Normal corn prices

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NORMAL CORN PRICES

BY

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A Thesis submitted to the Graduate Faculty for the Degree of

MASTER OF SCIENCE.

Major subject Agricultural Economics

IOWA STATE COLLEGE

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Iowa State College
1925
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ACKNOWLEDGEMENTS

The writer wishes to acknowledge the cooperation and unusual conference privileges given him in the preparation of this thesis by Dr. C. L. Holmes, Dr. J. A. Hopkins, Professor K. Bjorka, Professor P. L. Miller and Professor F. Robotka, of the Agricultural Economics Department, and Professor G. W. Snedecor, of the Mathematics Department, Iowa State College.

Especially is he indebted to Messers Miller and Robotka. The better parts of the thesis are the evidence of the time and thought which they have given to it, always with the greatest freedom. Working with these men has been an inspiration as well as a pleasure.
INTRODUCTION

This thesis constitutes the first few chapters of an extended study of corn prices.

The price of corn, as it progressively equilibrates forces expressing themselves through demand and supply, continuously fluctuates. These fluctuations occur, of course, not about the zero line, but about what has been called the normal price.

Our first concern, therefore, will be to study these fluctuations, to discover their causes and the quantitative relations existing between the causes and effects. The first step in this direction will be to measure these fluctuations, these effects; but before we can do that we must know from what to measure them.

We have already indicated that the point from which price fluctuations are measured is not zero, but the normal price. But what is this normal price? It is so elusive, so fugitive a concept, that it is so would be questionable wisdom to base a price analysis upon it without at least attempting to give it a precise definition and make it mean something.

For this reason, the first two chapters are devoted to the general concept of normal price, and the outline of a price theory based upon it. The procedure thereafter is to take up the fluctuations from the normal in the order
of their importance, beginning with the longer periods, proceeding to the shorter, and concluding with the limit of shortness, the fluctuations about the normal market price at a given instant.

This is the outline for the whole study. Obviously, however, it is more than could be covered in a master's thesis. It was therefore decided to start at the beginning and simply progress as far as possible, without attempting to cover more ground than could be given reasonably thorough treatment. Accordingly, the work is not to be regarded as completed, at the close of this thesis, but simply cut off.

Because of these things, the first two chapters, devoted to establishing the theoretical foundation for the whole study, may appear out of proportion or not clearly related to the succeeding chapters, because only a part of the superstructure erected upon it is brought into view before the work is brought to an arbitrary conclusion.

The conclusion is only temporary, however, as it is expected that the study may be resumed and carried forward, along the lines indicated, at a later date.
CHAPTER I.

THE CONCEPT OF NORMAL PRICE; ITS EVOLUTION.

A. Early History.

The concept of normal price, like the theory of value, has been a long time evolving and is still in the process.

It is as old as the study of economics itself. Economics was born around it; not around the term normal price, then unknown, nor round its present concept, but around its prototype, the just price of the Greek philosophers. This was a vague, nebulous preconception, dominated more by ethical than economic considerations.

Gradually this early form grew into the fair price of the medieval age. This again was more a philosophical dogma than an economic rationalization; it meant simply a fair price to the producer, one sufficient to recompense him for his efforts.

Not until the 16th century, the time of the Physicocrates of France, the heralds of the new science of economics, did the concept begin to shake off its ethical connotation. With them, it became the "bon prix," "the price which yielded a surplus over and above the cost of production,"1——a natural result of the working out of the natural order, were it given

free rein. This was a distinct advance, a change from the philosophical to the economic viewpoint.

Evolution continued with the progress of economic thought. With the advent of Adam Smith, and the founding of economics as a science, the bon prix lost the last traces of its ethical dogmatism and developed into the fully rational concept termed natural price.

B. Smith, Ricardo and Mill.

The natural price, as might be expected from Smith, its originator, is defined in terms of a cost of production about which the market price fluctuates but is "continually gravitating, if one might say so, toward the natural price." Briefly, the natural price was that established by a more or less stable cost of production, about which the unstable market price set by the minor and ephemeral forces of supply and demand was continually fluctuating, but toward which it was always being pulled back. It was purely a cost of production concept. It ignored the influence of demand, recognizing it only to the extent of taking it for granted as a sort of constant, therefore subject to elimination. Here we observe the production imprint common to practically all the older classical theory.

\footnote{Smith, The Wealth of Nations, Seligman's edition, page 55.}
Ricardo made a substantial contribution to Smith's value theory, but not to his normal price concept; we may pass on direct to John Stuart Mill. Mill's performance, in this as in other cases, was to make no new discoveries, but to develop more fully, round out and polish off the theories of his predecessors Smith and Ricardo. The following citation gives us clearly, not only Smith's and Ricardo's viewpoint, but Mill's own. 3

"Adam Smith and Ricardo have called that value of a thing which is proportional to its cost of production, its Natural Value (or its Natural Price). They meant by this, the point about which the value oscillates, and to which it always tends to return; the centre value, towards which, as Adam Smith expressed it, the market value of a thing is constantly gravitating; and any deviation from which is but a temporary irregularity, which at the moment it exists, sets forces in motion tending to correct it. On an average of yours sufficient to enable the oscillations of one side to of the central line to be compensated by those on the other, the market value agrees with the natural value; but it very seldom coincides exactly with it at any particular time. The sea everywhere tends to a level; but it is never at an exact level; its surface is always ruffled by waves and often agitated by storms. It is enough that no point, at least in the open seas, is permanently higher than another. Each place is alternately elevated and depressed; but the ocean preserves its level."

Further, "The cost of production, together with the ordinary profit, may therefore be called the necessary price or value, of all things made by labor and capital." Italics ours. 4

This now term expired with its author, and we may

disregard it. But the concept, as he finally presented it, was simply Smith's, with cost of production specifically rounded out:-

(a) to include, not only labor, with which Smith began, but capital, which he included later.

(b) to exclude rent, which Smith finally admitted and Ricardo threw out, and

(c) to be regarded, together with profits, as constituting the natural or necessary (we would say normal) price or value.

Earlier in his book, Mill distinguished quite clearly between what we now call fixed supply, constant cost and decreasing cost goods, giving a paragraph to the definition of each. He made no mention, however, of decreasing cost goods.


The next step is to Marshall, who developed the natural price into what might be called the orthodox concept of normal price, and gave it its present name.

In his exposition of normal price, he uses as a preliminary step the device of the stationary state, throughout which economic conditions remain essentially unchanged. Here the demand price (for the supply called forth) equals the supply price, (of the representative firm producing that supply),
the two prices coming into stable equilibrium at a price normal to those stable conditions, -- normal price.

This device of the stationary state is a useful one to give us the first grasp of the concept of normal price, and indeed it is used in a particular narrow sense in rationalizing in later concepts; but Marshall draws attention, immediately, to the inadequacy and danger of attempting to explain phenomena of our dynamic order by reference to a static state. It gives us, however, an approach to the normal price concept, and puts us in a position to apply it to the actual conditions of our changing order.

Marshall does this by reference to the fishing trade, taking up four chronological types of periods in turn. "Four classes," he says, "stand out. In each, price is governed by the relations between demand and supply. As regards market prices, supply is taken to mean the stock of the commodity which is on hand, or at all events 'in sight'. As regards normal prices, when the term normal is taken to relate to short periods of a few months or a year, supply means broadly what can be produced for the price in question with the existing stock of plant, personal and impersonal, in the given time. As regards normal prices, when the term Normal is to refer to long periods of several years, supply means what can be produced by plant which itself can be remuneratively produced and applied within the given time; and lastly,
there are very gradual or secular movements of normal price" the term secular being used in its present familiar sense. The italics and capitals are his.

It will be observed that Smith and Ricardo, in their use of the term natural price, applied it only to periods long enough to give the economic forces determining it full time to work themselves out,—to give producers time to move into or out of production and adapt themselves to any changes that had occurred. These correspond to the longest of Marshall's periods, the long time and the secular.

Marshall thus makes two specific contributions. The first is that he extends the types of normal periods to take in what he calls short time periods; that is, those too short for producers to move into or out of production, the supply therefore coming from the existing stock of plant, worked over or under time to meet the changed demand. He still leaves the shortest period of the four, the market period, out of the pale of normal price, however; he stops short of any period during which supply is not contingent upon price.

The second contribution is one that arises naturally from his adjudication of the cost of production versus marginal utility controversy. It will be remembered that this was settled, in brief, on the basis of the long run value being determined by both of them together, as he says, like

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the two blades of a pair of shears, both of which do the cutting. Bringing this viewpoint to bear on normal price determination, he makes the first departure from the straight and narrow cost of production path in connection with normal price. Three of his marginal notes bring this out.

They follow one after the other. "Influences of utility and cost of production on value." Then, "The former preponderates in market values;" and "the latter, in normal values." And on the same page, the citation, "as a general rule, the shorter the period which we are considering, the greater must be the share of our attention which is given to the influence of demand on value; and the longer the period, the more important will be the influence of cost of production on value." . . . In such a case the normal level about which the market price fluctuates will be this definite and fixed (money) cost of production."

These citations bring out two points, namely that Marshall's normal is still rather closely tied to the long

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6 This must be carefully distinguished from his treatment of value. For, whereas value, as now conceived, coincides with market price, the latter being simply the expression in physical units of the former, it is common observation that normal price and market price seldom are coincident; they are two entirely different things. Marshall's treatment of normal price, then, is to be considered as a thing apart from his treatment of value.

time period, and also that his tentative excursion from previous views goes but a short distance before it returns to an almost complete exclusion of all but cost of production as the determinant of normal price. The fact to note, however, is not that he does not go far, but that he goes at all. We shall have further reference to his division of the treatment of normal price into chronological periods, in a later chapter.

D. F. M. Taylor.

F. M. Taylor, more recently, has dealt with the subject in a different manner. We will present his approach in his own words.

"In order to make an adequate study of price, it seems almost indispensable to attack that problem at successive levels, in other words, with successive degrees of thoroughness. We shall begin, therefore, by trying to settle the more superficial phases of the problem; follow this with a solution somewhat more thorough; and finish with an attempt to penetrate the whole matter to the bottom. Our study will thus break roughly into three parts: (1) the immediate processes of price determination, — market price, (2) the intermediate processes, — normal price, and (3) the ultimate processes."

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Upon reflection, it becomes apparent that this is more than a new approach. It is a new concept, not so much of normal price as of the whole system of price determining forces. Previous authors have shown that, from the standpoint of their determination, there are different kinds of prices: market, short and long time, and so forth. These are, but these writers classified them on a chronological basis. In market periods, they said, prices are determined in one way, or by one set of forces; in short time periods, another; and in long, yet a third.

Taylor simply takes this classification and sets it up on end, regarding price at any given moment as being set by these same forces, but all working at the same time, simply as it were at various depths, one underlying the other.

Let us grasp the two distinguishing features of his treatment. First, his three-fold classification of price determining forces, not by chronological periods, but on the basis of depth, permanency, or underlying-ness; and second, that they do not operate, one set in one period and another in another, but all at the same time, together, at different depths, superimposed. These two features are important, for they are part of the basis of our present understanding of normal price as outlined in Chapter II.

To Taylor, normal price simply means "that which tends to be established by the more permanent forces, and
toward which the actual price" (set by the more fluctuating and superficial forces) "is constantly being driven."

Taylor spends a chapter on "Normal Demand Schedules," which range from elastic to inelastic, and another on "Normal or Long Time Supply Schedules." The third and fourth paragraphs of the next chapter present his ideas in condensed form, and are herewith cited:

"We shall treat in succession the three classes of goods the supply schedules of which were studied in the last chapter, taking them up in reverse order, -- fixed-supply goods, constant-cost goods, and increasing-cost goods. By this process we prepare ourselves to handle almost every case of normal price determination; for the three classes of goods named have their normal prices determined in three different ways, and those three ways include practically all the ways, and indeed quite all the most important ones, in which normal price can be determined."

"Speaking generally, we may say that the goods of the first class have their prices determined from the demand side only, -- through the prices of the demand schedule; that goods of the second class have their prices determined from the supply side only, -- through the prices of the supply schedule;"
and that those of the third class have their prices determined by elements from both demand and supply,—through the prices of both the demand and the supply schedules." The italics are his.

This is modeled on J. S. Mill's classification, to which previous reference has been made, although Taylor adds another chapter on special cases of normal price determination, including those of decreasing cost, monopoly supply, rare products, and so forth. We may sketch the demand and supply schedules for the main classes as follows:

- Fixed Supply, Increasing Cost
- Constant Cost
- Decreasing Cost

Through these, we see, the supply schedule rotates clockwise.

Both from his phrase "normal or long time supply schedules," and from his general treatment, we see that normal price, to Taylor, means that set by the more permanent forces in the intermediate layer which underlies the immediate or market forces. It is thus chronologically more restricted than Marshall's, for while the latter extended his normal price into short time periods, Taylor restricts his to intermediate, corresponding to Marshall's long time determinants, exclusively.

E. Taussig.

F. W. Taussig comes next. His reference to normal price is scanty, but what there is of it agrees substantially with Taylor's views. It is interesting to note that in his "Principles of Economics" he employs the concept of normal price without once, as far as the writer can discover, using the term. To him, even in the market and seasonal periods, equilibrium price and normal price are synonymous terms; apparently, therefore, he uses the more familiar and definite one. Wherever we would expect to find the word normal, he uses the term 12 equilibrium, price.

"Just what will be the seasonal equilibrium price for a crop of a given size," he says, "no one can say in advance." Here we find the germ of the extension of equilibrium or normal price into seasonal periods, developed later by E. G. Bource. Further, "From day to day and from month to month, the market price is settled by the adjustment of varying amounts offered in the market by dealers. For the season, it is settled by the adjustment of a fixed supply to the marginal price at which the whole (stock) "will be disposed of." Again, he observes, "the fluctuations in market price from day to day oscillate about this seasonal equilibrium." 15

12 That is, in his Principles of Economics. In an article entitled "Market Price" in the Quatr. Jour. of Eco., May 1921, page 147, however, he employs the phrase "long time or normal" twice. Further reference to this article is made on page 147 of this thesis. 15 Taussig, Principles of Economics, page 147.
F. Nourse.

E. G. Nourse has developed the idea in the preceding sentence into an article, entitled "Normal Price as a Market Concept." In it he draws attention to two features of what we have termed orthodox normal price treatment, to which we referred at the end of our presentation of Smith's and Marshall's concept. They are, it will be remembered, Smith's emphasis on supply and cost of production without taking demand into account, and Marshall's exclusion of market prices from the category of normal. Nourse styles the orthodox concept as a cost of production normal, one involving the conscious adjustment of a variable production to demand so as to cover the cost of production to the representative producers. His article widens the scope of normal to include prices determined not only during the short, but the seasonal periods, during which demand is the paramount determinant, and geographical distribution across the area served by the product receives the emphasis formerly given to production. Normal price as thus extended bears little or no relation to cost of production. From the agricultural standpoint, he shows, this new extension of normal price theory is concerned with the adjustment of a seasonally fixed supply to a given schedule of demand.

It has its cross-sectional or geographical distributive aspect, and the yearly longitudinal time aspect.

14 Published in the Quar. Jour. of Ec., Aug.1919.
although this is different from the time aspect considered in preceding normal treatments, the supply being fixed for the season. It is concerned with the adequacy of the market institution to bring about the adjustment of the actual supply and demand conditions, both across the area covered by the sale of the product and throughout the time during which the season's supply will be disposed of.

The foregoing two paragraphs are simply a condensed reproduction of Nourse's presentation of the market normal concept. He would employ it, not only as an extension of abstract price theory, but as the basis for an institutional market study. He gives the subject rather broad treatment, and several points come up for attention.

Like Taussig, he speaks in the market periods of the "adjustment of the seasonally fixed supply to the marginal price at which the whole will be disposed of."1 As far as one can gather, this seems almost like putting the cart before the horse. A fixed supply, by definition, cannot be adjusted. Demand is adjusted to that fixed supply at a price that will just move all of it, -- at the price normal to that season's set of conditions.

Again, there is the nature of the fixed supply to consider. It is not a true fixed supply in one or two respects. A fixed supply is one whose amount is not responsive to changes in price. The case here is that of a fixed stock.

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1 Citation 13, page 2 of this thesis.
the supply from which flows faster or slower to the market as
the price rises or falls; and in addition, a high price will
not only accelerate the flow of an agricultural commodity to
market, but may materially increase the amount of the stock
from which it comes, through the substitution for it of chea-
per products on the farms and, conversely.

Again, the seasonal curve does not show the charac-
teristics of a typical fixed supply curve. It is a cost of
production curve. It costs more to produce corn for the Aug-
ust market than for the January market, by 20 to 25%.

But these matters will be gone into more thoroughly
in later chapters. For the present, it is sufficient to note
that Horace has made a significant contribution, one, further-
more, that paves the way to the rounding out of the concept
of normal to its full estate.


Last of all, we have the new sidelight thrown on
the concept of normal price by the modern economic statis-
tician. One of the important branches of his field, the cor-
relation of chronological series, has its foundation in the
secular trend, usually of prices, the deviations of temporary
prices from which are correlated with those from the trends
in other series. The secular trend is the moving average,
a straight line or a curve of the potential series fitted to
the data by the method of least squares, or perhaps an
line arbitrarily drawn in free-hand.

The secular trend is not the same as the long time normal price, for two specific reasons which will be given later. They are not members of the same family; they are the offspring of different parents. But they look alike; they have a generic resemblance; and as the concept of trend is easier to grasp than that of normal price, we will draw attention to their similarity at this point for the sake of impression, and defer the important distinctions between them till later. The similarity between them, in that actual prices fluctuate about them in much the same manner, is shown by the graph on page 36, though it also shows the point that should always be borne in mind, that the trend and the normal are two different things.

That is where we stand to-day. In the light of the ground that has been covered by previous investigators and briefly presented in the preceding pages, we will endeavor to find a clear, comprehensive and concise concept of normal price that will serve us for all types of periods and all types of goods. In this we will turn in the next chapter.
CHAPTER II.

THE CONCEPT OF NORMAL PRICE; PRESENT SIGNIFICANCE.

A. Natural, and Institutional, Economic Forces.

It will help us in this chapter if we start with a point of view which is well brought out in F. M. Taylor's introductory chapters, namely that "Economic phenomena, like any other phenomena, are governed by natural laws," no matter in what economic order they may be under consideration. As an economic order he defines "the totality of artificial (man-made) "conditions, whether originating in law or custom, under which economic phenomena manifest themselves," through which natural economic law works itself out. That is, the laws of supply and demand, of diminishing utility, etc., would operate no matter in what economic order they were placed, be it capitalistic, cooperative, socialistic, or what not; they would simply express themselves differently in each case, since natural economic law works itself out only through the institutions of the order in which it is found.

The same thing is found in our mechanical order. The natural expansive force of steam works through the existing artificial machines, the turbine, the reciprocating engine, the locomotive. Similarly in the economic order, prices, for instance, are set by natural economic forces

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Ibid, page 11.
acting through the existing market and accessory institutions of that order. We will go more deeply into the distinction between natural and institutional economic forces later on.

Our reason for touching upon this matter here is that we wish to bring out the fact that in this thesis we will be studying, not the natural forces alone, but their expression through the artificial economic machines termed institutions; in this case our institution will be the market. We will be concerned, as it were, not with the 100% power which would be obtained from the locomotive if it were 100% efficient, but with the 7% which is actually obtained from it,— all that enters into the calculations of the railway engineer. If we had a perfect market, or if full time were allowed for forces to work out, prices might be thus and so; but we are not concerned with what they might be, so much as what they actually are. And our attempt will be to explain and understand not only the actual market prices,— how much the consumer pays, and the proportion that goes into the farmer's pocket,— but also the workings of the market institution that gives us these prices.

That is to say, we will not be concerned so much with the normal price under certain hypothetical perfect or static conditions, but rather with the price normal to our existing imperfect, dynamic order.
E. The Essential Nature of Normal Price.

Reflection upon the contents of Chapter I seems to lead logically to one conclusion. Through all the viewpoints there presented, the simple fact stands out that normal price may be found in all periods and for all commodities, and that it is essentially the same thing wherever found. To the writer, it seems a mistake to outline the concept of normal price by reference from the outset to four different periods, taken up in turn, as Marshall does it; or like Taylor, having outgrown the chronological classification, to restrict normal price to that determined by the intermediate layer of forces, and speak only of "normal or long time" schedules; or to imply, as the orthodox concept does, that the distinguishing feature, "the test of that normality, has been the adequacy of the price paid in the market to cover a wage which would secure the needful labor, interest which would secure the needful capital, and the necessary expenses for the purchase of raw materials and the payment of insurance, taxes, and the like," — in brief, the expenses of production. The latter obviously breaks down in the application of the concept to market periods or forces, and even in the long time stretches, is, as it were, only the result, — not the distinguishing feature.

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Following the evolution of normal price through the minds of economists of the past down to the present day, especially its later stages through Taylor, Taussig and Nourse, we find that it has now reached the point in its development when it may be defined in the following terms.

Normal price may be found, not only in long or short time periods, or in the intermediate layer, but throughout our whole price making system. Wherever found, it is simply the relatively stable equilibrium price set by the deeper lying economic forces conditioning supply and demand; it underlies the temporary unstable equilibrium prices, which fluctuate about it, tending always to return once driven away.

It is the price which would result if the temporary price fluctuations could be swept away, or never allowed to come into being. It is a magnet, pulling back actual prices temporarily driven away by more fleeting forces, to the position indicated by the more permanent. It is the objective toward which our economic organization is moving in its progressive perfection of supply and demand adjustment technique, in the market, and farther back at the farm and factory.

In the simplest terms, it is the underlying price that would equilibrate supply and demand for the period considered. Reflection will show that there are important differences between this and the older concept.

The orthodox concept was restricted to long time periods. "Normal or long time", -- "in the long run", -- those
are the terms. The newer concept has reached the stage where it is applicable throughout the entire price making system. We have the long time normal price underlying the annual fluctuations. We have a short time normal during a war,— normal to that set of conditions. Marshall had these. But we have, just as logically, a seasonal normal price underlying the monthly market oscillations, as Neurce has pointed out,— normal to that season. Still further we have a market situation normal of a few days' brief existence, as during a flurry in the cash market owing to maturing futures obligations at the end of the month of May, which will clear the market situation. There it underlies the hourly prices, which fluctuate, often wildly, about it. And finally, to be consistent, we have the normal market price at a given instant, at not even the pit enables the several trades being made at that instant to coincide exactly. The mere fact that one speculator buys and another sells indicates that there is a difference of opinion as to the normal market price.

C. Tide, Wave and Ripple Analogy.

Perhaps the tide, wave and ripple analogy will help to make this concept clear, although it should be borne in mind that these possess a regular periodicity not usually found in connection with price phenomena.

19 & 20

Suggested by Prof. Robotka.
We need to imagine a sea level which may be gradually rising or subsiding, these slow movements corresponding to the long time or secular movements of normal price. The varying height of the tide is analogous to the short time movements, the different cycles of business activity, hog and horse prices, and so forth. The irregular waves are the irregular annual fluctuations caused by the haphazard production inherent in all but a few favored commodities, or by the weather, or by both, as in agriculture. The larger ripples are the market situation disturbances, and the daily or hourly market price oscillations about the season's normal correspond to the smaller ripples.

The analogy would be closer if we used, instead of the tides caused by a single sun and moon and we know them now, the concept of tides resulting from half a dozen different sized satellites moving about the earth in irregular and unrelated cycles. And if we throw in an occasional comet, hurtling in from nowhere without warning, whirling about the earth as one focus of its elliptical path and swamping all other movements with the force of its upheaval before flying off again into space,—that is war,—we would come closer to actual conditions.

But there is no need to labor the point further. The normal height of the sea level is that which would result if there were no tides, here, the relatively temporary fluctuations. The normal height of the tide, at a given point,
is that which could be taken in one measurement, or calculated in one operation, of there were no waves; here the tidal height is the relatively stable price underlying the wave movements; and so on. The different forces, as Taylor has well brought out, are all acting at the same time, one beneath the other.

D. Graphical Explanation.

We will conclude our presentation of this concept with a graph, which is shown on the following page. The price of a bushel of corn on May 20, 1925, was perhaps 87 1/2 cents. The price is conceived as being determined as follows:-

The most underlying forces of all, marginal cost of production and marginal significance, were there no seasonal, market or any other fluctuations, would have set the price for that year at, say, $1.00. That would be the height of the general sea level, represented by the vertical line on the left.

We will do violence to the facts, however, by supposing that the corn crop of 1934 was 10% above normal, along with a similar superfluity in oats. Accordingly, the seasonal normal price would equilibrate that year's supply and demand, with appropriate modifications for time and space, at 80%—a temporary fluctuation of 20% below the long time normal. That is analogous to the trough of the wave.

However, this temporary fluctuation becomes the relatively stable equilibrium price for the season underlying the temporary market oscillations during the year. At the date
THE PROCESS OF PRICE DETERMINATION

a - relatively temporary seasonal fluctuation from the long time normal.
b - relatively temporary market situation fluctuation from the season's normal.
c - relatively temporary individual fluctuation from the market situation normal.
specified, May futures were maturing without sufficient actual grain on hand to discharge them. A flurry of one or two day’s duration required a rise of several cents to equilibrate the supply to the new demand. That brought the price up to 87¼; the seven cents was a temporary market fluctuation above the season’s normal, a larger ripple on the wave.

Still further, the price for the particular transaction was made between a buyer who was temporarily misinformed or overanxious, and a seller who was shrewd enough to take advantage of him. The deal was made between them at a price 1/2 ‰ above that really required to clear the market situation, the market situation normal price. That was the smaller ripple. The price was recorded and sent over the wire as the price of corn with which we began this discussion.

The whole process may be recapitulated as follows?—The actual price paid was the result of a fluctuation of 1/2 ‰ above the market situation normal. This in turn represented a temporary fluctuation above the seasonal normal price, the more stable price for the season’s stock and demand. Yet this again becomes a temporary oscillation below the long time normal price, the net result of them all being the price of 87¼.

Each one of these prices was as much an equilibrium price as any other. The only difference between them is that they equilibrate successively less and less underlying, more and more superficial, forces. It is as if the navigator dropped a plumb line, finding the total depth to be so many feet,
and of that depth it could be said, this much is due to the general sea level; this much, to the tide; this much, to a passing wave; and last of all, a fractional part, to a ripple.

It may seem illogical to call a given price a relatively stable equilibrium, a normal, price, from one point of view, and a temporary unstable equilibrium price from another; but this objection will hardly hold. It is not illogical, when dealing with geological ages, to refer to a short period of 10,000 years. Yet from the standpoint of the human historian, that is a long period, although he might consider 10 years not a long time. Yet, as before, to a biographer, 10 years is a considerable length of time; and so on.

E. Normal Price; Static, or Dynamic?

Last of all, it may be objected that since normal price connotes relative stability and presupposes time for the underlying forces determining it to work themselves out, we cannot have a market situation nor a seasonal normal, since before the determining forces have had time to register their full effect, the situation will have changed. This raises a more fundamental question; but it could be raised, with equal force, concerning the application of the original orthodox concept to our dynamic conditions.

For instance, the long time normal price for a given quality of automobile tire, if the forces determining it were to be given time to work themselves out, would be,
perhaps, $10.00. But it would take five, ten years for this full working out to be accomplished; and it is quite certain that by that time new conditions would have arisen to destroy the validity of the original normal price.

This is, in fact, the crux, the most important point in the presentation of normal price theory. The best approach to the matter is to propound a bald statement, and then give the arguments that confirm or refute it, followed by the conclusions to be drawn from the facts disclosed.

The statement, the proposition, is this. In the ultimate analysis, normal price is a static concept. Its graphical representation is a horizontal straight line.

Lack of space prevents a full recording of all the arguments this statement has precipitated. The reader is advised to pause and reflect, to refer again to the contents of Chapter I, and do his own thinking. This course may bring him to substantially the same conclusion as that reached by the writer, which will now be briefly given.

Normal price in its present stage of evolution is a relative, a dynamic concept. It is based on the assumption that change is more normal to our order than a static condition; this assumption appears to call for no lengthy proof.

This dynamic concept grows more and more implicit, although not explicit, in the works of recognized authorities, taken in chronological order, as far as the writer can

Advanced as a point of departure, by Prof. F. Robotka.
discover. Marshall appears to use both; his long time normal had a static foundation, although there are traces of the dynamic in its development; and his short time normal is dynamic. Taylor's concept appears to the writer as purely dynamic, and Tausig's, although neither expressly define them in these terms, one way or the other. We will attempt to show that there is a distinction between the two, and to define each, and finally to show which is the more significant.

This much seems evident from the accepted use of the term normal. We speak of a normal, meaning a long time normal, corn crop. Is it that production which we would have if the forces at present existing were given full time to work themselves out, say by ten years hence? Obviously not. It is the production resulting from the stage of worked out - ness that those forces are in at the present time.

Similarly with corn price. The older normal price, that would result if the forces were given time to work out, -- of what use, except in the most elementary stages, is it in a price study? It does not mean very much to the business man.

What we are interested in is the price normal to conditions as they exist, in the incomplete stage of working out necessarily found in a dynamic order, -- not the price normal to their fully worked out stage, by which time other conditions will have arisen and started on their way, invalidating the normal previously in process of being set up.
The need for a dynamic normal, and a clear distinction between it and the original static normal, becomes obvious from a comparison of economics with chemistry. The chemist isolates given sets of conditions in a test tube and allows the reaction to run for perhaps several days, to completion; thereby he obtains results normal to those conditions, completely worked out. But of what use, except in the elementary stages, is it for the economist to isolate a given set of conditions in a test tube called the static state? He is working with reagents that barely start on their way before fresh additions of one or the other are made, the temperature is changed, and so forth. What he is interested in, then, is the results which are normal to those changing conditions.

In the simplest terms, the economist is studying a market mechanism which resembles a spring balance that requires time to register perfectly, but never gets it. The ten-pound weight of a big crop is suddenly hung on the hook; but before the scale has time to register ten pounds, a war takes five pounds off it. By the time the scale has reached six pounds, another change in conditions occurs. Our point is this; that neither the ten, nor the five, pounds is ever paid, only the nine, and the six. In our price study the ten and five pound registers are of small importance compared with the nine and six pounds which the consumer actually paid, and the due proportion of which the farmer actually put in his pocket.
To return to our former example, the static long time normal price would be simply the $10.00 for tires mentioned on page 29. The dynamic long time normal price would be the $12.00, perhaps, which the existing more underlying conditions of technique of production, quantity demanded, etc., would set, in their present incomplete stage of worked-out-ness. The $14.00 which we actually do pay is the result of a temporary fluctuation from the dynamic long time normal, due to a temporary scarcity in rubber. Yet while that boom lasts, $14.00 is the normal price within the period of the scarcity. If the market price of tires were given to still more temporary day to day fluctuations, they would appear as deviations from this scarcity normal price, would be measured from it, and would tend to return to it.

The static normal price concept would give us only the $10.00 cited in the first sentence of the preceding paragraph. The dynamic normal gives us the cumulative bases given in the latter part. In a complete theory of prices, the latter concept appears by far the more significant.

Reference to another example may make this more clear. A static season's normal for corn would describe the same curve, year in and year out. A dynamic season's normal

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II. Working shows a graph of such a curve on page 33, and its application, on pages 34 and 35 of his bulletin, "Factors Determining the Price of Potatoes" Tech. Bul. 10, University of Minnesota Agricultural Experiment Station.
would not. To-day, war breaks out in Europe. Up goes the
dynamic season's normal for the remainder of the season;
demand will have increased. Next month, a general strike
cuts into the purchasing power of the labor class. The
remainder of the dynamic season's normal comes down; effec-
tive demand will be lessened. The market will fluctuate
about these new residual season's normals. The last thing
we would wish a market to do would be to remain at the
static season's normal through such changes as these: suggested.
Similarly, the last thing we want in a complete price
theory is a basis that assumes static conditions, or calls
for them as an aid in rationalization, in a state to which
we know dynamic conditions are normal. The dynamic normal,
in the opinion of the writer, seems the more significant,
not only from the standpoint of the business man, but from
that of the economist.

One might be justified, then, in regarding the
old time normal price, from which the present dynamic concept
has evolved, as not fully satisfactory in two respects. First,
in that it was restricted to long time periods, and therefore
was too limited in its application. And second, because it
was at bottom a static concept, whose outlines became
blurred in the effort to make it fit our dynamic order.
F. Is Long-Term Normal Price Simply That Which Covers the Cost of Production?

There is another sense in which the older normal price, as commonly regarded, was not fully adequate; that is, in its being generally regarded as equalling cost of production. This seems like only half, or a third, of the story. Some economic heretic could have arisen and just as logically have said that, from the consumer's standpoint, the test of normal price was that it equaled the marginal significance of the supply of goods called forth by that price. For all practical purposes, this is what the Austrian school did do with values and F. H. Taylor uses that phrase in his formula for the determination of the normal price of a fixed supply good. "Generally speaking, the normal price of a fixed-supply commodity must tend to be that price which expresses the marginal significance or utility of the existing stock of said good." And, concerning the case of increasing cost goods, "The normal price of increasing cost goods, . . . . tends to be a price which both expresses the marginal significance of the output and equals its normal marginal cost."

As a matter of fact, the orthodox normal price, restricted to long time periods, equals neither; that is, purposively. That is not its purpose. Its function is to

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simply to make marginal cost of production and marginal significance equal each other, through causing the supply to increase or decrease, and correspondingly the demand to decrease or increase, until the two come into equilibrium; or, in the simplest terms, until they equal each other. The price at which this demand and this supply come into equilibrium, or equal each other, is the more underlying, the long time normal, price; that is all. The equality of cost of production and marginal significance is the criterion; and when that is attained, that price is the normal price. But to say that the normal price is that which just covers, or even simply coincides with, cost of production in the long run, is very analogous to saying that value is that which equals cost of production in the long run,—possibly true enough, but only half the story.

H. J. Davenport, as usual, has an interesting and original viewpoint on the cost of production of which we have been talking with so little inquiry into its nature. He regards it simply as the producer's own demand for the good. "All along the line," he says, "cost for one thing traces back to demand for other things; and even for instruments of production that have only one line of application, the cost to any one entrepreneur is explained by the competing demands of other entrepreneurs. There is, therefore, no issue between demand and cost, simply because cost mostly
resolves itself into competing and resisting demands."

His view on the constitution of cost of production, refreshing as it is, does not alter the fact that it exists and tends to meet marginal significance in the long run. Let us grasp the general dynamic normal price concept as now outlined, and see how it works as the basis of our price theory.

G. Difference Between the Long Time Dynamic Normal and the Secular Trend.

One of the first things the newer concept does for us is to throw light on the question, does the normal determine the position of the temporary equilibrium prices, or is it determined by them, being simply a sort of progressive average of them; or do the two of them mutually determine each other? One feels that the normal, in a sense, existed first, and that the temporary prices fluctuate about it; yet how can we say where the normal price falls, except by locating it from the temporary prices? It is at this point that the difference between the trend and the normal price, previously referred to, comes in to clear the matter up.

The first distinction between them is that they come from different sources. The normal price is set by the more underlying economic forces conditioning supply and demand. He who desires to understand the normal price must study the general economic situation, the consumption habits and needs of the people, the cost of producing the product, the services rendered, the cost of labor in producing the product, and the like. On the other hand, the trend is determined by the conditions which exist at the particular time. It is the sum of all the forces at play, excluding the normal price.


By cost of production in this thesis we will mean the cost of production of the marginal producer.
SIMILARITY OF, AND DIFFERENCE BETWEEN,
THE LONG TIME DYNAMIC NORMAL AND THE SECULAR TREND.

The horizontal intervals represent years of normal production and price. Hypothetical data.
and demand, utterly without reference to the temporary price fluctuations. It is like the tidal forces, which heave and lower the sea irrespective of wave movements, determining their position, the height about which they rise and fall. The normal price is a living thing, full of underlying economic forces struggling for expression, moved not by single forces or simple pairs, but by "a bewildering complexity of influences summed up in one resultant".

On the other hand, the secular trend is nothing but a dry, statistical expression derived from the tracks left by prices in the past. It is the line that best fits them, and is purely derived from them.

The second difference between the long time normal and the secular trend is a demonstration of the truth of the first. The difference is that the one may ride persistently above the other; this may be shown as follows:

The typical demand curve is curved, concave upwards. This means, in the simplest terms, that a 10% increase in supply will result in a drop in price which is less than the rise in price that would follow upon a 10% decrease in supply. The condition results, therefore, which is shown graphed in a slightly exaggerated manner on page 36; that is, the average, secular trend price required to keep the marginal producer on the job is higher than the normal price which would result if the fluctuations did not exist.

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Intangible as it may seem, this normal price
can surpasses in significance the concrete and definite
market prices with which we are so familiar. The actual
waves along the seashore are the concrete and evident
things to the passer-by. But fleets of fishing-boats give
scant attention to the waves; they put out to sea in ac-
cordance with the movements of the underlying tides; and
once out, they spread their nets, or else beat back to
harbor for safety from an impending storm, according as
barometer indicates, even though the immediate weather may
be fine. So in economics, the movements of the business
cycle, the characteristic behavior of the economic sea in
the wake of a storm, and so forth, are more significant
than the superficial waves and ripples, the actual market
prices. Particularly is this so because, in economics as
in meteorology, we are gradually becoming able to see more
clearly and to predict storms and tides for whole areas and
periods of years together, with higher accuracy, enabling
the entrepreneurs to equip their businesses and plan their
routes with greater efficiency and safety.

Henceforth, whenever the term "normal" is used, the concept
"dynamic normal" will be implied.
II. Normal Price for Different Periods and Different Types of Goods.

The question now arises,—shall we proceed from this point to develop the application of the concept of normal price by reference to different periods, as Marshall does, or to different types of goods, like F. W. Taylor? Nearly all the attention Marshall gives the type of good is contained in one footnote. Taylor, on the other hand, by using the orthodox limitation, "normal or long time", avoids chronological complications. Yet his classification into types of goods seems open to question, since we have already seen that one type of good, like Marshall's fish, may belong to one division, that of increasing cost, in one period, and to another, in another.

However, the writer has it on excellent authority that Taylor, in his classes, repeatedly emphasized the warning that by type of good he referred, not to any actual commodity, but to the type of demand, supply and price relationship associated with it. Furthermore, if we refer again to the citation from Taylor on page 8 of this thesis, we stumble on a point of fundamental importance, already touched upon but requiring further emphasis, which will now be given.

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Professor P. L. Miller.
One leaves Marshall with the understanding that in one period, say, the long, prices are set by demand and supply forces which have had time to mature, to work out their full effect. In another, say, the short, by the same forces but partially worked out, with other new forces added. And if he had included market periods, in those, all these forces would be barely started on their way, and a host of other new influences would be added. To each period, it seems, belongs its price determining set of conditions.

The point in Taylor's citation is this. He regards these different sets of conditions as acting all at the same time to establish the price at a given point of time, simply underlying one another. We have all seen ripples on the surface of a wave, waves on the crest of a deep-sea swell; and beneath them both, is the tide. That is his idea.

We need to know the period, then, only to know the depths of the forces acting to establish a particular normal price. For example: in studying the annual fluctuations about the long time normal price, that normal price is determined only by the most underlying force of all, the temporary fluctuations in this case being the annual average, any shorter period fluctuations being disregarded. At the other extreme, however, all the depths of forces are taken into consideration, as in the daily market period, the normal price for which is the resultant of nearly all the depths of forces, superimposed.
Similarly, then, we need to know the type of good only to know the demand and supply conditions determining the normal price of that good in the period given. Both classifications, each covering all the ground in its respective field, may thus be brought to a single focus in the type of supply and demand conditions which is their resultant,— the most significant basis of classification, and at the same time a single one,— the relation between the supply and demand schedules, and price. We are thus able to reduce all cases of normal price determination to a combination of a demand condition which may vary widely in elasticity with four main and several lesser types of supply conditions. These four are, fixed supply, constant, increasing and decreasing cost; the others are monopoly supply, rare products, joint products, and a few others. The dynamic normal price is determined under such conditions as all prices are determined, for a full treatment of which the reader is referred to standard texts such as F. H. Taylor, F. W. Taussig, etc.

I. Reasons for Price Fluctuations.

Temporary equilibrium prices fluctuate about the normal for many reasons, which vary with periods of different length. They may be classified as follows.

In long periods, the forces acting through supply and demand which set the long time normal are respectively
cost of production and marginal significance. The chief reason for variation from this normal price is the haphazard production inherent in our economic order for all but the few commodities whose production lands itself to control concentrated in a few hands, which are able to operate the industry as a whole with a comparatively full understanding of economic conditions and laws. Much more commonly, entrepreneurs go into production without being very well informed as to underlying conditions or laws, simply because they see or think they see a chance to make what appears usually to be a permanent income or profit. If too many entrepreneurs see the same opportunity and act upon it, or if the opportunity is more apparent and fleeting than real and permanent, we get a swing of temporary price down past the normal, until the marginal entrepreneurs feel that they are in a good position to get out of the business, and do so. This generally results in a reverse swing up past the normal again, and so on.

This force acting by itself would result in simple harmonic motion, probably self-damping. The regular periodicity of its oscillations before they die out, however, is affected markedly by changes in demand or in productive methods, as when the invention of a new type of consumption good creates a new want, or a new productive invention changes methods and costs of production. Added to this is another influence, that of the weather, in the case of crop production, especially. And underneath all of them runs
the influence of the business and other cycles. Last of all comes such political influences as tariffs, wars, and so on.

The forces just enumerated determine the amplitude of the swing. The length depends upon the nature of the industry concerned,—whether it requires a heavy fixed investment in proportion to sales, in which case the cycles will be long as well as wide; or whether the reverse is the case, in which case the swings will be minimized. In other words, the amplitude depends upon the economic acumen of the supplies, and the length upon the mobility of capital into and out of the industry.

The amplitude and length of the swings indicate the imperfection of our productive system as a whole. They cause friction, waste and loss, although it is more than possible that they result in a wasteful progress where otherwise we might experience an economical stagnation. This question at present is highly controversial.

In short time periods, Marshall in his illustration assumed that the short time normal coincides with cost of production, as in the long time periods. In the case of a great many products, this may be called into question. The cost of production of wheat, corn, etc., was more than covered by the short time normal price of the war period; and it was much less than covered in the post war period. The cost of production has a sort of pull on the short time normal price, but they do not generally coincide.
Still more, when we get into the season's normal period, the season's normal price bears little or no relation to cost of production at all. Here, the extent of the fluctuations from the season's normal measure within the imperfection of the market institution either within itself or in the use made of it. This does not mean, of course, that a market should not fluctuate through the season. As shown in page 1 of this thesis, it should change with every change in the season's conditions. It is the irrational changes that we refer to here as the fluctuations about the season's normal.

J. Significance of Concept in a Theory of Prices.

It may be asked at this point,—of what use is the concept of normal price, outlined in the foregoing chapters? It is not the market price, except by accident, nor is it their average for a given period; it is not the trend, and only occasionally is it the cost of production. It is intangible, abstract; it seldom if ever appears in concrete form in real life. Then why spend two chapters on it?

The answer is this. The concept of normal price is the basis of our whole theory of prices, as the theory of gravitation is the foundation of the study of astronomy. It is the writer's opinion that much of the inadequacy of price theory is directly traceable to the inadequacy of its previous foundation, the older normal price concept.
The two chapters which have been spent upon this foundation may still appear long for the two shorter chapters which follow. The statement in the introduction should be remembered, however, that this thesis constitutes only the first part of a thorough study, for the whole of which these two chapters are the basis.

E. Application to Institutional Study.

The concept of normal price is also the basis of the application of price theory to institutional problems. One of the factors in the world's progress is the elimination of waste and the perfect adjustment of the parts which together form a whole. Entrepreneurial economics is concerned with this elimination of waste and maladjustment, especially, and anything that will expedite our progress in that direction is valuable.

A more definite objective than the general term "greater efficiency" or "greater accuracy" is an aid to this end. The concept of normal price in dynamic terms gives us that objective, toward the attainment of which production and marketing technique is moving. When it is continuously attained, friction and waste will have been reduced to a minimum.

Temporary departures from the normal always result in immediate loss to either producer or consumer, which is usually followed by a boomerang effect later on. The spectacular rise and fall of the price of wheat about
the season's normal, in the winter of 1925, is a case in point. The agricultural boom and subsequent depression in the period from 1916 to 1921 is another, although the fault here lay not with the conditions of the market, but with the conditions of production.

In both of these cases, farmers realized that the price was wrong somewhere,—"out of line" with something,—but with what? From what were farmers, economists, or consumers to measure and say, "Prices are off,—they should be at this point, or follow this curve." What should that point or that curve be? Not the cost of production, for that is not what determines the season's normal. Not a parity with conditions in 1915,—conditions have changed since then. Not a fixed price, except for emergencies. Not a fair price,—that would be different for each producer or consumer, and the average of either would be far from the estimate that would shift the other, even if there were no economic laws in the background preparing a boomerang for whichever got the better of the deal.

The point from which to measure in any situation is the normal price, the underlying price that will bring supply and demand into equilibrium for the period concerned, whether that period be a few days as in the case of the market situation, a year as with the season's normal, a few years, or a generation. For the winter of 1925, the price "should have been" that which would have just moved the stock pro-
duced in view of the demand existing, with proper changes throughout the season to reflect any changes in actual supply and demand conditions, and with due allowance for time and space considerations. Again we must emphasize the point that this does not mean that the season's normal should not change as conditions change, but it does mean that fluctuations which are not the reflection of changes in supply and demand conditions should be eliminated. The fact that "without marked changes in the 'statistical position', with great diversity of opinion as to the normal price of wheat, under influences largely psychological in nature, a 'bull' movement drove the price up to extreme heights in January, and a 'bear' movement brought about a crash in March" calls into question the qualifications of the cash grain market, as the government investigation still being held bears witness.

In the period from 1916 to 1924, however, the fact that prices rose and fell above and below the short time normal set by the new marginal cost of production and the new marginal significance of the supply, was due, not to an unfaithfully reflecting market, but to a faulty production for that market. This was and still is in part due to the well-known inherent slow rate of turnover in agriculture, and its

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Wheat Studded, Stanford University, April 2, 1925, page 149.

Observe the use of the term "normal". This is the connotation we endeavored to give the dynamic season's normal.
inflexibility of production, and in part to the non-economic considerations affecting production in an industry whose producers are necessarily small, who number up in the sixth million, and follow their occupation not only as a business but as a mode of living. More economic marketing, utilization and production of agricultural commodities, is the goal along the road to which this thesis will attempt to cast some light.
CHAPTER III

APPLICATION OF THE CONCEPT OF NORMAL PRICE TO
THE ANALYSIS OF CORN PRICES.

A. The Objective Counterpart of the Abstract Dynamic Normal.

Up to this point we have been dealing with the basis of general price theory, leading up to the concept of dynamic normal price. In this chapter we will turn to the application of this concept in the analysis and attempted explanation of actual corn prices.

Where will we find the dynamic normal in the market? We will not find the static normal there; we would not expect to. But the dynamic normal is going to mean something in application as well as in the useful abstractions of pure science, for, thanks to the modern statistician, its objective counterpart may be derived from the market prices.

We have already explained, in Chapter II, that the secular trend and the long time dynamic normal are two different things, which come from different sources and may not coincide. But whereas the normal exists only as an abstraction, the secular trend is something that can be put down in numerical terms in black and white. For commodities whose demand schedule is not strongly curved, the two approach coincidence so closely that for purposes of price analysis, using actual market data, we may regard the secular trend as the objective
counterpart or analogue of the subjective long time normal price.

The two are not identical, for several reasons, some of which have been given, along with (and) explanatory graph, on pages 35 to 37 of Chapter II. The final reason arises from the nature of the secular trend itself, as will now be shown.

There is no standard, absolute secular trend. There are literally dozens of methods of computing it, each yielding a slightly different result. First of all, the basic annual, semi-annual or quarterly data may be calculated by taking the median, mode or arithmetic or geometric weighted or unweighted mean of the daily, weekly or monthly prices. Whichever one of these bases is chosen, the secular trend may be derived from it by the use of any one of the following methods. One may use the two, three, four or any yearly moving average; or he may use the method of least squares to fit a straight line to the data, with an equation of the type \( y = a + bx \), or he may use a single-curve line, with a similar equation of the second degree, or a double-curve line, using a third degree equation, and so on. Or he may let his common sense overcome his mathematical scruples, and simply fit a curve free-hand. In each case a slightly different secular trend will be obtained, although any one is just as much the secular trend as any other.

These differences, however, are trifling, and of small weight in comparison with the usefulness of the secular trend. Admittedly, the trend lacks the absolute nature of the long time normal. But the long time normal cannot be
expressed in numerical terms; the secular trend can. And, if
judgement is used in selecting the method by which it is to
be derived, the small inherent error may be reduced to an
amount less than that due to errors from other sources, which
would still be present if the secular trend were absolutely
accurate.

Accordingly, wherever in the statistical analysis
we use the secular trend, it is to be regarded as the objec-
tive counterpart of, analogue or close approximation to the
abstract long time normal, which is part of the general dy-
namic normal concept arrived at as the basis of our price
theory in Chapter II.

B. Division into Long and Short Time, Seasonal, and Market,
   Periods.

   In the analysis of corn prices with the aid of the
statistical counterparts of the abstract concept of normal
price, which follows, we will begin with the longest periods
and the most underlying forces, proceed to the shorter per-
iods and more superficial influences, and conclude with the
briefest and most superficial of all.

   A word might be said here concerning these chron-
ological divisions into long and short time, seasonal and
market periods. These divisions are arbitrary, not absolute;
they are used, not for the sake of accuracy, but for
expediency. In the case of the price of wheat at Liverpool,
for instance, no one can say where the short period changes into the long, nor where the seasonal period begins and ends. Marshall gives a full discussion of this matter, however, to which the reader is invited to turn for sanction of the use of these arbitrary divisions.

It happens that with corn, the data fall into those divisions more naturally than is the case with most commodities; at least, as far as the seasonal and market periods are concerned. Corn is a commodity that comes on the market in well defined annual quantities, from a fairly homogeneous area, the corn belt, and is but little affected by imports or exports. Furthermore, the actual corn market has much better present and future trading and news facilities than most markets.

But to proceed. As stated in the first paragraph of this section, we will present the characteristics of the secular trend of corn prices first, and the shorter and shorter period movements later.

C. The Secular Trend of Corn Prices.

A graph of the weighted average annual price of corn at Chicago from 1935 to 1924 inclusive, shown on page 53, reveals a trend which may be represented by one straight line.

Data from the U. S. D. A. Year Book, 1925, Table 110, page 677. Before 1900, the unweighted mean of the monthly prices taken from a table furnished the writer by O. G. Stine, Chief, Dept. of Stat. and Hist. Research, U. S. D. A.? was used.

Graph reproduced by kind permission of Prof. K. Bjorka.

Principles of Economics, pages 378 to 380.
CORN PRICES AT CHICAGO - 1865 - 1924

PRICE YEARLY AVERAGE
PURCHASING POWER (1913 BASE) -----
SECULAR TREND
slowly descending for the first thirty years from 1865 to 1905, another rising more sharply from 1895 until 1915. These are represented by the two straight lines in the graph. Then there is a mountain peak during the war, when the price reached more than twice its previous heights, followed by a valley of three or four years, and finally a return to probably a new level and a new inclination.

This may be explained on the grounds that 1896 marks the point before which the extension of corn production was continuously outrunning demand, and after which it had reached the limits of its extension and the growth of demand had overtaken that of production. The war time peak was the result both of the increased demand for food products and the financial inflation associated with the international upheaval, and the subsequent depression, was the result of both of these conditions being reversed.

This is very good as far as it goes. But, if the whole price line is corrected year by year by the Bureau of Labor All-Commodity Index of Wholesale Prices, the secular trend or rather trends one by one disappear, leaving in their wake nothing but what might be called a super - secular trend that is almost a straight line. Perhaps it is better represented by part of a very large circle, concave upwards, gradually rising in one sweep from beginning to end except for the post-war period. This is the trend of the purchasing power of corn.
It shows no marked change at 1896, no rise during the war period, a deep depression after the war, owing to the reduction in demand and the heavy crop years of 1920, 1921 and 1922, and finally a struggle back towards the original trend line. The sea level is gradually rising, at a slowly accelerating pace. The purchasing power of corn, from 1900 to 1919, rose annually nearly one cent. It will be interesting to observe whether, once the post war period is well past, this rise is resumed.

The forces giving the secular trend these characteristics are probably as stable as can be found in any industry. They are, on the one hand, a very slow and consistent increase in acreage, and on apparently faster but equally consistent increase in demand, on the other. Improvements in production methods have resulted in a slight increase in yield per acre, since 1890, but naturally the increase in purchasing power has been accompanied by an increased cost of production as cultivation has been pushed closer and closer to the extensive and intensive margins.

What are the supply and demand conditions contributing to the stability of these forces? In the case of corn the condition of supply of the total stock is unquestionably one of diminishing returns, as production is pushed closer to the extensive margin approached in lands of poor corn adapt-

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33 Up to 1912, after which the acreage remains roughly constant. The annual fluctuations in corn acreage have been small, except for the shift with wheat in 1917 and 1919. These features are shown in the graphs on pages 56 and 57, reproduced from the 1921 and 1923 U. S. D. A. Year Books, respectively.

34 Also shown in the graph on page 56.
CORN
ACREAGE, YIELD PER ACRE, AND PRODUCTION
UNITED STATES, 1866-1921

Fig. 6. - Acreage and production of corn have increased rather steadily since 1866. Production has fluctuated from year to year much more than acreage, because it depends not only on acreage but also on yield per acre, which has fluctuated largely in different years. Upward and downward trends, however, have occurred in yield per acre.
tion and to the intensive margin found on all farms. That is one stabilizing factor.

Again, corn is a staple good; accordingly, as would be expected, its demand is inelastic,—not to a very high degree, but still relatively so. This means that the penalty of over or under production is rather severe, and ensures that the long time normal production line will not be departed from for very long. This is the other contributory element of stability.

D. The Short Time Normal Corn Price, and Normal Cycles.

We will pass from the consideration of the features of the long time normal direct to the seasonal normal price, and defer treatment of the short time periods until later. The reason for this is that the latter embrace so many erratic factors that discussion of them will yield better results if it follows rather than precedes the analysis of the more rational seasonal normal price fluctuations.

Furthermore, no cycles, analagous to tides, were observable in corn prices until during the study of the season's normal prices. Their nature is such that they are best left until they become apparent in the season's normal section.

All that need be said here is that with corn the situation in short time periods is different from that with Marshall's commodity, fish. With him, the cost of production still coincided with the short time normal price. Owing to
the sluggish features inherent in agricultural production, however, this is not the case with corn. During the rising price part of the period, the short time normal price rises faster than the cost of production, and during the falling price period, the reverse is the case. But this is already familiar ground.

E. The Season's Normal Corn Price.

A good deal of consideration was given to the method to be used in studying the season's normal price.

First of all, study of the monthly corn price data used, showed that the price of corn had a marked tendency to follow more or less closely the same type of curve within the season, except towards the opening and close of the season. The size of the corn crop shifted the vertical position of this curve as a whole, up or down, but once shifted, it retained its general characteristics until the arrival of news of the next crop, when as a whole it would be shifted up or down again.

The weighted average price for the year gives in a single figure an objective approximation to the "center of gravity", as it were, of the abstract season's normal. Accordingly, a tentative simple correlation was run, between the fluctuations in the weighted average annual price from its secular trend and the fluctuations in corn production.

34 Table 110, in the U. S. B. A. Year Book, page 677. This also furnishes the weighted average annual price referred to in the next paragraph.
from its secular trend. The correlation coefficient thus obtained was -9, approximately, and when the two series were graphed on transparent paper and the graphs compared, they fitted very well except for two or three individual years, during which the production of oats deviated from its long time normal (objectively, its secular trend) in such a manner as to account for most of the discrepancy.

The inference therefore was that the location of the season's normal as a unit was determined largely from the supply side, and that the units of supply came in annual amounts. Demand, accordingly, must be a relatively constant factor, such fluctuations as existed probably accounting for the rest of the correlation, and for most of the ordinarily minor changes in the season's normal.

These were necessarily tentative inferences, made only to be used as a guide to the method to be followed in analysing these season's normals. As far as could be seen, however, it appeared that the chief determinants of corn price were annual factors, and that once they had indicated the position of the season's normal, it was affected to only a relatively small extent by the less tangible demand factors.

In the light of these inferences, therefore, it was decided to divide the study of the season's normal corn price into two parts. The first would deal with the apparent-

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A considerable number of tentative trials in other directions were made, also, which yielded inconclusive results and are accordingly not recorded here.
more important factors determining the location of the season's normal as a unit; the second, with the characteristics of the normal within itself, and with the more minor and possibly irrational deviations therefrom. And, in accordance with our plan to progress from the more underlying to the more superficial forces, it was decided to take up the two parts in the order just given.

A complete list of the reasons for these decisions follows.

1. Reasons for using annual data.

   (a) Data for a considerable number of possible influencing factors would be collected, in order that the significant determinants might be sorted out by the method of linear correlation. The correlations would be run on the percentage deviations from the secular trends, over a period of perhaps twenty years. If monthly data were used from the first, this would involve a great deal of clerical work, much of which would be in a sense eventually wasted, since of the many factors commenced with, only a few would be finally selected.

   (b) Several of the more important factors were expressed in yearly figures only; as, corn production. Monthly figures could be based on this annual data, but the

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The 17 year period from 1900 to 1916 inclusive was finally used. Some of the data before 1900 was unreliable, and the war made it advisable to use no data later than 1916.
"splicing" between each year would have to be done arbitrarily, introducing the possibility of error.

(c) There is a belt of daily price range, a strip of "no man's land," a "penumbra," as Taussig calls it, within which prices fluctuate without reference to the regular, familiar laws of supply and demand. We wish to eliminate these peculiar oscillations as far as possible until we have determined as fully as we can whether the average price for the season's crop is rationally determined. The average price for the season tends to be located at the center of the "penumbra", allowing the smaller oscillations to neutralize each other until they can be studied separately later on.

(d) The final reason has been already touched upon. Chapter II presented the skeleton of the method of price analysis which will be followed in this thesis. The first step in

37 In an article in the Quar. Jour. of Ec. May, 1921, on page 401, he says:—

"Suppose a well known dealer cuts his price and puts eggs on the market at a lower figure; other follow his lead; the price will fall still further; the lower price will quite possibly stimulate still others, not to make purchases, as is usually assumed, but to make sales,--until the edge of the penumbra is reached. Then indeed there will be a reaction, or at least a check."

Again, speaking of the grain exchange,—

"A heavy sale by a big operator and a lower price accepted by him may easily mean, not that more will be bought by others, but that buyers will be scared off and that the price will fall still further. This is precisely what the big bear operator expects to bring about. Or, the bear's maneuver may not succeed. Price may not fall further; it may rebound and rise! In brief,—

"Within the penumbra there is no certainty about the effect of lowered price on supply or demand, or on the further course of prices."
that method is to set up the most underlying normal price line, and then to analyse the fluctuations of the season’s normal as a whole, from it. Next, to consider these season’s normal as the point from which to measure market fluctuations; and so on. To begin with monthly data, then, would be to study two "depths" of fluctuations at the same time, which would be a departure from the method outlined, and would introduce additional complications into a problem already sufficiently involved.

Here again, as with the secular trend, we have no absolute numerical representation of the season’s normal. In this first part of the season’s normal analysis, however, we are concerned only with the location of the normal as a unit. For this purpose, a single numerical figure giving us the "center of gravity" of the season’s normal is required, and again we have recourse to statistics. Some sort of average of the season’s prices will give us the objective point through which the abstract season’s normal would pass, could it be expressed in numerical terms, about as accurately as the secular trend represents the long time normal.

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38 The reader is advised to refer again to the distinction between the dynamic season’s normal, and the static season’s normal, given on page 32.

39 Page 37 gives the relation between the secular trend and the longer-term normal, analogous to that between the shorter-period statistical and abstract terms compared here.
2. Converting monthly data into annual figures.

The reasons for using annual data first being accepted as sufficient, the next step was to convert such monthly data as corn prices into annual figures.

Were it not for the disturbing effect of preceding and succeeding crops upon the price of corn, the weighted annual price figures for the crop year November of one year to October of the next, would have been excellent for our purposes. These, however, include the effect of the following year's crop, the size of which begins to make itself felt in the market as early as July, and also the carry-over from the preceding crop. Accordingly, although the table referred to was used to furnish monthly data, instead of using the weighted annual price also given in that table, the longest period free from terminal influences was used, rather than the full year.

For this purpose, the seven month period December to June, inclusive, was chosen.

The simple arithmetic mean of the prices in this period was taken, without weighting for each month as was done in the case of the Year Book's weighted annual price. This saved a considerable amount of clerical work, although it did admit of some error. By reference to another table, however, it may be seen that the marketing of corn is spread throughout

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40 Given in Table 110, U. D. S. A. Year Book, page 677.

41 Given on page 672, ibid.
the year more evenly than is generally supposed. Only about 35% of the crop, according to the table, was marketed in the heaviest three months, or 25%, of the year. The error is therefore not great; it remains constant, and is therefore self-eliminating throughout the period; so the extra accuracy of weighing was not considered worth the additional labor required to secure it.

The single figure obtained for each year was corrected by dividing it by the arithmetic mean of the Bureau of Labor All-Commodity Wholesale Price Index monthly figures for the same seven months that were used in the case of corn monthly prices. The object of this was to eliminate the fluctuations in the general price level from the corn price fluctuations with which we are concerned.

Oats prices and wheat prices were handled in the same manner, except that in the case of these two crops, the period October to April inclusive was used. Oats and wheat come on the market earlier than corn; and, too, this period is that during which most of the corn feeding takes place, and is therefore that in which the prices of oats and wheat will have their greatest effect on corn prices.

3. Concerning production figures.

A word should be said concerning the corn production figures used. It was thought advisable to correct the annual production figures for holdover, and carryover, exports and imports, as the domestic consumption rather than production was

Although this is a debatable point.
really the factor required. Accordingly, the first corn production series was made up by taking each year's production figure, plus the holdover November 1st from the preceding year, minus the carryover November 1st for the year in question, plus imports and minus exports.

However, it was found that another series made up of simple production figures, uncorrected for any of the items mentioned, yielded a slightly higher simple correlation coefficient with corn price than did the other. Because of this, and on account of their greater simplicity, plain uncorrected production figures were used from that point on.

4. Factors used.

Annual percentage deviations from their secular trends were then calculated, as indicated in the foregoing, for the following possible factors:

- Corn Price. X
- Corn Production A
- Oats Price B
- Oats Production B₁
- Wheat Price C
- Wheat Production C₁
- The Dow Jones Index D 45
- Hog Price E 46
- Hog Population E₁ 47
- Bank Clearings F 48
- The Price Level Index I 49
(Foot-notes for preceding page)

43
Obtained from a table given in the Crops and Markets Monthly Supplement, November, 1924, page 369.

44
The data used in these calculations, the graphs, the multiple correlations, etc., will not be given fully here, for obvious reasons. Only the more important tables, and the significant results, will be reported. The tables are to be found at the end of this thesis. The original calculations are placed on file in the office of the Chief, Dept. of Agricultural Economics, Iowa State College, available to any who may be interested in looking them up.

45
The Dow Jones Index was compiled as stated at the head of the table showing its deviations from the secular trend, Table V, at the end of this thesis. It represents demand.

46 & 47
These were computed from tables given in the section on hogs in the U. S. D. A. Year Book, 1923. The hog price figure for each year was obtained by taking the arithmetic average of the monthly prices for November to February, inclusive.

48
An Index furnished by the New York Federal Reserve Bank.

49
Computed as shown on page 65.
These factors were taken for the 17 year period 1900 to 1916, for reasons which have previously been given.

The lag to be given to most of these was one year; that is, the deviation in corn production for 1900 was lagged one year to correlate with the deviation in corn price for 1901, and so on down the line. However, some of them, for instance the Dow Jones Index of Twenty Industrial Common Stock prices, would give the best correlation when lagged a number of months which could be determined only by repeated multiple correlation trials. Again, to use all of these factors at once in a multiple correlation would involve a great deal of work, since although any of them might be finally selected as significant enough to be included in the final determination, probably only a few of them would be finally chosen.

For these reasons, correlations with corn price, progressing from simple to more and more multiple correlation, were taken, the obvious factors being used first. The deviations of the less obvious ones were then each separately graphed on transparent paper, and the sheets laid in turn on top of a graph of the percentage deviations of the actual price for each year from the price predicted from the prediction formula derived from the few factors already used. The reason for this is as follows.

If the deviations of one of the less obvious factors followed closely those of the actual price from the predicted, the inclusion of that factor in the determination of
the final multiple correlation coefficient, $R$, would seem warranted. If, on the other hand, the two lines showed no tendency to "fit", that factor could be safely discarded, without the labor of having included it in the determination of $R$. And furthermore, this method provided for the ready ascertaining of the best lag, if any were required, by the simple shifting of one graph to the right or left upon the other to the position of best "fit."

5. Simple correlations between $X$ and $A$, $B$, $B_1$, $C$, $C_1$, and $A_2$.

Simple correlations were then run on the more obvious factors, the results being as follows:

\begin{align*}
X.A &= -0.9895, \quad t = \pm 0.05 \\
X.B &= -0.7515, \quad t = \pm 1.05 \\
X.B_1 &= -0.7530, \quad t = \pm 1.05 \\
X.C &= -0.3167, \quad t = 0.52 \\
X.C_1 &= -0.1676, \quad t = 0.52 \\
X.A &= -0.2250, \quad t = 0.220
\end{align*}

The high (negative) correlation between $X$ and $A$ is natural. So is that between $X$ and $B$, $X$ and $B_1$. In view of the similarity of the two results, and the greater simplicity of $B_1$, it was finally chosen rather than $B$.  

50, 51 and 52.

These are correct only to the second decimal place, owing to a slightly different price level index being used in the later stages of the work. In view of the fact that they are discarded from this point on, however, it was not thought necessary to recalculate their correlation. The figures given are accurate enough for the purposes of comparison.
The low correlation between \( X \) and \( C \), \( X \) and \( C_1 \) was surprising, in view of the generally accepted belief that wheat and corn prices tend to move together, or that "corn follows wheat". This part of the work was checked with especial care, however, and the writer feels sure of his ground on this point.

Corn production had been mentioned as affecting price two years later through the production of hogs stimulated or inhibited by the price resulting from a large or small crop, by H. A. Wallace. That is, a large crop would result in a low price for corn, and an increase in the feeding and breeding of hogs, which would come to full fruition two years later in greater than normal inroads upon the corn surplus for that year, raising the price of corn to some extent. Its correlation is naturally not very high, but the graph of the price of corn predicted without the inclusion of the effect of corn production two years before "fitted" corn production two years before very well, indicating the advisability of including it. It was designated \( A_3 \).

In spite of the low correlation between \( X \) and \( C \), the latter was included in the first \( R \) calculated between \( X \), \( A \), \( A \), as it seemed possible that the influence of wheat price on corn price might turn out to be higher than indicated.

Correlative proof is afforded by the fact that an earlier multiple correlation, using an older price level series, yielded results confirming the negligible effect of wheat prices on corn prices.

by the simple correlation between them.

6. \( R_{YX_2A} B_1 A_2 G \)

The regression coefficients from the calculation of \( R_{YX_2A} B_1 A_2 G \) were found to be as given below:

- \( C_2X = .0652 \)
- \( A_2X = .2028 \)
- \( B_1 X = -.3495 \)
- \( A X = -.7153 \)

The multiple correlation coefficient \( R \) was .9465, and the standard error of estimate was, in terms of per cent.

5.2.

7. Regression equation and predicting formula.

From this data a regression equation of the standard type was then calculated. A prediction formula was then constructed upon this equation as its foundation, taking the form

\[
\bar{X} = \left[ \left( 100 - 1.063 a + .307 b_1 + .310 a_2 \right) \frac{N. P.}{100} \right] \frac{1}{100}
\]

where
- \( a \) = % deviations of \( A \)
- \( b_1 \) = % deviations of \( B_1 \)
- \( a_2 \) = % deviations of \( A_2 \)

\( N. P. \) - The long time normal price (corrected for price level) for that year.
- \( I \) - Price level for that year.
It will be noticed that the effect of wheat prices is not included in the formula. On account of the relatively small size of its regression coefficient on X, it was dropped from the list and a new R was run on the remaining factors. A few predictions were then run both with and without C included in the formula, and as they were identical to the second decimal place, C was finally abandoned.


The graph of the actual price deviations from those predicted by the use of this formula was used as the pattern to which the graphs of other possible factors were successively applied. It was expected that the graphs of hog prices, or of hog population, or both, would fit very well. Such, however, was not the case; they both exhibited an unsatisfactory relation, strongly positive in some years, equally strong negative in others, and a negligible amount in the majority of cases; nor could any amount of inverting or lagging make them fit.

The Dow Jones Index of Twenty Industrial Stock prices, an index of industrial activity and therefore demand, was not satisfactory when placed coincidently; but lagged three years, it showed a surprising tendency to "fit". Accordingly it was incorporated into the calculation of a new R, along

\[
X = M_x + \beta_{xA} \cdot \frac{e^A}{e_A} (A - M_A) + \beta_{xB} \cdot \frac{e^B}{e_B} (B - M_B) + \text{etc.}
\]

given in Snedecor and Wallace, *Correlation and Machine Calculation*, page 34.
with the same other factors used before, with \( D \) in the place of \( C \).

The grounds for using it were the fit it revealed in that position. Warren gives a rather tenuous explanation of its relationship, tracing it through the the business cycle, but the explanation is so much dependent upon a rather definite periodicity in the business cycle: that it is of doubtful value.

The results of the new \( R \) calculations were illuminating; The new regression coefficients were:

\[
\begin{align*}
X_D &= .02020 \\
X_A_3 &= .1863 \\
X_B_1 &= -.2383 \\
X_A &= -.6405
\end{align*}
\]

The regression coefficient of \( D \) on \( X \) has almost as high a value as that of \( B \) on \( X \), although, due to the relatively high \( R \) already obtained before \( D \) was added to the factors used, the inclusion of this new and distinctly significant factor raised \( R \) only .0145; that is, from .9465 to .9600. The standard error of estimate was reduced to 4.44.

This is, however, in accordance with the advice given on page 18, of Snedecor's handbook, previously referred to, and other texts on statistical method, that an apparently small increase in \( R \) as it approaches unity is of far greater significance than a large increase in the lower values of \( R \).

The Problem of Business Forecasting, page 260.
There are some observations to be made upon the demand factor $D$, for which the reader is referred to the statistical and mathematical appendix at the end of the thesis, Note I.

9. The major determinants of average annual corn price.

The chief determinants of the position of the season's normal corn price thus appear to be as given in the preceding page, with relative weights indicated by their respective regression coefficients. These findings are to be regarded as the significant results of the investigations in this section $F$, entitled "The Location of)"The Season's Normal Corn Price."

They may be interpreted in more everyday terms as follows.

The chief determinant, slightly outweighing the other three combined, is the size of the corn crop the year before that in which the price is considered, the influence being inverse. This is natural, and needs no further comment.

The three remaining important factors, so far as discovered, are oats production, (having approximately the same weight as oats price, but inverse instead of direct) corn production two years before the corn production given in the preceding paragraph, and industrial activity, as indicated by the Dow Jones Index for that year also. These three influences are roughly equal, although they are here ranged in the order of their size, the largest first. The influence of oats production is inverse, that of the other two, direct.
Last of all, the influence of average annual wheat prices on the location of the season's normal for corn appears to be negligible.

To test the accuracy of these statistical inferences, a prediction formula similar to the one given on page 71, was derived, and the annual price of corn predicted from 1900 to 1916. The calculations involved may be found as indicated in footnote 44. The results are given in Table VI in the appendix, and are presented in graphical form on the following page.

It should be borne in mind that these predictions are not the end to which our investigation has led, but are simply a convincing proof of the accuracy of the conclusions reached concerning the determinants of annual corn prices, presented in quantitative form on page 73. The predictions were also put through the war and post war period, the remarks concerning which process are to be found in Note II of the appendix.

It would be a simple matter to determine the partial or net correlation between any one of these factors and price, the effect of the other factors being held constant. The standard statistical method is outlined in Snedecor's handbook, already referred to. The results would probably be very interesting. They might show, for instance, that the high correlation between corn production and price is due partly to the effect of the oats crop, which appears to raise it in every one of the seventeen years studied. But, as Snedecor's book says, "the calculations are rather extensive, though simple in form," and lack of time renders their use impossible.
CHAPTER IV.

THE RELATION BETWEEN CORN PRODUCTION AND PRICE.

Before proceeding from the study of the factors determining the position of the season's normal as a unit, to the analysis of the season's normal itself and the market deviations therefrom, it was considered advisable to investigate the nature of the relation between corn production and price; or, as it might be considered, the nature of the demand schedule for corn.

The difficulties involved in studying this relation are obvious. So many other factors beside the supply of corn affect its price that it is difficult to isolate these two from all the others to get the simple relationship existing between them. It is possible, however, by the use of the formula whose derivation was given in the preceding chapter, to arrive at a serviceable approximation to this simple or net relation.

A. Net Relation for the Period 1900 to 1917, "Other Things Being Equal".

In the formula used in Chapter III, the price was predicted by simply projecting its secular trend, and "correcting" it for the influence of the size of the corn crop the year before, for corn production and industrial stock prices two years before that, and for oats production.
In plotting price against supply to get their net relation, therefore, the same corrections were made, but in the reverse direction. That is, instead of taking the price predicted by the secular trend, corrected for the major influence, the corn crop, and then further correcting it by algebraically adding the corrections for the remaining factors, to get the actual price, the procedure was reversed. The actual price was taken, and the corrections were algebraically subtracted.

The supply, or production, of corn was expressed for each year as a percentage of the long time normal amount for that year. The price was similarly expressed, and then corrected in the manner detailed above, for oats production, corn production and the index of industrial activity properly lagged, and the general price level. The dots representing the intersection of each year's production abscissa and price ordinate are shown in the graph on the following page.

The next step was to fit the line which best expressed the relation which these dots represent.

The first matter to be settled was the choice of the type of curve to use. Should it be a straight line, or a curve, and if the latter, of what mathematical type?

The remarks concerning the use of mathematical curves, in Note II of the mathematical appendix, apply here also. The line that would fit the dots the best appears to be one negatively inclined at about 50°, slightly convex upwards.
Relation between corn production and price.

"Other things being equal."

Slope, -0.90
But our data is limited, and the curvature is due almost entirely to the location of the two terminal dots. It is more than probable that the addition of a few more dots to the end of the line, from additional data, would straighten of the curve, or even give it a bend in the opposite direction. Accordingly, conservative judgment would favor the use of a straight line, at least, until further data have been compiled. See note IV in the appendix.

The objection may be raised that since the formula used was based on rectilinear multiple correlation, the only relationship that data derived from it could display would be rectilinear or straight line. The point would be well taken if the predicted prices were used as Y, but they are not. Actual prices are used. Corn price and production, taken alone, have a simple correlation coefficient of \(-0.899\); and in correcting the actual prices, only the minor corrections for the residuum indicated are on a straight line basis.

The scatter of the dots which still persists results from the fact that even R was only \(0.960\), showing that the price should have been still further corrected for some other factors not as yet determined.

The next question, once the type of curve was decided upon, was to decide the method of fitting it to the data.

For a full discussion of this subject the reader is referred to Note III in the mathematical appendix. All
that need be said here is that as a result of the considerations given there, the slope of the line is best expressed by the relation between the standard deviations of price and production, respectively.

This relation, with our data, was \(-0.99\), or practically \(-1\). This means that in the case of the straight line curve which we have here, the change in price resulting from a change in production will be \(-0.99\) times the change in production. That is, a crop 10\% below normal will result in a price, in round numbers, 10\% above normal; and conversely.

For a discussion of demand elasticity, see appendix Note V.

B. Actual Relation for the Period 1900 to 1917, "Other Things Being Included."

So far, we have dealt with the net relation, "caeteris paribus". But other things, in the case of corn, very seldom are equal. For instance, in every one of the seventeen years considered, a corn yield below normal, with its resulting price above normal, is accompanied by an oats yield below normal; and vice versa. With a regression of oats production on corn price of \(-0.2383\), more than 1/3 that of corn production itself, we see the need of taking some of these other things into consideration, especially when they fluctuate hand in hand with corn production, and consistently increase the effect of corn production upon price.

Because of the considerations given in the preceding paragraph, it was thought well worth while to plot the
points and draw the line showing the relation between corn production and actual uncorrected prices, as found in actual life.

The dots, and the curve that expresses their trend, is shown on the following page; as would be expected, the "scatter" of the dots is greater than in the corrected price graph. The curve is a straight line, as before, but the amplifying effect of the "other things being included" becomes apparent in the change in the slope of the line from -.99 to -1.47.

In application, the latter relation is the more significant of the two. It means that under the actual conditions of production, a reduction in the size of the corn crop of 10% is associated with a rise in price, not of 10% but 14.7%.

C. Actual Relation for the Period 1874 to 1917, "Other Things Being Included."

It was felt that the relation between actual average annual corn prices and production needed further verification. The percentage deviations from the secular trends of corn production and price were therefore secured for a longer period, beginning with 1874 and running down to 1917.

The original data came from the 1921 U. S. D. A. Year Book. The tables from which the position of the dots was taken are given in the appendix.
RELATION BETWEEN COMB. PRODUCTION AND PRICE

"other things included", Slope, \(-1.47\)

-------- Constant returns curve, \(y = \frac{10,000}{x}\)
The graph showing the production and price relation for that period is shown on page 86.

It will be seen that the inclusion of the greater number of dots bears out the relation previously implied. There is a "milky way" whose general direction is represented by the single straight line shown, of approximately the same inclination as in the similar graph for the shorter period, and passing as before through the point where X and Y both equal 100. It is possible that the relation below that point would be better indicated by a more steeply descending line; but the line used is not far out.

D. Comparison With Constant Returns Curve.

The final step in the study of the relation between production and maximum price will now be taken.

A constant returns curve is one expressing a relation between production and price such that the total return to the individual entrepreneur will remain the same no matter what the production. That is, the increase or decrease in price exactly compensates for the decrease or increase in supply or production.

Marshall has a graph showing a series of these, which is shown on the following page. Their general equation is

\[ YX = C \quad \text{or} \quad Y = \frac{C}{X} \]

They are rectangular hyperbolas, with Ox and Oy as asymptotes.
The wavy line may be disregarded.

RELATION BETWEEN CORN PRODUCTION AND PRICE

"other things included", 1874 - 1916.

Constant returns curve, $y = 10,000$
It is very illuminating to draw in one of these constant returns curves on the graph of the relation between corn production and price, giving a value to C such that the curve will pass through the "normal" point, where \( X \) and \( Y \) both equal 100. This may be done by giving \( C \) the value \( 100 \times 100 \), or 10,000, assigning different values to \( X \) and deriving the corresponding values of \( Y \), in the general equation, and plotting the resulting points.

This is the smooth curved broken line shown in the graph, along with the straight production and price line. From a comparison of the two, the following inferences may be drawn:

For production from 70 to 100% of normal, the actual corn price line does not deviate greatly from the constant returns line.

As production goes above normal, however, the constant returns curve swings up and away from the actual relation curve, at an accelerating pace.

This means that, for the farmer who sells all his corn for cash, he need feel no alarm, even though the weather reduce the general corn crop to as low as 70% of normal. His total returns will remain approximately constant.

The only thing he needs to fear is a general bumper crop! For as production goes above the normal, his actual total return will be reduced by the proportion represented by the distance from the actual price and production point for that ye
for that year, to the point on the constant returns curve on the same horizontal plane, divided by the total horizontal distance of this latter point from the Y axis.

It is interesting to observe that out of the 22 years in which production was above normal, there were only two in which the total return was even slightly greater than at the "normal" point. In the other 20, the returns were distinctly lower.

This, it must be repeated, is only for the man who sells his crop for cash. For the man who feeds it, altogether or in part, so many other considerations enter that no attempt can be made to generalize. A few of these considerations will be touched upon, however, to give an idea of the complications they bring in.

From one point of view, a big crop and a low price may be regarded as an advantage to the man who feeds. It means that he gets the raw material for his finished product that much cheaper, thereby lowering his costs of production and increasing his profits. On the other hand, however, it would seem that the returns from selling corn for cash in a year of big crops, would not fall below those to be secured by feeding it, since the two alternatives are open. Perhaps the time involved in going into feeding explains this apparent paradox. In any case, there is a whole field for study here, which can only now be indicated.
CONCLUSIONS

The next step, as indicated before, would be to proceed to the investigation of the characteristics of the season's normal, and the analysis of the market price deviations from it. It would involve a thorough study of the relation between cash and futures prices, the relative influence of futures sales and purchases on futures prices, an inquiry into the movements of price within the "penumbra", and so forth,—more than sufficient for a thesis in itself. In it, the price theory outlined in Chapter II will be continuously called into service.

However, this thesis has to be brought to a close at this point, owing to lack of time to proceed further. The fact that it is only the first part of an extended price study, of course, is obvious. It is expected, however, that it will be carried on along the lines indicated, at a later date.

We will conclude, then, with the presentation of some conclusions which may be drawn from the results of the work up to this point.

1. The dynamic normal, implied if not expressed in the works of the more recent authorities, and affording the basis of the price theory used in this thesis, is a more significant and useful concept than the older static normal.
2. The statistical secular trend is not the same thing as the abstract dynamic long time normal. It does, however, furnish us a means of quantitative price analysis, and may be regarded as the objective counterpart of the abstract long time normal concept, representing it accurately enough for the purposes of price analysis.

3. Similarly, an average of the prices of corn for a central period of from six to ten months is a workable numerical approximation to the "center of gravity" of the abstract season's normal considered as a unit, insofar as it can be expressed by a single figure.

4. By the use of these objective representations of some of the abstract elements in the general theory of prices, we have been able to explain in quantitative terms, a considerable part of the influences determining corn prices.

5. The position of the average annual price of corn appears to be determined for each year in a rational quantitative manner.

6. The more important determinants of the average annual price of corn, with their regression coefficients, are as follows:
(a) Corn production the year before, \(-.6405\)
(b) Oats production the year before, \(-.2383\)
(c) Corn production three years before, \(.1863\)
(d) Industrial activity, as reflected in
    the Dow Jones Index, three years before, \(.2020\)

The multiple correlation coefficient of these four
with corn price is \(.9600\).

7. These relations may be tested by converting the
regression into a predicting formula, and comparing the prices
thereby predicted, in the past, with the actual prices.
The formula gives results for the period 1900 to 1916 with a
standard error of estimate of 4.44 in terms of per cent.

8. The predicting formula becomes unreliable after
1917, owing to the inadequacy of the demand factor D used in
the formula.

9. No consistent cycles in either actual corn prices
    or prices corrected for general price level changes were dis-
    cernible in the period studied, (1900 to 1916 inclusive,) ex-
    cept of course for the swing within each season. The only
    movement of a somewhat cyclical nature discovered was this,
    that low prices resulting from a large corn crop the year
    before have a consistent tendency to raise the price of corn
    two years later, and vice versa, through their effect on hog
    breeding and feeding.
10. A corn crop below normal (the long time dynamic normal) even as far as 20% below normal, is shown to have a definite tendency to yield an aggregate value in dollars and cents as a normal crop.

11. A corn crop above normal shows an equally definite tendency to yield a lower aggregate value than a normal crop. This tendency becomes more and more marked as the crop becomes larger and larger.

12. Under the conditions of actual production, the net relation between corn supply and price is amplified by "other things" from -.99 to -1.47. That is, a crop 10% below normal on an average, results in a price 14.7% above normal, and vice versa.
BIBLIOGRAPHY


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Wall Street Journal, June 27, 1925.


Wheat Studies, Food Research Institute, Stanford University. p.148, April 2, 1925.
It seemed best not to burden the body of the thesis with too full a discussion of the statistical and mathematical method involved. At the same time, some of the ground covered in this field was new, and there were no standard guides to follow or refer the reader to for explanation. Accordingly, wherever necessary, a notation in the text has been made, referring the reader in search of further information to the note in this appendix dealing with the mathematics of the point involved.

It might be said that from a statistical point of view, this thesis could be described as a course in price fluctuations. The chief weapon of analysis throughout is the method of multiple correlation. If the reader is not already acquainted with this method, the exceedingly brief outline given in the next few paragraphs may be sufficient to give him the essentials of it enough for an understanding of the procedure in the text.

Correlation may be defined as the tendency toward concomitant deviations, apparent in two or more series of data. It may be either positive, that is, the correlated movements may be in the same direction, or it may be negative, in the opposite direction. The range, numerically expressed, is from 1, representing perfect direct correlation, to -1, representing perfect negative correlation; no correlation at all is represented by 0.

Not only simple correlation between two variables, but multiple correlation between many variables, may be used. In that case, if price is the "dependent" variable X, the movements in which are to be analyzed, the other factors are considered the "independent" variables, and a perfect correlation would mean that the movements of X had been completely explained in terms of the movements of the other factors.

The simple correlation coefficient between two variables is called r, and the multiple correlation coefficient, R. R is always positive; and although it may be made up of some positive and some negative r's, the addition of another r raises the R irrespective of the sign of the r added.

The regression coefficients mentioned in the text may be regarded as the coefficients of determination of the different independent variables or factors, derived from their r with X, and expressing the direction and "weight" of their influence.
Note I. Characteristics of the Demand Factor $D$. (from page 74)

There are some observations to be made upon this factor $D$. Our formula needs, beside the supply factors $A$ and $A_7$, and $B_1$, (although the latter is in a sense partially a demand as well as a supply factor,) a factor representing the influence of demand. This is the role which $D$ plays, and for that reason the formula is incomplete without it. It should be emphasized, however, that $D$ falls far short of filling the part satisfactorily. The reasons for this are as follows:-

Admittedly, $D$ has a fairly high $r$ with corn price three years later. However, by far the most important determinant of corn price is corn production the year before; and the major determinant of corn production, in turn, is the weather. In the simple $r$ between $D$ and corn production two years later, we find thirteen minus relations in rapid succession, without a break, from 1900 to 1912.

From the position of industrial stock prices, two years ahead of corn production, there are only two possible explanations of this. The first one is that there is a causal relationship running from the prices on the stock exchange to the weather two years later, the absurdity of which is apparent. Accordingly we are forced to fall back on the second explanation, that the high $r$ between $D$ and $X$ is mostly fortuitous. Only the $r$ between $D$ and the otherwise unaccountable deviations in $X$ can be taken as the grounds for including $D$ in the determination of $R$. The usefulness of the method by which $D$ was selected, namely its fit with the otherwise inexplicable price deviations, is apparent here.

These reflections upon $D$ are strengthened by the investigations of Warren, who states in "The Problem of Business Forecasting, page 261, that though the $r$ between $D$ and $X$ lagged thirty months was "amazingly" high for the period 1897 to 1913 inclusive, the dates referring to stock prices and the $r$ being .68, in the period 1890 to 1896 inclusive the $r$ with no lag was .35, and with a lag of eight to eleven months, .57. As he says,"the writers have as yet no explanation for the striking change in lag."

We are including it, therefore, in full recognition of the fact that, although it is supplied the missing link of demand in the predicting equation, its part is imperfectly played, particularly, as will be seen in the war and post-war periods.
Note II. The Predicting Formula in the War and Post-War Periods, (From page 75)

The view has been advanced that if a predicting formula based on pre-war relationships were projected through the war and post-war periods, it should not give consistent results there also, because new factors not taken care of in the formula would have been introduced into the situation. However, the writer decided to run the predictions through, these periods, and to use the deviations of the predicted from the actual prices either as an index of abnormality in the economic conditions of the times, or of shortcomings in the formula, not previously revealed. The procedure involved was not put into the body of the text, because all that was required there was a test of the formula for the period on which its derivation had been based.

Several precautions had to be taken. Plotting the total production of oats in the United States revealed the fact that 1917 marked the peak of oats production. From that time on, the normal production changed its trend from an annual increase of 29,600 bushels to an annual decrease of 8,900 bu. Corn acreage, and therefore production, (since the yield per acre has remained fairly constant) although steadily increasing until 1917, has since that date remained at a rather constant level, except for the interchange with wheat during the war. Most of these features are shown in the graphs on pages 56 and 57.

In the case of these two products, oats and corn, there was no valid reason to use as the normal line any but a straight line fitted to the data by the methods of least squares, breaking the line at the points indicated. Had the condition of change in trend been foreseen from the first, instead of using as the equation for the trend line the simple formula

\[ y = a + bx, \]

the second degree equation \[ y = a + bx + cx^2 \]

or third degree equation \[ y = a + bx + cx^2 + dx^3 \]

might have been used. There are several objections to these types, however, involving considerations which are detailed in the general Note IV of this appendix. All that need be said here is that the broken straight line was finally used, partly because most of the data was of a type that such a line fitted it best; and second, because of the reduction in the amount of calculation required.

The most important question of all was the determination of the normal price line for corn during the war and post-war periods. Perhaps the consistent course would have been to project it straight through along its old rising path:
there is no reason, apart from war influences and abnormalities, for this rise being lessened. The contrary should hold, for the acreage of corn has ceased in its pre-war increase, the yield has not risen very much, and demand has not markedly changed.

However, the most accurate predictions were secured by bringing the rise in corrected secular corn price to a stop in 1919, and continuing it thereafter at the same level, 69d. This is purely an arbitrary matter, and the reader is left free to prefer that the rise should have been left untouched. The result in that case can easily be graphed in the mind, by imagining the predicted price line from 1919 to 1925, in the graph on page 76, to be rotated counter-clockwise about the 1919 point until the 1925 price reaches 120.9d.

The writer is of the opinion that the unreliability of the predictions, during the post-war period especially, is due to the demand factor B being inadequate for the purpose. Indeed, one would hardly expect it to be otherwise. It is hoped that a better demand factor may be found that will enable the formula to be used with some confidence as the post-war period passes.

Note III. The Determination of the Slope of the Demand Line, Expressing the Relation Between the Supply and Price of Corn. [From page 80]

The standard mathematical method is based upon substitution of actual values in the equation

\[ y = a + bx \]

and the subsequent solution of a pair of simultaneous equations,\n
\[ a \Sigma x + b \Sigma x^2 - \Sigma yx = 0 \]

\[ a \Sigma x^2 + b \Sigma x^2 - \Sigma yx = 0 \]

(where \( s \) = an observed value of \( y \)) for \( a \) and \( b \), the origin and slope of the straight line, respectively.

Another method was the standard statistical least squares method, involving in this case the throwing of the \( y \) values into classes, as from 0.5 to 1.5, etc. Still another was to derive the regression equation from the simple correlation between \( y \) and \( x \), and use the regression line.

However, concerning this latter method it may be said that since there are always two regression lines, except in the case of perfect correlation, the question arises as to which one should be used. The orthodox answer is, if we wish to show the effect of demand on supply, use the \( x \) line; and conversely, if we wish to show the effect of supply on demand.

However, since demand and supply are mutually dependent, neither one will do here. The line of best fit is that which bisects the angles made by the crossing of the two regression lines. The quickest method of obtaining this is simply to assume that \( r \) is equal to -1, instead of only -.89, as
or, what amounts to the same thing, omitting it altogether, which results in one coefficient of regression being the reciprocal of the other.

Prof. G. W. Snedecor has proven mathematically, since, that the line bisecting the two angles formed by the crossing of the two regression lines is coincident with that obtained from simply setting $r$ equal to -1. The standard mathematical formula is also related to the regular correlation and regression equations as follows:

The mathematical formula starts out,

$$y = a + bx,$$

but the correlation regression equation is

$$y = r \frac{\Sigma X x}{\delta y},$$

but since $r$ is equal to $\frac{\Sigma XY}{n \delta X \delta Y}$

this can be written

$$y = \frac{\Sigma XY}{n \delta X \delta Y} \frac{\delta x}{\delta y} x = \frac{\Sigma XY}{n \delta x^2} x,$$

wherefore it may be seen that $b$, of the slope of the line, equals

$$\frac{\Sigma XY}{n \delta x^2}$$

This means that the formula gives us as the slope of the line, the same result that would be attained by deriving it from the regression formula.

This is rather an important finding, for it proves that the standard mathematical formula does not give us the line we want, and accordingly should not be used. It does, however, give us a very good check on our work, for the result from this mathematical formula, divided by the $r$, -.89, gives us a final result identical with that obtained by taking the bisector of the two angles, by setting $r$ in the regression equation equal to -1, or most simply of all, taking the simple relation between $\delta x$ and $\delta y$.

This proves that the slope of the straight line of best fit for this graph is the graphical expression of the numerical relation between $\delta x$ and $\delta y$.

That relation in this case was -.99.
Note IV. The Use of Mathematical Curves with Economic Data.

(from page 80)

This note is concerned with the general subject, the use of mathematical curves to express relations in economic data.

In the first place, using mathematical curves of a higher and higher complexity lends an imposing appearance of accuracy which may be thoroughly misleading. Choosing the type of mathematical formula, and therefore curve, to be mathematically fitted to the data, simply shifts the "arbitrariness" from the fitting to the choice of the curve. That is, the choice determines the nature of the curve, and the mathematical fitting only determines the fit within the possibilities of the curve.

For example, a curve of the second degree, that is, of the type \( y = a + bx + cx^2 \), would not be applicable to the corrected gold price data of the war and post-war periods. The curve then undergoes two changes in direction, while a curve of the second degree can have but one. That is, both ends "come out on the same side" of a straight line laid along its general path. A curve of the third degree, would from a mathematical standpoint be admirably suited to this period, for it comes out on opposite sides. But for the purposes of this study, such a curve would not be suited from an economic standpoint; it would probably fit the data too well, and minimize the fluctuations which should be brought out.

In short, it should be borne in mind that a curve of a higher order does not simply fit the data more perfectly, but retains its own characteristics to a degree, and fits the data only insofar as its characteristics fit the data. Last of all the greatly increased amount of calculation involved in the higher order curves is a big deterrent in some cases.

An example of the points touched upon here may be found in the comparison of the potato demand curves derived by E. N. Working and E. L. Moore, respectively. (See bibliography.) Working used the equation

\[ y = \frac{1}{-174.4 + 2.749x} \]

his curve being part of a parabola with its vertical axis to the right of the section fitted. It was strongly curved, especially at the lower end toward the focus of the parabola. Moore, on the other hand, used the equation

\[ y = x^{143.9} - 1.376(x-1) \]

his line being only slightly curved.

Moore's demand schedule for corn given on page 75 of his book, "Economic Cycles, Their Law and Cause" appears to
the writer as an example of the use of a complicated curve where a simple singly curved line would have been simpler as well as more truly representative of the data. An equation such as he uses there could be given enough members that the resulting line would pass through every point in the data,—obviously an absurdity.

Karl Pearson's whole emphasis is placed upon the use of the simplest curve possible.

As a matter of fact, the use of mathematical curves of any kind to express social data may be called into question. But that raises questions whose discussion is beyond the limits of this work.

Note V. Elasticity of Demand. (from page 81.)

The elasticity of demand may be defined in numerical terms. Marshall in page 103 and the footnote thereto, in his "Principles of Economics," uses as the measure of elasticity the relation between the deviation in price associated with the deviation in demand. The borderline between elastic and inelastic demand is a relationship of -1. That is,

when \( x = \text{price} \)
where \( y = \text{demand} \),
the demand is elastic or inelastic according as

\[
\frac{dy}{dx} < (\text{or} > -1.
\]

The quantitative expression of the elasticity of the demand for corn, as may be gathered from the text, is therefore

for the "net" demand curve, \(-1.01\), or \(-.99\)

and for the actual demand curve, \(-.68\), or \(-1.47\).
TABLE I.

X, Chicago Corn Prices.* Data from Table 110, page 677, U. S. D. A. Year Book, 1923.
$X_1$, X corrected by I.

<table>
<thead>
<tr>
<th>Year</th>
<th>XX</th>
<th>I</th>
<th>$X_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1909</td>
<td>35.1</td>
<td>82.7</td>
<td>42.4</td>
</tr>
<tr>
<td>1910</td>
<td>60.4</td>
<td>98.1</td>
<td>61.6</td>
</tr>
<tr>
<td>1911</td>
<td>49.4</td>
<td>95.3</td>
<td>50.7</td>
</tr>
<tr>
<td>1912</td>
<td>69.8</td>
<td>98.0</td>
<td>71.0</td>
</tr>
<tr>
<td>1913</td>
<td>51.6</td>
<td>99.7</td>
<td>51.8</td>
</tr>
<tr>
<td>1914</td>
<td>55.1</td>
<td>98.0</td>
<td>67.4</td>
</tr>
<tr>
<td>1915</td>
<td>72.4</td>
<td>98.7</td>
<td>75.4</td>
</tr>
<tr>
<td>1916</td>
<td>73.6</td>
<td>117</td>
<td>65.8</td>
</tr>
<tr>
<td>1917</td>
<td>134</td>
<td>166</td>
<td>74.7</td>
</tr>
<tr>
<td>1918</td>
<td>170</td>
<td>187</td>
<td>90.9</td>
</tr>
<tr>
<td>1919</td>
<td>185</td>
<td>199</td>
<td>77.9</td>
</tr>
<tr>
<td>1920</td>
<td>166</td>
<td>236</td>
<td>70.3</td>
</tr>
<tr>
<td>1921</td>
<td>63.4</td>
<td>157</td>
<td>40.4</td>
</tr>
<tr>
<td>1922</td>
<td>55.4</td>
<td>143</td>
<td>38.7</td>
</tr>
<tr>
<td>1923</td>
<td>75.1</td>
<td>187</td>
<td>45.5</td>
</tr>
<tr>
<td>1924</td>
<td>76.9</td>
<td>149</td>
<td>51.6</td>
</tr>
<tr>
<td>1925</td>
<td>118</td>
<td>161</td>
<td>73.3</td>
</tr>
</tbody>
</table>

* Each year's figure is obtained by taking the arithmetic mean of the figures given for the seven months December to June, inclusive.
### TABLE II.

Percentage deviations of annual corn prices from their secular trend. Data from Table I.

<table>
<thead>
<tr>
<th>Year</th>
<th>Price : X</th>
<th>Y : Trend deviations : (%deviations)^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>43.4 : -3</td>
<td>359.2 : 51.45 : -9.06 : -17.61</td>
</tr>
<tr>
<td>1</td>
<td>48.9 : -7</td>
<td>342.5 : 52.41 : -3.51 : 6.69</td>
</tr>
<tr>
<td>2</td>
<td>74.7 : -6</td>
<td>449.2 : 53.37 : 21.33 : 36.67</td>
</tr>
<tr>
<td>3</td>
<td>51.8 : -5</td>
<td>269.0 : 54.33 : -2.83 : 4.66</td>
</tr>
<tr>
<td>4</td>
<td>55.6 : -4</td>
<td>222.4 : 55.29 : -1.51 : 1.55</td>
</tr>
<tr>
<td>5</td>
<td>55.6 : -5</td>
<td>166.3 : 56.25 : -1.05 : 1.40</td>
</tr>
<tr>
<td>6</td>
<td>49.6 : -2</td>
<td>97.0 : 57.30 : -9.70 : 95.72</td>
</tr>
<tr>
<td>7</td>
<td>47.6 : -3</td>
<td>47.6 : 58.16 : -10.56 : 110.38</td>
</tr>
<tr>
<td>8</td>
<td>69.0 : 1</td>
<td>73.0 : 60.08 : 13.00 : 166.40</td>
</tr>
<tr>
<td>9</td>
<td>73.0 : 1</td>
<td>73.0 : 60.08 : 13.00 : 166.40</td>
</tr>
</tbody>
</table>

1910 : 61.5 : 2 : 123.2 : 61.04 : 1.56 : 2.39

11 : 50.7 : 3 : 152.7 : 61.99 : -11.29 : -18.51

12 : 71.0 : 4 : 204.0 : 62.95 : 8.05 : 12.79

13 : 51.3 : 5 : 259.0 : 63.91 : -12.11 : -18.98

14 : 67.4 : 6 : 404.4 : 64.87 : 2.33 : 5.00

15 : 75.4 : 7 : 515.8 : 65.83 : 7.57 : 11.50

16 : 63.2 : 8 : 505.6 : 66.78 : -3.78 : -5.40

17 : 74.7 : 9 : 67.74 : 7.00 : 10.2

18 : 70.9 : 10 : 68.70 : 22.82 : 32.4

19 : 77.9 : 11 : 69.0 : 3.9 : 12.8

1920 : 70.3 : 12 : 69.0 : 1.3 : 1.9

22 : 40.4 : 13 : 69.0 : -23.8 : -41.6

23 : 32.7 : 14 : 69.0 : -20.2 : -40.3

24 : 39.5 : 15 : 69.0 : -20.5 : -40.7

25 : 51.5 : 16 : 69.0 : -17.4 : -32.2

26 : 73.3 : 17 : 69.0 : 4.3 : 6.2

For the period 1900 to 1916 inclusive, the equation to the trend line is Trend = 59.12 + 0.969 Y, with origin at 1908. The sum of the %deviations is 4272.93, and the standard deviation of Y is 15.85, in terms of per cent.
### TABLE III.

Percentage deviations of annual oats production from its secular trend. Data from page 680, Table 114, U. S. D. A. Year Book, 1923.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production B</th>
<th>X</th>
<th>X Y</th>
<th>Trend</th>
<th>Deviation</th>
<th>Deviation^2</th>
<th>Trend^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1899</td>
<td>925.5</td>
<td>-8</td>
<td>-7404.0</td>
<td>828.1</td>
<td>97.4</td>
<td>11.75</td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td>913.8</td>
<td>-7</td>
<td>-6396.6</td>
<td>865.1</td>
<td>58.7</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td>1901</td>
<td>778.4</td>
<td>-6</td>
<td>-4870.4</td>
<td>882.0</td>
<td>-103.6</td>
<td>-11.75</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1056.5</td>
<td>-5</td>
<td>-5526.5</td>
<td>908.9</td>
<td>131.6</td>
<td>15.91</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>869.3</td>
<td>-4</td>
<td>-3477.2</td>
<td>965.8</td>
<td>-65.5</td>
<td>7.71</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1008.9</td>
<td>-3</td>
<td>-3026.7</td>
<td>962.7</td>
<td>45.2</td>
<td>4.00</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1090.8</td>
<td>-2</td>
<td>-2180.4</td>
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For the period 1899 to 1915 inclusive, the equation to the trend line is $Trend = 1043.9 + 26.9 Y$, with origin at 1907.

The sum of the $\%$Deviation^2 is 3185.35, and the standard deviation of $B_t$ is 13.68, in terms of per cent.

For the period 1916 to 1925 inclusive, the equation to the trend line is $Trend = 1549.68 - 8.0 Y$, with origin between 1920 and 1921.

The sum of the $\%$Deviations is not needed.
Table IV.

Percentage deviations of annual corn production from its secular trend. Data from Table 22, page 652, U. S. D. A. Year Book, 1925.

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For the period 1899 to 1925 inclusive, the equation to the trend line is Trend, = 253823 + 54.67 Y, with origin at 1907. The sum of the deviations is 1989.61, and the standard deviation of A is 10.82.
### TABLE V.

Percentage deviations of the Dow Jones Twenty Industrial Stocks Index from its secular trend. Data from The Wall Street Journal, June 27, 1925.

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Each year's figure is obtained by taking the arithmetic mean of the figures given for the twelve months October to September, corresponding to the seven month period used with prices.

For the period 1897 to 1915 inclusive, the equation to the trend line is Trend = 65.57 + 1.11, with origin at 1905. The sum of the %Deviations squared is 2199.55, and the standard deviation of D is 13.72.
TABLE VI.

Corn prices, actual and predicted. Data from Table I, and predictions from formula given on page

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1920: 166.0: 157.5: 8.5: 5.2
21: 63.4: 71.1: 7.7: 12.8
22: 55.4: 85.3: 27.9: 50.0
23: 75.1: 94.9: 19.8: 23.4
24: 76.9: 83.7: 6.8: 9.1
25: 118.0: 110.7: 7.3: 6.2
26: 3.0: 3.0: 0.0: 0.0

These results are presented in graphical form on page 74.
TABLE VII.

Corn Production and Actual Corn Price, in Percentage of Secular Trend, for the Period 1874 to 1915.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production Trend: 10 Mln. bu</th>
<th>%</th>
<th>Actual Price Trend: Cents</th>
<th>%</th>
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<tr>
<td>1874</td>
<td>108</td>
<td>76</td>
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<tr>
<td>75</td>
<td>124</td>
<td>115</td>
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<td>108</td>
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<td>45</td>
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<td>112</td>
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<td>113</td>
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<td>79</td>
<td>148</td>
<td>122</td>
<td>50.8</td>
<td>37</td>
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<tr>
<td>1880</td>
<td>154</td>
<td>110</td>
<td>49.8</td>
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<tr>
<td>81</td>
<td>158</td>
<td>72</td>
<td>48.3</td>
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<td>161</td>
<td>97</td>
<td>47.9</td>
<td>56</td>
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<tr>
<td>83</td>
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<td>91</td>
<td>46.9</td>
<td>54</td>
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<tr>
<td>84</td>
<td>166</td>
<td>100</td>
<td>45.9</td>
<td>43</td>
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<tr>
<td>85</td>
<td>172</td>
<td>108</td>
<td>45.0</td>
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<td>186</td>
<td>106</td>
<td>41.1</td>
<td>51</td>
</tr>
<tr>
<td>1890</td>
<td>190</td>
<td>77</td>
<td>40.1</td>
<td>58</td>
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<tr>
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<td>194</td>
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<td>230</td>
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<td>43.0</td>
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<tr>
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<td>233</td>
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<td>47.2</td>
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<td>244</td>
<td>113</td>
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<td>43</td>
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<tr>
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<td>100</td>
<td>57.7</td>
<td>67</td>
</tr>
<tr>
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<td>100</td>
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<tr>
<td>15</td>
<td>270</td>
<td>111</td>
<td>72.5</td>
<td>63</td>
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</tbody>
</table>
(Footnote for Table VII.)

In some respects this table is reliable, though in others it is not.

The production figures back to 1900 were taken from Table 92, page 662, U. S. D. A. Year Book, 1923. Before that date, however, they are unreliable, as was drawn to the writer's attention in a letter from O. C. Stine, Chief, Dept. of Historical and Statistical Research, U. S. D. A. Part of this letter may be cited as follows:

"May I suggest that you give some thought to the estimates of the size of the corn crop. Shifts in the basis of estimates at census periods may prove to be a stumbling block if you do not look out for them. For some of the earlier decades adjustments have not been made in the figures published in the Yearbook backwards from the census taken at the end of the 10-year period. The result is that you will find in some cases a marked change, which was due more to a change in the basis of estimate than to a change in the size of the crop. In the Yearbook for 1921 you will find on page 169 a curve of production. In the construction of this curve I made an attempt to mathematically eliminate variations due to change in base. You will find that this curve does not agree with the statistics published in the Yearbook."

Accordingly, the writer made a fine scale and took the production figures before 1900 direct from the curve in the 1921 Year Book. The figures are therefore not accurate in some cases to more than the second place, although this was considered better than to take the figures from Table 92 on page 662, which are inaccurate at times in the second and even the first place.

Concerning the price figures, those from 1900 on were the same as used in the previous calculations. Table 116 on page 577, however, does not go back further than 1900. The figures for the years before that date were compiled from another table furnished the writer by O. C. Stine. They are not absolutely comparable, but are nearly enough for this purpose. The prices were not corrected for changes in the general price level, as perhaps should have been done, as the secular trends to a fairly high degree took care of that.

Finally, owing to pressure of time, the secular trend in each case was simply established as a broken straight line, fitted in arbitrarily although as accurately as possible. More mathematical methods might have been used, but it is the opinion of the writer that the graph, admittedly questionable in many respects, as indicated, represents the economic situation as truly as if more mathematically accurate methods had been used.