The Market Value of Counter-Cyclical Payments:

Corn in the Northeast

David Skully & Gerald Plato

Economists, USDA/ERS/MTED

A paper supporting

"What (if anything) do Counter-cyclical Payments do?"

A presentation at

Modeling U.S. and EU Agricultural Policy: Focus on Decoupled Payments,

a workshop sponsored by

USDA/Economic Research Service & the Farm Foundation.

4-5 October, 2004

Washington, D.C.

Abstract: The counter-cyclical payments [CCP] of the 2002 Farm Act are put-option spreads on U.S. marketing-year average prices. The paper estimates the value of these spreads. It also calculates the hedge efficiency of corn CCPs; this value is low in the Northeast because much corn acreage is cut for silage.

 This is a conference paper that reports results from an on-going program of research; the authors welcome comments. Option-related comments are best addressed to Plato, and those related to hedging and base acreage, to Skully.

E-mail contacts: DSKULLY@ers.usda.gov; GPLATO@ers.usda.gov.

The Market Value of Counter-Cyclical Payments: Corn in the Northeast

1. Introduction

The 2002 Farm Act introduced two new forms of government payments that, in part, replace the production flexibility contract (PFC) payments of the 1996 Farm Act—Direct Payments (DP) and Counter-cyclical Payments (CCP). Both payments are based on a farm's program planting and yield histories; both payments are decoupled from current planting and production. Payment recipients are not obligated to plant or restrict planting of any program commodity: there is relatively unlimited planting flexibility. Direct payments are essentially the same as PFC payments and are relatively well-understood. Counter-cyclical payments are new and not well-understood.

This paper reports some results of on-going research on the economics of counter-cyclical payments. The paper has five sections. Following the introduction, Section 2 explains how CCPs work. It operationalizes the payments specified in the 2002 Act and shows that CCPs are equivalent to an average-price put option spread. Section 3 employs option-pricing theory to value CCPs, and values corn CCPs for the current and recent crop years. Section 4 identifies the factors that determine the counter-cyclical effectiveness of CCPs and examines the effectiveness of corn CCPs in the Northeastern States. Section 5 concludes the paper.

This paper, focuses on CCPs for corn in the Northeastern states. Corn is by far the most important program commodity crop in the Northeast, accounting for 3.1 million of the 4.8 million base acres in the 12 Northeastern states—63.5 percent in total. In New England, except for Maine, corn base is over 95 percent of total base. [See Figure 1 and Table 1 (at end of document)] Corn in the Northeast also provides an interesting case study because much of the acreage planted to corn is not harvested for corn grain, rather it is cut for silage. Although the paper restricts its focus to corn, the arguments presented here are generalizable to the CCPs associated with other program commodities. Focusing on a specific commodity in a specific region has the advantage of giving some concreteness to an otherwise abstract topic.

2. How Counter-cyclical Payments [CCPs] work

A farm's CCP for corn is determined by three factors: the farm's corn base acreage, the farm's corn counter-cyclical program yield, and the payment rate for corn. The amount paid is the product of these three factors and 0.85.

CCP = [Base acres X 0.85] X [CC program yield] X [Payment rate]

A farm's base acres are determined by its planting history and the farmowner's base designation under the 2002 Farm Act.[1] Similarly, a farm's counter-cyclical program yield is based on the farm's yield history. These two factors are unique to each farm (and for each program commodity). The Farm Act authorizes payments to "payment acres" which are defined as 85 percent of base acres; thus the factor 0.85 is applied to all base acres for determining payments. The final term, the payment rate, depends on "the national average market price received by producers during the 12-month marketing year for the covered commodity, as determined by the Secretary."[2] In this paper we refer to this price as USMYAP—the U.S. marketing year average price. It is what USDA-NASS reports in its publication, *Agricultural Prices*. Since USMYAP varies year-to-year, the value of the CCP can also vary.

---

[1] The language authorizing DPs and CCPs is found in Title I, Subtitle A, Sections 1101-1104 of the Farm Security and Rural Investment Act of 2002. See: http://www.usda.gov/farmbill/conference_report/title1.pdf

[2] Farm Act of 2002, Section 1104 (b)1:A. The word "producers" in the legislation points to an important issue which we do not address in this paper. This is the distinction between the owners of base acres and renters of base acres. Payments are attached to ownership of base acres, but payment is made to the producer. A tenant that cash leases base acreage receives the payments, but the value of the payment is probably captured in the rent paid to the landowner. In this paper we assume that the owner and the operator (or producer) are the same person(s).

The most direct way to define the payment rate for the CCP is that it is the "Effective Target Price" minus the "National Average Loan Rate" or USMYAP, whichever is greater. In no case is the payment less than zero. All these values, except USMYAP, are specified in the Farm Act. The values for corn are shown in table (below).

Corn (bu)	2002, 2003	2004-07
Target Price	$2.60	$2.63
Direct Payment	$0.28	$0.28
"Effective Target Price"	$2.32	$2.35
USMYAP	?	?
National Loan Rate	$1.98	$1.95

The "Effective Target Price" is the target price less the direct payment—$2.32 for 2003. When USMYAP is greater than the effective target price, as was in 2002 and is in 2003, the payment rate is zero. If USMYAP were to fall below the loan rate, the payment rate would be capped at 34 cents for 2003 and 40 cents for 2004-2007. So, the corn CCP payment rate can range anywhere between zero and 34 (or 40) cents, depending on the value of USMYAP. The next section shows that the payment rate is identical to an option position known as a bear put spread.

3. CCPs as Options

The payment rate for the CCP is shown in figure 2, it plots the payment rate ($/bu) against USMYAP ($/bu). The CCP payment rate is identical to a put-option position known as a bear spread. A put option, like the CCP itself, is a derivative. Its value is derived from, or based on, the price of a specific asset or commodity. The following expression defines the value of a put option at expiration.[3] For example, a put option with a strike price of $2.32 for corn pays $0.01 if the ending price of corn is $2.31; if the ending price is $2.33, the final value of the option is zero.

If Strike price > ending price	Put (.) = Strike price – ending price;
Otherwise	Put (.) = zero.

The bear spread that replicates the corn CCP is a combination of two put options on USMYAP. One buys a put with a strike price of $2.32 and sells an otherwise identical put with a strike price of $1.98.

$$CCP (t) = + Put (2.32, t) - Put (1.98, t).$$

Determining the payment rate at the end of the marketing year is simple because USMYAP is known with certainty: one simply adds and subtracts known values. What is the value of this derivative prior to expiration, when the key value, USMYAP, is not known? Suppose a CCP-recipient wished to sell or pledge the value of anticipated CCPs at harvest; what would be a fair price or value? Option-pricing theory can answer these questions.

Standard options are determined by the price of the underlying asset at expiration/settlement. Non-standard or "exotic" options have emerged to address more complex risk-management problems, among them is the class of "average options." The final value of an average option is determined by the *average price* of the underlying asset over a specified period. For example, a newspaper that purchases a predictable flow of newsprint could limit the exposure to the risk of newsprint price movements through an average option.

The intuition behind standard option pricing is that asset and commodity prices follow random walks. If we can forecast today the most likely distribution of prices at expiration, we can also calculate the expected value of the option at expiration. The price of the option today is this expected settlement value, discounted by the appropriate discount rate. Pricing average options is more complicated: one must forecast the

[3] USDA can pay the CCP in installments (in October and February of the corn marketing year) if it is expected to have a positive value, based on projections of USMYAP. Here we assume there is one payment at the end of the marketing year, 30 August. In option terminology this corresponds to European settlement.

distribution of price *paths*, not merely their final values, and then determine the appropriate average (arithmetic, geometric, weighted, etc.) price for each path. While analytical solutions (closed formulae) exist for the standard option pricing problem, there is no analytical solution for the average-price options other than for geometric-average options. For the marketing-year average options one must use simulation or an analytical approximation. Simulation has proven to be the most accurate and flexible method.

We make one simplifying assumption in simulation: we ignore storage, that is, we do not include the cost of storage or the convenience yield associated with ownership of a physical commodity. These values are difficult to estimate, and our sensitivity analysis indicates that ignoring this variable does not significally influence our simulation results. The following equation is used to simulate price paths.[4]

$$S_t = S_{t-1}\, e^{\left[-\frac{1}{2}\sigma^2 + z_i \sigma \sqrt{h}\right]}$$

σ – is the volatility of the price of the underlying asset, USMYAP. We use mid-month corn prices reported by NASS in *Agricultural Prices* to estimate corn price volatility. The table below shows estimated volatilities, expressed as annual volatilities, for marketing years 1995-2002. The average of these values, 0.21, is the estimate of σ used in simulation.[5]

z_i – is a standard normal variable. It is a random drawing from a normal distribution with zero mean and unit standard deviation, N(0,1).

h – is a factor that converts the annual volatility to a daily volatility: h = 1/365.

Annual Volatilities of the USMYAP for the 1995 through 2002 Marketing Years.

Marketing Year	Volatility
1995	0.16
1996	0.24
1997	0.18
1998	0.22
1999	0.27
2000	0.17
2001	0.23
2002	0.16

To simulate a price path extending to the end of the marketing year from planting, 475 days = 365 + 110 growing season, we start with today's expection of the season average price, S_{T-475}. We then draw a value of z from the standard normal distribution, and use the equation above to determine S_{T-474}. We repeat this process until we reach S_T. We then take the weighted-average value of the last 365 prices. This average is one simulated value of USMYAP. We then calculate option values for puts with strike prices of $2.32 and $1.98 and finally calculate the CCP option by subtracting the price of the $1.98 put from the $2.32 put. To get a useful distribution of USMYAP values and option prices, we repeat this process 10,000 times. The mean of this distribution is the expected value of the CCP at expiration; its value at planting its the present (discounted) value.[6] We also simulate the value of the bear spread at harvest, that is 365 days prior to expiration.[7]

[4] This is a "Monte Carlo" simulation approach; it is the preferred and most accurate method for the average option problem, see James, p. 215.
[5] The formula for estimating volatility from historical data can be found in most books on option pricing, for example, Hull, p. 239.
[6] The discount rate used is the 1-year Treasury, constant-maturity rate reported in April 2004—1.40%.
[7] The forecasted prices are constructed to be unbiased.

Figure 3 plots the at-harvest and at-planting option value (y-axis) against the expected value of USMYAP at harvest and at planting (respectively). Recall that we have fixed the volatility of USMYAP at 21%, so the variance of the distribution is determined by its mean. The three curves intersect at $2.15; this is the average of $1.98 and $2.32. For expected values greater than $2.15, the harvest and planting option values exceed the value at expiration. For expected value less than $2.15, the harvest and planting option values are less than the value at expiration. These differences increase the longer the time left remaining until expiration; the planting value is greater than the harvest value above $2.15, but less than the harvest value below $2.15.

Option pricing theory views options as having an intrinsic value and a time value. An option's intrinsic value is the difference between the strike price and the expected price [or zero if the difference is negative]. This is the value that would result if the option were settled immediately, as if there were no time remaining until expiration. The ending value is the same as the intrinsic value because there is no time remaining until expiration. Any difference between an option's observed value and its intrinsic value is attributed to its time value. Time value stems from the fact that prices can change in the time remaining until expiration.[8] The option spread is worth more than zero at expected values above $2.32 because there is a chance that USMYAP can fall below $2.32. The value at planting is greater than the value at harvest because the planting value has an additional 110 days for prices to fall. At very high expected prices (not plotted) the probability than USMYAP will fall below $2.32 approaches zero; the option value approaches the intrinsic value.

At values below $2.15 time values are negative. Negative time values can occur with option spreads but not with individual options. To understand negative time value, consider the point where the expected value of USMYAP is $1.98. At expiration the option spread pays exactly 34 cents. If we now allow some time until expiration, we increase the probability that expiration prices can change. For the $2.32 put higher prices will reduce its payoff below 34 cents, while lower prices will increase the payoff. For the $1.98 put, lower prices raise its payoff above zero, but higher prices do not lower its payoff because its value cannot fall below zero. So, although the values of both options increase when time remaining until expiration increases, the value of the $1.98 put increases more than the $2.32 put increases. Since the bear spread involves buying the $2.32 put and selling the $1.98 put, the net value of the spread falls. The tables below illustrate the negative and positive time value by reporting the values of both puts and the CCP-equivalent bear spread for different amounts of time remaining until expiration.

Negative time value (time value in parentheses)

Expected value of USMYAP	Time	days	Put($2.32)	Put($1.98)	CCP = P(2.32) – P(1.98)
$1.98	Expiration	0	0.34 (0)	0 (0)	0.34 (0)
	Harvest	365	0.35 (.01)	0.09 (.09)	0.26 (-.08)
	Planting	475	0.37 (.03)	0.13 (.13)	0.24 (-.10)

Positive time value (time value in parentheses)

Expected value of USMYAP	Time	days	Put($2.32)	Put($1.98)	CCP = P(2.32) – P(1.98)
$2.32	Expiration	0	0 (0)	0 (0)	0 (0)
	Harvest	365	0.11 (.11)	0.01 (.01)	0.10 (.10)
	Planting	475	0.15 (.15)	0.03 (.03)	0.12 (.12)

The analysis shows that using intrinsic values to estimate payouts at the end of the marketing year can both under and over estimate the expected payouts of the counter cyclical policy payments. The largest over

[8] Hull, p. 154, defines time value as that part of an option's value that derives the possibility of future favorable price moves in the underlying asset price.

estimate is at $1.98. The largest underestimate is at $2.32. These estimation errors are 29 and 26 percent of the maximum payment of $0.34.

One inference that may be drawn from these results is that corn CCP recipients may benefit by selling the rights to their CCPs at planting or harvest if the expected value of USMYAP is greater than $2.15. It is particularly advantageous to sell early when the expected value of USMYAP is $2.32. In this case, a CCP with an intrinsic value of zero can be sold for 10-12 cents/bu. Similarly, for expected values of USMYAP less than $2.15, it is generally best not to sell corn CCP rights prior to expiration.

4. How counter-cyclical are CCPs?

This section introduces an economic definition of counter-cyclical with the objective of measuring or evaluating the counter-cyclical value of CCPs to payment recipients. This economic definition should not be interpreted as formalizing the intent of Congress when it drafted Sect 1104 of the 2002 Farm Act. Various farm and commodity groups advocated some sort of counter-cyclical payment during the public debates preceding the 2002 Farm Act.[9] In this context, counter-cyclical payments were meant to replace and codify, or make more predictable or disciplined, the ad hoc appropriation of Marketing Loss Assistance (MLA) and other forms of emergency payments to producers in 1998-2001 when commodity prices fell below their 1996-97 levels. The general intent of the counter-cyclical provisions seems to have been to allow for decoupled payments to increase when program commodity prices fell below a specified price—what we have called the "effective target price" in section 2—but in a manner independent of whether recipients planted or produced the program crops.

CCPs, as specified in legislation and administered by USDA, are only determined by prices, specifically, the value of the USMYAP for the relevant program commodity: CCPs have nothing to do with a recipient's planting or production actions. So, if one asks: what are CCPs counter-cyclical to? The only plausible answer is that CCPs are counter-cyclical to USMYAP.

CCPs as a hedge

Hedging is a way of reducing one's exposure to future price changes. There is a large body of research on hedging; if CCPs are a kind of hedge, then one can draw upon this literature to analyze CCPs. This sub-section argues that CCPs belong to the class of hedges.

Here is a review of basic hedging. A farmer or a grain merchant (elevator) today (at time, t-0) owns or is about to own a quantity of corn. S/he plans to sell this corn at a later date (at time, t+1) but does not know how the price of corn will change in the interim. This (long) physical position in corn carries with it a large exposure to price risk. Hedging one's physical position with an off-seting futures position can reduce (and possibly completely remove) this price risk.

Physical position	$L/bu	$F/bu	Futures position
Buy corn: t-0	2.20	2.25	Sell futures: t-0
Sell corn: t+1	2.10	2.15	Buy futures: t+1
Net	-.10	+10	Net
Total change	0.00		

A futures position is a contract to buy or sell a standardized commodity at a specific time and place(s) in the future (time = t+1). The grain elevator buys corn from a local farmer today, t-0, for $2.20 (L, for local price); and simultaneously sells an equal amount of corn for delivery via a futures contract at t+1 for $2.25 (F, for futures). These are the prices prevailing in the corn market today, t-0 (local and future). No one knows what prices will be at t+1, but what the grain elevator does know is that local cash grain prices (at the elevator) and futures prices are highly correlated—assume for the moment that they are perfectly correlated. When time t+1 arrives, the elevator sells its physical corn position $2.10 and simultaneously

[9] Effland and Young (2001) survey the range of views about farm programs leading up to the 2002 Farm Act.

buys back its futures contract for \$2.15. The elevator incurs a loss on the physical transaction of 10 cents/bu; but gains 10 cents/bu on the futures transaction. The price changes exactly offset because we have assumed that local and futures prices are perfectly correlated; this implies that the two price *changes* are also perfectly correlated. For example, prices could have increased by 10 or 20 cents rather than falling 10 cents; but the total change of the hedge transaction will still be zero.

The standard measure of the efficiency of a hedge is based on the ratio of two variances. One divides the expected variance of the hedged position by the expected variance of the unhedged position. For a perfect hedge, the hedged position has an expected variance of zero, so the ratio of the variances is also zero. We subtract the ratio from one: thus E = 1 indicates a perfect hedge; E = 0 indicates that the hedge does nothing to reduce variance; and E < 0 indicates that the "hedge" actually increases variance relative to the unhedged position.[10]

$$E \quad = \quad 1 - \frac{Var(Hedged)}{Var(Unhedged)}$$

Is getting a corn CCP similar to hedging with a futures position? To start to answer this make two assumptions: 1) that one owns equal amounts of physical corn and corn CCP payment bushels [11] and 2) that local prices are perfectly correlated with USMYAP.[12] These assumptions place the CCP on an equal footing with the futures example above. When one knows that USMYAP will remain between \$1.98 and \$2.32 changes in USMYAP are exactly offset by changes in the value of the CCP: the CCP is a perfect hedge. So we can write E(CCP) = 1, but only when prices remain between \$1.98 and \$2.32. Alternatively, when one knows that USMYAP will either remain below \$1.98 or will remain above \$2.32, changes in USMYAP are not offset by changes in CCP. The CCP does not change at all; it offers no hedge, no variance reduction. So, under these conditions E(CCP) = 0. These are special cases, and the value of E(CCP) ranges from perfect to zero. The next sub-section examines E(CCP) under more general conditions.

The hedge efficiency of CCPs

Calculating the hedge efficiency of a corn CCP relative to USMYAP requires specifying the subjective or expected values of the mean and variance of USMYAP. This is similar to, but simplier than, the option price simulations of the previous section. Given a mean and variance for USMYAP one can determine the mean and variance of the CCP and the mean and variance of the sum, USMYAP + CCP. This gives us the two variance values needed to calculate hedge efficiency. One reads E(CCP|USMYAP) as the efficiency of CCP as a hedge for USMYAP.

$$E(CCP \mid USMYAP) \; = \; 1 \; - \frac{Var(USMYAP + CCP)}{Var(USMYAP)}$$

Figure 4 plots the value of E(CCP) for various expected distributions of USMYAP. The floor of the graph has two horizontal dimensions: the expected mean of USMYAP and the expected standard deviation of USMYAP. The hedge efficiency, E(CCP|..), is plotted on the vertical axis. The case where USMYAP is expected to remain between \$1.98 and \$2.32 is represented by mean = \$2.15 and standard deviation less than or equal to .05: in this range E(CCP|..) = 1. As the standard deviation increases, the probability that USMYAP will be outside the hedge interval increases and the hedge efficiency declines. The case where USMYAP always remains above \$2.32 is represented by mean ≥ \$3.00 and standard deviation ≤ 0.10; E(CCP) = 0. As the standard deviation increases E(CCP) increases because the probability that USMYAP < \$2.32 becomes greater than zero.

---

[10] Johnson (1960) is the seminal article.

[11] By payment bushels we mean: [Base acres X 0.85] X [CC program yield (bu/acre)]. These are the *quantity* factors determining the CCP.

[12] That is, we assume zero basis risk.

What is a plausible range for the mean and variance of USMYAP? To answer this we look to the data. The table below shows the mean and variance for USMYAP for the last 25, 20, 15 and 10 years and the first 10, 15 and 20 years following 1978. For these intervals, E(CCP) ranges between .372 and .506. If the future vaguely resembles the last 25 years then the 25-year value, E(CCP) = 0.448, is a reasonable estimate of the upper-bound of the long-run hedge efficiency of the corn CCP.

Corn USMYAP and CCP hedge efficiency

Period	Mean $/bu	St.dv $/bu	E(CCP)
Last 25 yrs. 1978-2002	2.36	.42	.448
Last 20 yrs. 1983-2002	2.31	.44	.445
Last 15 yrs. 1988-2002	2.31	.37	.506
Last 10 yrs. 1993-2002	2.31	.45	.449
First 20 yrs. 1978-1997	2.46	.41	.397
First 15 yrs. 1978-1992	2.40	.42	.428
First 10 yrs. 1978-1987	2.44	.51	.372

Before concluding this sub-section we emphasize that our estimate that E(CCP) ≈ .45 for corn is based on two assumptions: 1) that an individual farmer's average price received [APR] from corn grain sales during the marketing year is perfectly correlated with USMYAP (zero basis risk); and 2) that an individual farmer has (or produces) one bushel of corn grain for each potential payment bushel [CCP]. Altering either of these assumptions changes the hedge efficiency. In the next subsection we examine the first assumption by looking at how closely USMYAP is correlated with state-level prices. The less state-level marketing year average prices are correlated with USMYAP, the lower the value of E(CCP); the values in this section represent upper bound on the value of E(CCP).

Corn Prices and USMYAP

Figure 5 maps the correlation between corn USMYAP and state-level marketing-year average prices [MYAP] for corn in the United States. The Cornbelt states have the highest correlation with USMYAP; the Mountain and Southern States have lower correlations. The lowest state correlation is 0.814 (Florida); the highest is .9986 (Iowa). The simple average for all 41 NASS-reported states is 0.96. These high correlations reflect a highly integrated market for corn and other feedgrains in the continental United States. Only 41 states are included in the correlation analysis because NASS does not report corn MYAPs for Alaska, Hawaii, Nevada and the Six New England States. Three New England states—Maine, New Hampshire and Rhode Island—ceased reporting corn MYAPs in 1955; Connecticut, Massachusetts, and Vermont ceased reporting in 1966. From 1949 until they ceased reporting the five New England states (excepting Maine) reported identical corn MYAPs. The prices reported for Maine were either exactly 5 cents or 10 cents/bu greater than the other New England states. What's going on here? Why did New England stop reporting corn prices? The reason is simple: so little corn grain is harvested or marketing in New England that it became impossible to collect reliable or meaningful statistics.

Corn is planted in New England but almost all of it is cut for silage rather than harvested for grain.[13] [See figures 6 and 7.] The table below shows the proportion of acreage planted to corn that is cut for silage in the 12 Northeastern states. [2001 data for New England, 2002 data for other states] With the exception of the four southern-most states, each state also reports an average unit price for corn silage.[14] The table also reports the Pearson's *r* (the product-moment) correlation coefficients for state-level corn silage MYAPs and corn USMYAP for the period 1992-2001. The New England states have very low or negative *r* values;

[13] Program base acres are based on acreage *planted*, not on acreage harvest; USDA, for the purpose of determining program yields, imputes a grain yield to acreage on which silage or green chop is cut.

[14] In the six New England States, the New England Agricultural Statistics Service surveys farmers, asking them to estimate the market value of silage ensiled on their farm as of December 31st. This is a reasonable method given that virtually all silage is consumed on-farm and the absence of a cash market.

New York and Pennsylvania have low positive values. None of the eight states has a Pearson's *r* value that is different from zero at any conventionally accepted level of statistical significance. [This is a 2-tailed t-test with 8 d.f.] The null hypothesis that there is no correlation between corn USMYAP and state corn silage MYAPs cannot be rejected.

Corn Silage v. Corn USMYAP Analysis

State or Region	Corn acreage planted, % cut for silage	Pearson's *r*	H0: rho = 0 p(t-dist) 2-tailed
CT	94	-0.32	0.76
ME	89	-0.13	0.90
MA	86	-0.16	0.88
NH	93	-0.45	0.67
RI	100	0.04	0.97
VT	94	0.02	0.98
New England	93	-0.13	0.90
NY	56	0.22	0.83
PA	39	0.26	0.80
[NY & PA]	46		
DE	6	State Corn Silage MYAP not Reported	
MD	16		
NJ	20		
WV	38		
4-southern	15		

This lack of a correlation is not surprising. Unlike corn and other higher-valued feedstuffs, there is no active national cash market for silage. Silage is expensive to transport and most of it is consumed on the farm where it is ensiled. High transport costs also mean that silos tend to be within a short radius of where the corn is cut. Because silage is essentially a non-traded input (especially in the interstate sense) its value is determined by the value of its marginal product in the production of milk. Thus, silage prices are largely a function of the blend price for milk in the local milkshed. Milk marketing orders tend to insulate local fluid [Class I] prices from external market forces, this, in turn, tends to insulate local corn silage values. Most of the Northeast was especially insulated due to the Northeastern Dairy Compact (until 30 Sept, 2001) and by the current Northeast Marketing Area—Federal Order 1. The region has a higher-than-average Class I utilization rate.[15]

The lack of correlation between silage values and corn USMYAP means that corn CCPs are "non-cyclical" for silage producers. If USMYAP and silage value are not correlated, then a CCP that is determined by USMYAP will not reduce the variance in silage value in any predictable manner. Therefore the hedge efficiency of a corn CCP for a silage producer is very low, if not negative. Note that although the values of Pearson's r are not statistically significantly different from zero, these values are still unbiased estimates of the value of rho – the value of interest in CCP covariance analysis—the only drawback is that these estimates have high standard errors. Still, our best estimate of rho for New Hampshire is –0.45. Multiplying this value by our best estimate for E(CCP| USMYAP) of .448 gives us E(CCP|silage in New Hampshire) = -0.20.

Silage and Dairy in the Northeast

Silage only has economic value as feed for ruminants, specifically dairy animals. Since a large proportion of farms with corn base acreage that produce silage rather than corn grain are also (and primarily) dairy farms, corn CCPs need to be evaluated in a dairy farm context.

[15] For information on the Northeastern order see: http://www.fmmone.com/.

Proper feed management is central to a viable dairy. For ruminants to efficiently digest feed nutriants feedgrains and mixed feeds must be balanced with roughage (that is, hay, silage, pasture). Modern dairy rations are relatively fixed because of technical requirements. This makes the two feed classes complements, not substitutes. [This is another reason that corn and corn silage prices are not likely to be positively correlated.].

Let's take Vermont, the Northeastern state most specialized in dairy, and consider it as one big dairy operation. Since Vermont produces virtually no feedgrain essentially all of its feedgrain and mixed feed consumption is imported from outside the state. Vermont is a net buyer of feedgrains. In 2003, the New England Agricultural Statistic Service reports that Vermont dairies marketed 2,621 million pounds of milk from a herd of 149,000 cows.[16] This is an annual yield of about 177 cwt per cow. Assuming that each cow consumes 2,800 lbs (50 bushels) of feedgrain annually and multiplying by 149,000 cows, yields a Vermont dairy feedgrain requirement of 7.45 million bushels for 2003.[17] This calculation is repeated in the table below along with calculations that determine the number corn payment bushels in Vermont in 2003. The calculations reveal that Vermont was net buyer of 7.45 million bushels of corn (feedgrain) in 2003 and a potential recipient of 8.175 million bushels of corn CCPs. The hedge ratio equals –1.10 = 8.175/(-7.35). That is, Vermont owned negative 1.10 bushels of corn for each counter-cyclical payment bushel.

Physical	Vermont Physical	Vermont CCP	Payment
Dairy herd (1,000 cows)	149	92,812.3	Corn Base acres
Feedgrain bu/cow/yr	50	x 0.85	
Feedgrain purchase (bu.mil)	7.45	78,898.8	Corn Payment acres
		x 103.6137	Avg. CCP yield (bu.)
Corn production (bu.mil)	0	8.175	Corn CCP (bu.mil)
Net Feedgrain position (bu.mil)	-7.45		
Hedge ratio		- 1.10	
Correlation with USMYAP		0.964	
Adjustment factor		-1.06	
E(CCP|Vermont Dairy)		-0.475	

Our estimate of the correlation of the corn MYAP in New York and Pennsylvania with USMYAP is 0.964. The product of 0.964 and the hedge ratio, –1.10, is –1.06; this is our adjustment factor for E(CCP|USMYAP). The product of –1.06 and .448 is –0.475, thus E(CCP| Vermont Dairy). The negative value indicates that corn CCPs are a negative hedge for Vermont dairies: in Vermont, a corn CCP increases the price risk associated with purchasing corn.

Can we infer from this finding that corn CCPs make the representative Vermont dairy farm worse off? Absolutely not: corn CCPs do increase the variance of a recipient dairy farm's net corn/feedgrain outlays, but this increased price risk is offset by two factors. First, the corn CCP increases the farm's cash receipts: except for a truly pathologically risk-adverse recipient, the increase in the mean dominates the increase in

[16] New England Agricultural Statistics Service, *Ag Review* April 2004 Vol 24 (4) April 29, 2004. http://www.nass.usda.gov/nh/agreview.htm.

[17] Where did the 2,800 lbs/cow/yr figure come from? There are two sources. First, this is the low-end value for grain intake from the Vermont Dairy Profitability Project; it assumes a pasture-intensive operation. [weblink at end of note.] Second, we check the plausibly of the 2,800 lbs figure with ERS cost of production figures. ERS calculates "Monthly milk costs of production" for 15 Major dairy states, including—Pennsylvania, New York, and Vermont. The data can be download in html or in spreadsheet format, at http://www.ers.usda.gov/Data/CostsAndReturns. For Vermont in 2003, the cost of feedgrains per cwt of milk sold for was between $0.75 and $0.80. Given corn prices of $2.70 to $3.00/bu., this works out to about 0.28 bushels of feedgrain fed per cwt of milk sold. An annual yield of 177 cwt means a requirement of about 2,750 lbs of feedgrain per cow.
http://www.aftresearch.org/researchresource/caepubs/dairy/vt.dairy.html.

variance. Second, in the context of the dairy farm's household accounts, the corn-CPP-plus-feedgrain account is a minor source of variation for the household's total net income and net worth.

5. Conclusion

Our primary conclusion is that the counter-cyclical payments [CCPs] of the 2002 Farm Act are financial instruments. As such, they can be analyzed by the methods of financial economics. In this paper we show that option-pricing theory and hedging theory can be used to draw useful inferences about CCPs.

Among our findings are the following. CCP are identical to a bear spread option position. As an option, its market value prior to expiration can differ substantially from its intrinsic value. CCP are also a kind of hedge against changes in the price of the underlying commodity. Using the distribution of corn national marketing-year average prices we find that corn CCPs are unlikely to reduce the variance of expected average unit revenues from corn by more than 45 percent. In New England where corn is planted for silage rather than grain, the CCP offers no variance reduction. In fact, for dairy farms that produce silage on corn base acreage and are net purchasers of corn, corn CCPs increase the exposure to corn price risk.

References

Effland, Anne B. W. and C. Edwin Young (2001). U.S Farm Policy for the 21st Century: A Diversity of Visions for the Future. USDA, ERS: *Agricultural Outlook*, May 2001: 3-4. http://www.ers.usda.gov/publications/AgOutlook/may2001/AO281b.pdf

Hull, John C. *Options Futures, and Other Derivatives*, 5th edition, Prentice Hall, Upper Saddle River, NJ, 2003

James, Peter. *Option Theory*, Wiley and Sons, West Sussex, England, 2003.

Johnson, Leland L. 1960. The theory of hedging and speculation in commodity futures. *Review of Economic Studies* 27(3): 139-151.

McDonald, Robert L. *Derivatives Markets*, Addison Wesley, San Francisco, CA, 2003.

Stoll, Hans R. and Robert. E. Whaley. *Futures and Options: Theory and Applications*, South Western Publishing Company, Cincinnati, OH, 1993.

United States Department of Agriculture. *Agricultural Prices*, various issues. usda.mannlib.cornell.edu/reports/nassr/price/pap-bb

Westcott, Paul C., C. Edwin Young, and J. Michael Price. 2002. *The 2002 Farm Act: Provisions and Implications for Commodity Markets.* ERS ERS Agriculture Information Bulletin No. AIB778. http://www.ers.usda.gov/publications/aib778/

Figure 1

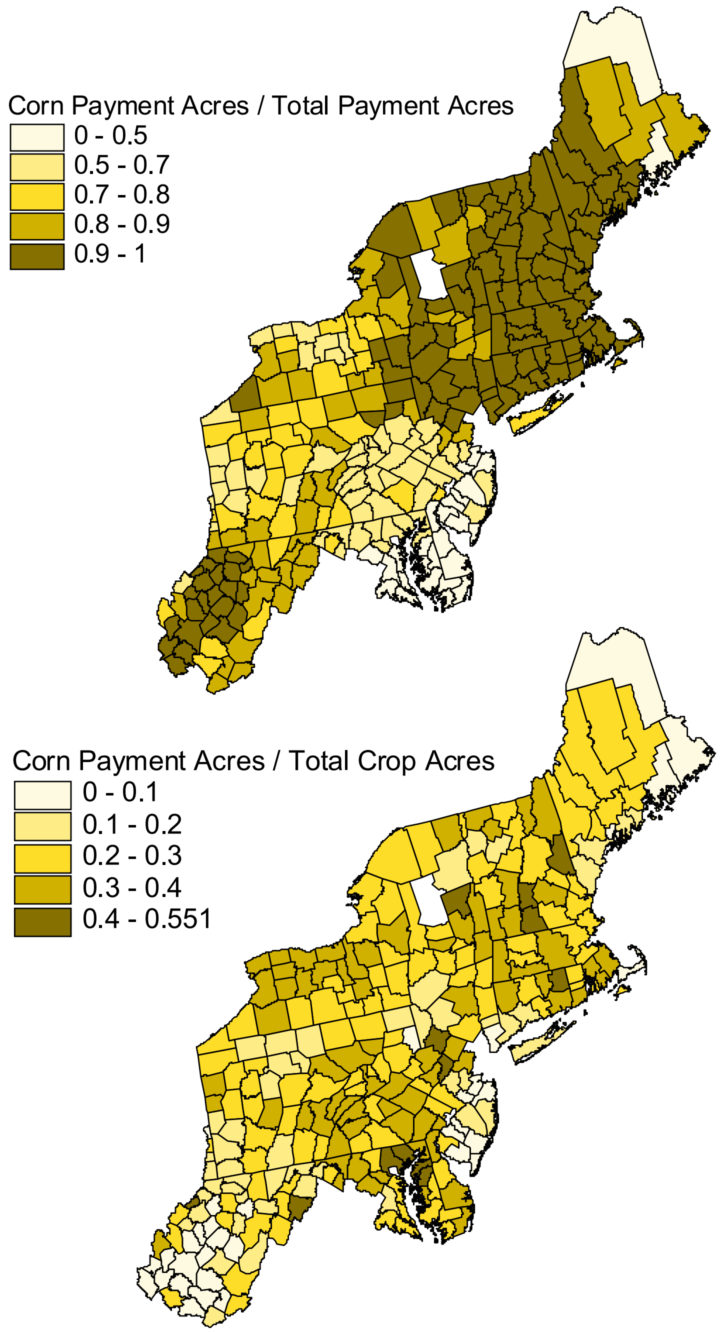

Corn Payment Acres / Total Payment Acres
0 - 0.5
0.5 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1
Corn Payment Acres / Total Crop Acres
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.551

Table 1

A: Base Acres in Northeastern States (2003)

	Total	Wheat	Corn	Barley	Oats	Sorghum	Soybeans	All other
CT	32,282	33	32,140	6	58	31	16	0
ME	80,934	551	34,888	20,740	23,091	6	1,274	386
MA	24,946	24	24,475	24	186	39	148	49
NH	16,242	0	16,111	32	35	23	41	0
RI	1,376	0	1,367	0	4	4	0	1
VT	96,423	756	92,812	799	915	25	1,084	32
NewEngland	252,204	1,364	201,792	21,600	24,289	128	2,565	468
NJ	152,114	20,712	73,110	2,943	1,708	1,509	52,131	2
NY	1,440,462	138,829	1,129,048	13,807	77,983	248	80,359	188
PA	1,382,204	120,314	940,932	30,697	79,819	3,550	206,345	547
Middle	2,974,780	279,855	2,143,090	47,447	159,510	5,307	338,835	737
DE	412,584	56,388	161,757	26,393	153	2,058	165,742	93
MD	1,102,730	169,847	493,576	42,840	2,647	8,619	384,750	451
WV	96,409	8,909	71,451	2,576	3,479	420	9,542	33
Southern	1,611,723	235,143	726,783	71,810	6,279	11,097	560,034	576
TOTAL	4,838,707	516,362	3,071,665	140,857	190,078	16,532	901,433	1,781

B: Percent of Total Base Acres (2003)

	Wheat	Corn	Barley	Oats	Sorghum	Soybeans	All other
CT	0.1	99.6	0.0	0.2	0.1	0.1	0.0
ME	0.7	43.1	25.6	28.5	0.0	1.6	0.5
MA	0.1	98.1	0.1	0.7	0.2	0.6	0.2
NH	0.0	99.2	0.2	0.2	0.1	0.3	0.0
RI	0.0	99.3	0.0	0.3	0.3	0.0	0.0
VT	0.8	96.3	0.8	0.9	0.0	1.1	0.0
NewEngland	0.5	80.0	8.6	9.6	0.1	1.0	0.2
NJ	13.6	48.1	1.9	1.1	1.0	34.3	0.0
NY	9.6	78.4	1.0	5.4	0.0	5.6	0.0
PA	8.7	68.1	2.2	5.8	0.3	14.9	0.0
Middle	9.4	72.0	1.6	5.4	0.2	11.4	0.0
DE	13.7	39.2	6.4	0.0	0.5	40.2	0.0
MD	15.4	44.8	3.9	0.2	0.8	34.9	0.0
WV	9.2	74.1	2.7	3.6	0.4	9.9	0.0
Southern	14.6	45.1	4.5	0.4	0.7	34.7	0.0
TOTAL	10.7	63.5	2.9	3.9	0.3	18.6	0.0

Source: USDA, Farm Service Agency, 2003.

BaseAcresTotalsNEStates.xls

Figure 2

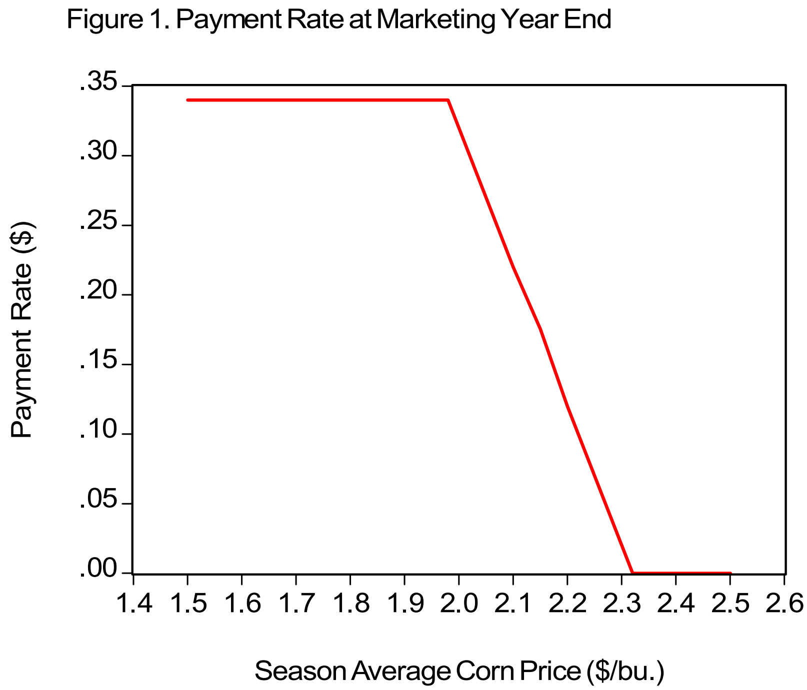


Figure 3

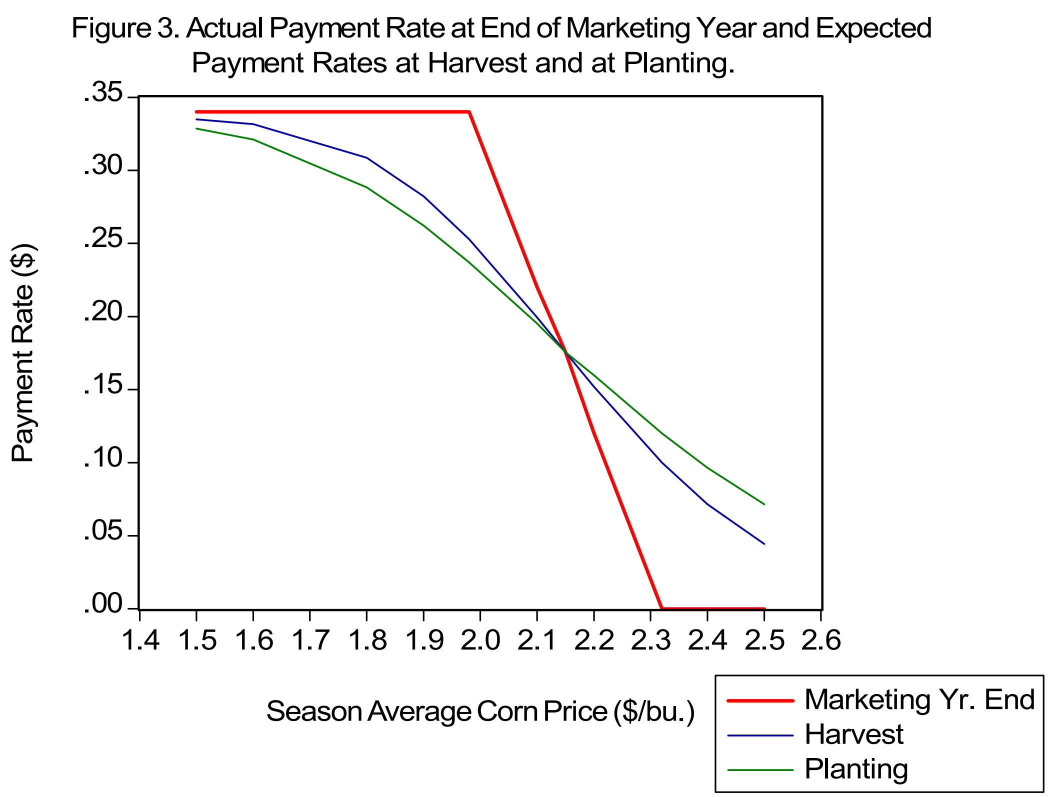


Figure 4

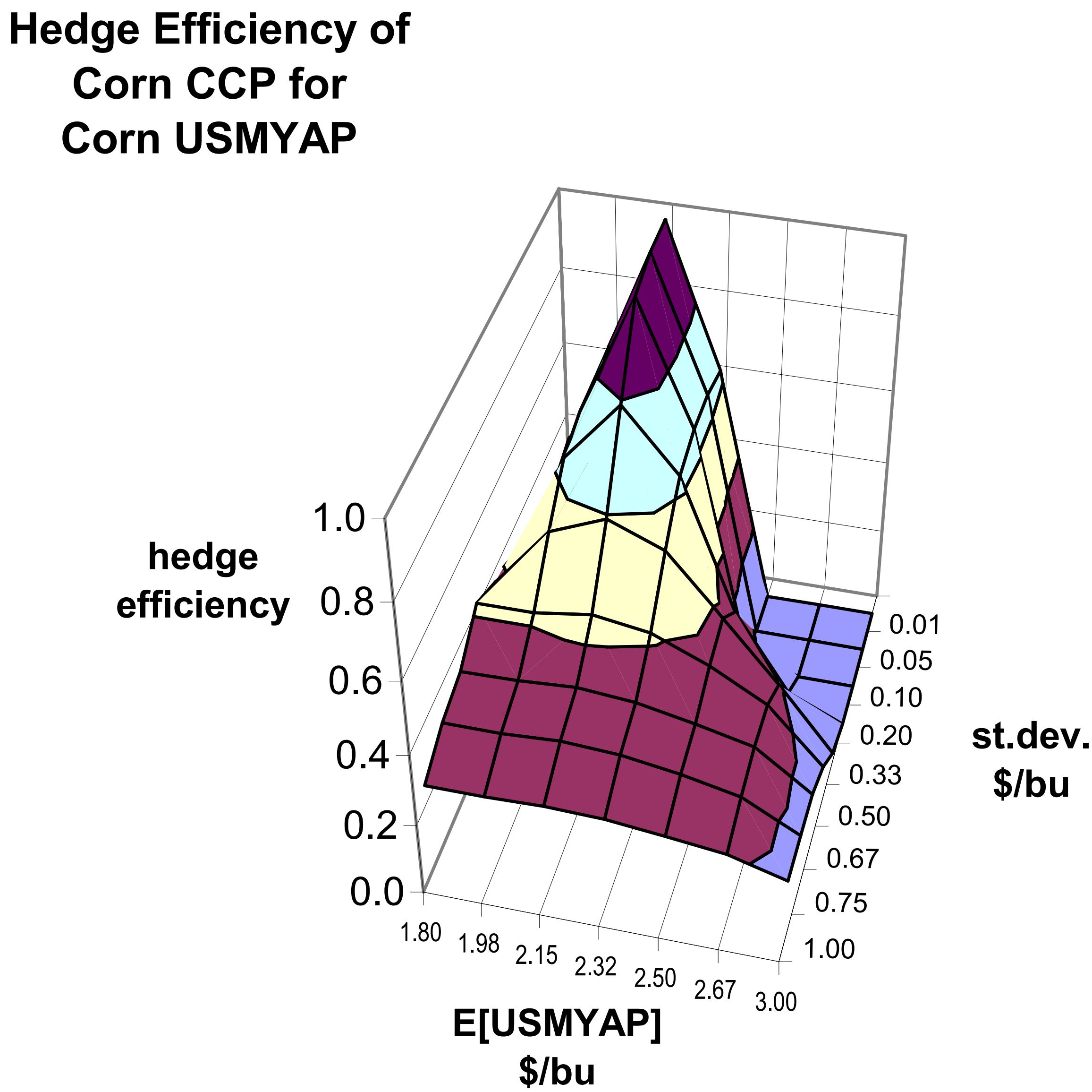

Hedge Efficiency of
Corn CCP for
Corn USMYAP
hedge
efficiency
1.0
0.8
0.6
0.4
0.2
0.0
1.80
1.98
2.15
2.32
2.50
2.67
3.00
E[USMYAP]
$/bu
0.01
0.05
0.10
0.20
0.33
0.50
0.67
0.75
1.00
st.dev.
$/bu

Figure 5

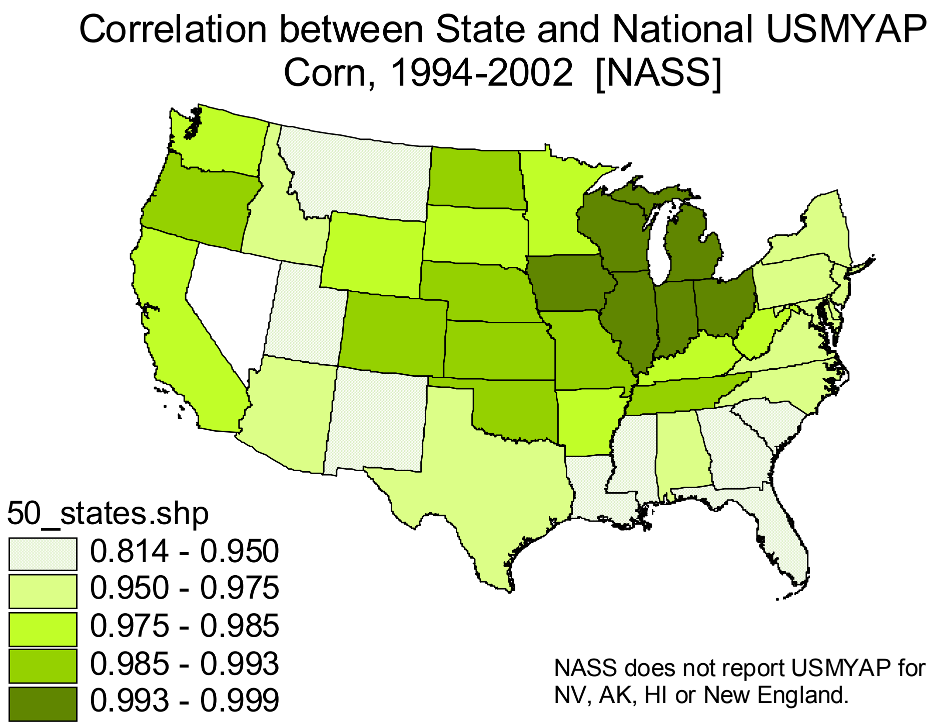

Correlation between State and National USMYAP
Corn, 1994-2002 [NASS]
50_states.shp
0.814 - 0.950
0.950 - 0.975
0.975 - 0.985
0.985 - 0.993
0.993 - 0.999
NASS does not report USMYAP for NV, AK, HI or New England.

Figure 6

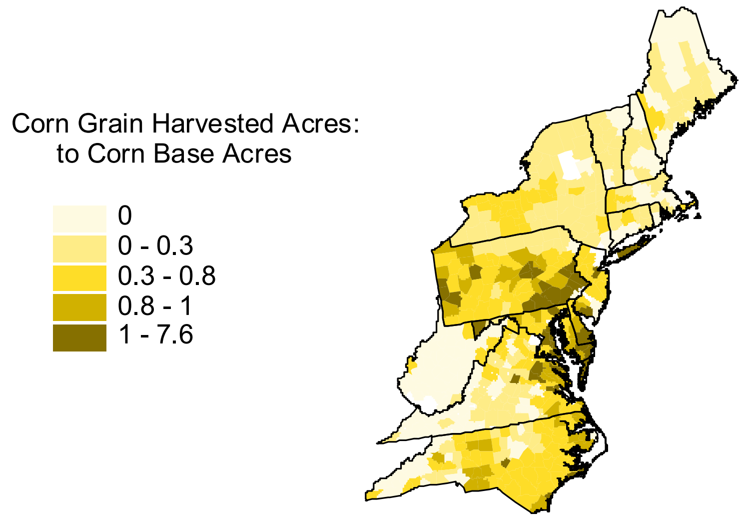
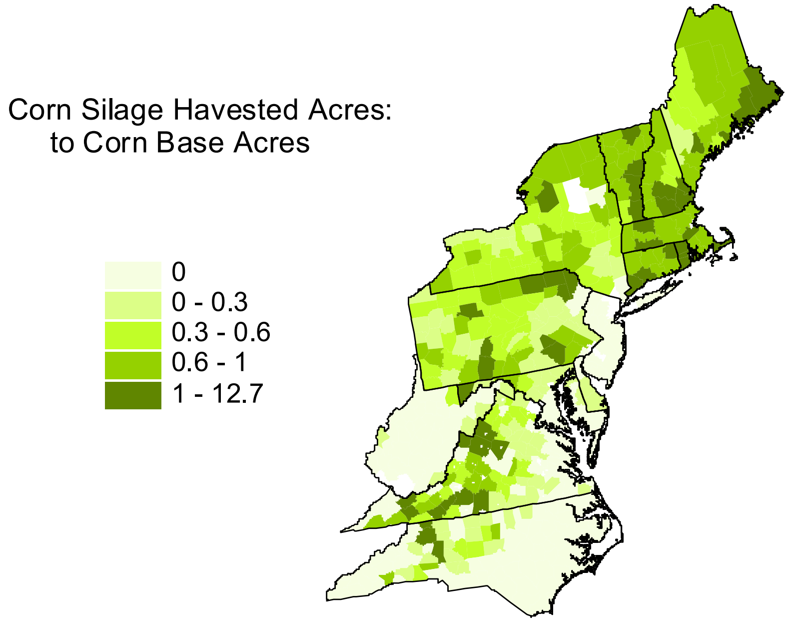

Corn Grain Harvested Acres:
to Corn Base Acres
0
0 - 0.3
0.3 - 0.8
0.8 - 1
1 - 7.6

Figure 7


Corn Silage Havested Acres:
to Corn Base Acres
0
0 - 0.3
0.3 - 0.6
0.6 - 1
1 - 12.7