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The Economic Role of Traditional Commodity Futures Markets
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The concepts and techniques of futures trading have recently been introduced to markets for commodities vastly different from the agricultural markets in which the system of trading first developed and to which it was largely constrained for nearly 100 years. In fact, metals futures markets were the only exceptions to the agricultural bounds of futures trading until 1972 and the introduction of currency futures markets. The de facto bounds arose in part from a regulatory vacuum. Before 1974 futures trading was regulated by the Commodity Exchange Authority (CEA), a bureau in the U.S. Department of Agriculture. The CEA did not regulate the introduction of new futures markets, nor did it regulate futures markets other than those for domestic agricultural products (and it regulated those only after the initiation of trading had been shown to be a success).

The absence of an explicit regulatory authority for all futures trading meant that innovative proposals in new products had to be approved by the regulators, if any, of the underlying markets. The original proposal of the Chicago Board of Trade (CBT) in the late 1960s and early 1970s to begin a futures market in securities issues is illustrative. The CEA had no interest in the proposal; but, since the proposal involved securities, the Securities and Exchange Commission (SEC) was interested. Indeed, the SEC asserted regulatory authority over the proposal and rejected it. A revised submission from the CBT proposed an organized options market for individual securities. The proposal could not be rejected on the grounds that options markets were themselves new, and a pilot program was finally approved. The Chicago Board Options Exchange (CBOE) began

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trading in 1973, several years after the initial CBT proposal to trade futures on securities.

Similarly, many of the new futures markets in financial instruments would not have been feasible before the Commodity Futures Trading Commission (CFTC) was created and given exclusive regulatory jurisdiction over all futures trading. Proposals for new markets no longer needed the explicit approval of the agencies responsible for regulation in the underlying market, although the CFTC has been very receptive to their reviews of contract proposals. It is not surprising that each proposed new market has attracted substantial concern—a concern that goes beyond the perceived infringement of regulatory authority. The Federal Reserve and the Treasury, for example, were concerned over the effects futures markets in government issues might have on their ability to finance the federal debt and to conduct monetary policy. More recently Congress voiced concern over the possible effect of futures markets in the financial instruments, particularly in stock indexes, on the process of capital formation.

The perception underlying the concerns is not misplaced, even though the concerns are often attempts to constrain the exclusive regulatory jurisdiction of the CFTC as well. If a new market is successful, it will be so because firms within the market find it useful. Commercial firms' use of the new futures market will affect their businesses and may thus have profound effects on the process of price discovery or risk management within the industry. Many of the same concerns have been expressed virtually every time a new market has been introduced. With more than 100 years of experience, the agricultural markets have provided extensive evidence on the economic effects of futures markets, and a summary of that experience is a useful beginning to understanding present concerns.

A second reason for this assessment of the role of the more traditional futures is simply their continuing importance. In 1970 a mere 12.6 million futures contracts were traded on the principal commodity exchanges. Grains and oilseeds accounted for more than 60 percent of the total and livestock and food products for virtually all the rest. In 1983 some 137.2 million contracts were traded, a more than tenfold increase. Although much of the growth in trading is accounted for by the new markets for financial products, the traditional markets also contributed impressively to the total industry growth. Trading in grains and oilseeds, for example, increased more than fivefold in the fourteen-year period, livestock futures trading increased fourfold, and trading in food products more than doubled. Major growth and innovation occurred in trading in industrial commodities, with new and increasingly successful contracts in

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petroleum products and sustained growth in copper futures trading. Finally, trading in precious metals, primarily silver and gold, contributed substantially to total market growth. Taken together, these commodities accounted for 88 million of the 137.2 million contracts traded in 1983, approximately 64 percent of the total.

The purpose of this chapter is to summarize the evidence and experience from traditional markets on the effects of futures trading on commodity markets and pricing. The assessment begins with a discussion of the evolution of futures markets and their role in the marketing of agricultural products. The principal participants—commercial firms and speculators—and their characteristic uses are then introduced. From these descriptions an assessment of the economic effects of futures markets begins. A consideration of their effect on storage decisions and hence on intertemporal commodity prices is followed by an assessment of their effect on basic commodity production and consumption decisions. Finally, the specific effects of speculation are considered.

The chapter is not a review of the literature, although its debts to that literature will be made clear. Many important lines of investigation, especially much of the fairly recent theoretical modeling of alternative market structures and assumptions, are not mentioned because they do not bear directly on the questions at hand. Similarly, not all studies bearing on the specific issues discussed here are mentioned. The references are meant to be illustrative, not exhaustive.[1] This chapter seeks to explain the important purposes for which futures markets have come to be used in agricultural markets and then to consider the effects of those uses on pricing more generally.

Evolutionary Development of Futures Markets and Their Role in the Marketing of Traditional Commodities

The pace of product innovation by futures exchanges in recent years has been truly phenomenal. Not more than twenty years ago, futures markets were limited to agricultural and metals products. Among agricultural products conventional wisdom dictated that only storable commodities were adaptable to futures trading. Given the pace and diversity of current innovation, one might assume that the initial development and adaptation of futures markets were as rapid. In fact, futures markets required some fifty years to develop into forms recognizable today. A brief description of this development—the emergence of futures markets—is a useful point with which to begin the assessment of their unique economic contributions.

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The Evolution of Commodity Futures Markets. Because their development was evolutionary, no specific date can be attached to the beginning of organized futures markets. They emerged as organized forward markets for grains—first in corn and then in wheat—in Chicago in the second half of the nineteenth century. Forward contracting was itself not revolutionary. Examples of futurity in commercial contracts can be traced as far back as seventeenth-century Japan. The first continuing record of the use of forward contracts in Chicago dates to 1851.[2] Incorporated in 1833, Chicago grew rapidly into the major terminal market of the Midwest because of its central location and the successive completion of major water and rail links with eastern markets and expanding production areas in the West. In 1848 the Michigan-Illinois Canal opened, providing river access to Chicago (and hence cheap transportation) from the interior fertile lands along the Illinois River. Farmers quickly responded to the new market opportunities along the river and canals. Irwin estimated, for example, that trade in corn to Chicago for subsequent eastern shipment grew from 67,000 bushels in 1847 to over 3 million bushels in 1851.

Although the canals greatly expanded the agricultural area that could economically ship to Chicago and hence Chicago's role as a terminal market, such transportation was usable only seasonally. Canal and lake transportation was closed in winter, which was the most reliable time for shipment of grain by road to the river or canal market. Thus corncribs and grain elevators spread quickly along the canal system. Farmers delivered most of their corn in winter and dealers held it until late spring or early summer for shipment to Chicago. According to Irwin, about 80 percent of corn received in Chicago from 1854 to 1858 arrived there between May and September.

Financing requirements grew apace with the increasing trade in corn and to a lesser extent wheat, both to finance the ever-increasing size of crops in storage and to expand storage space. Under such circumstances it is not surprising that merchants along the canal system went to Chicago to find buyers for their grain on a forward basis. In the *Chicago Journal* Irwin found a continuing series of reports of forward contracts beginning in 1851, with isolated references to such contracts even earlier. The early contracts were informal, specifying only quantity, price, and time of delivery. Irwin also reported that some contracts included a provision that a proportion of the final price be paid at the contracting date, although "the contracts were personal and each party relied principally upon the integrity of the other for fulfillment."[3] Forward contracting grew in volume

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as the Chicago markets developed and greatly increased with the provisioning required by the Crimean War in Europe and the Civil War.

Over the same period grain trading became more regularized. The Chicago Board of Trade was organized in 1848 as a merchants' association to centralize trading in grain and provisions. In 1859 it was chartered by the state of Illinois and authorized to establish and enforce grain standards. The acceptance of grading standards promoted homogeneity among contracts and permitted the development of the warehouse receipt as conveying title to grain and as collateral in financing grain transactions. The merchants' association was slow to recognize formally the emerging practice of trading in forward contracts. The first rule of the CBT explicitly referring to these contracts did not appear until 1865. In 1863 rules had been adopted according to which members could be suspended if they did not meet their contractual obligations. Evidently this proved insufficient to enforce forward contracts, and in 1865 a margin provision was adopted.

> On all time contracts made between members of this association satisfactory margins may be demanded by either party, not to exceed 10 per cent on the value of the article bought or sold on the day such margin is demanded, said margin to be deposited at such place or with such person as may be mutually agreed upon. Such margin may be demanded on or after the date of contract, and from time to time, as may be deemed necessary to fully protect the party calling for same. Should the party called upon for margin, as herein provided, fail to respond within 24 hours thereafter, it shall be optional with the party making such call to consider the contract filled at the market value of the article on the day said call is made, and all differences between said market value and the contract price shall be settled the same as though the contract had fully expired.[4]

Margin deposits were not to be required on all trades but could be requested by either buyer or seller. In addition, an adjustment in margin could be required—the first so-called variation margin requirement. Forward contracting was firmly established, and trading of those contracts was developing. Contracts included accepted grade standards, were of common sizes (1,000 or 5,000 bushels) and delivery times (for example, May and the opening of the canal), and were enforceable among members of the association. The margin rules, though optional, provided additional contract security. Because these contracts were fairly uniform, they could be exchanged, and the CBT became the primary site of such trading.

The final element in the creation of true futures markets, as distinct from physical or forward markets, was the development of the principle of offset, whereby an individual could easily reverse a contractual obligation. Formal clearinghouse offset was not established until 1891, at the Minneapolis Grain Exchange. The principle of offset developed earlier, however, in the ring settlement procedures at the CBT.

Suppose merchant A purchased 5,000 bushels of corn for May delivery in Chicago from an elevator on the Illinois River. Several weeks later, the merchant found this grain would not be needed and sold the contract to merchant B on the exchange. In some sense, merchant A would no longer be involved in this 5,000-bushel contract if the delivery and financial responsibilites could be sorted out. If A paid (or was paid) the difference in price between the purchase and sale contracts, A would have no further financial obligations. Suppose the original contract for forward delivery was priced at $1.00 per bushel and was sold to merchant B for $0.90. If the loss of $0.10 per bushel were paid to the original seller, the elevator, A would have no further obligation. The elevator would have $0.10 and a forward contract for sale of the grain to B at $0.90. If both parties fulfilled their obligations, merchant A would in fact have had no further obligation either. With a default by either party, however, A could become involved in the resulting dispute.

These basic procedures—though simplified in the discussion above—became formalized as the ring settlement method. It entailed the settlement of price differences on contract purchases and sales and permitted traders to enter and leave the market without having to wait until delivery to settle their accounts. Ring settlement methods were formalized in 1883 at the CBT with the formation of a clearinghouse. The sole purpose of this first clearinghouse was "facilitating the offsetting of trades between houses without waiting for customers to close them."[5] Firms with customers' accounts were required to maintain the bookkeeping for those accounts internally. Each day the firm settled its net position with all other firms through the payment of price differences to the clearinghouse. The ring settlement system remained in effect in Chicago until the 1920s.

In 1891 the Minneapolis Grain Exchange organized the first complete clearinghouse system. The clearinghouse, in addition to its daily accounting responsibility, became the third party to all transactions on the exchange, thereby creating true clearinghouse offset as it is known today and completing the evolution of forward contract trading to futures trading. Every potential buyer or seller must still find his opposite in the trading on the exchange floor. After the trade

is recorded with the clearinghouse, however, and both the buyer and seller agree to its terms, the clearinghouse becomes the third party to the transaction. At this point the buyer has a contractual obligation to accept delivery from the clearinghouse, and the seller has a contractual obligation to deliver to the clearinghouse. Contracts are completely impersonal, and the seller no longer must rely to any extent on the integrity of the buyer (and vice versa) to ensure contract performance. The integrity of each contract depends on the integrity of the clearinghouse.

The operations of the clearinghouse were designed to maximize contract integrity. Buyers and sellers alike are required to post margins with the clearinghouse directly (technically, clearing member firms are required to post the necessary margins for their own accounts and for those of firms and individuals clearing through them). The clearinghouse insists on daily settlement of all open positions, the so-called mark-to-market system. Losses on open positions are not paper losses: they are paid each day through the clearinghouse. The settlement price at the close of trading is used to value all open positions. The losses from positions adversely affected by the price change are then paid out to firms with open positions that show profits. Since the clearinghouse has no market position of its own (every buyer must have found a seller, and vice versa), the daily profits of traders always equal the daily losses of other traders. In addition, the margin each trader has deposited ensures that payment of losses can be made daily. If an initial margin is depleted, the trader is required to deposit additional funds, so-called variation margin. If the requested variation margin is not deposited promptly, the clearinghouse can close the outstanding positions of the trader. In principle, therefore, funds are always available to the clearinghouse to make the daily transfers, and default risk is very small.

With the development of clearinghouse offset, organized trading in forward contracts had evolved into futures markets. Forward contracts remain valuable to grain merchants, as will be seen, because each is unique in size, quality, timing, and location of actual delivery. Performance on a forward contract, however, continues to rely on the integrity of each party to the contract. In contrast, futures contracts are uniform and impersonal, their integrity established by the clearinghouse and margin system. Each market has come to have a unique role in facilitating the merchandising of grain. Although the distinctions between and the ultimate complementarity of futures and forward markets are evident today, no such distinctions were apparent during their development. Separate wheat futures markets emerged at nearly all major terminal markets, for example, including not only Chicago,

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Kansas City, and Minneapolis but also New York, Duluth, Milwaukee, St. Louis, and Omaha. In each case futures markets emerged from organized trading in forward contracts that were themselves uniquely valuable to local merchants because of their specific location and variety.

That the resultant futures markets at each location remained active for some years is testimony to the evolutionary nature of their development. More recent experience suggests that multiple futures for the same commodity are unlikely to coexist successfully. One market usually dominates trading very quickly, and the other markets inevitably expire. Wheat is not, of course, the perfect example of a homogeneous commodity, and high transportation and especially communication costs and delays in the middle to late nineteenth century surely account for some of the sustained trading in essentially regional futures markets. Nevertheless, some portion of the sustained proliferation of early futures markets is a direct result of their evolutionary character.

Merchants of the time appear not to have realized the precise value of the evolution. Rothstein's recent analysis of the adoption of hedging practices during this period clearly shows the suspiciousness with which even grain merchants viewed the emerging markets. Rothstein documents the remarkable change in attitude toward the new markets of a prominent Milwaukee grain merchant. In 1858 the merchant opposed the new markets: "I hope anybody will lose who ever enters into those kind of gambling operations of selling ahead. . . there is no speculation so dangerous, not even betting on a faro table."[6] Some twenty-five years later, in 1873, the same merchant wrote:

> In order that there be no speculation about buying wheat here, I mean to sell a seller Feby [against the shipment] and when you use this wheat, then buy it in here. If wheat goes up here, it will with you and this mode covers all speculation. . . . I do not know that you will understand this, but it is an excellent thing, if we do not want to speculate.[7]

Recognizing the fundamental usefulness of a futures market took the merchant more than two decades. It is thus no surprise that centralization of trading took much longer.

Finally, although the discussion here has focused on the grain trade and developments primarily in Chicago in the second half of the nineteenth century, the independent development of futures markets was not limited to either Chicago or grains. The Minneapolis Grain Exchange in fact completed the evolution with the introduction

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of clearinghouse offset. Active futures markets also emerged at many other midwestern grain markets. Irwin documents the nearly parallel and apparently unrelated development of a cotton futures market at the New York Cotton Exchange.[8] The present Chicago Mercantile Exchange can be traced to 1874 and the formation of the Chicago Produce Exchange (later the Butter and Egg Board), on which the trading of forward contracts in eggs and butter developed in much the same way as the grain exchanges. Similarly, the New York Mercantile Exchange originated from forward contract trading on the New York Butter and Cheese Exchange, organized in 1872. The New York Produce Exchange emerged as a futures market in this period. The Coffee, Sugar, and Cocoa Exchange began in 1882 as the Coffee Exchange. Sugar was added in 1916, but cocoa trading (on the originally separate Cocoa Exchange) was not begun until 1925. The Commodity Exchange dates to the 1920s with trading in metals—copper, silver, zinc, lead—and hides, albeit on separate exchanges.

Unfortunately, few analyses exist of the history of these exchanges and the evolution of organized futures trading on them. Irwin's account of the experiences of the Chicago Mercantile Exchange, the Chicago Board of Trade, and the New York Cotton Exchange are suggestive. Futures trading appeared on each exchange largely independently and was traceable to commercial practices within the specific commodity's market. In each case growing storage requirements led to the use of forward contracts, and trading in forward contracts led to organized futures markets. The case for independence and reliance on commercial practice within the industry is made stronger by noting that trading in butter and egg futures emerged some thirty to forty years after that in grains and cotton. The Chicago Mercantile Exchange, when formally organized as a futures market, did borrow the trading rules and arrangements of the well-established markets. Irwin's account shows clearly, however, that it was developments in the egg business that led to the emergence of a futures market.[9]

Evolution notwithstanding, futures markets have not replaced either cash or forward markets for agricultural and metals products. Each market remains uniquely valuable in the marketing, processing, and distribution of these commodities. Cash markets are immediate delivery markets in which transactions simultaneously price and convey ownership of commodities. Forward markets permit an individual buyer and seller to agree on a future transfer of commodity on terms, including price, that are mutually convenient. Futures are centralized forward-pricing markets, all contract terms are standardized, and only price is negotiated.

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Complementary Roles of Cash, Forward, and Futures Markets. The most common cash (also called physical or spot) market transaction is at the point of first marketing of the commodity by the producer to a merchant or processor. A farmer deciding to sell grain, for example, delivers it to a local elevator, has it weighed and graded immediately, and receives a check on the same day. The price is a cash market price. Before actually delivering the grain, the farmer does not know exactly what the price will be, although quotations can be obtained from the elevator of prices paid for standard grades that day. Surveys by Paul et al. and by Helmuth show that most grain moves from the farm through cash market transactions.[10] Although cash transactions are very common in grain marketing, centralized cash grain markets no longer play an important role in the movement of grain except perhaps for the organized trading in St. Louis of corn being barged to New Orleans (so-called CIFNOLA trading). In livestock marketing, however, centralized markets in Omaha, St. Louis, and throughout the major producing regions continue to be important both as sources of current price information and as sales channels.

Cash prices refer to specific locations and qualities. A published cash price quotation will normally be for the most common grade of the commodity (for example, number 2 yellow corn, number 1 yellow soybeans, or 900–1,000-pound choice steers). Individual cash buyers also maintain discount and premium schedules for commodities that do not meet standard grade specifications. Premiums and discounts may vary during a marketing season and do vary substantially between seasons or years. For example, in a year with a very wet corn harvest and associated high average levels of moisture in newly harvested corn, discounts for moisture higher than the standard 14 percent will be large. If the harvest occurs in much drier conditions, so that most of the crop does not require drying before storage, corn that is above the standard moisture level will probably be discounted much less.

Forward markets add a time dimension to cash markets. Like a cash contract, a forward contract is specific as to location, quality, and amount. Commodity ownership is not transferred, however, on the date the contract is entered into; rather, a forward contract sets the transfer sometime in the future, although the price is established on the contracting date. (Forward contracts may also be basis priced, with price levels established later through futures transactions.) With a forward contract, buyer and seller agree at the outset on what price will be paid for the commodity when it is delivered under the terms of the contract.

A farmer who has decided to plant 75 acres of corn, for example,

knows what the basic costs of production are. Further, the farmer may expect a yield of 115 bushels to the acre but, to be conservative, may be planning on the basis of 100 bushels to the acre. A local elevator will quote a forward price for corn to be delivered in the fall (October–November), at harvest. If the price covers the costs of production, the farmer may decide at once, while planting the corn, to sell it to the elevator for delivery in the fall. This forward contract usually includes provisions for delivery either earlier or later than agreed upon and for delivery of corn that does not meet other agreed upon specifications.

Forward contracts are used extensively in the export and import of commodities. In fact, virtually all such contracts are forward contracts—contracts made today for delivery sometime in the future—if only because the physical movement of commodities takes time. In addition, they are widely used by processors of agricultural commodities, such as flour millers and corn processors, to ensure a continuous supply of the commodity for their processing facilities, facilities that typically do not have large on-site storage capacity. Forward contracts are also common in livestock marketing and assure packers of a continuous supply of animals to their plants.

Forward contracts are not commonly accompanied by payment of a performance bond by either buyer or seller. That is, neither buyer nor seller is required to advance money to ensure contract performance. As market prices change over the period of the contract, the contract will assume a value to either the buyer or the seller, and one will have an incentive to default on the contract. Fulfillment of the terms of the contract depends on the integrity of the two contracting parties. Defaults are not common, in part because either the buyer or the seller will normally hedge the contractual obligation with a futures position, a common commercial use of futures markets discussed in the next section.

Finally, forward contracts for agricultural products are illiquid. A particular forward contract is specific as to quantity, quality, and location. These conditions make it attractive to the original buyer and seller but are unlikely to be attractive to any other potential buyer or seller. It is therefore relatively difficult to trade a forward commitment if market conditions change and the buyer, for example, no longer needs the commodity.

Futures contracts are standardized forward contracts, and futures markets are the organized trading of those contracts. All corn futures contracts, for example, are identical in that they are obligations to make or take delivery of a fixed amount and quality of corn in a specified location at some point in the future. Potential delivery

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months are prespecified, as is the time within the delivery month when delivery may be made. The only item to be negotiated when buying or selling a futures contract is price. Standardization of contract terms facilitates centralization of trading, and, although production and cash transactions remain regionally dispersed, futures trading is not. Futures contracts are traded on exchanges according to the rules of the exchanges, with regulatory oversight by the CFTC. All trades are by open outcry at the exchange—buyers and sellers offering the desired number of contracts and price to all assembled traders.

Unlike cash or forward contracts, futures contracts are rarely used to transfer actual ownership of commodities. The standardization of contract terms that facilitates market liquidity and price discovery discourages users of the physical commodity from accepting delivery. The standardized terms of futures contracts rarely coincide with the precise needs of a commercial user in timing, location, or quantity. Thus futures contracts are rarely held until delivery; instead, they are either replaced with contracts of more distant maturities (rolled over) or they are closed (offset) as the actual physical commodity is acquired at times and locations matching specific needs. Actual delivery occurs in less than 1 percent of the futures contracts traded.

Two additional institutional features—margins and the clearinghouse—distinguish futures from forward contracts. Margins are performance bonds that both buyer and seller must deposit before trading. The funds ensure, on a daily basis, that neither party has an incentive to default on the contract. The bond is renewed each day as open positions are marked to the market, margin accounts adjusted, and additional funds deposited if required. Once a futures transaction has been checked to ensure that both buyer and seller agree to the recorded transaction, the clearinghouse becomes the third party to the contract.

The third-party role of the clearinghouse enhances market liquidity by facilitating exit from the market and by depersonalizing contract performance. To fulfill contractual obligations, a buyer must either accept delivery of the commodity in the designated month or sell a like amount before the expiration of the contract. The latter transaction is an offset trade that makes the individual net even in the records of the exchange (having bought from and sold to the clearinghouse, in equal amounts).

Margins combined with daily marking of positions to the market reduce the risk of contract default virtually to zero. The clearinghouse, as a third party to all transactions, establishes the principle of offset as a means of reversing a previous decision. Standardization

of all contracts implies that only price is being determined. Taken together, these features reduce the costs of entering and exiting from the market, permit centralization of trading, and thereby greatly increase market liquidity.

Futures markets in agricultural and metals products have become the primary markets determining underlying values, and all other transactions, spot and forward, are priced in relation to these prices with due allowance for time, place, and quality differences. Both spot and forward market transactions remain important since they are the primary means by which commodity ownership is actually transferred. These transactions are not made independently of market prices, however, and futures positions are often necessary components of the total transaction.

Commercial Firms' Use of Futures Markets

Firms engaged in the production, processing, and distribution of agricultural and metals products use futures markets extensively in their commercial transactions. These firms are known as hedgers; they include farmers, feedlot operators, mine owners, merchants, farmers' cooperatives, import and export firms, wheat millers, corn processors, meatpackers, metal fabricators, sugar refiners, and coffee roasters. This list of users, though not exhaustive, is indicative of the diversity of firms that find futures markets useful in the course of their normal business operations. Given the diversity of firms and their needs, there is little likelihood that a single definition of hedging will encompass all legitimate potential business uses of futures markets.

Working's summary definition is perhaps as all-encompassing as is possible:

> Hedging in futures consists of making a *contract to buy or sell on standard terms, established and supervised by a commodity exchange, as temporary substitute for an intended later contract to buy or sell on other terms.* Then the hedger seeks to make the second purchase or sale, perhaps several months later, on terms that suit him better than those of the standard (futures) contract.[11]

Futures markets are used by commercial firms to price a transaction temporarily. The definition does not directly address motives, although it implies both the greater liquidity of a futures market and management of the price risks inherent in commodity ownership. How and why commercial firms use futures markets is the subject of this section. Understanding such use is fundamental to assessing the role

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of futures markets in the economy since these are the firms engaged in the allocation of the economy's resources in production, consumption, and marketing of these products.

The Arbitrage Use of Futures Markets. The most common example of a hedging transaction focuses on seasonal storage of an agricultural commodity and the use of futures markets to secure a return to storage through a predictable change in the relation between cash and futures prices. Consider an elevator in Chicago that is in a deliverable location for the CBT corn futures contract. Assume that it is early October and that new crop corn is in plentiful supply and is trading at $2.53¼ per bushel in Chicago. At the same time the closing price of the December corn futures contract is $2.85¼. In this circumstance the elevator might purchase 5,000 bushels of corn and simultaneously sell one contract of December corn futures with the intention of storing corn until December. In this idealized example, the elevator has assured itself of a $0.32 per bushel gross return to corn storage from October until mid-December.

The hedged return is invariant to changes in prices. If cash prices in Chicago decline to $2.00 by December, the December future will also be priced at $2.00, since it is in delivery and delivery is in Chicago. If the elevator sells the stored corn in December and simultaneously lifts (buys back or offsets) the futures positions, the cash purchase and sale lose $0.53¼ per bushel ($2.00 − $2.53¼) while the futures positions gain $0.85¼ ($2.85¼ − $2.00) for a gross return of $0.32 per bushel. If prices rise to $3.50 by December, the cash side of the transaction earns $0.96¾ per bushel ($3.50 − $2.53¼) while the futures side earns −$0.64¾ ($2.85¼ − $3.50), for the same gross return of $0.32 per bushel. The difference between the cash and the futures price at the time the corn was bought and stored is variously called the basis, the spot premium or discount, and the carrying charge or, if negative, the inverse carrying charge (although the last terms are usually reserved for futures price differences, not differences between cash and futures prices). In the example cash (spot) corn was $0.32 under the December future in October, the spot discount was $0.32, or the basis was 32 under the December future. The basis in December was zero, and the returns to storage are simply the change in basis from October, when the hedge was placed, to December, when the hedge was lifted.

In the example the basis prevailing when the arbitrage hedge was placed is a perfect forecast of the returns to storage and is an ideal situation. The hedger is in the delivery location and can rely on the convergence of cash and futures prices in the delivery month.

Working examined evidence of the reliability of this relation for a similar "ideal" situation in wheat—an elevator located in Kansas City hedging in Kansas City wheat futures.[12] He found that the currently observed basis predicted as much as 95 percent of the subsequent change in basis.

More generally, the essence of an arbitrage hedge is the predictability of the basis over time. In the delivery location predictability is nearly absolute. Clearly, not all (indeed, very few) grain elevators operate in this ideal environment. The operational question, then, is the predictability of the basis in relation to the cash price over the relevant storage period. The former determines the returns to hedged storage, and the latter determines those to unhedged storage. Figure 1–1 provides a graphic display of a typical basis relation for a series of years.Cash prices that are averages of quotations from elevators in the upper Illinois River basin are plotted in relation to the price of the May corn future on the Chicago Board of Trade. Corn prices, even measured relatively, are not identical every year, but the seasonal change in the basis relation is similar each year. Corn held until May averaged about $0.12 per bushel under the May future, with a range of almost $0.08. Since the basis is known at the time the corn is bought and put into storage, returns from hedged storage are clearly very predictable.

Arbitrage hedging is done to profit from the reliably predictable difference in prices in the two markets. For agricultural commodities such arbitrage requires storage space and is largely done, therefore, by commercial elevator firms. In contrast, nearly anyone could engage in such arbitrage in the precious metals market since specialized storage facilities are not required. The difference, however, is that grain elevators' primary business is merchandising grain—providing time and space utility in grain marketing. To the extent that the basis is both more stable and more predictable than absolute price levels over relevant storage periods, arbitrage hedging reduces the business risks inherent in commodity storage. For seasonally produced, continuously consumed, storable commodities, storage serves an important market function. That futures markets permit such firms to reduce the risks of storage implies a reduction in their storage margins. Empirical evidence on the reduction in storage margins is considered in the section "The Role and Effects of Futures Markets in Forward Pricing" in the form of the effects on seasonal price stability. Seasonal price changes are shown to have been significantly reduced when futures markets were present.

Arbitrage hedging links local prices to central prices directly. Thus, one might expect improved integration among regional market

FIGURE 1–1

THE CORN BASIS IN THE UPPER ILLINOIS RIVER BASIN,
MAY CORN FUTURES, 1976–1982
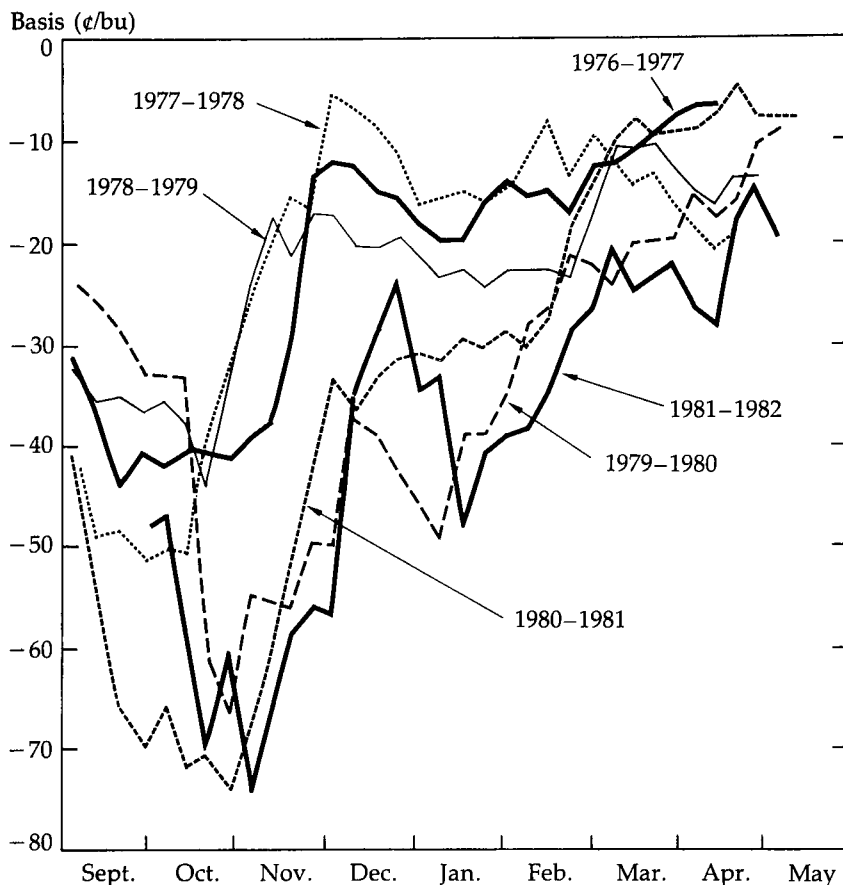
SOURCE: Chicago Board of Trade, *Commodity Markets: Development, Economic Uses, and Trading in Futures* (Chicago: Chicago Board of Trade, 1983), p. 21.

prices. Direct evidence from agricultural markets has not, to my knowledge, been analyzed.[13] Indirect evidence might compare an elevator's bid and asked prices when futures markets are open with those prices when futures are closed. Or average elevator margins for commodities like corn and wheat might be compared with those for nonfutures commodities the same elevators handle, such as barley and durum wheat.

In the absence of direct or indirect evidence, anecdotal evidence

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at least suggests the price transmission efficiencies caused by the availability of hedging on futures markets. When, for example, the grain futures markets closed after the presidential announcement of a grain embargo in January 1980, sales of grain in country locations were reported to be light and at prices significantly below those prevailing on previous days and below those that might have been anticipated if the futures market were open. Buyers of grain, having no hedging alternative, were forced to lower their bids dramatically to reflect the greatly increased risks of buying grain. When the markets reopened, local prices resumed their normal relations with futures prices. Prices were, to be sure, below those prevailing before the announcement, but they were significantly above those found during the two days the markets were closed.

Operational Hedging. A second reason for commercial use of futures markets derives from the much greater liquidity characteristic of those markets than of the underlying spot markets. Large commercial transactions can be priced very quickly with minimal effect on prices, leaving firms time to search for the specific grades or qualities in suitable locations to fulfill the terms of the contract. Working called this use of futures markets operational hedging; in essence, it is the use of futures as a substitute for an actual purchase or sale of a commodity, normally for a very short period to give a firm the time required to assemble the desired commodity on terms suitable for the contract.[14]

The classic example of operational hedging is a flour mill's use of wheat futures. Characteristically, flour mills do not have large, on-site storage capacities and are therefore unlikely to have in store the specific grades and qualities of wheat required to fill an order when it is being negotiated with a baker. A baker may call to order two to three months' flour requirements for delivery beginning in a month or so and wants a fixed price commitment from the miller for the entire order. Futures markets serve two related functions for the miller. First, the prices provide the miller with precise estimates of standard wheat values. To this standard a premium or discount will be added or subtracted to reflect the relative value of the specific wheats required to fill the order. The total calculation provides the miller with a firm price to bid on the baker's contract, and futures have established the basis for the bid.

If the bid is accepted, the miller immediately purchases wheat futures as a temporary substitute for the required wheat. The large quantities of the specific grades and quality of wheat needed to fill the order are unlikely to be immediately available in the local cash

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market precisely because of their specificity. Even if a local elevator happened to have wheat matching the miller's need, such large purchases would have a significant price effect. The same quantity of futures purchases, however, will affect the price by no more than a quarter or a half of a cent. With the hedge in place, the miller has the opportunity to accumulate the wheat as it becomes available and to shop for the most favorable terms. Although the futures positions may serve as only a very temporary substitute, their relative liquidity makes them a very attractive substitute.

The use of futures in agricultural commodities for operational convenience has received by far the least attention by economists. In part, the explanation is the overwhelming dominance of arbitrage hedging in the historical statistics of market use. In this context, however, it is worth noting that before 1960 flour mill hedging alone accounted for more than 50 percent of all long hedging on the three major wheat markets.[15] The average has declined substantially in more recent periods because of the tremendous growth of commodity exports and sympathetic growth in long hedging by exporters. Despite this relative decline in the importance of mill hedging, operational convenience remains an important reason for commercial use of futures markets because the typical export firm's use of futures combines both arbitrage and operational motives. The more distant the export commitment, the more important are arbitrage relations. The more distant the commitment, the less likely it is that the firm owns the grain it is committed to deliver, and the more important is the firm's estimation of cash values specific to future locations and times in relation to futures prices. That is, the export firm has sold forward at prices derived from basis expectations, much as an elevator purchases grain in response to basis expectations.

Whatever the time horizon of the export commitment, futures will almost invariably be the purchase that immediately covers the transaction. Cash markets are not liquid enough to accommodate the size of most export orders immediately without substantial (albeit short-term) effect on price, but the liquidity of an active futures market can accommodate all but the largest orders without substantial effect on price. The futures purchases occur whether or not the firm actually owns the grain that is to be exported. If the grain is owned, it has very likely been hedged by sales of futures, and the purchase of futures lifts the hedge as well as having priced the transaction. If the grain committed to export is not owned, futures purchases price the transaction and provide time to shop for the specific lots required by the transaction. Finally, to the extent that the shopping time involved in export transactions is months rather

than days or weeks, arbitrage relations assume a substantially greater importance than in pure operational hedging.

Finally, the use of futures markets for operational convenience significantly reduces the firm's exposure to price risks. Without futures the miller's processing margin would be as variable as cash wheat prices between the time the flour contract was accepted and the time the actual wheat was purchased. More important, without futures the miller's original bid would have had to include a sizable premium reflecting the potential risks of price change between the contract date and the date the desired wheat could actually be found in the market. With futures the miller's margin can be very nearly determined at the time of the sale, although the actual margin will depend on whether the miller is able to purchase wheat of appropriate quality at the anticipated premium or discount. The availability of futures markets and their use for operational convenience significantly reduce risks and hence margins in the marketing process.

Anticipatory Hedging. A third reason for the business use of futures is to price today an anticipated purchase or sale of the commodity that cannot be carried out today in the cash market. Most producers' hedging, some processors' hedging, and most end users' hedging illustrate this motive. By the nature of their businesses, these firms must buy or sell the physical commodity. If their marketing decisions are restricted to the cash market, factors other than price are likely to dominate their decisions. Farmers, for example, could not sell their crops until they were harvested. Processors who did not have extensive storage facilities could buy only as their processing operations required the physical commodity. With a futures market these firms can buy or sell as their market judgment dictates and not as required by the physical operation of their businesses. Such hedging is termed "anticipatory hedging" because the futures purchases or sales are made in anticipation of actual need or availability.

Some of the most detailed analyses of anticipatory hedging opportunities have focused on the cattle-feeding industry and have examined the effects on producers' returns of various futures marketing strategies. As the foundation for these studies, a typical cattle-feeding operation is simulated. Feeder cattle, for example, are purchased at about 600 pounds, fed for five or six months, and marketed at about 1,100 pounds. All inputs—primarily corn and protein supplement—are purchased at the beginning of the feeding period. Finally, the feedlot is generally assumed to be continuously filled to capacity, and possible losses from death are not a factor.

In the simplest of these evaluations, cash market sales of finished

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cattle are compared with results of futures sales of the cattle when they were put on feed. A second strategy includes futures sales at placement, but only when the futures price covers at least the costs of production. Otherwise the cattle are marketed when finished. In another variant the restriction on timing is removed, and futures sales are permitted at any time after the cattle have been put on feed. Various price-forecasting schemes have been used as well to guide the timing of futures sales.

Leuthold and Tomek, in surveying the results of these analyses, conclude that routine anticipatory hedging—for example, always selling futures when the cattle are placed on feed—does significantly reduce the variability of feeding returns but also results in very low average returns.[16] Anticipatory hedges using some price forecasting or break-even decision criteria generally provide higher and less variable returns than the alternative of cash market sales. Even with relatively simple, common-sense trading strategies, analyses have shown that feedlot operators can effectively use futures markets to time sales decisions to their advantage.

Like all anticipatory hedges, cattle feeders' use of futures markets requires the exercise of judgment concerning price; that is, it is fundamentally a price-fixing decision. Prices look "good" today for the commodity that must eventually be bought or sold. There is an important difference, however, between the cash market decision and a futures decision. Once a cash market decision is made, subsequent changes in prices do not appear in the accounting of the firm's profits or losses. Futures decisions, however, involve margin funds, and market losses or gains are subtracted from or added to the margin account daily. The losses or gains in the futures position are real; during the period for which the futures position is a temporary substitute for the eventual cash market transaction, the losses or gains are daily measures of the judiciousness of the marketing decision.

Finally, anticipatory hedges can involve more than the sale or purchase of the single output or input. Cattle feeding is again a useful example, and a study by Leuthold and Mokler is illustrative.[17] As before, the basic cattle-feeding operation is simulated. The operator's planning horizon is expanded, however, to include three months before the feeder cattle and other inputs are purchased. During this period the price relations among fat cattle, feeder cattle, and corn futures are examined daily; if a profitable feeding margin can be secured, feeder cattle and corn futures are purchased and fat cattle futures sold. When the feeders and corn are actually bought, the hedges in futures are lifted. Meanwhile, the hedge of the finished

cattle remains in place until the cattle are fattened and sold. If a profitable three-way hedge is not found during the planning period, production continues as planned, and the search continues for a profitable feeding margin, as in the earlier examples.

One of the most interesting aspects of Leuthold and Mokler's results is that a profitable feeding margin was available in every eight- to nine-month planning and feeding period. But, as the authors note, "each feeder must decide whether to take market positions and establish a profit level when a positive margin first appears, or to wait for larger margins, knowing that some lots of animals will never be forward priced."[18] The judgmental nature of anticipatory hedges remains, even with the assurance (in this study) of a profitable opportunity.

Commercial Use and Levels of Activity on Futures Markets. Some of the first evidence that futures markets are primarily commercial and not speculative markets was the observation that hedging was largely of the storage or arbitrage kind and showed a pronounced seasonal pattern, which was mirrored by the total activity on a number of grain markets. In particular, reported hedging was almost always net short, as it would be if storage hedging dominated and thus varied seasonally with the accumulation and decumulation of stocks of grain. The basic pattern, first noted by Hoffman and Irwin in the corn and wheat markets, persisted until the early 1970s.[19] It is shown in figures 1–2, 1–3, and 1–4 for data from the corn, wheat, and soybean markets.

In figure 1–2 visible supplies of each commodity are presented. These show the expected postharvest peaks and subsequent declines characteristic of commodities that are produced once a year, are storable, and are consumed year round. Figure 1–3 shows the average seasonal net hedging in each of these markets. Hedgers' use of these futures markets was net short most of the time during the year and followed a seasonal tendency closely related to the stocks pattern. That is, short hedging increased quickly after harvests (shown as an increasingly more negative net hedging in the month or months immediately after harvest) and thereafter declined as stocks of the commodities also declined. Figure 1–4 shows a sympathetic seasonal pattern in total open positions in each market, evidence that overall activity (the open interest) responds directly to hedgers' needs and not to speculative interests. Grain prospects are characteristically most uncertain in the months immediately before harvest. If speculative interests dominated, one would expect trading to peak during periods of the greatest speculative interest. Instead, trading was at

FIGURE 1–2

MONTHLY AVERAGE VISIBLE SUPPLY OF WHEAT, CORN, AND
SOYBEANS, 1947–1948 TO 1971–1972

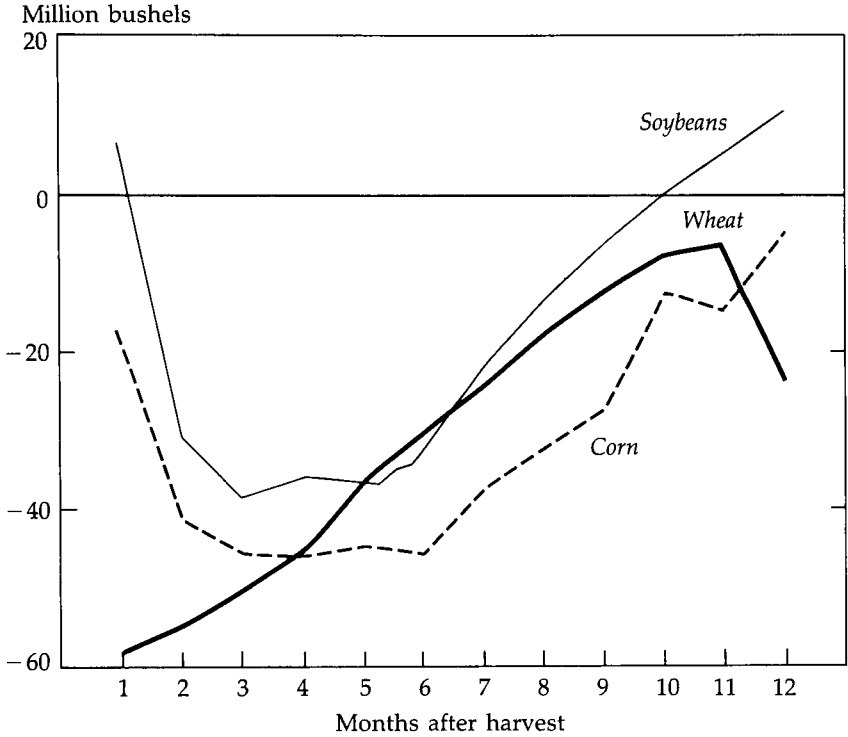Million bushels

Months after harvest
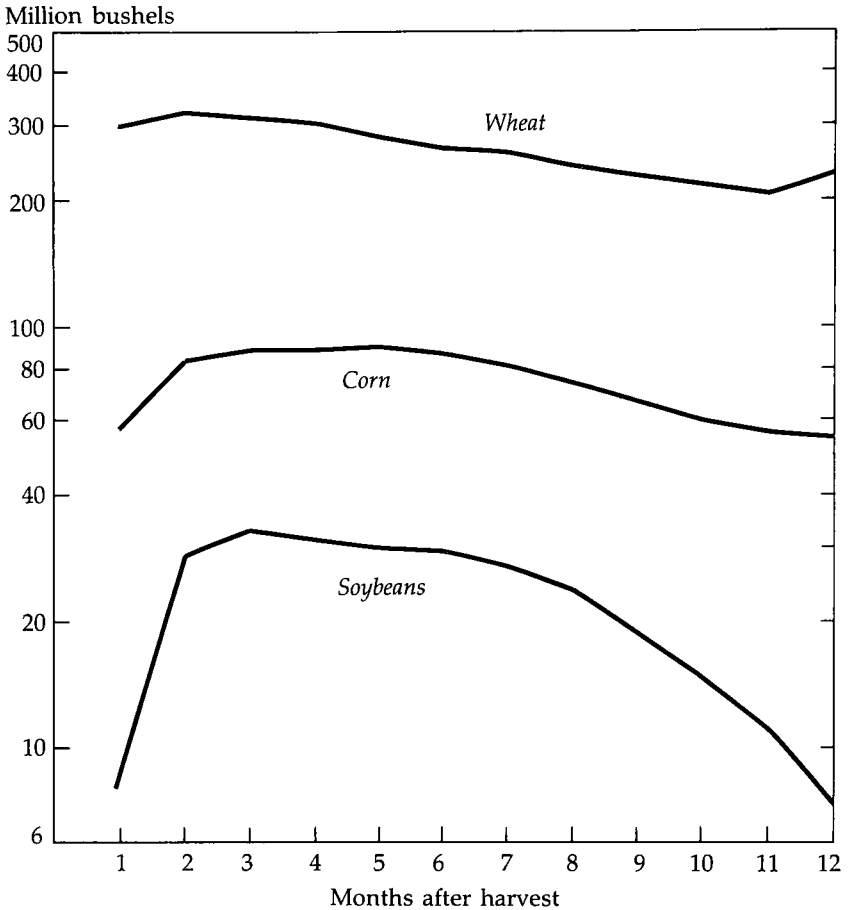
SOURCE: Anne E. Peck, "Reflections of Hedging on Futures Market Activity," *Food Research Institute Studies*, vol. 17, no. 3 (1979).

its lowest before harvest, rising and peaking with the increases in commercial use.

Since the 1971–1972 crop year, the patterns in market use have changed significantly and sympathetically with the dramatic changes in commercial flows of these commodities. Beginning with the 1972–1973 crop year, government-held stocks of corn and wheat were depleted, and export demand was unprecedented. Futures markets

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FIGURE 1-3
AVERAGE MONTHLY NET HEDGING IN WHEAT, CORN, AND SOYBEAN
FUTURES MARKETS, 1947-1948 TO 1971-1972

Million bushels

SOURCE: Peck, "Reflections of Hedging on Futures Market Activity."

activity grew apace with commercial activity. In 1971 month-end open interest of futures contracts averaged 149.5 million bushels of wheat, 261.8 million bushels of corn, and 290.8 million bushels of soybeans. By 1977 these figures were 335.4, 590.2, and 498.3 million bushels, respectively. Commercial use of futures markets grew more than proportionately. Short hedging of corn, which was averaging 46.6 percent of total open interest in the pre-1972 period, averaged 61.9 percent of the open interest from 1972 to 1977. Simultaneously, long hedging grew from 23.9 to 61.9 percent of the open interest. In the soybean market long hedging grew from 20.7 to 42.2 percent of the open interest and short hedging from 29.9 to 42.0 percent. Long hedging in the wheat market grew from 22.9 to 61.1 percent of the open interest and short hedging from 44.7 to 64.6 percent.

As these figures suggest, hedging became much more balanced

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FIGURE 1-4

MONTHLY AVERAGE TOTAL OPEN INTEREST IN WHEAT, CORN, AND
SOYBEAN FUTURES MARKETS, 1947-1948 TO 1971-1972

Million bushels

Months after harvest
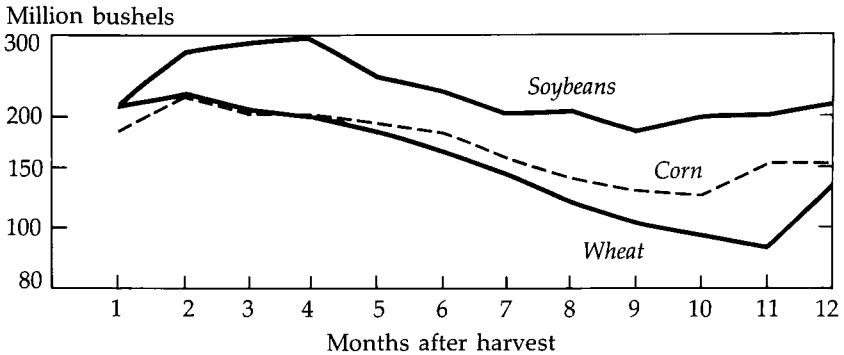
SOURCE: Peck, "Reflections of Hedging on Futures Market Activity."

in the 1972–1977 period, with long hedging nearly always as large as short hedging. Net hedging averaged near zero and showed no significant seasonal tendency. Similarly, the total open interest showed no seasonal pattern.

The emerging balance in hedgers' positions in these markets is due primarily to the much greater than proportional growth in long hedging. Most of this growth is a direct reflection of export growth and the concomitant increases in hedging by export firms, which are at least partially operational. Some growth in both long and short hedging is no doubt increased anticipatory hedging as well: the returns to successful timing of market decisions increased significantly with more volatile markets. Nevertheless, the major market change has been in the needs of firms in the export trade, and these changes are clearly reflected in the data on market use.

The relative composition of commercial users of other agricultural and metals markets is not as clearly reflected in the aggregate data on market positions, nor are the relations between commercial use and total activity as revealing. Comparable data do not exist from the metals or imported agricultural commodity markets. Data from the live cattle, pork belly, and old Maine potato markets indicate that overall activity on these futures markets is related to total commercial use. Except for pork bellies, however, which are storable, there is little evidence of a relation between levels of commercial use and any measure of activity in the underlying physical market. Leuthold, for example, finds no significant relation between variables

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such as placements on feed, slaughter, and marketings and futures market commitments in the live cattle, live hog, and feeder cattle markets.[20]

Summary. Although the motives for hedging vary, the diversity of commercial firms that find futures markets useful is testimony to their economic contributions. Futures markets provide a reliable basis for predicting storage returns, a liquid market to price and permit time-consuming acquisition of actual commodity needs, and a continuous market alternative for firms with marketing constraints. In each case firms use futures markets to manage the price risks inherent in their underlying businesses. The direct benefits are in the reduced margins that firms require when they use futures to reduce some of the price risks. As has been intimated in the preceding discussion, the more general economic effects of futures markets flow directly from the ways in which they are regularly used by those involved in the production, marketing, and processing of commodities. Before considering these, however, I turn to the role of speculators on futures markets.

The Role of Speculative Participation in Commodity Futures Markets

Speculation is an essential element in the formation of market prices— be they cash prices or futures prices. In the absence of a futures market, speculation on commodity prices usually requires a sizable investment in storage or transportation facilities to maintain ownership. Similarly, the production, processing, marketing, and ultimate use of agricultural products are time consuming, and at each stage the commodity is owned by someone. Ownership, either actual or prospective, is speculative.

With a futures market firms involved in the production or marketing of the commodity can use futures positions as temporary substitutes for intended purchases or sales of the commodity or its products, thereby separating physical ownership from price change speculation. Conceptually, a futures market could exist with trading restricted to commercial firms; if all firms in the production, marketing, processing, and consumption chain participated, price risks associated with commodity ownership at many of the stages in the chain could be largely internalized. Just as the underlying physical processes are themselves not coincident in timing, however, firms' individual purchase or sale decisions are rarely coincident. Thus one

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firm's futures sale or purchase would probably be coincident with another firm's futures purchase or sale only infrequently. Like cash markets, such a market would often be extremely illiquid.

The noncommercial participants in futures markets—speculators—absorb the frequently unbalanced demands of commercial buyers and sellers. Imbalances may occur between total numbers of buyers and of sellers, between the degree of futurity desired by buyers and that desired by sellers, or between the timing of buying and selling within a day. Reflecting the three dimensions of possible imbalance in commercials' desired transactions, three forms of speculative participation in futures markets are commonly identified: position trading, spreading, and market making. Each of these is described below.

The view that speculators absorb temporary imbalances in market timing suggests that the imbalances have price effects and that speculative returns ought to be connected to the commercial participants' positions. Thus the discussion of each kind of trader also considers the possible links between positions and profits and summarizes the empirical evidence. Finally, the distinction between commercial users and speculative participants is unique to futures markets. Such a distinction is not made, for example, in physical markets. The rest of the section takes up the more general links between speculative concentration on markets, market performance issues, and the related need for the regulatory distinction between commercial and speculative participants in futures markets.

A Typology of Speculative Traders. Position trading is the most frequently identified form of speculation. Position trading absorbs the imbalance between aggregate commercial buyers and sellers of futures contracts in the market on any given day. This form of trading is done in the expectation of making a profit from price changes over time, where the relevant time period may be as short as a day or two or as long as several weeks. Position traders use both fundamental analyses of data on market supplies and demand and technical analyses of past price data (and sometimes other indicators of market information) to determine their trading strategies. In recent years position traders have accounted for an average of 20–30 percent of futures contracts open at the end of the day in the principal grain markets. Their ranks include professional traders, most of the so-called amateur traders, professionally managed accounts, and commodity mutual funds or pools.

Although it is convenient to think of position traders as absorbing the imbalances in commercial positions in a futures market, it is

not an easy matter to link the profits of these traders to returns to speculators for assuming this net position. Nevertheless, a number of economists have proposed such links. Keynes was the first to propose a direct link.[21] At the time, commercial users were most often net sellers of futures contracts; therefore, futures speculators (position traders) had to be net buyers since buying and selling must match on a futures market. To induce speculators to buy futures contracts and absorb commercials' net selling, Keynes argued that futures prices would have to be biased downward, rising on average over the life of each contract so as to ensure a return to the speculative buyers. Cootner, noting the seasonal nature of commercial use of most grain futures markets, modified the theory to require upwardly biased prices and hence a regular return to speculators, if they are net short in response to net long hedging.[22]

The basic connections between net hedging, biased prices, and speculative profits theorized by Keynes and Cootner have been formalized in numerous economic models of futures markets and clearly have a great deal of intuitive appeal. Extensive empirical analysis in search of the hypothesized connection has, however, yielded no consistent verification. The exchange between Telser and Cootner in 1960 occasioned by Telser's assumption in an earlier article that futures prices were unbiased is illustrative of the debate and the difficulties of empirical resolution.[23] At the same time, Gray's analyses led him to conclude that bias was not a universal characteristic of futures prices and, when found, was attributable to the unique structural characteristics of a market rather than to futures trading per se.[24]

In a recent test for persistent bias induced by unbalanced commercial positions, Gray examined data from the corn and soybean markets from 1960 to 1977.[25] In each year his trading rule consisted of buying futures on the date that short hedging reached its maximum, holding that position until hedging first became net long, and then selling futures on the date net hedging reached its peak and holding the position until hedging became net short again. The test was designed to permit hedging pressure its maximum effect, initiating buying and selling decisions only at the times hedging was most unbalanced. A speculator following this strategy over the eighteen-year period would have lost an average of nearly four cents per bushel per trade in corn and twenty-two cents per bushel per trade in soybeans. Whatever the intuitive appeal of the link between speculative net positions and average price changes, it was certainly not the source of speculative profits over a fairly long recent period in two of the largest agricultural markets.

Additional, though now dated, insight is gained from Rockwell's examination of the amounts and source of profits that can be imputed to speculators. Using a technique developed by Houthakker, Rockwell combines data on traders' positions with market prices to measure actual speculative returns in the twenty-five agricultural futures markets more or less active over the period 1947–1965.[26] The results of these calculations varied among markets, especially between the three largest and the twenty-two smaller markets. Speculators as a group did earn substantial trading profits, but only the profits of large speculators were consistent and significant. Small, amateur speculators appeared to break about even on average across all markets. Rockwell's most interesting finding, however, is that speculative profits were attributable to price-forecasting skills, either short term or long term, and that little could be attributed to price biases related to hedgers' net positions.

More recent explorations of the link between hedging imbalance and speculative profits have cast the relation into a more formal framework of portfolio analysis and market models based on the capital asset pricing model. The results are again mixed. Dusak finds no evidence of price bias in wheat, corn, and soybean futures. Carter, Rausser, and Schmitz find evidence of a connection between systematic returns and net speculative positions, although their results have been seriously compromised by Marcus's criticism of their technique.[27] The argument continues. It is likely that economists will continue to search for direct links between imbalances in hedging needs, speculative positions, and speculative returns. The intuitive appeal of the connection is almost inviolate even though the empirical evidence is at best mixed. Position traders do earn profits as a group; nevertheless, the profits do not appear to be a predictable return from absorbing the changing requirements of commercial users.

A second form of speculation is spread trading. A spread trader can be seen to absorb imbalances in the degree of futurity required by commercial buyers and sellers. If, for example, a buyer was looking to the nearby future and a seller required a more distant future, a spread trader might match those positions. Spread traders seek to profit from predicting changes in relative prices rather than prices per se, holding simultaneous positions to buy and sell different futures. Spreads may be established within one market or between two or more markets.

An example of an intramarket spread is buying December corn and selling March corn, where both transactions are entered simultaneously—for example, in September. The trader expects that the December price will gain on the March price before December. Such

a trader will often have no opinion about which direction underlying values will go. Common (and most frequently watched) intramarket spreads are old crop–new crop spreads, such as September/December corn prices or May/July wheat prices. The economic importance of these spreads is discussed in the next section.

Intermarket spreads include those between two markets for the same commodity as well as between markets for different commodities. For example, there are three active wheat futures markets—Chicago, Kansas City, and Minneapolis. One intermarket spread trade consists of buying Chicago July wheat and selling Kansas City July wheat. Such a trade is made if Chicago wheat prices are expected to increase in relation to Kansas City prices. Again, increases or decreases in prices per se are immaterial.

Perhaps the most common spread among markets for different commodities is between soybean futures and soybean product futures. Buying soybean futures and selling soybean meal and soybean oil futures is called "putting on the crush" and is done when the processing margin is expected to narrow. The "reverse crush," selling beans and buying products, is done when the margin is expected to widen. Other intermarket spread trades can be derived from production considerations. For example, the relation between new crop corn and soybean prices (December corn and November beans) is frequently analyzed with a view to the relative incentives it reflects to plant corn and soybeans.

The third form of speculation on futures markets is market making, also known as scalping. Market makers trade in large volumes during the daily trading session but rarely carry open positions overnight. That is, only occasionally will a market maker speculate on price changes over even so short a period as overnight. Their trading has been described as standing "ready either to buy at ⅛ cent below the last price or to sell at ⅛ cent above it."[28] Today, the ⅛ cent would be ¼ cent, reflecting the change in the minimum permitted price change on grain futures. Working goes on to note that the definition must be qualified. A scalper will under some conditions trade only on price changes, is not always equally willing either to buy or to sell, and is not always unwilling to buy except at a price below the last one. The description does, however, capture the essential nature of market making. Scalpers' profits are derived from skillfully accommodating the flow of orders as they come to the market. Unlike specialists on the stock market, scalpers are not assigned to any one market, nor do they hold an "inventory" of public orders. Their income is derived solely from their trading.

The activity of scalpers is not measurable in the day's end open

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positions since they do not generally have open positions. Rather, their activity is included in the volume of trading during the day, which also reflects the changes in positions of all other traders during the day. The daily volume figures contain almost no information on the composition of trading. Rutledge's survey of the scanty evidence suggested that 90–95 percent of the volume is speculative and most of that is likely to be market making.[29] On active markets like those for the grains, the volume of trading during the day averages one-quarter to one-third of the open interest. Thus, if position trading constitutes only one-quarter of the open interest, market making activity is nearly as large. Put another way, the largest class of speculation on a futures market will frequently be that of the market makers.

In spite of the market makers' comparative importance, only two direct studies have been made of the returns to market making. Examining two months of a "representative" cotton trader's record, Working estimated a gross return of $4.64 per contract to his market making. More recently Silber analyzed the one and one-half month trading record of a "representative" market maker on the New York Futures Exchange (NYFE), finding gross returns of $10.56 per contract.[30] In both cases the returns per contract were less than the minimum permitted unit price change—$5 per contract in cotton and $25 per contract for the stock index—a result consistent with Working's definition of the market-making trader. It should also be remembered that these are gross returns and do not account for the costs of clearing the trades or the costs of membership on the exchange.

Market makers may be seen as absorbing the temporary imbalances in timing of orders to buy and sell within a trading day. The direct association with imbalances in commercial users' demands breaks down, however, since market makers buy from and sell to other speculators as well. They do not distinguish among orders coming to the floor of an exchange. Their trading serves to match orders from buyers and sellers desiring to hold positions for longer periods of time who are not in the market at the same instant.

Distinguishing speculators as position traders, spread traders, and market makers emphasizes the importance of differences in perspectives and timing. It also fits conveniently into a market balance framework, which serves to underline the importance of speculation as responding to temporary imbalances among buyers and sellers in the marketplace. As noted earlier, however, the connection between their profits and specific imbalances is tenuous at best, particularly among position traders. Further, the assessment of the economic effects of speculation is a much broader topic than the assessment

of its role in absorbing commercial demands on a market; it is considered in the section on price discovery below. Nevertheless, the market balance concept is useful in describing the comparative speculative composition of markets and in assessing instances of speculative inadequacy.

Comparative Levels of Speculation and Their Price Effects. To compare the composition of various markets, a single measure reflecting the level of speculation in relation to hedging is useful. Two such indexes have been used, both derived from the concept of market balance. At any time the total purchases of futures contracts must equal the total sales (for every buyer there must be a seller), and the total open interest in a contract is the sum of all sales or all purchases. If positions are categorized by whether they are held by hedgers or by speculators (either position traders or spreaders), the open interest may be subdivided on both the buying and the selling sides. Long speculation, SL, is the buying of both position traders and spreaders; when added to the buying of hedgers, HL, it must equal the total open interest and must also equal short speculation, SS, plus short hedging, HS. That is:

$$HL + SL \equiv HS + SS$$

Suppose, for example, that the total open interest in a market is 10 million contracts. If long hedgers hold 6 million of these, long speculators must be holding 4 million. Similarly, if short hedgers hold 5 million of the total, short speculators must hold the remaining 5 million. In the identity above, the open interest is not explicitly included. A market with the same amounts of hedging as above might have twice as much long speculation (that is, 8 million contracts). If so, short speculation would have to be 9 million contracts, and the total open interest would be 14 million. Differing amounts of speculation can accommodate the same amounts of hedging, although the open interest would vary as well.

The given amounts of long and short hedging also define the minimum amount of speculation that must be in this market. Conceptually at least, the 5 million sale contracts could be the purchase of 5 of the 6 million contracts held by long hedgers. Thus a minimum of 1 million contracts of short speculation are required by the unbalanced positions of commercial users.

The concept of minimum speculative requirements of a market is shown graphically in figure 1–5. The hedging ratio is defined as long hedging divided by short hedging when short hedging exceeds long hedging (and vice versa otherwise). In the example above, the

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FIGURE 1–5

RELATION BETWEEN HEDGING AND SPECULATIVE RATIOS FOR WHEAT,
CORN, AND SOYBEANS, 1964–1977
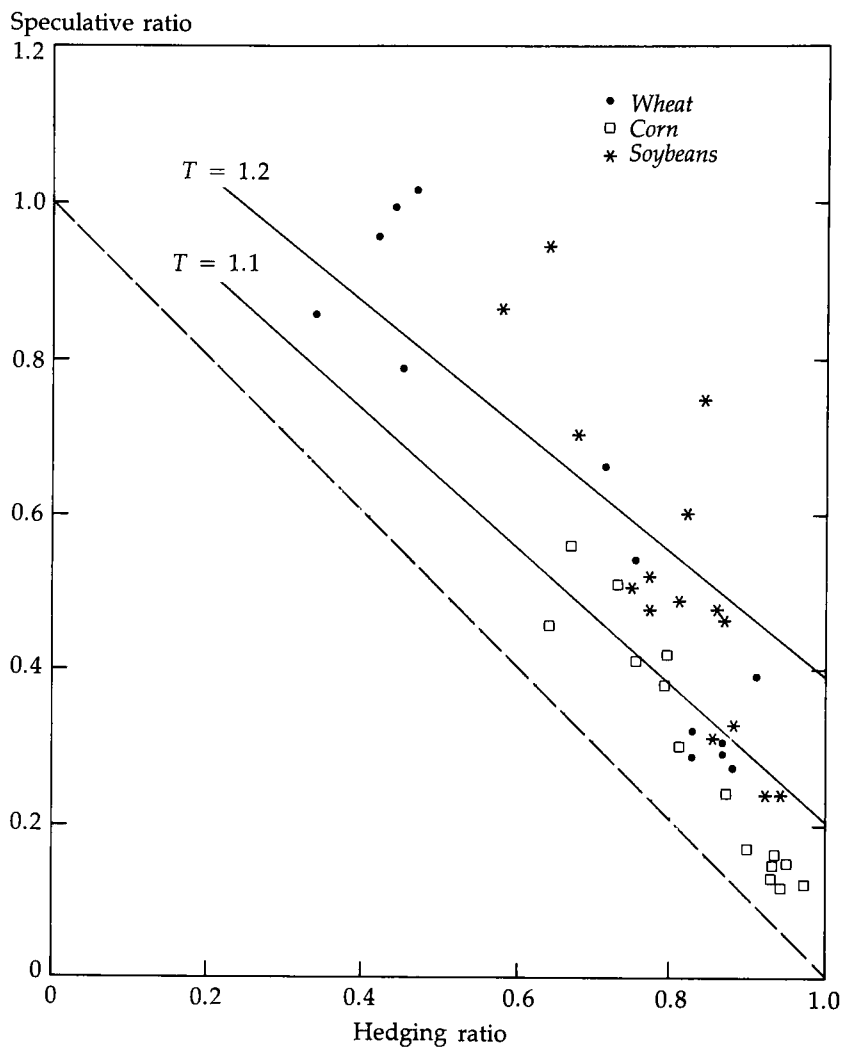
SOURCE: Anne E. Peck, "The Adequacy of Speculation on the Wheat, Corn, and Soybean Futures Markets," in Ray A. Goldberg, ed., *Research in Domestic and International Agribusiness Management* (Greenwich, Conn.: JAI Press, 1981), vol. 2, p. 23.

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hedging ratio is 5/6, or 0.83. The hedging ratio is always less than one since the denominator always contains the larger of the two amounts of hedging (in this case 6 million contracts of long hedging). When short hedging is greater, the speculative ratio is long speculation (by definition, the greater of the two measures of speculation) divided by short hedging. When long hedging is greater, the ratio is short speculation divided by long hedging. In the original example with 10 million open interest, the speculative ratio is 5/6 (0.83), 5 million contracts of short speculation divided by 6 million long hedging. The speculative ratio can take any positive value.

The dotted line in the figure connects all points of minimally required speculation on markets with varying levels of unbalanced hedging (that is, with varying hedging ratios). Mathematically, the dotted line is

$$SR = 1 - HR$$

where SR = speculative ratio, and HR = hedging ratio. More generally, a series of lines parallel to the dotted line are defined as

$$SR = M - HR$$

Each such line represents market compositions that are equally speculative, although the degree of imbalance varies significantly for market compositions on the line. M, the intercept term, is strictly greater than one and is one measure of the degree of speculation, given data on market composition. In the earlier example, $M = SR + HR = 0.83 + 0.83 = 1.66$. In other words, speculation in the example was 66 percent greater than that minimally required to absorb the unbalanced hedging. M is an upper-bound estimate of the amount of speculation that might be considered "excess." By construction, the measure assumes that only net hedging must be absorbed by speculation; commercial buying and selling directly offset each other to the maximum extent possible.

A second measure recognizes that not all hedging on opposite sides of the market can be offsetting. Working observed that markets with very unbalanced hedging demands tend to require less relative speculation than those with more balanced hedging.[31] The solid lines in figure 1–5 show varying market compositions that are equally speculative in this view. Mathematically, the lines are defined by the relation

$$SR = (1 + \alpha) - (1 - \alpha)HR$$

and Working's index is $T = 1 + \alpha$, the intercept. Manipulation of

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the relation gives

$$T = 1 + \frac{SS}{HL + HS} \text{ when } HS \geq HL$$

$$= 1 + \frac{SL}{HS + HL} \text{ when } HL \geq HS$$

In the earlier example, $T = 1.36$; that is, in this view, speculation was only 36 percent greater than that required to absorb both the long and the short hedging. The Working index is probably a lower-bound estimate of the amount of speculation above that needed to absorb the commercial positions.

The data in table 1–1 are evidence of the extent to which speculation varies both over time in a given market and between markets. Estimates of the degree to which speculation is greater than minimally required by commercial use (M) range from 1.35 for wheat futures in the 1972–1977 period to 12.3 for pork bellies. The lower-bound estimates (T) range from 1.18 to 8.99. Thus speculation on wheat futures over the 1972–1977 period was 18 percent to 35 percent greater than required, depending on the definition. Speculation in pork belly futures, on the other extreme, was 800 to 1,100 percent greater than the minimum. By either measure, the contrast is striking.

The commodities for which speculative indexes are reported in table 1–1 appear to form two groups in the most recent period reported there. The wheat, corn, and soybean markets have generally low levels of speculation while Maine potatoes, live cattle, and pork bellies have substantially greater levels. Indeed, levels of speculation in pork belly futures may be so much greater than the others as to warrant putting them into a third group. Among the grains, wheat and corn appear less speculative than soybeans. Note, however, that the live cattle market is no more speculative than the soybean market was on average in the 1947–1971 period, and by current standards that was not a highly volatile period.

Perhaps the most interesting comparison in these data is the change in degree of speculation in the grain and oilseed markets before and after 1971–1972. The popular view would allege that all three of these markets became a great deal more speculative after the 1971–1972 crop year; indeed, speculation on these three futures markets was frequently alleged to be the source of both excessive price volatility and absolute price levels that were either "too high" or "too low." Absolute levels of speculation on these futures markets did in fact increase; but, the increase was dwarfed by increases in commercial use of the markets, and speculation declined dramatically

TABLE 1–1

MEASURES OF THE DEGREE OF SPECULATION ON SELECTED
COMMODITY FUTURES MARKETS, 1947–1977

	Index of Average Degree of Speculation	
	Lower bound (T)	Upper bound (M)
All wheat		
1947–1971	1.59	1.89
1972–1977	1.18	1.35
Corn		
1947–1971	1.61	1.92
1972–1977	1.20	1.40
Soybeans		
1947–1971	1.95	2.60
1972–1977	1.31	1.62
Maine potatoes		
1952–1974	2.92	3.37
Live cattle		
1971–1977	2.17	2.41
Pork bellies		
1970–1977	8.99	12.3

SOURCE: Adapted from Anne E. Peck, "The Role of Economic Analysis in Futures
Market Regulation," *American Journal of Agricultural Economics*, vol. 62, no. 5, (1980),
table 1, p. 1039. Calculations here assume that all unreported, small positions are
speculative.

in relation to the demands placed on the market by commercial users.
On each of the three principal markets, speculation was significantly
below that experienced in the relatively calm, "nonspeculative" decades
of the 1950s and 1960s.

The data plotted in figure 1–5 show the decline in speculation
in much more detail than the averages in the table. For each commod-
ity, crop-year annual average speculative indexes are plotted for the
period 1964–1977. For all three commodities, the time-ordered obser-
vations show increasing balance in commercial uses. That is, ordering
the observations from left to right along the horizontal axis is not a
bad proxy for identifying them by years. With that identification,
the data there clearly reveal the relative decline in speculation, with
the observations from the more balanced and more recent markets
lying closest to the dashed line defining minimal speculation.

These comparisons serve to emphasize the need to consider a

market's composition and balance in determining its degree of spec-
ulation. Having done this, one wants to draw conclusions about
market performance from the comparative indicators. In the present
context two aspects of the possible linkage beg for attention. First,
are there measurable differences in pricing performance between
markets like those for grains and livestock with their disparate levels
of speculation? Second, are the declines in speculation on the grain
and oilseeds markets related to any aspect of pricing performance?
Unfortunately, very little research has attempted to examine the
possible relations between market performance and composition.

The observed decreases in speculation in the grain and oilseeds
markets have been associated statistically with increased price vari-
ability during the day, with other measures of price volatility and
trading activity held constant. Given that these three markets evidenced
relatively low levels of speculation and significant declines in spec-
ulation in recent years, the results were taken to suggest that spec-
ulation had become inadequate, unable to absorb commercial demands
without significant, albeit short-run, price effects.

It is important to place these results in perspective. Causality
was not established, merely statistical association. Further, no studies
have been made of the relation between price volatility and the
degree of speculation. It seems likely that there would be wide ranges
of speculative accommodation of commercial positions that have no
price effects. If the association reported here is evidence of a relation
between inadequate speculation and price volatility, it is also likely
that excessive speculation may be associated with increased volatility.
The data from these markets are simply not from markets with exces-
sive speculation. The absence of research notwithstanding, the concept
of excessive speculation has a long history in the regulation of futures
markets.

Excessive Speculation and the Role of Speculative Position Limits.
Congressional concern about commodity futures markets dates to
the late 1880s and arose from the widely held perception that futures
markets were speculative markets. In fact, the first futures bills to
be seriously debated in Congress—the Hatch and Washburn bills in
the House and Senate—were bills to tax speculative purchases and
sales of grain and cotton futures contracts discriminatorily. Cowing
reports that the bills passed their respective houses of Congress by
substantial majorities—80 percent of Congress favored them—but
ultimately failed because the vote to suspend the rules at the end of
the Fifty-second Congress to give the House time to consider differ-
ences in the two bills fell short of the required two-thirds majority.[32]

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The Grain Futures Act of 1922 was the first legislation authorizing federal regulation of futures markets. The constitutional authority for such regulation came from commerce clauses in section 3 of the act: futures transactions are

> affected with a national public interest; . . . that the transactions and prices of grain on such boards of trade are susceptible to speculation, manipulation, and control, and sudden or unreasonable fluctuations in the prices thereof frequently occur as a result of such speculation, manipulation, or control . . . and that such fluctuations in prices are an obstruction to and burden upon interstate commerce in grain.[33]

Section 3 of the present legislation, the Futures Trading Act of 1982, is virtually identical, although specific references to grains have been deleted in favor of more general terminology. The Grain Futures Administration, though largely an oversight agency, was empowered to collect reports of individuals' trading activity as needed for market oversight and to require exchanges to maintain records.

Major review and revisions of the legislation, the Commodity Exchange Act of 1936, added more specific antispeculative clauses, empowering regulators to establish limits on the amount of futures contracts in a single commodity an individual speculator could own at the end of the day or could trade during the day. Bona fide hedgers were exempted from the so-called position limits, and, since the distinction required a definition of hedging, the section went on to define hedging.

Whether by design or not, the 1936 act thus isolates a concern separate from manipulation, which is itself dealt with at length in later sections of the act. Bona fide hedgers are, for example, not exempted from the prohibitions against manipulation, and Johnson notes that at least half the alleged manipulation cases brought under the act have been cases against hedgers.[34] Such allegations almost always focus on delivery situations and concern substantial positions held in the underlying physical market as well as the futures market.

The perceived need for the new section arose largely from the results of a detailed analysis of two "unusual" price episodes in the 1925 and 1926 wheat markets. The analysis, summarized by Hoffman, indicated a substantial positive relation between changes in positions of large traders (those owning 500,000 bushels or more) and daily price changes and an even greater degree of association with position changes of very large (2 million bushels) traders.[35] In addition, the net positions of large traders were compared to price

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changes over time. Petzel's recent analysis of the data from the 1925 episode confirms a significant degree of same-day correlation between position changes of the twenty largest speculators and price changes. He found no evidence, however, of significant lead or lag cross-correlations; hence, causality between the positions and prices cannot in fact be deduced from the data.[36]

Nevertheless, these two episodes created significant concern about the effects on markets of very large speculative positions, whether or not such positions were established with the intent or even the result of manipulating prices. Perhaps the clearest example of the distinction drawn by this section of the act is in its best-known violation. In 1976 the Hunt family was found to be in violation of the speculative position limits in soybeans, holding an aggregate position of 22.7 million bushels, which is substantially above the limit of 3 million bushels. Even though the aggregate position was large, price manipulation was never alleged.

Speculative position limits were originally established at 2 million bushels on the major markets. The level reflected the high correlation found between prices and positions of the largest speculators in the two earlier (1925 and 1926) episodes in the wheat market. The initial limits have been revised only in the past decade to 3 million bushels, and limits were established only for commodities regulated by the Commodity Exchange Authority. More recently the CFTC has required that position limits be established for virtually all futures markets, directing the exchanges to establish limits for all commodities for which there are no federal limits. In addition, the restriction on the amount of trading during a trading session has been removed. Only positions open at the end of the session are limited.

Limits on the positions of individual speculators as distinct from other traders required, perforce, a definition of bona fide hedging. The remainder of section 4a in the act defined legitimate commercial uses that would be exempt from speculative limits. The early definition of hedgers was quite restrictive, including only those who actually owned the underlying commodity, who had fixed sales commitments, or who produced the commodity. Subsequent revisions broadened the definition somewhat by including those who might use futures to cover prospective needs of the commodity, as for example, in processing. Such positions were limited to twelve months' normal requirements. In 1974 specific legislative definitions were removed, and the new CFTC was directed to promulgate regulations defining bona fide hedging transactions and positions. The new regulations significantly broadened the definition of hedging,

including for the first time cross-hedging as a legitimate commercial use.

The difficulties with this approach are clear. Almost any definition of bona fide hedging will be restrictive—some legitimate commercial uses will be excluded. The closer the identification of futures positions with either actual or prospective cash market positions, the more restrictive will be the definition. Second, the historical record shows that changes in the established limits are very infrequent and generally not responsive to changing levels of market use. When established in 1936, the 2-million-bushel limits constituted some 1.5 percent of the average open contracts in the Chicago wheat market and 3.0 percent of those in corn. In 1977–1978 the new 3-million-bushel limits were still only 1.4 percent of the average open interest in wheat and 0.5 percent in corn. Even a 3-million-bushel position today is not nearly so large as a 2-million-bushel position was in 1936. A related problem is whether "large" should be defined in relation to the futures market alone or whether some reference to the physical market is appropriate. The potential price effects of a large speculative position must surely differ according to whether the underlying commodity is in short supply or is ample.

Definitional difficulties aside, a concern over excessive speculation is in fact a concern about large speculative positions and their disruptive potential in a market. Regulation of excessive speculation is regulation of large traders. In this view, the pork belly market is not excessively speculative, nor are waves of public speculation in specific markets matters for concern. More generally, there is no direct connection in this regulatory view between hedging demands in a market and levels of speculation. In at least one respect this separation is justified. There are no examples of futures markets that continue to exist only as speculative markets. If substantial commercial use does not develop on a new market or commercial use declines on an existing market, the market declines. Nevertheless, studies of the relation between pricing performance and the levels and composition of overall speculation would surely be useful in establishing the need for and appropriate design of controls on speculative excesses.

Conclusions. Speculation on commodity prices occurs with or without futures markets. There can be no doubt that a futures market increases such speculation since a potential futures speculator need not invest in facilities to produce, store, market, process, or otherwise use the commodity. It remains to consider the effects of futures markets on the process of commodity price formation. Narrowly

conceived, the issue is whether futures markets and the accompanying increase in speculation stabilize or destabilize commodity prices. "Narrowly" is used advisedly—speculation on futures markets affects the stability of commodity prices only through its effects on the allocative decisions of commercial users. As Gray notes, price variation over time will change only insofar as hedgers change their buying and selling decisions to reflect changes in their rates of production or consumption of the underlying commodity.[37]

The Role and Effects of Futures Markets in Commodity Storage

A futures market provides simultaneous quotations of value for a commodity deliverable at successively distant dates. This proposition, though so basic as not to need statement, indicates that important economic effects of futures markets derive from their role in facilitating storage decisions in markets for storable commodities. This section begins by describing the relations among futures prices, first for perfectly storable commodities like gold and silver and then for storable agricultural products. Pricing characteristics with and without futures markets are considered, and the particular effects of futures markets on storage decisions and hence on prices are derived. Finally, the empirical evidence of these effects is summarized.

The focus in this section is on holders of stocks, their willingness to carry inventory over time, and the role of futures markets in their decisions. To the extent that futures affect storage decisions, prices of the commodity over time will also be affected. In empirically assessing the effects of futures markets in this regard, however, it is not possible to isolate their storage effects from the concurrent influences of improved information, a centralized marketplace, and more efficient speculation. For example, the analysis of storage decisions suggests that futures markets reduce seasonal price fluctuations for storable commodities. Much the same conclusion is reached, however, in arguing that futures markets improve the information content of market prices by reducing transaction costs. Thus, although the focus here is on commercial uses of futures and their implications, the more general context of the empirical assessments cannot be ignored.

The Theory of the Price of Storage. The difference between two simultaneously quoted prices for successive delivery dates for a storable commodity must relate to the costs of storing that commodity between the two dates, as long as supplies of the commodity are ample. Consider, for example, the prices of silver deliverable in June

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and September, both quoted in June. Silver is perfectly storable, is continuously produced, and is virtually always available in ample quantity. (The only recent exception to the assumption of ample supply was the extraordinary accumulation of silver by the Hunt family in 1979–1980.) In this circumstance arbitrage can be relied on to ensure that the difference in price between two futures contracts is no more or less than the costs of storage. If the difference widens beyond costs, it is a simple matter to buy the nearby future (June), sell the more distant (September), accept and finance delivery of silver in June, and redeliver in September. If the difference is less than storage costs, it clearly pays to defer actual purchases, buying instead the more distant (but underpriced) future. As long as supplies are ample, anyone who desires to own silver will buy it through futures purchases until the full storage costs are reflected in the price differences.

The costs of storage that determine the spread are physical storage costs (warehousing and insurance) plus financial costs. Physical costs are constant for silver, but financial costs are not. Even with a constant interest rate, changes in the price of silver imply changes in financing costs and hence in the full costs of storage. With changing interest rates as well as changing silver prices, the spreads between delivery months will vary substantially, although the variation is directly related to interest rates. In examining futures price differences in the gold market, for example, Gray and Rutledge found that 85 percent of the weekly variation was explained by variation in short-term interest rates.[38]

The relation between futures prices for a storable agricultural commodity was first investigated by Holbrook Working.[39] His analysis showed that the difference between two simultaneously quoted prices for wheat with different delivery times was directly related to the level of private or free stocks of wheat available at the nearby delivery date. The price difference is thus a market-determined price of storage. If supplies are large, the market's price of storage approximates the total costs of storage, as in the silver market. In these circumstances hedging of stored wheat ensures a return to storage that covers costs and merchants are encouraged to store wheat that is currently in surplus. If, however, current supplies are relatively small, the market's price of storage is less than the full costs of storage and can be negative. In these circumstances an owner of hedged wheat earns a return on storage less than that required to cover the full costs. The market-determined disincentive for continued storage is the amount by which the market's price for storage falls below the full costs of storage. This amount is determined by current supplies.

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As in the silver market, arbitrage can be relied on to prevent the difference from exceeding the full costs of storage. Unlike silver stocks, however, wheat stocks vary significantly during the crop year, and with increasing scarcity arbitrage cannot prevent the difference from declining to less than full costs. As scarcity increases, the owners of the remaining stock place more and more value on the flexibility their ownership provides. New orders can be more readily accommodated and processing operations more nearly planned if, in growing scarcity, the merchant actually has the requisite stocks. Ownership yields convenience in these circumstances, and the degree of benefit increases with decreases in available market stocks.

For seasonal commodities, then, a third element in the cost of storage is the so-called convenience yield. In periods of ample supply the convenience derived from actual ownership is zero. With decreasing supplies convenience increases, and the net marginal costs of storage decline. Because scarcity is relative, there is no upper bound on the potential value to a merchant of ownership. Hence there is no lower bound on the possible negative difference between futures prices for a seasonal, storable agricultural product. Negative prices of storage, sometimes called inverse carrying charges, occur regularly in grain markets—reflecting seasonal, temporary shortages of grain. In his analysis of the wheat market, Working found that the degree of inverse in price between a nearby and a more distant future reflects the extent and significance of current storage.

Working summarized the relation between futures price differences and stocks of a commodity in the so-called supply-of-storage curve shown in figure 1–6. The relation shifted during the thirty-year period of his analysis, but its implications are clear. Stocks levels and price differences are closely related in a very nonlinear fashion. Large stocks will be carried between crop years when the market's price of storage covers the full costs of storage. For example, the large wheat carryouts of 1892 and 1893 in Working's figure constituted more than one-half of the average annual wheat production for that period.

Since Working's analysis, supply-of-storage curves have been estimated for a number of commodities. The empirical relation is almost always estimated by using year-end stocks of the commodity and the price difference between the last old crop future and the first new crop future. Even in a year of relatively small production, stocks immediately after the harvest are normally plentiful, and the markets nearly always reflect full carrying costs during this period. Significant variation in year-end stocks is common, however, and permits a clear view of the underlying relations. Examples of more

FIGURE 1-6
RELATION OF WHEAT STOCKS TO CARRYING CHARGE
IN CHICAGO WHEAT FUTURES, 1892–1932

Price difference between July and September wheat futures
(September over or under July, in cents per bushel)

Total Stocks July 1 (million bushels)
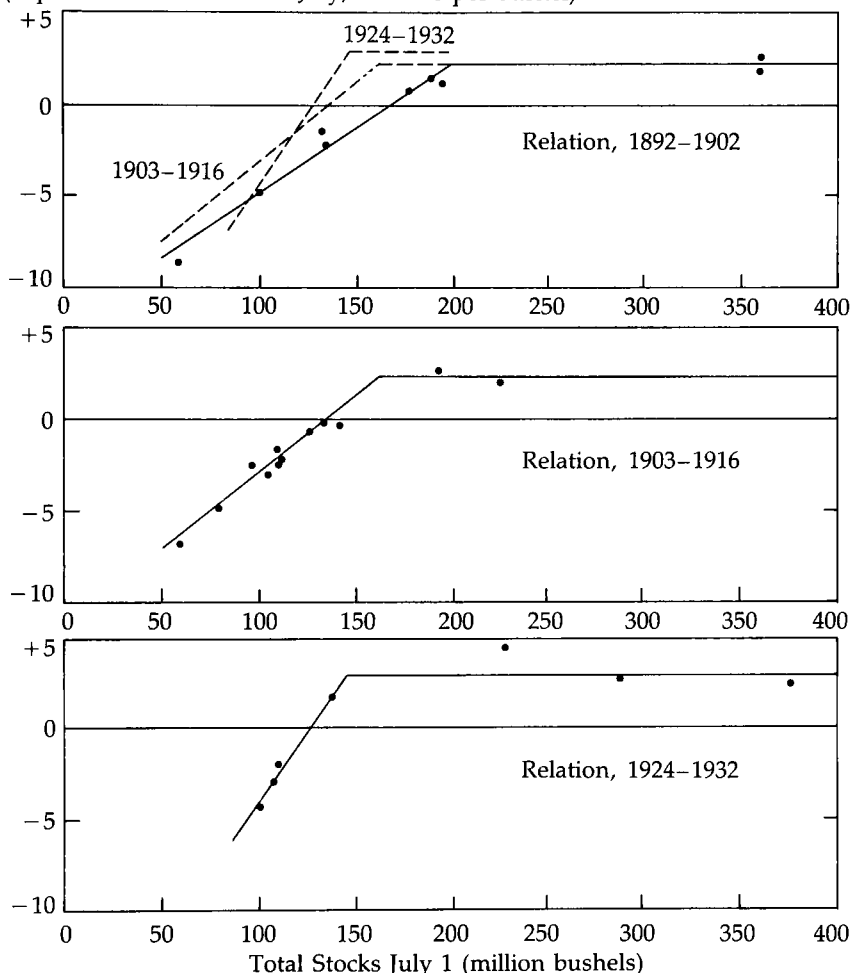
SOURCE: Holbrook Working, "Hedging Reconsidered."

recent estimates of supply-of-storage relations are available for wheat, cocoa, coffee, and cotton.[40] The analyses are not identical; each commodity and time period introduces its own complications. In more recent analyses adjustments in the observed price differences must be made for interest rate variation and its effect on the financial

component of storage costs. In many markets government agencies have become significant owners of commodity stocks, and total stocks must be adjusted by the percentage of government ownership each year.

In addition, Weymar demonstrated the logical necessity of including expectations in explaining observed price spreads.[41] For example, an analysis of the September quotations of the May/July wheat spread requires estimates, in September, of stocks expected in May. Similarly, if the price difference covers a fairly substantial period, for instance a December/July spread in wheat, events anticipated between December and July must have an influence. These effects are particularly important in the imported commodity markets, where the level of stocks on a particular date in the future depends heavily on shipments anticipated before that date. In such circumstances it is also true that the surplus or shortage reflected in a specific level of stocks will depend to a significant extent on the shipments expected after that date. With these caveats, the main point is that the observed price differences are reliable reflections of current surplus or shortage.

The Role of the Price of Storage in Facilitating Storage Decisions. The remaining question is how futures markets affect merchants' storage decisions. Stocks of a seasonally produced, storable commodity will vary during the year and between crop years with or without a futures market. In the absence of a futures market, the price difference important in storage decisions is that between today's cash price and an expected price. Simply stated, if prices are expected to increase, merchants are willing to carry more stocks than if they are not. Brennan provided empirical evidence of such storage relations in estimates of the relation between monthly expected price changes and levels of stocks for cheese, butter, and eggs—markets that did not have active futures markets.[42] The estimated relations (not reproduced here) are very similar to the supply-of-storage curves described earlier. Thus futures markets do not determine whether storage will occur but affect the decision to store and the predictability of storage returns.

In the absence of a futures market, the storage return is speculative and depends entirely on events that occur after the decision to store or not is made. With a futures market, storage returns can largely be determined at the time the decision to store is made if that decision is hedged with a classic, arbitrage hedge. The evidence presented earlier was clear: returns from hedged storage were

substantially more predictable and stable than returns from unhedged storage.

A futures market facilitates storage decisions through the substantial guidance it provides about prospective returns and through its substantial reduction of risks. It is the combination of these effects that is important. The price-of-storage relations show that futures prices reflect current surplus and shortage well. They thus guide inventory decisions in a rational way. In periods of surplus the market reflects full carrying charges and thus induces storage. In periods of shortage less than full costs are available, inducing merchants to sell unneeded stocks. The more severe the current shortage, the stronger the market-reflected inducement to bring stocks to the market. That the storage decision can be hedged implies that risks are reduced and more storage is likely at all prices. The analysis suggests that effects of a futures market on prices for a storable commodity are both seasonal and annual. Prices within crop years are stabilized, as are those between crop years.

Analyses of Seasonal Price Variation. It is logical to look first at within-season price variability to assess the effects of futures markets. Since most of the major accumulation and decumulation of stocks of a commodity occurs within the crop year, the strongest effects might be expected within the crop year. Prices of storable commodities as diverse as wheat, onions, and pork bellies have been examined. In each analysis seasonal variation in prices during a period before futures trading was introduced was compared with that from a period after trading began. Interpreting the results of these analyses requires a number of caveats, which are addressed after the evidence is summarized.

Although onions are a relatively obscure commodity, legislative concern over futures trading and its eventual ban occasioned several analyses of their seasonal price volatility. In the first, Working demonstrated that the period of futures trading was associated with much reduced average seasonal price changes in the onion market.[43] Gray's analysis of data from a period of years after the futures market had been closed established that the onion market returned to its earlier pattern of volatility.[44] Their combined results are shown in figure 1–7. The period 1949–1958, during which the onion futures market was active, was the period of the least seasonal variation in prices. Variation both before and after was significantly higher.

Most of the commodities for which these tests are applicable are commodities in which futures trading originated and for which price

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FIGURE 1–7

INDEX NUMBERS OF MARKETING SEASON PRICES RECEIVED
BY FARMERS FOR ONIONS, SELECTED PERIODS, 1922–1962

Index
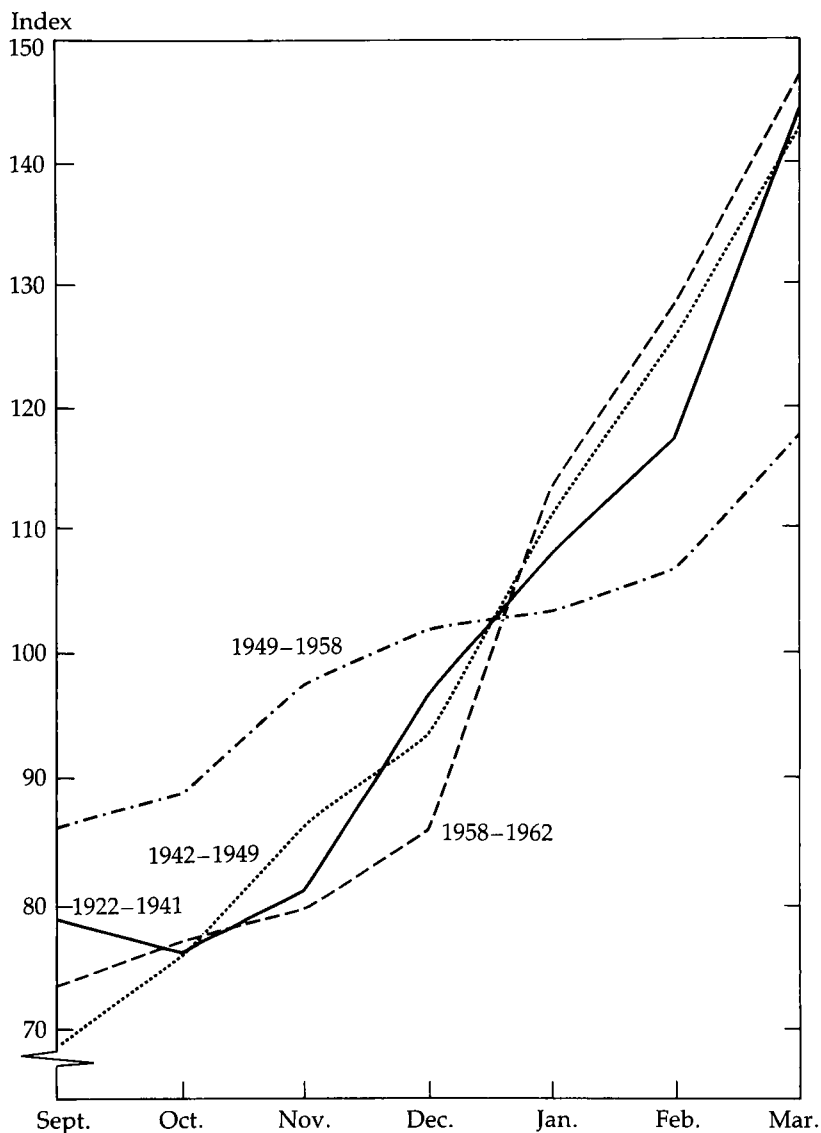
NOTE: The periods of no futures markets are 1922–1941 and 1958–1962; 1942–1949 was a transition period with little trading, and 1949–1958 was the period of active futures trading in onions.
SOURCE: Gray, "Onions Revisited."

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data are difficult to assemble. Tomek, however, examined an eighty-one-year record of monthly wheat prices from 1841 to 1921, a period that spanned the development of the wheat futures market, and found a significant reduction in seasonal price variation after futures markets became active.[45]

In addition to assessing the effect of futures markets on seasonal price change, research has also examined their related effects on short-run price volatility. Working, for example, found that a significant decline in within-month price volatility was also associated with the period of active futures trading in onions. Powers found significant declines in monthly volatility in pork belly prices after the introduction of futures markets. Taylor and Leuthold examined monthly and weekly price variation in the live cattle market from periods before and after the introduction of futures trading.[46] Both series showed significant declines in short-run volatility in relation to annual average price levels. Live cattle, though not storable in the usual sense, can be fed for varying periods, and current prices in relation to very near-term futures can guide the pace of marketing finished animals in a way analogous to storage decisions. As the authors all note, however, the effects on volatility measured by weekly and monthly data cannot be separated from the effects of improved information per se.

As the analyses demonstrate, futures markets are significantly associated with both reduced seasonal variation and short-term volatility of commodity prices, as predicted by the supply-of-storage and arbitrage arguments. The term "significantly associated with" is used advisedly here, since before-and-after comparisons cannot establish causality directly. Tomek's analysis of the wheat market is the most extreme case in point, of which Tomek himself was very aware. He notes that "observed changes in price behavior cannot be attributed solely to the advent of futures trading" and goes on to discuss changes in transportation and especially communications that also occurred over his data period and would be expected to have similar effects on prices.[47] Similar caveats, though perhaps not so extreme, apply to the other analyses as well. Although causality cannot be inferred in each case, the consistency of the evidence among commodities is reassuring and does suggest causality. The results are as predicted, and, to my knowledge, no contradictory results have been found for any storable commodity.

Analyses of Annual Price Variation. It is not so straightforward to evaluate the effects of futures markets on price variation between years. Futures markets provide forward prices as well as indications

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COMMODITY FUTURES MARKETS

TABLE 1-2

Comparative Responsiveness of Exports and Year-End Stocks to Increases and Decreases in Domestic Production of Wheat, Four Major Exporting Countries, 1970–1971 to 1980–1981
(millions of metric tons)

	Average Deviation from Trend Values		Average Change in Year-End Stocks
	Production	Exports	
United States			
Increased production	3.1	−2.6	5.1
Decreased production	−3.0	1.8	−5.7
Canada			
Increased production	1.7	0.2	−0.3
Decreased production	−2.9	−0.3	−4.1
Argentina			
Increased production	1.3	1.0	0.0
Decreased production	−1.0	−1.0	0.0
Australia			
Increased production	2.1	0.5	1.1
Decreased production	−1.7	−0.4	−2.0

Source: Adapted from Anne E. Peck, "Futures Markets, Food Imports, and Food Security," Agriculture and Rural Development Division Working Paper no. 43, World Bank.

of storage returns and, as between crop years, also influence prospective production and consumption decisions. Their effects on year-end storage levels are thus not separable from simultaneous supply-and-demand adjustments, and any effect on annual price stability is a joint effect. The difficulty in directly evaluating the between-year storage effects of futures markets seems even more perverse given that the supply-of-storage curve is usually estimated by using year-end stocks data and thus specifically depicts the stocks and stabilization possibilities of interest.

The clear responsiveness of U.S. stocks to prices of storage led Working to analyze the price responsiveness of storage in relation to that in other countries where there were no futures markets.[48] He concluded that nearly one-half of the year-to-year changes in U.S. production of wheat were absorbed in changes in year-end stocks. In contrast, the other major wheat-exporting countries exported most of their production variability, and adjustments in stocks were of

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TABLE 1–3

COMPARATIVE RESPONSIVENESS OF EXPORTS AND YEAR-END STOCKS
TO INCREASES AND DECREASES IN DOMESTIC PRODUCTION OF CORN,
TWO MAJOR EXPORTING COUNTRIES, 1970–1971 TO 1980–1981
(millions of metric tons)

	Average Deviation from Trend Values		Average Change in Year-End Stocks
	Production	Exports	
United States			
Increased production	10.8	0.9	3.4
Decreased production	−9.4	−1.0	−6.4
Argentina			
Increased production	1.2	1.0	0.1
Decreased production	−1.5	−1.2	−0.1

SOURCE: Adapted from Peck, "Futures Markets, Food Imports, and Food Security."

only minor importance. Comparable analyses of more recent data from both the corn and wheat markets are shown in tables 1–2 and 1–3, although their interpretation is admittedly less straightforward. The basic data on production, exports, and stocks change for each country are adjusted to deviations from a linear trend. For each country, the eleven-year period (1970–1971 to 1980–1981 crop years) is divided into years of production increases (more than trend) and those of production decreases. For each group of years export deviations (from their trends) and stock changes were recorded, and all three series were averaged by group to obtain the numbers in the tables.

For U.S. wheat years of increased production averaged 3.1 million metric tons (mmt) greater than trend values. Exports in these years actually declined by 2.6 mmt, and stocks necessarily increased an average of 5.1 mmt from the previous year. Similarly, in years of decreased U.S. production, exports increased, and again stocks absorbed both changes. This responsiveness on the part of U.S. stocks holders contrasts sharply with stocks behavior among the other major exporters. Argentina shows the sharpest difference. Virtually all the changes in production were absorbed by exports, and none appear in stock changes. Storage in both Canada and Australia was somewhat more responsive, but neither country absorbed

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nearly as much of its own instability as the United States did. International comparisons in the corn market are more difficult because the United States is by far the largest exporter. Comparisons between the United States and Argentina are shown in table 1–3. Though perhaps less meaningful, the contrast is striking. Stock changes absorb almost none of the production variability in Argentina but account for about half the variation in the United States.

The differences in the role of storage among the major grain exporters are striking. The United States is the least destabilizing major exporter in the world market and is the only exporter with active grain futures markets. Not all of this contrast, of course, can be attributed to the greater responsiveness of stocks in the United States induced by futures markets. Some of it must be attributed to government policies, especially to the marketing boards prevalent in the other major exporters. Combined, however, with Working's evidence from the earlier period—a period during which such interventions were not significant—the evidence is very suggestive. If permitted to do so, storage responds to prices in a way that will stabilize international commodity markets and is particularly impressive in the presence of futures markets.

The Role and Effects of Futures Markets in Forward Pricing

The preceding section focused on storable commodities, the meaning of futures price relations for those commodities, and the effects of futures markets on storage decisions and hence on price stability over time. By rationalizing storage decisions, futures markets led to more stable seasonal price variation. Most storable commodities are annually (rather than continuously) produced, are stored for consumption during the crop year, and are carried in significant but variable quantities between crop years.

Examining the role of storage between crop years is only a partial analysis of the effects of futures markets. In addition to the stocks response, the additional crop year brings new production and the prospect of substantially revised consumption needs. A complete analysis must thus consider the effects of futures markets not only on stocks carried between crop years but also on the amounts of new production and prospective consumption. This section considers these issues. With a focus on production and consumption adjustments facilitated by futures markets, it is no longer necessary (or desirable) to restrict the discussion to storable commodities. In fact, the economic analysis is considerably simplified if interseasonal storage is not a factor. Therefore, this section begins with an analysis of

the effects of futures markets for nonstorable commodities and then considers the additional effects of storability. The simple models lend themselves to a welfare analysis as well, and tests of market perform- ance are summarized in that framework.

Nonstorable Commodities. Conceptually, the role of futures markets for nonstorable commodities is simple—they reflect in prices antic- ipated supply and demand. A necessary complexity when dealing with agricultural products, however, is to include the requisite lags between the planning and realization of production. With annual, nonstorable crops, the lags connect crop years—production realized in the current crop year was planned in the preceding crop year. For livestock commodities the lags are more complex; they can include feeding periods, farrowing decisions, and even decisions to expand or contract the breeding stock. The analysis here presents the simplest case; modifications required for the more complex relations are then considered.

In the absence of a futures market, producers must form an independent expectation of what prices will be at harvest at the time they make their production decisions. As D. Gale Johnson noted nearly forty years ago, resources will be misallocated to the extent that producers' forecasts are retrospective and not prospective.[49] Resource misallocation implies significant social losses. The situation is illustrated in figure 1–8 with linear supply and demand curves. The supply curve is an expected supply relation in the sense that actual supplies will depend on a number of unpredictable events after planting and before harvest. Market demand is also an expec- tation. In any particular year it could shift up or down depending on consumer incomes, prices of other goods, or the level of export or import demand. Confronted with these prospective relations, the rational producer would conclude that the expected price is $\bar{P}$ and would gauge planned production accordingly to $\bar{Q}$. Any other expected price would be self-defeating. A higher one would induce more production, which would cause lower realized prices at harvest. Similarly, a lower expected price would create higher prices. Thus, if all producers were rational in the sense that they anticipated the effects of their collective production decisions, they would plan to produce an amount $\bar{Q}$ of the commodity.

In contrast with the model, numerous studies of producers' supply response in this situation have found that producers form their expectations of next year's price on the basis of current and past prices. Perhaps the most widely (and successfully) used model of the decision is Nerlove's adaptive model, which assumes that

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FIGURE 1–8
INTERTEMPORAL PRICING OF A NONSTORABLE COMMODITY
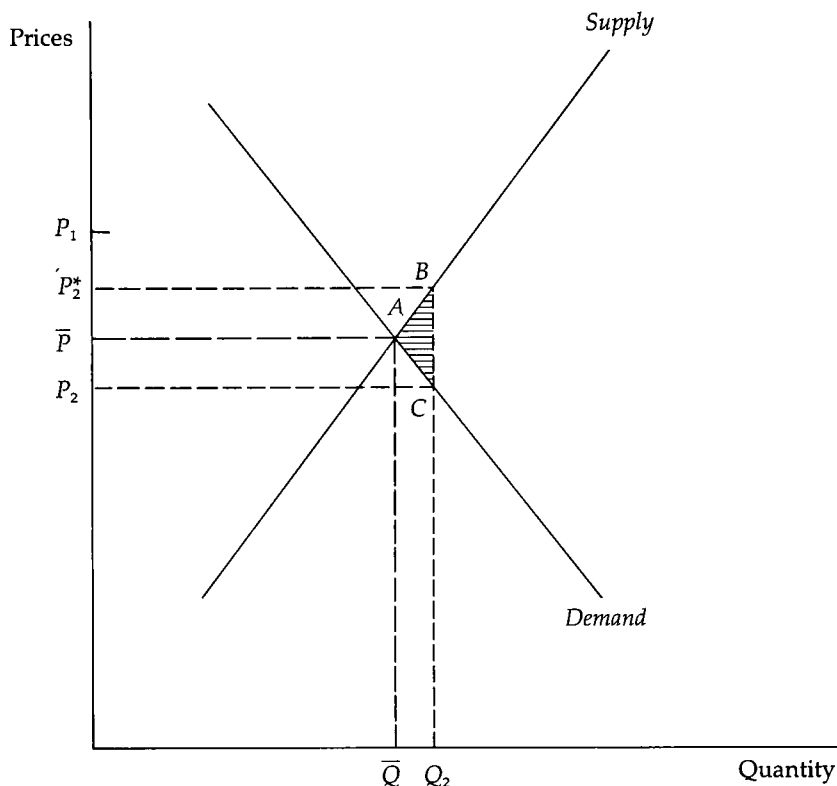
producers change their view of expected price from year to year by a proportion of the error they made in the preceding year.[50] The assumption implies that producers' expected price is a weighted average of past prices, where increasingly distant prices have decreasing effect. A number of other approaches have also been employed to extrapolate expected prices from past prices, but the Nerlovian model has remained one of the most popular.[51] It is particularly convenient for present purposes, although similar results could be derived with any of the extrapolative models. The essential point is that all such models assume that current and past prices are used to formulate expected prices.

Suppose that current prices in the figure are P_1, perhaps because

of an unfavorable growing season and a consequent relative shortage. If producers had expected a price of $\overline{P}$, the adaptive expectation model implies that some portion of the forecast error ($P_1 - \overline{P}$) will affect their forecasts for next year, for example, to a price P_2^*. This expected price calls forth too much production given an unchanged demand relation, and actual prices in the next period will be P_2. The forecast, P_2^*, was self-defeating, eliciting a supply that could not be sold at that price. As is well known, such a response causes social losses and unnecessary price instability, which could be eliminated with a rational forward price, that is, one that reflected the joint actions of producers and consumers. If the expected price for the second period was $\overline{P}$, there would be no ex ante misallocation of resources or social loss, whereas the losses associated with P_2^* are the shaded area on the figure.[52] After the fact losses may still occur if demand shifts or if yields are not as expected, but such losses cannot be reduced by planting-time adjustments of producers.

The question then is to what extent a futures market influences these relations. A particularly interesting example derives from the potato market and Maine potato futures trading. In the 1940s a futures market in Maine potatoes began on the New York Mercantile Exchange, becoming an active market in the early 1950s. Delivery months began with the harvest in November and extended until the end of the storage season in May. Although no fall potatoes are stored from May until the new crop is available in November, the futures contracts for that crop traded well in advance of the producers' production decisions in the spring and continued trading over the growing period. The first new crop future, the November contract, began trading in the preceding November or December, well in advance of the April planting decision. Thus the market provided a continuously available forward price by which producers could gauge their production and which was not linked to current conditions by interyear storage.

Before planting decisions, the market had to reflect both the prospective supply relation and the response of consumers once that supply was available. Tomek and Gray analyzed the preplanting quotations of the November futures and compared them with the eventual harvest prices. The results are shown graphically in figure 1–9.[53] The preplanting (February 28) quotation of the November future is plotted against the final closing price, both deflated by an appropriate index. The data, taken from the 1953–1971 crop years, form a nearly vertical line: the preplanting futures price was a virtual constant from year to year. Every year the preplanting quotation was

FIGURE 1-9
FEBRUARY 28 AND FINAL CLOSING PRICES OF NOVEMBER POTATO
FUTURES, DEFLATED BY ANNUAL INDEX OF PRICES RECEIVED FOR ALL
FARM PRODUCTS, 1953–1971
(dollars per hundredweight)
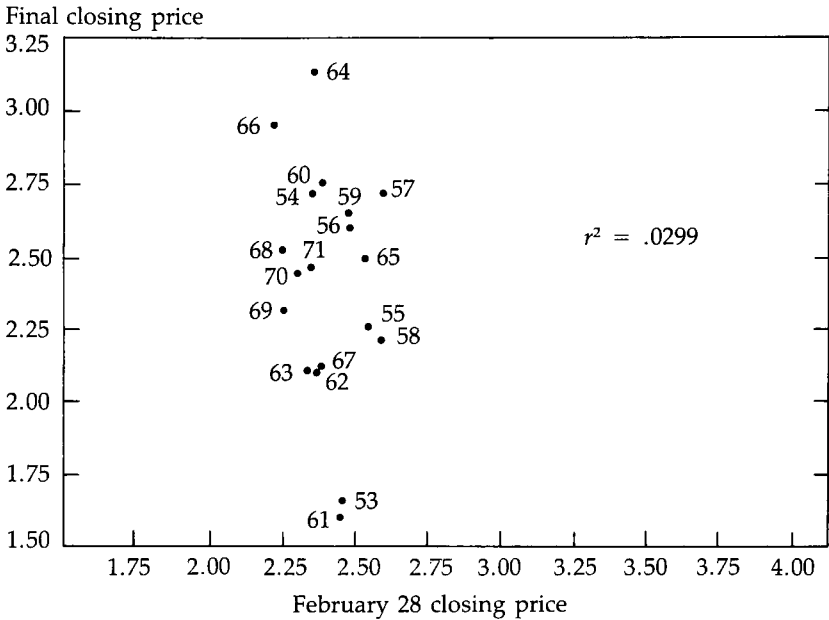
SOURCE: Roger W. Gray, "The Futures Market for Maine Potatoes: An Appraisal," *Food Research Institute Studies*, vol. 11, no. 3 (1972), p. 324.

approximately the mean price, $\bar{P}$. Actual prices at harvest varied from year to year, causing the vertical scatter of observations in the figure.

The effects of this market-determined forward price on Maine potato producers' decisions were dramatic. Before futures markets, a Nerlove adjustment model explained some 75 percent of the annual acreage planted, and both past prices and acreage were significant explanatory variables.[54] Gray's reestimates of the supply relation with data from the period of an active futures market found that neither lagged price nor lagged acreage coefficients of the same Nerlovian model were significant explanatory variables and that the regression explained only 7 percent of Maine producers' decisions.[55] Maine acreage planted to potatoes had virtually stabilized during the period of an active futures market. The rational, if constant, futures prices

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had completely eliminated the retrospective responses of Maine growers. In this circumstance the ex ante social loss was eliminated because, every year, the futures price was the mean price, $\bar{P}$.

The rational anticipation of Maine potato prices and the consequent stabilization of production are even more interesting when they are set against the continued retrospective responses of potato producers in other major producing areas. Other production was not deliverable on the Maine contract, and producers, especially in the West, did not respond to the futures prices. Gray's estimates show that they continued using current and past prices to form an expectation and hence their production continued a cobweb-like, feast or famine cycle. Consequently, harvest-time potato prices continued in a cobweb-like pattern. The price pattern was so pronounced that the last year's price could predict some 53 percent of the variation in the current year's price, whereas the predictive accuracy of the preplanting futures prices was nil. Not only was the market providing a rational forward price, but it was doing so at the same time that reasonably reliable predictions of the eventual outcomes were available. Cash prices in the current year were a good, if perverse, forecast of prices in the following year. Futures prices, however, remained responsive to both demand and potential supply adjustments and therefore remained at equilibrium prices at least until actual production decisions had been made. Such prices, though not useful as predictions in this circumstance, dramatically affected production decisions.

The Maine potato market is not the only example of a nonstorable commodity in which a futures market was introduced. Fresh eggs, live hogs, and live cattle are other examples, but these systems differ significantly as well. They are nonstorable commodities in the sense that, once delivered on a futures contract, none can be redelivered on a subsequent contract. Unlike potatoes, however, they are continuously produced through production processes that can be significantly altered at several stages. For live animals, decision points include breeding, putting on feed, the rate of gain while on feed, and variable marketing weights. As a consequence, there is substantial short-run price responsiveness in actual marketings of the finished animals.[56] For fresh eggs, the key decisions are about the size of the laying flock, and they are price responsive nearly continuously.

Because of the relatively complicated production processes, models of the potential allocative effects of futures prices are much more complex analytically. There have, however, been a number of evaluations of the "forecasting" performance of futures prices on these markets—to what extent they anticipate eventual cash prices—and

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comparisons of futures price performance with that of other potential forecasts. Such comparisons are clearly relevant to the question at hand, although their interpretation is not always straightforward.

In the simplest system futures prices were useless "forecasts," and better forecasts were easily constructed; nevertheless, the futures prices were rational and optimal in a welfare sense. Martin and Garcia provide comparative analyses of the forecasting performances of the cattle and hog markets.[57] In both markets and over almost all forecast horizons (one to eight months before maturity of each future), futures prices were found to be unbiased estimates of the eventual cash prices. Futures prices more than two or three months from their expiration date, however, were not good predictors—they explained eventual prices very poorly. In fact, lagged values of the actual cash prices did nearly as well and in some cases were even better.

The relatively poor forecasting performance of futures prices for hogs is further developed in the work of Leuthold and Hartmann.[58] They compared futures prices with forecasts from a purposely simple recursive model of supply and demand for hogs and found that their simple model predicted subsequent prices consistently better than futures prices did. They report 125 percent and 141 percent rates of return from trading futures based on the forecasts of their naive model. The evidence leads them to conclude that the live hog market is inefficient in an information sense since it does not reflect publicly available information well.

The interesting aspects of the evidence are the parallels with the evidence from the potato market. Potato futures prices were unbiased but useless predictors—results not very dissimilar from Martin and Garcia's results. Better predictions were available, as for the Leuthold and Hartmann results. In both cases the better forecasts were based on models tht precluded any response by producers to the predicted price. These similarities to the potato market results certainly suggest that the live animal markets are also rational pricing markets. Rational forward prices allocate productive resources optimally, and thus a major effect of futures markets for nonstorable commodities is in rationalizing production decisions. The evidence also shows that rational prices may not be informationally efficient; as Stein has shown, however, efficiency is irrelevant to the welfare effect of futures markets, which is the present concern.[59]

Storable Commodities. The possibility of storing the commodity between production periods fundamentally alters the preceding analysis. For a storable commodity, relations among futures prices of differing maturities reflect the market value of continued storage and

provide a reliable guide to the returns that can be expected from that storage. Evidence adduced in the preceding section showed that storage decisions within crop years were affected and resulted in less extreme seasonal price changes. The focus here is on the additional effects of a futures market on consumption and production decisions, that is, on the expectational character of futures prices.

The simplest storable commodity is one like corn or wheat that is produced once a year, is consumed continuously, and can be stored between seasons. The possibility of interyear storage requires consideration of the supply and demand expected in the following year; indeed, in the extreme, all future years must be considered.[60] For present purposes the level of stocks carried out of the second year is assumed to be known, fixed at average levels. The assumption is a strong one, but it simplifies the discussion immeasurably without significantly changing the conclusions. With the assumption, there are still seven important relations: supply and demand in the present period; supply and demand in the next period; market-clearing equations for each period; and a cost-of-storage relation.

The basic model is shown in figure 1–10. To focus on the interyear adjustments and the role of futures markets, supply in the current year (Q_1) is assumed known. In other words, this year's harvest is in, and current period prices must be determined. These prices depend on the consumption this period but also on expected prices next year, since some of the crop may be carried forward into the following crop year. D_1 and D_2 are the anticipated demand relations in each year, and Q_2 is the expected supply relation in the second period. The lower panel shows the cost-of-storage relation SS with stock levels shown as deviations from equilibrium levels. In equilibrum production is $\overline{Q}$ in each period, prices are $\overline{P}$, and stocks do not change between periods. That is, since there is incentive to store neither more nor less than average, the stocks relation is shown in this form.

To consider the effect of storage on commodity pricing, suppose first that the present crop is larger than normal, Q_1^+. If storage were not possible, prices in the present period would decline to A, all the excess would be consumed in the present period, and there would be no residual effects on expectations in the coming crop year. With the possibility of storage, some of the present surplus can be transferred to the next period. As prices in the present period decline toward A, owners of storage space will begin to have an incentive to store. How much they will store depends on the marginal costs of storage and the realization that the amount stored from the present period will add to surplus in the next period and have significant

FIGURE 1–10
INTERTEMPORAL PRICING OF A STORABLE COMMODITY

Two-Period Pricing Relation
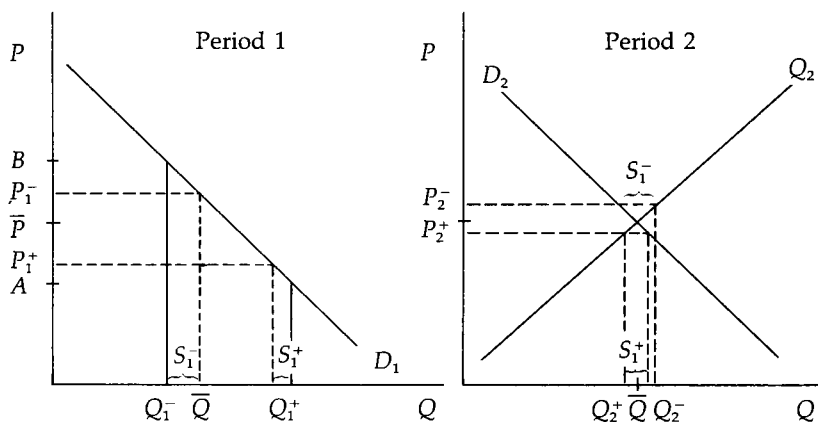
Storage Market Equilibrium
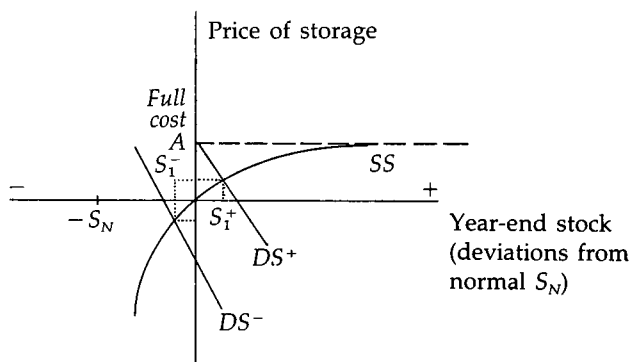
price effects then. If marginal storage costs were as much as $\bar{P} - A$, there would be no incentive to store any of the present surplus. If storage were costless, nearly all the present period surplus could be carried forward.

The net demand for the commodity to put into storage this period is the difference between excess supplies in the present period and excess demand for those supplies in the next period. The net demand

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for storage, assuming that the current surplus production is Q_1^+, is shown as DS^+. At a cost of storage A, there will be no increase in the normal levels of stocks carried forward. The slope of the storage demand relation is a function of the slopes of the demand and supply relations in the two periods. The storage supply relation, SS, is nonlinear, a direct reflection of the relation between futures prices and stocks. The supply-of-storage curve becomes nearly horizontal at the full costs of storage and, conversely, becomes nearly vertical as stocks are drawn down to zero. Stocks are exhausted at $-S_N$, since the diagram is drawn in deviations from long-run equilibrium stock levels (S_N). The shape underlines a fundamental asymmetry in the pricing of storable commodities—there is a defined limit on how much can be used from storage in a current shortage but no limit on how much can go into storage in a current surplus.

Given excess production in the current period, equilibrium in the storage market occurs at a level of storage S_1^+, an increase over normal levels. This amount is shown as a reduction in the amount consumed in the first period, resulting in a current price of P_1^+. Simultaneously S_1^+ must be added to the expected supply-and-demand equilibrium in the second period, since the market is assumed to return to equilibrium at the end of that period. Clearly prices in the next period will be below equilibrium as well, so that less is produced and the excess supply from storage into the period (S_1^+) can be consumed. The net effects are shown as P_2^+, the price expected to prevail in period 2. Total consumption in the second period will be Q_2^+ plus S_1^+, the excess will be entirely consumed in the second period, and the market will be in equilibrium again. The fundamental point is that current period surpluses affect prices both in the current period and in subsequent periods.

Similar arguments link the two periods in situations of current shortage as well, exemplified by the effects of current production Q_1^-. The full effects of the shortage (a price of B) are not felt in the current period. Rather, normal stocks are drawn down by an amount S_1^-, and prices increase only to P_1^-. Prices in the second period are also increased by an amount sufficient to replenish stocks to their normal levels and satisfy demand, to P_2^-. The demand for storage in this case is shown as DS^-. As before, the current situation affects events in the next period. With a current shortage, current stocks can be drawn down with the knowledge that increased production can replenish them in the next period. Since replenishment requires price incentive, prices in the subsequent period will be expected to be higher as well.

The ability to draw on current stocks in times of shortage is

rather like being able to borrow production from the next period to supplement current consumption. Because the next period's production can be expected to replenish stocks, given an appropriate price incentive, current stocks can be depleted. Obviously present stocks limit how much can be borrowed. If, for example, the shortage were more severe than that shown as Q_1^-, current prices would be affected proportionately more than the next period's expected prices. The limits on the extent to which stocks may be depleted thus distinguish the price effects of shortage from those of surplus crop years.

The fundamental asymmetry is neatly illustrated with data from two crop years in the soybean market, 1972–1973 and 1975–1976. At the end of the 1972–1973 crop year, stocks of soybeans were exceptionally low, whereas those at the end of the 1975–1976 crop year were exceptionally high. The carryout of 59.6 million bushels from the 1972–1973 crop year was in fact the smallest during the decade, and the carryout of 244.9 million bushels from 1975–1976 was the largest. Futures prices in May of each year reflected these extremes as well. In early May 1973 the price of the nearby July future was $6.93¼ per bushel, and the first new crop future, the November future, traded at $4.69. The difference, $2.24¼, was a clear signal of the extent of the current shortage and of stocks being drawn down from normal levels. In early May 1976, on the other extreme, July soybean futures traded at $4.89¼ while November futures were priced at $5.06½. The carrying charge of $0.17¼ was a clear reflection of the present surplus.

In both years new information came into the market in May that raised overall prices. In 1973 the July future rose from $6.93¼ to $10.58 by the end of the month. In 1976, the July future rose from $4.89¼ to $5.79. In both years the November future rose as well— but in varying amounts. In May 1973 the new crop November future increased in price from $4.69 to $6.31, an increase of only $1.62 as compared with the $3.64¾ increase in the July future. In May 1976 the November future rose from $5.06½ to $5.91½, an increase of $0.85, which was nearly equal to the $0.89¾ increase in the July future. Because stocks were ample in 1975–1976, the link between the present crop year and the next year was very close indeed. In 1972–1973, however, the current shortage was already severe, and new information affected prices in the current crop year much more strongly than in the next since there was little more that could be borrowed from the next crop year.

In spite of the asymmetry in storage effects, the analysis clearly shows the relatively greater importance of rational forward prices in

markets for storable commodities. In their absence misallocation occurs in both production and storage decisions, thereby compounding welfare losses in relation to the nonstorable case. The empirical question is thus the extent to which futures prices for storable commodities are rational. Two sorts of evidence are available on rationality—bias and predictability. The extensive literature on the question of bias in futures prices was discussed above, since the question has traditionally been considered in the context of speculative profits. It is sufficient to note here that the evidence shows that bias is not characteristic of futures prices. Biases have been found, but they appear to reflect particular market circumstances or time periods and not general tendencies. Thus futures prices generally guide production and storage decisions in appropriate ways, and there are no ex ante social losses.

The remaining question is the degree of predictability of futures prices. Tomek and Gray provide evidence for two storable commodities, corn and soybeans.[61] Because their concern is with production decisions and related interyear storage amounts, they compare the pricing of the new crop futures contracts before planting dates with their subsequent harvest prices. For corn the first new crop future is the December contract; for soybeans it is November. Prices of each contract on the preceding April 30 predate planting decisions for both crops. Expiration prices of each future (in December or November) are taken to represent harvest values for each of the crops. Their evidence shows no significant difference between the preplanting and expiration quotations of the futures. Whereas the earlier bias evidence included all futures, Tomek and Gray's evidence shows that the new crop futures in particular are unbiased.

In addition, the preplanting prices are shown to be both as variable from year to year and good predictors of the postharvest prices. In fact, Just and Rausser provide more general evidence that futures prices predict subsequent prices as well as the forecasts of several of the well-known forecast firms.[62] These results are in sharp contrast to the results from the potato market discussed earlier. The contrast in comparative variability and predictability is a reflection of the contrasting nature of rational forward prices in the two markets. With nonstorable commodities there is no link between production periods—what happens in this period will have no effect on decisions or prices in the next period (except insofar as a current change is a permanent change in a demand or supply relation). In contrast, current market events do influence next period prices and vice versa when the commodity is storable precisely because it is storable. Rational

forward prices for storable commodities must be nearly as variable from year to year as the subsequent, realized market prices because of the inventory links.

With inventories linking crop years, futures prices for these commodities also turn out to be good predictors of subsequent market prices. Tomek and Gray found that the preplanting quotations of new crop corn and soybean prices explained 65 or more percent of the subsequent harvest values. In addition, the coefficients of a linear regression showed that the relation was not significantly different from a 45-degree line, in contrast to the nearly vertical line apparent in figure 1–9 for prices from the nonstorable commodity. As the model suggests, there is predictable variation in prices from year to year, and the evidence shows that futures prices reflect much of that variation.[63]

Tomek and Gray also note that inventories facilitate adjustment to new information entering the market between the planting and harvest dates. If, for example, late spring rains significantly damage the emerging crop, prospects for realizing all the intended production diminish, and futures prices for the new crop year will immediately increase. Because of the inventory link, prices in the current crop year will also rise, and the degree of similarity in their increase depends only on the extent of current surplus or shortage. The concurrent rise in present prices will reduce current consumption and increase the amount of stocks that were previously intended to be carried into the next year, thereby ameliorating to some extent the full effects of the new information. In Tomek and Gray's terminology, the presence of inventory adds a "self-fulfilling" dimension to the preplanting "forecast" of new crop prices. Inventory adjustments to new information will help ameliorate the effects of the information, thereby improving the predictive quality of futures prices.[64]

In spite of their comparatively good performance, futures markets for storable commodities should not be viewed as independent forecasts. Futures prices for storable commodities are themselves directly linked to current cash prices according to the supply-of-storage relation. As a general rule, therefore, there is no more expectational information in futures prices than in current prices. For example, a futures price for a storable commodity can never "forecast" an increase in current prices more than the full costs of storage because futures prices can never exceed current prices by more than the costs of storage. Thus information implying that prices should increase raises both the current cash price and the futures price, more or less maintaining the cost-of-storage difference. Differential effects can occur,

as evidenced by the earlier example from the soybean market, but these are generally small in relation to the effects on prices reflected in both the cash and the futures prices. Put another way, expectations are reflected nearly equally in current and in futures prices. In this sense cash prices will be nearly as good predictions of subsequent cash prices as futures prices.

Although the performance of futures prices for storable commodities differs substantively from that for nonstorable commodities, prices for both appear to be rational, thereby facilitating optimal production, consumption, and storage decisions. An interesting consequence of rationality in futures markets for nonstorable commodities was the suggestion that rational prices may not at the same time be informationally efficient. In a number of cases substantially better forecasts of subsequent prices could be found. Gray found a similar circumstance in the pricing performance of the wheat market during the period of the government price support program in the 1950s and early 1960s.[65]

During that period government support prices for wheat were set consistently above market-clearing prices. Producers had approximately six months after harvest to decide whether to put their wheat "under loan," thereby removing it from the market. Prices were relied upon to induce farmers to commit wheat to the loan program; although not all producers elected to participate in the program, participation was sufficient to ensure that the support price could be reached. Immediately after harvest, cash market prices reflected total available supplies because producers had six months in which to decide whether to put their wheat under loan. It was well known that market prices would be at or near loan levels within six months, since the wheat was removed from the market and placed in the loan program. That is, by December wheat prices would be at or above the loan price.

With the government program "forecasting" prices, what price did the futures market reflect? Gray found evidence that prices of the December future rose consistently and significantly from July to December.[66] In July the December future could be priced at no more than the full costs of storage above cash prices in July, prices that had to remain "low" so as to induce farmers to move wheat into the loan program. If the July quotation of the December future had been at loan price levels, July cash wheat prices could have been no less than the cost of storage below the futures price, and there would have been no incentive for farmers to move their wheat under loan. In December, with no wheat removed from the market, cash prices would have had to fall to their original market-clearing levels. In

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other words, for the futures market to have "forecasted" the known price effects of wheat moving under loan would have been self-defeating. Such prices would not have reflected participants' response to them.

Summary. The most important economic effects of futures markets are those that can be adduced from the behavior of producers, storers, and consumers. While it is true that a futures market facilitates increased speculation on the prices of the underlying commodity, fundamental effects on prices occur only if producers, consumers, and storers change their economic decisions in response to the prices reflected on these markets. Futures speculators do not store excess supplies of a commodity today for later use. Elevator owners, merchants, and farmers store the commodity. Thus fundamental changes in the seasonal variation of a commodity's price or in stocks held between years must be traced to the indirect effects of the market's prices on the incentives for elevators and others to store the commodity. For both storable and nonstorable commodities, the most important effect of a futures market is in providing rational forward prices. Such prices eliminate ex ante social costs associated with economic responses based on retrospective expectations and the evidence confirms that futures prices for both storable and non-storable commodities have performed this fundamental economic function well.

The Price Discovery Role of Futures Markets

The preceding section analyzed the effects futures markets have on the production, consumption, and storage of commodities. Little has been said about the price discovery process per se, except to note that the results of the empirical measures of these effects cannot be attributed to commercial decisions alone. Even though these are clearly the decisions that actually alter the allocation of commodities over space, time, and form and of the productive resources devoted to them, the decisions are based on prices, and speculation is a central element of the price discovery process. Futures markets lower transactions costs and thereby facilitate speculation. Uniform contract terms, clearinghouse offset and third-party guarantee, and low margins all contribute to lowering the costs of participation and thereby increase market liquidity and price efficiency.

Speculation and Market Liquidity. Estimates presented earlier suggested that approximately 50 percent of the speculation on an

active futures market is market making by individuals who provide immediate market entry or exit for commercial and other speculative traders. In an active futures market, orders entering the trading ring can be executed at prices very close or identical to the price of the most recent transaction. Unlike specialists in securities markets, market makers in futures markets are not assigned to specific commodities, and there is no formal quotation of a bid-ask spread. Thus the level of activity in a market is an important determinant of the amount of market making it attracts and will support. Hence the level of activity directly affects the costs of entering or exiting from the market.

In an active market scalpers stand ready to buy or sell at a price no more than the minimum permitted change (a "tick") below or above the last quoted price. Such trading is not information trading—a pure unit-change scalper hopes that no new information will emerge while a position is open. Consider an active market with numerous competitive scalpers. Suppose that the last transaction is an outside order to sell, executed by a floor broker and taken by a market maker. In an active market numerous market makers would have been willing to accept the order at the bid price, and it is likely that if the next order were also a sell order, it would be taken at the same price. If the next order were one to buy, it would be accepted at the market maker's asked price. Roll diagrammed the sequence of possible prices as in figure 1–11.[67]

In reality, of course, a scalper's trading is more complex. Market value changes continuously during the day, and indications of changing value may be reflected in the sequence of orders as they appear

FIGURE 1–11
IDEALIZED SEQUENCES OF TRANSACTIONS PRICES IN A
LIQUID MARKET
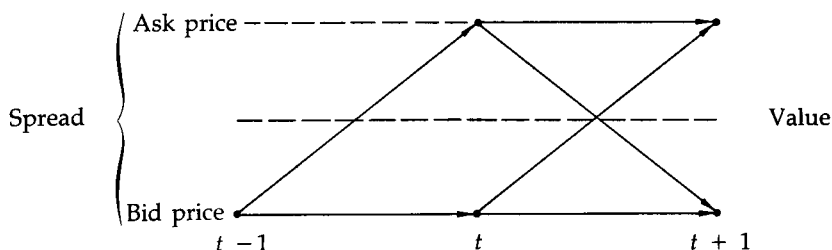
SOURCE: Roll, "Effective Bid-Ask Spread."

in the trading pit. Thus scalpers must also be aware of emerging price trends, even those of short duration, and must adjust their trading accordingly to be successful. Direct empirical evidence of scalpers' trading activity is limited, but Working and more recently Silber have analyzed the trading records of "representative" scalpers.[68]

Although the records are from very different markets (cotton and a stock index) and time periods (the 1950s and the 1980s), the similarity in their conclusions is remarkable. Both found that the average return per contract traded was less than the value of the permitted unit price change. In addition, Working concluded that a trader's returns were due solely to his success in pure scalping, with the net gains thus derived offset to a certain degree by net losses resulting from intraday price trends. Judging the emergence of such price trends is indeed important; they were the source of great variation in the trader's daily returns and of net losses. Silber's evidence from the "representative" index trader is even clearer on this point. The average profit on trades held open longer than three minutes was negative. Trades of shorter duration were consistently profitable. Recognizing trends is important to a scalper; they are the source of consistent losses. Such evidence suggests that scalpers specialize in skillfully accommodating the very short-term imbalances in orders coming into the market. The longer a position is open, the greater the chance of a change in real price, and the greater the likelihood of loss.

Active market making clearly creates liquidity, and hence the costs of market entry and exit are low. In the comparatively active markets from which the records of representative traders were taken, these costs clearly approached the minimum—the smallest permitted price change. There is little additional direct evidence of the costs of entry and exit in futures markets. Bid-ask spreads are not quoted publicly, and it is consequently difficult to assess the contribution of market makers directly. Roll's model suggests, however, that indirect evidence is available in the record of price changes. In the absence of new information, all paths shown in his diagram are equally likely, and he shows that the correlation coefficient between successive price changes will be $-\frac{1}{2}$.[69]

Thompson extends the model considerably, applying it to futures markets in particular and to markets with less activity in which the real value is changing with the sequence of market orders.[70] In these cases she shows that the correlation between successive price changes will still be negative, although its magnitude will decline markedly. Thus the correlation coefficients between price changes from the

TABLE 1-4
Comparative Statistical Dependency in Price Changes from Active and Inactive Futures Markets, 1974

Commodity	Contract	Number of Observations	Serial Correlation Coefficient	F-Test
Wheat	July 1974	30,198	−0.30	2994
	September 1974	27,670	−0.24	1734
Corn	July 1974	29,508	−0.33	3573
	September 1974	20,902	−0.19	807
Oats	July 1974	7,145	−0.12	112
	September 1974	6,166	−0.09	51
Soybeans	July 1974	28,358	−0.30	2769
	September 1974	8,498	−0.00	0
Soybean meal	July 1974	8,996	−0.38	1535
	September 1974	6,392	−0.24	390
Soybean oil	July 1974	22,597	−0.29	2005
	September 1974	11,953	−0.10	126
Broilers	July 1974	5,224	−0.21	247
	September 1974	4,945	−0.13	81

SOURCE: Adapted from tables 1–3 in Martell and Helms, "Reexamination of Price Changes."

record of transactions during the trading day can be expected to be negative in a trading market. They will be more negative the more actively the market is traded, and therefore such analyses may indirectly reveal the effects of active market making.

Four sets of transactions-based price data have been analyzed.[71] Although the specific purpose of each of these analyses was not necessarily investigating market making, their results provide remarkably consistent insights into the effects of market making on price formation. The specific results of two of the studies are considered below.

In table 1–4 Martell and Helms's results for seven commodities and two contracts are summarized. For the July 1974 contracts the data are all price change transactions recorded from February 19, 1974, through June 28, 1974. For the September contract the period was February 19 through August 20, 1974. In all cases there were more transactions in the July than in the September contracts, even though data for the latter contract include two more months of prices. The contrast is particularly sharp between the soybean contracts,

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TABLE 1–5
RELATION BETWEEN MEASURES OF DEPENDENCY AND AVERAGE BID-ASK SPREADS IN THE COCOA AND COFFEE FUTURES MARKETS, 1981–1983

Period	Contract		Number of Transactions		Serial Correlation Coefficients		Average Price Change	
	Near	Distant	Near	Distant	Near	Distant	Near	Distant
Coffee							(cents/pound)	
January 12–16, 1981	March	September	1,023	193	−0.16	−0.06	0.081	0.199
June 8–12, 1981	July	December	882	447	−0.02	−0.09	0.149	0.182
January 11–15, 1982	March	September	1,281	35	−0.21	−0.05	0.065	0.272
June 7–11, 1982	July	December	1,360	258	−0.07	−0.02	0.095	0.206
January 10–14, 1983	March	September	1,192	98	−0.15	−0.11	0.059	0.152
June 6–10, 1983	July	December	1,222	352	−0.12	−0.03	0.064	0.096
Average			1,160	231	−0.12	−0.06	0.086	0.186
Cocoa							(dollars/metric ton)	
January 12–16, 1981	March	September	1,019	151	−0.09	−0.01	1.16	2.38
June 9–12, 1981	July	December	598	476	−0.09	0.00	1.69	1.46
January 11–15, 1982	March	September	1,359	53	−0.13	0.04	1.08	2.48
June 7–11, 1982	July	December	831	200	−0.04	0.10	1.27	2.02
January 10–14, 1983	March	September	1,992	114	−0.11	0.14	0.97	2.85
June 6–10, 1983	July	December	1,840	856	−0.07	−0.01	1.41	1.89
Average			1,273	308	−0.09	0.04	1.26	2.18

SOURCE: Adapted from tables 1–3 in Thompson, "Price Changes from Transaction to Transaction."

where the July contract was more than three times as active as the September.

The serial correlation coefficients clearly reflect these comparative levels of activity. In all cases they are negative, and in all but one they are very significant. More important, serial correlations between price changes in the more active July contracts are always greater than those for the less active September contracts. In each case the serial correlation is less significant in the less active contract. The extreme contrast is again soybeans, where price changes in the markedly inactive September contract show no significant market-making pattern. An active market is supported by scalping, and such speculation ensures that prices fluctuate in a very narrow bid-ask difference around equilibrium prices. Less active markets have significantly less scalping, and market entry costs are commensurately higher.

Thompson's empirical analysis of coffee and cocoa data completes the connection between market liquidity, serial correlation measures, and bid-ask spreads. Her data consisted of six sets of transactions prices from the coffee and cocoa futures markets, where each set contained observations from both a nearby, actively traded contract and a more distant, inactive contract (see table 1–5). As the averages indicate, the nearby contracts were four to five times as active as the more distant contracts. Thompson also examined serial correlations between the price changes. The results are consistent with the previous analyses; in the more active contracts price changes show a much stronger degree of dependency as they fluctuate between bid-ask bounds. An interesting aspect of these correlations is that they are comparatively much smaller than those reported in any of the other liquidity studies. The transaction record from the Coffee, Sugar and Cocoa Exchange, however, records all transactions, whereas that from the Chicago Board of Trade includes only transactions for which there was a change in price. Thus the correlations here can be expected to be lower.

The contrast in performance between active and inactive months is similar to that noted earlier. For coffee transactions-based correlations are nearly twice as large for the nearby, active months as for the distant, inactive ones. For cocoa the contrast is even greater, with negative correlations consistent only in the active contracts. Finally, Thompson provides several direct measures of the average bid-ask spread in each market and thereby connects the observed patterns in dependency with entry and exit costs. One measure, the average of the absolute values of price change, is shown in the table. In both markets, the average price change between transactions is

markedly smaller in the more active contracts, averaging 50 percent less than changes in the much less active markets.

Taken together, the studies of individual traders' records and of statistical relations among prices confirm the important contribution of market making to the formation of continuously available and reliable prices. Active speculative trading in markets results in prices that fluctuate within very narrow bands, reducing market entry and exit costs to a minimum. In markets with much less speculation, prices fluctuate more widely and irregularly around equilibrium values, resulting in much larger market entry costs.

Price Efficiency. Speculation, particularly position trading and spreading, influences the process of price discovery as well. The two preceding sections have focused on seasonal price formation and storage adjustments to futures prices and on effects between crop years to incorporate both prospective production and consumption decisions and storage decisions. In both sections speculation was incidental to the analyses, which concentrated on adjustments by firms within the industry. There is no doubt, however, that the seasonal and annual price-stabilizing effects derived in each case are directly or indirectly related to the increased price speculation facilitated by a futures market as well as to commercial firms' adjustments.

Fundamentally, futures markets are expected to increase the information content of market prices. They can do so in at least three ways. First, transactions costs (that is, market entry costs) are typically lower in an active futures market than in a spot market, and the incentive for all participants to search for more and better information is consequently greater. Second, futures markets attract additional speculation, of which some is responsible for the marked decrease in transaction costs but some is willing to assume longer-term (at least overnight) price risks as well. Since speculative returns depend solely on trading expertise, the incentive to search for information is greater than for a commercial firm whose profits are relatively less dependent on trading returns. Thus the added speculation is expected to improve the amount of information reflected in the current price. Finally, in processing information, speculators must take into account the responses of all participants to the prices implied by any single piece of information, thus improving the rationality of market prices.

All of this suggests that market prices ought to become more informationally efficient with the introduction of futures markets. Fundamental models of supply-and-demand relations, when they are linked by storage possibilities, will continue to show a theoretical

dependency between current and some past prices, but the number of significant past prices should decline, as should the degree of importance of specific lagged prices. Cox tested this proposition directly with weekly cash price data from six markets—onions, potatoes, pork bellies, hogs, cattle, and frozen concentrated orange juice—for which there were periods before and during futures trading (and, for onions, a period afterward).[72] Initial regressions from periods before futures trading examined the dependency of current prices on past prices for five through ten previous weeks. The model that best explained current price from past prices in the period before futures was then applied to data from the period after futures trading.

In all cases comparisons of the estimated coefficients showed that current prices became less dependent on past information with the introduction of futures trading. In fact, the entire set of coefficients on prices lagged more than one week were found not to contribute significantly to explaining current prices during the futures trading period. Not all dependencies were eliminated within the period of Cox's analysis. Most of the commodities, however, are nonstorable or semiperishable, and a model of weekly market supply-and-demand relations is likely to contain some production-in-process or storage links that will be reflected in price links. These results thus confirm a consistent and remarkable degree of improvement in the amount of information contained in current prices when futures trading is introduced in a commodity market.

A different approach to measuring the effects of futures trading on the degree of information contained in price focuses on the comparative amounts of unexplainable variation in price before and after futures trading. In tests using weekly data, Powers found that the advent of futures trading reduced the random (or residual, unexplained) variation in live beef prices by nearly one-third, from twenty to thirty cents per hundredweight.[73] The reduction in variation in pork belly prices was nearly one-fourth, from $1.00 to $0.78 per hundredweight. That is, with futures trading there was significantly less unsystematic variation in weekly cash prices.

Finally, the question whether futures prices are themselves fully efficient has been the focus of a great deal of research. In a process first described by Working and later modeled by Samuelson, futures prices ought to fluctuate randomly over time.[74] Since new information bearing on price emerges unpredictably, prices ought to change unpredictably. Fama distinguished three degrees of pricing efficiency: efficiency with respect to past prices; efficiency with respect to publicly available information; and efficiency with respect to all information.[75] They are weak-form, semistrong-form, and strong-

form efficiency, respectively. Most analyses of the pricing efficiency of futures prices have been weak-form tests, examining statistical characteristics of observed (usually daily closing) price changes for deviations from randomness.

Irwin and Uhrig's recent analysis of dependency relations among futures price changes provides a useful summary of the results of standard tests, and their tests of specific trading rules well illustrates the variability in results among commodities and over changing time periods.[76]

The results are more mixed with tests of semistrong-form efficiency, where the behavior of futures prices is examined in relation to a specific information series or to forecasts derived from several fundamental series. Conklin, for example, examined changes in grain futures prices in relation to the weekly release of export sales information and concluded that market prices were efficient with respect to this information.[77] Leuthold and Hartmann's comparison of hog futures prices with forecasts derived from a simple price prediction model showed that substantial profits could be made by trading on the model's predictions and led them to conclude that the hog market was inefficient with respect to fundamental supply-and-demand information.[78] In an analysis of pricing in the soybean complex, Rausser and Carter developed a model based on fundamental information that consistently outperformed futures prices.[79] The authors thus concluded that futures markets in the soy complex did not completely reflect all available information.

Information is, of course, costly to acquire and process in these models, and speculation on futures prices is itself not costless, even though the costs are much reduced with futures markets. Nevertheless, costs do not explain all the documented inefficiencies, and additional studies will no doubt find other information-specific inefficiencies. These additional studies are required, however, to permit more general conclusions. Are the inefficiencies documented so far transitory in the same sense that deviations from random behavior in price changes appear to be largely transitory? Or are these systematic patterns in informational inefficiencies in markets that relate either to commodity characteristics or to observable changes in the important variables influencing prices? Although firm conclusions are not possible on the degree of information efficiency in futures prices, it is clear that these inefficiencies are small in comparison to the overall improvements in pricing efficiency coincident with futures markets.

Conclusions. Taken together, these studies show that futures speculation measurably improves pricing efficiency in commodity markets.

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The resulting futures price series may not be altogether information-
ally efficient, but speculation in futures clearly improves both market
liquidity and the information content of prices. Transactions costs
are reduced—the more active the futures market, the lower market
entry or exit costs are likely to be. These reductions increase the
number of participants and provide greater incentive to search for
relevant information. As a consequence the information content of
market prices is improved.

Conclusions

Futures markets evolved in the mid-nineteenth century with the
expansion of trading in major food and feed grains associated with
the development of the Midwest as a region of surplus agricultural
production. Two critical elements in their evolution were the devel-
opment of recognized grading standards, which led to standardized
contract terms, and the solution to contract default problems through
the establishment of a clearinghouse arrangement. Futures contracts
are homogeneous, specifying uniform grade, location, quality, and
times of delivery. The system of initial and maintenance margins
created with the clearinghouse substantially reduces the incentive
for either buyers or sellers to default on their contractual obligations.
The emerging system of trading thus lowered transaction costs,
promoting a centralized market in place of otherwise fragmented and
illiquid regional markets. Futures markets have thus become the
primary price discovery markets for most of the storable agricultural
products. The futures markets in industrial products, metals, and
livestock products, though later in developing, have assumed a simi-
larly important role in the pricing and marketing systems for those
products.

Although futures markets have become the primary pricing
markets for many commodities, they have not replaced either spot
or forward markets. Both remain important in the marketing of
commodities and are the primary means by which ownership is
actually transferred from producers to processors and consumers.
More important, futures markets are widely used to complement the
fundamental purchase and sales decisions. Futures prices are the
referent prices in all transactions, whether they are for immediate or
delayed delivery, because they provide a standardized, competitively
determined reflection of underlying current and future value.

They do more than provide a referent value, however. Because
futures markets exist, transactions with almost any time horizon can
be agreed to nearly instantaneously. Farmers can, on a moment's
notice, receive a quotation for and sell to their local elevator a crop

that has not even been planted or has not yet been harvested. An importer can purchase an entire year's requirements from an exporter, fixing delivery terms, quality, and prices today even though deliveries are not to begin for six months. All such transactions are facilitated by an actively trading, liquid futures market. Buyers and sellers are both aware of current, standardized values and are willing to commit themselves to transactions quickly because their commitments can be instantaneously hedged in futures with a minimal effect on price.

Futures markets have economic effects both directly on the prices of commodities and indirectly on production, consumption, and storage decisions responsive to those prices. Futures trading measurably improves the process of price discovery. Transaction costs are generally low; consequently the incentive to search for and evaluate market information is high. Analyses have shown that market prices reflect the improved price discovery process in at least two ways. First, current prices have been shown to be more informationally efficient, depending less on prices from more than a period or two before the present observations. Some dependency remains, of course, since fundamental relations require price links between periods. Second, the unexplained component of market price variation is markedly reduced as more systematic, fundamental information is incorporated into current prices. Futures markets facilitate speculation on commodity prices. Nevertheless, it is the increased speculation that improves the informational content of prices and provides the nearly instant liquidity characteristic of actively trading markets.

The indirect effects of futures markets arise because the markets are widely used by firms engaged in the production, marketing, and processing of commodities. Though indirect, these effects are perhaps their most important contributions to the economy. First, futures markets rationalize storage decisions. Futures prices are simultaneous quotations of value for today and for successive dates in the future, given current information. The difference in prices among contracts is itself a price, the market price of storing the commodity over time. Evidence shows a strong positive, though nonlinear, relation between the price of storage and stock levels. The price difference between two futures maturities is an accurate reflection of the present degree of shortage and thus an indicator of the market's need for continued storage. In addition, the availability of a futures market permits individual storage decisions to be hedged and thereby provides a reliably predictable return to storage. Storage decisions are thus more responsive to price, and as a consequence commodity prices have been shown to be more stable seasonally.

Finally, futures prices are themselves anticipatory prices that reliably guide the optimal allocation of resources to the production and consumption of commodities. The effects are most clearly seen in annually produced commodities. Trading in futures contracts that price new crop production is continuous over the production period. Such prices must be rational since they reflect not only anticipated production relations but also anticipated consumption relations. They are not forecasts in the sense that the weather may be forecast; that is, forecasts of the weather have no influence on what the weather will in fact be. Futures prices must reflect the responses they create; they are rational forward prices. To the extent that production decisions in the absence of a futures market rely on price expectations that extrapolate past prices, resources are misallocated, and ex ante social losses occur. A futures market with rational forward prices eliminates those losses, stabilizes annual production and consumption decisions, and thus stabilizes annual prices.

Obviously, not all commodities are affected to the same extent, either directly or indirectly, when a futures market is introduced. The relative contributions depend on the physical characteristics of the commodity. If trading is already centralized and relatively active, there will be little gain from centralization with the institution of a futures market. Even then, however, the characteristically low margins and clearinghouse performance assurances will reduce market participation costs and increase speculative interest. Much of the increased speculation will add liquidity to the market, and transaction costs for all participants will be lower. The effects of futures will also differ for commodities that are storable and those that are not. For storable commodities futures markets serve both an allocative and a forward-pricing function. For nonstorable commodities they can function only as a forward-pricing market. In spite of the basic differences between storable and nonstorable markets, futures markets have stabilized prices to an impressive degree in both.

The effects of a futures market in a commodity marketing system derive largely from the way it is used by the commercial firms in the industry. There is no question that futures markets support a greater amount of speculation than physical markets; nevertheless, it is also true that futures markets depend on commercial use for their continued existence. The total activity in futures markets clearly depends on hedging, not speculative, patterns of use. As the underlying physical market changes, so also must contract terms in the futures market. If they do not change commensurately, the contract's value to firms will decrease, and ultimately the market will close. Often those same commercial interests have been vocal in their oppo-

sition to a new market. One is reminded of Rothstein's grain merchant who in 1858 thought the "new" system of trading was merely a "kind of gambling operations of selling ahead" and twenty-five years later wrote to convince others of its usefulness "if we do not want to speculate."[80]

Opposition to futures has continued, seemingly unabated—the introduction of each new market seems inevitably to be accompanied by often very vocal opposition from important segments of the underlying physical markets. Although the organized efforts of the onion growers and shippers are the only instance where such opposition actually closed a market, the countless hearings on the effects of the Maine potato and live cattle futures markets are symptomatic. Commercial interests do not always welcome the new system of trading. The more concentrated the market, the more vocal the opposition. Nevertheless, in most instances firms come to find futures markets very useful and adjust their buying and selling in accordance with the opportunities for increased risk management and more flexible decision making. These adjustments have brought increased price stability to markets where fluctuation has been associated with large social losses in the misallocation of productive resources.

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