The Cost of Forward Contracting

by

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Abstract

The cost of forward contracting corn is estimated with weekly pre-harvest forward bases for seven regions of Illinois from 1975 to 2002. Given the panel structure of the forward basis dataset, we extend Townsend and Brorsen's univariate unit root model for forward bases to a panel unit root model. With the time series of forward bases modeled as unit root processes, the cost of forward contracting is estimated. The empirical results from the estimation show that the cost of forward contracting corn is about 1¢/bushel, one hundred days before the harvest, for all regions in Illinois as a whole. The results also indicates that the cost could vary across regions and that the cost of forward contracting could be substantially higher than that of futures hedging, especially at the beginning of the pre-harvest period.

Introduction

Both forward contracting and futures hedging have been used by farmers as pre-harvest marketing tools, but survey studies find that forward contracting is strongly preferred by farmers to make pre-harvest forward sales. Farmers clearly view forward and futures contracts as distinctive marketing options. For example, Patrick, Musser, and Eckman survey large-scale Midwestern grain producers regarding their forward selling practices over 1993-1995 and find that the percentage of producers using cash forward contracts ranges from 60 to 78 percent for corn and 51 to 88 percent for soybeans, while the percentage of farmers using futures contracts ranges from 7 to 26 percent for corn and 7 to 25 percent for soybeans. Earlier studies by the Commodity Futures Trading Commission, Asplund, Forster, and Stout, Goodwin and Schroeder survey broader samples of grain producers, yet report qualitatively similar results.

Forward contracting, as pre-harvest marketing instrument, has some advantages over futures hedging. The advantages include absence of lumpiness, no interest cost and absence of basis risk (Nelson). However, theory suggests that the cost of forward contracting could be substantially higher that that of futures hedging. The cost of futures hedging is measured as the net profit/loss from futures transactions and consists of commission, liquidity cost, and interest cost from the margin account. The cost of forward is, however, not so obvious for it is embedded into the forward basis bids offered by local elevators. After acquiring long positions through forward contracts with farmers, local elevators routinely hedge the positions with short futures positions to reduce their price risk exposure. But even after futures hedging, the elevators still have to bear

idiosyncratic basis risk and default risk associated with the forward contracts. To compensate their futures hedging cost and their bearing of idiosyncratic basis risk and the default risk, the elevators embed a fee for futures hedging and a risk premium for basis and default risk in their forward basis bids to farmers, which causes the cost of forward hedging higher than that of futures hedging.

There have been only a handful of empirical studies examining the cost of forward contracting due to the limited availability of forward bases (prices), particularly at the level of local cash markets, however, most of these empirical studies conclude that forward contracting is likely more costly than futures hedging. For example, Harris and Miller examine forward contract prices for corn and soybeans in South Carolina over 1975-1980 and find that the net cost of forward contracting versus hedging ranges from about 2¢ to 7¢ per bushel. Elam and Woodworth compare the monthly average forward soybean prices with the monthly average net prices from hedging for the East Central Arkansas elevators from 1978-1987. They report that the net prices received by soybean producers with forward contracts range from 18 ¢/bushel(10 months before harvest) to 2¢/bushel(1 month before harvest) less than the net prices from futures hedging.

The cost of forward contracting has also been estimated with more theory-based econometric models. Brorsen, Coombs and Anderson develop a model, which regresses the level of the forward basis against time to delivery, to estimate the cost of forward contracting. Using forward bases of hard red winter wheat at the Texas Gulf over 1975-1991, they find that the net cost of forward contracting ranges from 2¢/bushel to 5¢/bushel. However the time-series of forward bases likely have unit root (Townsend and

Brorsen), therefore the model could lead to spurious significance and biased parameter estimates. Instead Townsend and Brorsen estimate the cost of forward contracting using a univariate unit root model of the forward bases. With forward bases for hard red winter wheat at Arkansas River (Catoosa, Oklahoma) from 1986-1998, they find that the cost of forward contracting ranges from 6 ¢/bushel to 8 ¢/bushel, one hundred days before harvest. But the Dickey-Fuller tests on the unit root hypothesis of the model yields conflicting and inconclusive results: The Dickey-Fuller test statistic without the trend and annual dummies could not reject the null hypothesis of a unit root, but, the Dickey-Fuller test with trend and annual dummies included can reject the null hypothesis. As acknowledged by authors, the problem is that the univariate unit root tests such as Dickey-Fuller (DF) test, Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test lack power in distinguishing the unit root null from the stationary alternatives (Levin and Lin 1992, 1993, Maddala and Wu).

Since previous empirical studies only give limited evidence of the cost of forward contracting, there clearly is a need for further research to estimate the cost of forward contracting. In this study, we estimate the cost of forward contracting using weekly pre-harvest corn forward bases for seven regions of Illinois for 1975 to 2002 available from the Illinois Market News Service. Given the panel structure of the forward bases, we extend Townsend and Brorsen's univariate unit root model of forward bases to a panel unit root model. The panel unit root models combines information from the time series of forward bases with that from the cross-sectional and thus provides a straightforward and more precise inference about the unit root test (Levin and Lin 1992, 1993, Im, Pesaran,

and Shin, Maddala and Wu). With the time series of forward bases modeled as unit root processes, the cost of forward contracting is estimated. The empirical results of the estimation show that the cost of forward contracting corn is about 1¢/bushel, one hundred days before the harvest, for all regions in Illinois as a whole. The result also indicate that the cost could vary across regions and that the cost of forward contracting could be substantially higher than that of futures hedging, especially at the beginning of the pre-harvest period.

The rest of the paper is organized as follows. In the next section, we extend Townsend and Brorsen's univariate unit root model to a panel unit root model and discuss how to test the panel unit root null hypothesis and how to estimate cost parameters. In section three, we present the empirical results of the panel unit root test and the estimation of the cost parameters. In section four, we draw conclusions.

Method

The method section can be divided into two subsections. In the first subsection, we review and extend the univariate unit root model to a panel unit root model. In the second subsection, we discuss how to test the panel unit root null hypothesis with MW test (Maddala and Wu) and how to estimate the cost parameters.

Panel unit root model of forward basis

Townsend and Brorsen develop a univariate unit root model to estimate the cost of forward contracting. They define the cost of forward contracting as the expected

difference between the cash price at the harvest and the forward price. The expected difference measures the cost farmers are willing to incur in order to reduce the volatility of prices they received for their crops. Mathematically, the cost of forward contracting is

(1) $$c(t,t^*) = E_t[s(t^*) - f(t,t^*)]$$

where t and t^* denote, respectively, the current time and the time of the harvest, $c(t,t^*)$ denotes the cost of forward hedging at the time t for a crop harvested at time t^*, $s(t^*)$ denotes the spot price of crop harvested at time t^*, $f(t,t^*)$ denotes the implied forward price quoted at time t for crop harvested at time t^*, $E_t[\cdot]$ denotes conditional expectation at time t.

The forward basis is defined as the difference between the implied forward price and the settlement of the nearby futures contract. Mathematically, the forward basis is

(2) $$B(t,t^*,T) = f(t,t^*) - F(t,T)$$

where T denotes the expiration of the futures contract, and $F(t,T)$, the price of the referred futures contract at t, $B(t,t^*,T)$ denotes the forward basis quote at time t for crop harvested at time t^*, with respect to the futures contract expiring at time T. Notice that the relation between current time t, harvest time t^* and futures expiration T has to be $t \le t^* \le T$.

The cost of forward contracting is embedded in the forward basis bids offered by the local elevators because

$$
\begin{aligned}
c(t,t^*) &= E_t[s(t^*) - f(t,t^*)] = E_t[f(t^*,t^*) - f(t,t^*)] \\
&= E_t[(F(t^*,T) + B(t^*,t^*,T)) - (F(t,T) + B(t,t^*,T))] \\
&= E_t[F(t^*,T) - F(t,T)] + E_t[B(t^*,t^*,T) - B(t,t^*,T)] \\
&= E_t[B(t^*,t^*,T) - B(t,t^*,T)] \\
&= E_t[B(t^*,t^*,T)] - B(t,t^*,T)
\end{aligned} \tag{3}
$$

where $f(t^*,t^*) = s(t^*)$ due to the convergence of forward price and spot price at harvests, and $E_t[F(t^*,T)] = F(t,T)$ because futures prices are assumed to follow a martingale process.

Townsend and Brorsen also assume a linear functional form for the cost of forward contracting: $c(t,t^*) = \alpha + \beta * (t^* - t)$, where $(t^* - t)$ measures time left before the harvest. Notice that α has to be zero because there is no cost of forward contracting at the harvest due to the convergence of forward and spot prices. Thus the forward basis is

$$
B(t,t^*,T) = E_t[B(t^*,t^*,T)] - \beta * (t^* - t) \tag{4}
$$

and the first-order difference of the forward basis is

$$
\begin{aligned}
\Delta B(t) &= B(t,t^*,T) - B(t-1,t^*,T) \\
&= \beta + (E_t[B(t^*,t^*,T)] - E_{t-1}[B(t^*,t^*,T)]) \\
&= \beta + \varepsilon_{(t)}
\end{aligned} \tag{5}
$$

where $\varepsilon_{(t)} = E_t[B(t^*,t^*,T)] - E_{t-1}[B(t^*,t^*,T)]$ can be viewed as an error term because $E_{t-1}\{E_t[B(t^*,t^*,T)]\} = E_{t-1}[B(t^*,t^*,T)]$ due to the law of iteration. Equation (5) suggests that the cost parameter β can be measured as the draft term of the univariate unit root model of forward bases.

But the univariate unit root tests like Dickey-Fuller (DF) test, augment Dickey-Fuller

(ADF) test and Pillipis-Perron (PP) test have been criticized for their well known lack of power in distinguishing the unit root null from stationary alternatives. Panel unit root tests have been developed to increase the power of the unit root tests based on a single time series (Levin and Lin 1992, 1993; Im, Pesaran, and Shin; Maddala and Wu). Panel unit root tests combine the information from time series with that from cross-sectional and thus provide straightforward and more precise inferences about the unit roots.

Therefore, we extend the univariate unit root model (equation 5) to a panel unit root model, which can be specified as

(6) $$\Delta B(i,t) = \beta_i + \rho_i B(i,t-1) + \sum_{j=1}^{J} \gamma_{(i,j)} \Delta B(i,t-j) + \varepsilon_{(i,t)}$$

where i=1,…,I denote individual regions and t=1,…,T denote time before the harvest. $\Delta B(i,t) = B(i,t,t^*,T) - B(i,t-1,t^*,T)$ is the first-order difference of forward basis for region i at time t, and $B(i,t-1) = B(i,t-1,t^*,T)$ is the lagged forward basis for region i at $t-1$. $\sum_{j=1}^{J} \gamma_{(i,j)} \Delta B_{(i,t-j)}$ is added to account for the possible autocorrelation in the forward basis differences for the ADF test. N denotes the number of lagged forward basis differences used in the ADF test. β_i measures the cost of forward contracting for region i. The panel unit root null and alternative hypotheses are specified as

(7) $$H_0 : \rho_i = 0, \forall i \in I \quad H_\alpha : \rho_i < 0, \exists i \in I$$

Panel unit root tests and cost estimation

The three most widely used panel unit root tests are LL test (Levin and Lin 1993), IPS

test (Im, Pesaran and Shin) and MW test (Maddala and Wu). Banjee provides a detailed analysis and comparison of these three tests. Levin and Lin (1993) test the panel unit root null with a t-statistic, which can accommodate unit autocorrelation and heteroscedasticity in the error terms. But LL test is based on the homogeneity of autoregressive parameters under alternative hypothesis, which means that the null and alternative hypotheses are specified as $H_0 : \rho_i = 0, \forall i \in I$ and $H_a : \rho_i = \rho, \forall i \in I$, respectively. The null makes sense under some circumstances, but the alternative is too strong to be held in most interesting empirical cases. Im, Pesaran and Shin relax the restrictive assumption imposed on the autoregressive parameters and specify the alternative hypothesis as $H_a : \rho_i < 0, \exists i \in I$. However the IPS test still requires a balanced panel dataset and that the same lag length is used for all the ADF tests for individual series. Maddala and Wu propose testing panel unit root hypothesis with Fisher's (P_λ) statistic, $-2\sum log_e \pi_i \sim \chi^2$, where π_i s are the significance levels of unit root tests for individual series. The Fisher's statistic has a χ^2 distribution with $2N$ degrees of freedom if the individual unit root tests are independent. The MW test allows different lag lengths in the individual ADF tests and does not require a balanced panel.

However all three tests above assume that the error terms are not cross-sectional correlated. If this assumption is violated the derived distributions of the corresponding test statistics are no longer valid. For example, if the individual unit root tests are not independent, the Fisher's statistic will no longer have a χ^2 distribution. Maddala and Wu find that "in the case of cross-correlated errors there are substantial size distortions in

using the conventional test statistics for the IPS, Fisher and LL testes, although the size distortions are less serious for the Fisher test than for the IPS tests." Instead Maddala and Wu use a bootstrap method to obtain the empirical distributions of the Fisher's statistics to make inferences because "using the bootstrap method results in a decrease of these size distortions, although it does not eliminate them. The Fisher test does better than the IPS test overall using the bootstrap method".

Given the advantages of the MW test and its bootstrap testing procedure, we adopt the MW test to test the panel unit root hypothesis of forward bases. The sample distribution of the Fisher's statistic is empirically estimated with a bootstrap method modified from that proposed by Maddala and Wu. The details of the bootstrap method are discussed as follows. The bootstrap data are generated using the sampling scheme S_3 described in Li and Maddala. First, assuming the unit root hypothesis held, we estimate ARIMA(1,1,0) models for forward bases for individual regions, respectively.

(8) $$\Delta B_{(i,t)} = \hat{\beta}_i + \hat{\gamma}_i \Delta B(i,t-1) + \varepsilon^0_{(i,t)}$$

ARIMA(1,1,0) specification is selected among various ARIMA model specifications because it best fits to the forward bases. Second, we bootstrap estimated errors, $\varepsilon^0_{(i,t)}$ to obtain a bootstrap sample of the error terms. Maddala and Wu argue that since there are cross-sectional correlation among $\varepsilon^0_{(i,t)}$, one can not simply resample $\varepsilon^0_{(i,t)}$ directly, instead, one should resample $\varepsilon^0_{(i,t)}$ with the cross-sectional index fixed. They claim "in this way, one can preserve the cross-correlation structure of the error term." Thus we resample $\varepsilon^0_t = [\varepsilon^0_{(1,t)}, \varepsilon^0_{(2,t)}, \ldots, \varepsilon^0_{(7,t)},]'$ to obtain ε^*_t. Third, we use the bootstrap sample of

the error terms, ε_t^* combined with the estimated parameters of the ARIMA(1,1,0) models (equation 8) to generate a bootstrap sample of the forward bases as

(9) $$\Delta B_{(i,t)} = \hat{\beta}_i + \hat{\gamma}_{(i,1)} \Delta B(i,t-1) + \varepsilon^*_{(i,t)}$$

This simulation procedure is implemented with arima.sim, an R procedure (See R help file for the details of arima.sim procedure.). The simulation method is more intuitive and more easily implemented than the alternative method used by Maddala and Wu in their bootstrap procedure. With each simulated panel of forward bases, we conduct ADF tests for individual regions and then combine the p values of these individual ADF tests into a Fisher's statistic. A total of 2000 replications of the bootstrap are used to generate the empirical distribution of the Fisher's statistic. The critical value at 5% significance level for the Fisher's statistic is selected as the 1900_{th} observation of 2000 simulated Fisher's statistics sorted in the ascending order.

Since the MW test fails to reject the panel unit root null hypothesis (equation 7) as discussed in the next section, we can reasonably assume that the time series of forward bases has unit roots and thus the cost of forward contracting can be estimated with a regression model as

(10) $$\Delta B(i,t) = \beta_i D_i + \varepsilon_{(i,t)}$$

The regression model can be viewed as a reduced form of the panel unit root model (equation 6), where the lagged forward basis at *t-1*, $B(i,t-1)$, and lagged forward basis differences, $\sum_{j=1}^{J} \gamma_{(i,j)} \Delta B(i,t-j)$, are deleted because the unit root hypothesis has not been

rejected. D_i is a dummy variable for region i and correspondingly β_i measures the cost of forward contracting for region i. The significance of the cost parameters is tested with null and alternative hypotheses specified as

(11) $$H_0 : \beta_i = 0, \forall i \in I \quad H_\alpha : \beta_i > 0, \exists i \in I$$

Equation 10 implicitly assumes that the cost of forward contracting is linear in time, but if the cost of forward contracting is quadratic in time, the cost of forward contracting should be estimated with regression model

(12) $$\Delta B(i,t) = \beta_i D_i + \delta(t^* - t) + \delta_i D_i (t^* - t) + \varepsilon_{(i,t)}$$

where δ measures the common time trend effect for all regions, and δ_i measures the individual time trend effect for regions. If the costs of forward contracting is assumed to be same for all regions, equation (10) can be simplified as

(12) $$\Delta B(i,t) = \beta + \varepsilon_{(i,t)}$$

where β measures the cost of forward contracting for all regions. Similarly, equation (12) can be simplified as

(14) $$\Delta B(i,t) = \beta + \delta(t^* - t) + \varepsilon_{(i,t)}$$

Where the cost of forward contracting is measured by β and δ.

Empirical Results

Panel of forward bases

The panel of forward bases consists of pre-harvest forward bases on Thursdays for corn

for seven regions of Illinois over 1975-2002. These regions and their numbers are: Northern (1), Western (2), North Central (3), South Central (4), West Southwest (5), Wabash (6) and Little Egypt (7). The pre-harvest forward bases are generated as a part of a daily survey by the Illinois Ag Market News of 50-60 elevators throughout Illinois that conduct significant spot and forward transactions with farmers. The forward bases refer to # 2 grade corn bought for shipment by rail or truck for Fall delivery to country elevators. Illinois Ag Market News disseminates the forward bases on a daily basis, but, historical bases are published in a hard copy format only on a weekly basis. The range of bases in each of seven regions is reported for forward bids of new corn on every Thursday. The mid-point of the reported high and low price is used to obtain a single price for each region and week.

Reporting on pre-harvest forward bases usually begins in February and ends in September, but varies slightly from year-to-year. In order to obtain a constant number of weeks each year, the sample period for each year begins 36 weeks before harvest and ends one week before harvest. The 36-week period generally reflects the pre-planting, planting and growing seasons. The combination of 36 weekly observations per year, 28 years (1975-2002) and 7 regions, results in a total potential sample size of 7,056 observations. Most missing observations occur at the beginning and end of the 36-week period and are purged before the model test and parameter estimation. There are relatively few missing observations occurring insider the time-series of forward bases and they are emulated with the ARIMA(1,1,0) method aforementioned.

Results of panel unit root test and cost parameter estimation

The MW test is implemented according to the procedure described in the method section. First, we compute the Fisher's statistic, $-2\sum log_e \pi_i$. There are a total of 196 series of forward bases because the panel of forward bases for corn used in this study covers 7 regions over 28 years (1975-2002). For each time series of forward bases, an ADF test with both a drift term and a time trend included is conducted. The p values of the individual ADF tests are combined into the Fisher's statistic and it is equal to 296.11. Second, we calculate the critical value of the Fisher's statistic. If the cross-sectional correlation of error terms can be ignored, the sampling distribution of the Fisher's statistic is a χ^2 distribution with 2×196 degrees of freedom, whose critical value at 5% significance level is 439.16. However, if the cross-sectional correlation cannot be ignored, the sampling distribution of the Fisher's statistic no longer is a χ^2 distribution and has to be estimated empirically with the bootstrap method. The bootstrap sampling distribution of the Fisher's statistic calculated with 2000 repetitions gives the critical value at 5% significance level at 392.64. No matter which critical value is used, the panel unit root hypothesis clearly cannot be rejected. Thus the empirical results from the MW test suggest that the time series of forward bases likely have unit roots.

Accepting the time series of forward bases have unit roots, we then estimate the cost of forward contracting using regression models (equations 10, 12~14). The models are estimated with both OLS and GLS methods. The GLS method is implemented to account for observed significant heteroscedasticity in forward basis differences. The forward

basis differences apparently become more volatile as the harvest approaches, as shown in Figure 1. The pattern can partly be attributed to the fact that as the harvest approaches, more and more information becomes available to market participants and is subsequently incorporated into the market prices. The possibilities of time-series autocorrelation, contemporaneous correlation across regions and years are also examined for the forward basis differences, but we find little evidence supporting these possibilities and thus not consider in the modeling.

The estimated cost parameters based on regression models (equations 10, 12~14) are reported in Table 1. The OLS and GLS methods yield almost identical cost parameter estimates, though with slightly different t values. Using the simplest regression model (equation 13), we estimate that the cost of forward contracting corn is 0.0511¢/bushel per week for all regions of Illinois as a whole. The t statistic of the estimate is 1.7420, which is significant at 5% significance level based on a one-side t test. The estimate implies that one hundred days before harvest, the cost of forward contracting corn is about 1¢/bushel. The estimated cost of forward contracting corn is much smaller than the estimated cost of forward contracting hard red winter wheat, which is 6¢/bushel to 8¢/bushel, one hundred before harvest (Townsend and Brorsen). To identify whether the cost of forward contracting is quadratic in time, we estimate the regression model represented by equation 14. Both OLS and GLS methods show that the time trend component, δ, is significant at 5% significance level. With the quadratic-form cost function estimated, the cost of forward contracting corn is about 1.34¢/bushel per week, one hundred days before harvest. This is close to the cost estimate based on the linear cost function. Compared

with the linear-form cost function, however, the quadratic form cost function suggests a much higher cost of forward contracting at the beginning of the pre-harvest period, as illustrated in Figure 2.

However the cost parameters of forward contracting could be different across regions because part of the cost of forward contracting is a premium for basis risk, which could vary substantially across regions in Illinois. Therefore, we also estimate the cost of forward contracting using equations 10 and 12, allowing the cost parameters to vary across regions. The cost parameter estimates and their corresponding t statistics are also reported in Table 1. The cost parameter estimates suggest that the cost of forward contracting in West Southwest and Little Egypt regions could be higher than that in other regions of Illinois. But none of the t statistics of these cost parameter estimates is statistically significant. Therefore, we also examine the joint significances of these parameters using following null hypotheses: H_0: $\beta_1 = \beta_2 = \ldots\ldots = \beta_7$ for equation 10, and H_0: $\beta_1 = \beta_2 = \ldots\ldots = \beta_7$ and H_0: $\delta = \delta_1 = \delta_2 = \ldots\ldots = \delta_6$ for equation 12. Not surprisingly, all F tests fail to reject the non-significance null hypotheses. The problem is that by assuming different cost parameters for individual regions, we increase the number of parameters needed to be estimated from one to seven (in equation 10) or to fourteen (in equation 12) , but still estimate the models with the same panel of forward bases.

We also compare the cost of forward contracting with that of futures hedging. The cost of futures hedging for corn is assumed to be constant in time and consist of a commission cost and a liquidity cost. The commission cost is assumed to be $50 per contract (Martines-Filho, et al.). The liquidity cost is assumed to be 25$ per contract

(Brorsen). Thus the cost of futures hedging is $75 per contract or 1.5¢/bushel. The cost of forward contracting are estimated with both the linear-form and the quadratic-form cost functions. The parameters of the cost functions are substituted with GLS estimates of equations 13 and 14, respectively. The comparison as illustrated in Figure 2 indicates that the cost of forward contracting could be substantially higher than that of futures hedging at the beginning of the pre-harvest period, especially when the quadratic-form cost function is assumed.

Conclusions

Although forward contracting is strongly preferred to futures hedging by crop farmers to make pre-harvest forward sales, both theory and some empirical studies suggest that forward contracting could be more expensive than futures hedging and the cost difference could be substantial. Given the limited availability of data of forward bases (prices), particularly at the level of local cash markets, there have been only a handful of empirical studies examining the cost of forward contracting. There clearly is a need for further research on the cost of forward contracting. In this study, we estimate the cost of forward contracting corn using Thursday pre-harvest forward bases for seven regions of Illinois from 1975 to 2002. Given the panel structure of the forward bases, we extend Townsend and Brorsen's univariate unit root model for forward bases to a panel unit root model. The panel unit root model combines information from the time series of forward bases with that from cross-sectional and thus provides a straightforward and more precise inference about the unit root test. With the time series of forward bases modeled as unit

root processes, the cost of forward contracting is estimated as the draft term of the unit root model of the forward bases. The empirical results from the estimation show that the cost of forward contracting corn is about 1¢/bushel, one hundred days before the harvest, for all regions of Illinois as a whole. The results also indicate that the cost could vary across regions and that the cost of forward contracting could be substantially higher than that of futures hedging, especially at the beginning of the pre-harvest period.

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Table 1. The Estimated Parameters of the Cost Functions for Pre-Harvest Forward Contracting Corn (in ¢/bushel per week) , Illinois, 1975 - 2002

cost parameters	GLS estimate	GLS t statistic	OLS estimate	OLS t statistic
		Equation 10: $\Delta B(i,t) = \beta_i D_i + \varepsilon_{(i,t)}$		
β_1	-0.0052	-0.0676	-0.0052	-0.0680
β_2	0.0070	0.0899	0.0070	0.0900
β_3	0.0326	0.4186	0.0326	0.4190
β_4	0.0686	0.8860	0.0686	0.8860
β_5	0.1051	1.3557	0.1050	1.3560
β_6	0.0556	0.7076	0.0556	0.7080
β_7	0.0946	1.2189	0.0946	1.2190
		Equation 12: $\Delta B(i,t) = \beta_i D_i + \delta(t^*-t) + \delta_i D_i(t^*-t) + \varepsilon_{(i,t)}$		
β_1	0.0038	0.0220	0.0038	0.0220
β_2	-0.0440	-0.2668	-0.0440	-0.2670
β_3	-0.0293	-0.1780	-0.0293	-0.1780
β_4	0.0313	0.1908	0.0313	0.1910
β_5	-0.0791	-0.4902	-0.0791	-0.4900
β_6	-0.0671	-0.4074	-0.0671	-0.4070
β_7	-0.1176	-0.7212	-0.1180	-0.7210
δ	0.0126	1.4798	0.0126	1.4800
δ_1	-0.0131	-1.0871	-0.0131	-1.0870
δ_2	-0.0096	-0.8034	-0.0096	-0.8030
δ_3	-0.0089	-0.7393	-0.0089	-0.7390
δ_4	-0.0104	-0.8650	-0.0104	-0.8650
δ_5	-0.0015	-0.1273	-0.0015	-0.1270
δ_6	-0.0052	-0.4283	-0.0052	-0.4280
		Equation 13: $\Delta B(i,t) = \beta + \varepsilon_{(i,t)}$		
β	0.0511	1.7420	0.0511	1.7420
		Equation 14: $\Delta B(i,t) = \beta + \delta(t^*-t) + \varepsilon_{(i,t)}$		
β	-0.0414	-0.6653	-0.0414	-0.6650
δ	0.0054	1.6848	0.0054	1.6850

Note: 01. β_1~β_7 denote the cost coefficients associated with regional dummy variables as defined in equations 10 and 12. δ_1~δ_6 denote the cost coefficients associated with the regional time trend components as defined in equation (12). δ denotes the common time trend among the seven regions as defined in equation 12 and 14. 02. Seven Regions in Illinois are Northern (1), Western (2), North Central (3), South Central (4), West Southwest (5), Wabash (6) and Little Egypt (7).

Figure 1. The Time seires of forward basis differences during pre-harvest periods for corn, North Central region in Illinois, 2000-2002

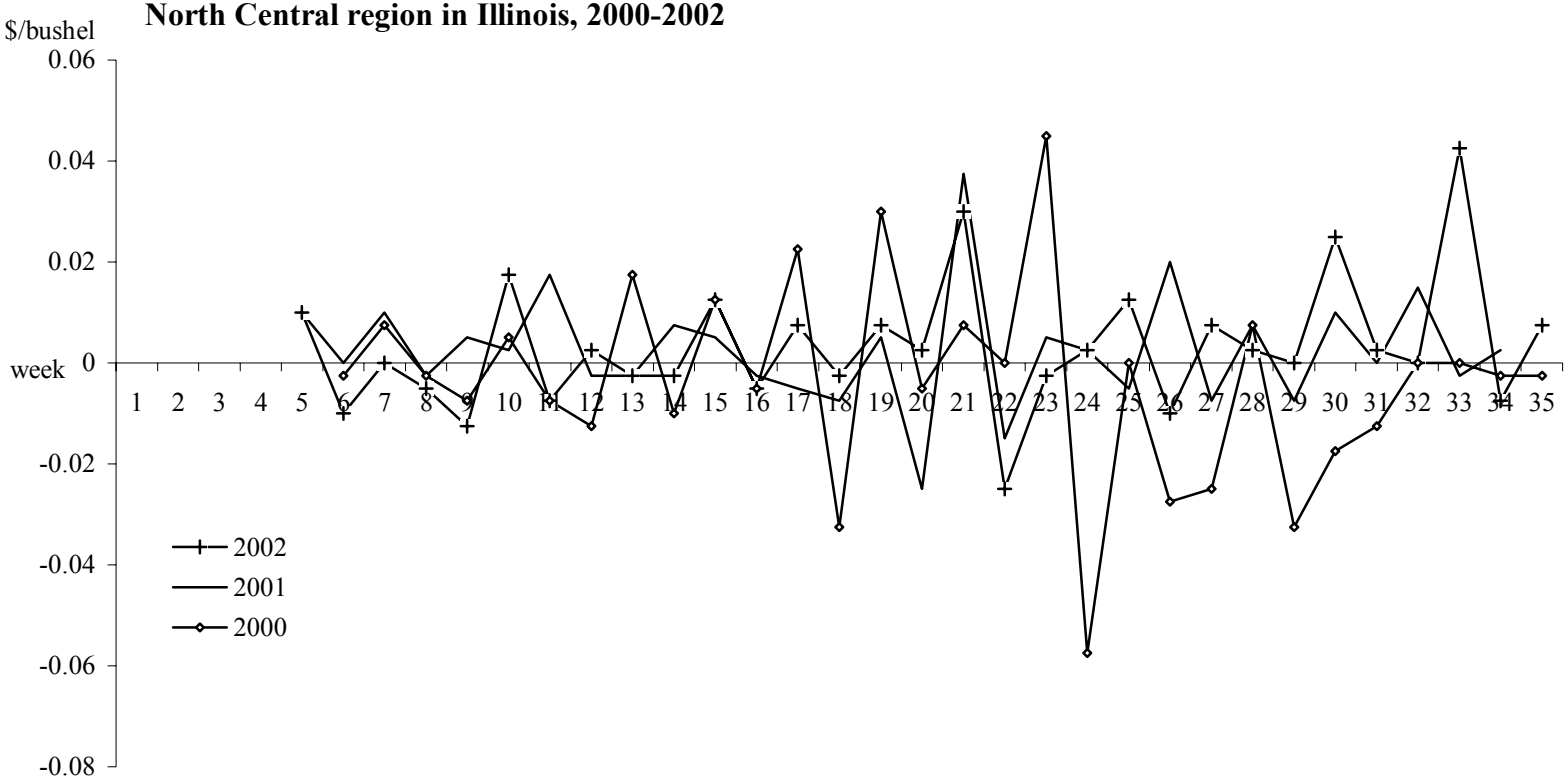

Figure 2. Comparison of Estimated Average Cost of Pre-Harvest Forward Contracting for Corn versus Hedging with Chicago Board of Trade December Corn Futures Contracts, Illinois, 1975-2002