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Wheat, Corn, and Soybean
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ANNE E. PECK AND JEFFREY C. WILLIAMS*

DELIVERIES ON CHICAGO BOARD OF TRADE
WHEAT, CORN, AND SOYBEAN
FUTURES CONTRACTS, 1964/65–1988/89 †

CHAPTER 1.

INTRODUCTION

In July 1989, the Chicago Board of Trade (CBOT), with the support of the Commodity Futures Trading Commission (CFTC), ordered a firm to reduce its large position in the then-expiring July soybean futures contract on a fixed daily schedule. The action, although taken in response to a possible squeeze in that one expiring contract, served to underscore a long-standing concern of numerous participants, namely, that contract expirations in the

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† The authors would like to thank the many people whose assistance made the study feasible. The members of the Commodity Exchange Committee of the National Grain and Feed Association, especially Co-Chairpersons Diana Klemme and Donald McElmury, have given freely of time, ideas, and data. The Association also provided financial support. Data were also provided by the Chicago Board of Trade, the Kansas City Board of Trade, the Commodity Futures Trading Commission, and the University of Illinois. The authors wish to emphasize that any errors that remain are theirs alone. This monograph is taken from the authors’ report (1991) to the National Grain and Feed Association. Changes are principally editorial, in conformance with Food Research Institute Studies format. None of the changes alter the principal conclusions of the study.

three principal agricultural futures markets at the CBOT—corn and wheat as well as soybeans—were perhaps not occurring as smoothly as might be desired.

CONCERNS ABOUT DELIVERIES OF WHEAT, CORN, AND SOYBEANS

Concerns about contract expirations have been expressed in many ways over the last two decades. The CFTC, for one, declared that an emergency existed in the expiration of the March 1979 wheat futures contract, and it tried to close trading in that contract early. Earlier in the 1970s, CBOT committees’ reviews of contract performance led to important expansions in the settlement terms for each commodity, adding Toledo (and St. Louis, in the case of corn) as a possible location for deliveries, thereby expanding certified delivery space by more than 50 percent. In 1974, the CBOT also experimented with a U.S. Gulf delivery wheat contract, providing settlement terms entirely outside of Chicago. More recently, the Warehouse, Weighing, and Custodian Committee at the CBOT adopted a series of rule changes to tighten the conditions under which facilities could remain regular for delivery. In 1988, the Feed Grain, Wheat, and Soybean Committees each requested and received studies of the performance of these contracts by the Economic Analysis and Planning Department. The Studies themselves drew no formal conclusions. The results in the Studies, however, “indicated that, in general, the CBOT...futures market has performed well as a pricing and hedging medium for the 1987 crop year as compared to other years” (Volume I of each of the CBOT’s Studies, Executive Summary, p. 1). At the same time, each Study suggested “that locational delivery differentials and price limit regulations should be considered to determine if the performance of the...futures contract could be improved” (Ibid.). Since then, the exchange and the CFTC have been discussing several possible changes in contract specifications, including changes in the discounts for delivery at non-par locations, possible changes in specific months for trading, the addition of more delivery space, and changes in the discounts and premia for the various non-par grades. In addition, the CBOT commissioned a study by the Mid-America Policy Institute (1991) of many of these issues and Congress asked the U.S. Government Accounting Office (1991) to report on the adequacy of the present delivery system.

In addition, market participants have expressed worries about market performance. Specific worries have varied over time and among the mar-

1 The three studies prepared by the Economic Analysis and Planning Department of the CBOT are the 1988 Wheat Study, the 1988 Corn Study, and the 1988 Soybean Study. Each is in two volumes: Volume I contains most of the data and analysis, and Volume II contains basis plots.
INTRODUCTION

kets, but have included possible declines in hedging effectiveness, increasing illiquidity in the cash and futures markets during the delivery period, the persistence of perplexing, allegedly uneconomic price relationships, and occasional accusations of manipulation. All these concerns suggested that a thorough analysis of the performance of the delivery system was necessary and provided the principal motivation for this study.

Deliveries are widely thought to be insignificant relative to the number of contracts traded, no more than 1 to 2 percent. Indeed, the accepted wisdom is that sizable deliveries are indications of problems in the market. Hieronymus put it most directly: “In markets that work, delivery is rarely made and taken; futures contracts are entered into for reasons other than exchange of title. Markets where there is a large amount of delivery fail... because extensive delivery is an indication of an out of balance contract, one that favors either the longs or the shorts” (Hieronymus, 1977, p. 340).

Although Hieronymus does not define large or extensive, the considerable variation among recent levels of deliveries in wheat, corn, and soybeans suggests there is no obvious standard. Over the five delivery months in the 1988/89 cropyear, wheat deliveries averaged 17 million bushels each expiration, some 13 percent of the maximum open interest in each contract and nearly 60 percent of the open interest remaining when deliveries began. For corn, deliveries averaged 16 million bushels in each delivery during this same cropyear, representing an average of 3 percent of the peak open interest and 13 percent of the open interest at the start of the delivery period. And, for the 7 delivery months over the 1988/89 soybean cropyear, 16 million bushels were delivered on average, representing 6 percent of maximum open interest and 23 percent of initial delivery period open interest. Moreover, each month’s deliveries represented an average of 284 percent of the deliverable stocks of wheat, 83 percent of stocks of corn, and 52 percent of stocks of soybeans. Do any of these deliveries represent extensive deliveries and markets threatened with failure?

Surprisingly, little published evidence indicates what levels of deliveries might be considered normal, or whether differences exist in these levels among markets, or even whether large deliveries are characteristic of markets with problems.2 As a consequence, there are virtually no accepted criteria against which to assess the performance of either a specific contract expiration or of expirations in one market versus those in another. That is, although most would agree with Hieronymus’s overall assessment, that assessment does not indicate whether deliveries averaging some 60 percent

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2 The principal exceptions are studies of specific markets when they are perceived to be (or to have been) in trouble. See, for example, Paul, Kahl, and Tomek (1981), which examined the delivery problems in the Maine potato market, or Gray and Peck (1981), which evaluated the rationale for the CFTC’s emergency action in the March 1979 CBOT wheat contract.
of the open contracts at the beginning of the delivery month, representing some 284 percent of available deliverable stocks as the case in the wheat market, should be a cause for worry.

Nor are the delivery levels themselves the only concern. Once Toledo was added as an alternate delivery location in the 1970s, the amount of warehouse space from which deliveries may occur has changed little. Over the 1980s, eligible space for wheat, corn, and soybean deliveries (excluding St. Louis) has been about 100 million bushels. Combined stocks of wheat, corn, and soybeans have filled more than 80 million bushels of this space at the beginning of some delivery months and, as a consequence, there were times when merchants could not have increased significantly the amount of stocks that could have been delivered. Concentration in ownership of eligible space has also been an issue. Of the approximately 100 million bushels of space in Toledo and Chicago, two firms own some 60 percent and four firms over 90 percent.

As the revisions of the 1970s demonstrate, concerns about the adequacy of the contracts’ delivery specifications are not new. The corn and wheat contracts, for example, date to the origin of the CBOT itself in the mid-nineteenth century. Chicago was then one of the principal grain trading centers in the United States and the specific delivery terms, emphasizing delivery in store, emerged quite naturally from common trading practices of the day. Chicago has long since declined as a center for cash grain trading, a decline reflected not only in statistics of grain movements but also in those of prices. Official U.S. Department of Agriculture (USDA) prices for wheat, corn, and soybeans in Chicago are processors’ bid prices and have become largely nominal quotations, with few actual transactions reported. The general decline of Chicago as a merchant center led to the addition of Toledo as a delivery location, although not until the 1970s. In 1973, Toledo became an alternate delivery location for the wheat contract (deliveries there at a 2 cent per bushel discount). In 1976, Toledo and St. Louis were added as alternative locations for the corn contract (at a 4 cent discount) and, in 1979, Toledo was finally added as an alternative for soybean deliveries (at an 8 cent discount). The discounts have not been changed since they were first established.

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3 As described in Chapter 4, the addition of St. Louis as an alternative location for corn deliveries has had little practical effect. There have, for example, been no corn deliveries in St. Louis since 1981. Thus, virtually all the data assembled for the analyses in this report do not include the St. Louis alternative.
INTRODUCTION

THE PLAN OF THE STUDY

The present study examines the performance of the principal aspects of the delivery system on the CBOT wheat, corn, and soybean futures markets. Chapter 2 assembles the available evidence about the amount of deliveries and their relation to levels of both futures trading and deliverable stocks for those three markets and also for wheat in Kansas City and copper. For wheat, corn, and soybeans, the representativeness of the delivery markets is then analyzed by considering the representativeness of the deliverable stocks to primary movements of each commodity. Crop production statistics from Illinois, Indiana, and Ohio and compilations of export originations from Great Lakes ports provide some background information as well. The purpose is to describe the importance and representativeness of the CBOT deliveries and to document changes, if any, in the last 25 years.

Chapter 3 assembles information on the concentration of positions in both the cash and futures markets, again comparing the recent experience in the CBOT markets both to historical levels when possible and to other markets. The focus is on assessing the depth and liquidity of the markets at the time of delivery. The price differences between the expiring and the next nearby future play a key role in delivery decisions and are examined carefully for the price movements they provide for continued storage and for evidence of the effects of congestion, if any, in trading during the delivery months.

The economic determinants of deliveries from deliverable stocks are described in Chapter 4, and the specific determinants of the value of the shorts’ options as to location and timing of deliveries are analyzed. In particular, economic relations describing the specific timing and location of deliveries are presented and their results used to assess the degree to which prices in delivery locations may be seen to have affected the relative amounts delivered.

Chapter 5 assesses evidence about hedging effectiveness, first of basis convergence at the delivery locations and then of usefulness of the markets at several non-delivery locations. Again, the focus is on changes over time. How, for example, has the degree of convergence of the Chicago basis changed with the addition of Toledo? And, accounting for the addition of Toledo, has basis convergence been as reliable as earlier? How have these changes affected the ability of country elevators to hedge their stocks?

Although the three CBOT markets are the principal focus, evidence from the Kansas City Board of Trade (KCBOT) wheat market and from the Commodity Exchange of New York (Comex) copper market is also adduced wherever possible to provide some comparisons. The KCBOT wheat market was selected for comparative analysis because it is, after
the CBOT markets, the largest grain futures market in the United States. Copper was selected because it is a storable commodity and subject to pronounced fluctuations in supply and demand like the grains and soybeans. Deliveries on the Comex contracts are by warehouse receipt, also like the CBOT commodities. Insofar as the authors have been able to determine, there have been no persistent delivery problems at either the KCBOT or for Comex’s copper contract during the study period. Certainly, there have been no formal manipulation charges brought in either market in recent history.

Nevertheless, it is important to be clear at the outset that neither the Kansas City wheat market nor Comex’s copper market is being proposed in any sense as the ideal futures market or even the market that sets the standard against which to compare the performance of the CBOT markets. Rather, evidence from these markets is intended only to help establish, along with the historical data from the CBOT markets themselves, what might be expected about futures markets in delivery. As but one example, the statistics on the size of the largest traders’ in the expiring contracts on the CBOT markets show high degrees of concentration are very common. Absent statistics from any other markets, there is no way to know whether this result is a reflection of a continuing problem or, rather, whether it is the normal relation, expected in all futures markets. And, since there have been no previous studies using these data, comparisons with other studies or published results are not possible. Comparisons then to similar statistics from the KCBOT and Comex can help assess the relations on the CBOT.

The approach throughout is empirical. After allowing patterns in the data and relations in them to establish normal (or average) expectations, specific markets, market situations, or recent experience are assessed against those norms. Two specific issues present themselves. First, what was the situation when Toledo was added as a delivery location and, second, how does the most recent situation compare? For example, one measure of the adequacy of today’s deliverable stocks is reached by comparing them to stocks in a period before the CBOT felt it necessary to expand delivery space by adding Toledo. Also important are comparisons with the 1987/88 and 1988/89 cropyears, the two cropyears coincident with heightened exchange and CFTC concerns.

As much as possible, analyses of the wheat, corn, and soybean markets begin with the 1964/65 cropyear. Major changes in U.S. government price support and loan program policies occurred at the end of the 1963/64 cropyear and, although their influences varied among the markets, analyses predating these major changes would be heavily influenced by the otherwise exogenous government programs. Some may wonder at the need to

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4 Comex has, however, recently switched to a contract with a higher grade of copper, and at times monitored closely the positions of large traders.
analyze data from markets of 25 years ago. This longer period is used in part because, whatever the current problems, there is reason to believe that some difficulties date to at least March 1979 and the CFTC emergency action in wheat. Moreover, analyses that predate the addition of Toledo as a delivery location provide comparisons to the relations that prevailed when the CBOT acted to add space. For both these reasons, it is inappropriate to compare the experience of 1988 and 1989 merely to the experience of the early 1980s.

In any case, it is surely inappropriate to judge one or two years’ evidence with that of just four or five preceding years as was done in the CBOT’s Studies. If, for example, the suspicious circumstance is coincident with a general shortage in the market, examining evidence from five years characterized generally by surplus will provide little insight as to whether the current circumstance is a problem or not. It would be much more instructive to examine pertinent relations in the previous five instances of equally severe shortage. In order to do that, 20 or more years of data are necessary to establish relations that reflect enough historical variation to be useful in the desired comparisons.

Four separate periods were initially identified to organize the data and to examine relations among them for possible changes. The first period begins in 1964/65 whenever the data permit. In the early 1970s, major changes in the market environment occurred, with significant increases in U.S. exports and significant declines in the levels of government stocks. Toward the end of that decade, higher prices and expanded production led to periods of increased influences of government programs. Although a major disruption such as the “Russian wheat deal” is readily pinpointed, many other changes vary among markets and cannot be dated so easily. Alterations in contracts at the CBOT began with the July 1973 wheat contract and so the second period begins with the 1973/74 cropyear. It ends with the 1978/79 cropyear, just before Toledo was finally added as a deliverable location in soybeans. The third period is the 1979/80 through 1986/87 cropyears.

Data from two recent cropyears, 1987/88 and 1988/89, were reserved for comparisons with the averages or average relations established from the preceding periods in order to test whether there were any significant changes in these most recent years. This study began more than a year ago and, at the time, the most recent complete cropyear was 1988/89. Thus, all the data and analyses, although current when begun, are already one full cropyear out of date, underscoring that market circumstances change. Undoubtedly, they have in the last year, and to the extent that these changes have alleviated problems identified here, readers will want to modify the conclusions.

The initial estimates of all the relations reported here were for each
of the identified subperiods and, in some cases, those subgroups remain evident in the discussions and tables. In many cases, however, the separate analyses show little significant difference between the results for some or all of the subperiods. Thus, reported results often encompass longer periods, accompanied by discussion of any observed differences.

Finally, the analyses focus on the delivery period and concentrate on examining the fundamental relations observed at specific points in the process. For example, in examining basis convergence, the three principal times at issue are the beginning of the prior month’s delivery period, the first day of the current month’s delivery period, and the expiration of trading in the current month’s delivery. Observations on these specific dates allow measurement of the degree of convergence each month and assessment of its sensitivity to such factors as the timing and location of deliveries. The selection of the specific dates for observation of the prices was guided by the hypotheses being tested. In addition, however, in virtually all the analyses, prices on alternative dates or weekly averages were also examined. In no case did the choice of specific date (or average) change the conclusions drawn from the analyses. At the same time, all of the relations analyzed, whether from specific dates or of continuous observations, are inevitably parts of a much larger simultaneous system, where all variables—deliveries, stocks, concentration, and prices—influence one another. Thus, conclusions about whether observed connections are described better as associations or causal relationships should be circumspect.
CHAPTER 2.

HISTORICAL LEVELS OF DELIVERIES AND THE CHANGING COMMERCIAL IMPORTANCE OF THE DELIVERY LOCATIONS

It is important to begin with a clear impression not only of what the levels of delivery on the CBOT contracts have been in recent years, but also how they have changed over time and how they compare to levels of delivery in other markets. The absolute amounts of deliveries then are compared to the available deliverable stocks and levels of trading in order to obtain a sense of their size relative to both the cash market and the futures market. Finally, historical data on production and export movements provide a broader perspective on production in the region and show how commodity flows in the delivery locations have changed.

LEVELS OF WHEAT, CORN, AND SOYBEAN DELIVERIES

By almost every measure, deliveries on the CBOT wheat, corn, and soybean futures markets are much larger than has been widely appreciated. From the 1964/65 crop year through the 1986/87 crop year, deliveries in absolute amount on individual CBOT wheat futures contracts averaged some 15 million bushels, with a minimum of 0.03 and a maximum of 102 million bushels. For corn, the average was 20 million, ranging from 0.03 to 100 million bushels, and for soybeans the average was 24 million, ranging from 0.06 to 119 million bushels.

There is also some indication that deliveries in each market have been growing in size. For example, wheat deliveries averaged 9 million bushels over the first nine years (1964/65–1972/73), 15 million over the next six (1973/74–1978/79), and then 21 million in the next eight (1979/80–1986/87). In the earliest period, corn deliveries averaged about 15 million bushels, which increased to about 23 million over the two periods 1973/74–1978/79 and 1979/80–1986/87. Soybean deliveries have increased
as well, from 13 million to 21 million bushels and then to 38 million bushels in the third of these periods. Although deliveries from month to month vary substantially relative to the averages, the long-term trends in the levels of deliveries on each of the three markets are positive and statistically significant. For example, soybean deliveries have increased an average of 142,000 bushels in each delivery period since 1964. With seven soybean contracts per year, the average annual increase amounts to about 1 million bushels. For wheat, the annual increase amounts to 0.4 million bushels while that for corn is 0.7 million bushels.

Other measures of the level of market activity provide a context in which to assess the absolute levels of deliveries and their growth. Comparisons with open interest and with deliverable stocks are listed in Table 2.1. Each comparison shows deliveries to be much larger than expected, given the prevailing wisdom that deliveries are insignificant in amount. Relative to the maximum amount of open interest in each contract (namely the peak open interest), deliveries of wheat futures averaged about 18 percent over the past 25 years, those of corn were 11 percent, and those of soybeans 19 percent. Data in Table 2.1 also show comparatively little variation in these percentages over time, especially for wheat and soybeans. Put differently, the levels of deliveries on both the wheat and soybean futures contracts increased in close correspondence with increases in the maximum levels of open positions in each contract. Deliveries of corn did not grow apace with levels of open interest in corn contracts, declining from an average of 15 percent over the period 1964/65–1972/73 to only 7 percent over the period 1979/80–1988/89.

These measures of the relative importance of CBOT deliveries are quite similar to those from both the Kansas City wheat market and the Comex copper market. Over the 1972–89 period, KCBOT wheat deliveries averaged some 7 percent of the peak open interest for each contract while copper deliveries in the five principal delivery months averaged 19 percent. The KCBOT also reports just the amount of original deliveries each month

1 In regressions of the levels of deliveries each expiration month on a simple trend variable, the coefficients of the trend variable are statistically significant in each market. These coefficients are the estimates of the amount of average increase in the level of deliveries from expiration to expiration and, when multiplied by the number of deliveries each year, are the estimated amount of the annual increase.

2 The amount of open interest in any individual futures contract follows a relatively predictable pattern, starting at zero when trading in that option begins a year or more before expiration, increasing gradually until the option is the most actively traded one, and then declining as delivery and expiration approach. The maximum level of open interest usually occurs while the contract is the most actively traded one, some two to four months before expiration.
Table 2.1—Deliveries as Percentages of Open Interest and Stocks: Average Over 1964/65–1988/89

<table>
<thead>
<tr>
<th></th>
<th>Wheat</th>
<th>Corn</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak open interest</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1964/65–1972/73</td>
<td>18.6</td>
<td>14.7</td>
<td>18.5</td>
</tr>
<tr>
<td>1973/74–1978/79</td>
<td>17.2</td>
<td>10.6</td>
<td>18.2</td>
</tr>
<tr>
<td>1979/80–1986/87</td>
<td>17.8</td>
<td>7.2</td>
<td>20.1</td>
</tr>
<tr>
<td>1987/88–1988/89</td>
<td>13.8</td>
<td>7.8</td>
<td>14.0</td>
</tr>
<tr>
<td><strong>Open interest at the beginning of the delivery month</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1964/65–1972/73</td>
<td>47.1</td>
<td>36.7</td>
<td>41.0</td>
</tr>
<tr>
<td>1973/74–1978/79</td>
<td>60.2</td>
<td>31.8</td>
<td>43.1</td>
</tr>
<tr>
<td>1979/80–1986/87</td>
<td>63.0</td>
<td>23.4</td>
<td>59.8</td>
</tr>
<tr>
<td>1987/88–1988/89</td>
<td>55.7</td>
<td>31.5</td>
<td>44.0</td>
</tr>
<tr>
<td><strong>Total free stocks in the deliverable location(s)</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1964/65–1972/73</td>
<td>117.9</td>
<td>116.3</td>
<td>148.6</td>
</tr>
<tr>
<td>1973/74–1978/79</td>
<td>109.5</td>
<td>159.9</td>
<td>243.9</td>
</tr>
<tr>
<td>1979/80–1986/87</td>
<td>192.5</td>
<td>123.1</td>
<td>208.9</td>
</tr>
<tr>
<td>1987/88–1988/89</td>
<td>275.2</td>
<td>130.8</td>
<td>114.8</td>
</tr>
</tbody>
</table>

Source: Based on data provided by the Chicago Board of Trade in their *Statistical Annuals*, in the Commodity Futures Trading Commission weekly “Stocks of Grain” reports, or in the U.S. Department of Agriculture, Agricultural Marketing Service, “Weekly Grain Stocks” reports.

<sup>a</sup>The open interest is measured at the close of the first position day for the approaching delivery month, which is two business days before the first day of the delivery month, because deliveries are subtracted from the open interest on first notice day, the last trading day in the month prior to expiration.

<sup>b</sup>Free stocks in the deliverable locations exclude government-owned stocks, but include stocks in the Farmer-Owned Reserve.

and these averaged some 5 percent of maximum open interest. Thus, in terms of maximum levels of trading in each commodity on each of the futures delivery options, the levels of deliveries at the CBOT in the 1980s do not appear to have been particularly different, either compared to those in earlier periods or to those in two other markets.

As another interesting indicator of the importance of deliveries, approximately 50 percent of the wheat and soybean futures contracts and 30 percent of the corn futures contracts that were still not closed at the beginning of the delivery month were settled by delivery. Again, in both wheat and soybeans, this percentage has been increasing over time, from less than half to 60 or more percent. Interestingly, the percentage declined somewhat...
in the two most recent crop years, 1987/88 and 1988/89, from 63 to 56 percent in wheat and from 60 to 44 percent in soybeans. The trends in corn were just the opposite. First, there has been a general long-term decline in the percentage of corn contracts remaining open just before deliveries began that were settled by delivery. Second, there was an increase in the last two crop years, from 23 to 32 percent. Yet all these figures are within range of comparable data from Kansas City wheat, where an average of 28 percent of contracts open prior to the beginning of deliveries were settled by delivery, and from Comex copper, where the comparable percentage was 95.

A third indicator, CBOT deliveries compared to the levels of stocks available in the delivery location, provides a quite different view of their amount, however. The measure of stocks is now provided by the CFTC; it is total free stocks in the deliverable locations on the Friday closest to the beginning of the delivery month. The averages reported in Table 2.1 show deliveries have been much greater than free stocks in the deliverable locations in all three markets over the entire 25-year period. Moreover, the percentages of deliveries with respect to these stocks have been increasing markedly over time. The increases in the wheat and soybean markets are greatest, with wheat deliveries increasing from an average of 118 percent of free stocks in the 1964/65-1972/73 period to 193 percent in the 1979/80-1986/87 period while soybean deliveries increased from an average of 149 to 244 percent and then declined slightly to 209 percent. Although much less, increases in the averages are evident in corn as well. Indeed, perhaps the most significant comparisons in the table are of the deliveries relative to deliverable stocks before and after Toledo was added as a delivery location and its stocks were added to the deliverable stocks. In each case, the addition of Toledo and its stocks served immediately to decrease the ratio of deliveries to stocks. Nevertheless, the longer-term cumulative effects of increasing delivery levels generally and declining cash markets in both Chicago and Toledo have meant the declines in the ratios were only temporary. For all three commodities, the post-1979 averages are already greater than those that prevailed prior to 1973 and the beginning of the contract changes that included Toledo. The increase in the percentages in wheat have been greatest, but even those for soybeans where Toledo was added may be considered a delusion since as long as delivery continues to be the easiest of the three commodities to make deliveries will continue.

The table shows that deliveries from the three markets are not directly comparable since the deliverable stock measure used is based on available (Free Stock) and includes deliveries. Even as the total deliverable stocks are relatively similar, the deliverable stocks vary significantly. The soybean deliverable stocks, the values for which are displayed in Table 2.2 with corn and wheat, are significantly lower. Several other deliverable stocks are also available.

On a year-by-year basis, the changes over the years in the CBOT deliverable stocks relative to the general market levels are shown in Table 2.3. Since the 1980/81 crop year, the CBOT deliverable stocks have been much higher than the available CBOT deliverable stocks. Prior to 1980/81, the deliverable stocks averaged 87 percent of the available deliverable stocks. In 1980/81, the average was 131 percent, and in 1981/82 the average was 115 percent.

The CBOT deliverable stocks have been lower than the deliverable stocks in the other two markets when returns to delivery have increased. Again, deliveries in KCBOT and CBT were not the same. The comparison of the CBOT deliverable stocks against the available deliverable stocks is, therefore, invalid because the deliverable stocks are not the same for the two markets. The comparison is more meaningful if it is to determine the ratio of deliverable stocks to the available deliverable stocks. The comparison is also valid if the CBOT deliverable stocks are of the same size in each of the three markets from year to year.
added most recently have been positive. Thus, while the addition of Toledo as a delivery location did increase the stocks available to make deliveries, the easing of the relation between amounts delivered and those available to make delivery was temporary at best.

These percentages also illustrate how difficult it is to draw conclusions from the separate experiences of the wheat, corn, and soybean markets. For example, wheat deliveries had been averaging a mere 118 percent of available stocks each month in the period just before the CBOT added Toledo and increased the available deliverable stocks. Over that same period, corn deliveries were almost identical averages of free corn stocks, at 116 percent, even as soybeans were the greatest, at 149 percent. Notwithstanding these relative magnitudes, the CBOT did not add Toledo to either the corn or soybean contract at the time it did for wheat. Clearly, there are no cut-off values for any of these indicators that would permit the analyst to conclude with certainty that the market is in difficulty. Indeed, that is precisely why several indicators have been examined, both here and in the analyses that follow.

One of the main reasons for separating the 1987/88 and 1988/89 crop-years in the data in Table 2.1 is their variability with respect to the averages generally and especially as regards the ratio of deliveries to stocks. During the 1987/88 and 1988/89 cropyears, deliveries as percentages of available stocks varied greatly among the three commodities. Wheat deliveries as percentages of free wheat stocks increased again, to some 275 percent of available stocks on average. Corn percentages remained about the same, at 131 percent, and soybean deliveries were most unusual, declining to only 115 percent of total free stocks, levels lower than those seen in the 1960s.

These figures—deliveries significantly greater than 100 percent of stocks—make especially clear that the only available measure of deliveries on CBOT contracts includes redeliveries, namely those deliveries made when individuals who receive delivery notices do not hold them but re-deliver them by initiating a second delivery procedure. By contrast, the KCBOT does distinguish original deliveries in its reports. Therefore, comparisons with the KCBOT are especially important, although the intramarket comparison of total to original deliveries is swamped by the intermarket differences in deliveries relative to stocks. Over the 1972-90 period, total deliveries on the KCBOT wheat contract averaged only 28.5 percent of deliverable stocks. Original deliveries were just 18 percent. For the other comparison commodity, copper, total deliveries averaged some 53 percent of warehouse stocks. Thus, compared to KCBOT wheat and Comex copper and to their own historical levels, deliveries of wheat, corn, and soybeans on the CBOT are large as percentages of deliverable stocks. Moreover, their size is not explained by the fact that CBOT data do not distinguish original from total deliveries.
Another check on the comparison matches deliveries from just the first day of the delivery period against deliverable stocks. Deliveries on the first day must be original deliveries. Over the significant subperiod beginning in May 1976 for which daily delivery data are available from the CBOT, an average of 38 percent of available stocks of wheat were delivered on just the first day of the delivery month. For corn, the average was 29 percent while for soybeans it was 25 percent. These percentages also varied a great deal among the delivery months, with first-day deliveries of wheat and soybeans representing as much as 90 percent of the available stock and those of corn as much as 67 percent. Both these averages and the extremes reinforce the impression that CBOT deliveries are very substantial relative to the available deliverable supply.

One overall measure not included in Table 2.1 is of deliveries with respect to volumes of trading. Although such comparisons are often made, they are much more difficult to justify conceptually because the volume includes all the within-day trading of market makers, which rarely results in overnight open positions, let alone deliveries. Nevertheless, for completeness, some comparisons with volume are necessary. For the 29 corn contract expirations from March 1982 through September 1987 (a nearly six-year period), deliveries averaged 0.3 percent of the volume traded in each contract over its life. In the wheat market over the period March 1982 through May 1987, deliveries averaged 0.6 percent of cumulative volume. For the 41 contract maturities in soybeans through September 1987, the average was 0.5 percent. As with the other measures reported here, the variability underlying these averages is high, with a range from 0.0 to 4.1 percent in wheat, 0.0 to 1.0 in corn, and 0.0 to 3.7 in soybeans.

These percentages of trading volume are the sorts of numbers people seem to have in mind when they speak of futures markets as markets where few contracts result in delivery. Even granting that the ratio of deliveries to trading volume is informative, it is important to place it in context with open interest and physical stocks available for delivery. When the total volume of trading is many times the level of the peak open interest, even very small delivery-to-volume ratios imply substantially higher delivery-to-open interest ratios. And, with relatively small physical stocks underlying both measures of levels of futures trading activity, the small delivery-to-volume ratios imply significant delivery-to-stocks ratios.

The most revealing comparisons remain those of deliveries to the deliverable stocks. Whether by their own historical standards or by comparison with other physical delivery markets, deliveries of wheat, corn, and soybeans are strikingly high percentages of the stocks available for delivery. The percentages became extraordinarily high for wheat in the 1987/88 and 1988/89 crop years at some 275 percent, but declined markedly for soybeans, from levels, however, that were already more than 200 percent. Because of
WILLIAMS

their level and variability, these ratios underscore the need to examine the representativeness of supplies available in the delivery system. The remainder of this chapter examines data on the position of the delivery locations in the structure of production, marketing, and storage of the three crops.

CHANGES IN THE POSITION OF CHICAGO AND TOLEDO AS TRADING CENTERS

In the second half of the nineteenth century, the importance of Chicago as the principal market for surplus agricultural production was unquestioned. At that time, the CBOT emerged as a merchants’ association to organize and regularize the already extensive trading of grains; more specifically, futures contracts emerged from standardization of the growing trade in time contracts. Direct reflections of their evolutionary character, the terms of the original grains futures contracts represented what was then standard in the substantial commercial movement of grains through Chicago elevators. Today, although Chicago remains the undisputed center for futures trading, its primacy as a cash market for grains has long since eroded. The city’s decline as a cash market over the last 25 years is documented here and the extent to which the addition of Toledo as a delivery location has compensated is examined.

Direct evidence of the status of Chicago and Toledo as commercial grain centers is provided by the records of annual receipts and shipments of grains and soybeans that are maintained by the CBOT. In addition to those for Chicago and Toledo, the CBOT also collects receipts and shipments data for ten other so-called primary markets. Even though the annual summaries of these data are not available after 1985, the clearly established trends in them nonetheless provide a picture of a continuous fall in the commercial importance not only of Chicago and Toledo but also of all the primary markets over the 20 years since 1964. In 1964, for example, receipts of wheat in Chicago were some 34 million bushels. By 1985, they were a mere 7 million. Receipts of corn and soybeans in Chicago declined as well, from 156 to 95 million bushels and from 39 to 23 million bushels, respectively. Receipts of wheat, corn, and soybeans in all primary markets in 1964 were 960 million bushels; in 1985 merely 507 million bushels.

4 Irwin documented the emergence of futures trading in the grains from the trading of time contracts in Evolution of Futures Markets (1954). Even today, designing contract terms that reflect important commercial flows of a commodity when developing a new futures market is important and is well documented in Sandor’s (1973) description of CBOT’s development of the plywood market.

5 The other primary markets are Indianapolis, Kansas City, Milwaukee, Minneapolis, Omaha, Peoria, St. Joseph, St. Louis, Sioux City, and Wichita.

6 The amounts of the declines are little affected if the terminal date is 1989.
Table 2.2—Average Annual Changes in Production and Terminal Market Receipts of Wheat, Corn, and Soybeans, 1964–85

<table>
<thead>
<tr>
<th></th>
<th>Wheat</th>
<th>Corn</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual changes in receipts (million bushels)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicago</td>
<td>-1.2</td>
<td>-2.3</td>
<td>-1.2</td>
</tr>
<tr>
<td>Toledo</td>
<td>0.0</td>
<td>3.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Chicago and Toledo</td>
<td>-1.5</td>
<td>0.0</td>
<td>-0.3</td>
</tr>
<tr>
<td>Total primary markets</td>
<td>-14.6</td>
<td>-7.0</td>
<td>-1.6</td>
</tr>
<tr>
<td><strong>Annual changes in relative receipts and production</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicago and Toledo receipts as percents of primary market receipts</td>
<td>0.0</td>
<td>1.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Production in Illinois, Indiana, and Ohio as percent of national production</td>
<td>-0.2</td>
<td>-0.3</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Sources: Receipts of wheat, corn, and soybeans in Chicago, Toledo, and the aggregate primary markets are taken from Chicago Board of Trade Statistical Annuals. Production data are from U.S. Department of Agriculture, Agricultural Marketing Service, “Crop Production” series. Entries in the table are the slope coefficients from linear regressions of the indicated dependent variable on a trend variable. If the coefficient was not significant at the 10 percent level or better, a 0.0 appears in the table.

Table 2.2 shows estimates of the average annual declines in receipts from 1964 to 1985 in the markets of interest. For each market, the annual receipts were regressed on a simple linear trend. The coefficient of the trend variable is thus the average annual change in receipts and is reported in Table 2.2. If the trend was not statistically significant, a change of 0.0 is reported in the table. As these results show, wheat and soybean receipts in Chicago declined an average of 1.2 million bushels per year, and those for corn an average of 2.3 million per year. The estimates also show that the decreases in Chicago were somewhat offset by increases in receipts for soybeans and corn in Toledo. When Toledo and Chicago are measured together, however, total receipts declined significantly in soybeans as well as wheat, with no net change in corn.

Instead of 1985. Annual receipts in Chicago of all three commodities declined further from the 1985 levels reported above; 1989 is not used as a terminal date for these analyses because annual data on any of the other individual primary markets are not available from the CBOT after 1985.
levels of deliveries, delivery locations 145

The diminishing role of Chicago and Toledo as principal markets for these commodities presents a general pattern shared by all the primary markets the CBOT records. Thus, the position of Toledo and Chicago combined has not changed very much when measured relative to all primary markets, as evidenced by the figures representing annual-percentage changes in the next-to-last row in Table 2.2. The relative position of the two cities, however, belies the overall declines evidenced in all markets and, hence, the continued erosion of underlying commercial grain flows to support futures contracts. Another important implication of the annual declines in receipts at the primary markets is that none of them individually is likely to be a alternative delivery location with significantly increasing commercial flows. In other words, while the addition of another primary market as an alternative location for contract deliveries might add short-run support to the market, it is unlikely to solve the longer-run problems caused by declining cash markets everywhere.

Another indication of the waning importance of Chicago and Toledo as commercial markets is the evident decline in the relative production of these commodities in the surrounding states. Production of all three commodities in the states principally tributary to the Chicago and Toledo markets—that is, Illinois, Indiana, and Ohio—has diminished relative to nationwide production. In wheat, there has also been an absolute fall in production in the three states from 165 million bushels in 1964 to 133 million in 1985. And, although production of corn and soybeans has risen absolutely since the 1960s, the results in Table 2.2 show that these increases were less than those experienced elsewhere.

Moreover, the production data do not tell the full story. Estimates of the direction of export movements of these commodities from Illinois, Indiana, and Ohio show a marked decline in the use of the Great Lakes ports. Data in Table 2.3 summarize some results from the Hill et al. studies on just this question. They show that in 1977 some 26 percent of the 106 million bushels of wheat exports originating in Illinois, Indiana, and Ohio went through the Great Lakes ports. Although in 1985 the percentage was little changed, the level of total exports from the three states had shrunk by more than one-half, with a consequent decline in export origination of wheat from the Great Lakes. The losses for both corn and soybeans have been even greater, a combination of falling exports of corn and soybeans

7 Chicago also attracts some grains and soybeans from Iowa and Wisconsin, depending on price relations. The purpose here, however, is simply to provide some sense of their overall position, and so focus on just the three principal states seemed most appropriate.

8 Data in Table 2.3 do not include exports that may have originated in Chicago but were moved to the Gulf for export, which was the most common direction of export movement of grain and soybeans from Illinois in both 1977 and 1985.
Table 2.3—Total Shipments for Export from Illinois, Indiana, and Ohio and the Percent Shipped Through the Great Lakes Ports, 1977 and 1985

<table>
<thead>
<tr>
<th></th>
<th>1977</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wheat</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total exports (million bushels)</td>
<td>106</td>
<td>50</td>
</tr>
<tr>
<td>Percent through Great Lakes</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td><strong>Corn</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total exports (million bushels)</td>
<td>108</td>
<td>51</td>
</tr>
<tr>
<td>Percent through Great Lakes</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td><strong>Soybeans</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total exports (million bushels)</td>
<td>51</td>
<td>25</td>
</tr>
<tr>
<td>Percent through Great Lakes</td>
<td>22</td>
<td>12</td>
</tr>
</tbody>
</table>


from the three states with sharp reductions in the percentage that passes through the Great Lakes ports.

Taken together, the evidence clearly underscores the increasing scarcity of grains available for delivery as Toledo and even more so Chicago have become less important as commercial grain centers, although the extent of decline varies by commodity, location, and measure. In addition to the flows of grains into and out of Chicago and Toledo, concerns have been expressed about the seasonal representativeness of stocks there relative to other commercial centers. Accordingly, the next section examines the relation between deliverable stocks and broader, aggregate series.

**REPRESENTATIVENESS OF THE DELIVERABLE STOCKS**

An examination of the representativeness of wheat, corn, and soybean deliverable stocks, both historically and over 1987/88 and 1988/89 in particular, provides yet another view of the adequacy of the current delivery arrangements.\(^9\) If stocks in Chicago and Toledo vary in proportion to those held elsewhere, the incentives for delivery on futures contracts are consistent with conditions at many other locations. Such proportional movement

\(^9\) Recall deliverable stocks are the total free stocks in eligible warehouse space in approved delivery locations, as reported by the CFTC (since 1973) and by the CBOT earlier. They exclude CCC stocks but include stocks in the FOR.
includes the seasonal component, for Chicago and Toledo should not be out of phase with other commercial locations.

Consequently, deliverable stocks need to be compared to more aggregate measures of supplies, the so-called visible supply and total national free stocks of grains. The visible supply is a USDA series, currently reporting stocks in some 53 commercial locations nationwide. It includes both government-owned and under-loan stocks, which are held in the surveyed commercial facilities and yet are unresponsive to commercial price signals. Because of this problem with the definition of visible supply, a second measure of stocks, national free stocks, is also tested. The limitation with the national stocks measure is its availability only on a quarterly basis.

Figure 2.1 shows the average seasonal patterns of wheat, corn, and soybean stocks in the deliverable locations as they have varied by subperiod. The effects of adding Toledo as a deliverable location for each commodity are clear in the panels of Figure 2.1, namely with the obvious shift upward in the average levels of total deliverable stocks over the entire season. Deliverable wheat stocks increased the most, on average, in the initial period after Toledo was added, that is, 1973/74–1978/79. Also evident in the top panel of Figure 2.1 is the marked decline in deliverable stocks for wheat in the 1980s, a direct reflection of the continuing declines in receipts noted earlier. In the middle panel of Figure 2.1, for corn, the seasonal index for stocks in the middle period (1973/74–1978/79) is omitted because the transition to Toledo delivery occurred mid-period. Although not as large an effect, the addition of Toledo added to corn stocks throughout the season. Similarly, as shown in the bottom panel, the addition of Toledo added to soybean deliverable stocks. The increase in the average stocks of soybeans was also accompanied by a pronounced shift in the pattern of accumulation, with levels of deliverable stocks peaking much sooner in the crop year after the addition of Toledo.\(^{10}\)

Of particular interest is the relation of these seasonal patterns to those of stocks representing broader commercial movements of the commodities. Visible supplies and national stocks are the two most widely used such measures. The results in Table 2.4 show the degree to which deliverable stocks relate to these series. Each entry is the degree of squared correlation (\(R^2\)) between deliverable stocks and the indicated series along with a set of seasonal shifts in order to account for regular differences in the individual seasonal pattern in each. Table 2.4 indicates substantial variation in the degree of relation among these series. The relations involving wheat were most variable over the last 25 years, with corn second, and soybeans third.

\(^{10}\) Separate seasonal indices were calculated for the 1964/65–1972/73 and 1973/74–1978/79 subperiods, both periods entirely before Toledo was added as a delivery location for soybeans. The separate indices were virtually identical and statistical tests rejected finding significant differences in the seasonals.
Figure 2.1—Average Seasonal Accumulations of Deliverable Stocks of Wheat, Corn, and Soybeans
**LEVELS OF DELIVERIES, DELIVERY LOCATIONS**

Table 2.4—The Degree of Relation Between Deliverable Stocks and Aggregate Commercial Stocks, Wheat, Corn, and Soybeans, 1964/65–1986/87

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visible supply</td>
<td>0.37</td>
<td>0.80</td>
<td>0.13</td>
</tr>
<tr>
<td>National free stocks</td>
<td>0.46</td>
<td>0.21</td>
<td>0.65</td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visible supply</td>
<td>0.57</td>
<td>0.61</td>
<td>0.52</td>
</tr>
<tr>
<td>National free stocks</td>
<td>0.46</td>
<td>0.81</td>
<td>0.29</td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visible supply</td>
<td>0.62</td>
<td>0.59</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Sources: Deliverable free stocks are from the Chicago Board of Trade Statistical Annuals and Commodity Futures Trading Commission “Stocks of Grain” weekly reports, while visible supply and national stocks are U.S. Department of Agriculture series. Entries in the table are squared correlation coefficients (R^2) from linear regressions of the indicated aggregate stock measure on the deliverable supply. All regressions also include a set of monthly or quarterly shifter variables in order to take account of any differences in the seasonality of the two series. Visible supply relations are monthly and national stocks ones are quarterly.

The pronounced variability in relations involving wheat and corn stocks is in part a reflection of the changing influence of the various government programs. For example, so-called free deliverable stocks exclude stocks in the deliverable locations that are owned by the Commodity Credit Corporation (CCC) but include those in the Farmer-Owned Reserve (FOR). Visible supplies have included all forms of program stocks over the years as well as truly free commercial stocks. Not surprisingly then, the relation between deliverable wheat stocks and visible supplies was 0.80 in the 1970s—a period characterized by comparatively little government intervention in the market and, hence, less program-induced difference in the relation between the two series—whereas in the 1960s, the squared correlation was only 37 percent and, in the 1980s it was only 13 percent. Both periods 1964/65–1972/73 and 1979/80–1988/89 were characterized by extensive government

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11 Tests of the overall relation indicate the observed differences between periods are generally statistically significant.
wheat program activity. Although not as pronounced, the degree of relation between deliverable corn stocks and visible corn supplies was also influenced by government programs.

The deliverable stocks have also been compared to the quarterly stocks series comprising total national stocks less those owned by the CCC and less those being held under the provisions of the loan programs. FOR stocks were left in this measure of total stocks because they are also included in reported deliverable stocks. In wheat, these relations are just the opposite of those with visible supplies, with the poorest relation evident in the 1970s and substantially stronger ones in the earlier and later years. The results underscore the difficulties in assessing commercial representativeness when government programs have had differential effects on the available measures.

Taken together, these comparisons about the representativeness of corn and wheat stocks unfortunately offer few conclusions. The relations of deliverable stocks to broader measures of commercial stocks have clearly changed over the years examined here. Much of this variation is apparently due to the differential effects of government programs on the measures themselves, not necessarily to changes in the representativeness of deliverable stocks per se. But perhaps this too is an important message—changes in government programs have had pervasive effects on otherwise fundamental market relations. These changes, often comparatively dramatic, as with the announcement of new program provisions, serve to mask the nature of other changes that are occurring more gradually. With those caveats, it is not surprising that subsequent analyses revealed no statistically significant changes from the previous period in the wheat or corn stocks relations during the 1987/88 and 1988/89 crop years.

For soybeans, only the relation between deliverable stocks and visible supplies could be profitably analyzed. Quarterly estimates of national stocks were not made until the 1970s and, more important, government programs in the soybean market have been much less extensive. Indeed, the USDA does not publish a separate free stocks series for soybeans. The results in Table 2.4 suggest there has been little change in the relation between deliverable and visible stocks of soybeans. On the contrary, the relations are statistically significantly different among the periods. The primary difference in the relations has been the degree to which visible supply accounts for the overall degree of fit. In the 1980s it has been most closely related. Moreover, comparison of the relations in 1987/88 and 1988/89 with those existing in the 1980s showed another significant change, with the overall degree of correspondence increasing to some 72 percent. During this period, however, the portion of that explanatory power attributable to visible supplies declined. That is, the simple (squared) correlation between visible supply and deliverable stocks (excluding the shifter variables for differ
ferential monthly seasonality) declined from 62 percent in the 1980s to 47 percent in just the last two crop years, even as differences in the two series’ seasonalities became more important. Again, variability is the rule—stocks in the deliverable location(s) appear to be quite variable related to more aggregate measures of stocks.

CONCLUSIONS

For many years, the amount of deliveries clearly has been important on all physical delivery markets, including those of the CBOT. Although highly variable, delivery amounts seem to bear some relation to open interest, so that, as the levels of trading of a specific commodity increase so also do deliveries. The CBOT deliveries do stand out, however, in relation to the deliverable stocks where they are multiples rather than fractions of available stocks. Redeliveries make this possible, of course. But redelivery was also possible historically and is possible on both the Kansas City wheat market and the Comex copper market and, compared to both history and the two other markets, the current CBOT markets are exceptional. The evidence also shows that the addition of Toledo has not fundamentally altered the underlying relations, and deliveries are already at relative levels beyond those that existed when the CBOT began contract reversions in 1973 to add Toledo to each of the contracts.

Chicago and, to a lesser extent, Toledo are declining as cash markets. Total receipts have been trending downward in Chicago for the last 25 years. Although the addition of Toledo as a second delivery source has slowed the overall total decline, there is little prospect for significant increases in receipts or stocks to match the growth in levels of futures trading. Production in tributary areas has been falling and the Great Lakes have been declining as a source of export origins. Without some significant changes in their terms, the current CBOT wheat, corn, and soybean contracts appear to be increasingly jeopardized by comparatively small deliverable stocks. These deliverable stocks do seem to move reasonably closely, both across seasons and across years, with a broader measure of stocks. The dominant influence on the closeness of these relationships is, however, government programs, which have been both important and highly variable in their effects in recent years.
CHAPTER 3.

CONCENTRATION IN CASH
AND FUTURES MARKETS

A second general area of concern about the current delivery provisions is the breadth and depth of the underlying spot market and hence the susceptibility of the market to manipulation. Beyond dispute, the cash markets for wheat, corn, and soybeans in both Toledo and Chicago are thin markets. As documented in the preceding chapter, aggregate receipts of all three commodities into both Chicago and Toledo have been generally declining over the last 25 years. And, although the addition of Toledo as a deliverable location in the 1970s enlarged deliverable supplies, the long-term declines in receipts in Chicago and Toledo means the increase has been transitory. Indeed, deliveries are already larger on average than the available deliverable stocks by amounts that exceed the percentages that prevailed in the late 1960s and early 1970s before Toledo was added to any of the contracts.

Another indication of thinness of the underlying cash markets in both Chicago and Toledo is in the cash price reports themselves. The official USDA quotations are frequently only nominal prices, the average of reported bids that are posted each day. Thus, many of the prices do not represent actual transactions. To be sure, grain and soybeans do still move in and out of Chicago and Toledo. However, much of it is not actually purchased or sold over the scale in either location. (Cash transactions for the item in store are even less frequent.) In the absence of numerous transactions, it is difficult to know how much could be bought or sold at the posted prices or how rapidly they would change if transactions were sizable.

Thin markets are susceptible to manipulation and more so, the more concentrated are positions in them. It is important to be clear that thin markets are not by definition frequently manipulated. Rather, thinness simply indicates the comparative difficulty an individual faces in trading in quantity without a significant price effect. And, because of this possibility
of price effect, the potential for manipulation is greater in a thin market than in a broader, more liquid market. Similarly, a high level of concentration among positions is not a priori manipulation, but is only indicative of potential. With these admonitions stated, in this chapter the available evidence is examined on the extent of concentration first in the physical markets in the delivery locations and then in the futures markets as contracts approach expiration. Observed levels of concentration are high, and the last section looks for their possible effects on market prices. The analysis begins with consideration of the size of stocks relative to the available warehouse space.

UTILIZATION OF THE AVAILABLE DELIVERY SPACE

The data assembled in Figure 3.1 show the relation between stocks of wheat, corn, and soybeans together and the capacity of approved delivery warehouses in Chicago and then Toledo from December 1964 through September 1989. Total stocks are measured five times per year, on the first of each of the principal delivery months: March, May, July, September, and November/December.\(^1\) The measure of stocks in Figure 3.1 also includes recorded CCC stocks held in Chicago and Toledo, but does not include stocks of other grains, such as barley or oats, which have occupied some space in these facilities from time to time. Finally, the capacity includes Toledo space as of July 1973 and, at that time, the measure of stocks was adjusted to include Toledo stocks of all three commodities even though corn and soybeans were not deliverable there until somewhat later.

As evident in Figure 3.1, total stocks have increased on average over the 25 years plotted there. Most of the increase results from the addition of Toledo stocks in the 1970s. Some portion, however, is attributable to CCC as well as FOR stocks, both of which tend to stay in place for some periods of time. Thus, the longer-term downward trends in receipts (or transactions more generally) are not inconsistent in principal with overall increases in stocks evident here.

More important, stocks of the three commodities together appear never to have exhausted the eligible warehouse capacity underlying the futures contracts, at least on the Friday nearest the first of the principal delivery months. Put differently, it would seem that space per se is not a binding constraint. Room for at least several million bushels of any particular commodity could have been found if there had been the demand for delivery.

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\(^1\) The delivery months of January and August for soybeans are ignored in these series, and the stocks of soybeans as of the first Friday in November have been added to the stocks of corn and wheat as of the first Friday in December to create the fifth observation each year.
Chapter 3

FUTURES MARKETS

Cash and Futures Markets

Figure 3.1—Stocks of Wheat, Corn, and Soybeans, Including Commodity Credit Corporation Stocks, in Registered Warehouses

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At the same time, it is also clear that if it were desirable to increase the deliverable supply substantially, the space available in Chicago and Toledo would be inadequate. Moreover, the historical record also shows that space relative to deliverable stocks is currently at a ratio similar to that when the CBOT acted in the 1970s to add space by permitting Toledo deliveries. During the period before Toledo was added as a delivery location, total stocks filled some 54 percent of the eligible space on average, with a maximum of 86 percent in December 1964. Since November 1979, when Toledo was eligible to deliver all three commodities, the average has been 59 percent, with a maximum of 92 percent. To the extent that space was a constraint on the delivery capacity of the markets before the contract changes in the 1970s, it is a constraint now.

CONCENTRATION IN THE DELIVERY SPACE

One measure of the degree of competition in the futures delivery system is the number of potential participants. On the long side, the potential is large—almost anyone can hold a futures contract to expiration and thereby acquire warehouse receipts to stocks in eligible space. On the short side, however, deliveries are limited by available stocks in eligible space. To the extent that warehouse receipts for these stocks are traded and held by others than those elevators containing the stocks, there are a larger number of people (or firms) who are potential deliverers in any specific contract than simply the number of firms owning the eligible space. Similarly, elevators eligible to make delivery on CBOT contracts are to some extent public elevators, and an individual who wants to make delivery on a futures contract can call an eligible elevator, reserve space, pay the necessary fees, deliver the grain or soybeans and receive the warehouse receipt to give to the clearinghouse. No data indicate how frequently individuals make use of the delivery elevators in this way; anecdotal evidence suggests that it is infrequent. Thus, although the concentration among the owners of the deliverable warehouses may overstate the concentration among those able to deliver on any specific contract, that concentration is relevant for the longer term because only exchange-approved warehouses introduce into the system warehouse receipts eligible for delivery.

Figure 3.2 depicts the concentration in ownership of warehouse space eligible for delivery on CBOT wheat, corn, and soybean contracts from 1964 to 1989, based on data reported annually in the CBOT's "Letter to Members." From 1964 to 1973, eligible space averaged 56 million bushels, with the Cargill and Continental operations accounting for some 68 percent. Other elevators in Chicago in this period included variously the Irondale

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2 These operations comprised several different facilities, including the three separate Continental elevators ("A," "B," and "D") and the Cargill elevator.
desirable to increase

the potential is

and thereby

On the short side, there is

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individuals make use

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relevant for the

introduce into the

of warehouse space

contracts from 1964

Letter to Mem-

million bushels, with some 68 percent.2

Fondale

including the three

Cargill elevator.
Elevator, the Garvey Elevator, the Gateway Elevator, the Calumet Elevator, the Rice Powell Elevator, and the Sante Fe Elevator. The inclusion of Toledo in 1973 added the considerable elevator space owned by the Andersons (some 16 million bushel capacity at the Maumee and Riverfront Elevators in 1973) and the 6.6 million bushel capacity of facilities owned by Cargill. Others in Toledo have included Michigan, Mid-States, and Peavey. Finally, the Cargill facility in Burns Harbor was added in 1982. From 1973 to 1989, the Andersons, Cargill, and Continental accounted for an average of 76 percent of the total eligible delivery space.

Clearly, ownership of the eligible space is highly concentrated. The addition of Toledo changed the balance somewhat, by introducing a third large firm. The two-firm concentration declined on average when facilities in Toledo were added from the 68 percent contract by Cargill and Continental to 59 percent on average by Cargill and the Andersons. But, a three-firm ratio in the post-Toledo period of 76 percent is still high by standards in most industries.

CONCENTRATION OF FUTURES POSITIONS

An additional perspective from which to consider the adequacy of the cash market underlying the CBOT contracts is provided by data on concentration in the futures positions themselves. In the delivery month, futures positions that remain open are essentially cash market positions—promises to accept and pay for deliveries and promises to supply the commodity. One issue, therefore, is the degree to which these positions appear to encumber the available supplies.

For this analysis of the issue, the CFTC made available data comprising the daily positions of the four largest longs and the four largest shorts in the expiring contract during (and just before) each of the delivery months for CBOT wheat, corn, and soybeans from 1982 through 1989. Although similar data are not available to help establish what levels of concentration were in earlier periods, the CFTC also provided data on the largest traders' positions in the Kansas City wheat and Comex copper markets. Unfortunately, the first three years of the data for these two markets proved unusable; but, comparisons are still possible with these series from 1985 through 1989.

The data on holdings in expiring contracts derive from the reports that traders with so-called large positions (in the CBOT contracts, larger than 500,000 bushels) make to the CFTC. Because of this minimum quantity for reporting, the number of reported positions will drop below four toward the end of the daily series for each contract. Thus, the concentration levels reported in this chapter are in some sense a minimum estimate of the positions of the principal longs and shorts. In almost all expirations, there
are (at least) four shorts and four longs with positions greater than 500,000 bushels early in the delivery month.

The day before the shorts can first give notice, namely the first position day, is an important day for the analysis because the deliveries that will occur on the first delivery day have not yet been removed from the open interest. To observe the changes in the degree of concentration to later in the delivery period, the tenth business day of each contract month was chosen. It is approximately the middle of the delivery month, with just three to four days of trading remaining on the expiring contract, but the remainder of the month to fulfill any delivery obligations. Finally, the four largest traders, long or short, on position day are not necessarily the same four largest traders remaining in the middle of the month or even the same on the next day. The data did not identify any firm's position over time.

To assure confidentiality, all statistics presented here aggregate the data for the top four traders and do not identify individual contract months. Because the entire sample is relatively short and because inspection of the data from 1987/88 and 1988/89 indicated they were not obviously different, no subperiods are broken out in the statistics reported below.

The entries in Table 3.1 summarize the average levels of concentration represented by the four largest traders in each expiration month for the five commodities. The aggregate absolute positions are reported as are the positions relative to both the open interest and deliverable supplies. As an example of the underlying series, Figure 3.3 presents the frequency distribution of the aggregate concentration levels from the soybean market. It shows the number of contract expirations that the positions of the four largest longs (top panel) and four largest shorts (bottom panel) were of the indicated size as of the first position day. For example, in only one delivery month in the entire 1982–89 period was the aggregate position of the four largest longs 2.5–5 million bushels of soybeans; whereas, in nine expirations, the aggregate shorts' position was 0–2.5 million bushels. The distributions show the levels of concentration are quite variable from expiration to expiration and that isolating any as obviously small or unusually large is difficult. Although not shown, the frequency distributions from the other markets are similar. Also in Figure 3.3, the contract expirations from 1987/88 and 1988/89 are highlighted to show they are indistinguishable in level and distribution from those of the longer series.

The summary statistics in Table 3.1 show that the typical aggregate positions of the top four largest traders are surprisingly large, for both the longs and the shorts. For example, as of the first position day, the positions of the four largest longs averaged some 13.1 million bushels over the 39 wheat contract expirations in the sample. Average aggregate positions were larger in both soybeans and corn. With deliveries about to begin, these positions represented sizable calls on the available deliverable stocks,
Table 3.1—Average Concentration of the Four Largest Long and Short Futures Positions

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Four largest futures longs on position day</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate position (million bu)</td>
<td>13.1</td>
<td>37.5</td>
<td>16.8</td>
<td>10.0</td>
<td>102.3(^c)</td>
</tr>
<tr>
<td>Percent of open interest</td>
<td>39</td>
<td>34</td>
<td>3.0</td>
<td>59</td>
<td>40</td>
</tr>
<tr>
<td>Percent of deliverable stocks</td>
<td>377</td>
<td>446</td>
<td>224</td>
<td>93</td>
<td>168</td>
</tr>
<tr>
<td><strong>Four largest futures shorts on position day</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate positions (million bu)</td>
<td>12.1</td>
<td>26.5</td>
<td>19.5</td>
<td>7.6</td>
<td>94.6(^c)</td>
</tr>
<tr>
<td>Percent of open interest</td>
<td>36</td>
<td>25</td>
<td>33</td>
<td>44</td>
<td>37</td>
</tr>
<tr>
<td>Percent of deliverable stocks</td>
<td>319</td>
<td>237</td>
<td>235</td>
<td>70</td>
<td>129</td>
</tr>
<tr>
<td><strong>Four largest futures longs midway through the delivery period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate positions (million bu)</td>
<td>3.2</td>
<td>11.2</td>
<td>5.5</td>
<td>0.9</td>
<td>32.1(^c)</td>
</tr>
<tr>
<td>Percent of open interest</td>
<td>59</td>
<td>62</td>
<td>57</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Percent of deliverable supply</td>
<td>132</td>
<td>131</td>
<td>90</td>
<td>9</td>
<td>76</td>
</tr>
<tr>
<td><strong>Four largest futures shorts midway through the delivery period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate positions (million bu)</td>
<td>1.7</td>
<td>5.4</td>
<td>3.2</td>
<td>0.5</td>
<td>20.3(^c)</td>
</tr>
<tr>
<td>Percent of open interest</td>
<td>27</td>
<td>31</td>
<td>32</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>Percent of deliverable supply</td>
<td>93</td>
<td>67</td>
<td>54</td>
<td>5</td>
<td>51</td>
</tr>
</tbody>
</table>

Source: Position data were provided by the Commodity Futures Trading Commission. Open interest and stocks data are from the indicated exchange, their statistical annual, or the CFTC.

\(^{a}\)Data for January contracts were missing.

\(^{b}\)Data exclude December 1988.

\(^{c}\)In million pounds.
Figure 3.3—Size of the Four Largest Long and the Four Largest Short Futures Positions in the Expiring Soybean Contracts, 1982–89

Source: Position data were provided by the Commodity Futures Trading Commission. Open interest and stocks data are from the indicated exchange; their statistical annual or the CRYC.

Note: Data exclude December 1988.

In million pounds.

- Black: March 1982-September 1987
- Gray: November 1987-September 1989

Percent of deliverable supply

<table>
<thead>
<tr>
<th>Percent of deliverable supply</th>
<th>0.5</th>
<th>1.7</th>
<th>5.4</th>
<th>17.8</th>
<th>28.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of open interest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
more than 200 percent of the available stocks of soybeans on average, almost 400 percent of the available stocks of wheat and more than 400 percent of the stocks of corn.

For their part, the shorts had nearly as large commitments to deliver from the available stocks at the beginning of the average delivery month. The aggregate position of the four largest shorts averaged 12.1 million bushels of wheat, which amounted to more than three times the available stock. The comparable averages represented 26.5 million bushels of corn and 19.5 million bushels of soybeans, both also more than double the stocks in the deliverable locations. And, as the distribution of the concentration figures from the soybean market showed, the positions of the top four shorts and the top four longs are not only large on average, they are also highly variable. An aggregate position of twice the average is not unusual nor is an aggregate position less than half the average rare.

The comparisons of the large futures positions with the available stocks is not meant to suggest that all (large) positions entering the delivery month will in fact make or take delivery. Some will simply be closed, with perhaps a new position established in a more distant maturity. Other positions will be settled with exchanges of futures for physicals. Nevertheless, these transactions have not taken place as of the beginning of the delivery period, and short of interviewing them, it is impossible to know traders' intentions. And, with concentrations as high as percentages of deliverable supplies as the data indicate, it is quite likely that the exchange and the CFTC have had to increase their monitoring activities substantially.

By the middle of the delivery month, concentrations have typically declined, both relatively and absolutely. For example, the positions of the four largest longs in wheat futures represent a call on only 3.2 million bushels on average, down significantly from the 13.1 million at the beginning of the month. Still, these positions continue to be greater on average than was the deliverable stock at the beginning of the month. With at most three or four days of trading in the contract remaining, they are rather larger than might have been expected. Similarly, the four largest remaining shorts are still committed to deliver nearly the entire stock on average. And, in most months, the delivery data show those stocks would already have been delivered at least once.

Another comparison in Table 3.1 is the combined holdings of the largest four traders as percentages of the open interest. Of course, nothing limits the "supply" of open interest in futures contracts, as opposed to the physical availability of the commodity in a specific location. And by the nature of futures contracts, the last remaining short and long have 100 percent of the open interest on each side of the market. Nevertheless, the concentration in the open interest, say, on the first position day, may indicate how liquid the futures market might be should an individual trader want to trade out of a position.
of a position in the expiring contract. Presumably, the potential for a price effect would be larger if that trader’s position represented a large percentage of the open interest (and possibly that potential for a price effect might also inhibit the trader from closing out the position in as timely a manner as otherwise).

Although the complete distributions of these ratios involving open interest are not displayed here, they are quite symmetric and quite diffuse. The average concentration in terms of the open interest, especially by the tenth business day and especially among the longs, is often very high. The suggestion is strong, therefore, that these concentration percentages must be interpreted carefully in regard to futures markets, because no one has asserted that these three CBOT markets or any other futures market have been manipulated nearly continuously throughout the 1980s.

Interestingly, the concentration among the four largest longs in terms of the open interest typically increases during the delivery month, whereas there is no such increase in concentration among the shorts. In wheat, the average percentage of open interest held by the four largest longs increases, from 39 to 59 percent from first position day to the tenth business day. For corn, it is from 34 to 62 percent, and for soybeans, from 30 to 57 percent. This increase is true for most individual contracts as well, not just the averages. In other contexts and for particular contracts, similar increases in concentration among positions have been taken as exceptional and as an indication of congestion.\(^3\) Instead, they appear to be the norm, at least for the CBOT markets in the 1980s.

The comparable data from the CFTC on positions for Kansas City wheat and Comex copper futures expirations are also summarized in Table 3.1. Again, they provide some interesting comparisons. Most obvious, the seemingly high concentrations of the four largest positions relative to the open interest at the beginning of the month are also the norm in Kansas City wheat and Comex copper. Thus, the suggestion is even stronger that high levels of concentration, at least compared to all traders with futures positions, are typical as contracts move into expiration.

The data from the Kansas City wheat market and from the copper market provide two contrasts with the CBOT data, however. Most important, the four largest positions, long and short, in Kansas City wheat and Comex copper are much smaller percentages of the deliverable stocks as the

\(^3\) For example, to justify terminating trading in the CBOT’s March 1979 wheat contract, the CFTC noted the increase during March in the percent of the open interest controlled by four large traders as one concern. As of mid-March, the positions were some 81 percent of the open interest which, while greater than the average of 59 percent reported later in Table 3.3, is not out of line for the entire distribution where 10 of the 39 expirations had concentration levels greater than 75 percent. See Gray and Peck (1981) for more detail on the CFTC’s concerns.
delivery month begins. Second, the size of the four largest long positions declines about as rapidly as the open interest in these two markets so that there is not the pronounced increase in concentration among the longs just before the end of trading.

Taken together, the evidence points again to concern about the adequacy of the deliverable stocks of wheat, corn, and soybeans. The statistics on amount and ownership of available space on the one hand and of future positions on the other reveal that high degrees of concentration are common as futures contracts expire, both for the three CBOT contracts but also for the other contracts examined here (where comparable data were available). Where the three CBOT contracts do differ is in the higher degree of concentration of large futures traders relative to the deliverable stocks. The deliverable stocks are again pivotal, precisely because they link the cash and futures markets. Such high concentration levels relative to the stocks undoubtedly have increased regulatory monitoring of the contracts, which is itself an important increased cost. Nevertheless, the concentration might be less of a concern if it did not also affect prices. The next section explores possible price effects.

**PRICE EFFECTS OF THE HIGH LEVELS OF CONCENTRATION RELATIVE TO DELIVERABLE STOCKS**

The difference in price between the expiring futures contract and the next nearby futures indicates the return to continued storage and is the obvious price difference to examine first for possible effects of concentration.\(^4\) Firms with short positions in the expiring futures held against stocks must decide whether to deliver, to sell the stocks and offset the futures position, or to continue holding the stocks but move the futures position into another contract. Similarly, longs must decide whether to stand for delivery, to purchase their requirements elsewhere and close out their futures position, or to roll over their expiring futures position for one in a more distant delivery. Both shorts and longs might also exchange their futures against positions in the cash markets. These decisions will be affected by and possibly will affect the price difference between the expiring and next nearby futures.

Figure 3.4 provides a view of the changes in these spreads over the entire 1964–89 period. In it are plotted the maximum for each commodity during each cropyear of the interest-cost-adjusted (see below for details) spreads between the expiring and next nearby future. That is, for each commodity, the largest spread each cropyear is selected from those observed on the first of the five principal delivery months identified earlier. It

\(^4\) The price difference was termed the price of storage by Working (1949), where he presented evidence about its relation to storage decisions.
CONCENTRATION STOCKS

The futures contract and the storage and is the object of concentration. The spread against stocks must be the futures position, position into another for delivery, to pursue futures position, or more distant delivery. These against positions vary and possibly will affect nearby futures.

The spreads over the for each commodity (see below for details)
That is, for each spread from those obtained earlier. It by Working (1949),

then is the maximum for that cropyear that is plotted in the figure. The heavy solid line plots the largest of the individual commodity maximums each year, and the heavy dashed line plots the exchange-approved costs of storage in the eligible warehouses. Figure 3.4 shows how variable the maximum spreads, and hence maximum returns to storage, have been both over cropyears and among the three commodities competing for the same storage space. They have been much more variable than have been offi-

5 The largest spread each period has been called the price of binspace because it represents the maximum return that an owner of warehouse space might expect given the separate returns for each commodity. See Paul (1970).
cial costs and, in the more recent years 1980–89, they have clearly been declining on average.⁶

The other interesting aspect of the data in Figure 3.4 is the evident difference in the post-1980 period between the maximum spreads (which are net of interest costs) during the crop year and the official fees for storage. In part, the difference is larger than has been the case historically because the prime interest rate, which was used to adjust the spreads for interest costs, is higher than the rate at which most large firms would be borrowing during this period. Therefore, the interest adjustments were also made with the 90-day Eurodollar rate because it is a plausible lower bound to corporate borrowing costs. Use of these rates increased the net spreads in Figure 3.4 by less than 1 cent (per bushel per month) and did not affect the statistical significance of the overall pattern of decline in the spreads during the period. Thus, although the visual impression in Figure 3.4 of an historically large difference between the official fee for storage and the price spreads may overstate the difference, it is still true that the fee has been greater than the maximum returns throughout the 1980s by more than was true in the past. Such a difference may have been a discouragement to firms other than those owning the eligible delivery space to bring or keep stocks in the delivery locations, thereby helping to limit those who actually delivered on the contracts to the owners of the delivery space.

The data in Table 3.2 report the average changes in the price spread between the two future contracts in each market during the delivery month. It is the nearby spread, the difference between the price of the expiring future and the next nearby future, net of interest costs and adjusted for the time between the two options.⁷ The change is measured from the first day of the delivery month to the next-to-the-last trading day.⁸ A positive change indicates the spread is widening (the nearby future trading at a greater premium to the expiring contract). A negative change indicates a decline in the spread during the month. Two periods are identified. The first is from December 1964 through September 1979 when Toledo was finally

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⁶ The decline in the annual maximum spread in the soybean market from 1979/80 through 1988/89 crop year was statistically significant, amounting to nearly 1/2 cent per bushel per year. The decline in the overall maximum was also significant, amounting to 1/4 cent per bushel per year.

⁷ Chapter 4 discusses the need to adjust the spread both for the calendar difference and for the timing of deliveries within each month. Interest costs are measured by the prime rate throughout for consistency. Adjustments were also made using 90-day Eurodollar rates for the 1979–89 period, but they do not affect the comparative changes reported in Table 3.2.

⁸ The next-to-the-last trading day was selected to assure synchronous price quotations for the two futures. On the last trading day, trading in the expiring future (only) ceases at noon.
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the spreads for interest

ents were also made

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overall maximum was

both for the calendar

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adjustments were also

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ending in the expiring

Table 3.2—Changes in the Price Spreads in Wheat, Corn, and Soybean Futures from the First to the End of the Delivery Month (Cents per bushel)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Largest decline</th>
<th>Largest increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 1964–May 1979</td>
<td>-0.03</td>
<td>-5.91</td>
<td>9.28</td>
</tr>
<tr>
<td>July 1979–Sept. 1989</td>
<td>-1.52</td>
<td>-21.81</td>
<td>4.27</td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec. 1964–Sept. 1979</td>
<td>-0.79</td>
<td>-4.99</td>
<td>4.01</td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov. 1964–Sept. 1979</td>
<td>-0.01</td>
<td>-9.16</td>
<td>17.54</td>
</tr>
</tbody>
</table>

Source: Based on data provided by the Chicago Board of Trade or available in their Statistical Annual. Entries are the change in the adjusted spread between the expiring and next nearby contract from the first to the next-to-last trading day in the expiring contract’s delivery month. The spreads are in cents per bushel per month, interest cost has been subtracted, and the time between delivery months in these calculations is adjusted for the expected timing of deliveries.

deliverable for all three commodities. Coincidentally, it is approximately the time when the official cost of storage was increased to its present level of 16/100 cents per bushel per day (or 48 cents per bushel per month). The second period encompasses the deliveries from November (December) 1979 through September 1989.

The average changes in spreads reported in Table 3.2 are all negative as might be expected because the calculation of the spread change did not take into account the effect (in some months) of the decline in time (and hence interest and storage charges) between the two futures from the first to the next to the last trading day. The reason for not including this effect in the calculation is precisely its variability—the decline is expected only when the expiring future is effectively the cash price as it is when the expiring contract is an early delivery contract. If deliveries do not occur until late in the month, the expiring future is not equivalent to a cash price even in the delivery month and so no such narrowing of the spread is expected.9 Thus, the expected sign of the change in the spread is negative, the sum of months with no expected change and those with a small expected decrease.

What is most interesting in the average changes reported in Table 3.2 is

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9 Chapter 4 discusses the timing of deliveries within the delivery month in detail.
the contrasting amount of average decline in the spreads in the two periods. In the pre-1980 period, the average change was negative but virtually zero. In the post-1980 era, however, the decline each month is appreciably larger on average. The range of changes for each commodity also shifted, with the largest increase in the second period smaller than in the first and the largest decline bigger.\textsuperscript{10}

The results in Table 3.2 are consistent with relatively more congestion and less liquidity in the expiring contracts in recent years being associated with the high levels of concentration noted earlier. The high concentrations in futures positions at the start of the delivery month show that large positions are regularly taken into the delivery month. With the positions of the four largest shorts multiples of the deliverable supply, not even the positions of these four traders can be settled by delivery and thus, for many, delivery is not a realistic option. Large deliveries (or the threat of large deliveries) would effect the expiring futures price (but not that of the next nearby future) thereby widening (or threatening to widen) the difference between them. Insufficient deliveries (or the lack of a threat of sufficient deliveries) mean more of the short positions in the expiring future must be offset, thereby having a tendency to narrow the price difference between the two futures during the month as seen in each market in the 1980–89 period. Moreover, the longs are aware of the dilemma the shorts in aggregate face and can therefore wait until they must trade.

A direct test of the association between concentration and price effects is possible for the somewhat more limited period of 1982–89 for which there are concentration data. Specifically, the change in the spread during the delivery month is regressed against the net concentration in the futures positions relative to deliverable stocks at the start of the month.\textsuperscript{11} Each delivery month (e.g., March, May) was also permitted to have a separate

\textsuperscript{10} The figures on the largest declines—-21.8 cents in wheat, -10.35 cents in corn, and -19.09 cents in soybeans in the recent period—are largely, but not entirely, from the last contract each cropyear, i.e., are changes in an old crop/new crop spread. If this last spread each cropyear is deleted from the data, the maximum decline in a wheat spread is -6.89 cents, but those in soybeans and corn remain unchanged. Deleting each of the old crop/new crop spreads from the series also has some effect on the averages reported in the first column in Table 3.2. The average declines in wheat and soybean spreads are reduced to only -1 cent per bushel in wheat and -1.6 cents in soybean. The average decline in the corn spread increases, however, to some -1.73 cents per bushel. Thus, neither the average nor the range of declines reported in the table are due to including the old crop/new crop spreads in the calculations.

\textsuperscript{11} The level of concentration among the largest longs is generally highly correlated with that among the largest shorts from expiration to expiration causing multicolinearity problems if the variables are included separately.
Table 3.3—The Effects of Concentration in Futures Positions on the Change in Price Spreads During the Delivery Month, Wheat, Corn, and Soybeans, March 1982–September 1989

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wheat</th>
<th>Corn</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall intercept</td>
<td>-0.774</td>
<td>-0.940</td>
<td>-0.876</td>
</tr>
<tr>
<td></td>
<td>(-1.29)</td>
<td>(-2.15)</td>
<td>(-1.01)</td>
</tr>
<tr>
<td>Additional effect in:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>-0.629</td>
<td>-2.639</td>
<td>-6.487</td>
</tr>
<tr>
<td></td>
<td>(-0.42)</td>
<td>(-2.52)</td>
<td>(-3.55)</td>
</tr>
<tr>
<td>July</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.003</td>
<td>-0.002</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(-1.67)</td>
<td>(-2.86)</td>
<td>(2.20)</td>
</tr>
<tr>
<td>Additional effect in:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>-0.038</td>
<td>-0.001</td>
<td>-0.032</td>
</tr>
<tr>
<td></td>
<td>(-3.77)</td>
<td>(-0.27)</td>
<td>(-2.40)</td>
</tr>
<tr>
<td>July</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.438</td>
<td>0.356</td>
<td>0.363</td>
</tr>
</tbody>
</table>

Source: Futures positions data were provided by the Commodity Futures Trading Commission, and deliverable stocks and prices were provided by the Chicago Board of Trade or were available in their Statistical Annuals. Price spreads are net of interest costs and adjusted for timing of deliveries. Entries in the table are from ordinary least squares regressions, and figures in parentheses are t-statistics.

effect both on the average change and on the relation with concentration. In each case, only one month had significantly different effects on either the average or the relation and the results in Table 3.3 are from regressions that include a shifter for that month. The month is identified in the table as are the separate effects and their degree of significance.

The results in Table 3.3 show that the concentration of positions among the four largest traders relative to the deliverable stocks at the beginning of the delivery month has been significantly associated with subsequent changes in the spread during the delivery month.\footnote{Similar tests were also made with the rather more limited data from the Kansas City wheat and the Comex copper markets. In both, the average (interest-adjusted) spread change was negative but virtually zero. In KCBOT wheat, there was no sign of association between changes in spreads and the degree of concentration relative to stocks. In copper, changes in spreads were associated with the degree of long and short concentration relative to stocks separately, but were not related to the net degree of concentration.}
ANNE E. PECK AND JEFFREY C. WILLIAMS

July futures, respectively. In soybeans, the association is positive overall, but most pronounced and net negative in September. Thus, the levels of concentration in futures positions relative to the available deliverable stocks in the wheat, corn, and to a lesser extent the soybean market are affecting prices during the delivery month. Generally, months with higher levels of net concentration at the beginning of the month are also those with a greater decline in the spread. The levels of concentration are measured relative to the deliverable stocks; hence, the higher the level of net long concentration, the more are the shorts required to simply trade out of their positions. Such trading in lieu of delivery (and without a threat to delivery) typically causes the spread between the expiring and the next nearby future to decline during the declining month.

CONCLUSIONS

In delivery months, the levels of concentration in futures markets as diverse as CBOT wheat, corn, and soybeans, KCBOT wheat, and Comex copper are higher than widely known, with the four largest positions on both sides of the market regularly accounting for 30 to 50 percent of the open interest remaining at the beginning of the month. The CBOT markets are different, however, because these levels of concentration in futures positions translate to multiples of the available deliverable stocks, not fractions. Ownership of the deliverable space is also highly concentrated for the three CBOT commodities, and although it has been highly concentrated for virtually the entire 25-year period analyzed here, the evidence suggests that recently there has been relatively less incentive for others to participate in the delivery system because the official fees for storage in these facilities have been at levels much greater than market returns.

A high level of concentration relative to the available stocks is, of course, always a regulatory concern because of the threat posed to orderly trading in markets. Undoubtedly, the CBOT markets have attracted significant monitoring both by the exchange and by the CFTC because of their high levels of concentration. These levels of concentration would be less worrisome, if there were no evidence that they were having significant effects on contract pricing. Unfortunately, that is not the case. Evidence in the chapter showed the price differences between the expiring and the next nearby future were regularly declining during the delivery months by substantially more than they had in the 1960s and 1970s. Moreover, the amount of the decline in a particular month was significantly associated with the level of net concentration relative to stocks. The higher the net concentration, the greater the decline in the spread. The effects were strongest in the wheat and corn markets, where concentrations among the four largest traders have been regularly 300 to 400 percent of the deliverable supply.
supplies. The effects were not as consistent in soybeans, but in at least one month each crop year the same negative relation between spread changes and concentration was noted. Perhaps the overall relation in soybeans differed because concentration levels have been averaging "only" some 200 percent of the deliverable supply. Together, the evidence in this and the previous chapter points to markets increasingly jeopardized by a paucity of deliverable supplies.
CHAPTER 4.

ECONOMIC DETERMINANTS OF THE AMOUNT, TIMING, AND LOCATION OF DELIVERIES

The preceding two chapters have examined aggregate monthly deliveries on the CBOT and other futures contracts in relation both to other measures of overall trading activity and to levels of concentration in the cash as well as the futures markets. Now the delivery process itself is considered and the extent to which various aspects of it reflect underlying economic variables is analyzed.

Delivery on the CBOT grain and soybean futures contracts is undertaken at the seller’s initiative, as in most futures contracts with physical settlement. The seller also chooses the quality, timing, and location of any deliveries. An explicit model of the simultaneous valuation of all the seller’s options involves evaluation of at least four decisions: whether, when, where, and what quality to deliver. This chapter undertakes the simpler task of describing how each decision may be explained by the economic incentives observed in the market, in other words, prices. The more successful such descriptions are, the more confidence may be placed in observed prices as guides to potential policy changes. For example, if the timing of deliveries during the month is found to be responsive to the current basis, then policies affecting the basis will also influence the timing of deliveries in the delivery month. The subsequent sections examine the amount, timing, and location of deliveries on the CBOT markets, with comparisons as appropriate. The process of delivery is described first.

1 Among physical settlement futures contracts, several of the energy futures contracts of the New York Mercantile Exchange are buyer’s option as to time of delivery.

2 The seller’s option as to which quality of grain or soybeans to deliver is not examined because available data do not indicate what qualities were delivered each month. Thus, there was no way to see how much the amount of a #3 yellow corn delivered in each delivery varied with the prevailing market price differences between #2 and #3 corn.
THE DELIVERY PROCESS

On the CBOT, delivery requires three days to complete. Holding a warehouse receipt for grain eligible for delivery (in an approved storage facility, of allowable grade, in an approved location), a firm that has an open short futures contract apprises the clearinghouse of its intention to deliver. This day is called position day. At this time, the firm also provides the clearinghouse with as much detail as possible as to the specifics of the delivery—amount, location, and grade. On the next day, notice day, the clearinghouse notifies an individual with an open long futures position that delivery is to be made. At the CBOT, purchasers are identified by the date they bought contracts that are still open, and the clearinghouse selects the individual (more precisely, the clearing member) whose position has been open longest to receive the delivery. Once notified, the purchaser may accept the notice and prepare to complete the purchase the next day, or may notify the clearinghouse of an intention to redeliver the as-yet-not-delivered warehouse receipt. If redelivery is the choice, notice day becomes a position day for the purchaser, triggering the start of another three-day sequence. Whether the notice is accepted or redelivery is initiated, the clearinghouse considers both futures positions—the seller’s and the purchaser’s—to have been closed, and the open interest is reduced accordingly at the end of the day.3

Delivery occurs on the third day, delivery day. The seller passes the warehouse receipt to the identified purchaser and payment takes place. Whether or not the purchaser intends to redeliver, payment must be made to the holder of the receipts. If the receipt is redelivered, this delivery day is also notice day for the redelivery, with payment anticipated the following day. In effect, the purchaser who redelivers must pay for at least one day’s interest (funds borrowed overnight) and warehouse fees (because the warehouse certificate must be “current” when delivered the following day), even if the redelivery is initiated on the same day the notice was received.

Delivery on the CBOT contracts may occur on any business day in the expiration month. The first delivery day for each contract expiration is the first business day of the month. Thus, the delivery process can actually begin two business days before the first business day with the “first position

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3 Exact delivery procedures vary among futures exchanges. A particularly important difference for analysts is the individual exchange’s custom for subtracting deliveries from the open interest. Comex, for example, reduces the open interest on position day, not on notice day as at the CBOT. In addition, the procedures are modified to permit more rapid delivery and redelivery at the expiration of trading.
day” and the “first notice day.” Deliveries can continue throughout the delivery month, including the last seven business days when trading in the contract has ended. Positions still open at the close of a contract’s trading must be settled through deliveries.

For each market, contract specifications include detailed descriptions of the grades, varieties, and locations of the commodity acceptable for delivery at the contract price and establish what is expected as par delivery. In addition, the specifications also include details of additional varieties, qualities, and locations that are permitted and the associated premium or discount. For example, #2 yellow is the par grade of corn that is deliverable on CBOT corn futures contracts, but #3 yellow is also deliverable at a discount to the contract price. The par delivery location is Chicago, but corn is also deliverable in Toledo and St. Louis.

THE AMOUNT DELIVERED

For a merchant with a warehouse and grain in a deliverable location, the decision to deliver depends upon the financial benefit of alternative sales opportunities. These include an outright sale with its consequent loadout of the grain (as into barges for shipment to the U.S. Gulf); delivery into the futures market; and continued storage, either hedged or unhedged, in order to sell the grain later. The gross return from an outright sale for delivery to the U.S. Gulf, for example, is the value of barged grain in New Orleans less barge freight. The gross return from delivery into the futures market is the current futures price (adjusted by premia or discounts for locations or grades), plus the official warehouse fees for storage (until the receipts are canceled), and the anticipated loadout fees is the grain when actually moved. The gross return is uncertain because it is not known in advance when the warehouse receipts against the stored grain will be canceled and shipment requested. The third alternative, to store the grain in order to sell it later, also has an uncertain gross gain, depending on the market price of storage, the interest expense, and the ultimate sales price. If currently quoted prices are good reflections of expected prices and merchants are risk neutral, deliveries will occur when they are the best sales opportunity.

Obviously, as the stocks available in the deliverable locations become greater, deliveries can grow larger. Some positive correlation between deliveries and deliverable stocks is therefore not surprising. For example, free stocks of wheat in Chicago “explained” some 35 percent of the variation in wheat deliveries in Chicago from May 1976 through May 1987. Chicago stocks of corn explained 50 percent of the variation in corn deliveries from December 1976 through September 1987, and those of soybeans 64 percent from November 1979 through September 1987. In Toledo, the comparable statistics were 28, 18, and 35 percent. If deliveries occur in response to...
comparative assessments of returns, several economic variables should also contribute to explaining the relation between stocks and deliveries. The expected returns depend upon the current basis (the cash price in the delivery location minus the expiring futures price), the carrying charge as represented by the spread to the nearby future (the price of the nearby future minus that of the expiring future), and interest costs.

The nearby futures spread represents a return of variable duration depending upon the number of months between the contract expirations, the timing of deliveries within each month, and interest rates. Calendar spreads in the wheat and corn markets are of two and three months duration; those in soybeans are of one and two months. The timing of deliveries within months varies, however. If this timing can be anticipated, it will add variability to the duration of the calendar spread. A simple anticipatory model suffices: The timing of delivery is merely associated with the sign of the more distant spreads. If the difference between the September and December futures prices (observed on September 1) is positive, deliveries will occur early in September. If the difference is negative, they will take place late in that month. Similarly, if the difference between the December and March prices (observed on September 1) is positive, December deliveries are anticipated to occur early in December. In this way, price indicators are used to measure the expected number of actual months between deliveries in order to adjust the observed price spreads to a per-month return.

Interest costs have been calculated using prime interest rates and the expiring futures price converted to a per-month cost (again, in cents per bushel). The monthly interest cost of storage together with the anticipated number of months between deliveries provide an estimate of the interest cost in the price difference between the two futures. In the final adjustments,

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4 For example, the difference in time between the September and December corn futures is three calendar months. If deliveries within each month are both early, the actual time between deliveries is also three months. However, if deliveries in the September future occur late in September, and those in December are early, the actual time between the quoted prices is only two months. If September deliveries are early and December late, the time is four months. Analysis of the timing option later in this chapter shows it is important and can be explained by price spreads. Additional analysis also shows that the timing of deliveries may be anticipated because spreads are reasonably forecastable, especially within cropyears. See Williams and Peck (1991), a previous version of which was presented at the First International Conference of the Centre for Research in Finance, IMI Group, in Rome, September 3-4, 1990.

5 Interest cost was also calculated using the 90-day Eurodollar interest rate for the substantial (but not complete) portion of the period that Eurodollar rates were available. There was virtually no difference in the results of the analyses because the two rates are so highly correlated.
variables should also and deliveries. The cash price in the due
be carrying charge as price of the nearby costs.

of variable duration contract expirations, pret rates. Calendar
three months duration
timing of deliveries anticipated, it will add
is simple anticipatory associated with the sign of
September and Defi
deliveries, deliveries will
they will take place
the December and
ember deliveries are
price indicators are
ches between deliveries
month return.

test rates and the
again, in cents per
the anticipated
ate of the interest cost
final adjustments,
ember and December
ach month are both
ations. However, if deliv-
ose in December are months. If September
ths. Analysis of the
can be explained by
of deliveries may be
cially within cropy-
which was presented
Journal of Finance, IMI

dollar interest rate
that Eurodollar rates
e of the analyses

this cost is subtracted and the net spread expressed as a per-month return
(in cents per bushel).

The interest cost, spread, and basis are measured on the first of the delivery month, and in the case of stocks, on the nearest Friday. Thus, deviations from the expected levels of deliveries do not feed back on these variables as they would if they were measured at the end of the month. Of course, the anticipated level of deliveries does influence the spread, basis, and stocks on the first of the month. Thus, regression estimates, strictly speaking, are reasonable estimates of the degree of association rather than of causality between the so-called independent variables (which are themselves related) and the dependent variable, namely the level of deliveries. Sensitive to this issue of simultaneity, prices were also measured one week (five business days) before the first of the delivery and as their average over the entire week preceding delivery. Neither of these alternatives changed significantly the results reported here.

The estimates from the basic model explaining the amount of deliveries each month are shown in Table 4.1. The analyses provide confirmation that economic variables are important in firms' decisions to deliver, although their contributions vary by commodity and by time periods. Separate results are reported for the months in which Toledo has been a delivery point. For purposes of comparison, estimates for Kansas City wheat (both original and total deliveries) and Comex copper are also reported.6

Several points deserve notice. The estimates for wheat from the pre-Toledo era clearly support the overall model. The overall explanatory power is comparatively high (an $R^2$ of 0.77), and both the (adjusted) nearby futures spread and the basis add significantly to explaining the relation between (deliverable) stocks and levels of deliveries. A larger spread is associated with increased deliveries, reflecting the more attractive market-determined returns to storage. The basis affected deliveries as expected—cash prices further above futures were associated with lower deliveries, and prices further under futures were associated with more deliveries. Interest costs had no significant effect on the amount delivered for reasons probably relating to the comparatively little variation in rates and wheat prices for

6 Estimates reported in Table 4.1 are uniformly from linear regressions for ease of interpretation. Occasionally, a different functional form provided a slightly improved fit. Tobit models were estimated for the relations in the Toledo era for both Toledo corn (where no deliveries occurred in 16 of 65 delivery months) and Toledo soybeans (where no deliveries occurred in 14 of 70 delivery months). In no case did the alternative estimates change the nature of the reported results substantively. A number of potential econometric problems were also explored and corrected, for example, serial correlation and heteroskedasticity whenever indicated. The corrected estimates did not lead to different interpretations of the results.
<table>
<thead>
<tr>
<th>Period</th>
<th>Wheat</th>
<th>Adj. nearby futures spread</th>
<th>Adjusted total free stocks</th>
<th>Interest cost</th>
<th>Basis</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964-65-1972/73</td>
<td>Chicago</td>
<td>0.59</td>
<td>-0.20</td>
<td>(1.96)</td>
<td>0.61</td>
<td>0.59</td>
</tr>
<tr>
<td>May 1976-1988/89</td>
<td>Toledo</td>
<td>0.30</td>
<td>1.28</td>
<td>(2.32)</td>
<td>1.87</td>
<td>0.50</td>
</tr>
<tr>
<td>May 1976-1988/89</td>
<td>Corn</td>
<td>0.30</td>
<td>1.50</td>
<td>(1.50)</td>
<td>1.36</td>
<td>0.50</td>
</tr>
<tr>
<td>1964-65-1975/76</td>
<td>Chicago</td>
<td>1.48</td>
<td>4.98</td>
<td>(2.27)</td>
<td>1.87</td>
<td>0.43</td>
</tr>
<tr>
<td>1976-77-1988/89</td>
<td>Toledo</td>
<td>0.47</td>
<td>1.48</td>
<td>(1.87)</td>
<td>1.36</td>
<td>0.43</td>
</tr>
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</tbody>
</table>

Table 4.1—The Influence of Economic Factors on the Amount of Deliveries
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Toledo</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicago</td>
<td>1964/65–1978/79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.19</td>
<td>-0.27</td>
</tr>
<tr>
<td></td>
<td>(2.43)</td>
<td>(-2.20)</td>
</tr>
<tr>
<td></td>
<td>1.27</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(3.28)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Toledo</td>
<td>1979/80–1988/89</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.06</td>
<td>-0.43</td>
</tr>
<tr>
<td></td>
<td>(0.39)</td>
<td>(-4.04)</td>
</tr>
</tbody>
</table>

**Kansas City Wheat**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.15</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>(1.33)</td>
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</tr>
<tr>
<td></td>
<td>0.05</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>(0.66)</td>
<td>(-1.81)</td>
</tr>
</tbody>
</table>

**Copper**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.65</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>(1.09)</td>
<td>(3.94)</td>
</tr>
</tbody>
</table>

Source: Based on data provided by the exchanges, the U.S. Department of Agriculture, or the Commodity Futures Trading Commission. Entries in the table are from least squares regressions of deliveries on the indicated independent variables and a set of intercept shifters for the individual delivery months. Figures in parentheses are t-statistics. Deliveries and stocks are measured in units of one million bushels or pounds, and prices in cents per bushel or per pound, so that the coefficients are roughly comparable across the commodities.
most of the period before Toledo became deliverable in 1973.

The results from both the corn and soybean markets before the addition of Toledo as well as the KCBOT wheat and copper markets are similar. The amount of stocks available for delivery is clearly the principal determinant of deliveries, always statistically significant at the 1 percent level. The interest-adjusted futures spread is consistently important as well. In these results, interest costs generally are also important determinants of the amount delivered, presumably because the periods over which the estimates were made had substantial variability in both interest rates and commodity prices. When variable, interest cost clearly affects delivery decisions. Finally, when it is statistically significant, the basis has the expected sign.

As indicated in Table 4.1, the model was also applied separately to deliveries in Chicago and Toledo for the period in which both were deliverable locations. The stocks variable was redefined to include only those in the specific location in the individual regressions and, in the Toledo regressions, the basis is the Toledo basis. The results are in many ways similar to those for the pre-Toledo periods in each market. Stocks in the deliverable location are the consistently most significant factor determining the amount of deliveries, but the economic variables contribute significantly as well. Interest rates are also generally significant explanatory variables, the adjusted spread is usually important, and the basis is less regularly important.

The most interesting aspect of these results, however, is in the clear contrast between Chicago and Toledo deliveries in the amount by which stocks available to be delivered in each location affect deliveries. In wheat, for example, and holding constant for the effects of the other economic variables, an additional million bushels of stocks in Chicago increased Chicago deliveries by 1.50 million bushels, whereas an additional million bushels of wheat in Toledo increased Toledo deliveries by only 0.73 million bushels. The result is consistent in all three markets—increases in stocks in Chicago increase deliveries by more than twice as much as do increases of stocks in Toledo. Because this effect is shared by all three markets, it cannot be caused by the differential discounts applied to delivery in Toledo for the

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7 Data distinguishing the location of deliveries were provided by the CBOT beginning with the May 1976 delivery. Thus, they include the entire period Toledo has been deliverable for corn and soybeans; however, the July 1973 to May 1976 period when Toledo was deliverable for wheat cannot be included in these analyses.

8 Note that for corn and soybeans in particular the coefficients reported in the table for the Toledo regressions are biased because of the number of instances when deliveries from Toledo were zero. Technically, Tobit estimators should have been used although the ordinary least squares (OLS) estimates can also be adjusted for the bias (see Kmenta, 1986, pp. 561–66, for details). They are reported here because the adjustments do not change the interpretations offered in the text.
three. More likely, it reflects the greater demand for grains and soybeans in Toledo for commercial purposes generally.

The results reported here use all the available data. Separately, estimates were made of the wheat, corn, and soybean relations in the Toledo era up through the 1986/87 crop year, and then for the last two crop years 1987/88 and 1988/89. In four of the relations, wheat and soybean deliveries in Chicago and corn deliveries in both Chicago and Toledo, there were no significant changes in the most recent two years. For wheat deliveries in Toledo, in contrast, the overall explanatory power of all the variables increased markedly in the last two years. The relation for soybean deliveries in Toledo likewise shifted in an important way, and here the change amounted to a decided switch in the contributions of specific variables to the explanatory power of the model. In 1987/88–1988/89, stocks of soybeans in Toledo did not influence the amount of soybeans delivered there; only the basis was a significant determinant of deliveries in this period. This finding stands in marked contrast to the other results reported here and the only instance when stocks were unimportant. The evidence confirms there was some change in soybean delivery patterns in these two years.

**TIMING OF DELIVERIES DURING THE DELIVERY MONTH**

The CBOT futures contracts also give the deliverer substantial choice in the flexibility of the day of delivery within the delivery month. Hoffman’s account (1932, p. 27) of the evolution of futures trading in the mid-nineteenth century indicates the one month period emerged as the standard for grain futures contracts very early; it was well-established by 1864 and became regular practice during the next four years. The patterns in soybean deliveries in May 1986 and later that same year in September 1986, shown in Figure 4.1, demonstrate the timing option is exercised. Deliveries in May 1986 were a comparatively large 16.9 million bushels, and some 30 percent of them occurred on the first business day of the month. By contrast, deliveries in September 1986 were only 0.5 million bushels, and the first delivery did not occur until the fourteenth business day in the month, just two days before the close of trading in the September contract.

The delivery patterns evident in Figure 4.1 suggest that both the day deliveries begin and their pace are important in describing the distribution during a particular month. A single number summarizing the possible configuration is provided by the area under a curve describing the complete cumulative distribution. That is, if the cumulative amounts of deliveries on the vertical axis are converted to cumulative proportions of deliveries and the business days recorded on the horizontal axis are converted to cumulative proportions of time in the delivery month, the resulting delivery pattern is the cumulative distribution, sometimes also called a Lorenz
ECONOMIC DETERMINANTS

curve.⁹ The area under a Lorenz curve is a proportional measure of the complete distribution.

The area is a proportion, since both axes in the diagram have been converted to cumulative proportions, and is called here the timing proportion.¹⁰ Cumulatively, no more than 100 percent of total deliveries can occur in 100 percent of the available days. If all the deliveries occur on the first day, the area under this curve is 1.0 and the timing proportion is 1.0. If no deliveries occur until the very last day, the area under that curve is zero and the timing proportion is 0.0. In the specific cases diagrammed in Figure 4.1, the timing proportion for the September 1986 deliveries is 0.2, a late delivery, whereas that for May 1986 is 0.8, a comparatively early delivery.

The average timing of deliveries for each of the markets is shown in Table 4.2. Perhaps the most striking aspect of these averages is their similarity. Although not indicated by the averages, the timing of deliveries on all these markets ranges widely, from nearly complete delivery in the first few days to virtually no deliveries until the end of the month. In the CBOT markets, this variation in timing affects Chicago and Toledo nearly equally. When Chicago is experiencing early deliveries, so also is Toledo, and conversely. The distributions of the timing proportion over all delivery months are skewed as well, with more early than late delivery situations. The nearly identical averages in Table 4.2 along with the other tests indicate the pattern of daily deliveries in Chicago and Toledo is essentially the same. This close relationship is important, for it means that the frequency of redelivery of the receipts issued in the two cities must also be similar.

The same economic variables that affect the amount of deliveries should also affect the seller's choice as to the timing of deliveries. The costs of delay are the interest and storage costs that the deliverer must continue to pay on stocks being held for delivery. The benefit from delay is the use, if any, to which the stock may be put in the interim. Working has termed this yield the “convenience yield”; it is the fee a firm would require in order to lend stocks to another firm for the month.¹¹ The yield is reflected in both

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⁹ Lorenz curves are widely used in describing income distributions (see Bonnen, 1968).

¹⁰ In terms of various alternative cumulative measures examined, it was most closely correlated with the proportion delivered within the first ten business days in the delivery month.

¹¹ Working defines the convenience yield and shows its effects in “The Theory of Price of Storage” (1949) and “The Theory of the Inverse Carrying Charge” (1948). In the absence of a positive convenience yield, Boyle shows deliveries will always occur as early as possible because it never pays to delay (1989). Silk develops a formal evaluation of the timing option when the convenience yield is important (1988), showing that the optimal timing of deliveries varies with the amount of the convenience yield.
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Figure 4.1—Examples of Different Timing of Soybean Deliveries

May 1986

Deliveries (thousand bushels)

Cumulative

Daily

Business Days in the Delivery Month

September 1986

Deliveries (thousand bushels)

Cumulative

Daily

Business Days in the Delivery Month

PORTANTS

The diagram have been made to show the timing proportion of soybean deliveries can occur. Deliveries occur on the first proportion is 1.0. If no curve is zero and the diagrammed in Figure deliveries is 0.2, a late date is relatively early delivery. The market is shown in the average timing of deliveries complete delivery in the middle of the month. In the Chicago and Toledo nearly delivery, so also is Toledo, where delivery is essentially the same that the frequency must also be similar.

The timing of deliveries should be examined. The costs of delay must continue to pay any is the use, if any, of damage has termed this will require in order to this is reflected in both distributions (see 

In examined, it was most

first ten business days

Effects in “The Theory of the Carrying Charge” shows deliveries to delay (1889). Silk convenience yield is varies with the
Table 4.2—The Average Timing of Deliveries in the Delivery Month

<table>
<thead>
<tr>
<th></th>
<th>Timing proportions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Period</td>
<td>Total deliveries</td>
<td>Chicago deliveries</td>
</tr>
<tr>
<td>Wheat</td>
<td>May 1976–Sept. 1989</td>
<td>0.69</td>
<td>0.69</td>
</tr>
<tr>
<td>Corn</td>
<td>Dec. 1976–Sept. 1989</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Soybeans</td>
<td>Nov. 1979–Sept. 1989</td>
<td>0.66</td>
<td>0.65</td>
</tr>
<tr>
<td>Kansas City wheat</td>
<td>Sept. 1972–Sept. 1990</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>Mar. 1976–Dec. 1989</td>
<td>0.70</td>
<td></td>
</tr>
</tbody>
</table>

Source: Based on daily delivery data provided by the Chicago Board of Trade, the Kansas City Board of Trade, and Comex. The timing proportion is the area under the Lorenz curve describing the pattern of cumulative daily deliveries in the delivery month.

The basis and the adjusted nearby spread.

Coefficients from the estimates of the relation between timing of deliveries and the three economic variables appear in Table 4.3. The clear message is that the shorts' decisions as to when to deliver respond to economic variables as expected. Deliveries are earlier the greater is the nearby spread, the lower the cash price premium relative to the futures price, and the higher the interest costs. Estimates of the timing of Toledo and Chicago deliveries separately are not provided; they did not differ especially from the results reported in Table 4.3. Similarly, there were no significant differences between these results and those for just the last two years.

Taken together, the results confirm the importance of the timing option, its wide use, and its value as reflected by the available economic variables. Indeed, these results document the need, as explained earlier in this chapter, for adjustment of the per-month spread. They also foreshadow one of the difficulties in studying basis convergence (as done in the next chapter) since the time of month by which convergence should be expected is so variable.

THE LOCATIONS OF DELIVERIES

Along with timing, the other important option included in the current CBOT contracts is where to deliver. Optional delivery points such as Toledo were added by the exchange as so-called safety valves to prevent futures prices from following an abnormal price in Chicago. With delivery possible elsewhere, the cash price in Chicago could deviate, but because Chicago would not be the delivery location that month, futures
### Table 4.3—Economic Determinants of the Timing of Deliveries Within the Delivery Month

<table>
<thead>
<tr>
<th>Period</th>
<th>Adjusted nearby futures spread</th>
<th>Basis</th>
<th>cost</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>May 1976–Sept. 1989</td>
<td>0.09</td>
<td>−0.02</td>
<td>−0.03</td>
</tr>
<tr>
<td></td>
<td>(6.11)</td>
<td>(−2.35)</td>
<td>(−0.63)</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>May 1976–Sept. 1989</td>
<td>0.18</td>
<td>−0.02</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(6.57)</td>
<td>(−1.53)</td>
<td>(0.31)</td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td>May 1976–Sept. 1989</td>
<td>0.04</td>
<td>−0.02</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(4.41)</td>
<td>(2.84)</td>
<td>(1.57)</td>
<td></td>
</tr>
<tr>
<td>Kansas City wheat</td>
<td>Total deliveries</td>
<td>0.06</td>
<td>−0.05</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Sept. 1972–Sept. 1990</td>
<td>(3.26)</td>
<td>(−4.72)</td>
<td>(3.02)</td>
</tr>
<tr>
<td>Kansas City wheat</td>
<td>Original deliveries</td>
<td>0.08</td>
<td>−0.05</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Sept. 1972–Sept. 1990</td>
<td>(3.36)</td>
<td>(−4.49)</td>
<td>(3.52)</td>
</tr>
<tr>
<td>Copper</td>
<td>March 1976–Dec. 1989</td>
<td>0.45</td>
<td>n.a.</td>
<td>−0.73</td>
</tr>
<tr>
<td></td>
<td>(7.83)</td>
<td>(−2.50)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources: Based on data provided by the exchanges or available in their yearbooks or from the U.S. Department of Agriculture. Entries in the table are the coefficients and R²'s are from logistic regressions. The dependent variable, the timing proportion, is expressed as the log of the ratio of proportions. Regressions also included a set of shifters for the various delivery months. Figures in parentheses are t-statistics.
prices would converge to the cash price in the alternate location. It appears that the CBOT intended to set the discounts for Toledo deliveries at the same relative level in all three markets, so that 70-75 percent of the deliveries would continue in Chicago. The principal analyses underlying the choice of specific premiums or discounts were studies of the differences in cash prices between the two locations.\textsuperscript{12} Implicit in these studies is the belief that the differences in observed prices between the two locations affect the choice of a delivery location.

A direct evaluation of the effects of the current system of discounts is to examine the distribution of deliveries themselves. In all, the focus is on the role of Toledo as an alternate delivery point. Toledo was added to the wheat contract in July 1973, to the corn contract in December 1976, and to the soybean contract in November 1979. For corn and soybeans, the analysis covers the entire period Toledo has been a deliverable location. For wheat, the first three years of Toledo deliveries are excluded because CBOT data identifying location do not begin until May 1976. The analysis also ignores the role of St. Louis as a delivery location for corn, although it was added with Toledo as an alternative location in the December 1976 contract changes. There have been no deliveries in St. Louis since July 1981. Between December 1976 and July 1981, deliveries in St. Louis were as much as 10 percent of total deliveries on only three occasions, in September of 1977, 1978, and 1979. The maximum amount of a St. Louis delivery was only 4.9 million bushels. Clearly, the present analysis is not unduly affected by excluding these deliveries. Figure 4.2 presents the distributions of the proportions of each month’s total deliveries that were in Toledo for each of the three commodities. For example, of the 68 delivery months in wheat from May 1976 through September 1989, eight were months when 5 percent or less of the total deliveries were in Toledo. At the other extreme, deliveries in two months were between 85 and 90 percent in Toledo and in two months between 95 and 100 percent. For corn and soybeans, the distributions are much more skewed. Some 25 of the seventy soybean delivery months from November 1979 through September 1989 were months where less than 5 percent of the total deliveries were in Toledo. In corn, 32 of 65 delivery months occurred with less than 5 percent of the total in Toledo.

Two messages are apparent from the distributions in Figure 4.2. First, the delivery months from the last two crop years, which are indicated in the figures with the lighter portion of the bars, do not differ substantially from

\textsuperscript{12} Similarly, each of the CBOT’s Studies has a chapter that presents the annual distributions of price differences between Chicago and Toledo. The distributions are examined for consistency, the current discount for Toledo delivery is compared to how frequently differences of more than that amount were observed each year, and then the level of difference that would account for 75 percent of the observation is also calculated.
Figure 4.2—Distributions of the Percentage of Deliveries in Toledo

ANNE E. PECK AND JEFFREY C. WILLIAMS

The diagram shows the distributions of the percentage of deliveries in Toledo for different months and years for wheat, corn, and soybeans. The percentage is measured on the x-axis, and the number of expirations is measured on the y-axis. The data are divided into three groups: May 1976-May 1987, July 1987-September 1989, and December 1976-July 1987 for wheat. For corn, the groups are December 1976-July 1987 and September 1987-September 1989. Soybeans have two groups: November 1979-September 1987 and November 1987-September 1989.

The diagram illustrates that the distribution of deliveries in Toledo varies significantly between different time periods. For wheat, the distribution is relatively even across the percentage range for the May 1976-May 1987 period, but it becomes more concentrated in the lower percentage range in the following periods. For corn, the distribution is more concentrated in the lower percentage range in the December 1976-July 1987 period, and for soybeans, the distribution is more even across the percentage range in the November 1979-September 1987 period compared to the November 1987-September 1989 period.
those from the preceding years. Thus, the analyses of economic determinants of the delivery location include all the data. Second, Toledo has been a source of deliveries much more variably than was apparently intended, by almost any measure of “significant deliveries,” if the CBOT was trying to treat each commodity similarly. For example, to conclude that Toledo was a significant source of deliveries only 25 percent of the time in the wheat market, only months in which Toledo deliveries were more than 55 percent of the total could be counted. In corn, the count would include months where Toledo deliveries were more than 25 percent of the total; in soybeans, the cutoff would be 30 percent. Put differently, deliveries of wheat in particular have been much more evenly distributed between Chicago and Toledo, suggesting Toledo is more nearly a multiple delivery location, not a safety valve. By contrast, corn and soybean deliveries were much more concentrated in Chicago, the pattern expected when the second location is a safety valve.

The tests of the responsiveness of deliveries to relative price incentives are summarized in Table 4.4. The proposed explanatory variables are only two, because the purpose is in explaining the amount of deliveries in Toledo relative to those in Chicago, that is, the proportion each delivery month originating in Toledo. Neither the total level of stocks nor the interest cost affect deliveries differentially and so neither is included in these regressions. The principal economic determinants of the location of deliveries should be, first, the difference in price between Chicago and Toledo (called the Chicago cash premium in the table) and second the Toledo basis. Both were computed as of the first of the delivery month using the U.S. Department of Agriculture’s series for the two locations.

The first row of results for each commodity attempt to explain the proportion of the total deliveries each month that occurred in Toledo. The overall lack of explanatory power of the difference in price between Chicago and Toledo is striking and is one of the most surprising findings of this study. For none of the commodities was this difference—the Chicago cash premium—related at all to the proportion delivered in Toledo. That is, delivery months with USDA’s reported cash prices in Toledo a great deal below those in Chicago were no more associated with relatively large deliveries in Toledo than were ones with Toledo prices close to or even above those in Chicago.

The lack of relation in the statistical results is readily evident in Figures 4.3, 4.4, and 4.5 where the percentage of total deliveries in Toledo each month is plotted against the difference in price between Chicago and Toledo. On each figure, the vertical line indicates the price difference at which Toledo is the cheaper source of the commodity. In Figure 4.3 for wheat, it

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13 Moreover, both stocks and interest costs were included in preliminary analyses of the location decision, but they were never significant.
of economic determinants. Second, Toledo has been apparently intended, by the CBOT was trying to exclude that Toledo was one time in the wheat more than 55 percent included in months of the total; in soybeans, deliveries of wheat between Chicago and delivery location, not deliveries were much more second the location is relative price incentive.

Table 4.4—Economic Determinants of the Location of Deliveries

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Toledo basis</th>
<th>Chicago cash price premium</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total delivery in Toledo</td>
<td>-0.07</td>
<td>-0.01</td>
<td>0.09</td>
</tr>
<tr>
<td>Proportion of first day delivery in Toledo</td>
<td>-0.17</td>
<td>-0.08</td>
<td>0.22</td>
</tr>
<tr>
<td>Corn: December 1976–September 1989</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of total delivery in Toledo</td>
<td>-0.27</td>
<td>0.09</td>
<td>0.20</td>
</tr>
<tr>
<td>Proportion of first day delivery in Toledo</td>
<td>-0.33</td>
<td>-0.05</td>
<td>0.27</td>
</tr>
<tr>
<td>Soybeans: November 1979–September 1989</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of total delivery in Toledo</td>
<td>-0.19</td>
<td>-0.08</td>
<td>0.16</td>
</tr>
<tr>
<td>Proportion of first day delivery in Toledo</td>
<td>-0.22</td>
<td>-0.10</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Source: Based on data provided by the Chicago Board of Trade or available in their Statistical Annual, or in the U.S. Department of Agriculture's weekly, Grain Market News. Coefficients and R²'s are from logistic regressions where the dependent variable, the proportion of deliveries in Toledo in a specific month, is expressed as the log of the ration of proportions. Regressions also include a set of shifter variables for the individual delivery months. Figures in parentheses are t-statistics.

is at a Chicago cash price premium of 2 cents per bushel. If location were the only option in the contract, all points to the right of the vertical line are points where the premium of the cash price in Chicago is more than 2 cents above the price in Toledo, Toledo would be the cheaper source of supplies for delivery, and the observed deliveries should all be along the top of the figure showing that 100 percent of them were in Toledo. Similarly, all points to the left of the vertical line are cash premiums less than 2 cents, Chicago would be the cheaper source of supply, and all deliveries should be from Chicago. All observations should be along the bottom of the figure, showing 0 percent delivered in Toledo. In Figure 4.4 for the corn market, the vertical line is at 4 cents and in Figure 4.5 for soybeans it is at 8 cents. As is evident, in each figure, there is no association between...
Figure 4.3—The Relation Between the Location of Deliveries of Wheat and Relative Cash Prices, May 1976–September 1989

Figure 4.4—The Relation Between the Location of Deliveries of Corn and Relative Cash Prices, December 1976–September 1989
the price differences and the observed delivery percentages each month, the visual confirmation of the statistical results in Table 4.4.\footnote{Moreover, the estimates of Table 4.4 are from logistic regressions, an approach chosen specifically to accommodate the expected shape of the relation.}

Although no similar formal tests were attempted, the CBOT’s Studies also presented data clearly showing the lack of relation between price differences and deliveries. In the 1986/87 crop year in soybeans, for example, the CBOT Soybean Study noted that the USDA soybean prices in Toledo were no more than 7 cents below those in Chicago 95 percent of the crop year. Separately, it reported that Toledo accounted for some 46 percent of the deliveries in the September 1986 contract, some 64 percent in November, and more than 75 percent in each of the January, March, and May contracts. These are surely not percentages consistent with the price differences indicating Chicago was nearly continuously the cheaper location at which to deliver.

Because the results in Table 4.4 and Figures 4.3–5 were so unexpected,
a large number of variations on the model and data were explored. In particular, concern centered on whether the prices reported by the USDA were representative of values in Chicago and Toledo. Thus, a number of alternative representations of value were assembled, compared to the USDA series and then included as possible reflections of economic determinants of the location of deliveries. Among the alternate representations of value in Chicago were U.S. Gulf export values (where the cost of barge freight from Chicago to the Gulf was subtracted from the price of the barge commodity in the Gulf), and for corn, the series of the highest bid prices in Chicago, as published in the *New York Times*. The Andersons in Toledo provided a long series of their weekly basis bids for soybeans. None of these alternative measures of prices proved to be associated with the location of deliveries each month.

With relative cash prices apparently unimportant in the location of deliveries, it is further surprising that the Toledo basis explains to even a small degree the location of deliveries, as indicated by its consistent sign and statistical significance in Table 4.4. This result is not strong, but it does suggest that deliveries are not totally unresponsive to relative prices—here, the difference in price between the expiring future and the cash price in Toledo.

Of course, the location option is not the only option the terms of the contracts give to the seller. As has been seen, the timing option is very important as well, both in theory and in fact.\(^{15}\) To examine the extent to which the simultaneity caused by the two options was effecting the results because the delivery proportion was measured over the entire month, the delivery proportion was redefined to be just the proportion of the deliveries on the first day that were delivered in Toledo. The explanatory variables were already prices as of the first day and thus required no change. The results of these regressions are in the second row in Table 4.4 for each commodity, and there is an improvement in the explanatory power of the model. For each, the Toledo basis increases in importance as a factor in explaining the location and, in both wheat and soybeans, the cash price differential between Chicago and Toledo also increases in importance.

Thus, some part of the explanation for the observed lack of relation between the location of deliveries and the cash price differential is the interaction of the location and timing options.\(^{16}\) This is surely not the entire explanation, however, as no result in Table 4.4 shows that more than one-third of the observed variation in the location of deliveries is explained. As for additional factors explaining the lack of relation, the evidence at hand

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\(^{15}\) It is precisely this joint valuation problem that both Boyle (1989) and Silk (1988) solved.

\(^{16}\) Additional analyses also explored whether any of the other price series improved the explanation of first-day deliveries. None was noted.
is less clear. Other analyses clearly indicated the delivery decisions were rational in both their amount and their timing. Thus, other factors besides price must be significant determinants of the location decision. Whether the paucity of available stocks from which to make deliveries and thereby change the price difference observed in the markets to that dictated by the economic model is one of those determinants is beyond the scope of these analyses.

CONCLUSION

Taken together, these analyses indicate that the reported price differences between Chicago and Toledo are not associated with the location of deliveries as well as expected. This finding stands in contrast to the behavior of the level and timing of deliveries, which are sensitive to observable prices. Prices presumably do matter to the location of deliveries, and some hint of their relation was noted when only first-day deliveries were analyzed. Even so, the results suggest how futile it is to examine the price differences themselves to determine whether 2 cents, 4 cents, or even 8 cents is the discount that will lead to a specific desired distribution of deliveries. There appears to be some information in the delivery patterns themselves, but the reported prices provide little guide to the appropriate level of discounts. The distributions, shown in Figure 4.2, indicate Toledo deliveries have been much more regular in wheat than in corn and soybeans. Thus, the wheat contract has operated much more nearly as a multiple-delivery-location contract, whereas the corn and soybean contracts have remained effectively Chicago deliveries with safety-valve deliveries in Toledo.
CHAPTER 5.

BASIS CONVERGENCE
AND HEDGING EFFECTIVENESS

Most commercial users of futures markets are concerned with the predictability of the convergence of cash and futures prices. Indeed, the subject of deliveries is important to them because deliveries are the mechanism forcing convergence at deliverable locations and by extension establishing predictable relations at many other locations. Of course, the difference between a particular cash price and the futures is the basis. Hence, a study of convergence is a study of basis behavior.

Basis behavior can be looked at from several perspectives. If, for example, in early October the local cash price of wheat is 20 cents per bushel under the December futures contract, it matters considerably to the return actually realized from holding hedged stocks whether the local cash price is 5 cents under or 5 cents over the expiring futures contract as of mid-December. That is, what matters is how well the change in the basis (measured against the December contract) from early October to mid-December matches the original basis. Put differently, what matters is how well the basis as of early October predicts the change in the basis.\(^1\) Clearly, if the original basis predicts exactly the subsequent change, the basis risk is zero. This measure also has the advantage of taking into account the size of the initial basis, so that basis changes from 80 cents under can be compared easily with those from 20 cents under.

The same issue of basis predictability also arises in the setting of regulatory oversight and contract design. For example, an extreme positive basis is often taken as an indication of market congestion. Such a characterization of the basis presupposes a standard of comparison from earlier periods. It also requires that any movements in cash prices relative to an

\(^1\) Holbrook Working (1953) emphasized the importance of the predictability of basis changes and proposed the tests used here.
expiring futures contract be examined against the size of the basis some weeks or months before. If, on the first of December, cash is 20 cents over the December futures price, the interpretation of that basis as indicating congestion is very different should the basis in early October have been 80 cents over rather than 15 cents over. The degree to which the early October basis predicts the change in the basis to early December is a method for making this standardization.

These examples also illustrate why calculation of the average basis pattern such as was done in the CBOT Studies is virtually meaningless, whenever the average is over many contract months and many years. With both positive and negative initial bases and both good and relatively poor convergence in any reasonable sample, the average basis path is likely to be close to zero and the relative convergence behavior not revealed. Nor does it help much to divide the sample between situations with an initial positive basis and an initial negative basis; these averages measure basis convergence from, say, 80 cents over, by the same criterion as from, say, 10 cents over. These difficulties explain why the CBOT's Studies found no statistically significant evidence of convergence in the prices they examined.

Thus, in the case of a deliverable location, the central hypothesis is whether the basis converges to 0 cents (or a similar predictable constant such as the load-out fee) by the expiration of each futures contract, that is, whether the current basis is an exact forecast of the subsequent change. However, the measurement of and, more specifically, the predictability of basis convergence are not straightforward. In the remainder of this chapter, the methodological issues are discussed in three applications of increasing complexity. The first section briefly discusses basis convergence for forward contracts and then studies the actual KCBOT wheat basis, which adds the complication of delivery timing inherent in futures contracts. The second section discusses the expected effects of multiple delivery locations and then analyzes the degree of basis convergence for each of the three CBOT markets.

For other than deliverable locations, the hypotheses about basis behavior are more varied. One hypothesis deals with the degree of basis convergence by the delivery month. The path of the basis over that period is important, too, because holders of stocks at non-deliverable locations must at some moment close out or roll forward their futures positions. As a result, they are subject to basis risk. In turn, any unpredictable movements in the basis reduces hedging effectiveness. Thus, a second hypothesis concerns the hedging effectiveness of the CBOT markets, specifically whether there has been a decline during recent years. This hypothesis is tested with data on weekly prices, from September 1966 through July 1989, for eight elevators in Illinois for corn and soybeans. The third section of this chapter presents those tests.
CONVERGENCE AND EFFECTIVENESS

THE EFFECTS OF THE TIMING OPTION ON BASIS CONVERGENCE

The ability of a basis to forecast the subsequent change in basis would be perfect were there no ambiguity in the quoted cash price and no complexity due to the options in the three CBOT futures contracts to deliver any day within a month or to deliver at more than one location. Forward trading of lead at the London Metal Exchange (LME) permits no timing option for delivery on its contracts and only limited location variation. Thus, it provides the least complicated example to explain expected basis behavior. Every day the official ring session on the LME establishes a spot price and a price for a contract to deliver in 90 days. Although the value of that forward contract is not publicly quoted again, it is sometimes traded among the member firms privately, as it becomes successively a contract for delivery in 89 days, 88 days, and so on. On its final day, the expiring forward contract is effectively a spot contract. That is to say, at expiration of a forward contract, the basis is 0 pounds sterling. (The difference between the spot price and the new 90-day forward contract is another matter, of course.) Convergence is complete at expiration and the previous basis predicts exactly the change in the basis. Graphically, all points plotting the change in the basis over a 90-day interval against the previous basis fall on a line with a slope of $-1.00$. If, however, the cash price used were not the LME’s own spot price, the exact relationship with the expiring forward contract would not be assured.

Futures contracts add first the complexity of an option in the timing of delivery, and, for most grains and soybeans, the difficulties of a spot quotation other than for the commodity in store. The Kansas City wheat contract illustrates well the effects of these difficulties. The cash market in Kansas City is relatively active, especially compared to Chicago. The KCBOT’s Grain Market Review provides a number of cash quotations, including a high and low range for Ordinary Wheat, which has the protein content closest to that commonly delivered on futures contracts.\(^2\) The low of the range appears to be the one more closely related to futures prices.

For this cash price series, the basis relative to the next futures contract was calculated as of the first business day of each month during which a contract expired. Its changes both to the first day of the delivery month and then to the next-to-last day of the month were also calculated.\(^3\) Thus, for each of 91 wheat contract expirations from September 1972 through

\(^2\) Recorded as a low and a high basis, these two quotations, when converted to flat prices, are closely related (but not identical) to the USDA’s reported range of Kansas City prices for hard wheat.

\(^3\) As in the earlier calculations of changes in spreads, the last day of trading is not used because the close is not simultaneous with other contracts.
September 1990, there are two pairs: the change in the basis from the first of the prior contract's expiration to the next-to-last trading day with the basis on that prior first day, and the basis change to the first of the month with that basis on the prior first day. These are plotted in Figure 5.1. The top panel plots the basis change to the first of the delivery month against the earlier quotation of the basis while the bottom panel plots the change to the end of the month against the same earlier basis.

The scatter diagram in the lower panel involving the basis change to the end of trading reveals there is a good forecast of basis change in the Kansas City basis. More precisely, the variable Previous basis "explains" 89 percent of the variation in the subsequent change in the basis, as can be seen in the $R^2$ given in the upper right of Table 5.1. Although the points do not fall exactly on a line parallel with the diagonal, they come very close to doing so; specifically the estimated slope is $-0.88$. The standard error of the regression, 6.00, is in units of cents per bushel, and represents the degree of basis risk.

Although when fitting a regression line one speaks of an "error term," the differences between the predicted change in the basis and the actual change in the basis from these regressions represent not measurement error but substantive economic factors. In particular, the cash price here is not as precise as in the forward market example. The premiums for protein may change or the spread between wheat in store and wheat on track may narrow. These protein premiums, elevating spreads, and transport rates may also have predictable seasonal components. In Table 5.1, the middle regressions allow for regular variability in these components by including a set of dummy variables for the four contract months after the new-crop July contract. The $R^2$ for the change in the basis to the next-to-last day of trading increases slightly to 0.91.

Although the inclusion of seasonal dummy variables does not change the conclusion about the degree of basis convergence involving the Kansas City wheat contract, measuring the change in basis only to the first of the delivery month does have a dramatic result, as shown in the upper panel of Figure 5.1. The points in the upper panel are more scattered than those in the lower panel and more off the anticipated line with its slope of $-1.00$. More precisely, as can be seen in the first column of Table 5.1, the estimated slope is $-0.70$, and the previous basis predicts only 72 percent of the variation in the change in the basis. Likewise, the standard error of the regression is greater, 8.74 cents rather than 6.00 cents per bushel, which represents some 46 percent more basis risk. If basis convergence were measured only to the first of the month, which is the common practice, the conclusion might well be drawn that the Kansas City wheat contract has a problem.

Thus, the principal conclusion of the example of Kansas City wheat
Figure 5.1—The Relation Between the Previous Kansas City Wheat Basis and the Change in the Basis, September 1972–September 1990

Change in Basis to First Day of Delivery Month (cents per bushel)

Change in Basis to End of Trading in Current Delivery Month (cents per bushel)
Table 5.1—Kansas City Wheat, Regressions Explaining the Change in the Basis, September 1972-September 1990*  

<table>
<thead>
<tr>
<th></th>
<th>To first of month</th>
<th>To end of trading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simple regressions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>7.25</td>
<td>6.68</td>
</tr>
<tr>
<td></td>
<td>(7.32)</td>
<td>(9.85)</td>
</tr>
<tr>
<td>Previous basis</td>
<td>-0.70</td>
<td>-0.88</td>
</tr>
<tr>
<td></td>
<td>(-14.97)</td>
<td>(-27.53)</td>
</tr>
<tr>
<td>R²</td>
<td>0.72</td>
<td>0.89</td>
</tr>
<tr>
<td>Regression standard error</td>
<td>8.74</td>
<td>6.00</td>
</tr>
<tr>
<td><strong>Regressions with seasonal shifters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.25</td>
<td>2.28</td>
</tr>
<tr>
<td></td>
<td>(-0.12)</td>
<td>(1.51)</td>
</tr>
<tr>
<td>September</td>
<td>4.83</td>
<td>4.03</td>
</tr>
<tr>
<td></td>
<td>(1.77)</td>
<td>(2.03)</td>
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<tr>
<td>December</td>
<td>11.45</td>
<td>7.02</td>
</tr>
<tr>
<td></td>
<td>(3.98)</td>
<td>(3.38)</td>
</tr>
<tr>
<td>March</td>
<td>9.24</td>
<td>4.36</td>
</tr>
<tr>
<td></td>
<td>(3.40)</td>
<td>(2.22)</td>
</tr>
<tr>
<td>May</td>
<td>10.11</td>
<td>5.05</td>
</tr>
<tr>
<td></td>
<td>(3.84)</td>
<td>(2.65)</td>
</tr>
<tr>
<td>Previous basis</td>
<td>-0.65</td>
<td>-0.84</td>
</tr>
<tr>
<td></td>
<td>(-13.57)</td>
<td>(-24.31)</td>
</tr>
<tr>
<td>R²</td>
<td>0.78</td>
<td>0.91</td>
</tr>
<tr>
<td>Regression standard error</td>
<td>7.90</td>
<td>5.71</td>
</tr>
<tr>
<td><strong>Regressions with seasonal shifters and delivery timing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>7.56</td>
<td>3.81</td>
</tr>
<tr>
<td></td>
<td>(2.53)</td>
<td>(1.65)</td>
</tr>
<tr>
<td>September</td>
<td>5.77</td>
<td>4.21</td>
</tr>
<tr>
<td></td>
<td>(2.22)</td>
<td>(2.11)</td>
</tr>
<tr>
<td>December</td>
<td>11.47</td>
<td>7.03</td>
</tr>
<tr>
<td></td>
<td>(4.24)</td>
<td>(3.38)</td>
</tr>
<tr>
<td>March</td>
<td>9.06</td>
<td>4.33</td>
</tr>
<tr>
<td></td>
<td>(3.55)</td>
<td>(2.20)</td>
</tr>
<tr>
<td>May</td>
<td>8.10</td>
<td>4.66</td>
</tr>
<tr>
<td></td>
<td>(3.18)</td>
<td>(2.38)</td>
</tr>
<tr>
<td>Previous basis</td>
<td>-0.74</td>
<td>-0.86</td>
</tr>
<tr>
<td></td>
<td>(-14.06)</td>
<td>(-21.07)</td>
</tr>
<tr>
<td>Delivery timing</td>
<td>-13.17</td>
<td>-2.58</td>
</tr>
<tr>
<td></td>
<td>(-3.45)</td>
<td>(-0.88)</td>
</tr>
<tr>
<td>R²</td>
<td>0.81</td>
<td>0.91</td>
</tr>
<tr>
<td>Regression standard error</td>
<td>7.44</td>
<td>5.71</td>
</tr>
</tbody>
</table>

*The basis, in cents per bushel, is the low of the range provided by the Kansas City Grain Market Review. Figures in parentheses are t-statistics.
is that the issue of timing within the delivery month itself is central to any study of price convergence. An indirect indication of the influence of the pattern of deliveries within the month is the greater importance (as measured by the increase in $R^2$) in the regressions listed in Table 5.1 of the seasonal dummy variables, because these are associated with the frequency of price inversions. A more direct test is provided by including in the regressions the variable Delivery timing, which is the timing proportion variable defined and analyzed in Chapter 4. When Delivery timing has a low value, deliveries are late in the month. If convergence is also late, so that the change in the basis to the first of the month is not as large as forecast by the previous basis, the coefficient on Delivery timing should be negative and statistically significant. This is precisely what happens, as can be seen in the regressions reported at the bottom of Table 5.1. By contrast, the variable Delivery timing adds no explanatory power in the regressions that involve the change in the basis to much later in the month as shown in the comparative results in the lower right-hand column in Table 5.1.

BASIS CONVERGENCE FOR THE CBOT CONTRACTS

In addition to timing and possible changes in the economic content of the cash price, analyses of basis convergence of CBOT contracts must account for the variation in location of deliveries described in Chapter 4. Over the period during which both Toledo and Chicago have been deliverable, cash prices in any one location should not be expected to converge to the futures price in all months. If Toledo is the principal delivery location during a particular month, cash prices in Chicago may differ significantly from the futures price. Similarly, the Toledo cash price should be expected to move more independently of the futures price whenever the futures contract is effectively a Chicago delivery contract. The lack of convergence of a particular basis in any particular month, therefore, need not indicate a problem with the contract, but the natural workings of a contract with more than one delivery point.

Consequently, the location of actual deliveries should be an important factor in explaining the change in the basis, whether the Chicago basis or the Toledo basis. Should deliveries be predominantly in Toledo, one would expect the Chicago basis to have narrowed less, if previously over the futures, or to have gone from under to over, if previously under. Two measures of possible location effects are available, the actual proportion of deliveries in Toledo and the cash price difference between Chicago and Toledo. The proportion is the preferred measure because it reflects the effects of the relative price incentives throughout the delivery month, at least in theory. Evidence in the preceding chapter showed, however, that this theoretical expectation is not met by the actual delivery data. There-
fore, a second measure, the observed price difference, is also used in later analyses to evaluate more precisely the effects of multiple delivery on basis convergence. Specifically, the difference in cash prices between Chicago and Toledo on the first of the delivery month is included with the previous basis to explain the change in basis. This Chicago premium should be positively related to the change in the Chicago basis and negatively related to the change in Toledo.

To examine basis convergence at the CBOT’s deliverable locations, the cash price series to be used was first identified. The results reported here all come from analyses using the USDA quotations in Chicago and Toledo. Whenever a range was reported the midpoint was calculated. These quotations are not ideal for tests of basis convergence because they are processors’ bid prices. Nevertheless, they are the prices that are routinely examined whenever there are regulatory or market performance concerns. In addition, analyses not reported here made use of a number of other measures of value in Chicago and Toledo with no important changes in the conclusions.4

The results of the statistical estimates are in Table 5.2. For each of the three commodities, Table 5.2 is organized to make possible comparisons when Toledo was and was not a deliverable location in addition to Chicago. For each of the two eras is shown the coefficients and R² of a regression relating the change in the basis to the previous basis and the variable Percentage (delivered) in Toledo (if relevant). Although not reported, the regressions also included a set of seasonal dummies and constant, identical to those in Table 5.1.

The figure for each commodity presents the scatter of points that would correspond to a simple regression for that commodity. Each figure, such as Figure 5.2 for wheat, shows the relations using Chicago cash prices. (Comparable figures for Toledo cash prices look much the same.) In each, the top panel plots the relationship for the change in the basis to the first of the delivery month and the bottom panel the change in the basis to the next-to-last trading day. The data for the figures cover the Toledo era, including the more recent crop years, which have the empty square rather than cross markings.

Inspection and comparison of these tables and figures suggest six conclusions, the first four of which pertain to the operation of a contract with two deliverable locations. First, there appears to be less predictable basis convergence in Chicago during the Toledo era, even accounting for the

4 For Chicago, alternative wheat, corn, and soybean prices were constructed from the USDA’s Gulf quotations and prevailing barge rates which were provided by the Consolidated Grain and Barge Company. For corn, a “best bid” series for Chicago was provided by CPC International. Finally, the Andersons provided Toledo bid prices for all three commodities for a substantial period of time.
Table 5.2—The Changing Degree of Predictability in the Basis at the End of Delivery Months

<table>
<thead>
<tr>
<th></th>
<th>Pre-Toledo era</th>
<th>Toledo era</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chicago</td>
<td>Chicago</td>
</tr>
<tr>
<td><strong>Wheat</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous basis</td>
<td>-1.03</td>
<td>-0.88</td>
</tr>
<tr>
<td></td>
<td>(-11.35)</td>
<td>(-15.04)</td>
</tr>
<tr>
<td>Percentage in Toledo</td>
<td>8.01</td>
<td>4.06</td>
</tr>
<tr>
<td></td>
<td>(1.70)</td>
<td>(0.98)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.86</td>
<td>0.85</td>
</tr>
<tr>
<td>Regression standard error</td>
<td>2.94</td>
<td>9.90</td>
</tr>
<tr>
<td><strong>Corn</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous basis</td>
<td>-1.23</td>
<td>-0.90</td>
</tr>
<tr>
<td></td>
<td>(-14.75)</td>
<td>(-17.86)</td>
</tr>
<tr>
<td>Percentage in Toledo</td>
<td>-1.50</td>
<td>1.46</td>
</tr>
<tr>
<td></td>
<td>(-0.37)</td>
<td>(0.33)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.87</td>
<td>0.87</td>
</tr>
<tr>
<td>Regression standard error</td>
<td>3.69</td>
<td>6.02</td>
</tr>
<tr>
<td><strong>Soybeans</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous basis</td>
<td>-0.82</td>
<td>-0.72</td>
</tr>
<tr>
<td></td>
<td>(-18.71)</td>
<td>(-11.54)</td>
</tr>
<tr>
<td>Percentage in Toledo</td>
<td>11.97</td>
<td>14.83</td>
</tr>
<tr>
<td></td>
<td>(2.39)</td>
<td>(3.11)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.84</td>
<td>0.79</td>
</tr>
<tr>
<td>Regression standard error</td>
<td>8.36</td>
<td>8.70</td>
</tr>
</tbody>
</table>

*The basis is derived from the U.S. Department of Agriculture's series for cash prices in Chicago and Toledo, taken variously from the Chicago Board of Trade Statistical Annuals, USDA's weekly Grain Market News, and the Minneapolis Daily Market Record. Regression standard errors are in cents per bushel. All regressions include a constant and intercept shifters for the various delivery months. Figures in parentheses are t-statistics.

The proportion delivered each month in Toledo. That is to say, the $R^2$'s in the regressions are the same or lower in this period, and more important, the standard errors are higher. For example, for soybeans the $R^2$ in Table 5.2 of the regression for the change on the basis to the end of the month is 0.79 in the Toledo era versus 0.84 in the pre-Toledo era. The increase in

5 It is particularly important that these comparisons were made with the change in basis to the end of the month because it is not affected as much by the timing of deliveries within the delivery month.
Figure 5.2—The Relation Between the Previous Chicago Wheat Basis and the Change in the Basis

Change in Basis to First Day of Delivery Month (cents per bushel)

Change in Basis to End of Trading in Current Delivery Month (cents per bushel)

Figure 5.3—The Relation Between the Previous Chicago Corn Basis and the Change in the Basis

Change in Basis to First Day of Delivery Month (cents per bushel)

Basis at First of Previous Delivery Month (cents per bushel)

Change in Basis to End of Trading in Current Delivery Month (cents per bushel)

Basis at First of Previous Delivery Month (cents per bushel)

+ May 1976–May 1987

□ July 1987–September 1989
Figure 5.4—The Relation Between the Previous Chicago Soybeans Basis and the Change in the Basis

the standard error of the regression from 8.36 cents to 9.02 cents, although small, tells the same story. And although the pre-Toledo era for corn includes the turbulent years 1972–74, the standard error of 6.02 cents in the Toledo era is substantially larger than 3.69 cents.

Second, the change in the Toledo basis to the end of the month is more predictable, as measured by the $R^2$, and the discrepancy at the end of the month less variable, as measured by the standard error, than the change in the Chicago basis for wheat and soybeans, while for corn the evidence is weak in the other direction. For example, for soybeans the $R^2$ for the regression involving the seasonal shifters is 0.85 for Toledo and 0.78 for Chicago. These relative $R^2$'s suggest for wheat and soybeans either that Toledo, not Chicago, is the more relevant cash market from the perspective of the futures contract or that the USDA cash quotations for Chicago are less representative of market values than those for Toledo.

The third pattern is evidence of systematic effects in the nature of the USDA quotations. The variable Percentage (of deliveries) in Toledo has the expected positive sign in explaining the change to the end of the month in the Chicago wheat and soybean basis. The same variable, however, has a positive effect rather than the expected negative effect in explaining the changes in the Toledo basis. (It has no measurable effect on corn.) The implication is that a component of the USDA’s quotations for wheat and soybeans, which are processors’ bids, is related to the factors that lead to delivery in Toledo.

The effect of Toledo as a possible delivery location on the behavior of Chicago prices can perhaps be seen more directly in Table 5.3. The data behind this table measure the change in the basis only to the first of the month. A comparison of the first two columns would suggest a marked deterioration in basis convergence, more so than seen in Table 5.2. For example, the $R^2$ for corn declined from 0.86 to 0.66. But much of this apparent decline can be attributed to the natural workings of a contract with a month-long delivery window with more than one delivery location. Adding the Chicago premium over Toledo, which should indicate where deliveries are most likely and hence to which cash price the futures is most closely related, and the variable Delivery Timing to the regression, shows most of the deterioration in convergence is precisely the effect of these embedded. This evidence with prices is stronger than with the deliveries themselves and works in the anticipated direction: When the Chicago premium is large, the Chicago basis is more over (or less under) the futures than otherwise, and when the deliveries are late the basis convergence is less. Thus, the fourth conclusion is that study of basis convergence must allow for the effects of location and timing of deliveries, although when convergence is measured to the next-to-last trading day, only the effects of the location needed be included. In this instance, they explain a large part of the apparent decline.
in basis convergence at Chicago.

The fifth conclusion may be so obvious as to be overlooked. Although the performance by era, location, and commodity are different, the previous basis is always a significant explanatory factor. Just as it should account for location and timing, any discussion of whether cash and futures prices have converged should account for the magnitude of the original basis. The CBOT's Studies amount to a regression specification with a dummy variable for whether or not the previous basis was positive and several weekly shifters in the context of explaining changes in the basis. It should not be surprising that this specification had so little explanatory power. It should also be clear that any conclusions about basis convergence derived from such a specification are dubious, because of the problems resulting from omitting the most important explanatory variable, the previous basis.

Sixth and finally is the answer to the question whether the two most recent crop years have behaved differently, or more precisely, whether the predictability of basis changes has decreased. The empty boxes are the observations for 1987/88–1988/89 in Figures 5.2, 5.3, and 5.4 allow a visual test of this question. (A more formal statistical test for structural change yields the same answer.) This period is indistinguishable from the earlier years in the era of Toledo deliveries. The impression of later and more problematic convergence in the last two crop years may be explained by the clustering of the points for the most recent period toward the lower right of the figures. (The clustering is even more pronounced when 1985/86 and 1986/87 are added to the definition of the most recent period.) Disproportionately, the last few years have been characterized by markets with inverse carrying charges late in the crop year. When the basis is positive, convergence should be expected to be later in the month than when the cash price is under the futures price.

BASIS BEHAVIOR AT NON-DELIVERABLE LOCATIONS

The previous section was concerned with basis behavior at official delivery locations. Most users of futures markets, however, are commercial firms at other locations. This section examines basis behavior and hedging effectiveness at some of them.

The evidence could begin with a study of the previous basis forecasting the change in the basis at each of these locations, but it would mainly serve to reiterate the points made earlier. The available data suggest a slightly different approach. These data are series of weekly (Thursday) corn and soybean prices at eight different elevators in Illinois, as well as weekly USDA quotations for Chicago, Toledo, and the Gulf. They cover, for most of the elevators, September 1966 through July 1989.6

6 These data have also been used by Thompson, Hauser, and Eales (1990.)
CONVERGENCE AND EFFECTIVENESS

Table 5.3—The Changing Degree of Predictability in the Chicago Basis at the First of Delivery Months*

<table>
<thead>
<tr>
<th></th>
<th>Pre-Toledo era</th>
<th>Toledo era</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wheat</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous basis</td>
<td>-0.90</td>
<td>-0.63</td>
</tr>
<tr>
<td></td>
<td>(-12.50)</td>
<td>(-11.10)</td>
</tr>
<tr>
<td>Chicago premium</td>
<td></td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.50)</td>
</tr>
<tr>
<td>Delivery timing</td>
<td></td>
<td>-15.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-1.80)</td>
</tr>
<tr>
<td>R²</td>
<td>0.89</td>
<td>0.78</td>
</tr>
<tr>
<td>Regression standard error</td>
<td>2.34</td>
<td>9.92</td>
</tr>
</tbody>
</table>

| **Corn**      |               |            |
| Previous basis| -0.90         | -0.69      | -0.79       |
|               | (-12.36)      | (-9.84)    | (-12.60)    |
| Chicago premium|             | 0.83       |             |
|               |               | 6.16       |             |
| Delivery timing|             | -12.32     |             |
|               |               | (-2.60)    |             |
| R²            | 0.86          | 0.66       | 0.81        |
| Regression standard error | 3.21 | 8.38 | 6.43 |

| **Soybeans**  |               |            |
| Previous basis| -0.75         | -0.62      | -0.69       |
|               | (-17.78)      | (-8.08)    | (-9.84)     |
| Chicago premium|             | 0.77       |             |
|               |               | (5.21)     |             |
| Delivery timing|             | -20.50     |             |
|               |               | (-2.38)    |             |
| R²            | 0.83          | 0.65       | 0.77        |
| Regression standard error | 8.05 | 10.72 | 8.85 |

*The basis is derived from the U.S. Department of Agriculture’s series for cash prices in Chicago and Toledo, taken variously from the Chicago Board of Trade Statistical Annuals, USDA’s weekly Grain Market News, and the Minneapolis Daily Market Record. Regression standard errors are in cents per bushel. All regressions include a constant and intercept shifters for the various delivery months. Figures in parentheses are t-statistics.
A conventional measure of hedging effectiveness is the (squared) correlation coefficient between changes in the cash price and changes in the futures price. Presumably, the more closely the cash and futures prices change together, the more useful the futures contract is at reducing the risk of price changes. Put another way, the lower the correlation, the greater the basis risk. A simple correlation has a number of defects as a measure of hedging effectiveness—not least because the theory was developed for deliverable locations and the application is to other places—but many, including the CBOT's Studies, use it because of its simplicity.\footnote{Kahl (1983) shows how many definitions of hedge ratios rely on the simple correlation.}

Thus, this long series of cash prices at the 11 locations permit tests of changes in hedging effectiveness. More specifically, they have been broken into (sometimes overlapping) segments, each covering the 12 Thursdays before the first delivery day of a futures contract.\footnote{If fewer than 11 prices were recorded over the 12-week intervals, say, because of holidays, the correlation was not computed. These instances are not random—they come disproportionately from 1973 and 1974 and similar periods of inversion.} The correlation of the changes week to week in the cash price with the relevant futures is computed. Except for the overlap when the contracts are closer than twelve weeks, this exercise corresponds to perpetually rolling forward a hedge just before the first notice day and recording contract by contract the resulting hedging effectiveness for each period. It creates a time series of correlation coefficients, which are shown in the upper panel of Figure 5.5 for the soybean prices from an elevator in Macoupin County, which is southwest of Springfield, Illinois.

The series of correlation coefficients, such as in the upper panel of Figure 5.5, still contain much information. Table 5.4 compresses the information to more manageable amounts. It gives the average of the correlations involving just the March contracts (that is, those computed every year for the 12 weeks before March 1) and the July contracts (that is, those computed every year for the 12 weeks before July 1). The number of correlations is up to 46, depending on the elevator.\footnote{Correlations, of course, cannot be above 1.00; the occasional low correlation pulls the average down. The median may be a better indication of the typical correlation, but the conclusions are the same.} The March and July contracts do not have substantively different averages for any of the 11 locations. Both have higher averages than the last old-crop or first new-crop contracts, where the occasional year of steep price inversion disconnects the cash price from the new-crop futures prices.\footnote{Measured 12-week correlations are inversely related to the basis prevailing at the start of the period, as would be expected. An implication of this relationship,
CONVERGENCE AND EFFECTIVENESS

Figure 5.5—Hedging Effectiveness of the Chicago Board of Trade Soybean Contract for a Country Elevator in Macoupin County, Illinois

The (squared) correlations 

and futures prices 

reducing the risk 

of the soybean 

prices—were 

but many, 

7

and 

12 Thursdays 

the 

futures is 

closer than 

hedge just 

the 

resulting 

prices of correlation 

Figure 5.5 for the soy-

is southwest of 

The upper panel of 

the image of the corre-

computed every 

(that is, those 

March and July 

of the 11 

or first new-crop 

disconnects the 

years with 

on the simple 

narrow periods of inversion. 

low correlation 

the typical 

basis prevailing at 

relationship, 

and without Toledo delivery. For corn, some of the 11 locations have an apparent increase in hedging effectiveness and others slightly less. (None is markedly different from Chicago itself.) For all elevator locations, the hedging effectiveness of the soybean contract appears to have been higher in the Toledo era than during 1966/67–1978/79. The soybean series of the elevator in Macoupin County in Figure 5.5 is typical in this respect. As can be seen in that figure, the performance during 1987/88–1988/89 seems barely different, although there is a small decline around 1985–87, as is true for other elevators' soybean prices. This decline may explain why concern arose over the hedging effectiveness of the soybean contract. From 

however, is that a study of hedging effectiveness, like one of basis convergence, should standardize for the degree of price inversion.
Table 5.4—Average Hedging Effectiveness*

<table>
<thead>
<tr>
<th></th>
<th>Corn Pre-Toledo era</th>
<th>Corn Toledo era</th>
<th>Soybeans Pre-Toledo era</th>
<th>Soybeans Toledo era</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Illinois country elevators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whiteside County</td>
<td>0.79</td>
<td>0.79</td>
<td>0.85</td>
<td>0.89</td>
</tr>
<tr>
<td>Boone County</td>
<td>0.79</td>
<td>0.81</td>
<td>0.83</td>
<td>0.90</td>
</tr>
<tr>
<td>Knox County</td>
<td>0.84</td>
<td>0.80</td>
<td>0.82</td>
<td>0.89</td>
</tr>
<tr>
<td>Kankakee County</td>
<td>0.78</td>
<td>0.81</td>
<td>0.82</td>
<td>0.91</td>
</tr>
<tr>
<td>Champaign County</td>
<td>0.87</td>
<td>0.91</td>
<td>0.82</td>
<td>0.95</td>
</tr>
<tr>
<td>Macoupin County</td>
<td>0.78</td>
<td>0.84</td>
<td>0.85</td>
<td>0.92</td>
</tr>
<tr>
<td>Effingham County</td>
<td>0.69</td>
<td>0.83</td>
<td>0.80</td>
<td>0.92</td>
</tr>
<tr>
<td>St. Clair County</td>
<td>0.84</td>
<td>0.88</td>
<td>0.84</td>
<td>0.87</td>
</tr>
<tr>
<td><strong>Terminal elevators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicago</td>
<td>0.77</td>
<td>0.81</td>
<td>0.94</td>
<td>0.95</td>
</tr>
<tr>
<td>Toledo</td>
<td>0.79</td>
<td>0.88</td>
<td>0.88</td>
<td>0.95</td>
</tr>
<tr>
<td>Gulf</td>
<td>0.80</td>
<td>0.78</td>
<td>0.80</td>
<td>0.92</td>
</tr>
</tbody>
</table>

*Figures in the table are the average correlation of changes in weekly prices with the futures for the 12 weeks preceding the March and July contracts, in the years 1967–89. Futures prices are from Chicago Board of Trade Statistical Annuals or provided by the exchange; Illinois county elevators’ prices were provided by the University of Illinois; and terminal elevators’ prices are from the U.S. Department of Agriculture’s weekly Grain Market News.

A longer perspective, one that includes the late 1960s and early 1970s, the hedging effectiveness of the soybean contract, as represented by the correlation coefficient, was above average. The changes in measured hedging effectiveness of the soybean futures contract may be attributable to substantive changes in the wider market rather than the specifics of the contract. In the late 1970s and early 1980s strong export demand through the Gulf dominated the structure of prices. That is not to say that prices at the many interior points did not change week to week relative to Chicago or the Gulf, but rather that each location was firmly in the web of prices. This may explain why the correlations for the Macoupin County elevator and others were higher in the Toledo era, and from 1978 through 1983 in particular. In periods of less export activity, such as the late 1960s and late 1980s, or in periods with major government programs, local conditions are proportionately more important. Because each local price moves rather more independently, the measured hedging effectiveness of a futures contract with delivery at one or two locations is lower. But under such circumstances, the decline is not due to the design of the contract as much as changing patterns in the entire market.
A second problem is also apparent in using correlation coefficients as measures of hedging effectiveness. In Table 5.4 for corn and soybeans in Chicago, the average correlation is higher for the Toledo era. Yet the detailed study of basis convergence discussed in the previous section found the opposite. The implication is that correlation coefficients are not especially reliable indicators and that little should be read into small differences in them.

To determine whether changes of pattern in the entire market or the specifics of contract design are more to blame for declines of hedging effectiveness requires information about the whole spatial configuration of prices. This is the same information needed to determine, for example, that a single location's price is "out of line" (an allegation made in every manipulation case). Inspection of the prices themselves offers little evidence of their being out of line without comparison to the prevailing costs of transportation such as barge rates, which quite reasonably change continuously. The point at issue can be seen in the lower panel of Figure 5.5, which shows the difference in the Macoupin County elevator's soybean cash price from Chicago (or Toledo). The series is highly variable—there is some basis risk—but it is impossible to say that any one price is "wrong," without information on the direction of soybean shipments and on the cost of transportation.11

In sum, there is no pronounced evidence of a long-term decline of the hedging effectiveness of the corn and soybean contracts in the weeks prior to the delivery period. There is some evidence of a temporary decline in the period approximately 1985–87, but this decline is small compared to situations in the late 1960s or early 1970s. The results are also clear that the specific measure of hedging effectiveness is itself not sensitive enough to detect the changes caused by adding Toledo to the contract.

HEDGING EFFECTIVENESS AND MULTIPLE DELIVERY POINTS

A frequent proposal for reform of the three CBOT contracts is to add delivery points, the approach already adopted in adding Toledo. Such changes in the possible locations for delivery would not increase hedging effectiveness for all users of the contract. The effects would vary markedly by location.

Although no one is proposing adding a delivery location on the Pacific Coast, the potential effects on specific firms are most easily seen by considering such an extreme.12 To describe such an extreme situation,

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11 In passing, it is worth noting in the lower panel of Figure 5.5 that this Illinois elevator's price in the Toledo era is not recognizably more in line with Chicago than with Toledo.

12 The idea is not without precedent, however. Pacific Coast delivery points
imagine a commodity that is exported to Europe through Chicago and to Asia through Pacific Coast ports and that is grown everywhere in between. A futures contract might be designed to permit delivery at both locations (whether at par or at a discount is immaterial), or it might permit delivery at only one location. If multiple delivery is the choice, Chicago would be the delivery location in practice when prices there were lowest, as for example when export demand from Europe was low. Those elevators and processors in the interior near Chicago would find that their local prices would move closely to the Chicago price during this period; the futures contract would be an effective hedging mechanism for them. By contrast, those elevators nearer the Pacific Coast would find that changes in the futures price would be largely uncorrelated with movements in their own cash prices. Those elevators and processors in some middle region would sometimes be connected to Chicago and sometimes not. In contrast, in crop years when export demand is relatively low through the Pacific, and prices there are lowest, the futures contract would be effectively one with Pacific Coast delivery. Those nearer the Pacific coast would find their prices highly correlated with the futures price during these periods whereas those near Chicago would find the contracts' hedging effectiveness low.

Compared to a single delivery point, the contract with either Chicago or the hypothetical Pacific Coast delivery is not universally preferred. Obviously, those near Chicago would prefer a contract restricted to Chicago delivery. Those near the Pacific Coast would prefer a contract with Pacific Coast delivery, although they might prefer a contract with both locations than one with just Chicago. Only those in the middle region might prefer the multiple location contract to any other configuration. More generally, any redesign of the contract terms would not mean an improvement in trading terms for all firms.

In the real world, the web of locational differences is much more complex, and, as analyses here have shown, it is extremely difficult to assess the effects of contract changes on specific basis patterns. The more closely linked by transport and commodity flows are the market locations being considered as additional delivery locations, the less pronounced will be the effects on basis convergence and hedging effectiveness as seen by firms in specific locations. But, even for locations so closely linked as Toledo and Chicago, analyses here demonstrated the addition of Toledo did affect the degree of basis convergence in Chicago. More generally, any additional options conferred by the futures contract, if they are at all valuable, will affect basis convergence and hedging effectiveness.
CONCLUSIONS AND RECOMMENDATIONS

This study was undertaken because of widely shared concerns that the CBOT's three principal agricultural futures contracts were not performing well. At various times, market participants have expressed specific worries about matters as diverse as declines in hedging effectiveness, illiquidity, perplexing price patterns, and allegations of manipulation. All point to concern about the specific terms of the contracts. Hence this study focuses on deliveries and on the price patterns just before and during the period of contract expiration.

The prevailing wisdom has been that deliveries are an insignificant aspect of futures markets; indeed, that large deliveries are a symptom of a contract in trouble. As the analyses here show, the prevailing wisdom is in need of significant modification. Many futures markets, including the CBOT wheat, corn, and soybean markets, have delivery on the order of 10 to 20 percent of peak open interest. Moreover, of those positions still outstanding on the day just before the delivery period, as many as 50 percent are satisfied through actual delivery.

Deliveries on the three CBOT markets appear to be rational, in the sense that they respond to observable economic incentives. Not surprisingly, the amount of deliveries in any one month is primarily connected to the amount of free stocks in the deliverable locations. Thus, the amount of deliveries is both directly and indirectly influenced by the observed carrying charge, with the smallest levels of delivery occurring in periods of price inversions and lowest stocks. The influence of stocks and of the carrying charge is also true for the level of deliveries in Chicago and Toledo taken separately. The timing of deliveries within the delivery month also follows the rational pattern that a theory of "embedded options" would suggest. Shorts take advantage of their option to deliver late in the month whenever carrying charges are negative, and conversely. In these relationships, the spread between the expiring and next futures is generally a stronger influ-
ence than is the basis, although the latter does contribute to explaining the amount and timing of deliveries for some of the commodities.

In addition to the practical importance of deliveries and their connection to economic fundamentals, a number of other relations have been examined, including that between stocks of wheat, corn, and soybeans in deliverable locations and so-called visible supplies and nationwide stocks. Similarly, the degree of basis convergence has been looked at, especially in Chicago and Toledo. Using weekly prices from eight country elevators in Illinois, the degree of hedging effectiveness has been examined, as conventionally measured by the correlation between changes in futures prices and local cash prices, of the corn and soybean contracts.

In all these comparisons, one question was whether they had changed in the 1987/88 and 1988/89 crop years in particular, or in the 1980s more generally. Although there is some evidence of change in some of the measures in 1987/88 and 1988/89 compared to the early 1980s, this effect is not pervasive. Changes in averages among all the periods are also hard to identify statistically because of the variability in the series themselves. For example, relations among the various stocks measures and among all the periods were quite variable and, in soybeans the 1987/88 and 1988/89 relations differed too. But, even though basis convergence changed with the addition of Toledo, convergence in the 1987/88 and 1988/89 crop years did not appear to be different from that in the 1980s more generally. Hedging effectiveness (as measured by correlation coefficients) in the soybean market in the last few years was found to be lower compared to the early 1980s, but it was higher than the average achieved over the whole period 1967–89.

Rather than a period of sudden and marked changes in performance, the late 1980s might be more accurately characterized as continuing long-term trends, ones dating to the 1960s if not earlier. A number of these trends are worrisome. For example, the degree of basis convergence for prices in the principal delivery location appears to have worsened in the 1980s compared to the 1960s. To be sure, most of measured decline in convergence is the effect of multiple delivery on the basis in any one of the delivery locations. Nevertheless, holding constant the effect of adding Toledo, basis convergence in Chicago has deteriorated from the 1960s to the 1980s.

Deliveries on the three CBOT contracts have also been increasing as a percentage of deliverable stocks. Often total deliveries in a month are more than 100 percent of deliverable stocks (which obviously reflects the redeliveries present in the statistics). Even deliveries on the first business day, which must all be original deliveries, are often 50 percent or more of deliverable stocks. More important, both these first-day deliveries and the total deliveries are now much higher proportions of deliverable stocks.
CONCLUSIONS

than observed for either KCBOT wheat or Comex copper or for the CBOT commodities themselves in earlier eras. The suggestion has been made that such high ratios reflect the greater efficiency of CBOT stocks in settling contracts. Quite apart from the disruption if someone should decide to hold onto receipts rather than redeliver them, other evidence suggests an interpretation that stocks are simply too low.

The CFTC has provided the positions of the four largest longs and the four largest shorts day by day for each of the CBOT grain and soybean expirations over 1982–89 and for the KCBOT wheat and Comex copper expirations over 1985–89. In all five of these markets, the four largest longs together and the four largest shorts typically account for more than 40 percent of the open interest as of the first position day. Where the CBOT markets differ is that the positions of the largest traders are much larger than the current deliverable stocks. Almost every expiration, the four largest longs together have a call on and the four largest shorts have commitments to deliver much more than the available stocks. The average for both wheat and corn is a multiple greater than three. For soybeans, they are more than two times the available stocks. Although some of these positions are regularly settled by exchanges against physical market positions, the positions are of such a size relative to the stocks that delivery or even the threat of delivery is no longer a credible alternative to a sufficient number of the short positions.

The paucity of stocks in deliverable locations does not result from a direct constraint on warehouse capacity. Rather, total stocks of wheat, corn, and soybeans in Chicago and Toledo in recent years have not filled listed capacity, although percentages are slightly higher than those from earlier years. Rather, grain is not being attracted to Toledo and, even more so, to Chicago. One such reason may be that the official price of warehouse space (4.8 cents per bushel per month) is now relatively higher than the market’s value of that space, as reflected in the maximum interest-rate-adjusted spreads observed each year. Although this gap between official and market prices of binspace may place the warehouse operators an incentive to deliver (to put receipts out on the street), it places other participants at an increasing disadvantage in holding stocks, which may preclude them from remaining in the market until the delivery period. In any case, it is not obvious why the official fee should remain constant for many years when almost nothing else in the grain trade does. Indeed, the fee was raised comparatively frequently during the 1970s as the differentials observed in the market seemed to dictate. In the 1980s by contrast, the market differentials have been declining steadily, but there have been no comparable adjustments in fees.

According to other evidence, the (interest-adjusted) spreads in the 1980s compared to earlier periods have tended to narrow during the course
of delivery months. Moreover, the amount of the narrowing each month was found to be significantly associated with the net concentration of the largest traders at the beginning of the month. This evidence also suggests that the contracts are increasingly jeopardized by the comparatively low stocks. Deliveries directly and movements of grain into deliverable positions indirectly should, if anything, increase spreads. Instead, spreads regularly narrow. The high degrees of concentration mean the large shorts cannot all deliver, and thus the longs can wait until the shorts trade out of their positions and affect prices.

Fundamentally, the paucity of deliverable stocks arises because of the inexorable decline of grain terminal markets, Chicago in particular. The CBOT contracts calling for delivery in Chicago elevators emerged in the halcyon days when the area tributary to Chicago was the dominant grain growing region in the United States and when most grain in the region passed through Chicago elevators. The trend has been downward for the 100 years since, with important effects especially in the last 20 years. The area near to Chicago is responsible for less production in percentage terms, and in the case of soft wheat, in absolute terms. Likewise, less and less grain and soybeans in percentage terms passes through any Great Lakes port.

Two specific reforms, additional terminal market delivery points and cash settlement, have been proposed. Given the causes of the problems with the CBOT contracts, neither would work. An additional terminal location, namely Toledo, has already been tried and with some success. The corn contract also added St. Louis as well, but there have been no deliveries in St. Louis since July 1981. (With a different discount, of course, St. Louis might have been more useful.) But among the terminal markets at all close to Chicago, Toledo is by far the largest in terms of receipts and stocks; the obvious candidate has already been selected. More important, the primary terminal markets together have been suffering declines in receipts as fast or faster than Chicago. Less and less grain and soybeans are marketed through them as sales are more and more from farmers directly to processors and other merchandisers.

Toledo was conceived of as a safety valve to Chicago, and discounts were set for Toledo delivery that would discourage delivery there unless Chicago cash prices rose to an unusual premium. The corn and soybean markets apparently work this way in practice; during many expirations Toledo deliveries are a small share of total deliveries. In wheat by contrast, in most expirations neither Toledo nor Chicago dominates. The result of any change in the official discounts is hard to predict. The existing discounts were set by reference to the USDA cash quotations. Yet these same USDA quotations, which are processors' bids, are not strongly associated with the observed patterns of delivery. Hence, analysis with these quotations will
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not help the exchange or the regulators set more appropriate discounts.

The fundamental decision, however, must be whether Toledo should be a safety valve for Chicago or whether it should be a true multiple delivery location. If it is desired as a safety valve only, then the present discount in wheat surely needs to be increased. If, however, Toledo is expected to play a regular delivery role for all these markets, the evidence suggests the present corn and soybean discounts need to be decreased.

A second proposal, cash settlement, presumes a deep and active cash market, from which reliable quotations can be taken. Yet active cash markets have been the first casualty of the decline of terminal markets. Even now it is not clear how many transactions occur at any of the posted prices—or, what size transaction would cause them to change. What would discipline firms who now provide the nominal bids to the USDA, inasmuch as they are not obliged to transact at those prices? The potential for manipulation—and nearly as disruptive, allegations of manipulation when none occurred—would be greater with cash settlement than even physical delivery. The experience of the stock index futures is instructive here, where the securities markets, which are many times broader and deeper than the cash grain and soybean markets, were not broad or deep enough to prevent significant congestion at contract expiration. To substitute for liquidity in any one cash market, some have suggested an index-type settlement including prices from many locations in the index. But this is no solution: When each price can easily be influenced, the entire index can be influenced.

Instead, it would seem important for all the participants to take the opportunity to rethink the need to deliver grain in store. At one time, the warehouse receipt was the only method of delivery. But the plethora of commodities now traded on exchanges has led to important innovations in settlement terms. One possibility might be to design terms for barge delivery, incorporating aspects of a call on production. Another possibility, which might be considered if the Gulf were to become the principal delivery location and where the elevators are primarily used for throughput, would be to model the delivery terms on the New York Mercantile Exchange's crude oil and heating oil contracts. Delivery is at a loading terminal or pipeline, at buyer's option as to time of lifting, with one month's notice given.

More to the point, the CBOT now has the remarkable advantage that many different forms of delivery mechanisms have been incorporated into contract terms. Their existence provides officials with the laboratory that has already tested the effects of various provisions. How well, for example, do contracts settled with a call on production encourage storage during periods of surplus and discourage it in shortage? Have the terms of the petroleum contracts performed this function, too? The specific questions that need to be addressed are best known to the exchange and the partic-
ipants. Many alternatives could be analyzed with experience gained from other contracts.

Finally, in almost all circumstances, a completely new contract would not compete well with the existing contracts, because the existing contracts would retain the overwhelming advantage of greater liquidity and familiarity at the beginning. Such a problem plagued the launching of the CBOT's Gulf-delivery contract in the 1970s. Whether or not a better design, it never attracted enough trading to challenge the existing contract's liquidity. Change in contract terms will not be easy; but, the evidence here leads to the conclusion both short-term adjustments are needed and that the search for long-term solutions should begin.
CITATIONS


APPENDIX: DATA SOURCES

DELIVERIES

Aggregate deliveries on CBOT futures contracts each month were assembled from the CBOT Statistical Annuals for 1964 through 1985. From 1986 on, the data were published in the CBOT Statistical Supplements. Public Affairs at the KCBOT provided delivery data for the KCBOT wheat contracts between 1972-90. Deliveries on Comex contracts were taken from their annual Statistical Yearbooks, 1977-89.

The records of daily deliveries identified by location on CBOT contracts were provided by the Economic Analysis and Planning Department at the CBOT for the period May 1976 through September 1989. These data were used in the calculation of the timing of deliveries and to identify the location of deliveries when multiple locations were possible. The daily data did not always aggregate to the totals reported in the Statistical Annuals, although in most cases the differences were comparatively small. Obvious errors in either series were discarded. Daily delivery records for Kansas City wheat were provided by the KCBOT. Comex Statistical Yearbooks contain these data for copper.

FUTURES MARKET POSITIONS

Volume and open interest data were taken variously from CBOT Statistical Annuals, the Wall Street Journal (noting that WSJ reports are always “as of the previous day”), and daily computerized records provided by the Economic Analysis and Planning Department at the CBOT. Comex data were available in their Yearbooks. Volume and open interest data for the KCBOT wheat market were taken from the Kansas City Grain Market Review, a daily publication.

Data on the concentration of futures positions during the delivery month were provided by the CFTC. These data covered CBOT wheat, corn, and soybean contract expirations from 1982 through September 1989. The data are daily reports of the positions in the expiring contract of the four largest traders on both the long and short sides of the market for a period 5
days before the first delivery day through the last trading day in the expiring contract month. The only exception is for January soybeans where the records for the five days prior to the first delivery day could not be included due to problems in the data records at the CFTC when crossing calendar years. The CFTC also provided concentration data for Kansas City wheat and Comex copper for the 1982–89 period. Inspection of their records from 1982, 1983, and 1984 revealed significant reporting problems, and the data appeared not to be very reliable. Thus, only the 1985–89 data were used in the comparative analyses.

PRICES

Cash prices examined in the analyses of the wheat, corn, and soybean markets are primarily USDA-reported price series for Chicago and Toledo. They were compiled from the USDA, Agricultural Marketing Service, *Grain and Feed Market News* (formerly *Grain Market News*), Weekly Summary and Statistics, 1964–89. Use was also made of the CBOT *Statistical Annuals* for reports of the same price series; however, the *Annuals* contained numerous errors, especially in more recent years. Neither the USDA nor the CBOT reported daily cash market prices before 1970. The *Wall Street Journal* and the Minneapolis *Daily Market Record* have been referred to for Chicago prices on the specific days required by the analyses of this period.

Gulf prices for hard and soft wheat, corn, and soybeans were also taken from the USDA publication. The series were “Export Offers Prompt or 30 Day Shipment, Delivered Port” in the Gulf and, when distinguished, the barge quote was used. If ranges for these prices were reported, these were recorded. Preliminary analyses indicated the mean of the range was as good a measure of value in most of the analyses. A separate series of cash corn prices, daily 1973–90, in Chicago were provided by CPC International, Inc. They are the best, posted Chicago cash price bids for #2 yellow corn, daily 1973–90, and are published in the *New York Times*. The Andersons provided weekly (Wednesdays) basis bid prices in Toledo, 1977–89, for wheat, corn, and soybeans and weekly FOB Toledo values for soybeans from 1985–90. Cash prices for wheat in Kansas City were taken from the Kansas City *Grain Market Review*.

Weekly barge freight rates on the Upper Illinois River were provided by Consolidated Grain and Barge Company, and when combined with Gulf prices, the rates permitted construction of an export price series for Chicago. The University of Illinois provided its weekly record of corn and soybean prices at some 13 separate elevator locations in the state. The records date to 1967 for the most part, and those from eight locations were judged to be complete enough to permit detailed analysis of their relations to futures prices.
STOCKS

Visible supplies are total stocks at selected terminal and elevator locations, reported weekly by the Agricultural Marketing Service of the USDA in "Stocks of Grain at Selected Terminal and Elevator Sites." Until 1986, these data were also reported in the CBOT Statistical Annuals. The latter was used as the principal source, although care was taken to select the observations so that they were consistently for the Friday closest to the beginning of each month. From 1986–89, data were taken from the USDA publication directly. Quarterly national stocks are reported regularly in the USDA's Wheat Situation and Feed Grain Situation; the USDA provided a convenient summary of the series needed.

Chicago free stocks of grain were constructed from various tables in the CBOT Statistical Annuals or Supplements. For 1964–69, the Annuals report "Free Stocks" directly. For 1970–89, the Annuals report "Total Stocks in Chicago" and "CCC Stocks in Chicago." These tables, however, have consistently indicated that no CCC stocks were in Chicago (or Toledo) since the 1970s. In spite of their titles and associated notes, data in the tables in fact report free stocks in Chicago and Toledo, not totals. There were substantial quantities of CCC stocks in Toledo and Chicago during the 1980s, confirmed by the CFTC weekly "Stocks of Grain" reports. When total stocks in Chicago or Toledo were needed, resort was made to the CFTC and USDA stocks publications. Stocks of wheat in Kansas City were provided by the KCBOT or were found in the Grain Market Review; warehouse stocks of copper are in the Comex Statistical Yearbooks.