Post-Harvest Grain Marketing with Efficient Futures

by

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This study is a simulation that tests whether Kansas wheat, corn, milo (grain sorghum), and soybean producers could have used deferred-futures-plus-historical-basis cash price expectations to profitably guide post-harvest grain storage decisions from 1985 through 1997. The signaled storage decision is compared to a representative Kansas producer whose crop sales mimic average Kansas marketings. Twenty-three grain price locations are examined. The simulation resulted in a 15¢ per bushel annual increase in grain storage profits for wheat producers, 23¢ for soybeans, -6¢ for corn, and -8¢ for milo; but storage profit differences varied substantially across locations. Inferences for random Kansas cash price locations were robust to alternative basis expectations, marketing year starting dates, model starting dates, interest rates, and storage cost structures.

Introduction

In recent years the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Marketing Risk Management has contained a thread focusing on differences in research findings and extension teachings. Zulauf and Irwin suggest that routine and systematic marketing strategies offer little hope for returns above simply selling at harvest, suggesting decreased extension emphasis on grain marketing strategies. However, using 1964-89 data for Ohio corn, and following Working, they hint that marketing gains may accrue to producers who use futures prices as a source of information rather than as a trading medium. Specifically, using current basis and deferred futures, along with expected future basis, they find projected returns to storage are reasonable indicators of actual storage returns.

If Zulauf and Irwin are right, it makes sense for producers to focus less on pre- or post-harvest price-picking and more on futures-based storage signals. However, if cash markets are efficient, positive economic returns to grain storage should not generally prevail. Of course, markets likely appear efficient at only sufficiently aggregated levels (because of the information available there) and from only the perspective of average participants (with average costs). Management decisions, however, are regularly made at highly disaggregated levels, and by managers with widely varying costs. Thus, although it is important to point out the fallacies of grain marketing strategies that depend on futures inefficiency for profits, it should be valuable to develop marketing strategies that apply to disaggregated prices and producer-specific costs, and which *assume* futures efficiency. At those levels, inefficient markets might be uncovered that could be exploited for profit, even for average cost producers. Essentially, the supposition is that producers could exploit local information advantages. Further, explicitly including storage costs

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in alternative marketing strategies should make them more useful for producers, who must sell their crops at some point.

This research is motivated by repeated producer questions regarding appropriate grain marketing strategies. It follows up on Zulauf and Irwin's suggestion of using futures and cash prices as indicators of storage returns and is structured to develop post-harvest grain marketing strategies that are useful to extension economists and grain producers. The specific objective is to test whether Kansas wheat, corn, milo (grain sorghum), and soybean producers could have used deferred-futures-plus-historical-basis cash price expectations to profitably guide post-harvest grain storage decisions over the last 13 years. More specifically, would producers who had used futures-based grain storage signals been more profitable than a representative producer whose crop sales mimicked average Kansas marketings? That question is answered with a simulation of 1985-97 grain storage returns covering multiple Kansas locations.

Background

Grain storage decisions depend intimately and intuitively on expected cash prices (e.g., Williams and Wright). In particular, if the present value of a future cash sale less grain holding costs is greater than current cash sales, it is profitable to store grain. Intuitively, if the cash price expectation, taken at time t, for some future time period $t+h$, is greater than the current cash price at time t plus interest and storage costs over time h, then a profit-maximizing grain producer would store grain. Conceptually, grain storage is viewed as an all-or-none decision: either it pays to store or it does not, which means producers would be expected to market a crop only once. However, Goodwin and Kastens found that Kansas producers market their crops more frequently than once, and suggested that fixed marketing costs, capital constraints, and risk are some of the factors impacting marketing frequency.

Although the futures efficiency literature is large, with diverse procedural approaches taken and diverse conclusions, the evidence generally favors efficiency — especially for grain futures. Further, there is little evidence that futures, and especially grain futures, contain risk premia (Kolb 1992, 1996). Grain businesses regularly forward price based on deferred futures, and futures prices *are* price expectations (Eales et al.). Futures prices are inexpensive to obtain and are at least as accurate as commercial and public providers of price forecasts (Just and Rausser; Marines-Filho and Irwin; Kastens, Schroeder, and Plain). Adding historical basis to deferred futures prices provides a simple and reasonably accurate procedure for using futures prices to formulate cash price expectations (Kastens, Jones, and Schroeder). Given grain futures efficiency, accuracy, and ubiquity, and given the simplicity of futures-plus-historical-basis cash price forecasts, using deferred futures plus historical basis as cash price expectations in grain storage returns models should be appropriate. Also, as long as futures prices and basis expectations are unbiased, resulting storage returns over time should not depend on actually taking the associated storage hedge futures positions.

Because of such grain storage mechanics as grain handling and elevating, which tend to be one-time events, and monitoring and aerating, which tend to be ongoing, grain storage costs can be characterized as the sum of fixed and variable cost components. For example, the Agricultural Market Advisory Service (AgMAS) Project, which examines pricing performance of market advisory services and crucially relies on grain storage costs, applies a fixed storage cost of 13¢ per bushel for corn and soybeans from October 15 through December 31, and a 2¢ per bushel per month charge thereafter — a cost structure considered representative of commercial storage in the corn belt (Jackson, Irwin, and Good). Other studies have used only variable storage costs, either to represent reality or to impose simplicity (e.g., Heifner; Fackler and Livingston). For Kansas, commercial grain storage costs are characterized as variable-cost-only (USDA's *Summary of Offer Rates for Country Elevators*).

Opportunity, or interest, costs for stored grain are potentially complicated because reduced-interest grain storage loans have traditionally been available to producers through the Commodity Credit Corporation (CCC) of the U.S. Department of Agriculture, albeit typically for less than 100% of the market value of the grain stored. Further, how a producer might use the cash generated from grain sales (e.g., add to savings or pay off loans) will determine appropriate grain storage interest costs for that producer. The important point is that, to ensure reasonable inferences, when alternative producer behavior is posited across different storage cost scenarios, the scenarios should involve reasonable and feasible estimates of interest and storage costs.

Storage Simulation Procedure

This research relies on a simulation of grain storage decisions based on futures plus basis cash price forecasts that lead to expected storage returns conditional on alternative storage cost scenarios. As with all simulations, understanding the underlying assumptions, decision rules, and data is crucial to judging validity of the process. Thus, a careful description of this information is warranted.

Grain Storage Rule or Model

In each week t, beginning at harvest ($t=harvest$), a grain producer looks ahead to all possible future weeks, $t+1 \ldots t+H$, where H is the maximum look-ahead horizon available, and calculates an expected return to storage for each week. An expected return for horizon h (i.e., week $t+h$) is calculated as: the expected selling price in week $t+h$ less the market price in week t (current market price) less interest and storage costs accrued over h weeks (as used here, returns are *net* returns — net of costs). If any of the $t+1 \ldots t+H$ expected returns are positive, grain is stored from week t to week $t+1$. In that case, the producer steps ahead to week $t+1$, now labeling that week as t, and begins the expected storage returns calculations anew. On the other hand, if all $t+1 \ldots t+H$ expected returns are nonpositive, all grain is immediately sold (in week t), and the producer waits until the next harvest before again engaging in the look-ahead expected storage returns process. Note that there is nothing in the grain storage model that precludes storing grain beyond the crop year, thus simultaneously storing multiple harvests. Nor is the model based on taking futures hedge positions.

Benchmarks for Comparison

How shall the grain storage model be evaluated by researchers and potential users? One possibility is to test historically whether the model generated positive returns to storage. Was a model user more profitable than a producer who merely sold at harvest? Or, on average, was the model's harvest-equivalent price (sale price less interest and storage costs) greater than the harvest price? That method of evaluation has at least two problems. First, in small samples, average returns to storage are highly conditional on observed price patterns in individual years, so model evaluation is masked by underlying price movements. Second, returns to storage are highly conditional on storage costs. Low-cost grain storers may be correctly signaled by the model to store grain, but the model may be no better than simply storing grain for a fixed time period each year. In this case, model evaluation is masked by the fact that grain markets are expected to yield profits to low-cost grain storers — with or without the use of a model.

A second way for evaluating the grain storage model's success is to test historical storage returns when using the model against those of a representative grain marketer over the same time period. Crops are not typically marketed by producers only at harvest, but throughout the crop year (although disproportionate shares are marketed around harvest). This evaluation process answers the intuitively appealing question, Would marketing grain using this model have been more profitable than a typical producer during the period examined? Moreover, by assigning the representative marketer the same storage cost structure as a model user, this process should not give undo credit to the model if storage costs are assumed low. Thus, although some comparisons are made with prices available at harvest, this research focuses on comparing model-based storage returns with representative returns.[1]

Expected Prices

Expected prices are deferred futures prices plus historical basis. Following Hauser, Garcia, and Tumblin; Jiang and Hayenga; and Kenyon and Kingsley; 3-year historical bases are generally used in the simulations, but the process is tested with 5-year historical bases as well.

Marketing Year Start

A post-harvest returns-to-storage marketing study logically should begin around harvest. A reasonable starting point is the week at which 50% of the Kansas crop is typically harvested. However, some producers might begin post-harvest marketing early in the harvest and others

[1] It is possible that a producer with low (high) storage costs has a different pattern of marketings than the representative marketer, however, information to determine that is not available. Thus, the marketing pattern is assumed to be the same for the representative marketer regardless of cost structure. Using the representative returns framework should help determine whether observed storage returns when *following* the model are actually *due to* the model. Nonetheless, tests of rule-based marketing strategies in small samples are always plagued with low power, and more conclusive evidence awaits more years of data.

late, thus, one week earlier (than the average 50% point) and one week later beginning points are also considered. Except where the distinction is needed, the marketing year beginning point is simply referred to as harvest.

Representative Price or Representative Marketer

The representative marketer is one who, in each week of each year, markets that portion of his crop which equals the estimated portion of the total Kansas crop marketed by all producers in that week of that year. The representative price is the harvest-equivalent (adjusted for storage and interest costs), marketings-weighted price of the representative marketer.

Interest Charges

Two interest rates are considered in the simulations, a bank loan rate and a CCC (Commodity Credit Corporation) loan rate reflecting the cost of funds when government commodity loans are taken. Because CCC loans are typically not for 100% of grain market value, charging CCC rates against market price tends to understate actual interest costs for government loan holders — especially in years of high market prices. Nonetheless, the goal is to make some allowance for alternative interest rates. The precise historical accuracy of interest rates used is not particularly relevant because model users and non-users are each charged the same interest rate.

Storage Costs

At harvest, grain is considered either sold or placed in storage. Farm and commercial storage are differentiated only by the storage costs. That is, commercial storage cost is simulated by assigning commercial storage rates throughout. According to USDA's *Summary of Offer Rates for Country Elevators*, annual commercial grain storage rates for 1987-98 averaged 2.6¢ per bushel expressed on a per month basis for each of wheat, corn, milo, and soybeans. Further, with standard deviations around 0.06¢ per bushel (on a per month basis), the rates were quite stable over the time period. Communication with several grain elevator operators confirmed that rate and noted further that it is customary for Kansas elevators to have a 30 day grace period after grain is first delivered to an elevator (grain sold within 30 days has no storage charge but is charged 31 days of storage if sold on day 31). Consequently, the commercial storage rate simulated here is 0.65¢ per bushel per week, with a 4 week grace period.

Because grain is assumed delivered to a commercial elevator at some point, and because grain would be stored commercially if that were less expensive than farm storage, simulated farm storage rates should generally be less than commercial rates. To cover alternative cost structures, simulated farm storage rates used here contain fixed and variable components. We consider two farm storage rates. Farm storage rate #1 assumes a 9¢ fixed charge coupled with a 1.1¢ monthly charge. This is an arbitrary division of fixed and variable charges that equates to commercial rates at 6 months. Farms with this storage cost structure would be better off storing on farm than in commercial elevators as long as the grain was held for at least 6 months. But, short term on-farm storage would have large penalties relative to commercial storage, which is as it should be if physically moving grain in and out of storage is costly.

At harvest, grain must be hauled somewhere. It seems reasonable that some farms would want to avoid hauling grain to commercial elevators during harvest in order to avoid the high opportunity cost of machinery and labor associated with long distances to elevators or long waiting-to-unload times at elevators. Also, some farms may expect gains associated with the marketing flexibility of on-farm storage (e.g., truck bids, or bids from more than one elevator). Such situations can be represented with a fixed cost wedge between commercial and farm storage costs. Thus, farm storage rate #2 uses the same 1.1¢ monthly variable cost as rate #1, but assumes an arbitrary fixed cost of −9¢. Farms with this storage cost structure have a high market incentive to store grain, much as they would have in the examples just given. Regardless of the farm storage rate considered, to simulate making room for the new crop, all grain stored past 44 weeks accrues storage costs at commercial rates.

Multiple Grain Sales

Because producers demonstrate multiple sales for each crop harvested, grain storage is not typically an all-or-nothing decision and modifications to the grain storage model should allow for that. Furthermore, a producer may not wish to commit all of a crop to one marketing rule. Functionally, that is like initiating the storage model from different vantage points following harvest. For example, for cash flow or other reasons, a grain marketer may choose to sell a portion of his crop at harvest (or even ahead of harvest) and not revisit the marketing task on the remainder until a later date. Here, we consider starting the model 8 weeks after harvest and 16 weeks after harvest. For each year, at the selected model starting date, grain that was already marketed by a representative marketer is also considered sold in the same manner by the model marketer. Thus, the later the model starting date, the less likely it is that a model follower would receive a different average price than the representative marketer.

Data

The base data used here are Wednesday closing cash prices for Kansas markets from January 1982 through February 1998. Prices were available from 23 locations for wheat, 11 for corn, 17 for milo, and 13 for soybeans. Cash price data were collected in 4-week months, or 48-week years; 4th and 5th Wednesday prices were averaged and reported as one value in months with five Wednesdays (see Kastens, Jones, and Schroeder for additional data detail). Kansas City wheat, Chicago corn, and Chicago soybean nearby and deferred futures prices were collected in the same manner and matched to the cash prices. Consistent with elevator behavior, nearby contracts avoid delivery months (e.g., the May contract is the nearby in March, even though a March contract trades — March basis is off the May contract). Together, cash and nearby futures prices allowed construction of 3-year and 5-year historical basis values (milo used corn futures). Historical bases were added to deferred futures prices for cash price expectations.

Availability of futures price data allowed for consistently formulating cash price expectations, thus expected returns to storage, up to the following number of weeks ahead (H): wheat, 31; corn and milo, 45; soybeans, 44.

To determine which week should be used to begin the marketing year for each crop, USDA's weekly *Crop Progress Reports* were used to determine the following 1985-96 mean 50%-completion harvest dates in Kansas: wheat 24 June, corn 30 September, milo 18 October, and soybeans 13 October. In the 48-weeks-per-year data structure used, these average dates correspond to the following weeks: wheat, week 24 (4th week of June); corn, week 37 (1st week of October); milo, week 39 (3rd week of October); and soybeans, week 38 (2nd week of October). On average, one week prior to these dates corresponds to harvest being 18% complete for wheat and 35%, 33%, and 31% complete for corn, milo, and soybeans, respectively. Similarly, one week after the 50% date corresponds to harvest being 80% complete for wheat and 63%, 66%, and 65% complete for corn, milo, and soybeans, respectively.

Marketing year weekly marketing portions are needed to construct the representative price series, with a marketing year beginning in the week of harvest and ending with the week preceding harvest in the following year. Monthly Kansas crop marketings were obtained from *Kansas Agricultural Statistics*, and apply to official 12-month crop years where wheat begins in June and corn, milo, and soybeans begin in September. Official crop years do not coincide exactly with our marketing years. Nor do officially reported crop marketings distinguish old and new crop sales. Thus, some modification was required to develop the weekly marketings numbers underlying our representative price series.[2]

Annual average annual interest rates charged by banks on new farm loans were collected from the Federal Reserve System (*Agricultural Finance Databook)* and assigned to weeks by calendar year. Monthly average annual CCC interest rates were obtained directly from USDA's *Commodity Credit Corporation's Interest Rate Charges* and appropriately assigned to weeks. Because CCC rates were unavailable from March 1995 through February 1998, the 1982-95 average bank interest rate to CCC interest rate ratio was used to construct a proxy for CCC rates

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[2] As a first step in constructing the representative price series, reported Kansas crop marketings for only the first month of each official crop year were adjusted downwards — by the average marketings in the last month of 1982-96 official crop years — to reflect the fact that a portion of old crop tends to carry into the new crop year and is counted as marketings there. Next, these slightly modified (new-crop-only) official monthly marketing weights were assigned to weeks (the September weight to each week in September, and so on). Our marketing year weeks that run past the end of the official crop year were assigned the same weights as those of the last month of the official crop year (e.g., the four September and two October weeks at the end of our milo marketing year were assigned the August weights). To ensure that our marketing year marketings-to-date were compatible with those of the new-crop-only official monthly series, we assumed "catch up" marketing at harvest. For example, the marketing weight for milo in the week of harvest (3rd week of October) was actually the sum of the marketing weights for the four September weeks and the first three weeks of October. Finally, all weekly marketing weights were appropriately normalized to sum to one over the marketing year. For 1997, all marketing years end with the 4th week of February in 1998.

for that period. From 1985 through February 1998 the average annual interest rates were 8.47% and 6.49% for the bank and CCC rates, respectively.

Simulation Results

To explore the stability of the futures-based grain storage model tested here, several simulation runs were performed. Marketing patterns (percent sold each week) for the benchmark representative marketer do not change across simulation runs, except when considering different marketing year starting dates. Nonetheless, the representative price typically does change across runs because interest rates and storage costs impact storage returns for both the representative marketer as well as for the storage model. To provide sufficient depth to the exposition, much of the results focus on the base run (e.g., all of the figures and table 1). The base run assumes the marketing year begins the average week of 50% harvest completion (wheat 24, corn 37, milo 39, and soybeans 38), and that the storage model is allowed to begin the same week. It assumes 3-year basis histories are used in cash price expectations, interest charges are based on rates charged by banks on farm loans, and storage charges are 2.6¢ per bushel per month (0.65¢/week), which is the commercial storage rate.

To help visualize marketing patterns of the representative marketer, figures 1-4 show weekly Kansas marketing-year marketings aggregated by month for each crop using the marketings calculation procedures discussed earlier and base run marketing year starting dates (average 50% harvest completion weeks). With the exception of corn (figure 2), where harvest is in the first week of the month, the figures span 13 calendar months — because the 48 weeks of the marketing year involve all or part of 13 calendar months. The figures show the highest marketings in the month of harvest or the month after harvest, with substantially lower marketings over the last half of the marketing year.

To put the base models' results in perspective, figures 5-8 show the harvest-equivalent prices for each crop by year and averaged across locations for: (a) the harvest price, or that obtained by someone marketing 100% of a year's crop at harvest; (b) the representative price, which is that obtained by a marketer whose sales and storage patterns mirror those of a typical Kansas producer (those shown in figures 1-4); and (c) the model price, which is the price obtained by a marketer following the base model. Although some years show substantial disparity among the three location-average prices (e.g., 1996 on wheat, corn, and milo; 1988 on corn and milo, or 1987 on wheat and soybeans), the three prices for a crop do not appear dramatically different on average. That means the base storage model for a crop is reasonable and that marketers should not be averse to following it over time. However, it also suggests there is no compelling reason to follow the model either. Interestingly, because the average harvest and representative prices are similar in each of figures 5-8, this presents a graphical confirmation of market efficiency.

Figures 9-12 depict the average (1985-97) gain by location for the model over the representative marketer. Clearly, within a crop, the model performs much differently for some locations than for others. For example, the model had an approximately 14¢ per bushel advantage over representative marketing for corn (figure 10) location number 3 (Emporia). Yet, locations 1, 6, and 8 (Colby, Hutchinson, and Pratt) showed around a 20¢ disadvantage over representative marketers for corn. All locations for wheat and soybeans (figures 9 and 12) show positive gains for the model over representative marketing, which contrasts sharply with the typically-negative model gains for corn and milo locations (figures 10 and 11), however, there is still considerable variation across locations.

The visual base-run information depicted in figures 9-12 is presented numerically and in more detail in table 1; locations are named there as well. On average, across the 23 wheat locations over 1985-97, the base storage model's price was 14.5¢ per bushel higher than that of the representative marketer. Observing 23 of 23 locations where the model's gain was positive is highly improbable (see the nominal count pvalue) if model vs. representative superiority for each location can be thought of as a binomial, or coin-flipping experiment. Thus, if inferences are to be made about a random, or typical, wheat location, our results suggest that the grain storage model is successful as a grain storage strategy. But, for inferences about individual wheat locations, results are somewhat mixed. Only 8 of 23 locations had statistically positive model gains, as judged by a paired-t test across the 13 yearly observations (1985-97) of wheat price for each location.

Soybean results in table 1 are similar to wheat, with 13 of 13 locations showing higher prices for the model than for the representative marketer, and an average price that is 23.3¢ per bushel higher for the model. One location, Topeka, had a 58.6¢ gain for the model. Also, 9 of 13 locations had statistically higher model prices and two of the other four were close to being statistically higher — which means that inferences apply to most individual soybean locations. In general, the simulation results broadly support using futures-based cash price expectations as indicators of returns to storage for wheat and soybeans.

Table 1 results for corn and milo are dramatically different than for wheat and soybeans. Only 5 of 11 corn locations and 3 of 17 milo locations showed the storage model's price to be higher than the representative marketer's. Also, only 1 of 11 corn locations and 0 of 17 milo locations showed the model to be statistically higher. Average 1985-97 model gains were −6.0¢ and −8.2¢ per bushel for corn and milo, respectively. Clearly, the storage model does not appear to perform very well for corn and milo; rather, it suggests that the storage model may actually be worse than the representative marketer. If the paired-t tests were reversed, testing the null of no difference against the alternative that the representative marketer received a higher price, then 5 of 11 corn locations and 8 of 17 milo locations would have had statistically higher prices for the representative marketer. Also, the binomial experiment nominal count pvalue associated with finding the 14 of 17 negative model gains for milo would be 0.07.

Figures 13-16 show the 1985-97 average number of weeks crops are stored by model followers at each location. Straight lines are included corresponding to the average number of weeks a representative marketer stores grain. The wheat model stores wheat for 13.0 weeks on average against 14.7 weeks for the representative wheat marketer. Corresponding values for soybeans are: model, 13.2 weeks and representative, 14.1. On the other hand, storage weeks for corn are: model, 27.9 weeks, representative, 14.0; and for milo: model, 23.5 weeks, representative, 13.0.

For both corn and milo the model tends to store much longer, on average, than did the representative marketer. Could this be why the model fared poorly in corn and milo? Did expectations of higher cash prices repeatedly not materialize? Assuming accurate basis expectations, that would imply upwardly biased corn futures (tendency for prices to fall from their expectations), which is not typically found in futures efficiency literature, nor here.[3] Or, were basis expectations upwardly biased, implying actual bases that were repeatedly wider than expected? In our data, the mean errors for basis predictions (actual basis less 3-year historical basis at the time it was forecasted) were 1.15¢, -0.01¢, 0.54¢, and -0.09¢ for wheat, corn, milo, and soybeans, respectively. Clearly, these average basis forecasting errors are not indicative of bias, upward or downward.

Although it does not immediately appear that generally biased futures or basis forecasts drive the negative average model gains for corn and milo, it may still be that short term upward biases come in just the wrong years, years when storage signals caused multiple harvests to be held.[4] For milo, the 1986 and 1987 crops fall in that category. The 1986 harvest price was $1.31 (17 location average); the representative marketer acquired $1.21; and the model, after storing milo for a somewhat lengthy 65 weeks (over 48 weeks implies two crops are in storage), acquired only $1.04. The 1987 harvest price was $1.43; the representative marketer acquired $1.49; and the model, after storing for 66 weeks, acquired only $1.38. This contrasts with wheat in 1987. There, the harvest price was $2.32 (23 location average); the representative marketer obtained $2.31; and the model, after storing for 79 weeks (nearly 1 year and 8 months), received $2.86. Thus, the timing of any short run price or basis biases may critically determine the storage model's success. What is not known is whether milo and wheat are intrinsically different on this or if the research sample is simply not long enough to make reliable inferences.

How sensitive was the grain storage model to different assumptions for basis histories, marketing year starting dates, model starting dates, interest rates, and storage rates? Table 2 reports these results for wheat and corn and table 3 for milo and soybeans. The top row in each crop section depicts the base run results, which are the same as those reported in table 1. Each subsequent row for a crop, beginning with 5-year basis and ending with farm storage rate #2, shows results for a different simulation.

The 3- and 5-year basis histories are compared in tables 2 and 3 looking across the top

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[3] For October 1985 through February 1998 weekly nearby corn futures, the period covered by the simulation, the average price for the same contracts observed from 1 through 45 weeks earlier was only 1.2¢ higher.

[4] By definition, the representative marketer cannot hold grain more than 48 weeks.

two rows for each crop in the 87-97 model gain column (data availability precluded using the model until 1987 when using 5-year bases). Model gains with 5-year bases were around 1¢ to 10¢ less than with 3-year bases for wheat, corn, and soybeans, but 8¢ greater for milo. Although not shown, the pvalue of the location nominal counting binomial experiment changed only marginally with the 5-year basis runs for wheat, corn, and soybeans, suggesting that the grain storage model was not particularly sensitive to the basis forecasting procedure for those crops.[5] For milo, using 5-year basis had more impact, resulting in 10 of 17 rather than 3 of 17 locations having positive model gains (still only 0 of 17 were statistically positive). The nominal count pvalue was now 0.32 rather than 1.00, still not supporting significant model gains for milo overall. Thus, if results are confined to testing the alternative hypothesis that the model was better than the representative marketer, then using a 5-year basis did not alter conclusions.

Average model gains and positive model gain location counts changed little from the base runs when considering early or late marketing year starting dates, at least for corn, milo, and soybeans. For wheat, model gains improved over 2¢ with a one week earlier marketing year starting date (week 23) and decreased nearly 6¢ for a one week later start (week 25). Still, all 23 wheat locations showed positive model gains for both early and late marketing year starting dates.

Starting the model 8 weeks or 16 weeks after harvest generally diminished model gains over the base runs for wheat (10¢ drop) and soybeans (6¢ drop). This was expected because starting the model later impacts less of the total crop (more of the crop sales are predetermined). Nonetheless, the number of wheat locations with positive model gains was still greater than expected in a random draw; although, they dropped from 23 to 18 for the 8-weeks-after-harvest starting point and from 23 to 22 for the 16-week delayed start. Results of delayed model starts for corn and milo were mixed, with the 8-week delay lowering model gains and the 16-week delay raising them. In general, delayed starting dates did not alter conclusions — the model was still better for wheat and soybeans but not for corn and milo.

Storage model results were not particularly sensitive to which interest rate series was used. In terms of either model gain or nominal location counts, the CCC interest rate run differed little from the base run for any of the four crops. Largely different storage cost structures (farm store #1 and #2) did not change model results much from the base run for wheat or soybeans, but changed corn and milo results more. In particular, the farm store #1 (9¢ fixed plus 1.1¢/month) storage assumption changed model gains from –6.0¢ to 3.8¢ for corn and from –8.2¢ to –1.9¢ for milo. Similarly, positive location counts rose from 5 to 7 for corn and from 3 to 7 for milo. Nonetheless, consideration of different storage cost structures did not generally alter results - the model was still not superior for corn and milo. Interestingly, despite the improvement in model gains with the farm store #1 storage costs, the average number of weeks grain was stored

[5] The number of positive model gain locations for the 3-year basis base runs, only over 1987-97 rather than 1985-97, was identical to that reported for 1985-97 except for corn, which had 4 positive model gain locations rather than the 5 reported.

by the model (not shown) went from 27.9 to 29.9 for corn and from 23.5 to 27.7 for milo. Apparently, it was not necessary to have grain stored for shorter periods in order to enhance model gains.

Conclusion

Relevance is always an issue in agricultural economics. The less aggregated, the more comprehensive, and the simpler the underlying empirical process, the more likely results will be believed and the methods incorporated in producers' management decisions. This project sought to develop simple, post-harvest grain marketing strategies that depend only on futures price, historical localized basis, and producer-level storage costs, and which crucially assume futures efficiency. We used cash price data from 23 Kansas locations in a grain storage decision simulation to test whether Kansas wheat, corn, milo, and soybean producers could have used deferred-futures-plus-historical-basis cash price expectations to profitably guide post-harvest grain storage decisions over the last 13 years.

A producer who had used deferred futures with 3-year historical basis and commercial storage rates to determine grain storage decisions would have improved profits by 14.5¢ per bushel per year for wheat and 23.3¢ for soybeans, but would have reduced profits by 6.0¢ and 8.2¢ for corn and milo, respectively, over the typical Kansas producer. However, with only 13 years of data, one should be cautious in reading too much into these results. Also, benefits to using the futures-based grain storage procedure were highly variable across cash locations, which suggests that economists should be careful when making grain storage strategy recommendations to individual producers. Furthermore, for some crops and years the decision model would have stored grain for more than a year, obviously necessitating adequate equity or debt financing on the part of the model-follower.

If inferences are confined to random rather than specific Kansas cash price locations, then the grain storage decision model was generally not sensitive to marketing year beginning date, using a different basis expectation (5-year), starting the decision framework later in the crop year than at harvest, using bank or government commodity loan interest rates, or using alternative storage cost structures such as those which might be encountered in a farm storage situation. Even though futures prices and basis expectations may not be biased in the long run, short run upward or downward biases may come in years when more than one harvest is signaled to stay in storage, exacerbating storage gains or losses in those years, and ultimately impacting long run results. A longer data set is needed to confirm our results. In the meantime, grain marketing practitioners could cautiously use the grain storage model developed here to guide post-harvest wheat and soybean storage decisions, but should hold off on using the model for corn and milo.

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Table 1. Advantage of Base Storage Model over Representative Kansas Marketer, 1985-97[a]

Kansas Location	Wheat: Model Gain (¢/bu/yr)	Wheat: paired-t pval.[b]	Corn: Model Gain (¢/bu/yr)	Corn: paired-t pval.	Milo: Model Gain (¢/bu/yr)	Milo: paired-t pval.	Soybeans: Model Gain (¢/bu/yr)	Soybeans: paired-t pval.
Andale	10.0	0.19			–22.9	0.99	18.2	0.11
Beloit	13.9	0.12			-18.1	0.97	27.4*	0.03
Colby	14.4	0.10	-19.4	0.96	-2.9	0.72	14.1	0.27
Concordia	12.2	0.16						
Dodge City	9.6	0.19	4.4	0.33	6.2	0.24	19.3*	0.06
Emporia	14.6	0.12	13.8*	0.03	-11.3	0.97	25.7*	0.03
Garden City	12.8	0.14	3.6	0.36	-6.2	0.78	8.4	0.17
Great Bend	18.7*	0.06	-10.8	0.88	-16.1	0.99	24.5*	0.05
Hays	11.6	0.16			-2.3	0.61		
Hoxie	15.8*	0.10						
Hutchinson	23.8*	0.03	-18.8	0.96	-13.5	0.96	31.5*	0.02
Kansas City	13.4*	0.10	-8.3	0.84	-7.3	0.88	16.8*	0.03
Liberal	15.2	0.11			-16.2	0.99		
Marysville	20.1*	0.03						
Pratt	11.4	0.18	-21.9	0.98	-4.4	0.69	28.6*	0.03
Russell	9.4	0.20						
Salina	16.2*	0.08			2.3	0.26		
Scott City	5.7	0.30	-16.5	0.96	-4.9	0.79	11.1*	0.06
St. Francis	24.8*	0.02						
Topeka	19.9*	0.06	3.8	0.17	-15.7	0.97	58.6*	0.02
Wellington	12.4	0.15						
Whitewater	14.7	0.11	4.6	0.34	6.0	0.24	18.4	0.12
Wichita	12.5	0.16			-12.4	0.91		
Average	14.5	0.12	-6.0	0.62	-8.2	0.76	23.3	0.08
Total Loc.	23		11		17		13	
No. Loc.>0 (nominally)	23		5		3		13	
No. Loc.>0 (statistically)	8		1		0		9	
Nominal count pval.[c]	0.00		0.73		1.00		0.00	

[a] base model uses 3-year historical basis; bank interest rate; 2.6¢/bu./mo. physical storage cost

[b] each paired-t is across 13 observations: one for each year, 1985-97; asterisks mark significance at 0.10 level

[c] probability of drawing at least the observed number of nominally positive values in a random binomial experiment

Table 2. Advantage of Alternative Storage Models Over Representative Kansas Marketer; 1985-97; Wheat and Corn

	Simulation Parameters						Results			
Simulation Run	Week Market Yr. Begins	Weeks After Mkt. Yr. Begins when Model Starts	Basis History (yrs)	Interest Series	Variable Storage Rate (¢/bu/mo)	Fixed Storage Rate (¢/bu)	Model Gain 85-97 (¢/bu/yr)	# Locations Gain>0 (nominal)[a]	# Locations Gain>0 (statistical)[b]	Model Gain 87-97 (¢/bu/yr)[c]
							Wheat (23 locations)			
Base Run	24	0	3	bank	2.6	0	14.5	23*	8	13.8
5-yr. Basis	24	0	5	bank	2.6	0	----	23*	1	9.1
Early Mkt. Yr.	23	0	3	bank	2.6	0	17.1	23*	13	----
Late Mkt. Yr.	25	0	3	bank	2.6	0	8.8	23*	2	----
Start Late #1	24	8	3	bank	2.6	0	3.4	18*	1	----
Start Late #2	24	16	3	bank	2.6	0	4.1	22*	1	----
CCC Interest	24	0	3	CCC	2.6	0	13.4	23*	6	----
Farm Store #1	24	0	3	bank	1.1	9	13.3	23*	8	----
Farm Store #2	24	0	3	bank	1.1	-9	10.5	23*	4	----
							Corn (11 locations)			
Base Run	37	0	3	bank	2.6	0	-6.0	5	1	-5.9
5-yr. Basis	37	0	5	bank	2.6	0	----	4	0	-6.7
Early Mkt. Yr.	36	0	3	bank	2.6	0	-4.8	5	2	----
Late Mkt. Yr.	38	0	3	bank	2.6	0	-5.9	4	0	----
Start Late #1	37	8	3	bank	2.6	0	-7.5	3	0	----
Start Late #2	37	16	3	bank	2.6	0	-4.8	4	0	----
CCC Interest	37	0	3	CCC	2.6	0	-6.4	3	0	----
Farm Store #1	37	0	3	bank	1.1	9	3.8	7	3	----
Farm Store #2	37	0	3	bank	1.1	-9	-1.5	4	1	----

[a] asterisks in column mark runs where probability of drawing at least the observed number of nominally positive values in a random binomial experiment ≤ 0.10
[b] number of locations where model gains were significantly positive according to a paired-t test (significance = 0.10) across 13 years
[c] required to compare 5-year with 3-year basis in first two rows of each crop section; analysis began in 1987 when used 5-year historical basis

Table 3. Advantage of Alternative Storage Models Over Representative Kansas Marketer; 1985-97; Milo and Soybeans

	Simulation Parameters						Results			
Simulation Run	Week Market Yr. Begins	Weeks After Mkt. Yr. Begins when Model Starts	Basis History (yrs)	Interest Series	Variable Storage Rate (¢/bu/mo)	Fixed Storage Rate (¢/bu)	Model Gain 85-97 (¢/bu/yr)	# Locations Gain>0 (nominal)[a]	# Locations Gain>0 (statistical)[b]	Model Gain 87-97 (¢/bu/yr)[c]
							Milo (17 locations)			
Base Run	39	0	3	bank	2.6	0	-8.2	3	0	-8.7
5-yr. Basis	39	0	5	bank	2.6	0	----	10	0	-0.7
Early Mkt. Yr.	38	0	3	bank	2.6	0	-7.6	3	0	----
Late Mkt. Yr.	40	0	3	bank	2.6	0	-8.5	2	0	----
Start Late #1	39	8	3	bank	2.6	0	-9.4	3	0	----
Start Late #2	39	16	3	bank	2.6	0	-7.3	3	0	----
CCC Interest	39	0	3	CCC	2.6	0	-7.8	2	1	----
Farm Store #1	39	0	3	bank	1.1	9	-1.9	7	0	----
Farm Store #2	39	0	3	bank	1.1	-9	-5.6	5	1	----
							Soybeans (13 locations)			
Base Run	38	0	3	bank	2.6	0	23.3	13*	9	25.0
5-yr. Basis	38	0	5	bank	2.6	0	----	11*	9	15.4
Early Mkt. Yr.	37	0	3	bank	2.6	0	25.4	13*	7	----
Late Mkt. Yr.	39	0	3	bank	2.6	0	23.2	13*	10	----
Start Late #1	38	8	3	bank	2.6	0	17.8	13*	7	----
Start Late #2	38	16	3	bank	2.6	0	17.5	13*	7	----
CCC Interest	38	0	3	CCC	2.6	0	23.4	13*	8	----
Farm Store #1	38	0	3	bank	1.1	9	26.2	13*	10	----
Farm Store #2	38	0	3	bank	1.1	-9	24.6	13*	9	----

[a] asterisks in column mark runs where probability of drawing at least the observed number of nominally positive values in a random binomial experiment ≤ 0.10
[b] number of locations where model gains were significantly positive according to a paired-t test (significance = 0.10) across 13 years
[c] required to compare 5-year with 3-year basis in first two rows of each crop section; analysis began in 1987 when used 5-year historical basis

Figure 1

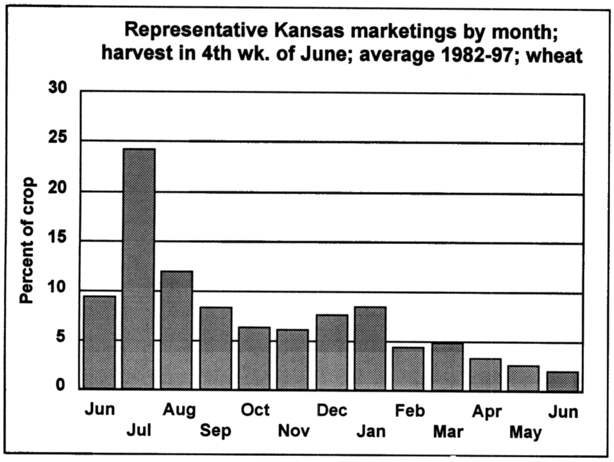


Figure 2

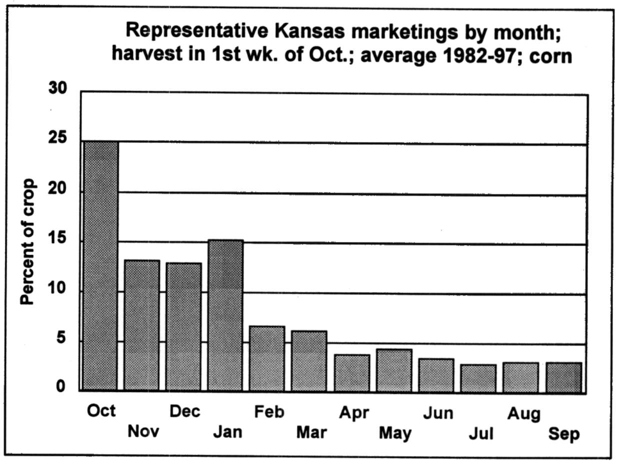
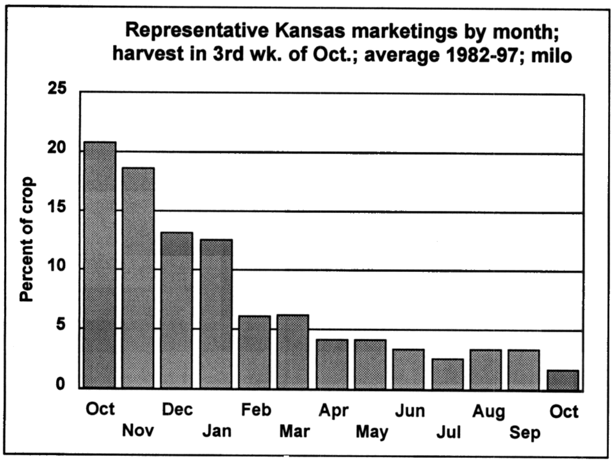


Figure 3



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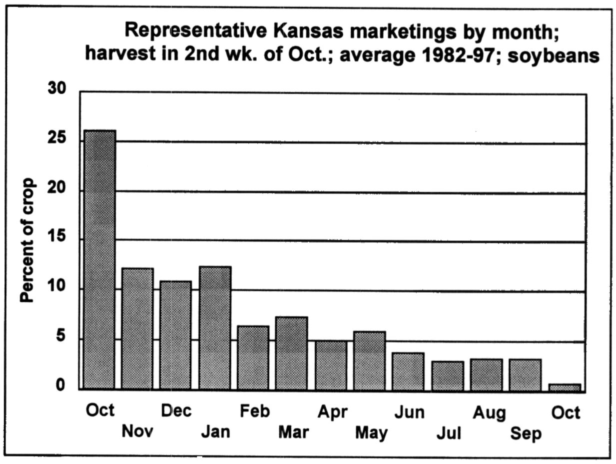

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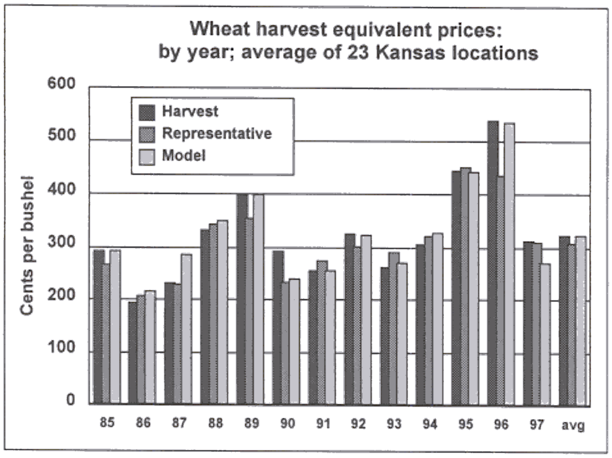

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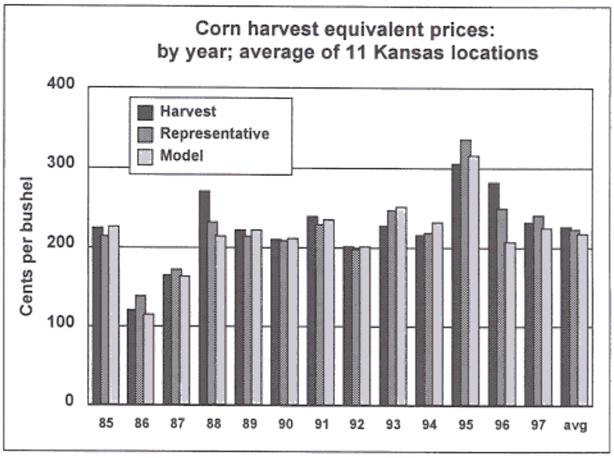

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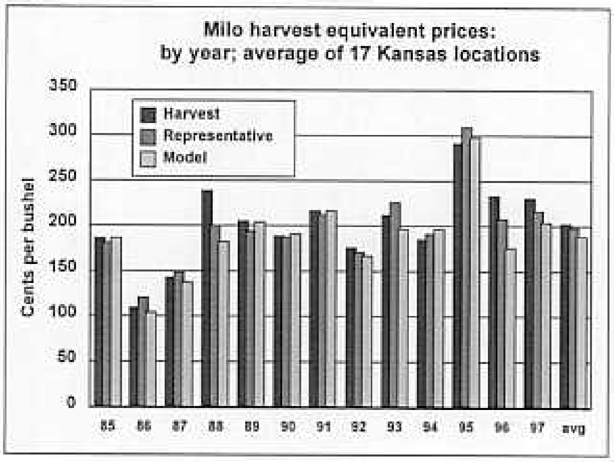

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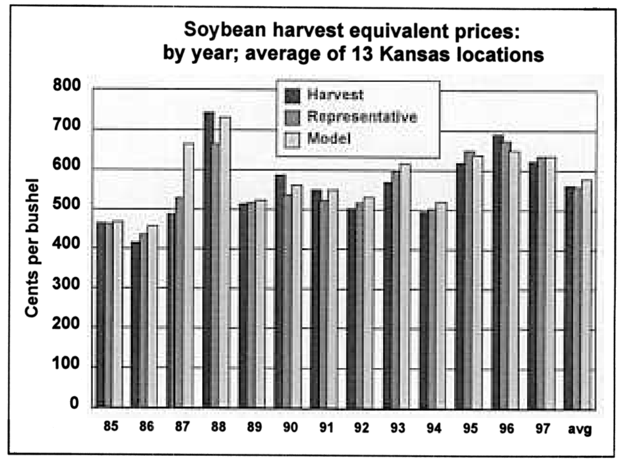

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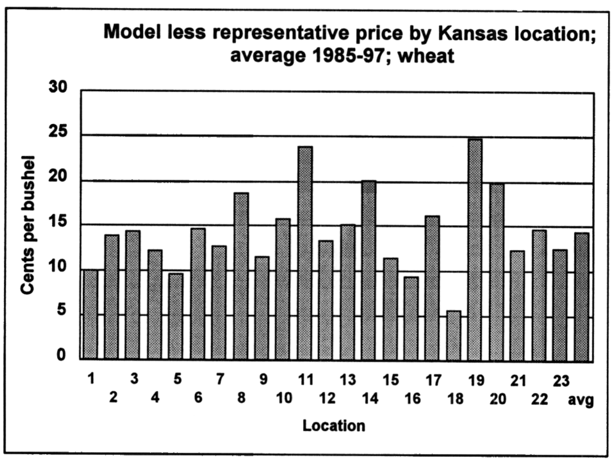
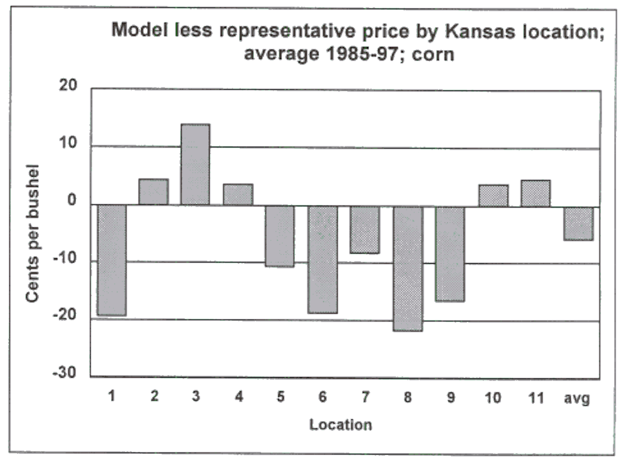


Figure 10



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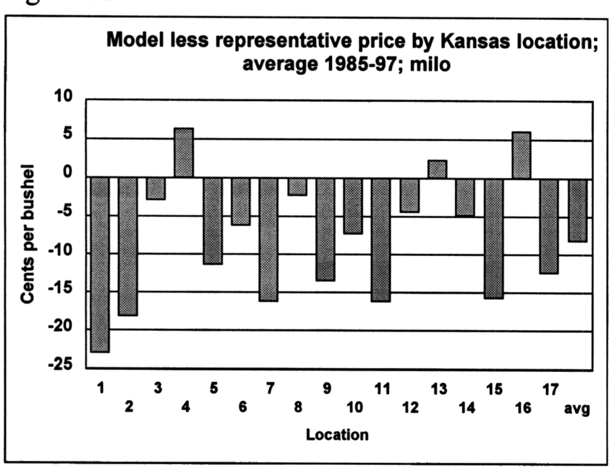


Figure 12

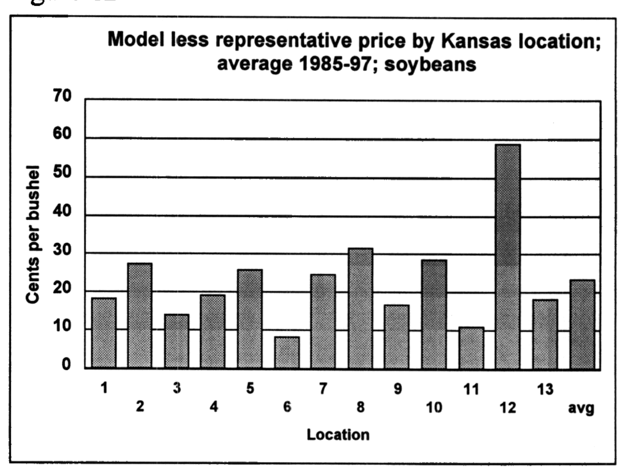
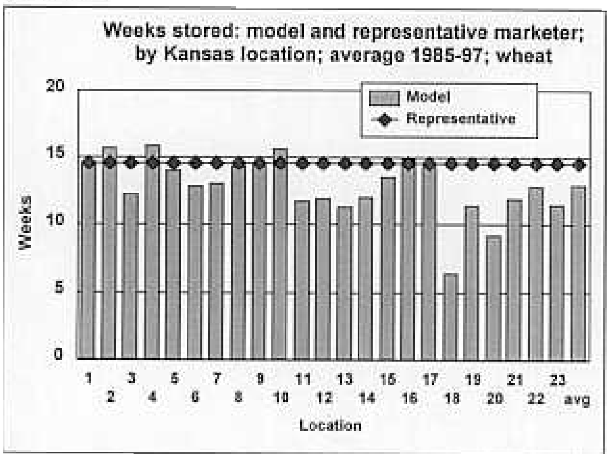


Figure 13



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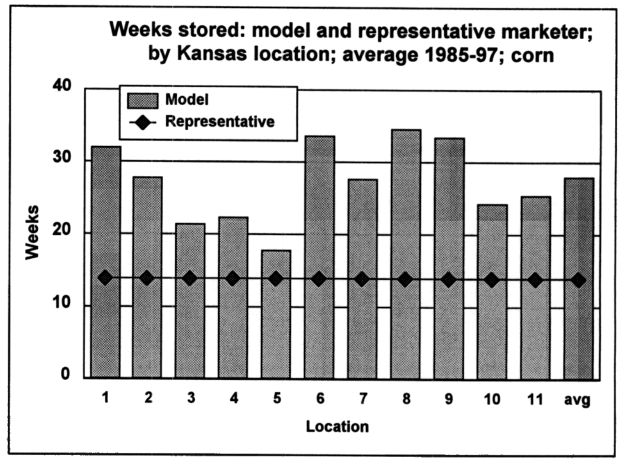

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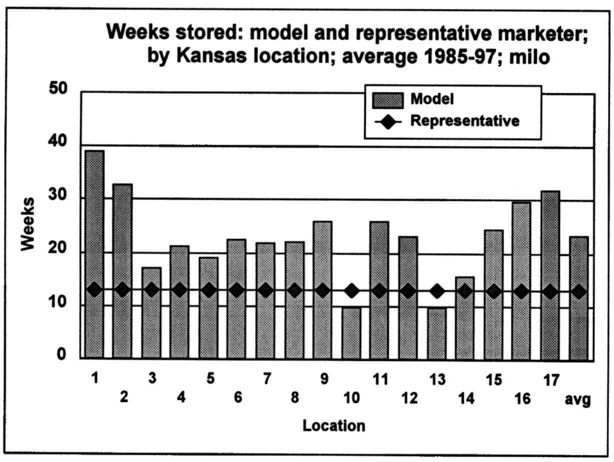

Figure 16