Australian Journal of Agricultural Economics, Vol. 28, Nos 2 and 3 (August/December, 1984), pp. 153-162.

CROSS HEDGING AUSTRALIAN CATTLE*

STEVEN C. BLANK
South Dakota State University, Brookings, South Dakota. 57007, USA

A major part of Australian cattle trade takes place in markets for animals which do not meet the specifications for the trade steer contract. However, producers, processors and marketers of cattle which are non-deliverable on the futures market may be able to make use of the futures market through the process of cross hedging.

The aim is to determine whether or not various types of Australian cattle could, in fact, have been cross hedged successfully in the past using the existing Australian cattle futures contracts. Cross hedging is evaluated over time, space and product form to assess the potential for cross hedging that has existed since the Sydney Futures Exchange's cattle contract was first offered for trading. No attempt will be made to identify 'optimal' cross-hedging strategies.

The specifications of the trade steer contract have changed over time. When first introduced in July 1975 the contract was labelled 'futures type steers'. Prior to 1 July 1977 the contract called for carcass deliveries. Since that date, live deliveries have been made, hence the references to 'live cattle' contracts in the literature. Due to this change in specifications, data from live delivery markets only were used in this analysis.

Hedging and Cross Hedging

The processes of hedging and cross hedging are means by which a person can insulate business activities from price level speculation while retaining the opportunity to speculate in variations between prices. In other words, people hedge (and cross hedge) to retain a profit-making opportunity (Hieronymus 1977, p. 150). Australian cattle traders could benefit from profitable opportunities offered by the futures market if they could identify those opportunities and develop a plan to realise them.

The process of hedging is usually defined as taking a futures market position that is equal and opposite to an already existing or immediately anticipated cash market position (Hieronymus 1977, p. 150; Goss 1980). Cattle producers could undertake hedges to reduce the price risks they are exposed to while holding an inventory of cattle. In so doing, the hedgers hope to improve the chances of realising the profitable relationship which existed between the purchased inputs (steers for example) and the market price for the intended output (fattened steers) at the time the production process was initiated.

Perfect hedges are extremely rare. For a perfect hedge to occur, the basis must remain constant during the life of the hedge (Hieronymus

* An early draft of this paper was written while the author was on assignment with the Bureau of Agricultural Economics, Canberra.

1977, p. 149).[1] The basis is forced to change in real markets through the forces of arbitrage between markets over time, space and product form. Thus, hedgers are said to speculate on the basis (Anderson and Danthine 1981*a*).

In addition to basis risk, there are several factors that affect the risk associated with hedging. A producer with random production volumes must contend with quantity risk as well as price risk. A hedger located away from a futures contract delivery point must bear location risk. In addition, a hedger who deals in the cash market in a grade of a commodity not traded in a futures market must bear quality risk (Rolfo and Sosin 1981).

Hedgers facing quality risk are involved in the process called cross hedging. Simply defined, cross hedging is the hedging of cash positions using futures contracts for different commodities (Hieronymus 1977, p. 236). It follows, therefore, that there must be some price relationship between the different spot and futures markets for cross hedging to be feasible as a risk reducing exercise. Such a relationship could exist for Australian cattle markets if the 'law of one price', as outlined by Bressler and King (1970) and Jain (1980), is operating through an efficient arbitrage process.

The arbitrage process that establishes the 'law of one price' is often assumed to take place instantaneously at spot prices. Unfortunately, Kravis and Lipsey (1978) 'think it unlikely that a high degree of national and international commodity arbitrage . . . is typical of the real world'. Also, Richardson (1978) concludes that 'when commodity arbitrage takes place, it is never perfect'. This implies that an expansion of hedging and cross hedging could improve the arbitrage process in the Australian cattle market.

In Australia, analysis of the cattle futures market has been centred on the market's price forecasting performance rather than its hedging (forward pricing) performance. For example, Gellatly (1980) and Giles and Goss (1981) found that operators in the cattle futures market did a reasonable job of anticipating future spot prices of trade steers. It follows from these results that there may be a sufficient price relationship existing between spot and futures markets to make hedging feasible. The aim, therefore, will be to look beyond trade steers to determine whether cross hedging of other cattle types is feasible in spatially diverse markets.

The Potential for Cross Hedging

Basis stability or predictability is considered the major determinant of the potential for cross hedging. Therefore, to begin the evaluation of the potential for cross hedging various types of cattle traded throughout Australia, the stability of the relationship between spot and futures prices over time, space and product form was evaluated.

The correlation coefficients between the price of the nearby trade steer futures contract and the spot prices of four different types of cattle in

[1] The basis is usually defined as futures price minus spot price, or distant futures price minus near futures price (Rolfo and Sosin 1981). It is the certainty equivalent value of carrying the commodity from one period to another. Keynes (1930), Hawtrey (1939), Kaldor (1939), Hicks (1946) and others have identified elements of the basis as physical costs (such as handling and processing), monetary costs (financing and insurance), and the 'convenience yield'.

each of five different locations are presented in Table 1. The nearby contract is whichever contract is nearest to its expiry date at each point in time. These correlations were calculated using weekly average prices for animals with a fat score of 4, as reported by the Australian Meat and Live-stock Corporation in their weekly *Market Notes for Livestock and Meat* from July 1977 to October 1982. The series were corrected for first and second order serial correlation before the correlation coefficients reported in Table 1 were calculated.[2] Since the nearby futures price is virtually a spot market quote for the delivery centres, it is expected that some relationship should exist between that futures price and spot prices.

If the arbitrage process within the Australian cattle market were perfect over time, space and product form, all of the correlation coefficients in Table 1 would be close to unity. Of course, the coefficients are not unity, but they do indicate that spot and futures markets have been related statistically in some markets. It is interesting to note that there appears to have been no relationship between spot markets in Adelaide and Perth and the trade steer market; seven of the eight relationships tested were not statistically significant at the 1 per cent level. This is not surprising given that the futures delivery points are located in eastern Australia (principally in New South Wales).

There appears to have been some cross hedging potential for traders operating in various product spot markets in eastern Australia in that their spot and futures prices have been correlated. It also appears that, during the 1977-82 period considered, Adelaide and Perth were generally operating outside the market region which includes Sydney, Melbourne, Brisbane and the trade steer contract delivery centres. This, in turn, implies that there may be more than one cattle 'market' (as defined by the 'law of one price') operating within Australia.

TABLE 1

Correlations of Spot versus Nearby Futures Prices 1977-82: 270 Observations

Product traded[a]	Spot market				
	Sydney (Homebush)	Melbourne (Newmarket)	Brisbane (Cannon Hill)	Adelaide (Gepps Cross)	Perth (Midland)
Steers < 250 kg	0.416	0.387	0.226	0.084†	0.112†
Bullocks 301-350 kg	0.198	0.336	0.278	0.116*	0.236
Young cattle 161-200 kg	0.322	0.332	0.410	0.046†	0.135*
Cows 201-250 kg	0.229	0.115†	0.285	0.098†	0.064†

[a] All data for animals with a fat score of 4.
* Insignificant at the 1 per cent level.
† Insignificant at the 5 per cent level.

[2] A particular futures price series will nearly always exhibit some serial correlation (Tomek and Robinson 1981). In this study, concern is centred on identifying the extent to which different markets are correlated as they adjust to random events. To make this phenomenon more visible, each price series was corrected for serial correlation.

However, these results are by no means conclusive. Even though aggregate cross-hedging potential has existed for some products in some locations, the key issue which must be dealt with is whether that potential has existed in the short term. Commodity futures contracts, by their nature, are short-term marketing instruments. Each individual contract is available for trading for approximately one year only. Therefore, to assess real cross-hedging potential, the relationship between individual futures contract prices and spot prices must be evaluated.

Weekly average prices for particular Sydney Futures Exchange trade steer futures contracts were paired with the corresponding prices for the various spot markets and the correlation coefficients were then calculated. The coefficients are presented in Table 2. The contracts which expired in March, July and November 1981 were used to provide insight into the seasonal performance of the cattle futures market.

By comparing the results presented in Tables 1 and 2, it is possible to see the difference in the stability of the relationship between spot and futures markets from the average to the short term. For example, the general level of stability in the eastern markets declined while a few significant relationships appear for Adelaide markets, as shown in Table 2. In Table 1, 12 of the 20 relationships evaluated were statistically significant at the 1 per cent level, while only 10 of 57 relationships in Table 2 were significant.

TABLE 2

Correlations of Spot versus Futures Contract Prices 1981: 50 Observations

Futures contract	Spot market				
	Sydney (Homebush)	Melbourne (Newmarket)	Brisbane (Cannon Hill)	Adelaide (Gepps Cross)	Perth (Midland)
			Steers		
March 1981	0.319*	0.273	0.092	0.140	0.015
July 1981	0.397†	0.063	0.281*	0.027	0.018
November 1981	0.397†	0.307*	0.470†	0.615†	0.124
			Bullocks		
March 1981	0.121	0.200	0.089	0.417†	0.076
July 1981	0.012	0.197	0.160	0.299*	0.056
November 1981	0.588†	0.266	0.048	0.390†	0.196
			Young cattle		
March 1981	0.104	0.026	[a]	0.218	0.133
July 1981	0.212	0.069	[a]	0.200	0.240
November 1981	0.301*	0.392*	[a]	0.197	0.258
			Cows		
March 1981	0.126	0.140	0.134	0.232	0.040
July 1981	0.149	0.017	0.206	0.062	0.044
November 1981	0.397†	0.066	0.514†	0.403†	0.179

[a] Young cattle were no longer traded in significant volumes at Cannon Hill by 1981.
* Significant at the 5 per cent level.
† Significant at the 1 per cent level.

It appears that few stable relationships have existed between live cattle futures prices and the spot prices of other types of cattle. Also, those strong relationshps which did occur during 1981 appear to be somewhat random. This suggests that cross hedging would not be a low-risk process. However, to consider risk further, it is necessary to evaluate the level of variation in price movements.

Coefficients of variation of prices for steers in Sydney and Adelaide are presented in Table 3. Steers were chosen for analysis because they were generally the product for which the prices exhibited the highest level of correlation in Table 2. Sydney and Adelaide were selected because the prices in these markets had the strongest relationships amongst the cities in the 'eastern' and 'western' markets and, therefore, would allow spatial comparison. The March, July and November 1981 futures contracts were used to allow seasonal comparisons. The amount of variance (risk) in cash and futures markets has been similar, but increases when considering the basis for either Sydney or Adelaide markets. This would appear to indicate that hedging (speculating on the basis) is not a means of reducing risk. This point will be evaluated in more detail later.

Another observation which can be made about the results in Table 3 is that location-basis variability exists for both Sydney and Adelaide steer markets. Location-basis variability can be defined as the distortion in hedging results that occurs by virtue of the hedger's location at some point distant from a futures contract delivery centre (Bobst 1979). Theoretically, in a perfectly competitive spatial market, price differences between any two points cannot exceed the transfer cost between them in the short term, which leads, *ceteris paribus*, to perfect correlation among prices and eliminates location-basis variability (Bressler and King 1970). Therefore, since it has been shown (Table 1) that prices are not highly correlated, Australian hedgers must expect some distortion in basis movements due to the spatial dispersion of markets. However, an analysis of variance study of cash prices for Sydney versus Adelaide and of basis movements for the same markets yielded the results presented in Table 4 for the null hypothesis that there is no significant difference between the variances of the two series. Only the test of basis movements for the 50-week period ending in November 1981 resulted in a significant difference (5 per cent level only) between the Sydney and Adelaide markets, implying that location-basis variability is small, but does exist (as indicated by the correlation coefficients).

TABLE 3

Coefficients of Variation for Steer Prices

Relevant market	50-week period ending	Cash prices	Futures prices[a]	Basis
Sydney	March 1981	0.072	0.043	0.186
Sydney	July 1981	0.056	0.068	0.181
Sydney	November 1981	0.073	0.114	0.172
Adelaide	March 1981	0.078	0.043	0.225
Adelaide	July 1981	0.048	0.068	0.210
Adelaide	November 1981	0.092	0.114	0.179

[a] Sydney and Adelaide use the same Sydney Futures Exchange contracts, hence, the identical levels of variation.

TABLE 4

Relationships between the Sydney and Adelaide Steer Markets

	Correlation coefficient for 50-week period ending			*F* statistic for 50-week period ending[a]		
	March 1981	July 1981	November 1981	March 1981	July 1981	November 1981
Cash prices	0.523	0.382	0.660	0.12	3.62	3.45
Basis	0.495	0.527	0.419	0.09	3.03	5.89

[a] The critical values for the *F* statistic are 7.19 and 4.04 at the 1 and 5 per cent levels, respectively.

The Profitability of Cross Hedging

There appears to be mixed potential for successful cross hedging of various types of cattle when the aim is to reduce risk. This is due to the limited stability in the relationship between trade steer futures prices and the spot prices. Unless a price of a futures contract leads to a stable basis pattern, that futures market does not fit the 'traditional' concept of a medium for risk reduction and the market appears useless to potential cross hedgers. Yet, Working (1953*a*) argued that a hedger does not seek primarily to avoid risk, but to earn an expected return arising from futures market transactions. Since the hedger is not motivated primarily by a desire to reduce risk, it is misleading to judge the effectiveness of hedging solely according to the degree to which futures and spot price movements are parallel (Working 1953*b*). In fact, it is expected that about half of all price variation *increases* returns to hedgers, so looking at variance only is not a good measure of the value of futures markets to potential traders.

Therefore, to make a complete determination of whether the trade steer futures market can, in fact, be used successfully to cross hedge other types of cattle, it is necessary to consider the effect that cross hedging would have had on hedgers' profitability in the past. This is illustrated in Table 5. If cross hedging would have led to an improvement in a trader's net profits (as explained below) then cross hedging could be considered a successful marketing activity. The analysis involves evaluating the contribution to net profit from two standard hedging strategies by simulating trading using weekly closing prices over the last 50 weeks that each contract was available. The normal strategy is one of routine hedging by making a single round-turn transaction during the period in which a spot position is held; this hedge is placed when the spot position is taken, and the hedge is lifted when the spot position is liquidated. The selective strategy involves using a one cent per kilogram trailing stop order to place and lift hedges whenever justified by current price trends. This multi-period type of strategy often leads to making several round-turn transactions during the period in which a single spot market position is held.

The results which would have occurred if the two hedging strategies had been implemented over the period 1976-82 are presented in Table 5. The July 1977 futures contract is the first in the series because it is the first contract for which live deliveries could be made. The results in Table

TABLE 5

Effects of Hedging on Profitability

Futures contract used	Effect on profit received[a]			
	Normal hedge		Selective hedge[b]	
	Short hedge	Long hedge	Short hedge	Long hedge
	c/kg	c/kg	c/kg	c/kg
July 1977	+ 3.5	− 3.5	+ 2.7 (5)	+ 0.2 (4)
November 1977	+14.0	−14.0	+13.3 (3)	− 1.7 (3)
March 1978	+ 7.0	− 7.0	+ 8.1 (5)	+ 2.1 (4)
July 1978	−17.0	+17.0	+ 2.8 (7)	+18.8 (7)
November 1978	−12.5	+12.5	+ 3.2 (7)	+13.7 (7)
March 1979	−42.6	+42.6	− 1.3 (7)	+42.6 (7)
July 1979	−40.0	+40.0	+24.9 (7)	+65.9 (6)
November 1979	−42.0	+42.0	+57.5 (5)	+98.5 (6)
March 1980	+ 5.0	− 5.0	+87.1 (7)	+83.1 (6)
July 1980	−30.5	+30.5	+60.3 (10)	+91.8 (10)
November 1980	+17.2	−17.2	+70.0 (12)	+53.9 (12)
March 1981	− 9.0	+ 9.0	+31.3 (9)	+39.3 (10)
July 1981	+20.2	−20.2	+50.7 (8)	+31.5 (7)
November 1981	+36.0	−36.0	+52.8 (6)	+15.0 (6)
March 1982	+16.5	−16.5	+40.1 (7)	+23.3 (8)
July 1982	+12.1	−12.1	+43.3 (8)	+32.2 (7)
Total	−62.1 (16)	+62.1 (16)	+546.8 (113)	+610.2 (110)
Average per round-turn	−3.88	+3.88	+4.83	+5.54

[a] Ignoring brokerage fees.
[b] Figures in parentheses are the number of round-turn transactions which would have occurred using the trading strategy.

5 are presented in terms of cents per kilogram hedged. For example, a short hedger using the July 1982 contract with a normal hedging strategy would have received an increase in revenue totalling 12.1c (ignoring commissions) times each kilogram hedged. This increase would have come solely from futures market transactions and would have been added to spot market receipts when calculating total receipts.

When evaluating the simulated results in Table 5 for the normal hedging strategy, it is clear that such a strategy would not have consistently increased profits. Using the naive approach of placing a single hedge to be carried for the entire period in which a spot position is held (assumed here to be 50 weeks), would have led to futures profits as high as 36c/kg for short hedgers (such as cattle producers) and 42.6c/kg for long hedgers (such as cattle processors), but losses on other contracts would have been equally high. Over the long term, a long hedger using each of the 16 contracts considered would have received on average 3.88c additional revenue for each kilogram hedged during the period. A short hedger would have suffered a reduction in revenues totalling an identical amount. These results are to be expected over a period during which cattle prices trended upward despite wide short-term fluctuations.

The results for the selective hedging strategy indicate that the potential to increase profits improves if an effective multi-period trading strategy can be identified. The simulated results are artificial in that only weekly closing prices are used, ignoring price fluctuations during the week which

would have influenced trading volume and, hence, profitability. However, it is significant to note that the average return per round-turn was positive for both long (5.54c) and short (4.83c) hedgers using the selective strategy.

Viewing the period from the acqusition to liquidation of a spot market position as one period, over which one futures position should be held, is certainly not an optimal approach if profits are sought. Anderson and Danthine (1981*b*) and numerous others have shown that all types of multi-period hedging strategies consistently out-perform the normal, one-period strategy. Hence, professional hedging managers consider each time period separately, making the 'hedge/no-hedge' decision once each period (Purcell 1977, 1978). Such selective hedging strategies will usually result in many round-turn futures transactions being made during the time that the spot position is held because the trader gets out of the futures (is unhedged) whenever prices are moving in an unfavourable direction.

Results of empirical studies, such as those cited above, which indicate that hedging can increase profits contradict the random walk hypothesis as applied to futures markets. The theory of anticipatory prices, proposed by Working (1956, 1958) and formally developed by Samuelson (1965, 1976) leads to the hypothesis that futures price changes are best described as a random process. The implication is that prices will be serially independent which means that mechanical trading strategies cannot be used to increase profits.

Most empirical work in this area, mainly of grain futures, has been conducted using formal statistical analyses (Larson 1960; Stevenson and Bear 1970) and trading rule techniques (Houthakker 1961; Smidt 1965; Stevenson and Bear 1970). Studies such as these have found minor departures from the random walk hypothesis, but typically these have not been large enough to provide for profitable trading rules (Leuthold and Tomek 1980).

The first study of livestock futures price behaviour was by Leuthold (1972). Applying both spectral analysis and several mechanical trading rules to US live cattle futures, he found that cattle futures prices did not appear to behave randomly. Farris (1972), Menzie and Archer (1972), McCoy and Price (1975) and Erickson (1978) for example have found that both routine and selective hedging of cattle can increase cattle market returns. Purcell (1978), Anderson and Danthine (1981*a*) and Rolfo and Sosin (1981) have found that selective hedges using mechanical trading rules result in higher net returns than the routine normal hedge.

In Australia, studies of Sydney Futures Exchange markets have yielded results similar to those of US markets. For example, Giles and Goss (1981) found that the trade steer market (as an example of a non-storable product market) has not produced unbiased estimates of maturity date spot prices, but the reverse has been true for wool (which is a storable product). These results imply that hedging potential might be greater for non-storable products. As suggested by Smidt (1968), differing deviations from randomness could be explained by structural characteristics specific to the market and to the time period examined. Indeed, Leuthold and Tomek (1980) point out that the relatively short period of time for which livestock futures markets have been in existence limits studies of

their performance. This is particularly relevant for Australian traders. Gellatly (1980) showed that the trade steer market was biased in the first few years of its existence, but has improved with time. The implication of such results is that hedging potential is changing over time; trading strategies which may have been profitable in the past will not necessarily perform as well in the future.

Conclusions

The results presented in this paper are mixed, but it does appear that the Sydney Futures Exchange trade steer contract could have been used by a knowledgeable trader to cross hedge other types of cattle. It appears that cross-hedging potential existed but was weak for spot markets across time, space and product form. Also, it was shown that the normal, one-period hedging strategy would not have performed well in consistently increasing profits. However, it was noted that selective hedging strategies might have generated futures market profits for both long and short hedgers in the past. This should not be interpreted as a recommendation for selective cross hedging. It must be remembered that selective hedging is essentially a speculative procedure; when a futures position is not held, a trader is speculating on whether the trading system being used is adequate to capture sufficient gains to outweigh losses and brokerage fees. If the hedger does not understand the futures market and its relationship to the relevant spot market, the potential for successful cross hedging may not be realised.

References

Anderson, R. and Danthine, J. (1981*a*), 'Cross hedging', *Journal of Political Economy* 89(6), 1182-96.

—— (1981*b*) *The Time Pattern of Hedging and the Volatility of Futures Prices*, Working Paper No. 7, Center for the Study of Futures Markets, Columbia Business School, New York.

Bobst, B. (1979), 'The effects of location-basis variability on livestock hedging in the south', in R. Leuthold (ed.), *Commodity Markets and Futures Prices*, Chicago Mercantile Exchange, 171-201.

Bressler, R. and King, R. (1970), *Markets, Prices, and Interregional Trade*, John Wiley, New York.

Erickson, S. (1978), 'Selective hedging strategies for cattle feeders', *Illinois Agricultural Economics* 18(1), 15-20.

Farris, D. (1972), *Livestock Futures and Price Management—Results of Hedging Six Consecutive Lots of Cattle and Hogs*, Texas Agricultural Experiment Station Information Report 72-1.

Gellatly, C. (1980), 'Analysis of price and volume movements in the live beef cattle futures market'. Paper presented to the 24th Annual Conference of the Australian Agricultural Economics Society, Adelaide, February.

Giles, D. and Goss, B. (1981), 'Futures prices as forecasts of commodity spot prices: livecattle and wool', *Australian Journal of Agricultural Economics* 25(1), 1-13.

Goss, B. (1980), 'Aspects of hedging theory', *Australian Journal of Agricultural Economics* 24(3), 210-23.

Hawtrey, R. (1939), 'A symposium on the theory of the forward market', *Review of Economic Studies* 7(3), 202-5.

Hicks, J. (1946), *Value and Capital*, 2nd edn, Oxford University Press, London.

Hieronymus, T. (1977), *Economics of Futures Trading for Commercial and Personal Profit*, 2nd edn, Commodity Research Bureau, New York.

Houthakker, H. (1961), 'Systemic and random elements in short-term price movements', *American Economic Review* 51(2), 164-72.

Jain, A. (1980), *Commodity Futures Markets and the Law of One Price*, Michigan International Business Studies No. 16, University of Michigan, Ann Arbor.

Kaldor, N. (1939), 'Speculation and economic stability', *Review of Economic Studies* 6(5), 1-27.
Keynes, J. (1930), *A Treatise on Money, Vol. 2*, Harcourt Brace, London.
Kravis, I. and Lipsey, R. (1978), 'Price behaviour in the light of balance of payments theories', *Journal of International Economics* 8(2), 193-246.
Larson, A. (1960), 'Measurement of a random process in futures prices', *Food Research Institute Studies* 1(3), 313-24.
Leuthold, R. (1972), 'Random walk and price trends: the live cattle futures market', *Journal of Finance* 27(3), 879-89.
—— and Tomek, W. (1980), 'Developments in the livestock futures literature', in R. Leuthold and P. Dixon (eds), *Livestock Futures Research Symposium*, Chicago Mercantile Exchange, pp. 39-67.
McCoy, J. and Price, R. (1975), *Cattle Hedging Strategies*, Kansas State University Agricultural Experiment Station Bulletin 591.
Menzie, E. and Archer, T. (1972), 'Hedging as a marketing tool for western cattle feeders', *Western Agricultural Economics Association Proceedings*, 86-90.
Purcell, W. (1977), 'Effective hedging of live cattle', *Commodities*, July, 16-30.
—— (1978), 'A closer look at the long feeder cattle hedge', *Commodities*, August, 34-5.
Richardson, J. (1978), 'Some empirical evidence on commodity arbitrage and the law of one price', *Journal of International Economics* 8(2), 341-51.
Rolfo, J. and Sosin, H. (1981), *Alternative Strategies for Hedging and Spreading*, Working Paper No. 22, Center for the Study of Futures Markets, Columbia Business School, New York.
Samuelson, P. (1965), 'Proof that properly anticipated prices fluctuate randomly', *Industrial Management Review* 6(1), 41-9.
—— (1976), 'Is real-world price a tale told by the idiot of chance?', *Review of Economics and Statistics* 58(1), 120-3.
Smidt, S. (1965), 'A test of the serial independence of price changes in soybean futures', *Food Research Institute Studies* 5(2), 117-36.
—— (1968), 'A new look at the random walk hypothesis', *Journal of Financial and Quantitative Analysis* 3, 235-61.
Stevenson, R. and Bear, R. (1970), 'Commodity futures: trends or random walks?', *Journal of Finance* 25(3), 65-81.
Tomek, W. and Robinson, K. (1981), *Agricultural Product Prices*, 2nd edn, Cornell University Press, Ithaca, 229-51.
Working, H. (1953*a*), 'Futures trading and hedging', *American Economic Review* 43(2), 314-43.
—— (1953*b*), 'Hedging reconsidered', *Journal of Farm Economics* 35(4), 547-9.
—— (1956), 'New ideas and methods for price research', *Journal of Farm Economics* 38(5), 1427-36.
—— (1958), 'A theory of anticipatory price', *American Economic Review* 48(2), 188-99.