of the acreage planted in 2002-2006) affects VB. Hence, the higher the value of δ, the stronger is the link between acreage planted in 2002-2006 and future farm payments.

The two SDP problems are solved for a five-year time horizon, representing the years 2007-2011, for a discrete state and control space. The control or decision variable is the current acreage, A_t, which is discretized into r values. The stochastic state variables are price and yield. Both the variables are discretized into t and s number of states respectively. Additionally, for SDP_{VB} the state space includes all the possible values for the new base. Since price and yield are stochastic, there is a probability associated with the realization of each of the possible t price and s yield states. The probability transition matrix, which is a $(t * s) \times (t * s)$ matrix contains these probabilities. An element $p^{i,j,k,l}$ of the probability transition matrix represents the probability of moving from a current price of i and a yield of j to a price of k and yield of l in the next period. We rewrite (2) as:

$$\max_{A_t} \sum_{t=0}^{4} \sum_{k=1}^{t} \sum_{l=1}^{s} \beta^t P^{i,j,k,l} \overrightarrow{\pi_t}(A_t, \tilde{P}_t, \tilde{Y}_t) + \beta^5 \sum_{k=1}^{t} \sum_{l=1}^{s} P^{i,j,k,l} (\delta * \overrightarrow{VB} + (1-\delta) * \overrightarrow{VNB}). \quad (3)$$

The two SDP problems for 2007-2011 are:

$$\begin{aligned} &VB_t(\tilde{P}_t, \tilde{Y}_t, BA') = \\ &\max_{A_t} \left[\sum_{k=1}^{t} \sum_{l=1}^{s} P^{i,j,k,l} \pi_t(\tilde{P}_t, \tilde{Y}_t, A_t, BA') + \beta \sum_{k=1}^{t} \sum_{l=1}^{s} P^{i,j,k,l} VB_{t+1}(\tilde{P}_{t+1}, \tilde{Y}_t, BA') \right], \\ &\qquad t = 1, 2, ...5. \end{aligned} \quad (4)$$

$$VNB_t(\tilde{P}_t, \tilde{Y}_t) = \max_{A_t} \left[\sum_{k=1}^{t} \sum_{l=1}^{s} P^{i,j,k,l} \pi_t(\tilde{P}_t, \tilde{Y}_t, A_t) + \beta \sum_{k=1}^{t} \sum_{l=1}^{s} P^{i,j,k,l} VNB_{t+1}(\tilde{P}_{t+1}, \tilde{Y}_t) \right], \quad t = 1, 2, ...5, \quad (5)$$

where BA' is the new base acreage for the DPs and the CCPs for 2007-2011 and is the average of the acreage planted during 2002-2006. The option of not updating is also included amongst all the possible base states considered. Here BA' is treated as an endogenous state variable.

The solution to equation (2) provides the optimal acreage planted in 2002-2006, which depends on δ. Thus, corresponding to each value of δ, is an optimal acreage allocation. The optimal acreage for $\delta = 0$ (certainty of no base update), is determined by market conditions and the farm policies of the 2002 FSRI Act. It is the benchmark we use to compare the optimal acreage for $\delta > 0$. The difference between the optimal acreage for $\delta > 0$ and $\delta = 0$ measures the supply effect of the expected base update.

Numerical Solution

The numerical analysis is carried out at the national level using national season average price and yield[4]. We also take into account payment limitations while computing profits[5]. We assume that the farmer receives DPs and CCPs on a base acreage of 1000 acres. $Y_d = 118$ bu/acre is the same as the program yield established in the Food, Agriculture, Conservation, and Trade (FACT) Act of 1990. Farmers were given the opportunity to update their program yields for the CCPs. The following two methods were allowed: (i) 93.5% of the 1998-2001 average yield or, (ii) $Y_d + 70\% * ((1998 - 2001$ average$) - Y_d)$. If farmers chose not to update their yield then Y_d would be used. With $Y_d = 118$ bu/acre, method (ii) results in the highest Y_c and equals 130.48 bu/acre.

The functional form considered for the total cost[6], $TC(A_t)$, is $F + bA_t + cA_t^3$ where F is the fixed cost and b and c are constants. Given F^7, we calibrate b and c for a 1000 acre farm using the profit maximization condition and the acreage price elasticity [8].

[4]National level yields underestimate farm-level yield variability as the latter is about two to three times more variable than the former. In the sensitivity analysis, we solve the model with increased yield variability. We thank Bruce Babcock for raising this point.

[5]The 2002 Farm Act sets payment limits at \$40,000 per person per fiscal year for DPs, at \$65,000 for CCPs and at \$75,000 for LDPs. In our analysis the payment limitations are binding only for LDPs when $LR > \tilde{P}_t - 0.26$.

[6]We also consider an alternate specification as suggested by our colleague, David Hennessy. The results are robust to this specification. See appendix A2 for details.

[7]Data for F has been taken from ERS data on production costs for corn for the year 2005.

[8]We use an estimate of acreage price elasticity equal to 0.412. This estimate has been taken from Lin et al. 1996. We abstract from different supply responses to the LR and prices. See Appendix A1 for details on total cost calibration.

Both the price and yield state variables are discretized into eight values each, yielding a total of 64 states. A_t is discretized into eight values, starting at 900 acres with increments of 50 acres. Since the farmer can choose any one of the eight acreage choices in each of the five years, 2002-2006, the total number of new base states is large (32,768) and, the total number of states for SDP_{VB} is even larger ($32,768 * 64 = 2,097,152$). For SDP_{VNB} the total number of states equal 64.

The elements in the probability transition matrix are derived from the joint distribution of price and yield. We assume that price and yield follow a bivariate normal distribution with negative correlation between price and yield[9]. The Shapiro-Wilk test was used to test whether the price and yield distributions follow a normal distribution. The null hypothesis of normality could not be rejected at the 5% level of significance. Alternate distributions for yield have been postulated in the literature. Particularly, the beta distribution has been widely used to model yield distribution (for example, Babcock and Hennessy 1996, Hennessy et al. 1997 and, Coble et al. 1996). We recognize the limitation of not allowing for skewness in the yield distribution, but we employ the normal distribution to keep the computation of the probability transition matrix tractable, since we are dealing with the joint distribution of price and yield, where price and yield are correlated.

To compute the transition matrix, we also need to estimate the first and second moments of price and yield. Equations for expected price and yield are estimated as seemingly unrelated regressions, using time series data for the period 1980-2005 (price and yield data

[9]The correlation coefficient was estimated as -0.62 for price and yield for years 1980-2004 with a p value of 0.001.

are obtained from the National Agricultural Statistics Service (NASS)). Nominal prices are deflated to 2005 prices using the GDP price deflator. The results of the estimation are obtained as[10]:

$$EY_t = 95.80 + 1.95 * T - 29.06 * D_y, \tag{6}$$

$$EP_t = 0.83 + 0.65 * P_{t-1} + 1.35 * D_p. \tag{7}$$

Expected yield, EY_t, depends on a trend variable, T and expected price, EP_t, depends on lagged price, P_{t-1}. D_y is a dummy variable which is equal to 1 for 1988 and 0 otherwise. D_p is a dummy variable which is equal to 1 for 1983 and 1995 and 0 otherwise. The dummy variables are used to treat for outliers[11]. The variance of yield, σ_Y^2, is estimated as 115.31 and the variance of price, σ_P^2, is estimated as 0.162.

Yield is known to have an upward trend and it is important to capture this in the per-period profit. To capture the trend in yield in (1) and to allow the yield states to be constant over time, we transform yield into a standard normal variable while calculating probabilities. Actual yield in a particular year, t, can be written as a function of the normalized yield

[10] All coefficients are statistically significant at the 5% level of significance. We also test for autocorrelated errors in the yield and price series using the Durbin-Watson test for yield and Durbin's h test for price. We could not reject the null hypothesis of no autocorrelation at the 5% level of significance.

[11] Outliers in the price and yield series were detected using studentized residuals. An alternate specification was also considered by deleting observations corresponding to the outlier years. Huber's M estimation was also used to identify outliers. In this case only outliers in the price series were detected, corresponding to the same two years. Two specifications of the EY_t and EP_t equations are estimated, one with a dummy variable for price and the second by deleting the observations for the outlier years. Finally we also estimate the two equations without treating for outliers. The results are robust to all the specifications used. See appendix A3 for details.

as $\tilde{Y}_t = \tilde{Y}_n * \sigma_Y + E(Y_t)$. We use this relation to substitute for $\tilde{Y}$ in the profit function. Then, π_t is a function of $\tilde{P}_t$, $\tilde{Y}_n$ and A_t. $\tilde{Y}_n$ also replaces $\tilde{Y}_t$ as the state variable in (4) and (5). Thus the yield states are specified in terms of $\tilde{Y}_n$: -1.75, -1.25, -0.75, -0.25, 0.25, 0.75, 1.25 and 1.75. The following price states ($/bu) were chosen to represent the probable range of prices: 1.625, 1.875, 2.125, 2.375, 2.625, 2.875, 3.125 and 3.375. The price and yield states have been constructed as mid-points of intervals. The first price interval starts at $ 1.5/bu and goes upto a maximum of $ 3.5/bu in increments of 25 cents. The first normalized yield interval starts at -2 bu/acre and goes upto a maximum of 2 bu/acre in increments of 0.5 bu/acre. Probabilities are then derived from the joint distribution of price and normalized yield[12]. While calculating the probability transition matrix we also take into account the truncation caused by the loan rate on the joint distribution of price and yield (following Greene 2002, chap. 22). We use numerical integration Miranda and Fackler 2002, chap. 5 to compute the probability transition matrix.

SDP_{VB} and SDP_{VNB} are solved using backward recursion. The terminal value functions, VB_6 and VNB_6 are initially assumed to be zero. We then solve for VB_1 and VNB_1 and substitute these back as VB_6 and VNB_6 to get an estimate of expected future income. We then solve again for VB_1 and VNB_1. These are the values that enter in (3). Finally we calculate the present value of expected profits as defined in (3) for each base state $\in BA'$. The farmer maximizes the expected present value over all base, price and yield states.

[12]An element of the transition matrix, $p^{i,j,k,l} = \int_{\underline{k}}^{\bar{k}} \int_{\underline{l}}^{\bar{l}} f(P, Y_n; \rho) dY_n dP$, where $f(\cdot)$ is the probability density function of a bivariate normal distribution and ρ is the correlation coefficient between price and yield. Price state $k \in (\underline{k}, \bar{k})$ and yield state $l \in (\underline{l}, \bar{l})$.

Results

The solution to the optimization problem is the optimal planted acreage to be planted in each of the years 2002-2006, conditional on the price state in the year 2001 and the farmer's subjective probability about the expected base update. For ease of exposition, we present the results in terms of the average of the optimal planted acreage for the years 2002-2006, $\bar{A}$, which is determined by the price states. This is because the expected price states depend on the lagged price states (equation 7). This does not mean that yields have no impact on the optimal acreage. The trend in yield affects the acreage choice in each year, though this effect is equal across all price states. Hence, we present the results for the eight price states. We refer readers to Appendix A4 for detailed annual results.

$\bar{A}$ for each of the price states and all values of δ is shown in table 3. With a few exceptions, $\bar{A}$ strictly increases as δ increases. For price state \$1.625/bu and $\delta = 0.25$ and 0.5, price state \$1.875/bu and $\delta = 0$ and 0.25 and price state \$2.125/bu and $\delta = 0$, it is optimal for the farmer not to make any changes to the acreage, i.e., it is optimal for the farmer to continue planting 1000 acres in each of the years 2002-2006[13]. This result is driven by low prices. Figure 1 plots $\bar{A}$ against the price states for each value of δ. As δ increases, $\bar{A}$ shifts outwards. Figure 2 measures the supply response to the expected base update. When $\delta = 0$, $\bar{A}$ is determined by market conditions and farm programs in place in 2002-2006. Thus, $\bar{A}$ at $\delta = 0$ is the benchmark to which we compare the $\bar{A}$ for $\delta > 0$. $\bar{A}_{|\delta>0} - \bar{A}_{|\delta=0}$ measures the supply effect of the expected base update. We also compute

[13]We assume that the farmer is producing 1000 acres at the beginning of 2002.

the percentage increase in $\bar{A}$ for $\delta > 0$ relative to $\delta = 0$. These are presented in table 4. For price states, \$1.625, \$1.875 and \$2.125/bu farmers receive both DPs and CCPs. There is therefore a link between an expected base update and future DPs and CCPs. The maximum percentage increase is 6% for \$2.125/bu and $\delta = 1$. It decreases to 4% as δ decreases to 0.5. For \$2.125/bu, the percentage increase is the highest for all values of $\delta > 0$. For price states, \$2.375, \$2.625, \$2.875, \$3.125 and \$3.375, only DPs are made to farmers and therefore the results for these price states captures the supply effect of the expected base update for the "decoupled" DPs. Note that the effect of the CCPs are not removed entirely for these states, as there is a possibility of the realization of a low price state. However, since the probability of the realization of a low price state is very small, the effect of the CCPs are weak for these price states. Averaged over the five price states, the percentage increase in acreage for $\delta = 1$ is about 4%. When δ falls to 0.5 it decreases to less than 3%.

Uptil this point in our analysis, we assume that the policy parameters in the 2002 and 2007 Farm Bills remain the same and the farmer is faced only with uncertainty about the expected future base update. Next we analyze the effect of a reduction in the loan rate and the target price over 2007-2011, which would effect the LDPs and CCPs[14]. The reduced rates are taken from FAPRI 2005. These rates have been reduced to meet the October 2005 U.S proposal in the WTO agricultural negotiations. First, we assume that there is no uncertainty about the reduction in the LR and TP. We also solve the model by assuming that there is uncertainty about the reduction in the LR and TP. Then, δ captures not only the uncertainty about a future base update, but also the uncertainty about the reduction in LR

[14]The reduction in LR also affects the probability transition matrix, via the effect of truncation.

and TP. With reduced LR and TP, (with and without uncertainty about their reduction), the expected present value of profits are lower compared to our earlier results. However, there is no change in $\bar{A}$. This is because the reduction in the expected present value of profits is not large enough to affect the optimal planted acreage.

We also conduct sensitivity analysis for a change in the acreage price elasticity. Results for an acreage price elasticity of 0.6 are presented in tables 5 and 6, and figures 3 and 4. Comparing tables 4 and 6 shows that increasing the acreage price elasticity has a significant effect on the acreage supply response to the expected base update. However, the effect remains small. The maximum percentage increase changes from 6% to around 8%. Much Lower values of acreage price elasticity would be consistent with viewing our model as a stylized representation of aggregate agricultural supply. Hence, the 6-8% range corresponds to a single crop response to a future base update, whereas the response of aggregate agricultural supply to a future base update would be much lower than 6%.

We also solve the model with increased yield variability[15]. Increased yield variability results in a widening of the range of $\tilde{Y}_t$ ($\tilde{Y}_t = \tilde{Y}_n * \sigma_Y + E(Y_t)$), which widens the range of profits and expected profits. This results in a decrease in $\bar{A}$ for most price states and most values of δ. The results are presented in tables 7 and 8. However, the difference in the percentage change in $\bar{A}$ is small as compared to table 4. While important, yield variability assumptions do not affect our qualitative results. The magnitude of the estimated acreage expansion induced by possible future base update remains virtually unchanged.

[15]It is assumed that farm-level yields are three times more variable than national level yields.

Conclusion

There is a large literature analyzing the effects of decoupled payments in the United States (the PFC payments in the 1996 FAIR Act and the DPs in the 2002 FSRI Act) on farmer decisions. The literature has identified five major coupling mechanisms of decoupled payments. They arise because of the presence of uncertainty and imperfect credit markets; because they affect the labor supply decisions of farmers and they increase land values and rents. Farmers also form expectations about future decoupled payments and respond to these expectations by changing current production decisions. The take home point from the literature on decoupling as well as from our paper is that decoupled payments do have some coupling effects, though these effects are small in magnitude. One obvious exception is the impact of decoupled payments on land values. Since decoupled payments are non-stochastic in nature and are paid on historical acreage, they increase land values significantly. One obvious exception is the impact of decoupled payments on land values. Since decoupled payments are non-stochastic in nature and are paid on historical acreage, they increase land values significantly.

Our paper adds to the current literature, by presenting a formalized model to examine and quantify the role of base updating in a farmer's decision making process on current acreage decisions. The latter has been conjectured but not formalized in previous analyses. We analyze the effect of an expected base update in the 2007 Farm Bill on a farmer's acreage decision in 2002-2006, in the presence of price and yield uncertainty. The average optimal planted acreage over 2002-2006 is weakly increasing in the subjective beliefs of the farmer about a future opportunity to update base acreage. We find that the maximum percentage increase in the average of the optimal planted acreage over 2002-2006 is 6%, conditional on price and certainty of a base update being allowed. At low prices, when CCPs are positive, any opportunity to update base increases both the DPs and the CCPs. But at higher prices the link between optimal acreage planted in 2002-2006 and future DPs is stronger.

Our results indicate that expectations about future policies also influence producer decisions. These results have important policy implications for the WTO negotiations in the Doha round. At present, the proposals of the U.S. and EU, or even the Harbinson proposal for the Doha round do not contain any changes to the green-box payments. Furthermore, the WTO ruling against the cotton DPs in the United States, was on the basis of the planting restrictions. The WTO appellate body did not rule against the base updating allowed for the DPs. Our results provide a measure of the effect of base updating. Even though the magnitude of the effect is small, base updating shouldn't be allowed for decoupled payments. Hence, the green-box criteria for decoupled payments must be made very clear, with no room for ambiguities. Once a base update is allowed, decoupled payments should no longer be classified as green-box payments.

Lastly, our model assumes a single crop for tractability. In a more realistic scenario, farmers would plant more crops and DPs would affect the allocation of land between these crops drawing land away from non program crops in addition to drawing from idled land. We mimic this situation with a higher acreage supply response but without any ability to say what would happen to all individual crops. Rationalizing our model as a stylized aggregate agricultural model, our results provide an upper bound on the aggregate supply response to an expected base update. Last and somewhat offsetting, our analysis is conducted in the short run. In the long run, costs curves are flatter and one would expect the acreage response to be higher than in the short run, even in aggregate. In the long run, acreage expansion resulting from expected future base update would also increase.

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Table 1. Model Parameters

β	0.95
BA	1000 acres
D	0.28
Y_d	118 bu/acre
Y_c	130.48 bu/acre
F	$ 208230
b	-23.47
c	0.00012
ρ	-0.62

Table 2. Loan Rates and Target Price for 2002-2011

	2002	2003	2004	2005	2006
LR	1.98	1.98	1.95	1.95	1.95
TP	2.60	2.60	2.63	2.63	2.63

	2007	2008	2009	2010	2011
LR	1.91	1.86	1.82	1.78	1.74
TP	2.59	2.56	2.52	2.48	2.45

Table 3. Average Optimal Planted Acreage over 2002-2006

	δ				
Price State	0	0.25	0.5	0.75	1
1.625	990	1000	1000	1020	1040
1.875	1000	1000	1020	1040	1050
2.125	1000	1020	1040	1050	1060
2.375	1030	1050	1050	1060	1080
2.625	1050	1060	1070	1090	1100
2.875	1070	1090	1100	1100	1120
3.125	1100	1100	1120	1130	1140
3.375	1120	1130	1140	1150	1160

Table 4. Percentage Change in $\bar{A}$ Relative to $\delta = 0$

	δ			
Price State	0.25	0.5	0.75	1
1.625	1.01	1.01	3.03	5.05
1.875	0.00	2.00	4.00	5.00
2.125	2.00	4.00	5.00	6.00
2.375	1.94	1.94	2.91	4.85
2.625	0.95	1.90	3.81	4.76
2.875	1.87	2.80	2.8	4.67
3.125	0.00	1.82	2.73	3.64
3.375	0.89	1.79	2.68	3.57

Table 5. Average Optimal Planted Acreage over 2002-2006 with Acreage Price Elasticity of 0.6

	δ				
Price State	0	0.25	0.5	0.75	1
1.625	1000	1010	1030	1050	1070
1.875	1010	1030	1050	1070	1090
2.125	1040	1050	1070	1090	1110
2.375	1060	1080	1100	1120	1130
2.625	1100	1110	1130	1140	1160
2.875	1130	1140	1160	1180	1190
3.125	1160	1180	1190	1210	1220
3.375	1190	1210	1220	1230	1250

Table 6. Percentage Change in $\bar{A}$ relative to $\delta = 0$ with Acreage Price Elasticity of 0.6

	δ			
Price State	0.25	0.5	0.75	1
1.625	1.00	3.00	5.00	7.00
1.875	1.98	3.96	5.94	7.92
2.125	0.96	2.88	4.81	6.73
2.375	1.89	3.77	5.66	6.60
2.625	0.91	2.73	3.64	5.45
2.875	0.88	2.65	4.42	5.31
3.125	1.72	2.59	4.31	5.17
3.375	1.68	2.52	3.36	5.04

Table 7. Average Optimal Planted Acreage over 2002-2006 with increased yield variability

	δ				
Price State	0	0.25	0.5	0.75	1
1.625	950	950	970	990	1000
1.875	960	980	1000	1000	1020
2.125	1000	1000	1010	1030	1040
2.375	1010	1030	1040	1050	1060
2.625	1050	1050	1060	1080	1090
2.875	1060	1080	1100	1100	1110
3.125	1100	1100	1110	1130	1140
3.375	1120	1140	1150	1150	1160

Table 8. Percentage change in $\bar{A}$ relative to $\delta = 0$ with increased yield variability

	δ			
Price State	0.25	0.5	0.75	1
1.625	0.00	2.11	4.21	5.26
1.875	2.08	4.17	4.17	6.25
2.125	0.00	1.00	3.00	4.00
2.375	1.98	2.97	3.96	4.95
2.625	0.00	0.95	2.86	3.81
2.875	1.89	3.77	3.77	4.72
3.125	0.00	0.91	2.73	3.64
3.375	1.79	2.68	2.68	3.57

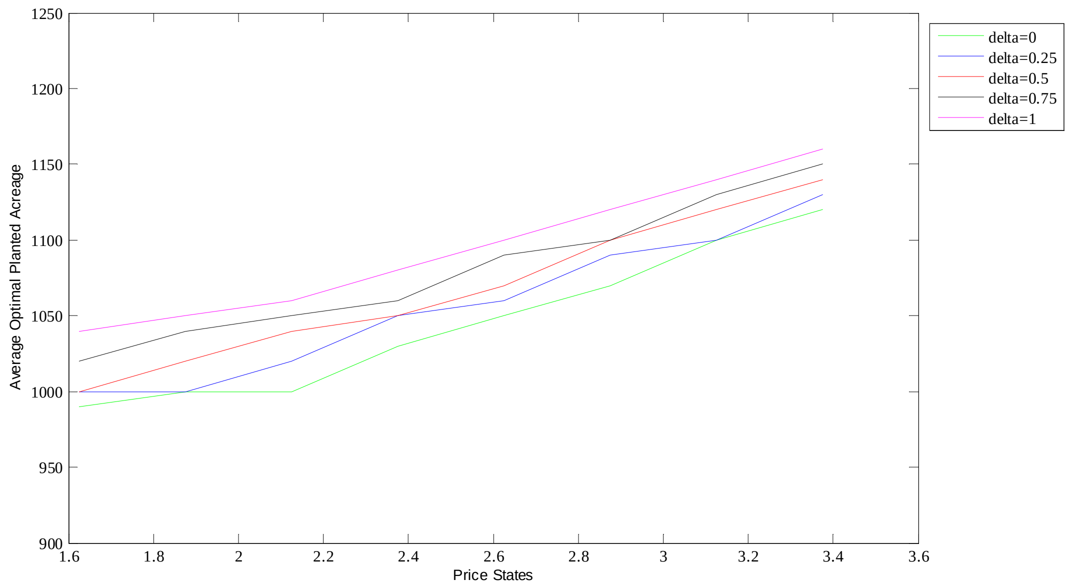

Figure 1. Average optimal planted acreage

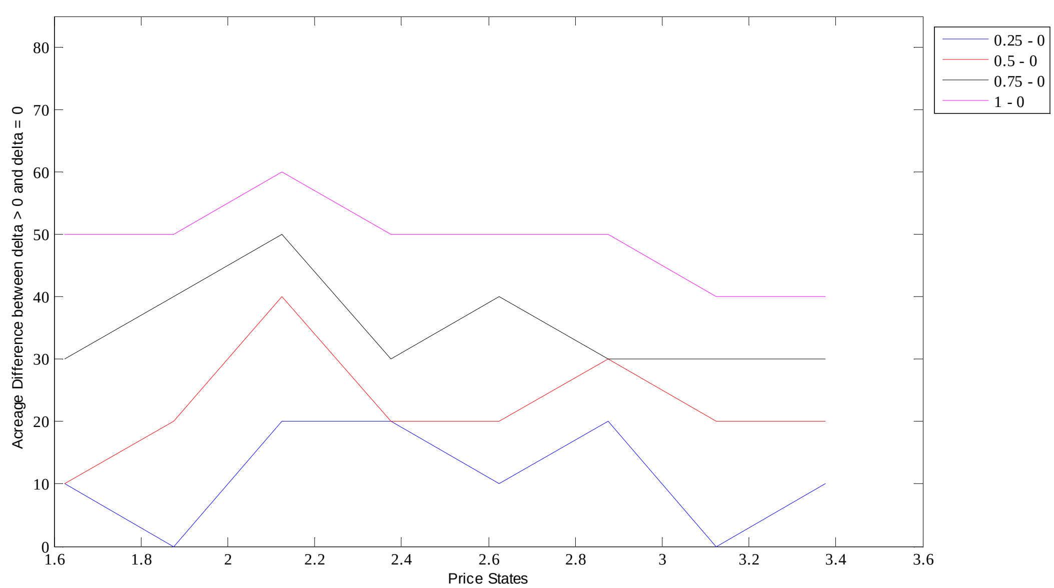

Figure 2. Difference between average optimal planted acreage at $\delta > 0$ over $\delta = 0$

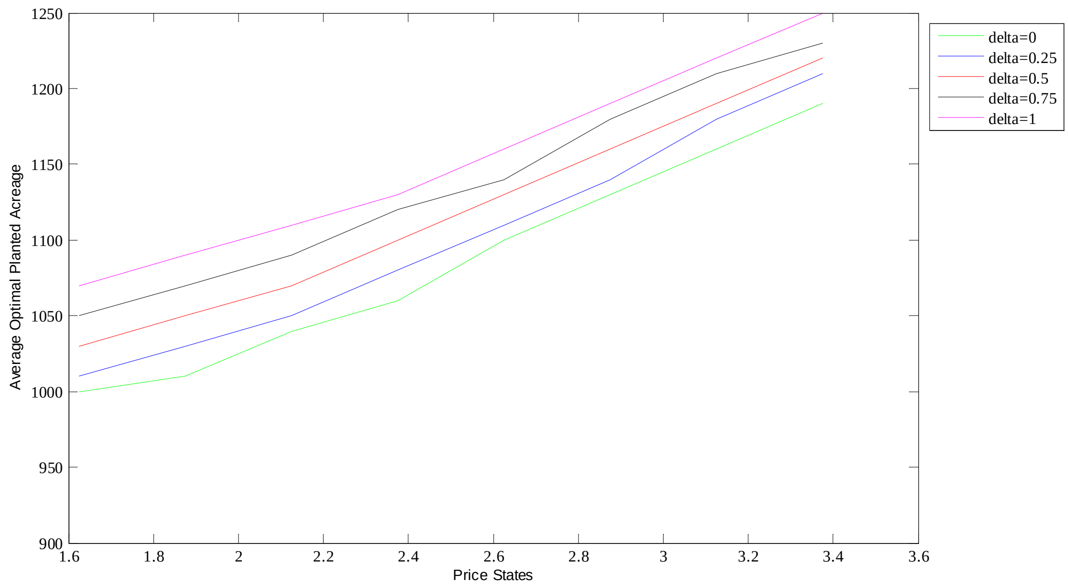

Figure 3. Average optimal planted acreage with acreage price elasticity of 0.6

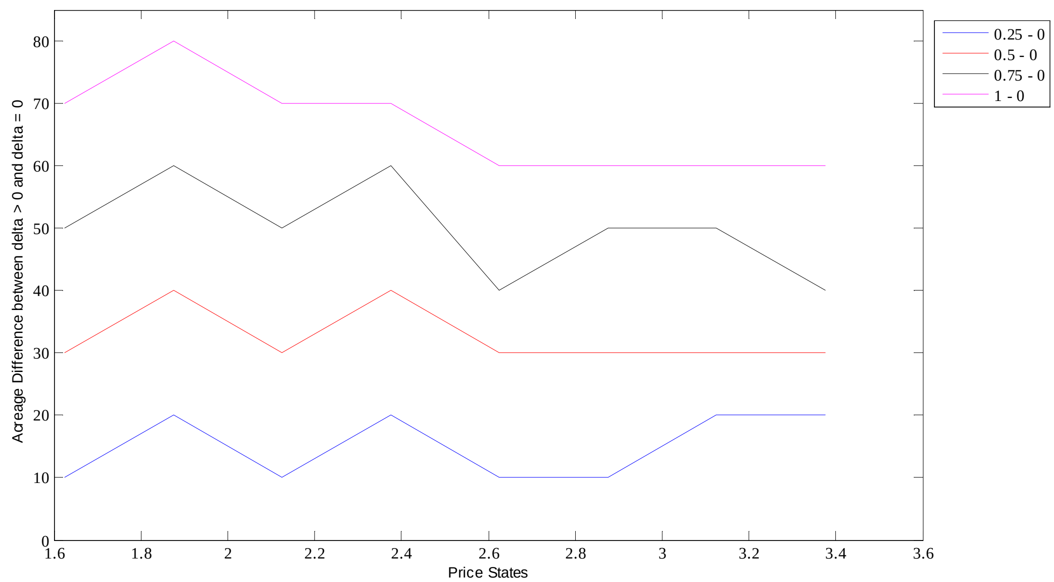

Figure 4. Difference between average optimal planted acreage at $\delta > 0$ over $\delta = 0$ with acreage price elasticity of 0.6

Appendices

A1. Total cost calibration

Data for the fixed cost, F, has been taken from Economic Research Service (ERS) data on production costs for corn. F has been defined as the total allocated overhead per acre and includes the following: (i) hired labor, (ii) opportunity cost of unpaid labor, (iii) capital recovery of machinery and equipment, (iv) opportunity cost of land (rental rate), (v) taxes and insurance and, (vi) general farm overhead. Given F, we solve for the coefficients, b and c, using the profit maximization condition and the acreage price elasticity. We calibrate total cost to 2005 data. The corn price and yield, equal \$1.9/bu and 147.9 bu/acre respectively. For a 1000 acre farm, F = $\$208,230$.

(1) $\pi_t = \bar{P}_t\bar{Y}_tA_t + max(LR - (\bar{P}_t - 0.26), 0)\bar{Y}_tA_t + DP + CCP - (F + bA + cA^3).$

DPs and CCPs do not enter into the profit maximization condition. The LR for 2005 was \$1.95/bu, while the corn price was \$1.9/bu. This results in a positive LDP rate. The profit maximization condition with a positive LDP rate is:

(2) $$\frac{\partial\pi}{\partial A} = (LR + 0.26)\bar{Y} - b - 3cA^2 = 0.$$

The optimal acreage responds to the loan rate, LR and we have:

(3) $$\frac{\partial A}{\partial LR}\frac{LR}{A} = \left(\frac{(LR + 0.26) * \bar{Y} - b}{3c}\right)^{-1/2} \frac{LR * \bar{Y}}{6cA}.$$

We solve for b and c for a 1000 acre corn farmer, with an acreage price elasticity equal to 0.412. We get $b = -23.47$ and $c = 0.00012$.

A2. Alternate Specification of Total cost

An alternate specification of total cost considered is, $TC(A_t) = F + \gamma A^{\eta}$. We calibrate γ and η, following the method specified in A1, with the same data. The per-period profit is given by:

(4) $$\pi_t = \bar{P}_t \bar{Y}_t A_t + max(LR - (\bar{P}_t - 0.26), 0)\bar{Y}_t A_t + DP + CCP - (F + \gamma A^{\eta}).$$

The profit maximization condition with a positive LDP rate is :

(5) $$\frac{\partial \pi}{\partial A} = (LR + 0.26)\bar{Y} - \gamma \eta A^{\eta - 1} = 0.$$

From the FOC:

(6) $$LR + 0.26 = \frac{\gamma \eta A^{\eta - 1}}{\bar{Y}}.$$

and,

(7)
$$\frac{\partial LR}{\partial A} = \frac{\gamma\eta(\eta - 1)A^{\eta-2}}{\bar{Y}}.$$

Acreage Price elasticity, $\epsilon = \frac{\partial A}{\partial LR}\frac{LR}{A} = \frac{LR}{(\eta-1)(LR+0.26)}$, which allows us to identify η as $\frac{LR}{\epsilon(LR+0.26)} + 1$. This in turns gives us, $\gamma = \frac{(LR+0.26)\bar{Y}}{\eta A^{\eta-1}}$. Solving we get, $\eta = 3.14$ and $\gamma = 0.00004$ for LR = 1.95, A = 1000 and $\bar{Y} = 147.9$ bu/acre.

The results for $\bar{A}$ and the percentage change in $\bar{A}$ relative to $\delta = 0$ are presented below. Comparison with Tables 3 and 4 indicates that the results very similar with this specification of total cost.

Table A2.1: Average Optimal Planted Acreage

	δ				
Price State	0	0.25	0.5	0.75	1
1.625	1000	1000	1010	1030	1050
1.875	1000	1010	1030	1050	1050
2.125	1010	1040	1050	1050	1070
2.375	1050	1050	1060	1070	1090
2.625	1050	1070	1090	1100	1100
2.875	1090	1100	1100	1120	1130
3.125	1100	1110	1130	1140	1150
3.375	1130	1140	1150	1160	1170

Table A2.2: Percent change in $\bar{A}$ relative to $\delta = 0$

	δ			
Price State	0.25	0.5	0.75	1
1.625	0.00	1.00	3.00	5.00
1.875	1.00	3.00	5.00	5.00
2.125	2.97	3.96	3.96	5.94
2.375	0.00	0.95	1.90	3.81
2.625	1.90	3.81	4.76	4.76
2.875	0.92	0.92	2.75	3.67
3.125	0.91	2.73	3.64	4.55
3.375	0.88	1.77	2.65	3.54

A3. Alternate Specifications for the estimation of expected price and yield

Outlier detection for the price and yield series has been conducted using two methods. The first method used to identify outliers, compares the studentized residuals to the critical value $t(1 - \frac{\alpha}{2}; n - k - 2)$, where k is the number of explanatory variables excluding the intercept, n is the total number of observations and α is the significance level. For $n = 25$ and $k = 1$ and 5% significance level, the critical value is $t(0.975; 22) = 2.074$. Comparing this to the absolute value of the studentized residuals, leads to the identification of one outlier in the yield series (corresponding to the year 1988 (yield $= 84.6$ bu/acre) and to two outliers in the price series (corresponding to years 1983 and 1995 (deflated price $= 5.44$ and 3.89 respectively). Based on this, two alternate specifications (models 1 and 2) have been considered. The first one employs dummy variables to capture the effect of these years. D_y is the dummy variable used in the yield equation and is equal to 1 if year $= 1988$ and 0 otherwise. Similarly, D_p is the dummy variable used in the price equation and is equal to 1 if year $= 1983$ and 1995 and 0 otherwise. The second model is estimated after deleting observations for the outlier years.

Model 1

$$EY_t = \beta_0 + \beta_1 time + \beta_2 D_y \quad (1)$$

$$EP(t) = \gamma_0 + \gamma_1 P_{t-1} + \gamma_2 D_p \quad (2)$$

Model 2

$$EY(t) = \beta_0 + \beta_1 T \quad (3)$$

$$EP(t) = \gamma_0 + \gamma_1 P_{t-1} \tag{4}$$

Using robust regression (Huber's M estimation), only outliers in the price series are identified. The outliers identified are the same as the ones identified using the studentized residuals. Model 3 is estimated with a dummy variable for the price equation. Model 4 is estimated after deleting observations for the price outlier years.

Model 3

$$EY(t) = \beta_0 + \beta_1 T \tag{5}$$

$$EP(t) = \gamma_0 + \gamma_1 P_{t-1} + \gamma_2 D_p \tag{6}$$

Model 4

$$EY(t) = \beta_0 + \beta_1 T \tag{7}$$

$$EP(t) = \gamma_0 + \gamma_1 P_{t-1} \tag{8}$$

Finally model 5 is estimated using all 25 observations without accounting for price and yield outliers.

Model 5

$$EY(t) = \beta_0 + \beta_1 T \tag{9}$$

$$EP(t) = \gamma_0 + \gamma_1 P_{t-1} \tag{10}$$

All specifications have been estimated using Seemingly Unrelated regression (SUR); T is a trend variable and P_{t-1} is lagged price.

Table A3.1: Comparing estimates of coefficients across models

Parameter Estimates	Model 1	Model 2	Model 3	Model 4	Model 5	Robust regression
$\hat{\beta}_0$	95.80	97.73	93.48	94.52	92.80	96.10
$\hat{\beta}_1$	1.95	1.85	2.04	1.98	2.09	1.89
$\hat{\beta}_2$	-29.06	-	-	-	-	-
$\hat{\gamma}_0$	0.83	0.88	0.85	0.90	0.63	0.93
$\hat{\gamma}_1$	0.65	0.64	0.65	0.64	0.72	0.62
$\hat{\gamma}_2$	1.35	-	1.37		-	-

Table A3.2: Comparing estimates of yield and price variance across models and R^2

	Model 1	Model 2	Model 3	Model 4	Model 5
$\hat{\sigma}^2_{Y_t}$	115.31	83.43	145.11	123.58	145.11
$\hat{\sigma}^2_{P_t}$	0.162	0.19	0.162	0.18	0.226
R^2_Y	0.6950	0.6924	0.5987	0.6284	0.5987
R^2_P	0.8279	0.7076	0.8279	0.7127	0.6376

A4. Optimal planted acreage for each of the years 2002-06

Table A4.1: Optimal Planted Acreage

	2002	2003	2004	2005	2006
δ			**\$1.625**		
0	950	1000	1000	1000	1000
0.25	1000	1000	1000	1000	1000
0.5	1000	1000	1000	1000	1000
0.75	1000	1000	1000	1050	1050
1	1000	1050	1050	1050	1050
			\$1.875		
0	1000	1000	1000	1000	1000
0.25	1000	1000	1000	1000	1000
0.5	1000	1000	1000	1050	1050
0.75	1000	1050	1050	1050	1050
1	1050	1050	1050	1050	1050
			\$2.125		
0	1000	1000	1000	1000	1000
0.25	1000	1000	1000	1050	1050
0.5	1000	1050	1050	1050	1050
0.75	1050	1050	1050	1050	1050
1	1050	1050	1050	1050	1100
			\$2.375		
0	1000	1000	1050	1050	1050
0.25	1050	1050	1050	1050	1050
0.5	1050	1050	1050	1050	1050
0.75	1050	1050	1050	1050	1100
1	1050	1050	1100	1100	1100
			\$2.625		
0	1050	1050	1050	1050	1050
0.25	1050	1050	1050	1050	1100
0.5	1050	1050	1050	1100	1100
0.75	1050	1100	1100	1100	1100
1	1100	1100	1100	1100	1100
			\$2.875		
0	1050	1050	1050	1100	1100
0.25	1050	1100	1100	1100	1100
0.5	1100	1100	1100	1100	1100
0.75	1100	1100	1100	1100	1100
1	1100	1100	1100	1150	1150
			\$3.125		
0	1100	1100	1100	1100	1100
0.25	1100	1100	1100	1100	1100
0.5	1100	1100	1100	1150	1150
0.75	1100	1100	1150	1150	1150
1	1100	1150	1150	1150	1150
			\$3.375		
0	1100	1100	1100	1150	1150
0.25	1100	1100	1150	1150	1150
0.5	1100	1150	1150	1150	1150
0.75	1150	1150	1150	1150	1150
1	1150	1150	1150	1150	1200