NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

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Suggested citation format:

Leuthold, R. M. 1992. "Evaluation and Performance of the Frozen Pork Belly Futures Markets." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. [http://www.farmdoc.uiuc.edu/nccc134].

EVALUATION AND PERFORMANCE OF THE FROZEN PORK BELLY FUTURES MARKET

Raymond M. Leuthold[1]

Frozen pork belly futures contracts began trading at the Chicago Mercantile Exchange (CME) on September 18, 1961. At the time this contract was introduced, it was innovative for the futures markets. Previous attempts at trading livestock or livestock products had not been successful and, except for soybean products, processed products had not enjoyed long-run success either. The contract fit one tradition of the times in that frozen pork bellies are storable, however, they differed from traditional storable commodities with associated futures contracts in that this product cannot be stored, hedged and remain deliverable from one storage season to the next. Nevertheless, the contract developed and matured and has now enjoyed 30 years of trading success. The frozen pork belly futures contract certainly served as a forerunner to the introduction in the mid-1960's of nonstorable livestock contracts, live cattle and live hogs, at the Chicago Mercantile Exchange.

Production of pork bellies is in direct proportion to hog slaughter, with bellies comprising about 18 percent of the total hog carcass. The seasonal pattern of pork belly production is the same as commercial hog slaughter. Production is highest in the spring and fall months, lowest in the summer and winter months. However, consumption of bellies, i.e., sliced bacon, follows a different seasonal pattern. Bacon is most heavily consumed during the late summer months, especially when fresh tomatoes are available from backyard gardens. It is these different seasonal patterns between production and consumption that cause pork bellies to be frozen and held in cold storage. Simultaneously, meat packers, processors, and warehouse operators faced both variable hog prices as well as price risks on processed products held in inventory. These different seasonal demand and supply characteristics, and associated price risks, were foundations to establishing the frozen pork belly futures contract.

Despite its success, trading volume on the frozen pork belly futures contract is now about one-half of its volume of the early 1980's. Concern has been expressed that the contract may be losing some of its economic justification due to structural changes in hog production, meat processing and pork belly storage. An evaluation is overdue.

The purpose of this paper is the review the history of the contract, and to provide an evaluation of its performance. The first section establishes the background for this analysis, followed by an evaluation of hog slaughter seasonality and subsequent pork belly storage seasonality in section 2. Section 3 examines commitments of traders data. Section 4 presents some standard hedge and cross-hedge ratios, while section 5 examines characteristics of the basis. The last section summarizes the analysis.

BACKGROUND AND HISTORY

Academic Literature

Surprisingly, for a contract that is 30 years old, very little academic research on frozen pork bellies appears in the literature. In most cases, analysis on frozen pork bellies occurs when the contract is included in an empirical study conducted on several commodities. There are few exceptions.

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The most visible exception is an article by Powers (1967) who did a study shortly after the contract was introduced. Powers noted that there were six provisions of the original contract that caused dissatisfaction among the traders. These were shrinkage allowance, limitations on storage time, grades and standards, transportation allowance, methods of storage protection, and delivery time. Revisions in contract specification in 1963 relative to each of these items set the stage for its eventual trading success.

Two other studies focused only on pork bellies. Foote, Williams and Craven (1973) developed a simultaneous three-equation forecasting model of pork bellies. Using quarterly and monthly relationships, they predicted pork belly prices up to two quarters ahead. The authors noted that bacon is most often consumed jointly with other food, hence, bacon demand is highly inelastic.

Pickett (1979) applied the theory of temporal price relationships for storable commodities to the frozen pork belly market. He examined several models of whether cash-futures price spreads provided guidance to seasonal inventory levels. Regressing inventories on current and lagged cash-futures price spreads as well as lagged inventories gave mixed results with regard to support of the supply of storage hypothesis. Pickett had several specification and measurement problems.

One possible reason for the lack of specific research on the frozen pork belly contract may be its long held reputation for being highly speculative. This was borne out in a study by Peck (1980) who, using a speculative index measure developed by Working, found this index for pork bellies during 1970-77 to be 9.0, while the range of the index for seven other agricultural commodities and financial instruments analyzed was 1.5 to 3.4. Even under an alternative calculation of nonreporting traders, Peck found the index for bellies to be 3.7, while for the other seven contracts this alternate index ranged from 1.1 to 2.0. This means there is considerably more "excess" speculation present in the pork belly contract than in any of the other well-performing, liquid markets analyzed.

This notion of excess speculation occurs despite data reported by Skadberg, et al. (1973) for 1968-1971 and by Hieronymus (1977) for 1969-1973 that from 50 to 87 percent of the stocks of pork bellies were hedged. Hieronymus noted that the structure of the pork belly market was predominantly speculator against speculator, yet trading activity was very responsive to hedging needs.

Other studies have included pork bellies in empirical investigations of several contracts. Cargill and Rausser (1975) examined market efficiency for six agricultural commodities with a series of statistical tests on the random walk model and with mechanical trading filter rules. Cox (1976) investigated the effect of organized futures trading on information in spot markets for six agricultural commodities. Leuthold and Hartmann (1981) performed semi-strong form tests to evaluate the forward-pricing efficiency of the cattle, hog and pork belly contracts. Finally, Hartzmark (1987) calculated daily returns for all reporting traders in nine different markets over the period 1977-1981. He found that the frozen pork belly contract was the only one of nine markets analyzed where both "all traders" and "commercial" traders earned significantly positive total net dollar returns. Except for this last qualification, these studies did not find the performance of the frozen pork belly contract distinguishable from other contracts being analyzed. Hence, many studies of multiple contracts do not find unusual characteristics for this market.

Historical Perspective

Trading volume on the frozen pork belly futures contract was initially extremely low, with only 2,724 contracts traded over the first 28 months. As noted earlier, several contract provisions were changed in 1963 to avert failure. Many additional specification modifications have been made over the years to accommodate trader interests and industry changes. Most notable among these were increasing the contract size, increasing the number of allowed minor and major defects, modifying the acceptable

weight range of deliverable bellies, increasing price and speculator position limits, and even modifying trading hours. The CME continually monitors contract performance and recommends specification changes as marketing conditions for cash pork bellies change.

The pork belly storage season begins in the late fall, October and November, when hog production increases seasonally and bellies begin moving into storage. Storage levels usually peak in about May or June, and the storage season ends in August. Delivery contract months are February, March, May, July, and August. To be eligible for delivery, frozen pork bellies must not have been produced or stored prior to November 1 of the previous year. That is, frozen bellies cannot be stored, hedged and remain deliverable from one storage season to the next. Bellies also cannot be moved from one CME approved cold storage warehouse to another and still remain eligible for delivery on a futures contract. Par delivery of frozen pork bellies must be made from approved warehouses in Chicago, and they are subject to USDA inspection. In 1990, there were 51 approved warehouses in total, most of them west of the Mississippi River.

Table 1 presents annual trading volume of frozen pork bellies since their inception in 1961. Volume exceeded 2 million contracts in both 1969 and 1972, but fell to 735 thousand in 1974. The decline in trading in 1973-1974 is likely associated with meat price controls imposed by the Nixon administration and with the oil crisis and high energy costs during that time. This latter phenomenon likely caused drops in trading volume in 1976 and again in 1981. The peak trading period was during 1980 through 1984, with an annual average of 2.27 million contracts. Afterward, trading volume fell off to slightly more than 1 million contracts annually, but rebounded in 1989 and 1990.

Table 2 shows the number of deliveries during the delivery month relative to the size of the open interest on the day before the maturity month. The overall average is 16.4 percent, which is considerably less than the range of 23.4 to 63.0 percent for wheat, corn and soybean futures reported by Peck and Williams (1991). However, this percentage is much larger than for cattle and hogs which averaged 4.0 and 1.7 percent, respectively, from 1970 to 1989 (Leuthold, 1992a). The May contract is most active with about 30 percent of open interest resulting in deliveries, while only seven percent of open contracts are delivered on the August contract. Over time there is no perceptible trend.

SEASONALITY OF SLAUGHTER AND STORAGE

Hog Slaughter

A principal force behind the need to store pork bellies is the seasonal nature of hog production, and hence, hog slaughter as described earlier. Pork bellies are in surplus and should move into storage during the spring and fall, and are in deficit and should move out of storage in the winter and summer. This expected pattern is modified by the seasonal demand for bacon. Consequently, storage stocks for pork bellies begin to accumulate in late October and early November, with a slight out movement in January. This build up of storage continues until May or June, after which stocks decline rapidly until they are nearly depleted in August (Figure 1). Hence, that if the seasonal nature of hog production were to change, the pattern of pork belly storage would change in response.

The first variable to analyze is the seasonal nature of hog slaughter. Observers of the hog industry are certainly aware of the changes that have been occurring in hog production such as rapidly declining farm numbers and increased confinement production, both of which can impact seasonality. Monthly seasonal indexes of hog slaughter for each year from 1970 through 1990 were generated (Leuthold, 1992b). As expected, most of the index numbers in excess of 100 are in the spring and fall months, while the summer months are almost always below 100. Also computed for each year was a coefficient of variation. Data for 1982 are an anomaly since they were reported only quarterly, meaning much of the seasonality is already averaged out.

These data were grouped into selected years for analysis over time. Highest and lowest monthly index numbers were recorded for each year, and their difference calculated. These annual high-low differences (range) were averaged, along with the coefficient of variation, as follows:

Year	Average Difference	Average Coefficient of Variation
1970-1974	30.91	0.089
1975-1979	34.66	0.098
1980-1984	26.86*	0.078*
1985-1990	22.79	0.072

*Excludes 1982 (see text)

These results demonstrate clearly that the extreme high and low of the monthly seasonal index numbers came closer together during the decade of the 1980's relative to the previous decade. Also, the average of the coefficient of variation is considerably smaller in the 1980's than in the 1970's. These summary statistics provide evidence that seasonality of hog slaughter is decreasing. Calculating seasonal index numbers from weekly hog slaughter data for 1966-1990 demonstrate a very similar pattern over time as the monthly data; seasonality of hog slaughter is dampening (Leuthold, 1992b).

Pork Belly Storage

Pork belly stocks data are available both monthly and weekly, although the data sources differ. Monthly stocks are from the USDA, while weekly data report stocks in CME approved warehouses. On average, stocks in CME approved warehouses are 86 percent of stocks reported by the USDA. Also, the size of U.S. pork belly stocks averages 19 percent of pork belly production, although this ranges from 12 to 30 percent on monthly data.

Monthly seasonal indexes were calculated for pork belly stocks for each year from 1963-1964 to 1989-1990 along with the coefficient of variation (Leuthold, 1992b). These data correspond to the storage season, each year starting in October and ending the following September. Annual high-low index differences were calculated and averaged as above, and are reported, along with coefficients of variation, as follows:

Year	Average Difference	Average Coefficient of Variation
1963/64-1968/69	153.64	.53
1969/70-1973/74	138.86	.45
1974/75-1978/79	173.22	.56
1979/80-1983/84	137.66	.46
1984/85-1989/90	120.89	.40

As with hog slaughter, these results demonstrate a definite reduction in the seasonality of pork belly storage. Both the high-low range and coefficient of variation are reduced by over 20 percent from the late 1960's, and by nearly 30 percent from the late 1970's.

Weekly data on pork belly storage are reported for CME approved warehouses for both inside and outside of Chicago. These data include: 1) total frozen pork belly storage (bellies on hand), 2) pork bellies of deliverable size in storage (classified as 12 to 18 pounds), and 3) pork bellies in storage certified for delivery. Bellies in the latter group are a subclass of those in the middle group, which in turn are a subclass of those in the first group. Hence, six series of data are available. Deliverable bellies average about 80 percent of total frozen pork belly storage, while those certified for delivery average about 43 percent of deliverable bellies.

Seasonal indexes are generated for each storage year and each series in order to see how storage patterns have changed over time. Table 3 presents the annual average of the high-low range and average coefficient of variation for these data grouped into three-year periods. There is no question that the seasonality of frozen pork belly storage based on weekly data has diminished in the 1980's. The peak seasonal variability for total frozen pork belly storage occurred in the late 1970's, but since then seasonality has dampened considerably. The average high-low range for total pork belly storage inside Chicago dropped from 207 in 1977-1980 to 146 in 1986-1990. Similarly, the average high-low range for total storage held outside Chicago decreased from 196 in 1974-1977 to 137 in 1986-1990. Average coefficients of variation dropped about 30 percent from their peaks during this same period. Seasonality of bellies of deliverable size has decreased considerably also from the late 1970's, while bellies certified for delivery have shown a general trend toward less seasonality, except for a reversal to increasing in the last three years.

These results indicate that the frozen pork belly market is undergoing a structural change. The seasonal storage pattern is becoming more evenly distributed throughout the year. This could have an effect on the frozen pork belly futures market and price behavior. These changes could affect warehouse operators' perceived needs to hedge or manage price risks, reducing both open interest and trading volume. Direct links between seasonal storage patterns, price behavior, and trading activities are difficult to make, but additional analysis follows.

COMMITMENTS OF TRADERS

Commitments of traders, as reported by the CFTC in monthly publications, are examined in much the same way as the storage data. Observations for several classifications of traders were collected monthly from October, 1970 through September, 1990, and summary statistics were calculated to analyze changes over time in the composition of traders (Leuthold, 1992b). The data were organized into annual storage seasons, each year beginning in October and terminating the following September. Data were collected for volume of trading (VOL), open interest (OI), long reporting speculators (LRS), short reporting speculators (SRS), long reporting hedgers (LRH), short reporting hedgers (SRH), long nonreporting traders (LNRT) and short nonreporting traders (SNRT). Data on reporting spread traders, whose positions are usually balanced, are ignored[2]. The CFTC did not report commitments data in 1982, so those observations are missing.

Table 4 shows each of the six trader classifications as a percent of open interest. Some distinct trends, or changes, are observable. Long and short reporting speculators have increased, both absolutely and percentage wise. Their proportion of the open interest has more than doubled since the early 1970's. Short reporting hedgers have increased in a similar manner, while long reporting hedgers have increased a lesser amount proportionately. If these reporting traders have increased their market proportions, then

[2] Reporting traders hold 25 or more contracts. This reporting requirement level has not changed over the life of the frozen pork belly contract.

some other trader groups must decrease, and that has been nonreporting traders, especially on the short side of the market. In the early 1970's both long and short nonreporting traders comprised over 60 percent of their respective sides of the market, but long nonreporting traders are generally now under 60 percent while short nonreporting traders are currently less than 40 percent of the market. Consequently, concentration ratios of the largest 4 and 8 traders have increased, especially on the short side of the market (Leuthold, 1992b).

Unfortunately, we can no longer carefully analyze the proportion of frozen pork belly stocks that are hedged. The CFTC changed its reporting procedures prior to 1982 due to cost-reducing policy changes. Reporting traders are now classified as commercial and noncommercial by the CFTC, and traders no longer identify which positions are for hedging and which are speculation. That is, if a trader reports in as a commercial, then all of the trader's positions are likely classified as commercial, even if some positions are speculative. This could include a floor trader who takes large speculative positions, but occasionally stands for delivery and thus reports as a commercial. Reporting traders may self-select to be a commercial to garner lower fees and to request exemptions from position limits. Thus, it is no longer possible to easily analyze trader commitments and the real intentions of a trader's positions.

Finally, seasonal indexes for volume, open interest, and long and short traders in each of the three trader commitment classifications, reporting speculators, reporting hedgers and nonreporting traders, were generated for 1970-71 through 1989-90. These seasonal patterns follow a similar pattern, but not exactly, as frozen pork belly storage. Generally, these seasonal index numbers peak in the April-May-June period, and are smallest in either late summer or early fall. There are, of course, individual differences. Important for this investigation is whether there has been any structural change in these commitments data over the years. Using the same methodology as for the storage data previously, the range between the high and low indexes each year were calculated along with coefficients of variation, and averaged into 5-year subgroups (Leuthold, 1992b). There is no clear trend or pattern in these results over time. That is, trader commitment data do not show any distinct changes in seasonality over the past 20 years.

Frozen pork belly trader composition has changed over time. The proportion of the market composed of reporting traders has increased, while nonreporting traders have decreased. This has increased concentration ratios. However, seasonality patterns of trader commitments have not changed substantially over the past two decades.

HEDGE RATIOS

One method for describing and assessing the performance of a futures market is to examine how effectively cash market participants can hedge their price risks. This is done by computing simple hedge ratios.[3] These ratios are found by regressing the change in cash price on the change in futures price. Regression coefficients indicate the number of futures contracts to buy or sell for each lot of cash bellies being hedged. The R^2 coefficient is an absolute measure of the hedging effectiveness of the futures contract.

Using weekly data from 1974 through 1990, hedge ratios were calculated for the entire data set, and for three-year subperiods. Ratios for hedges of 1, 4, 8, and 12 weeks in length are presented in Table 5. All data sets begin in November of the preceding year and end in July of the last designated year of the set.

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[3] For a theoretical background and model development, see Leuthold, Junkus, and Cordier (1989).

CASH-FUTURES BASIS

Critical to the economic performance of a futures contract is the behavior of the cash-futures basis. Hedgers use the futures market to manage price risks. Hedgers can never eliminate risks, but they can reduce risks as long as the price variability, or risk, in the basis is less than the risks associated with price levels. The mean, standard deviation and coefficient of variation were calculated for the cash price, futures price, and basis for each contract from February, 1982 through August, 1990 based on daily observations (Leuthold, 1992b). The futures price almost always exceeds the cash price, indicating a positive basis and cost of carry. Alternatively, the coefficient of variation of the cash price usually exceeds the corresponding statistic for the futures price, probably reflecting price limit moves that apply to the futures market, but not to cash prices. The standard deviation for the basis is typically smaller than the corresponding standard deviation for the cash or futures prices, but not always both prices. There is generally more stability with the basis than with price levels.

The basis usually begins relatively wide in November, narrowing into December and January. However, it does not continue to narrow for the remainder of the storage season. After reaching a narrow point in either January or February, the basis generally widens again to either April or May, after which it narrows very rapidly (Figure 2). The basis inverts in June, and is strongly negative in July and August. That is, cash prices exceed futures prices. Apparently, this inversion of the basis reflects the nature of the difference between fresh and frozen pork bellies. Warehouse operators do not expect to carry frozen bellies into the next storage season, but those coming out of storage need to be thawed before being sliced. Thus, the cash price for fresh bellies becomes a premium to frozen bellies in storage because fresh bellies are more readily available. This higher cash price for fresh bellies attracts frozen bellies out of storage, but there are processing costs, resulting in an inverted basis.

What explains the unusual basis behavior in January, dubbed the "January effect"? It is strictly a cash market phenomenon; the futures market does not respond in kind. That is, arbitrage profits do not appear available to speculators, only to cash market traders with storage facilities.

There is an institutional explanation of the January effect. The unusual basis behavior is partly associated with the movements of bellies themselves. As seen in Figure 1, storage numbers build up until January, and then there is a small out movement of bellies into February, before they begin building again until the May-June period. Hence, some bellies are coming out of storage in January, associated with a relative increase in the cash price. There are supply and demand explanations for why cash prices might be bid up relative to futures prices at that time. Seasonal slaughter is low in January, thus the supply of fresh bellies is relatively low. To draw frozen bellies out of storage means the cash price must increase. At the same time, hams and other pork products have been heavily consumed during the Christmas-New Year's season, and packers need to begin planning for heavy ham consumption during the forthcoming Easter season. That is, hams move into storage. Because of labor agreements and fixed plant operating costs, processors wish to keep their smokehouses and processing lines busy, and frozen pork bellies are available to satisfy those needs. Accordingly, processors start moving bellies and feature them to buyers. Bacon is often featured on sale in retail stores in January in order to move more product. This combination of declining fresh supply, seasonal demand for ham products, and the desire to continuously utilize processing capacity, causes processors to bid bellies out of storage in January[4]. Thus, the storage season, and basis pattern, for bellies is bimodal. Warehouse operators hedge their fall stocks in the nearby February contract, rotate some of the stocks out of storage in January, then roll

[4] Unfortunately, monthly data on bacon slicings have not been available since the late 1970's, so the demand side cannot be fully documented.

The hedge ratios are all quite large and reasonably near 1.0, the value for the naive (equal and opposite) hedge. Only when they reach 12 weeks in length do they show some instability, ranging from .60 to 1.01. More interesting is the hedging effectiveness measure. For hedges of one week in length, the effectiveness of hedging pork bellies in the frozen pork belly futures market is not very strong, and often below 50 percent. However, these performance measures increase as the hedge lengths increase except for those that are 12-weeks in length. Even then, the effectiveness during the 1980's is not overwhelming. As to any pattern over time, it appears that the ratios and hedging effectiveness measures increase slightly during the late 1980's as opposed to the earlier periods. This indicates hedging performance of the market could be improving, but not substantially.

Using daily data, hedge ratios were also computed annually for 1982 through 1990 for hedge lengths of 1, 5, 10 and 20 days. These results are presented in the left half of Table 6. Again, data analyzed begin in November of the preceding year and end in July of the noted calendar year. Hedge ratios and hedging effectiveness for one-day hedges are very low and unstable over these years. Hedge ratios for 5, 10 and 20 days range from .66 to 1.31. Hedging effectiveness is more unstable, with 1983 and 1987 being years of poor performance. It is difficult to find any noticeable trend over the eight-year period.

Thus, except for the very short 1-day hedges and longer 12-week hedges, most hedge ratios are reasonably close to one, meaning warehouse operators can often utilize a naive hedge. Relatively lower R^2's imply that considerable basis risk remains. These results show no large changes over time in hedge ratios or hedging performance in the frozen pork belly futures contract. This means lower trading volume is not attributable to changing price relationships.

To further evaluate whether structural changes are taking place in the pork belly market, cross-hedge ratios between pork belly cash prices and live hog futures prices were calculated over weekly and daily data analogous to that just described. Table 7 presents the weekly cross-hedge ratios, and the right half of Table 6 gives the daily cross-hedge ratios.

Cross-hedge ratios between pork bellies and hogs in Table 7 are all larger than the hedge ratios in Table 5, but the comparable R^2's are lower for the cross hedges than for the own-product hedges. This latter point is as expected, risks can be more effectively managed in the own-product futures market than in a related futures market. Larger cross-hedge ratios (regression coefficients) reflect higher price variability in pork bellies than in hog futures prices. Nevertheless, cross hedges in the late 1980's are in general more effective than in the early 1980's, providing no evidence for a deteriorating price relationship between the pork belly and hog markets.

Cross-hedge ratios and performance for cross hedges one day in length are relatively poor, but usually improve as hedging horizons increase to 5, 10 and 20 days (Table 6). The last year, 1990, is a notable exception. Regression fits for 1982 and 1986 are the best. Cross-hedge ratios are usually larger than the comparable pork belly hedge ratio, but the effectiveness (R^2) is nearly always higher for the own-product hedges, a situation parallel to the results based on weekly data. There is no real noticeable pattern in these results over time, except some decrease in performance in 1989 and especially 1990.

Thus, there have been no apparent changes over time in cash-futures price relationships in the pork belly market, nor any substantial changes in the relationships between prices in the cash belly market and live hog futures market. That is, price relationships have not deteriorated in a manner that would drive pork belly hedgers from the market. These results also indicate that naive hedges in frozen pork bellies are often appropriate, that pork belly prices fluctuate more than hog prices, and that considerable basis risk remains in the pork belly market.

hedges for remaining and new stocks into later seasonal contracts. Most bellies move out of storage by the end of the season in August as the basis inverts.

A final characteristic noted in Figure 2 is that the bases for the February, March and May contracts terminate during delivery month at a large positive value, while the bases for the July and August contracts terminate strongly negative. The difference between these positive delivery bases and negative delivery bases can exceed $10 per hundredweight. Each average maturity month basis is strongly significantly different from zero. Why such a large discrepancy exists is not clear, however the price series are not exactly comparable. Cash price represents fresh bellies, futures price is for frozen bellies only. There is no "cash" price for frozen pork bellies.

SUMMARY

The frozen pork belly futures contract has enjoyed considerable success over its three decades of existence. However, trading volume has declined considerably in the last six years. There is no evidence that cash-futures price relationships have changed, nor the relationships between cash pork bellies and hog futures prices. The futures market remains a reasonably effective market for hedging, especially for hedge lengths between one and two months. In fact, the market treats those with warehouse facilities well. They can obtain a storage return from November to January, and then again from February to June. This may explain why reporting traders have increased proportionally in the market, and nonreporting traders have become a smaller share of the market.

What explains the decline in volume? There could be several reasons, but two are proposed here. One is the diminishing seasonality in hog production, hence a lessening of pork belly storage seasonality. This declining seasonality could reduce the need to hedge. The other possible explanation is offered as a hypothesis. The decline in pork belly trading coincides with the introduction of many alternative trading opportunities on the floor of the CME, especially Eurodollars, foreign currencies and their option contracts. It may be that floor traders and public speculators have been attracted away from the frozen pork belly market to the many new markets where trading activity is more liquid and profit opportunities better. This could be investigated by the CME.

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FIGURE 1

U.S. Frozen Pork Belly Storage Pattern By Months,
1970-1990, United States

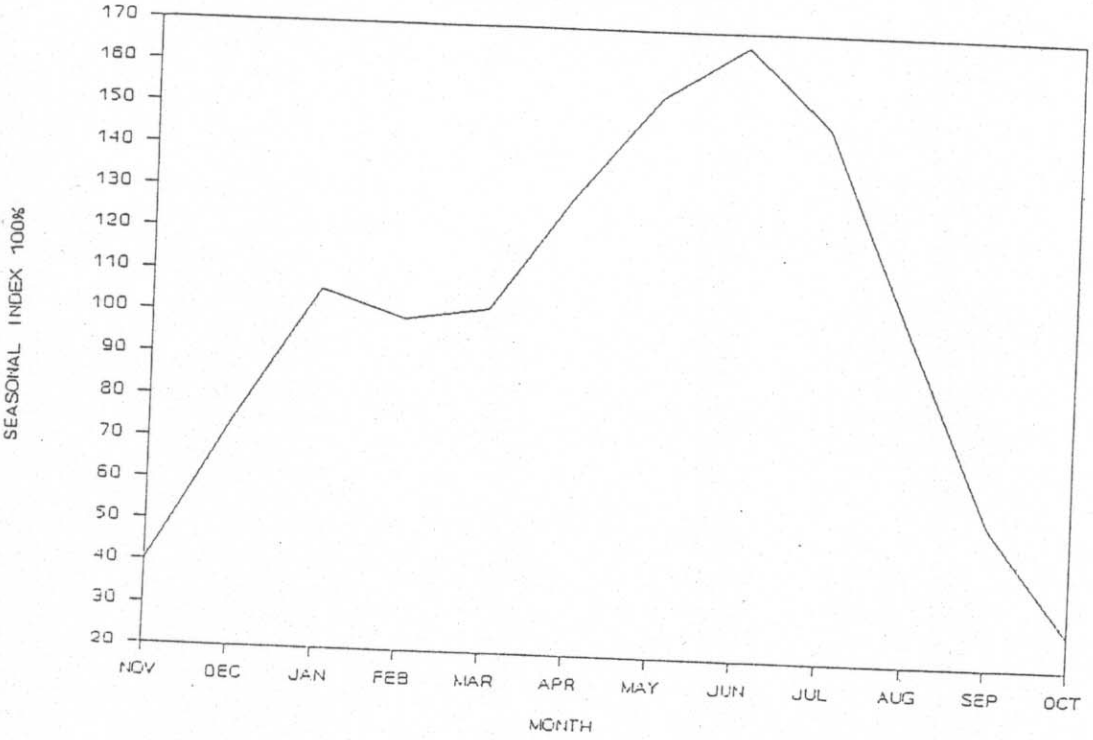

FIGURE 2

Average Cash and Futures Price For Frozen Pork Bellies
1982-1990

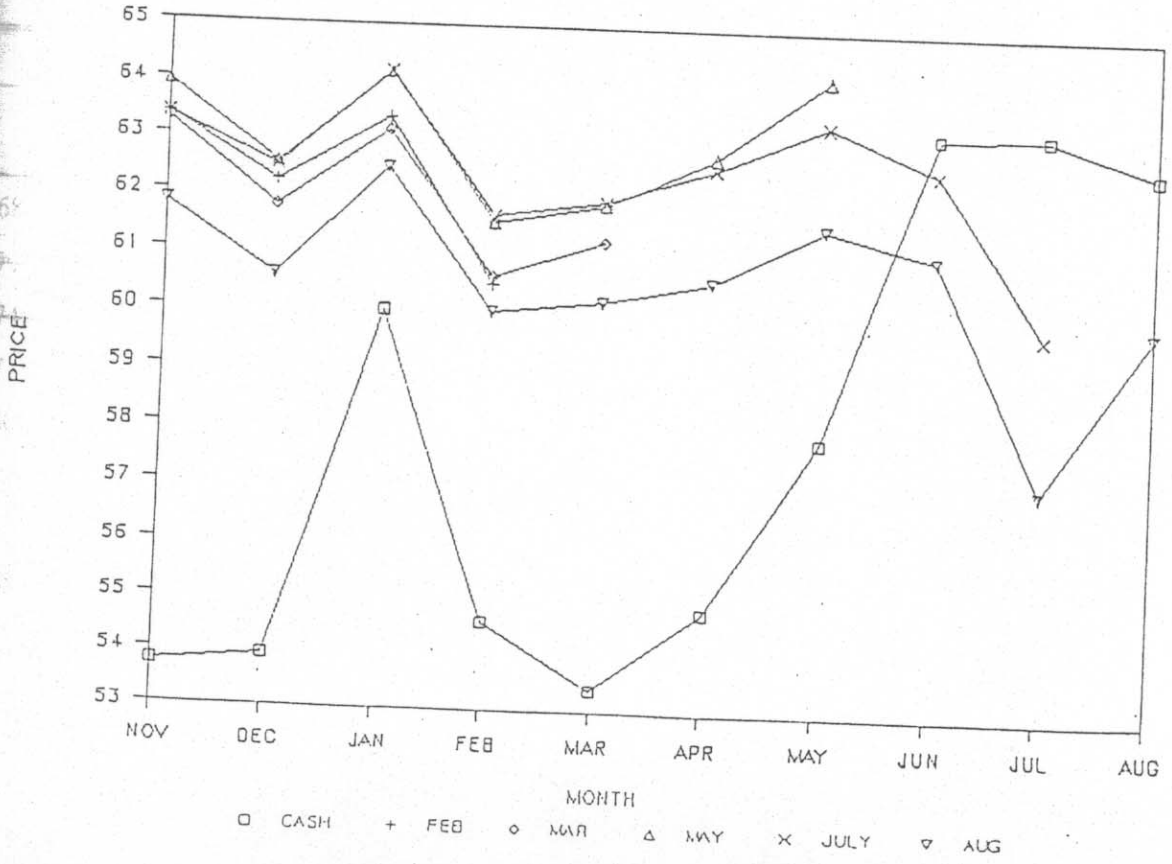

TABLE 1

Volume of Trading
Frozen Pork Belly Futures Contract
1961-1990

YEAR	VOLUME	YEAR	VOLUME
1961	435	1976	1,201,066
1962	561	1977	1,358,730
1963	1,728	1978	1,439,651
1964	154,679	1979	1,514,176
1965	715,234	1980	2,250,945
1966	727,998	1981	1,997,697
1967	1,047,131	1982	2,811,674
1968	1,398,200	1983	2,403,277
1969	2,175,775	1984	1,908,045
1970	1,779,139	1985	1,457,386
1971	1,695,992	1986	1,100,339
1972	2,056,720	1987	1,097,010
1973	1,151,168	1988	1,186,599
1974	735,246	1989	1,310,976
1975	1,443,464	1990	1,303,129

TABLE 2

Number of Deliveries Relative to the Open Interest
on the Day Before Maturity Month, 1966-1990

Years	Percent	Delivery Month	Percent
1966-70	18.2	Feb	16.6
1971-75	17.8	Mar	19.8
1976-80	11.0	May	29.8
1981-85	20.0	July	13.6
1986-90	16.6	Aug	7.5
		Overall Average	16.4

TABLE 3

Average High-Low Range and Average Coefficient of Variation for Frozen Pork Belly Storage Seasonal Indexes Based on Weekly Data

High - Low Range

Years	Total Storage		Deliverable Size		Certified for Delivery	
	Inside Chicago	Outside Chicago	Inside Chicago	Outside Chicago	Inside Chicago	Outside Chicago
66/67 - 67/68	--	204.28	--	--	--	--
68/69 - 70/71	--	182.50	--	--	--	--
71/72 - 73/74	--	161.95	--	--	--	--
74/75 - 76/77	190.71	196.01	--	--	--	--
77/78 - 79/80	207.45	187.94	210.24	194.55	186.61	175.33
80/81 - 82/83	157.00	165.18	163.46	166.86	176.67	160.10
83/84 - 85/86	152.12	134.98	158.36	137.55	151.07	148.39
86/87 - 89/90	146.01	137.10	156.74	140.00	173.05	157.52

Coefficient of Variation

Years	Total Storage		Deliverable Size		Certified for Delivery	
	Inside Chicago	Outside Chicago	Inside Chicago	Outside Chicago	Inside Chicago	Outside Chicago
66/67 - 67/68	--	.62	--	--	--	--
68/69 - 70/71	--	.55	--	--	--	--
71/72 - 73/74	--	.48	--	--	--	--
74/75 - 76/77	.58	.61	--	--	--	--
77/78 - 79/80	.64	.59	.65	.62	.56	.56
80/81 - 82/83	.45	.49	.46	.49	.50	.41
83/84 - 85/86	.48	.40	.50	.42	.41	.37
86/87 - 89/90	.45	.41	.46	.42	.52	.42

TABLE 4

Trader Commitments as a Percent of Open Interest,
Annually, 1970-71 to 1989-90

YEAR	LRS	SRS	LRH	SRH	LNRT	SNRT
	Percentage					
1970-71	7.4	11.3	5.6	6.2	65.3	60.7
1971-72	14.2	10.2	2.2	7.7	57.1	55.5
1972-73	18.4	10.9	2.2	8.9	63.8	64.6
1973-74	12.7	12.4	4.8	11.1	69.6	63.6
1974-75	15.2	8.7	3.8	6.8	61.8	65.2
1975-76	13.1	16.9	5.4	5.9	59.0	54.7
1976-77	15.0	20.3	2.0	8.9	59.8	47.6
1977-78	22.2	19.4	1.9	8.7	59.4	55.4
1978-79	16.5	26.8	1.5	10.8	67.3	47.7
1979-80	13.3	24.2	1.4	9.5	70.9	51.8
1980-81	18.7	14.8	3.0	12.4	61.7	56.2
1982-83	16.5	23.2	13.4	13.7	60.2	53.2
1983-84	16.7	20.8	8.7	16.9	58.4	46.2
1984-85	24.3	21.2	10.7	13.7	53.1	53.2
1985-86	20.6	21.6	9.8	14.1	61.1	55.7
1986-87	17.0	27.8	12.2	8.2	59.5	52.8
1987-88	17.2	30.3	8.4	20.7	63.3	37.9
1988-89	22.1	35.7	8.4	21.3	59.1	32.7
1989-90	25.8	24.5	6.6	20.6	52.5	39.9

TABLE 5

Hedging Performance of Frozen Pork Bellies
1974-1989 for Hedges of 1, 4, 8 and 12 Weeks

Time Period	Length of Hedge	No. of Observations	β	$\bar{R}^2$
1974 - 1990	1	646	.89	.44
	4	153	.93	.68
	8	68	.89	.74
	12	51	.88	.64
1974 - 77	1	152	.89	.49
	4	36	.91	.71
	8	16	.88	.87
	12	12	.60	.40
1978 - 81	1	152	.98	.57
	4	36	.97	.66
	8	16	.89	.72
	12	12	.75	.54
1982 - 85	1	152	.89	.39
	4	36	.96	.64
	8	16	.75	.54
	12	12	.86	.35
1986 - 90	1	90	.79	.32
	4	45	.95	.65
	8	20	1.01	.72
	12	15	1.01	.74

TABLE 7

Cross-Hedging Performance of Frozen
Pork Bellies with Hog Futures
1981 - 1990 for Hedges of 1, 4, 8 and 12 Weeks

Time Period	Length of Hedge	No. of Observations	β	$\bar{R}^2$
1981-1990	1	381	1.06	.16
	4	90	1.23	.39
	8	40	1.26	.40
	12	30	1.68	.45
1981-1985	1	190	.97	.14
	4	45	.98	.33
	8	20	1.23	.44
	12	15	1.23	.30
1986-1990	1	191	1.24	.19
	4	45	1.61	.39
	8	20	1.39	.34
	12	15	2.32	.60

TABLE 6

Hedging and Cross-Hedging Performance of Frozen Pork Bellies
1982 - 1990, for Hedges of 1, 5, 10 and 20 Days

	Hedging				Cross-Hedging with Hogs			
Year	Length of Hedge	No. of Observations	β	$\bar{R}^2$	Length of Hedge	No. of Observations	β	$\bar{R}^2$
1982	1	187	.67	.19	1	176	1.08	.13
	5	37	.89	.55	5	35	.92	.20
	10	18	1.00	.73	10	17	1.37	.46
	20	9	.90	.69	20	8	2.19	.63
1983	1	187	.48	.09	1	185	.70	.05
	5	37	.94	.41	5	37	1.45	.34
	10	18	.66	.11	10	18	1.57	.27
	20	9	1.12	.30	20	9	.52	-.08
1984	1	187	.15	.08	1	187	.76	.11
	5	37	.76	.43	5	37	1.50	.22
	10	18	1.09	.82	10	18	1.75	.32
	20	9	.99	.69	20	9	1.46	.09
1985	1	187	.57	.14	1	187	.47	.01
	5	37	.79	.36	5	37	1.29	.17
	10	18	.90	.59	10	18	1.52	.26
	20	9	.83	.64	20	9	1.99	.47
1986	1	186	.44	.07	1	187	.34	.04
	5	37	.95	.58	5	37	1.99	.35
	10	18	.95	.76	10	18	2.06	.67
	20	9	1.02	.80	20	9	1.79	.75
1987	1	187	.32	.03	1	187	.51	.02
	5	37	.77	.30	5	37	1.95	.29
	10	18	.98	.24	10	18	1.18	.10
	20	9	1.31	.49	20	9	1.33	.16
1988	1	186	.46	.09	1	187	.50	.04
	5	37	1.12	.51	5	37	1.08	.20
	10	18	1.15	.50	10	18	1.44	.33
	20	9	1.15	.47	20	9	1.59	.45
1989	1	187	.25	.07	1	187	.70	.09
	5	37	.90	.31	5	37	1.08	.20
	10	18	1.19	.61	10	18	.96	.38
	20	9	1.03	.56	20	9	.83	.07
1990	1	187	.16	.12	1	187	-.18	.11
	5	37	.97	.52	5	37	1.42	.06
	10	18	.88	.58	10	18	1.22	.04
	20	9	.79	.60	20	9	.62	-.10