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The American Economic Review, Vol. 48, No. 2, Papers and Proceedings of the Seventieth Annual Meeting of the American Economic Association. (May, 1958), pp. 188-199.

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A THEORY OF ANTICIPATORY PRICES

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President Copeland, in his presidential address, implied that what he called the "model analysis view" is characteristically one which tends to involve exploring the regulatory function of competition in disregard of the problems of institutional supplementation. I offer you this morning, however, a model analysis that is oriented toward problems of institutional supplementation.

My model deals with a class of markets which has been the subject of much criticism and some institutional supplementation. Here and there the supplements have taken rather drastic form. An immediate implication of the model analysis is that some of the institutional supplements have been conceived in error and administered under delusions. The moral that I draw is not that we should keep hands off the markets but that we need really to understand such markets before we can effectively improve them.

I. *Price Fluctuations*

In 1921 F. W. Taussig published a paper under the title, "Is Market Price Determinate?" It has been read and discussed more widely, perhaps, than any other of Taussig's journal articles. What drew so much attention to it was not any statement of facts previously unrecognized, nor the suggestion of a new theory, but the clear statement of a problem that had been troubling economists and that has continued to trouble them. It was a problem that had been troubling others, also. Ten years earlier George Binney Dibblee, a British businessman, wrote a book which posed at its beginning the same problem as Taussig's article.

The class of prices concerning which Taussig wrote included such commodities as eggs, potatoes, wheat, and cotton. Of these he spoke explicitly. With them he included prices of stock exchange securities, as having the same general characteristics of behavior. These are sometimes called speculative prices, but to call them that may be misleading. At the time Taussig wrote, potatoes had no speculative market in the usual sense of that term. All of these prices, however, have the characteristic that they are influenced by expectations; if we call them anticipatory prices, we cannot be understood to exclude some prices that we mean to include.

Taussig's theme, which many of you will recall, may be indicated by a brief quotation:

Thus . . . a fall in the price of eggs may cause the country dealers and the cold storage people not to hold back their supplies, but to send them in hurriedly, for fear of a further fall; while city dealers, so far from buying more, will hesitate to buy, having the same fear. The bottom will drop out of the market. On the Chicago Board of Trade the bears, when they sell wheat short and pound away at the price, count on the same course of events. The lower price will not tempt others to buy, but frighten them to sell. Your equilibrium will not necessarily work out at all. . . .¹

This theme Taussig developed at considerable length, with consideration of various causes of price fluctuations. But he held that there are limits to the possible extent of these fluctuations:

The underlying conditions of supply and demand are known for all the staples well enough to make possible a rough prognostication of the season's course of prices. It may be quite clear that potatoes will be higher than last year. But there will be a penumbra of uncertainty. Within this there will be ups and downs, many and perhaps wide fluctuations. (*Ibid.*, page 400.)

For a crop like potatoes, Taussig suggested, the width of the penumbra within which price fluctuations may occur is somewhat restricted by the need to dispose of the total supply within the season. Concerning products like wheat and cotton, of which supplies may be carried over from one crop year to the next, he said:

There is a wider range for unexpected developments in the situation, for the calculations and guesses among dealers and speculators, optimism and pessimism, waves of sentiment and belief. There is a zone of uncertainty, a penumbra, of considerable extent. (*Ibid.*, page 401.)

Whether or not they found Taussig's concept of a penumbra to seem realistic and satisfying, most people who have thought about the matter, including many not counted as economists, have shared at least Taussig's view that supply and demand do not determine market prices with precision. I have spoken of Taussig's discussion of the matter only as one particularly prominent and clear statement of a prevalent view concerning price fluctuations: that in large part they cannot be explained by supply and demand.

II. *Supply and Demand*

Alfred Marshall spoke of price fluctuations, of the "higgling and bargaining" of the market, and of "speculative manoeuvres" in futures markets, but in his long discussion of "the general theory of equilibrium of demand and supply"² in Book V of his *Principles*, these matters received only passing mention. Writing more than thirty years before Taussig, Marshall simply had not set himself the task of considering market price with any great care. His concern was with what he called "normal" prices; that is, with equilibria for periods of different lengths

¹ F. W. Taussig, "Is Market Price Determinate?" *Q.J.E.*, May, 1921, pp. 396-397.

² These words are from the title of the summary chapter of Book V.

longer than those involved in the consideration of market prices. His "illustration from a corn-market in a country town" was not primarily a discussion of the formation of market price but an illustration to develop the concept of equilibrium.

The words supply and demand mean widely different things in different contexts. One may, of course, define them in a sense such that market price is indicated as precisely determined by the bids and offers that are in effect at any instant when a price is formed. I think it indicative of Marshall's purpose that he did not discuss market price thus, but in terms of price-related intentions to buy and to sell during the course of a day. He thus began at one step removed from a direct and automatic connection between the equilibrium price and the actual price at any moment. In his later discussion of the equilibria of "normal" demand and supply for periods of different lengths, the connection would be still less direct.

In later years economists began to give more attention than did Marshall to short-period economic phenomena; to economic fluctuations. When they studied market prices, they sought of course to deal with them by means of the theoretical apparatus which was at hand. Although the theory had not been designed, either by Marshall or by others, to explain fluctuations in actual market prices, it appeared serviceable for that purpose. The fluctuations seemed to have the nature of a sort of "higgling and bargaining," on a grand scale. And statistical studies showed that, if one took an average over a whole season of the widely varying prices of, say, potatoes or cotton, that average usually conformed fairly well with the underlying conditions of supply and demand for the season.

But when statistical study was directed at the price fluctuations themselves, the fluctuations proved to have different characteristics from what the theory seemed to require. In the main, they were not of the sort called for by Taussig's concept of "ups and downs, many and perhaps wide fluctuations" within a penumbra. Statistical evidence regarding the nature of the actual fluctuations was published over twenty years ago for both commodity prices and stock prices.³ But few people recognized this evidence as having any significant meaning for the theory of prices; and no one, so far as I know, had any clear idea of what the meaning of the evidence might be. I, at least, was long at a loss to interpret the observations. Then, nine years ago at a meeting of this Association, I suggested an interpretation of the peculiar characteristics the price fluctuations have been shown to possess, and now I

³ W. I. King, *Index Numbers Elucidated* (1930); Holbrook Working, "A Random-difference Series for Use in the Analysis of Time Series," *J. of the Amer. Statis. Asso.*, Mar., 1934, pp. 11-24; Alfred Cowles, 3d, and Herbert E. Jones, "Some a Posteriori Probabilities in Stock Market Action," *Econometrica*, July, 1937, pp. 280-294.

want to offer a model which can give a better understanding of the true nature of price fluctuations than we have had.

The basic idea underlying the model is that it must make adequate place for expectations in the formation of demand. Prices of such commodities as potatoes or wheat, if formed in a "free" market, must be formed under the influence of expectations.

One may think it conceivable that the prices of such commodities could be arrived at without influence from expectations, but this is a delusion. Suppose, for example, a potato market consisting only of producers on the one hand and of consumers on the other; and suppose that at harvest time producers and consumers met in a great auction, at which consumers had to bid for what potatoes they wanted during the season, knowing that they could neither buy more later nor resell a surplus if they bought too much. Such a market would not be free of influence from expectations. Consumers would be forced to anticipate their wants during all the future months of the season; to guess at the prices which they would later have to pay for bread and for meat, as influencing what they were willing to pay for potatoes; and to forecast what income they would have during the season.

In short, this grand auction would not bring consumption demand directly into the market; it would merely force consumers to become in a sense speculators, anticipating their future consumption demands. And I should think it not at all certain that consumers, operating thus, would more accurately anticipate and aggregate their future utility functions than dealers and speculators do with the present organization of the potato market. But that is beside the point at the moment. The point is that prices such as we are discussing must be formed under the influence of expectations, and we therefore need a theory of market price founded on expectations. We are dealing with prices that must be anticipatory.

III. *A Realistic Model of an Anticipatory Market*

When we undertake to build a market model which takes account of expectations, we may simplify matters by taking supply as fixed. Prices are set from moment to moment, and at any given moment the supply is the quantity then in existence. Expectations, therefore, are involved only in the formation of demand. This requires that reservation prices be considered as part of the demand. In a market where "short" sales are possible, or forward sales of any sort that influence the present spot price, the "shorts" form a negative component of the demand. It is not necessary that we proceed thus, instead of treating short sales as in effect adding to the supply with which demand must equate, but it will simplify matters to do so.

The demand schedule which we thus conceive is not a schedule of

amounts that will be bought during any particular interval of time, as is a consumption-demand schedule, but is a schedule of amounts that will be held at a particular time. When the schedule moves up or down, price moves up or down with it, but the movement tells nothing about resulting sales. The price movements may be accompanied by a large volume of buying and selling—that is, by a large transfer of ownership from one group of holders to another—or by only the single small transaction necessary to establish a price. Because this holdings-demand schedule is not all of the same sort as a consumption-demand schedule, the two are no more comparable than a reservoir is comparable with a stream. The schedules are nevertheless related, because the holdings schedule is based on expectations concerning consumption demand, along with opinions concerning the magnitude of existing supplies.

The nature and the behavior of the expectations included in the model will depend on the kinds of people supposed to be in the market. These may be taken to include producers and consumers as well as dealers and “speculators,” in proportions such as may be found in actual markets.

The major problem in designing our model is to state appropriate specifications concerning the information and the quality of judgment employed by traders, and the manner in which they act. The specifications must be such as to permit deducing what sort of price fluctuations the model would generate; else the model will be of no use in the study of price fluctuations. Second, the specifications must not depart too much from reality; else the usefulness of the model will be impaired. For example, the model must not assume that future events can be predicted with a precision much greater than in the real world. Third, we should exclude from the model such influences as manipulation and the release to traders of “information” known to be false. And finally, we shall do well to exclude higgling and bargaining from the model. Reasons for the latter exclusion, which may seem questionable, cannot be fully stated at this point, but I think the virtues of simplicity in a model give sufficient reason.

In the traditional model of a “perfect market,” all traders were assumed to have equal knowledge and presumably equal ability to apply their knowledge; but that assumption would impair the usefulness of our model because it would eliminate the differences of opinion that are the source of much trading in a real market. To provide for differences of opinion, it is necessary only to specify that the traders are human rather than superhuman in their mental capacity. The amount of pertinent information potentially available to traders in most modern markets is far beyond what any one trader can both acquire and use

to good effect. Circumstance and inclination lead different traders to seek out and use different sorts of available information; and if at any time some sort of available and useful information is being generally neglected, someone is likely soon to discover that that neglect offers him a profitable field to exploit. In short, traders are forced and induced to engage in a sort of informal division of labor in their use of available information. Using different information, different traders must find themselves often of different opinions, one buying at the same time that another sells, even though all may stand at an equal high level of intelligence, steadiness of judgment, and quantity of information at their command.

Even though differences in level of ability among traders in our model need not be assumed in order to have a good deal of trading, some such differences must be assumed in order to approach reality as closely as I think the model should. Perhaps enough disparity would be provided by supposing only that most producers and consumers of the commodity have poor judgment as traders, while all other traders stand on an equal, high plane of competence. I should like, however, to include in the model a small group of other traders with a low level of trading competence. I include them in order to feel sure that the model requires substantial exercise of the realistically necessary function of countering the effects of ill-informed and inept trading. But I keep the amount of such inept trading small enough in the model to avoid overstraining the corrective power of the market; the inept trading is without substantial price effect. To summarize, then, the model that I propose has these characteristics:

1. It assumes prices to be always formed through the medium of human decisions, on the basis of information such as may realistically be supposed available to traders.

2. It assumes existence of conditions, within and around the market, such as have actually prevailed in the world during recent years, except in certain specified respects.

3. The specified departures from reality, chosen with a view to eliminating sources of undesirable price behavior, are as follows: (a) The number of traders in the market is large, no one trader can by himself exert an appreciable effect on the price, and no trader enters into agreements to act in concert with others. (b) The information available to traders, though sometimes erroneous, incomplete, or false, is never intentionally so. (By this and the previous specification I mean to eliminate all possibility of "manipulation.") (c) Nearly all of the traders are persons of rather exceptional trading ability and judgment, emotionally stable, with a large fund of pertinent knowledge, skilled in using their knowledge, and they give all of their working time and

energy to the business of trading and keeping appropriately informed. (By these specifications I mean to eliminate all but a small residual amount of undesirable market behavior arising from the presence in the market of ill-informed and unskillful traders.)

IV. *Conclusions from the Anticipatory Market Model*

Reasoning concerning price behavior on the basis of the model used by Taussig has encouraged the belief that there is no good economic reason for very frequent change in prices; and that there is little, if any, good reason for the sort of speculative trading that involves buying today and selling tomorrow, or next week. The Taussig model has no way of accounting for frequent price change or for in-and-out speculative trading, and consequently these phenomena in actual markets, being left outside what the model can account for, appear wholly as evidence of defective performance of the actual markets. Let us see if our anticipatory market model can account for them.

In our model, traders must seek information to guide their actions in price formation. Some traders concentrate on getting pertinent market information quickly, ahead of others. Instead of waiting for the publication of official crop estimates, for example, they go out through the country themselves and observe the condition of the crops; or they arrange for observers in the country to telephone reports to them. There are many sorts of information, bearing on prospective supplies, on prospective consumption demand, and on prospective changes in business conditions and in the general price level, which they may seek to obtain in advance of routine publication of the information.

Another class of traders seeks the advantage of timeliness in a more adroit manner. Such traders consider, for example, that the progress of the crops depends on the weather. So they watch the weather. And by obvious extension of this idea, they watch the weather forecasts and perhaps study the weather map and make their own forecasts. As there are many sorts of obviously pertinent information that a trader may seek to get early, so also there are many sorts of information that a sophisticated trader can use to get advance indications of coming events.

Anticipating events requires special knowledge and special skills. While some traders seek to predict crop developments, others seek to predict changes in general business prospects. Traders who concentrate intensely on getting certain sorts of information early cannot do so for all sorts of information. And the time and the effort spent on gaining special knowledge and skill in prediction cannot be spent on developing skill in appraising precisely the appropriate effects of the events predicted. So the traders who seek especially to get information early,

either information on events or information to predict events, are traders who tend to seek quick profits. If events falsify their predictions or if the price moves contrary to expectations because of overriding influence from some other sort of event that they did not foresee, they take their losses quickly.

In short, the kinds of information that deserve to influence prices are many and varied. There is an almost continuous flow of such information, through private channels of information as well as through public channels. So it is reasonable that price changes should be frequent. Moreover, the problems of getting information early and the diversity of sources and kinds of information lead logically to much trading in which profits or losses are taken very quickly. In-and-out trading can be merely a consequence of a desirable sort of division of labor among traders.

From our model we can also deduce something about the nature of the price fluctuations that it will generate. The able and well-informed traders whom we have been considering make their profits by getting information that permits them to predict price changes. The information on which these predictions are made, however, so far as it is new and useful for price prediction, is itself unpredictable, or substantially so. Consequently we may say, subject to slight qualification, that the price changes generated by the model are unpredictable price changes. That is, no change is predictable except on the basis of the information that gives rise to the change. But this statement must be slightly qualified because an important piece of new information must ordinarily generate a somewhat gradual price change, not an instantaneous one.

The reasons for gradualness of most substantial price changes may be suggested by considering the measures required to avoid gradualness in the price effects of one particular sort of information; namely, official crop estimates. First, the day and hour when such estimates will be released is advertised in advance, so that everyone interested may be prepared to give prompt attention to the information. Second, great care is taken to avoid having the information leak out to anybody in advance of public issuance. And third, the information is released shortly after the close of trading on one day, to allow a maximum amount of time for traders to receive and digest the information before trading begins on the next day. The explicit purpose of these measures is to give all traders equal opportunity to make use of the information, but the conditions required for that purpose are also conditions required to avoid gradualness of price change, which must occur if a few traders acquire information ahead of the rest or if a few traders perceive price significance in information before others see that it has such significance.

An interesting consequence of the tendency of price changes to develop somewhat gradually, in our model, is that this tendency introduces a small degree of very short-time predictability into the changes—predictability even without knowledge of the information that is producing the price changes. When a small amount of price change has occurred, there will exist a certain probability that that change is the beginning of a larger one.

Knowledge of the existence of this probability may be used differently by two different classes of traders. Traders accustomed to act primarily on the basis of new information recognized as deserving to have a price effect may view an adverse price movement as a warning that the price is responding to other information which they do not have. Such a trader, having bought on the basis of information that, by itself, warrants a price advance, may therefore sell promptly if the price movement goes contrary to his expectations.

But what of the small group of relatively ill-qualified traders whom we have included in our model but have thus far ignored? Some of them, with little opportunity for being first in the acquisition of information, and little ability to interpret the information that they do get, may choose often to utilize the probability that small price movements are the beginnings of larger ones. They may choose to base much of their trading on an effort to "go with the market." Such trading cannot be very remunerative in a market such as our model provides; it cannot be nearly so certain of yielding profits as trading on the basis of information acquired early and appraised accurately. But done skillfully, though it resembles living on crumbs dropped from the table by others, it may be the surest way by which an otherwise ill-equipped trader can gain some net profit. And incidentally, it is a sort of trading that can help a beginning trader to graduate into the ranks of the well-informed and skillful traders of whom our market is mainly composed.

How well, finally, do the price fluctuations generated by the model correspond with actual price fluctuations? This is a particularly interesting question because the price fluctuations of the model are not vagaries of the market—ups and downs within a penumbra of indeterminateness—but results of expert appraisal of the significance of changing economic information. The question is objectively answerable from at least two sorts of statistical evidence.

One kind of evidence involves reasoning in terms of a class of statistical characteristics with which economists are not generally familiar; namely, such characteristics as distinguish a random chain, on the one hand, from a random series or from a more or less irregular cyclical series, on the other hand. Concerning such evidence, I need say here only that it was what first led me to see that actual price

fluctuations are mainly not of the sort that they are commonly imagined to be; and that after I had devised a market model that could account fairly well for the main characteristics observed in actual price fluctuations, that it was further and more searching evidence of this sort which showed that I needed to introduce a certain amount of gradualness of price change into the model. In short, the market model that I have presented was devised expressly to meet the requirement that it generate price fluctuations closely resembling those observed in actual prices. The quite different line of argument for the model that I have given here is simply a demonstration that the need for such a model can be shown by a different line of reasoning than actually led me to it.

A second kind of statistical evidence that the model corresponds fairly well with conditions in actual markets can be obtained through study of correlations between the prices of annual crops and the appropriate statistics of supplies. Consider corn, in the United States, for example. The crop is harvested mainly in October and November. The size of the supply that must serve until harvest of the next crop is fairly accurately estimated by mid-October, is known more precisely by mid-November, and is the subject in December of a "final" official estimate that is almost universally accepted as giving the best information then available on the size of the supply. What relations should we expect to find among correlation coefficients expressing the degree of relationship between the final official estimate of the supply each year and prices, or price averages, for different times in the year?

For the years 1921-22 to 1938-39, when corn prices were little influenced by governmental interposition at any time, the correlation between the December estimate of the corn supply (crop plus carry-over) and the seven-month average spot price for November-May, inclusive, was $r = -0.88$ (based on first differences of logarithms of both series). The correlation between the December supply estimate and the average price for any one month, on the supposition that the vagaries of market price are large, must be a good deal lower than this. And the correlation between the December supply estimate and the price on any one day of a month—say December 15—must be considerably lower yet. And if we think of price as being formed largely by a supply and demand that act impersonally, it seems reasonable to suppose that the price soon after harvest would show a comparatively low correlation with the supply; and that the highest correlation for a price taken in any one month would appear at some time near the middle or end of the crop year, after there had been time for discovery and correction of any early-season maladjustment of price to supply.

But the facts, as may be seen from Table 1, are that the November-May average price, the average price for December alone, and the price

on December 15 all show about the same degree of correlation with the December supply estimate: the coefficients of correlation are -0.88 , -0.87 , and -0.88 , respectively. And the highest correlation between supply and price occurs in the month of issuance of the "final" crop estimate, almost immediately after completion of the harvest, not later in the crop year.

All of the main relationships of the coefficients in Table 1 can be

TABLE 1
CORRELATIONS BETWEEN ESTIMATED ANNUAL SUPPLY OF CORN
AND VARIOUS CORN PRICES*

Months	Weighted Average No. 3 Spot, All Days	July Future, All Days	July Future, Midmonth
November-May	-.88	-.86	
November	-.86	-.84	-.84
December	-.87	-.85	-.85
January	-.85	-.82	-.80
February	-.84	-.80	-.73
March	-.83	-.81	-.82
April	-.83	-.83	-.86
May	-.80	-.85	-.70
Average	-.84	-.83	-.80
December			(December Future) -.88
November			-.86
October			-.80
September	-.58		-.78
August			-.72
July			-.24

* Based on correlations of annual first differences of logarithms of December official estimate of supply (carry-over plus crop) and of price, for crop years 1921-22 to 1938-39.

explained, however, with the aid of our anticipatory-market model. In a market in which the prices were formed wholly by expert judgments based on existing information, it would be the price in December that was most highly correlated with the supply information available in December. The correlations for later months would diminish progressively, perhaps partly because later prices would sometimes be influenced by later evidence of some error in the December estimate of supply but more particularly because variations in consumption demand from year to year, which are largely responsible for the correlations between supply and price falling below unity, exert their influence on the December price mainly on the basis of uncertain expectations, but affect later prices more strongly, on the basis of a good deal of direct evidence concerning what the domestic and export demand has proved to be.

From the model we may see why the price of the July future in months prior to July should be less highly correlated with the December supply estimate than is the spot price. The spot price is the expected price in July minus a "carrying charge," and the carrying charge is highly correlated with the supply of corn; thus supply exerts its influence on the spot price in two ways and on the price of the July future in only one of those ways. And the same reasoning, adjusted to one difference in the facts of the situation, explains why the spot price in September, prior to the harvest, shows a lower correlation with the December supply estimate than does the price of the December future: the spot price, as before, is the price of the future minus a carrying charge, but this carrying charge, which is often strongly negative, depends on the size of remaining old-crop supplies, and that has little relation to the size of the supply that will be available after the harvest—indeed the correlation between supplies in successive years for the years of this record is negative ($r = -0.43$), perhaps by chance, or perhaps because there is some real tendency for a large crop to be followed by a small one and a small crop by a large one.

I would not want to leave the impression of suggesting that my anticipatory market model explains everything that can be observed in actual markets. According to the model, as a first approximation, at least, the correlation of the December supply estimate with the November-May average price should be no higher than the average of the correlations with prices in the seven months separately; but in fact it is -0.88 as against -0.84 . And according to the model, the correlation of the supply estimate with an average of daily prices for one month of each year should not be sensibly higher than its correlation with the price on any one day near midmonth each year; but in fact, though that happens to be the case for some months, such as December, the averages of correlations for all of the seven months are -0.83 for the "all-days" prices and -0.80 for the single-day prices. In short, there are imperfections in the functioning of real markets that have been excluded from the model. But the model, by explaining the good reasons for a great part of what occurs in actual markets, shows that the imperfections of such markets are not nearly so large as reliance on an inappropriate market model has led people to infer.