THE ECONOMICS OF COMMODITY FUTURES MARKETS: A SURVEY

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This article reviews some of the literature pertaining to futures markets. After briefly considering how the evolution of the institution of futures trading has required changing interpretations, we devote a longer section to the interplay between theory and evidence concerning intertemporal price relationships. While disputed and inconclusive interpretations persist, Working's theory of the price of storage and his revision of hedging doctrine are clear landmarks of progress in understanding these price relationships. We deal separately with hedging theory; then with the relation between futures and price variability; and finally with the stochastic attributes of futures prices.

Anyone who undertakes a survey of the literature on futures trading is confronted with an amorphous and rather disjointed list of publications. It was tempting for us to try hanging as much of this list as we could on the framework provided by Working [139], as probably the only "history of economic thought" pertaining to futures. We resisted this as a formal procedure, seeking by our own devices to bring some order out of the chaos; but probably have not in the final analysis strayed very far from Working's outline. In the process we have permitted the emphasis upon certain questions in the literature (e.g., futures and price variability) to be more fully reflected than may be warranted by the importance of the question, but we have not escaped the point of view imparted by our own studies in this field. In particular, the inquiry into future markets initiated by Working at the Food Research Institute more than 40 years ago became a continuing focus of his attention, which has been shared and extended by us and others here. We readily acknowledge that this circumstance may have influenced our own perspective, and we have felt at liberty to inject our own interpretations into this paper.

Another consequence of our own concentration upon this area of study has been a tendency to think of it as neglected by most economists. A glance at our bibliography (which is inevitably incomplete) might suggest the contrary—that it may even have been studied out of proportion to its importance. Surely, however, there remain interesting unanswered questions. One conclusion to which our studies have drawn us, but which is not elaborated in this paper, is that the chief distinction between futures markets and alternative forms of commodity marketing lies in the greater degree of competition in futures—or if one prefers, their

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closer approach to the competitive model. Alternative candidates for "chief distinction" might well be that futures markets are "forecasting agencies" (which they are not); or that futures markets afford superior means of coping with price risk (which they undoubtedly do, but which is not, in our view, a highly important distinction). To the extent that the study of futures markets may have been neglected, we suggest that some tendency to confine analyses to a price forecasting model or an insurance model could explain this. We think that a price determination model is not only more appropriate; but that economists who adopt this way of looking at futures markets will find them more interesting. The recent casting of futures price behaviour in the martingale model (see section 7) may reflect just such arousal of interest.

Given the choice, we should much prefer to attract interest than to do justice to the literature. If this article is a sufficiently inviting sampler to encourage others to delve further into the literature, or to organize any teaching around the available writings, we shall not feel apologetic about its incompleteness or imbalance as a survey.

1. EVOLUTIONARY ASPECTS

Certain features or stages in the evolution of futures trading have some bearing upon economic questions which have arisen in its study, yet little has been written on the history of the institution. It is not even an easy matter, nor necessarily very important, to define futures trading unambiguously; but consideration of its evolution enables us at least to distinguish present practice from its antecedents. Forward trading of one sort or another is of course virtually as old as commerce itself, but markets organized for the conduct of futures trading have become prominent only during the past century. The levels and types of trading on these organized futures markets differ significantly from those observed in other marketing arrangements.

It is first of all clear that futures trading grew out of the merchandising trade already in existence [63, 103, 142]. Merchants, dealers, processors, etc., the regular tradespeople, organized the markets to better facilitate the trading they were already engaged in. An alternative possibility—that they might have been organized by persons outside the trade who were desirous of speculating in price movements—finds no historical support. Among the earliest, and still among the most important futures markets were those for the grains in Chicago. Irwin's contention [63] that these grew out of time contracts conforms much better with the evidence (and logic) than Taylor's earlier interpretation tracing them back to the so-called "to arrive" contracts which were (and are) for prompt shipment (see Working [141], p. 8). It seems clear then that the early futures markets were first viewed as delivery markets, markets upon which contracts contemplating delivery would be undertaken and fulfilled at least in large part by deliveries. Probably not the role, and certainly not the extent of hedging as it presently emerged was contemplated when the markets were organized. They were organized to facilitate the existing

merchandising trade by providing uniform rules governing the transactions (mainly to assure open competition); standards of grade, quantities, and delivery terms; and clearing arrangements whereby the clearing house guaranteed each contract. These features would have refined and perhaps supplanted the pre-existing trade in forward contracts for later delivery, had it not soon become apparent that futures contracts served better as *temporary substitutes* for merchandising contracts, with the merchandising contracts continuing to better serve the purpose of actual delivery. Thus instead of supplanting forward trading, futures markets came to complement the existing trade by enabling traders to conveniently establish prices for a future date in a standardized version of the commodity, against which they could buy or sell for immediate or later delivery at negotiated prices for specific lots, specific as to quantity, grade, location, and time and form of delivery. Futures markets were better adapted to hedging usage than to direct merchandising usage; thus the statistics of all modern futures markets reveal that usually only a small fraction of outstanding futures contracts culminate in delivery.

Hedging proved useful to various participants in the trade in annual crops (where the early important markets developed), from the grower to the final processor, but most of all to the merchant-warehouseman whose function was essentially to store commodities for later resale. He could afford to acquire large inventories if the cash price was low relative to the futures price, hence his acquisitions and dispositions of inventory became closely geared to this "carrying-charge" relationship, which in turn came to reflect closely the aggregate stocks picture. The most important role played by futures markets was in the hedging of inventories, hence it is not surprising that economic interpretations came to focus upon this role. Several important contributions emerged from this focus. Keynes [69] emphasized the enormity of the financial burden posed by the necessity for carrying inventories of annual crops, and correctly pointed out that this burden was shouldered in the futures markets. Hoffman [52] was probably the first to publish evidence of the close seasonal and year-to-year correspondence between stocks of grains and open futures contracts. The significance of this correspondence may not have been fully appreciated at the time, but it came to be recognized as the best general evidence that futures markets are hedging markets [63, 131, 134]. (The alternative view, that futures markets are speculative markets, would require that open contracts reach a seasonal peak prior to harvest, when uncertainty is greatest, rather than at the time of peak stocks accumulation, when the size of crop is much better known.) Irwin [63] demonstrated further that the seasonal accumulations of butter and eggs, which went into coldstorage during the summer months, gave rise to inventory hedging, and hence futures trading in those commodities. And finally the inventory hedging view of the futures markets had its culmination in Working's price of storage theory [127, 129], with the demonstration that the (positive or negative) cash-futures price differential reflected a true price of storage for continuous inventory commodities.

It can already be observed that the practice of futures trading evolved through several stages, whereas the theory did not always afford an explanation of current practice. Futures markets evolved out of the practice of forward trading, and were undoubtedly devised as delivery markets; but the convenience of trading futures combined with the inconvenience of futures delivery shortly dictated that futures contracts be employed as temporary substitutes for merchandising contracts. Subsequently futures markets were long thought of as speculative markets because the evidence that their business was generated out of hedging needs was largely ignored. Meanwhile the function performed by futures markets in guiding inventory levels came to be quite well, if belatedly, understood. More recent practice requires interpretation in terms of the forward-pricing function of futures, as distinguished from nventory guidance, which in some instances cannot be performed because no inventories are carried.

The evolution of trading in egg futures at Chicago provides a good illustration of the adaptation of futures trading to changing commercial needs, and of the requirement that theory be modified as the role of futures trading is dramatically altered. The egg futures market first emerged as an inventory hedging market *par excellence.* Irwin shows that the practice of assemblers, who placed eggs in coldstorage during the flush production period in the spring, for later marketing during the deficit season of fall and winter, provided the basis for egg futures trading. For several decades, this movement in and out of storage was guided by cash-futures price relationships—storage eggs being hedged in futures contracts purchased by speculators. Egg futures deliveries were not provided over the non-storage interval, hence the sole commercial purpose served by the futures market was the hedging of coldstorage stocks. This marketing system was based upon small, sideline enterprises which entailed a natural seasonal production cycle. During the past two decades United States egg production has been almost completely transformed into highly specialized "egg-factories", based upon selective breeding, scientific feeding, and controlled temperature, humidity, and lighting conditions. The rate of lay per hen has been vastly increased, in large part by extending the flush production season to a near even rate of lay the year around. Thus the holding of seasonal surpluses in coldstorage has virtually disappeared, from annual average peak coldstorage holdings of 8 or 10 million cases in the 1930's to current peaks averaging only a quarter-million cases. The present egg marketing system is accordingly geared to the movement of fresh eggs directly into consumption channels.

The egg futures market which served an inventory hedging role was doomed to extinction as the need to carry seasonal inventories disappeared. Egg futures trading declined, although not as rapidly as the inventory hedging declined, since the institutional mechanism whereby outside speculation had been engendered generated a lagged response to the declining need. It became apparent to exchange officials that a futures contract calling for delivery of coldstorage eggs would not survive in a situation where inventory hedging was disappearing. Consequently they introduced a fresh egg futures contract in 1967,

designed to serve the entirely different role of enabling forward-price hedging. Egg producers, users, and retail food chains have reason to price eggs in advance, even though inventories no longer dictate the need; hence a futures market based upon different hedging needs has emerged and is already enjoying substantial trading volume. Clearly a traditional theory which explains cash-futures price differentials as a price of storage[1] cannot be asked to explain price relationship for a commodity which is not stored. Hence the economic theory of futures trading requires amendment, as it has in the past, to accord with evolving practice.

The literature on futures trading owes more than any similar body of literature to the fact that the institution has been periodically attacked in the political arena. These attacks have been based largely upon misunderstanding, particularly the aforementioned misconception that futures markets serve the whims of speculators rather than the needs of hedgers. There have been in consequence numerous efforts to legislate against futures trading (successfully on occasion) and several official investigations which have frequently contributed significantly to better understanding. The early reports of the United States Industrial Commission [112] and the United States Federal Trade Commission [121] provided valuable evidence of futures market performance. Also governmental regulations of numerous futures markets in the United States has occasioned many official investigations which, together with the publication of official statistics, now comprise a very substantial segment of the literature.

Among the concerted attacks upon futures trading was the relatively recent assault upon potato and onion futures in the United States [113, 114, 115, and 116]. This is of some interest as it reflects in part the failure of theory to keep abreast of emergent developments, which we were just discussing. It is not uncommon for a segment of a commodity trade to resist the advent of futures trading, either through misunderstanding or out of a rational fear that trading may become more competitive and thereby threaten an entrenched monopoly. But beyond these considerations, the opposition to futures trading in potatoes and onions also rested partially on the ground that these were not futures markets in the traditional inventory-hedging mould. Many proponents of futures trading in the traditional mould were skeptical of these newer forward-pricing markets, and even some exchange officials were lukewarm in their advocacy of futures markets for these "perishable" commodities. The economic analyses conducted in light of the controversy of the time [38, 39, 137, 140] enhanced the general understanding of futures trading, but did not suffice to spare onion futures trading from statutory prohibition, and also did not differentiate these markets from the traditional inventory-hedging markets as sharply as has subsequent work done by Tomek and Gray [111]. A striking characteristic of the potato futures market is that it emerged from growing-season hedging rather than storage-season hedging. The

[1] This theory is discussed in the next section.

traditional markets for the grains and cotton (as well as butter and eggs) were geared to storage-season hedging. The inventories that built up *after* harvest gave rise to hedging, causing the open futures contracts to correspond with inventories. But hedging in potato futures built up during the *growing* season and reached a peak at harvest time. Thus it rose over a period when no inventories were carried, then declined during the inventory period. The full significance of this contrast was not encompassed by a theory which had been developed to explain price behaviour with an inventory linkage between present and future prices. More recent studies, recognizing this lack in the traditional theory, have begun to extend the theory to newer market situations [20, 111].

Hedging practices other than short sales against inventories had emerged long before the new potato and egg futures markets were established, and Working [132] had carefully distinguished such practices as operational hedging and anticipatory hedging from the traditional inventory hedging. But recognition of the importance of other classes of hedging, and of the implications for development of new futures markets, has only recently become widespread. The statutory definition of hedging under the United States Commodity Exchange Act was amended as recently as 1956 to include anticipatory hedging (of processing requirements or forward sales commitments). The delivery instrument for a number of newer markets has had to be something other than a warehouse receipt (the traditional instrument) because the commodity is not regularly stored. This kind of explicit recognition of commodity characteristics not encountered among the traditional markets has enabled the extension of futures trading to fresh eggs, fresh broiler chickens, live cattle, live hogs and to such manufacturers or semi-manufactures as soybean oil and meal, plywood, and lumber. In none of these markets is a warehouse receipt employed as the delivery instrument; the delivery instrument employed is in effect a "call upon production" instead of a "call upon inventories". As futures trading is extended to new and different kinds of commodities, the commercial use of markets (hedging) takes new and different forms, which in turn forces futures trading theory out of its traditional narrow mould. As recently as 1959, Houthakker [55, p. 158] wrote that "The mainspring of futures trading, according to the view presented here, is the need to finance inventories in the face of fluctuating prices. A prerequisite for sustained trading, therefore, is the existence of considerable inventories". Yet as important as the inventory financing role has been, historically, to futures trading, the markets which have sprung up in the past decade have clearly exceeded the scope and limits set forth by Houthakker, who had wisely observed in the same article that "The analytical problems that arise (in the study of institutions) are often both a challenge to conventional theory and a useful reminder of the relativity of accepted doctrine" (Houthakker [56, p. 134]). This dictum is especially cogent when the institution under study is as diverse and as rapidly evolving as futures trading today. Active futures markets exist for a wide variety of commodities, with a wide range of characteristics and uses. The mechanics of trading, its composition according to the commercial

functions and purposes of the participants, the degree of speculative participation by "outsiders", and even the delivery or other specifications of the contract being traded differ considerably from one market to another. Most of the world's futures trading is conducted in the United States, where the number of contracts traded (aggregated over all markets) has increased by approximately fourfold in past decade, and where several of the most important futures markets were not in existence a decade ago. Such diversity and such a ferment of expansion make it particularly hazardous to venture any generalizations, yet at the same time make it more urgent to endeavour piecing together such understanding as already exists.

2. INTEMPORAL PRICE RELATIONSHIPS: RISK, BIAS, PRICE OF STORAGE, AND THE DISTRIBUTION OF PROFITS AND LOSSES

A common point of departure for some earlier theoretical work and subsequent empirical work regarding futures price behaviour has been what came to be regarded as the "Keynesian theory of normal backwardation".[2] We find, however, only one instance (Keynes [70], p. 144) where Keynes ever used the words "normal" and "backwardation" together. This is not to suggest that Keynes attached no significance to his thoughts in the matter, but rather to place this particular contribution in perspective. The fact that Keynes never responded to subsequent references to this "theory" suggests further that it was not very high on his list of priorities and that he might never have laid claim to having propounded a "Theory of Normal Backwardation".[3]

Keynes [69] first advanced his hypothesis in an essay in the *Manchester Guardian Commercial* in 1923, where he maintains that, without any forecasting ability whatsoever, one could profit handsomely by holding long futures positions throughout the cotton crop year; year-in and year-out. In relation to the size of this profit he states:

> I should doubt whether in the largest and most organized market the cost of a hedge-sale works out at less than 10 per cent per annum (e.g., 5 per cent for a sale 6 months forward) and often rises to 20 per cent per annum (e.g., 5 per cent for a sale 3 months forward) and even much higher figures (p. 785).

This bold assertion was not to go unchallenged (nor undefended) in time to come. A contrary opinion was expressed by Hardy [46, p. 225], and Working concluded in 1931 [125, p. 435] that "speculators in wheat futures taken as a group have in the past carried the risks of price changes on hedged wheat and have received no reward for the service, but paid heavily for the privilege". But before proceeding to the theoretical and empirical controversies that Keynes had innocently

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[2] "Backwardation" is a British trade term referring to that situation in which spot prices exceed forward prices. "Contango" is the opposite term in this parlance, covering the situation in which forward prices exceed spot prices.

[3] Keynes did, however, entitle two and one-half pages of his *Treatise*, "The Theory of the Forward Market".

ignited, we may look briefly to the basis for his estimate. In a statement that is noteworthy only for its evocation of incredulity, Keynes [69, p. 785] wrote, "I have examined a good deal of material relating to several different commodities, but it does not lend itself to tabulation". Laying to one side the intriguing theoretical question of what kind of material does not lend itself to tabulation, and how Keynes otherwise extracted his conclusion from such material, the fact is that the United States Federal Trade Commision [121] published in the following year, detailed tabulations of wheat, corn, and oats prices over a 30-year span, of exactly the sort needed to formulate the estimate required by Keynes. At least one useful set of tabulations had been published as early as 1901 [112], and while neither set of tabulations supported Keynes' estimate, he repeated it in essence in his 1930 *Treatise* [70, p. 143].

> The statistics of organized markets show that 10 per cent per annum is a modest estimate of the amount of this backwardation in the case of seasonal crops which have a production period approaching a year in length and are exposed to all the chances of the weather.

Elsewhere in the *Treatise*, Keynes enumerated the "other" costs of carrying commodity stocks (deterioration, warehouse and insurance charges, and interest), and elaborated upon the risk cost (backwardation) in two respects. He argued (1) that in normal conditions (as distinguished from shortage) backwardation still prevails, and (2) that in situations of redundant stocks, when a "contango" prevails, backwardation not only exists, but is higher than usual, although obscured by the countervailing costs of warehousing, depreciation, and interest.

> . . . the additional element of uncertainty introduced by the existence of stocks and the additional supply of risk-bearing which they require mean that he must pay more than usual. In other words, the quoted forward price, though above the present spot price, must fall below the anticipated future spot price by at least the amount of normal backwardation; and the present spot price, since it is lower than the quoted forward price, must be much lower than the anticipated future spot price (p. 144).

Already Keynes has confused us, by adopting trade jargon then using it to describe something other than the trade connotation; so this may be the time to say that similar confusion persists in the literature, and to attempt to clarify some terminological issues. No small part of the controversies surrounding the economics of futures markets owes to semantics (what is meant by hedging?), to conflicting views as to how certain phenomena should be measured (which may in turn relate to definitions), and to the sometimes careless adoption of trade terminology, which in itself may carry different connotations in various branches of commodity trade. "Backwardation" is the term employed at the London Stock Exchange to describe the premium paid by a seller to a buyer who allows him to defer delivery of stock certificates. "Contango" (possibly a corruption of contingent) refers there to the premium a buyer pays a seller to be allowed to accept and pay for stock certificates later. In the commodity markets, the British refer to any excess of the *spot* price over the *forward* price as a backwardation; whereas in American usage it would be said that any excess of the *cash* price over the *futures* price is an inverse carrying charge.[4] Symmetrically, contango

is the opposite of backwardation and carrying charge the opposite of inverse carrying charge (and these are commonly abbreviated in the trade to "carry" and "inverse"). Thus, Keynes might better have referred to a *risk premium* component of a contango, rather than a backwardation component, which entailed a contradiction in terms. He could then have said that markets sometimes reflect contango and sometimes backwardation, but that in either case a risk premium is a normal component of the difference between spot and forward prices. Other determinants of this difference would include the three he mentioned, as well as any return to speculators as a reward for successful price forecasting, within the Keynesian framework together with other elements which we shall encounter in references to subsequent work (convenience yield, market balance, and its various episodic or institutional explanations).

ADDITIONAL THEORETICAL WORK

Following Keynes' observations, a group of British economists took up the "theory of the forward markets" in a series of papers in the *Review of Economic Studies* [4, 18, 19, 48, 66, 67]. Kaldor treated the generalized question of speculation and economic stability and not the economics of commodity futures markets *per se*. His incidental attention to this problem was quite explicit, however, and he contributed in more ways than one to its conceptualization. Kaldor pointed out, for example, that what Keynes had called "normal backwardation" was actually a marginal risk premium, thereby affording an escape from awkward and ambiguous terminology which has unfortunately not been uniformly traversed in subsequent writings. More importantly, he introduced the hitherto neglected concept of convenience yield of stocks, which became a key consideration in later interpretations of cash-futures price relations. Kaldor's "generalized price expectations" came in for subsequent criticism [4, 48, 127], but he nevertheless formulated a notation which helped to provide a framework for fruitful discussion. Kaldor's "theory of commodity futures markets" was, as with Keynes, an incidental building block and only part of a more generalized treatment of speculation and economic stability. And in the final analysis Kaldor [66, p. 11] appears to accept the Keynesian estimate of the magnitude of "normal backwardation". If we might paraphrase a famous Keynesian sentence: these discussions reached that third-degree where their intelligences were devoted to the question of how the way in which commodity markets might work might influence the way in which the economy might work. Both writers contributed more to our understanding of the whole than the particular part which occupies our present concern.

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[4] Even this is subject to caveat, but is sufficiently clear for present purposes. In the American grain trade, "cash" carries the connotation "now", whereas "spot" tends to connote "here" (although this usage is not uniform); whereas in the cotton trade "spot" tends to mean "now".

We can at least see Dow's account [18] uncluttered by larger issues, as he endeavoured to bring the focus directly to commodity futures markets in his reaction to Kaldor's article. Dow pointed out quite properly that Kaldor's futures market theory was "by way of a parenthesis to the rest of the article", as we have been saying of both Keynes and Kaldor. Dow's chief contention was that there were "negative" as well as "positive" risks; from which it would follow that "the futures price would lie between $EP - r$ and $EP + r$" (where EP = expected price and r is the marginal risk premium). Dow, in short, was not at all persuaded that "normal backwardation" would be as high as Keynes and Kaldor thought it was; nor was he even convinced that it need be positive. Also, while accepting Kaldor's concept of "representative expectation", his conjecture was at variance with Kaldor's regarding its probable level:

> About the vagaries of individuals' expectations it is not possible to say very much; but it is, perhaps, worthwhile to guess, though tentatively, at the general way in which expectations are distributed between hedgers and speculators. It might be argued that speculators would be more sensitive to the tide of feeling in the market, and the "elasticity" of their expectations greater than would be the case with hedgers, and this particularly in the upward direction. Experience presumably does help a man, in forming his expectations, better to sift the relevant considerations from the irrelevant; and while the speculators are a floating population, the hedgers are the inhabitants of the land. That speculators are very generally over-optimistic we do know, since it frequently happens that the average risk premium that is realized *ex post* is actually negative. It may be that hedgers are less badly out than this. If there were truth in this guess, it would be an additional reason for the transfer of risk-bearing to the speculators (p. 190).

It is worth noting that while Dow refined the concept of risk, neither he nor the other theoretical writers of this group ever questioned that the transfer of risk from hedgers to speculators was the *raison d'etre* of futures markets.

Kaldor [67], in response, went a step further than Dow; not only accepting the concept of negative risk, but dividing speculators into two groups:

> Bull speculators will be *buyers* of *futures*, and their demand price is $EP - r$ (where both EP and r are subjective terms and refer to mean value of the individual speculators' expectation, and his individual risk premium, respectively): bear speculators will be *sellers* of futures and supply price will be $EP + r$ (p. 200).

Hawtrey [48] raised serious objection to the "generalized expected price" which had been adduced by Kaldor, and in so doing at least vaguely adumbrated the radical theories which Working was to introduce later. After noting that:

> When there is very little difference of opinion among dealers as to price movements, there may be practically no speculation. The professional dealers will then content themselves with a commission or a "turn" between buying and selling prices. The hedging trader pays this by way of remuneration to the dealer for making a price. It is not so much a risk premium as a fee for the organization of a market, and the trader gets in return the quotation of a price which he can rely on as reflecting the true market conditions (p. 204).

Hawtrey goes on to point out:

> If the forward price quoted for any future date does not afford a sufficient premium over the spot price to cover carrying costs, holders of stocks will refuse to sell forward at that date. If that applies to all futures dates they will refuse to sell forward at all; they will either sell spot, or will hold their stocks speculatively uncovered. Such a condition of the market tends to evoke sales of spot supplies, till the fall in spot price restores the normal condition in which every forward price provides a sufficient premium to cover carrying costs (p. 205).

Several threads of the foregoing discussions were brought together by Blau [4], who again focused upon commodity futures markets. The relation between cash and futures prices, the impact of futures trading upon the price stability, and the relation between futures trading and commodity control were recurrent themes which Blau considered at some length and in somewhat greater detail than previous writers. The first of these has been the focal point of this part of our survey, as the theme which has been more persistent in the literature, and also the one which leads most directly to Working's revisions, towards which this discussion is directed. Blau's contribution on this score was to formalize and refine what had already been said, and to specifically include the marginal risk premia of hedgers as well as speculators in the model. Hawtrey's objections to the "generalized expectation" were rejected, and Blau placed futures buying and selling limits into the following taxonomy:

Buying Limits:

(1) Speculators.. .. .. $FP = EP - r$

(2) Hedgers .. .. .. $FP = SP + c + r$

Selling Limits:

(1) Speculators.. .. .. $FP = EP + r$

(2) Hedgers .. .. .. $FP = SP + c - r$

where:

SP = the spot price ruling in the futures market

FP = one of the series of forward prices (say, the price for delivery 3 months hence in the futures market)

EP = the "expected price", i.e., the price which a trader expects to rule in the market at the forward date

c = *net* carrying cost (i.e., all carrying charges including interest minus the yield

r = marginal risk premium (Blau [4], p. 9)

The theoretical work which we have been examining takes on a distinct "Alice-in-Wonderland" quality when we pause to consider how sharply it focused upon the question of the relationship between futures price quotations and the subsequent cash prices during the futures delivery

month. Carrying cost, convenience yield, risk premium, or expectation might each influence or "explain" the relationship, but the relationship was long since a matter of record. Without suggesting that the statistics are that easy to interpret, we may at least wonder why they were not consulted. The theory *required* that futures prices be downward biased estimates of subsequent cash prices—nothing else would do. After every possible adjustment was made for carrying costs, convenience yield, market imperfections, mistaken expectations, etc., futures prices *had* to underestimate subsequent cash prices. Kaldor could well question the *magnitude* of the bias, and could well adduce offsetting considerations (convenience yield); but he did *not* question the ineffable logic of the risk premium. Dow could adduce *negative* risk, but he too was confined to the assumption that futures markets existed for the purpose of transferring risk. The risk premium was the king's raiment; is the king be espied naked, one observed that the king was wearing no clothes, and thereby reaffirmed the assumption that kings wear clothes. Read Kaldor, who was clearly in doubt regarding the substance of the king's raiment, but who was not about to question the postulate of garmented kings. Better to anticipate the "see-through" garment than to acknowledge nudity. Only Hawtrey, among this group, verged upon the inevitable heresy. Whether because each man's observations must be consistent with his *weltanschauung*, or because some *weltanschauungs* are built upon observation while others are not, none of these writers looked to the available evidence, to which we now turn.

EARLY STATISTICAL EVIDENCE

In a report to the United States Congress [112] published in 1901, Stone had included detailed charts and tabulations of cash and futures prices covering several commodities and locations over varying lengthy periods of years. The results are worth quoting at some length.

> The tables 11, 12, and 13 were prepared especially to show the relation between spot and futures prices of cotton at different places. They contain corresponding averages by months for New Orleans, New York, and Liverpool, so that corresponding quotations at these three markets may be compared.
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> It has been contended that the future price, as a matter of fact, is always less than the spot price. These figures do not sustain any such contention if, for example, we compare October future in July with the spot price realized in October. Out of fifty-seven different futures . . . compared with the spot prices realized . . . in the New York cotton market, from 1881–82 to 1899, in twenty-nine cases the futures proved to be higher than the spots realized 3 months hence, and in twenty-eight cases the future prices were lower than the spots at maturity—that is, the speculative judgment anticipated the realized value of cotton a little too favourably in half of the cases and not quite favourably enough in the other half.
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> In the Liverpool market, out of fifty-seven cases of comparison of future bids with spot prices realized at the expiration of the contract period . . . it appears that in thirty cases the future prices were lower than the spot prices realized at maturity of contract, and in twenty-seven cases the future prices were higher than the spot prices realized at maturity. In the New Orleans market, out of fifty-seven cases, in twenty-five of them the future price was lower than the spot price realized 3 months later, and in twenty-six cases the future price was higher than the spot price.

> These results would seem to support the conclusion that in the long run the speculative quotations for future delivery are neither uniformly above nor below the level of the proper cash value of cotton as determined at the future date but that they are tentative anticipations of such realizable value as the conditions of the supply and demand are most likely to determine at the time when the future contract matures (p. 213).

In addition to these results for cotton at different markets, the report concluded with regard to wheat (1883–1898):

> . . the speculative price (December price of May wheat) was in seven cases higher and in eight lower than the anticipated price (May spot); i.e., the "bear" was about as many times successful as the "bull", with the balance in favour of the latter (p. 204).
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> and
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> By comparing the prices of October wheat in July and of spot wheat in October, we find that in seven cases the "futures" were higher than the spot, the divergence from the spot expressed in per cent being 13, 7, 4·9, 6·2, 1·4, 5·8, and 18·5 respectively, making an average of 8·1 per cent. In six cases the "futures" were higher, as follows: 30 per cent, 8·9 per cent, 9·4 per cent, 4·9 per cent, and 24·6 per cent, making an average of 13·1 per cent (p. 204).

The compilation of Chicago wheat prices in this report is a particularly useful one, in that it allows an estimate of the bias in futures prices for a *continuous* 15-year period. In other words, a direct test of Keynes' postulate that the speculator could "earn substantial remuneration *merely* by running risks and allowing the results of one season to average with those of others" [69, p. 785], is made possible by the publication [112, table 6] of average spot and futures prices during *each* delivery month. The results of buying each future during the prior delivery month, holding it to delivery and buying the next future, seriatim for this 15-year period, would have been as below:

For sixty successive trades (four futures per year x 15 years, 1883–1898) the subsequent spot price was overestimated forty times and underestimated twenty times. The average overestimate was 8·1 cents and the average underestimate 9·7 cents per bushel. In sharp contrast to the Keynesian estimate of 10 per cent price rise per annum in futures relative to spots, there was a decline of more than 10 per cent annually in this relationship. This report also included extensive tabulations of wheat prices from Berlin, Germany; but makes reference to a summary by Emery [22] which is more to the point. We quote Emery's paragraph:

> A rather more interesting question is that of the agreement of present prices of futures with future cash prices. Whether the price of the future is but the cash price plus carrying charges, or is determined independently by anticipated future conditions, it stands as an estimate of the actual cash price at the future time. The question of the agreement of these prices is then a fairly adequate test of the accuracy of the speculative judgment, and, in so far, of the desirability of the speculative market. Professor Cohn, about thirty years ago, made a collection of statistics to show this relation in the case of rye in Berlin, which have been brought down to 1890, with additional figures for wheat by Dr Kantorowicz. These figures show the prices of rye in May and June for future delivery in September-October, compared with spot prices in the latter months, and also the September-October prices for delivery at the May-June *Termin* with like comparison. The results of the figures for 40 years (1850–1890– give one case in which the predicted (speculative) price exactly agreed with the spot price, 43 cases in which it was below the spot price by an average of 8·75 per cent, and thirty-six cases in which it was above by an average of 9·28 per cent (p. 132).

Rather than excerpting the voluminous study of the United States Federal Trade Commission [121] which extended and refined such measurements as the foregoing, we may borrow Working's summary [127] of their findings:

> One of the most critical and painstaking inquiries into the subject was that made by the Federal Trade Commission. It attacked the problem in several different ways. All the methods produced evidence, in price data subsequent to 1896, of some "downward bias" in futures prices of wheat and corn, but not of oats; but for the 10-year period prior to 1896, the indicated bias was in the opposite direction for all grains. The method which the Federal Trade Commission appeared to regard as quantitatively most trustworthy, and the only one from which it drew a value which was discussed as a measure of bias, yielded for wheat, 1906–16, the estimate that it amounted to —2·39 cents (about 2·4 per cent) for a twelve-month interval (p. 9).

This statistical evidence had been published before Keynes' *Treatise* and the subsequent theoretical discussion, yet not a shred of it was adduced in that discussion. Working was later to quote [142], apropos another problem of interpretation of futures market data, Conant's observation that ". . . a theory is only overthrown by a better theory, never merely by contradictory facts" (p. 15). The quotation is apt in the present context, too, and it was Working who was to provide theory which would accommodate the facts. Working's approach to the problem may be seen in retrospect as having two major thrusts. First, instead of merely examining the statistics as an empirical test of the theory of normal backwardation, he formulated a more generalized interpretation of cash-futures price relationships, capable of subsuming such other elements (e.g., convenience yield and risk premium) as the facts might warrant. This appeared first as the "Theory of the Inverse Carrying Charge" [127], because inverse carrying charges were the more puzzling and poorly explained phenomena (in contrast to carrying charges). Subsequently the more general "Theory of Price of Storage" [129] incorporated the same reasoning. In the course of presenting these *direct* explanations of intertemporal price relationships, in which price *differences* (positive or negative) are viewed as *prices* (of storage), Working had occasion to reject as inadequate those explanations which viewed prices at two points in time as being separately determined [123, 128]. These included the general notion of "discount on the future" and, within that, the particular theory of "normal backwardation" reflecting a marginal risk premium. The price of storage theory could account for observed price behaviour (including the entire range from full carrying charges to steep inversions) as the theory of normal backwardation could not. This left open several questions; e.g., (1) was it possible that a very small risk premium was included in intertemporal price spreads? (2) was it possible that the major grain markets from which Working took his observations exhibited fundamentally different price behaviour from that other organized futures markets? (3) what were the implications of the price of storage theory for the accepted view of hedging?

This last question provided the second major thrust in Working's approach. The first question was not very important because there was no possibility that a risk premium could account for any more than

a small fraction of intertemporal price differences. The second question was *a priori* not very promising, there being no good reason to think that its answer would be affirmative. But the theory of hedging which had virtually imposed the risk premium explanation of intertemporal price relations had surely to be re-examined with the failure of this explanation. Once again illustrating the principle enunciated later by Conant that only theories refute theories, Working [131, 132] provided a radical revision in hedging theory. We sketch the earlier and later development of hedging concepts in the following section, after first resuming here the discussion of what remained of the "risk premium controversy".

The risk premium (cum normal backwardation) hypothesis was not. dropped in consequence of Working's price of storage theory, nor, indeed, as we have pointed out, were they necessarily mutually exclusive. Working had observed that any downward bias in futures prices for the major grains was far smaller than the Keynesian estimate of backwardation, and that observed levels of inverse carrying charges greatly exceeded anything explainable as risk premium. This may have been almost (but at least it was not quite) tantamount to denying the existence of a risk premium in intertemporal price differentials. Moreover, the door had been left slightly ajar in Working's acknowledgment that hedging reduces business risks. Houthakker [55] was the first to approach the question in terms of the estimated returns to reporting and non-reporting categories of traders, whose holdings of futures contracts are published by the United States Commodity Exchange Authority [118]. At least two earlier studies had estimated returns to speculators from other data (Stewart [101], Working [125]) and both had found that their sample of speculators had lost money. Houthakker not only concluded that his sample of speculators earned profits, but also ingeniously estimated the share of profits attributable to forecasting skill *versus* that share attributable to risk premium. Elsewhere Houthakker [53, 54] had concluded on the basis of empirical evidence that the Keynesian estimate of normal backwardation had been reasonably correct. Whereas the discussion two decades earlier had been purely theoretical, there now emerged an econometric search for the risk premium. Telser [106] was first to take issue with Houthakker's findings, concluding, for cotton and wheat (whereas Working's findings had applied only to wheat), that "the seasonal pattern of stocks determines the [price] spreads", and moreover accepting "the hypothesis that the futures price equals the expected spot price" (p. 253); that is, there is no risk premium. Telser [106] rejected Houthakker's evidence on the grounds that "transactions costs are not deducted from the speculators income, only 9 years are studied (1937–39 and 1946–52), and the method of estimating gains and losses neglects changes in commitments and prices within each month" (p. 243). More importantly, he provided evidence for both cotton (1926–54) and wheat (1927–54) that "changes in the general price level are not fully anticipated [in futures prices]" (pp. 245–246) and hence that the test for bias should be conducted for stable price years only. Brennan [8] meanwhile had

concluded with Working and now Telser that the level of stocks determined the price spreads, but had differed from them in that he thought that a risk premium had also been rediscovered.

The ensuing controversy over the risk premium found Cootner [12] challenging Telser's conclusions; Gray [36] challenging the findings of Houthakker, Brennan, and Cootner; Telser [107] and Cootner [13] subsequently reaffirming their disagreement; and Rockwell [88] applying essentially Houthakker's method to a larger mass of data but with results that were construed as contradicting Houthakker's.

The resort to the "statistics of organized markets" raised numerous questions regarding the interpretation of these statistics; and a superficial reading of the result of these inquiries may leave the impression that they are scarecely more conclusive than the purely theoretical accounts three decades earlier. It seems to us, however, that its advocates have failed to demonstrate the existence of a significant risk premium; whereas more importantly the analyses have led to more cogent interpretations of some observed bias in futures price behaviour, and subsequent work has helped to round out the theory of futures markets without the heavy reliance upon the risk transference role which characterized earlier theory.

After the four-part exchange between Telser and Cootner [12, 13, 106, 107] in which Cootner criticized Telser's findings for failure to take account of variations in the level of hedging, and Telser, upon considering further evidence, acknowledged some support for the Keynesian hypothesis, but rejected Cootner's hypothesis of seasonality in the relationship, the focus was still upon the question of price bias as a manifestation of the risk premium. Gray, having encountered little evidence of bias in the major futures markets under normal conditions, encountered what he termed a "characteristic bias" in some thinly traded futures markets and subsequently sought [34, 36] to broaden the focus of such analyses toward interpretations other than risk. In the course of arguing for the broader focus, Gray also disputed the findings of Houthakker, Brennan, and Cootner (the latter on rather different grounds than had been adduced by Telser). It would ill behove the senior author of the present paper to reiterate these criticisms in a survey paper, hence it seems most appropriate at this point to comment on the later papers, then revert to a brief discussion of alternative explanations of bias which he has set forth.

Telser's conclusions from his later study of wheat, corn, and soybean futures were as follows [108]:

> These results are consistent with the hypothesis that by maintaining a long position in futures one cannot expect a systematic positive return except from inflation of the general price level that is unanticipated. Therefore, the futures price can be regarded as the market expectation of subsequent spot prices. In general the evidence confirms the conclusions I reached in my earlier studies of futures trading. The short hedging relation is the stable and the speculative relation the volatile factor in the futures market. Speculators cannot count on receiving a positive return from a simple strategy of maintaining a long position in futures to remunerate them for their bearing the risk of price declines for the holder of inventories. Although short

> hedging provides price insurance, speculators seem sufficiently eager so that not only are short hedgers able to obtain price insurance cheaply, they also sometimes obtain a larger return on their hedged than on their unhedged stocks. In my opinion the futures price can be considered as an unbiased predictor of the subsequent spot price.

While we do not agree with Telser's dichotomy between short hedging as risk-reducing and long hedging as risk-increasing; this does not affect his conclusions regarding bias, with which we are in substantial agreement.

Cootner [16] summarized the work on wheat futures in the following passage:

> It may be worthwhile to review briefly some of the published work on risk premiums in wheat futures because of the considerable confusion in the literature. In Cootner (4) I showed that a statistically significant seasonal pattern could be found in wheat futures if the pattern were keyed to the pattern of the harvest. The period chosen for that test was a number of years chosen by Telser (31) on the basis that wholesale prices had changed by less than 5 per cent in those years. In later testing, Telser (33) confirmed that the May wheat futures price showed an upward trend, but a related test, not keyed to the harvest, showed no trend in December wheat futures. In Gray (14) the hypothesis was presented that my results were due to some unspecified bias resulting from use of percentage rather than absolute price changes. A test in that paper, again not keyed to the yearly pattern of harvest, showed markedly lower level of statistical significance than indicated in my work. Although the test differed from mine with regard to both treatment of the harvest and use of absolute price changes, Gray concluded that my results arose from the latter "bias". He also voiced some reservations about the proper way to account for inflation. After private correspondence, Gray later concluded that a seasonal did exist in postwar futures prices (14), but that it was an adventitious effect of the government loan program. This latter conclusion was derived from some empirical work which showed that while a strong seasonal showed up (on a calendar rather than a harvest basis) in the postwar years, the seasonal was much weaker in the prewar years. At this stage, therefore, both Telser and Gray agree that postwar years show an upward trend in futures prices after harvest, and Gray accepts a preharvest futures price decline, but ascribes it to the government loan program rather than risk aversion (pp. 89–90).

The relevant portion of Gray's [36] allegation of bias in Cootner's earlier work follows:

> . . . The average 30th November price of the May future in the 6 years of rising prices was 88-3/8 cents *and in the* 4 *years of declining prices* 208 *cents.* This contrast introduces a large bias into Cootner's results because he computes a price index for *each* year and thus implicitly relates price change to price level. The total price increases in 6 years was 90 cents, and the total price decline in 4 years was 69-3/4 cents, for a net increase of 20¼ cents spread over 10 years. This net increase, when related to the average 30th November price of 136-1/8 cents, is not an 8 per cent average increase over the 5-month span but, rather, a 1½ per cent average increase which is not significantly different from zero (p. 259).

Elsewhere in criticism of Gray's argument regarding the influence of the loan programme (which is spelled out below) Cootner [16] contends that "the difference in behaviour seems primarily due to the changing seasonal pattern of the wheat harvest" (p. 95). Without going into detail here, we can say simply that since 1961 (the latest year included in Gray [37]) the loan programme has diminished markedly in importance,

and the seasonal pattern in wheat futures prices which Gray attributed to the loan influence has been markedly attenuated.

It seems appropriate to leave the subject of "normal backwardation" with a quotation from a very recent study. After looking at 7,900 semi-monthly observations covering 25 (United States futures) markets for 18 years beginning with 1947, Rockwell [88] concluded:

> . . . normal backwardation is not characteristic of the 23 smaller markets either when hedgers are net long or net short; and it is characteristic of the three larger markets only when hedgers are net short. The theory clearly does not have general applicability for all futures markets and it is questionable whether an analysis of variance performed over the 25 markets would indicate a single market with a positive return significantly greater than zero.[5]

Despite the considerable dispute engendered by these efforts at statistical testing, the measurement problem does not appear to be especially complex from the present vantage point. Keynes posited that the futures price would be lower than the price expected to prevail at the later delivery period, by an amount representing the speculators' reward for bearing the risk of price change during the interim. In the unambiguous notation of Blau, this proposition is expressed as:

$$FP = EP - r$$

where FP is the observed futures price quotation, EP is the generalized market expectation of the price expected to prevail when the future matures, and r is the marginal risk premium. Since EP is not observable (unless it is the same as FP) the theory has had to be tested indirectly in terms of its implications. One implication is that FP is downward biased, and hence will display a rising tendency not observed in spot prices. Another implication is that speculators will earn profits by merely holding long positions in futures markets over sufficiently lengthy time periods. These implications follow for the situation of continuous short sales of futures contracts against inventory positions. When account is taken of *long* hedging offset by *short* speculation, and of the highly seasonal pattern of inventories of annual crops, adjustment in the measurement procedure is implied. Theoretically, speculators should reap the risk premium, if any, by being consistently on the opposite side of the market from hedgers.

The foregoing makes no reference to differential *forecasting* skills, hence the risk premium must be net of any changes in spot price levels. If spot prices rise, carrying futures prices with them, a speculator might have forecasted the rise, but his gain is fortuitous from a risk premium standpoint. He does not reap a risk premium. The simplest method of measuring for any bias that might reflect a risk premium, therefore, is to measure futures price changes over a long period of time, adjusted for any change in spot prices. Or, if spot prices are at virtually the same level at the beginning and end of the period, then the net change

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[5] We should point out, however, that the argument from which Rockwell concludes [88, p. 116] that the price decline over the period of observation (1·2 per cent annually) does not seriously affect his results is not convincing to us.

in future prices may be attributed to bias. No question arises regarding changes in the general price level, as these would be reflected in spot as well as futures prices. Hence while inflation or deflation *might* be relevant to the question of *forecasting* success (depending upon whether one assumes that commodity futures traders endeavour to forecast changes in the general price level) they need not be considered in testing for bias. It is appropriate, where data permit, to adjust for the changing composition of trade, seasonal or otherwise, between hedging and speculation. Thus the method devised by Houthakker and applied (in a somewhat refined form) to a larger mass of data by Rockwell is probably the most accurate test thus far devised for isolating any bias that might be imputed to a risk premium. The existence of any such bias as a general phenomenon is a highly dubious proposition in the present state of the evidence, and it is important to note that its existence would be only a necessary but not a sufficient condition to establish the existence of a risk premium.

Reluctant as we would be to bury this corpse too quickly, we are yet convinced that, "Understanding futures markets, with all due respect to the masters, is more important than supporting or refuting the Keynesian hypothesis of normal backwardation" (Gray [36], p. 260). We wonder whether it may not be the case that this particular corpse has been too frequently exhumed.

OTHER CAUSES OF BIAS

The point that bias need not be construed as transfer of a risk premium has been stressed by Gray [34, 36] in the argument that thinly traded futures markets characteristically evoke biased price estimates which are not related to differential price variability. It thus seems preferable to attribute such bias to the lack of balance between hedging and speculation observed on thin markets (presumably resultant from imperfect information) rather than to the transfer of a risk premium. Rockwell's results fit this interpretation, as the markets with smallest open interest displayed the largest (positive and negative) bias. Gray also mentioned other possible explanations of bias which could apply as well to more heavily traded markets. Chief among these is the influence of the government loan programme upon certain United States commodity prices [37]. While futures market prices have risen with considerable regularity (and predictability) toward the level guaranteed in the government programme, the futures price cannot accurately reflect such a level until the movement into government hands has occurred. This is but another illustration of Working's [127] dictum that:

> The idea that a futures market *should* quote different prices for different future dates in accordance with developments anticipated between them cannot be valid when stocks must be carried from one date to another. It involves supposing that the market should act as a forecasting agency rather than as a medium for rational price information when it cannot do both. The business of a futures market, so far as it may differ from that of any other and to give them due expression in present prices, spot and near futures as well as distant futures (p. 14).

So long as the movement into loan is *anticipated,* it would be an irrational price which reflected it, for such a price, incorporating the anticipation, would prevent the event.

Other institutional factors which can impart bias to rationally formed futures prices without inviting as a risk premium-transfer interpretation have been mentioned in [36]. It is also implied by the characteristic bias in thin markets that the prices of remote futures contracts would be biased in some markets where the nearby contracts, being more heavily traded, display no such bias. Evidence of this sort was provided in [43] as an appropriate interpretation of some of Houthakker's findings [57]. Yamey [144] has also suggested that the existence of weak sellers may have accounted for an observed bias in Liverpool cotton futures.

THE DISTRIBUTION OF PROFITS AND LOSSES FROM FUTURES TRADING AMONGST CLASSES OF TRADERS

In taking the Keynesian "theory of normal backwardation" as a point of departure for this section, we were acceding to an emphasis it has received in subsequent literature which we consider to have been greatly exaggerated. It cannot have been prominent in Keynes' thinking, and the weight of both earlier and later evidence has scarcely enhanced its prominence. We are less concerned with persuading the reader what the balance of the evidence shows with regard to "normal backwardation", however, than we are to invite attention to the proposition that the departures have been considerably more important than the point of departure. Working's direct explanation of intertemporal price spreads, and the radical revision of hedging theory which followed, have tended greatly to moot the question of any risk premium in futures prices. Gray's explanation of certain observed biases in futures prices, especially that which is characteristic of thin markets, have further mooted the risk premium question. If it is chastening to have to recognize that evidence already available might have suggested more robust hypotheses to those leading economists who promulgated the risk premium interpretation of futures trading, it is at least invigorating to observe that some such hypotheses did emerge.

If the risk transfer model has not been a very fruitful depiction of futures trading, however, this does not mean that the distribution of profits and losses among the participants in this zero-sum game is any less interesting—indeed it may be said to strengthen the interest in this question, posing a challenge to both ascertain and interpret the facts. Before summarizing the rather scant evidence on this question, we may posit some of the alternative interpretations.

(1) A profit transfer among classes of traders need not display any consistent pattern; rather members of the exchange may be content to conduct the zero-sum game for the commissions they earn. This was suggested by Smith [94] in the following passage:

> Some years ago it was estimated that 105,000,000 bales of cotton were sold annually on the New York Cotton Exchange. About the same time there was reason to suppose that approximately one-third of the cotton sales were then between member and member of the exchange; one-third between members of the exchange and outsiders, and one-third between one outsider and another outsider, the members in this last case acting as commission men only. Calculating merely the commission fees exacted by members from the outside public, if an equal division had been made among them the share of each would have been close on $16,000, a sum which alone would have paid all expenses and left a very fair profit besides. But, in addition, there were the profits on their dealings as principals with the outside public; and there was also some swallowing up of the smaller fry by the larger in the one-third between member and member (pp. 103–104).

(2) The advantages which hedging firms obtain may be paid for by a mechanism other than the price trends implied in risk premium—consider that floor traders are predominantly market-makers rather than price-forecasters or risk-absorbers. Theirs would be a reward for skilful defense of price, anticipating the dips and bulges caused by hedging (or other trading). (See the quotation from Hawtrey on p. 19 above.)

(3) Hedgers may not pay at all for futures trading. They are the "inhabitants of the land" and the best users of futures. This implies a different breakdown from the hedger-speculator dichotomy:

- (a) Hedgers who break even or better.
- (b) Floor traders (market-makers) who consistently earn profits.
- (c) Avocational speculators who lose money, which can be explained variously by:
  - (i) the continuous replacement of losers by new losers (probably only 25–50,000 individuals ever hold futures contracts at one time);
  - (ii) a risk-loving attitude explainable in terms of the small proportion of "discretionary income" which individuals apply to commodity futures. This is also, of course, consonant with the observed fact that many persons speculate against the odds (expected returns of less than one) in lotteries, casinos, etc.;
  - (iii) and even in part by tax considerations in the United States, where futures transactions are one device for converting ordinary income into long term capital gains, taxed at much lower rates; and for deferring income tax payments until the subsequent year.

This general postulate (3) was also put forward by Smith [94] as early as 1922:

> The question naturally arises concerning the source of the profits of this class of expert risk takers; for it is obvious that without profits it could not long continue in business. One source, indeed, consists of the small losses incurred by the genuine dealers in produce when they hedge, the sums already described as resembling premiums for the insurance against heavier loss afforded by hedging transactions in general. As this is largely offset by similar gains on the part of the same dealers, it cannot be the real source from which the speculators obtain the greater part of their remuneration.

> There are no adequate statistics of the ultimate source from which the profits of the successful expert speculator are derived. The main contribution comes probably not from producer, consumer, or genuine dealer, but from the very many small speculators drawn from the outside public who, in the long run, always lose, and from the occasional large speculator who happens to err and has to pay heavily in consequence. "The outside public, more especially in the United States, at times undoubtedly speculates heavily in cotton", and invariably loses when it does so (p. 103).

The evidence now available simply does not allow a choice among these or other interpretations. By virtue of the focus upon the risk transfer model, it has become the most studied and least supported of equally plausible hypotheses, yet surely no hypothesis should win by default. Perhaps the alternative hypotheses suggested here would have received equally mixed support from similar attention, but it does remain to test the various hypotheses more fully.

The available evidence on the distribution of profits and losses from futures trading comes from three types of sources. We shall here note these only briefly, with particular reference to their limitations. Stewart [101] was able to analyse the complete trading records of 8,922 customers of a large Chicago commission firm over a 9-year period (1924–32) in wheat, corn, oats, and rye. He found that 6,598 speculators had net losses and 2,184 had net profits; and that the net losses approximated $12 million in contrast to net profits approximating $2 million, with net losses accruing in all four grains. This dismal record is ameliorated by two major considerations: (1) the commission firm went bankrupt, suggesting that traders dealing through other commission firms may have had better success, and (2) the period was one of net price decline, and a disproportionate share of the losses were incurred during the last 3 years, when prices declined sharply, whereas the sample of traders was mainly on the long side. It is perhaps too much to expect avocational commodity speculators to forecast a severe slump in general economic conditions. It is unfortunate, to say the least, that this is the only published *record* of trading results for any substantial group of traders over any extended time period.

The second class of evidence comprises the studies of Houthakker [55] and Rockwell [88], who have estimated returns to the trader classifications of the Commodity Exchange Authority. We have commented elsewhere (p. 28) on these findings with regard to the risk premium. Rockwell's findings, based upon Houthakker's method of analysis, cover more years and commodities and may therefore better sustain a generalization. Large (reporting) speculators earned profits, small traders (probably mainly speculators) broke even, and reporting hedgers incurred small losses, according to Rockwell's estimates. These estimates are taken from semi-monthly observations during a period of general but gradual price declines, the trader classifications are highly aggregative, and the positions are not classified by delivery month—hence no sharp picture of the profit flow emerges. Nevertheless, the results cast grave doubts on the representativeness of Stewart's sample.

The third sort of evidence is the detailed record of one professional trader in cotton futures for a brief period, analysed by Working in [141].

While this obviously does not purport to be a representative sample, its chief interest lies in the interpretation of trading technique, which for this trader was "scalping" of rather large "dips and bulges", as opposed to trend or news trading. To the extent that such a technique is common to many floor traders, it allows reconciliation of their profits to the absence of trends in futures prices. More significantly, it provides an explanation for the otherwise puzzling fact that the amount of speculation in commodity futures corresponds closely with the amount of hedging.

3. CONCEPTS OF HEDGING

We have already touched briefly upon one view of hedging, that developed by Working. In this section we trace the development of various concepts of hedging (including Working's) and attempt to place some of the more controversial issues into a precise framework.
It is convenient to demarcate four classes of hedging theory; each distinguished from the others on the basis of assumptions which are made about hedgers' attitudes towards risk and hedgers' motivation to profit from futures operations. Any classification scheme of this nature is bound to be imperfect and the present one is no exception. Several discussions of hedging theory which appear in the literature do not clearly fall into any of the four classes. However, each class does represent a formally distinct approach to the question of hedgers' motives and each is logically internally consistent.

HEDGING CARRIED OUT TO ELIMINATE THE RISKS ASSOCIATED WITH PRICE FLUCTUATIONS

Two quotations serve to illustrate the nature of this view of hedging:

> Whatever it (the milling company which sells hedges) gains or loses on the original purchase of cash wheat will be exactly offset by an equal loss or gain on the future sale (Taylor [104, p. 294]).
>
> A person who is neither long nor short is running no risk; he is hedged (Boyle [6, p. 34]).

The risk *elimination* view of hedging, which is the most naive of those catalogued here, was most commonly expounded during the first quarter of this century (see for example, the many references in Hardy and Lyon [47]). However it retains a certain following, for as recently as 1966 Skadberg and Futrell [91] were able to report:

> Proponents of the new markets have expressed the view that they will *eliminate* price risk for feeders, moderate production cycles, stabilize prices and make capital easier to obtain (p. 1485).

The importance of the risk elimination view is that it permits an analogy to be drawn between hedging and insurance; only to the extent that hedging eliminates the risk to the hedger of fluctuations in price is this analogy valid. Despite this, hedging is often equated to "price insurance", even by those who do not claim that hedging eliminates price risk, as we shall see below.

The validity of this concept of hedging can be readily subjected to empirical test. Risks associated with price fluctuations will only be completely eliminated for a hedger if cash and futures prices move completely in parallel (note that this is a stronger statement than "only if cash and futures prices move in parallel *on average*"). Several studies of the relationship between cash and futures prices have been carried out and there is abundant evidence that they do not move in parallel. While the parallelism hypothesis is rejected, however, there is a significant positive correlation between cash and futures prices. This leads us to the second view of hedging.

HEDGING CARRIED OUT TO REDUCE THE RISKS ASSOCIATED WITH PRICE FLUCTUATIONS

Even though cash and futures prices do not move in parallel, any given change in the cash price is often accompanied by a "similar" change in the futures price. To the extent that this is true, hedging may be said to reduce (for the hedger) the risks associated with price flictuations. Furthermore, if one accepts risk reduction as a major function of hedging, the usefulness of a futures market to a hedger "depends on the degree of correspondence between movements in [cash] prices and movements in futures prices" (Gruen [44, p. 1]).[6]

Attempts to measure the usefulness of a futures market for hedging, in this definition, have generally proceeded in the following fashion [30, 45, 59, 60, 61, 95, 96, 124, 143].[7]

(a) Measure the "risks from changes in cash prices". This has usually been done by attempting to estimate the expected change in cash price over a given time interval.

(b) Measure, in the same way, the "risks from changes in the basis".

(c) Compare the "price risks" with the "basis risks". The smaller the ratio of "basis risk" to "price risk" the more effective is the market as a hedging medium.

The USDA studies applied this procedure to cotton (U.S. markets), grains, wool, and wool tops [59, 60, 61]. Essentially the same analysis was employed by Yamey [143], in his analysis of the Liverpool cotton futures market, and by Snape [95], for New York and London sugar futures, and the Sydney wool futures market [96]. There were, of course, variations in findings from commodity to commodity, but in virtually every instance "basis risks" were found to be smaller than "price risks". In other words, the correlation between cash and

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[6] The arithmetical difference between cash and futures prices is known as the "basis". The expression "stability of basis" is often used in discussions of the relationship between cash and futures prices.

[7] Not all the studies cited here follow this technique but it is nevertheless quite representative.

futures prices is high enough that there is considerably less variance in the difference between the two than in either series. Thus hedging on these markets does reduce risk substantially and consequently the markets have been considered to provide useful service to commodity merchants and processors. It is this fact which has caused several writers to maintain the analogy between hedging and insurance [62, 145].

We offer the following comments on these measurements of "basis stability" or "risk reduction".

(a) The concept of risk which is employed is generally vague. Indeed, in none of the studies mentioned above is an attempt made to define the term "risk". However, one may infer from the context that risk is taken to mean the statistical expectation of unit loss. It is worth noting firstly that marginal "risk", so defined, is constant; secondly that according to this definition, it is quite possible for risk to take on negative values. In some more recent literature on the behaviour of individuals faced with uncertainty, risk has come to be associated with the *variability* of possible outcomes as distinct from the expected return (see below, p. 49). Suffice it to say here that the concept of risk implicit in the discussion of basis stability is rather restrictive and that no attempt was made in these studies to formalize the decision rules under which hedgers operate.

(b) The term "basis stability" is actually equated with "basis constancy".

> The less the fluctuation in the [cash-] futures spread, . . . the more satisfactory are conditions for the hedger, and vice versa. Lack of stability in this spread largely destroys the serviceableness of the futures market for hedging by introducing an element of uncertainty or speculation as to whether the spread in question will widen or narrow (Stevens [99, p. 28]).

On the other hand if hedgers (or potential hedgers) can forecast basis fluctuations, then these need not impair the usefulness of the futures market for hedging. The question is not the extent of basis variability *per se* but rather the predictability of basis change. It remains an open question, to which we now turn, whether or not hedgers may be able to forecast fluctuations in the basis.

HEDGING CARRIED OUT TO PROFIT FROM MOVEMENTS IN THE BASIS

The first objections to using basis stability to measure returns to hedgers were raised by Working [132]. He pointed out that many of these calculations revealed that hedgers would often incur substantial losses after storage costs, insurance and interest rates were accounted for, *if they hedged in the routine fashion implied by the basis stability measurement*. Rejecting the hypothesis that such losses could represent payment of a "risk premium", he was led to question the implied behaviour of hedgers:

> Hedging would not have the reputation that it does among experienced hedgers generally, and among their bankers, if its results were anything like those represented by the calculations just considered. What is wrong with the calculations? (p. 545).

Working proceeded to show that while the basis does fluctuate, these fluctuations are highly *predictable.* Using data on wheat prices at Kansas City he showed that the return on hedged stocks (i.e., the change in the basis) in any given period is negatively related to the value of the basis at the beginning of that period. Recently Heifner [49] has provided similar results for corn and soybeans.[8]

In the light of the predictability of basis fluctuations, Working [132] suggested four considerations which motivate hedging.

> (1) It facilitates *buying and selling decisions.* When hedging is practiced systematically, there is need only to consider whether the price at which a particular purchase or sale can be made is favourable in relation to other current prices; there is no need to consider also whether the absolute level of the price is favourable.
>
> (2) It gives *greater freedom for business action.* The freedom most commonly gained is that of buying, for example, when a particular lot of the commodity is available at a relatively low price, regardless of its absolute level (this freedom is related to, but distinct from the facilitation of decision mentioned above); often, moreover, the freedom gained is to make a sale or purchase that would not otherwise be possible at what is judged a favourable price level, as when a cotton grower sells futures in advance of harvest, or a textile mill buys futures because cotton prices are judged to be favourable, but the desired qualities of cotton cannot be bought immediately in the spot market. (3) It gives a *reliable basis for conducting storage of commodity surpluses.* The warehousing of surplus commodity stocks is a very uncertain and hazardous business when based on trying to judge when the price is favourable for storage; hedging allows operation on the basis simply of judgment that the spot price is low in relation to a futures price. And (4) hedging *reduces business risks.* There is usually reduction of risk when hedging is done for any of the previous three reasons (though often not under the second reason), but any curtailment of risk may be only an incidental advantage gained, not a primary or even a very important incentive to hedging (pp. 560–561).

The foregoing contrasted sharply with the orthodox view that risk reduction was the *leit-motiv* of hedging, but it conformed more closely to many observations of business practice, e.g., [24, 50]. One such observation, which antedated Working's revision by more than two decades, was the following:

> The commercial character of hedging trades is implied in a remark of an oldtime trader, who says that hedging is a sort of spread between the cash and the futures. Of course, the spread often goes against the trader, as well as favourably to him. The process of hedging does not allow the grain dealer to reckon in anticipation just what his profit on hedged grain is going to be, except where he expects to deliver the grain on the hedging sale. Hedging, therefore, sometimes does not serve the purpose of insuring an ordinary merchandising profit with any great degree of efficiency. It sometimes, of course, adds to the profits of the seller of grain, but that is another matter. It is possible that the normal result of a hedge, viewed as a spread between the cash and the future, would be a profit to the seller of the grain, since he may get the benefit of a premium on the cash, due to quality or temporary scarcity. There is always the possibility of "making a turn" in the cash grain between the placing and the closing of the hedge. All these elements in the situation, however, involve risks as well as possible profits [121, Vol. 7, p. 60].

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[8] These results were foreshadowed in a 1950 study of egg storage [72].

Arbitrage hedging, as it came to be called [131, p. 325], placed primary emphasis on the expected return from hedging and de-emphasized the role of risk. In discussing risk Working [132] states:

> There is usually a reduction of risk when hedging is done for any of the previous three reasons . . . but any curtailment of risk may be only an incidental advantage gained, not a primary or even a very important incentive to hedging (p. 561).

Although Working considered most short hedging to be motivated by expected profit from basis changes, he left open the possibility that expected changes in spot prices could influence hedging decisions. He argued that the nature of most hedging firms' activities are such as to allow them to develop intimate knowledge of the price-determining influences in the commodity with which they deal and hence that "many hedgers often form quite definite opinions on price prospects" [132].

Working identified two classes of hedging based on price expectations, which he called "selective" and "anticipatory" hedging. Selective hedging may occur, for example, if a merchant places high subjective probability on a price rise in the next period: he may then leave all or part of his inventory unhedged. Anticipatory hedging may be carried out either in response to expected future needs (anticipatory long hedging) or in response to expected future sales (anticipatory short hedging).

A similar class of hedging is that based on futures price spreads. This is available, for example, to U.S. soybean processors by virtue of the fact that viable futures markets exist for each of soybeans, soybean oil and soybean meal. In formulating their hedging policies, soybean processors may be guided in large part by their expectations as to the future behaviour of the price relationship between soybeans and soybean products. Again the emphasis is placed on expected returns and, in this respect, anticipatory and selective hedging are similar to arbitrage hedging.

The arbitrage view of hedging integrates the hedging decision into overall management strategy. The businessman, whether he be merchant or processor, is not viewed as making the decision to accumulate stocks (or to sell forward) independently of the decision to hedge. Indeed the perceived opportunity to hedge stocks profitably may often be the motive for accumulating them.

This view of hedging does, however, pose the question of risk reduction versus expected gain as an "either-or" proposition. In this respect it is similar to the insurance view of hedging. It differs, of course, in that it rejects risk reduction as the motive for hedging and accepts expectation of gain, whereas the insurance view adopts the diametrically opposed position.[9]

Yamey [145] has recently elaborated upon his view of insurance hedging. He argues that basis movements may be regarded as a "cost of insurance" and that the amount of insurance undertaken (i.e., the level of hedging)

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[9] The controversy which evolved from these differing interpretations is reflected in [36, 97, 145].

will vary inversely with its cost. Basis movements which are favourable to the hedger represent negative costs of hedging and may be expected to induce more hedging than do positive costs. To thus substitute positive or negative costs for positive or negative returns stretches the insurance analogy beyond the breaking point.

HEDGING CARRIED OUT TO MAXIMIZE EXPECTED RETURNS FOR A GIVEN RISK (VARIABILITY OF RETURN) OR MINIMIZE RISK FOR A GIVEN EXPECTED RETURN

Several recent studies of hedging behaviour have made use of portfolio theory and in particular of the "mean-variance" formulation due to Markowitz [80]. The hedger is regarded as being able to hold one or more of several "assets". In the case of a short hedger, for example, these assets could be:

(i) unhedged stocks;
(ii) stocks hedged by sale of futures;
(iii) stocks hedged by forward cash sale.

The return on each "asset" is a random variable and it is assumed that each (potential) hedger has a subjective probability distribution over these variables. The hedger is assigned a cardinal utility function whose argument in the net value of his assets at the end of the period under consideration. If this utility function is concave he is said to be "risk averse". It is further assumed that the hedger will act in such a way as to maximize the expected value of his utility function.

In the Markowitz framework the hedger chooses among alternative portfolios on the basis of their means and variances—this implies the existence of mean-variance indifference curves. If μ and V are respectively the mean vector and variance-covariance matrix of the hedger's subjective probability distribution, any portfolio X will have an expected return $X'\mu$ and risk $X'VX$. The hedger is assumed to select a portfolio which maximizes $X'\mu$ for a fixed value of $X'VX$. This gives rise to an "efficient" set of portfolios and the hedger chooses that which allows him to attain his "highest" mean-variance indifference curve.

The most significant theoretical studies of hedging viewed as portfolio selection have been carried out by Telser, Stein and Johnson [65, 98, 105]. Johnson and Stein consider a merchant or processor who holds a predetermined level of stocks and who has to decide what proportion of these stocks should be hedged. Using mean-variance analysis they show that, in general, some fraction of stocks will be left unhedged. This corresponds to selective hedging discussed earlier. Notice, however, that the decision to hold stocks is made independently of that to hedge.

A slightly more general problem is considered by Telser. The merchant or processor, before accumulating stocks, is to decide what quantity of stocks to hold hedged and what quantity to hold unhedged. In this framework the volume of stocks held by an individual is not predetermined but is a function of price and basis expectations.

Portfolio theory appears to provide a useful framework in which to formalize a discussion of hedger behaviour. It affords an explanation of the fact that not all stocks are hedged and, of those that are, some are hedged by forward cash sales and some by sale of futures contracts. In the final analysis, however, its usefulness will be determined by its empirical content.[10]

By way of summary it should be said that certain of the divergent interpretations of hedging outlined above may never be reconciled. The possibility remains, for example, that practices differ considerably from one firm or commodity trade to another or, less likely perhaps, from one country to another. Working's reconstruction of hedging theory was the most radical, and his remains the most compelling argument, if for no other reason that it is common practice to engage in cash and futures transactions simultaneously (and to refer to these combined transactions as "going long or short the basis"), which is strongly suggestive of continuous arbitrage.

4. FUTURES AND PRICE VARIABILITY

A persistent question in the literature of futures trading is, What is its effect upon price variability? Virtually all of the earlier works cited in the previous section dealt with this question, which has given rise to numerous conceptual and measurement problems. If later developments in futures trading theory have lessened the emphasis placed upon the variability question, or helped to resolve it, still it persists in some degree. There are several considerations out of which the question has arisen in one form or another.

The agricultural and raw material commodities to which futures trading chiefly applies are characteristically subject to greater price fluctuations than most other classes of goods. Their lower elasticities of demand and supply are well-established phenomena, whereas their characteristic market organization, even in the absence of futures, is one in which prices are flexible rather than administered. Indeed, futures markets are not viable unless the anterior marketing system is flexible. The systemic price variability common to these commodities affects the incomes of primary producers, and the consumer prices of various staples, posing serious economic problems. An important dimension of "improvement" in the market organization is therefore taken to be "reduction" in price variability.

Early studies had to take account of widespread agrarian opposition to futures trading, which was frequently manifest in legislative proposals to prohibit or circumscribe futures [23].

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[10] A recent study by Rutledge [89] has yielded promising results, but further work is clearly necessary before a verdict can be reached.

> About the years 1894 and 1895, when prices were considerably depressed, the question of the influence of the active operation of a market in futures was widely discussed in England, America, and the Continent. Anti-option bills were promoted in more than one American State; the so-called Exchanges Act was passed in 1896, in Germany, to regulate speculation on the exchanges there; and a committee of the section of Economic Science and Statistics of the British Association reported in 1900 on the effects of dealings in futures upon prices, with special reference to wheat. The particular point then under discussion was the assertion that futures tended to depress prices. This was a natural supposition in view of the prevailing low prices at that time, but the exactly opposite opinion has been maintained in times of high and rising prices with as little justification in the one case as in the other (Smith [94, p. 127]).

This would not be the last time that price *level*, instead of price *variability*, would be blamed upon futures markets. In the United States in more recent years, potato and onion futures markets came under investigation when prices were low [113, 114, 115, 116]; coffee, copper, and sugar futures markets when prices were high [117, 122], a pattern which manifests concern for the *producer* of home-grown commodities and the *consumer* of imports. Some of the political crusades against futures, launched under the banner of price fluctuation *or* levels, have been little more than efforts to "break the thermometer because the temperature is unpleasant".

But the question of futures influence upon price variability cannot be lightly dismissed just because some fallacies have been perpetrated in its name. There are perfectly serious and sound reasons for examining the question. One reason why it was raised more persistently during the early history of futures trading may be found in the fact that this early history is replete with instances of manipulations and corners. Taylor's *History of the Chicago Board of Trade* [103] recounts many of these, along with the efforts of the Board to stamp them out. These efforts bore fruit by the turn of the century, and since 1922 Federal laws regulating futures markets in the United States have undoubtedly much reduced both the incidence of manipulation as well as unwarranted fears or allegations of manipulation. Successful manipulations or corners introduced unwarranted price fluctuations, as in fact did unsuccessful attempts to manipulate or corner. Thus quite apart from the relationship between speculation and price variability in principle, certain unrestrained practices in futures trading gave rise to occasional unwarranted price fluctuations.

Another element in which the divorcement between principle and practice was seen was the appeal of futures trading to the uninformed or unskillful speculator. Smith [94] wrote of this problem, in adumbration of the later theory by Friedman [28] that profitable speculation reduces price variability, that:

> . . . it cannot be denied that there is great evil in the participation in the market by a large outside public, who assume unnecessary risks and simply bet on fluctuations. These amateurs, who have neither capital nor the mental equipment necessary to form a real opinion concerning the course of prices in the market, are attracted by the possibilities of making great and speedy gains from the fluctuations in prices. Their action is, in fact, the merest gambling and leads to unsteadiness of the market in times of excitement (p. 121).

This observation has been echoed down to the present day, not only by impartial observers but by some leading participants in futures trading, who argue not only that the lambs are fleeced by the wolves, but that erratic price movements could be avoided if only the lambs would stay out of the way and let the wolves cannibalize [81]. The tendency for small traders to lose money speculating was more cogently interpreted by Smith [94] half a century earlier.

> . . . it is difficult to see how the speculative market can be maintained for the legitimate traders without the admission of the foolish outsider also, in quite considerable numbers. As has been pointed out already, it is from this latter class that the expert speculator in the long run derives the main portion of his remuneration for the valuable services he renders. It would not be possible to bring about a condition of affairs under which expert speculators of great experience and knowledge carefully investigated all the circumstances bearing on prices and then alone worked out the consequences and arrived at a scientifically determined market price. Desirable as such a state of things may be, the fact remains that the experts are not prepared to act in this way. It simply would not afford them a living; for it would merely redistribute their individual capitals among their number without any increase in the way of profit. For their full activity, an adequate supply of outside lambs to fleece is a first necessity (pp. 121–123).

The propensity of small speculators to lose money is fairly well-established in later empirical studies [55, 88, 101], which of course implies their contributing to price instability, *ceteris paribus;* but this being offset or more than offset by the diminution in fluctuations brought about by larger speculators. The question whether futures trading affects price variability is seen to be separate, in this and other respects, from the question whether speculation, in principle, influences the variability of prices [42, pp. 180–81].

Futures markets have also received deserved consideration as an alternative mechanism to such official price stabilizing devices as buffer stock schemes. Keynes [70] and Blau [4] among the theoretical writers emphasized this choice. In the case of an official scheme, price stability is purposefully sought; whereas in the futures market case it is expected as an incidental consequence of profit-seeking, but in either case stability is the result of inventory or production adjustments through time.

> The logic underlying a true reserve price scheme, whose *sole* objective is price stability at *economic levels*, is indisputable. It recognizes simply the tendency of prices to fluctuate about their average levels (including any secular trends) and postulates that inventory accumulation at low prices and decumulation at high prices will diminish price fluctuations about the average. The eminently sound logic is of course precisely the logic underlying private speculation. Anyone, whether it be official agency or private trader, who buys at low prices and sells at high prices has by definition contributed to price stability, by adding to the demand at low price levels and to the supply at high price levels. The real issue which is thereby posed is whether speculation should be done by private traders or official agencies, or by some combination of the two (Gray [40, p. 5]).

Keynes' concern was that insufficient venture capital was attracted to futures markets for many commodities, hence he was led to endorse

official stabilization schemes, albeit at a time before the world had gained much experience with such arrangements. Blau, having observed the many practical difficulties encountered by existing schemes, was much more skeptical. We would be carried far beyond the scope of this survey to pursue this comparison into any detailed discussion of official price stabilizing schemes. And despite the logical validity of the comparison between futures markets and price stabilizing schemes, recognition of other important functions of futures, and of the varied problems and purposes found in price "stabilization" plans, complicates the seemingly simple comparison. Working's conclusion from extensive study of wheat futures prices and inventories that the response of the latter has been "in the main, appropriate" ([131, p. 332]) carries with it in this context the implication of reduced price variability.

On the other hand there can be little doubt but that the United States price support programmes for wheat reduced price variability still further albeit at considerable cost. This only points up the distinction between variations around the equilibrium price level and variations around higher levels.

A related consideration arises in relation to policy proposals entailing "forward prices" for agricultural producers. The argument for guaranteed forward prices is essentially that if growers' production decisions are geared to prospective prices, greater individual and industry stability can be achieved, as contrasted to a situation in which such decisions are geared to current or retrospective prices (Johnson [64]). Cyclical price fluctuations of the cobweb or harmonic motion varieties in particular should be reducible through forward price guarantees. Again the question becomes whether a futures market cannot accomplish the same goal without government guarantees, and again the logic is the same in either case, the determining factors being whether the agency or the market can make better forecasts, and which is more likely to elicit appropriate grower response. Thus far only fragmentary evidence is available on this question, partly because futures markets are quite new in commodities affected by indigenous price cycles, and partly because price guarantees have often been above equilibrium levels.

The acreage planted to potatoes in the State of Maine, a major United States production area, has become remarkably stable since futures trading in Maine potatoes achieved significant levels (Gray [39]). The earlier history of planted acres in Maine was one of great volatility and a close association with current and recent prices. As with any such analysis, the conclusion that futures trading caused the improvement may entail the *post hoc ergo propter hoc* fallacy. Certainly other factors, such as the planting guidelines and outlook information promulgated by the United States Department of Agriculture, may have contributed to the changed acreage pattern. Yet futures hedging by growers has increased steadily, and the "forecast" price at planting time displays very little year-to-year variability. The stability which has emerged is at least logically accountable to futures trading. Larson also found

that the storage egg futures market succeeded "to some extent in predicting cyclical price changes" [76, p. 64], but he did not examine the question of producer response to these futures prices.

Other commodity sectors in which we would expect to find some damping of price-production cycles as a result of increased futures use include hogs, live cattle, fresh eggs, and broiler chickens. No studies that we are aware of have yet analysed this question for these markets, but this is not surprising in view of the fact that their futures markets have been trading for only a few years and at levels much below the potential.

Futures markets can enable price fluctuations to be reduced through either production or inventory response (or in some cases, both). Tomek and Gray [111] demonstrate the contrast between corn and soybeans, on the one hand, and potatoes, on the other, from the standpoint of the growers' opportunities to reduce year-to-year price variability through hedging. The planting time "forecasts" of the harvest period prices of corn and soybeans, they argued, are to a large extent self-fulfilling prophecies because inventories adjust to these prices (as indeed may production, although they did not discuss this possibility). But since no potato inventories are carried over this interval, the planting time "forecast" in the futures market is virtually the same each year, and hence uncorrelated with the subsequent harvest-period price. Thus the potato grower can greatly reduce *his* price variability through hedging, as the corn and soybean grower cannot. But it is implied on the *other* sides of these coins that corn and soybean price variabilities have been reduced (through generalized production and inventory response) as potato price variability has not.

The acreage response of the Maine potato grower, mentioned above, has not introduced noticeably greater price stability because producers in other major producing regions have not responded similarly. A further anomaly lies in the fact that corn and soybean growers do not, for the most part, hedge in futures. Their direct response (selling their crop forward in futures hedges) has not been needed because the merchants who buy their crops use futures and relate their country bids to futures prices. Futures prices can elicit production or inventory responses even if these prices are taken only as guides by the decisionmakers, just so long as others in the system use futures directly, and base their dealings with non-users of futures upon futures prices. The production and inventory response of growers of grains and cotton in the United States cannot be presumed lacking simply because most of them do not hedge.

We may sum up to this point. Appropriate adjustments in either inventories or production can help maintain prices near their longer run equilibrium level. Inventory management (buffer stock) schemes can, in principle, ration existing supplies, so as to maintain prices nearer the long run equilibrium level. Production guidance can alleviate the perverse response that leads to cyclical price behaviour around the

equilibrium level. In both cases, official intervention and futures markets represent alternative devices for achieving the same end.[11] The problem then resolves itself into comparison of the practical experience under these alternatives,[12] of which it may safely be said that not enough has been done to provide a clear-cut answer for all cases. Suggested limitations of the futures mechanism in this context have included:

(1) Manipulation of futures prices, which deliberately create non-equilibrium prices through exploitation of weaknesses in the mechanism. Suffice it to say that this is illegal where futures markets are regulated by government, and contrary to to exchange rules in other cases. Without saying that manipulation does not occur, it seems fair to say that fraudulent practices arise in all financial dealings, and we find no reason to suppose that futures trading is today peculiarly subject to abuses.

(2) Participation in futures trading by ill-informed or inadequately financed persons who may be more gamblers than speculators [94, p. 121]. It may be posited, on the grounds of ease of entry into futures markets on small margins, either that amateur traders will carry prices away from the equilibrium level, or that resources will be wasted through too *much* participation, even if equilibrium prices are evoked. (What if millions of persons traded wheat futures, is this not too high a price to pay, even for "perfect" wheat prices?) The observed responsiveness of futures speculation to hedging needs [33, 35, 138, 141] substantially alleviates these sorts of concern. The more realistic concern relates to the adequacy of speculation [34, 42, 58, 70]. We reckon that not more than 50,000 individuals and firms hold positions in all United States futures markets at any given time.

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[11] Although Blau [4], for example, recommends a combination of the two: . . . "In fact, it might be said that in the case of products for which the requisites of effective comprehensive control are not given, the best recipe for greater economic stability is to create conditions of "management" under which sensitive exchanges can be made to be, and can afford to be permanently "dull" whilst retaining their functions as liquid media for shifting the ten moderate risks, and as reliable barometers of the trend of independent market forces", and Houthakker [58] has proposed that the government agency participate in futures trading (in remote contracts) on Keynesian grounds that inadequate private capital is attracted to futures markets to enable price stabilization at achievable levels. The brief experience of the United States Federal Farm Board in futures operations (Evans [25]) is not encouraging in this respect. A somewhat similar policy has been suggested by McKinnon [78].

[12] In this discussion we are ignoring the question of the desirability of price stability. Arguments from consumer or producer surplus, price versus income stability, or institutional considerations such as taxes, have a bearing on this question, but would carry the present survey too far afield.

(3) The counter suggestion to the one that speculation helps to achieve the equilibrium price, found in the comment by Chamberlin [10] that "although speculation *may* actually stabilize prices, the writer is at a loss to find any *a priori* reason why it should do so, or why it should lead to the ultimate establishment of the equilibrium price . . . Indeed, it seems more likely that speculation would cause more and greater fluctuations" and the more famous Keynesian [71] dictum that "We have reached the third-degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be" as well as Farrell's [26] conclusion that the "basic proposition (that profitable speculation stabilizes prices) is too strong to hold with any great generality".

If these observations are transferred to a futures trading context (which is not the context in which they were originally set), the responsiveness of futures speculation to hedging in futures is again cogent evidence. It is not necessary to deny that the speculator would gladly profit from mistaken price movements if he could anticipate these, in order to assert that he may more confidently and consistently estimate appropriate price changes.

HISTORICAL EVIDENCE IN THE STATISTICS OF PRICE FLUCTUATIONS

Virtually all of the early empirical studies of futures trading included some indications of its effects upon price fluctuations. We do not undertake an exhaustive cataloguing of this evidence, but endeavour instead to convey something of its general thrust by quoting a few major portions. Since the question whether futures trading affects price fluctuations takes various forms, it is not surprising to find that the statistics have been presented in various forms as well.

Among the early writers on the subject, Emery [22] warned of the limitations of such analyses in the following passage:

> Statistics regarding the influence of speculation on prices must be regarded with due caution. We may compare the prices of some commodity during a speculative and a non-speculative period, or we may compare the course today of prices of a speculative and non-speculative commodity or security. In the first case it is never quite possible to tell what other changes besides the introduction of speculation may have been of influence; in the second case it is difficult to weigh the various influences, other than the presence or absence of speculation, which affect the price of the two commodities.

He then presented a series of tabulations, as follows:

(1) For cotton at New York the highest and lowest prices each year for three separate decades (1821–30, 1851–60, and 1885–94) showing constantly diminishing fluctuations, but less diminution between the middle decade and the last (with futures) than between the first two.

(2) For wheat at Chicago (1865–95) showing a pronounced diminution in fluctuations between the first and second halves of the period.

(3) For winter wheat at New York (1855–59 versus 1890–93) showing smaller fluctuations in the latter period.

In addition, Emery quoted other findings whose authors had drawn similar conclusions. He also adduced the advantage of speculation that it gives early warning of price change, and presented data showing with what success spot prices had been anticipated in futures.

The United States Industrial Commission [112] adopted Emery's findings, and addressed the further question whether the post-harvest price was higher or lower relative to later months under futures trading. Their conclusion, drawn from numerous tabulations of cotton and wheat prices, was that "evidence believed to be conclusive has been presented showing that, under speculation, prices prevailing at the time when producers dispose of the greater part of their products are greater in comparison to the rest of the year than they were before the advent of modern speculation".

The United States Federal Trade Commission (1924–26) analysed grain price variability in great detail and from several standpoints, including complex measurements of year-to-year, month-to-month, and seasonal variability. (See [112], vol. VI, chapters I, II, III, and XI, and vol. VII, chapters I and VIII.) The best that can here be done with their voluminous study is to excerpt key statements from their conclusions.

> Frequently attempts have been made to deal with the question of the stabilizing effect of future trading by comparing periods prior to the practice of trading in futures with periods since there has been such trading. Such a comparison, in order to prove anything, must first prove that the other things are equal—either that there have been no other changes between the two periods or that any other changes that may have occurred had no effect on the fluctuations of grain prices. Obviously no such proof can be offered in the case under consideration (vol. VI, p. 261).
>
> Evidently the before-and-after type of historical comparison has little convincing force as applied to the question whether future trading stabilizes prices (vol. VI, p. 263).
>
> It cannot be claimed that the results of the foregoing studies and comparisons of price movements lead to a definite conclusion one way or the other regarding the alleged tendency of futures to operate as a stabilizing influence upon prices. It appears that the data and analysis should be much extended before being accepted as a satisfactory basis for conclusions of this nature. The readings are not definitely enough on one side or the other to give even a conclusion much qualified with reference to the complicating conditions (vol. VI, p. 263).
>
> It seems to be conclusively proved by this bit of analysis that futures trading under existing conditions itself generates certain elements of risk and uncertainty. In other words, it causes some fluctuations. Its stabilizing influence must, therefore, depend upon its stilling or checking other causes of fluctuation that are more important than those it creates (vol. VI, p. 264).
>
> The claims frequently made for the stabilizing effect of futures trading upon prices have been considered at some length in this report and have not been found to be warranted. The statistical data studied yield results that are on their face negative, but because of necessary qualifications, they do not afford conclusive evidence (vol. VII, p. 289).

Similarly divergent interpretations appear throughout the literature. Whereas Boyle [5] concluded from more than 100,000 observations on wheat prices.

> In the light of these facts, it cannot be said that future trading causes prices to fluctuate or increases the fluctuations in price. This evidence shows that future trading lessens price fluctuations—"put on the brake" against bulges and breaks in price (p. 9).

Hoffman [51] reiterated the kind of objection that has been made repeatedly to such conclusions:

> This conclusion is, however, subject to question on the ground that important evidence was omitted from the study. During the period 1871–1913 the telephone, the telegraph, the cable, improved railroad and steamship service, improved methods of grading and handling, became an established fact. In the period 1841–1860 these facilities were largely lacking and particularly so in the then frontier town of Chicago. Grain traders gathered to await the arrival of the pony express from the East. If word was received that the latest boat from England wanted a cargo of wheat, prices advanced several cents a bushel; if no wheat was wanted a similar decline occurred. These variations were certainly in the main due to an imperfect system of communication and transportation (particularly communication) and not to a lack of futures trading. Studies similar to the one just cited have been made at earlier times, but the results are not conclusive (p. 429. See also [120], pp. 261–64).

Hoffman also noted the close correlation between futures trading volume and price variability, but was careful to say that its effect was "to demonstrate the dependence of trading upon price fluctuations" [51, p. 329] rather than the other way around. He also examined more up-to-date statistics of wheat and cotton prices, only to conclude with regard to fluctuations that "it is still difficult to draw any dependable conclusion regarding the influence of future trading [51, p. 431].

Such divergent conclusions as the ones cited here have continued down to the present day, with perhaps the balance of the argument favouring some tendency to reduction of fluctuations owing to futures trading [32, 110]. We feel also that official studies by investigatory or regulatory agencies reflect more skepticism on this question than do academic studies, although any such contrast is by no means uniform.

Another approach to the question of futures influence upon price variability is suggested in Ashby's [1] finding:

> Comparison of spot prices . . . with 11-months futures plotted for the month of maturity . . . then, will indicate the exactness with which spot cotton prices are forecasted 11 months previously, while comparison of the spot price curve with the curve of 11-months futures plotted as of the month sold . . . will indicate the relations existing between the prices of spots and long futures sold concurrently. The conclusions below are based upon an analysis of the three curves over a period of 37 years.
>
> In the first place, it is noticeable that, in their long swings upward and downward, forecasted prices never rise as high as actual prices, nor descend as low. This would seem to be additional evidence of the truth of the well-known generalization that futures speculation is an influence tending toward an equilibrium of prices and steadier trading, seeking always to establish a mean price and bring back the fluctuating spot curve to a norm (p. 68).

There is real danger of proving too much by such statistics, as indeed was pointed out by a critic who wrote to Ashby [1]:

> There is no future price of cotton today. All prices are current prices made today on the basis of today's information, and not reflecting tomorrow's information in any degree except as it is foreshadowed by today's. Prices, rather than being tied to future months' probabilities, are all tied together by the straddlers so that any current information which might affect next May's deliveries serves to move the whole current structure. Futures may not sell at more than the spot price than by the amount of the carrying charge, nor for less than by the amount for which cotton users are willing to defer their purchases (pp. 70–71).

The point is made most simply by noting that, for the continuous inventory commodities such as grains, if the current price is $1.00 and the price 6 months hence *turns out to be* $1.50, there is no way that such a disparity can be reflected *now*. If it costs ten cents to carry the grain for the 6-month interval, then the futures price 6 months hence will not exceed today's price by more than ten cents. From this (and symmetrical but more flexible and complicated considerations dictating inverse carrying charges) it follows that extreme price levels, high or low, are most likely to be higher or lower, respectively, than the earlier futures estimates. This does not of itself prove that the extremes actually observed fall within a narrower range than would have occurred without futures. Yet such evidence is not to be dismissed lightly on this account, for the very fact that inventory levels do interrelate with price spreads is the chief mechanism by which futures are supposed to diminish price fluctuations. And for the non-inventory case, such as the potato evidence mentioned on p. 57, it is surely worth considering whether the stability of the planting-time estimates lends some stability to the harvest-time prices.

EVIDENCE FROM ONION FUTURES

Special attention has been devoted to onion futures prices in this connection for two reasons: (1) onion futures came under political attack, essentially on the ground that futures trading caused excessive price fluctuation; (2) in an unprecedented law, the United States Congress prohibited futures trading in onions (Public Law 85–839, 1958), thereby providing an unprecedented opportunity to analyse prices before, during, and *after* futures trading. The evidence for onions is more detailed than for other commodities, and less subject to the *caveat* that "other factors did not remain the same". Onion futures trading was relatively new, and not very highly developed, when it was abruptly truncated by legislation. Working [137], after intensive study of onion futures data, concluded "the evidence in foregoing pages clearly indicates that futures trading in onions substantially reduced the *amount of variation in spot prices of onions*".

Gray [38] found evidence that the seasonal range of onion prices was diminished during the futures trading era, and subsequently increased again after the futures market was closed.

> "Only time would tell whether the prohibition of onion futures trading would lead to a restoration of the earlier seasonal price range. Perhaps not enough time (4 years) has elapsed to permit a firm judgment, but the evidence is already highly suggestive of a return to the same old pattern (figure 2). It looks all the more as though futures trading in onions had the desirable effect upon the seasonal price range that it is supposed to have" (p. 276).

MORE RECENT ANALYSES

Some additional studies deserve brief mention. Emerson and Tomek [21] concluded (in contrast to arguments made in Congressional hearings on the subject) that futures trading exerted a positive influence upon Maine potato prices, and also confirmed from a different standpoint, the conclusions drawn in [39]. Powers [86] found that some reduction in the random element of price variability in cash prices of pork bellies and cattle could be ascribed to the advent of futures trading. His statistical results are intriguing, but as his point of departure is a somewhat unusual (in this context) interpretation of systematic versus random price behaviour, we are presently at a loss to interpret them fully. This fact in itself underlines the need for further work.

Pavaskar [84] studied groundnut prices in India with and without futures trading, from which he concluded:

"The statistical evidence presented in this study clearly indicates that spot prices of groundnut fluctuated less widely when there was futures trading than in its absence".

In much the same vein Naik [182] examined both the seasonal and short-term price fluctuations for groundnut, hessian, and linseed in India and found that under futures trading the price fluctuations were generally diminished, although the results were uneven among the commodities.

CONCLUDING OBSERVATIONS

The question posed at the beginning of this section comprises many questions; involving the several meanings or types of price variability and numerous futures markets attracting various levels and classes of trading, and there can be no single answer. We think, with Working [14], that the evidence is:

> . . . conclusive on only one point, namely, that the average amount of seasonal variation in the price tends to be less in the presence of a futures market than in its absence. There is much statistical evidence indicating that selling pressure by producers at times of seasonal surplus causes less price depression in the presence of a futures market than in its absence; and there is no evidence, so far as I know, that points toward a contrary conclusion (p. 44).

On the other hand, price manipulations have clearly introduced unwarranted fluctuations on occasion; but this is a sporadic phenomenon of diminishing importance. There is also a rather compelling presumption, where inventories and cash-futures spreads are closely

interrelated, that inventory management is more appropriate than it would be in the absence of futures. The evidence of reduced year-to-year price variability of Maine potatoes is at least highly suggestive, if not conclusive. The emergence and growth of futures markets for potatoes, fresh eggs, broiler chickens, and live hogs will provide opportunities to study the impact of futures trading upon cyclical price variability.

5. THE STOCHASTIC NATURE OF FLUCTUATIONS IN COMMODITY FUTURES PRICES

The behaviour of short run fluctuations in commodity prices has long fascinated economists and statisticians. While the fundamental laws of supply and demand have been generally accepted as determining long run (such as year-to-year) price behaviour they have not provided comparable insight into the determinants of daily or weekly fluctuations in price. Yet it is the short run behaviour of prices which is of interest to the commodity trader; and when complaints are lodged of "excessive price fluctuations" they generally refer to short run fluctuations. More important, it is this aspect of price behaviour which is referred to in discussions of market performance.

Most discussions of short run speculative price behaviour take the "random walk hypothesis" as their point of departure. Under this hypothesis prices, $\{p_t\}$, are generated by the process

$$p_t = p_{t-1} + \varepsilon_t \tag{1}$$

or

$$\delta_t = p_t - p_{t-1} = \varepsilon_t$$

where $\{\varepsilon_t\}$ is a sequence of independent identically distributed random variables. Variants of the random walk hypothesis have been popular[13] since the empirical work of Bachelier in 1900 which suggested that $\{\varepsilon_t\}$ is a sequence of independent normal random variables with zero mean and common variance. Since then, a number of studies, mostly of stock market prices, have provided general support for this assertion.[14]

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[13] There are variations from author to author in the definition of random walk. (1) is probably the most common, see e.g., Feller [27]. Several writers allow the distribution of $\{\varepsilon_t\}$ to depend on t, but require $E(\varepsilon_t) = 0$, all t. Others suggest that (1) should be replaced by

$$\log P_{t+1} = \log p_t + \mu_t \tag{1)i}$$

(1)i may be preferable to (1) because it satisfies the condition $p_t > 0$ and because there is some evidence that $\{\triangle \log p_t\}$ is stationary while $\{\triangle p_t\}$ is not.

[14] On this see Granger and Morgenstern [31], Kendall [68], and Osborne [83]. Some of the results contained in these studies indicated the presence of certain deviations from the random walk model, but they did illustrate the value of the model as a "jumping off point" for analysis of price behaviour. The above three papers are reprinted together with a number of other important studies of the random walk hypothesis in Cootner [15]. A more recent survey is Smidt [93]. See also Stevenson and Bear [100].

In the light of the evidence which began to accumulate supporting the random walk hypothesis, several economists turned their attention to its implications for economic theory. Classical comparative statics analysis was not designed to provide insight into this type of price behaviour. The first enunciation of a theory designed to explain the random walk nature of commodity prices was Working's "theory of anticipatory prices" [126, 130, 136]. Working couched his discussion in terms of an idealized market in which price responds immediately and appropriately to new information. Since truly new information is random, prices perform a random walk. This heuristic argument was formalized (and modified somewhat) by Samuelson [90]. The fact that new information is random guarantees only that $E(\delta_t/p_{t-1}, p_{t-2}, \ldots) = 0$; it makes no assertion as to the distribution of δ_t nor to the independence of the sequence $\{\varepsilon_t.\}$ Thus in Working's "ideal" market, prices form a martingale see (see Mandelbrot [79]). A random walk is a special case of a martingale in which the price changes are distributed independently and identically.

Concurrently with this theoretical discussion further empirical work suggested that many price series deviate slightly from the idealized martingale model. Working [133, 135] noted positive serial correlation (for lags of more than one day) in changes of grain futures prices and negative serial correlation for changes in price during a daily trading session. Brinegar [9] observed a tendency for grain futures prices to exhibit "price reaction" over short periods (1 to 2 weeks) and "price continuity" over longer periods (4 to 16 weeks). "Price reaction" refers to a disproportionately large number of reversals as appears for example in a series with negative first order serial correlation, while "price continuity" refers to an excessive number of runs in price changes. Smidt [92] reported negative serial correlation in soybean futures prices while Houthakker [57] noted a tendency for price changes to persist in wheat and corn futures (a phenomenon similar to Brinegar's "price continuity").[15]

A comprehensive discussion of the properties of short run price behaviour is contained in a recent study by Rocca [87] which examines daily price fluctuations in the price of twenty-three commodities over a 7-year period. Rocca rejects the random walk hypothesis but finds only minor deviations from the martingale hypothesis. These "imperfections" consist mainly of small, but nevertheless non-zero, low-order serial correlation co-efficients in the series of daily price changes. They are not large enough to form the basis of a profitable trading programme.[16]

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[15] There exist several inconsistencies in the results we quote here which are due to a combination of effects: different markets, different time periods, and different estimation procedures. Considerations of time and space have prevented us from discussing these discrepancies in detail; and, in any event they are surprisingly few in number.

[16] Another recent study in the same vein is Labys and Granger [73].

Several theories have been advanced to explain the observed deviations from the martingale model. Taussig [102] had postulated that the equilibrium price is only approximately determined by the intersection of supply and demand schedules and that there exists a region within which price fluctuates randomly (Taussig refers to this region as the "penumbra"). As Larson [75] has pointed out, Taussig's discussion is not sufficiently precise to allow explicit formulation of the process by which price is generated. An alternative model for which such a formulation is possible is due to Larson and Working (Larson [74]). This model relaxes the assumption (implicit in the martingale model) of zero lag between the time at which new information is available and the time at which it is incorporated into the price level. Let ε_t be a random variable which denotes the appropriate price change due to information newly available on day t. If some fraction, say p, of this appropriate price change is dispersed over s days surrounding day t then the observed price change δ_t is generated by the process

$$\delta_t = (1 - p)\varepsilon_t + p \sum_{i = t - s + v}^{t + v} \varepsilon_i \qquad (2)$$

Consequently if $\{\varepsilon_t\}$ is "white noise" price changes are generated by a moving average process. Larson [75] estimated the parameters of a slightly modified version of (2) for the corn market and found that approximately 81 per cent of the appropriate price change is incorporated into the price on the first day. Over the following 4 days there is a price *reaction* of 8 per cent and over the next 45 days the "remaining" 27 per cent is incorporated into the price.

Of the many other explanations of observed market "imperfection" we will mention only two. The first was proposed by Cootner [14] to explain deviations from randomness in stock market prices, but could equally well apply to commodity futures prices. It envisages two classes of traders. The first of these consists of individuals whose primary occupation is something other than stock market trading. Their opportunity cost of market research is high and consequently they select stocks not on the basis of price expectations but "largely on the basis of their attitudes towards risk". The market operations of this class of traders are such as to produce a random walk (more precisely a martingale) not because future prices are perfectly anticipated but because the factors which determine their market operations fluctuate randomly. The second class of traders consists of "market professionals" who have a relatively low (but still positive) cost of market research.

> Their profit will come from observing the random walk of the stock market prices produced by the non-professionals until the price wanders sufficiently far from the expected price to warrant the prospect of an expected return [14, p. 234].

The threshold levels at which the professional trader enters the market act as reflecting barriers which constrain the random walk generated by non-professional traders. Furthermore the position of these barriers will fluctuate randomly as professional traders react to new market information. Cootner argues that a time series generated by a process

such as this will exhibit certain departures from the random walk model consistent with his empirical findings in the stock market. Stated briefly these are:

(a) Negative first order serial correlation coefficients (for one week time periods), i.e., a tendency for price changes to reverse themselves.

(b) Leptokurtic distribution of price changes over small time periods with the kurtosis declining as the time period over which the price change is measured increases. This means that over small time periods there will be a disproportionately large number of small price changes but that this proportion will decline as the time interval increases.

Yet another explanation of short run price fluctuations is offered by Houthakker [57] to explain his findings that commodity price changes tend to persist. He suggests that the market excess demand curve may have a positively sloped segment. If this is so the market will have a point of equilibrium which is unstable: price movements away from this equilibrium point would thus be followed by further movements in the same direction. Houthakker points out that such a positively sloping segment of the excess demand curve could arise if "movement trading" played a significant role in price determination. Secondly he suggests that, since futures are traded on very low margins, the wealth effect of a price change (analogous to the traditional income effect) may exceed the substitution effect. Speculators might thus regard futures contracts as an inferior good.[17]

The theories outlined above are not necessarily competitive. Each may be appropriate to different markets or to any one market at different points in time. In any event we should not forget that they are attempting to explain only minor deviations from the "ideal" martingale model. All the empirical evidence referred to in this section indicates that commodity futures markets perform very well in comparison to the "ideal". Once account is taken of the temporal dispersal of the price effects of new information, as did Larson [75], observed autocorrelations can be rationalised and reconciled with "ideal" price behaviour.

6. OTHER ASPECTS OF THE ECONOMICS OF FUTURES TRADING

There are a number of issues which have not been adequately treated here, and which have only been touched upon in the literature. One of these concerns the direct usefulness of futures markets to primary producers, which relates to price and income variability. In the United

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[17] Without questioning Houthakker's results, Gray and Nielsen [43] applied the identical technique ("stop-loss" orders) to additional data to show that Houthakker's results were not necessarily typical of the markets he examined. The tendency for price changes to persist, which Houthakker observed, was attributed by Gray and Nielsen to (1) the influence of the government price support program, and (2) Houthakker's application of his test to relatively distant futures contracts.

States, where futures markets have become the central coordinating mechanisms in some commodity sectors, it has not been widespread practice among growers to use the markets directly. Merchandising and commission firms may be said to have extended the futures markets *to* growers, however, by basing forward price contracts upon futures. The inventory linkage, described in section 3, has tended to obviate the growers' concern with year-to-year price variability. But with the emergence of potato and livestock futures markets in particular, primary producers participate more in hedging. Several studies have approached the problem from this standpoint ([39, 41, 77, 78, 111], and several of the papers in Bakken [2]). The export commodities of less developed countries have tended to be traded in futures markets at the import centers (cocoa, sugar, coffee, copper, tin, rubber, etc., at New York; and a similar list at London, in addition to cotton and wheat at Liverpool, all exemplify this tendency). Whether locally consumed products in less developed countries could benefit from futures trading, or whether they should organize futures markets for their export items, are questions which may arise increasingly. Generally speaking, storage facilities and financial intermediaries are probably not sufficiently well advanced to enable futures markets to succeed at present, but the simultaneous development of marketing and auxiliary institutions is surely not to be precluded.

In considering such questions, the policy alternatives come into clear focus. Official marketing programmes which entail stocks-carrying by government agencies, and floor prices at effective levels, tend to supplant futures trading [7]. When the role of government goes beyond promulgation of information bearing upon price, or regulation of futures markets to assure competitive practices and extends into various forms of price control or direct participation in marketing, it is generally viewed as being inimical to futures trading. Futures trading in the United States was at very low levels as recently as a decade ago, when government grain and cotton programmes in particular had resulted in large stocks accumulations, but the trading has steadily revived as the programmes were revised to curtail government influence.

The direct regulation of futures trading is a curious patchwork. Most ountries do not regulate their futures markets under any special laws or agencies. Yet there have been outright prohibitions against all futures trading (Germany) and against onion futures trading only (United States). In the United States, the agency first established (1922) to regulate futures markets was the Grain Futures Administration, whereas subsequently (1936) the legislation was amended to include some other commodities (Commodity Exchange Act) but, even with subsequent amendments to bring additional commodities under its purview, the list of regulated commodities includes only domestically produced agricultural commodities. Thus the rather anomalous situation is that several important futures markets (e.g., silver, copper, cocoa, sugar) are unregulated, whereas at several individual exchanges some trading is regulated while some is not. In India, the Forward Markets

Commission regulates all futures trading, and exercises considerably greater authority than the U.S. Commodity Exchange Authority. Indeed, the Indian commission has frequently ordered the cessation of futures trading under circumstances of exceptional price movement, which suggests a tendency to close the markets just when they are most needed.

Economic analysis has important roles to play in the identification of aberrant price behaviour and manipulative influences, in the determination of appropriate contract specifications and the price effects of inappropriate specifications, and in the general suitability of specific commodities or other items for futures trading. Little published material exists in these areas (although see Powers [85] and USDA [119]), but some valuable economic analysis does occur in proprietary studies commissioned by the exchanges. A rather large body of literature also emanates from the exchanges, the commission firms, and from writers who purport to guide the investor in trading commodity futures. Some portions of these works may deserve consideration by economists (e.g., [3, 11, 17, 29, 109]).

The new concepts enumerated by Working [139] comprise most of the safe generalizations that can be drawn from evidence to date. Beyond these, additional research is clearly warranted into the intertemporal price relationships for non-inventory commodities; the significance of market-making versus price-forecasting approaches to speculation; the portfolio approach to hedging; and the functions, performance, and portents of some of the newer non-commodity futures markets. Whatever the ultimate scope and limits of futures trading, it is clearly a growing institution in the United States today.

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