THE INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

(Organ of the Indian Society of Agricultural Economics)

Vol. XI	JULY—SEPTEMBER 1956	No. 3

CONTENTS

ARTICLES

Rs. 4/-

BOOK REVIEWS

THE STABILIZATION PROBLEM OF AGRICULTURE AND THE COBWEB MODEL

By

Eino Haikala

Concerning the grouping of cyclical fluctuations several opinions are presented in literature. In the following we shall use the term "general cycles" indicating fluctuations which appear in the whole economy simultaneously and under similar forms. The term "specific cycles" is used in connection with fluctuations characteristic of each special branch of production and depending on the field in question as well as on the entrepreneurs. Thus the general cycles are experienced within agriculture as alternating good and bad times in the same way as in the other fields of economy, whereas the specific cycles of agriculture appear as hog cycles, cattle cycles, cabbage cycles etc.

Cyclical fluctuations are, accordingly, to be considered on the whole as a result of the combined influence or an interference of these two, from each other almost independent wave movements. Thus there may be, *e.g.*, a depression in agriculture as a whole, when regarded from the viewpoint of general cycles, but at the same time there may be prosperity of the specific cycles in hog production, for instance.

Depending on the special character of agriculture its specific cycles are very clear and simple. A high price level in a certain field of production attracts new enterpreneurs and tempts also old enterpreneurs to expand their production, which often already after one production period leads to a low price level. The length of the period of the specific cycle is, accordingly, the same as two production periods or somewhat longer.

The formation of the specific cycles in agriculture is evidently influenced by the following factors :

(1) The production is biological and thus not easily transformed once it has been commenced. In this connection the seasonal character of the production is also to be noted, which in many cases compels to simultaneous production decisions. Further, it is to be remembered that agricultural production requires a definite length of time which cannot be changed to any noticeable extent.

(2) The enterpreneurs engaged in agricultural production are mostly small scale entrepreneurs. Owing to this fact there are such features as a lack of general view and the producers'naive reaction to the prevailing price, *i.e.*, it is believed that the prevailing price level will hold on.

The specific cycles of agriculture—as economic processes in general—can be illustrated by means of economic models. Their use has become very common during the last few years and they have been widely discussed in literature. It is, therefore, not necessary to give here a closer examination to the theory connected with them. Particularly the Cobweb model has been successfully used to illustrate the specific cycles of agriculture. If we restrict ourselves at first to linear approximation, the Cobweb model includes the following three equations :

$$\text{(1)}\quad \begin{aligned} &\text{(a)}\quad p_t = \alpha d_t + \alpha_o \\ &\text{(b)}\quad r_t = \beta p_{t-1} + \beta_o \\ &\text{(c)}\quad d_t = r_t \end{aligned}$$

The price of the product p, the quantity of marketed commodities, d, (calculated per time unit) and the quantity produced, r, (also calculated per time unit) are endogenous variables, α and β are constants and α_o and β_o either constants or functions of certain exogenous variables and a random disturbance.

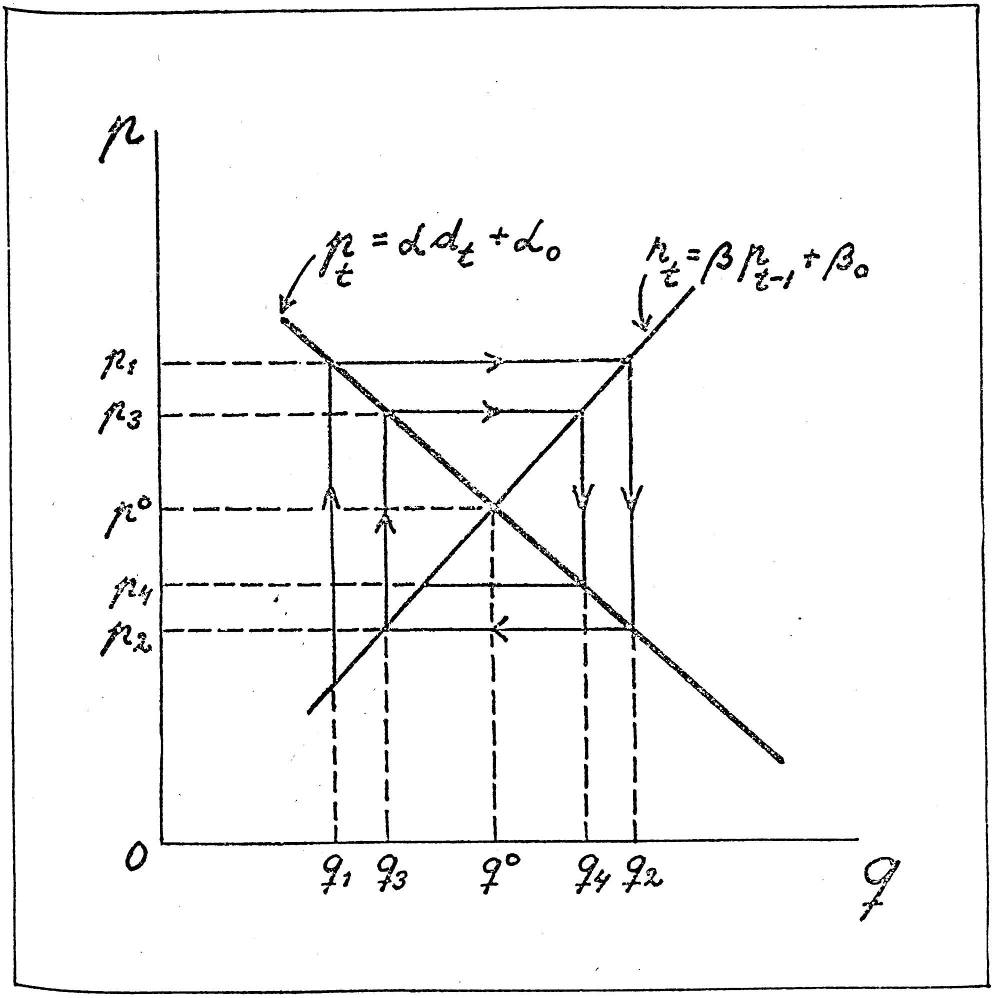
Each equation of the Cobweb model illustrates the behaviour of a certain group of persons. Thus (1a) represents the reaction of consumers. In this case the prevailing price is depending on the quantity of products marketed at the same time. This is the natural development of pricing expressly in the agricultural market, in case it is not influenced by the Government or corporations. (1b) again represents the reaction of producers. The produced quantity is depending on the price by one time unit earlier so that $\beta > 0$. In this case it is supposed that one production period has been used as a time unit. (1c) again represents the reaction of merchants. It shows us that the produced quantity is the same as the sold quantity, *i. e.*, no speculative stock holding is supposed to take place, at least only stock holding of technical character which is a part of the production process.

It is proper to measure the variables so that each equation of the model fills also the condition of the denomination, *i.e.*, there prevails an equivalence also regarding the denominations, as the parameters are numbers without denomination. It is, accordingly, in general advisable to measure the variables as relative to their average values, for instance. In the case in question p, r and d can be measured as relative to the coordinates of the intersecting point of the straight lines (1a) and (1b).

The reader may have already been wondering why the old terms "demand" and "supply" have been left out of use in the representation above. This has been done deliberately. It is true that the term "demand" can without a very great confusion be used to indicate the equation (1a), but the term "supply" has been already burdened with so many different specifications that there does not exist a clear conception any more. A reference to the active group in question is more in accordance with precise terminology.

As known, the Cobweb model can also be represented in p , q —axis setting, where p has the same meaning as previously, whereas q signifies the commodity quantity, *i.e.*, either r or d. The intersecting point (q°; p°) of the reaction curves (1a) and (1b) will in the following be called the Cobweb centre.

FIGURE 1—A GRAPHIC REPRESENTATION OF THE COBWEB MODEL



The produced quantity $r_1 = d_1 = q_1$ causes the price reaction p_1. This, on its part, evokes the production reaction r_2 which $= d_2 = q_2$, which again causes the price reaction p_2 and further $r_3 = d_3 = q_3$ and p_3 a.s.o.

It is depending on the mutual slope of the reaction lines (1a) and (1b), whether the result will be an "explosive" or a "dying" specific cycle. In the case illustrated by our figure it is dying, since both p and q approach the corresponding coordinates of the Cobweb centre, and the oscillation is thus damping. We can see from the figure that if the $|\alpha\beta|<1$ wave movement is of the dying type, the $|\alpha\beta|>1$ again "produces" an explosive movement.

In order to explain this condition in a little more familiar terms we can present it as follows :

If 1. $\left|\frac{R_p^o}{D_p^o}\right| < 1$ the movement is dying

(2) 2. $\left|\frac{R_p^o}{D_p^o}\right| > 1$,, ,, ,, explosive

3. $\left|\frac{R_p^o}{D_p^o}\right| = 1$,, ,, ,, stationary

R_p^o and D_p^o mean here respectively the price elasticities of production and demand in the Cobweb centre.[1] The explosion or dying of the cycles is thus depending on the numerical value of the elasticity ratio, (2).

It is natural that the explosion can in practice take place only between finite limits. Production has namely always its own upper limit, while the under limit is determined by the in their reaction passive producers. Due to this, there is, when the specific cycles of agriculture are explained, a certain need of nonlinearism at least regarding the reaction function of producers.

The good and bad qualities of the Cobweb model are well known in literature.[2] The small number and, notwithstanding, great explaining capacity of the endogenous variables is, on the one hand, its strength and, on the other hand, its weakness. The deficiencies can, however, be modified by means of adding the number of both endogenous and exogenous variables.

The experience shows, nevertheless, that the elasticity ratio (2) determines in the first place the character of the specific cycle in question.

The stabilization of agriculture may, on the basis of what has been presented above, accordingly have two different aims : either the damping of the general cycles in the whole domain of agriculture or that of the specific cycles separately in each branch of agricultural production. Though it is generally not mentioned,

---

1 *Cf.* Paul Anthony Samuelson : Foundations of Economic Analysis, Cambridge, 1948, P. 265.

2 *Cf.* J. Tinbergen : "L'utilisation des équations fonctionelles et des nombres complexes dans les recherches économiques," *Econometrica,* Vol. I, 1933, Pp. 36-51.

Mordecai Ezekiel : The Cobweb Theorem, Readings in Business Cycle, Philadelphia-Toronto, 1944, Pp. 422-442.

Henri Guitton : "Les fluctuations économiques," Paris, 1951, Pp. 406-407.

by stabilization is meant in the first place the damping of the specific cycles of agriculture. Thus the elasticity ratio presented above (2) is of great significance when the stabilization problem of agriculture is considered. It may therefore be appropriate to give a little closer examination to it.

The elasticity of demand in the denominator of the elasticity ratio is, as known, a function of the prevailing price level of the product in question. When the price rises, the numerical value of the elasticity of demand increases ; when the price declines, the numerical value decreases. Each product has a definite average numerical value of the elasticity of demand which corresponds to the price level corresponding to the Cobweb centre. But also this average value of the elasticity of demand changes gradually as a function of time. At the beginning, when the production of the product in question is new or the production technics undeveloped, the price is high, also in average and the numerical value of the elasticity of demand is consequently also rather big. In the course of time the developing production technics and also the competition have, however, a lowering influence on the price level and, as a consequence, the average numerical value of the elasticity of demand decreases gradually. In other words, *the elasticity ratio contains in its denominator a labile equilibrium factor.*

On the other hand, the nominator of the elasticity ratio has a somewhat similar development as the denominator. At the beginning, when the product in question is still new and its cultivation is at an experimental stage, the elasticity of production is remarkable. Even small adversities lead easily to radical restriction of production, while, on the other hand, success has correspondingly an encouraging effect. Regarding old and stable products the reactions of producers are damped and in this case the nominator of the elasticity ratio has —at least in the long run—the tendency to decline, which again has a stabilizing effect.

While the development of the specific cycles of agriculture is under examination, it is further to be noted that agriculture has—with time and under conditions of exchange economy—a tendency to shift into the circle of market and business economy. This development, during which the farmer becomes gradually a calculating entrepreneur, is apt to strengthen the reactions of producers and has thus a disturbing effect upon the equilibrium of the production. The conception which we have had of the "Cobweb characteristics" of the different agricultural products is hardly in harmony with what is presented above. In Finland it has, *e.g.*, been customary to regard hog and egg production as specially sensitive to cycle fluctuations whereas bread grains are without hesitation classified among stable products. This may partly be due to the fact that the first-mentioned products have been marketed freely, nearly without any restrictions, whereas the trade in bread grains is a state monopoly with fairly fixed prices.

If we, however, combine the results of Bean's investigations of the reactions of production[3] and, on the other hand, the well-known conclusions of Henry Schultz on the elasticity of demand of the different agricultural products, we must, to some extent, alter our conceptions of the specific cycles of bread grains. In Figure 2, we see Bean's curve of winter wheat RR′ and the corresponding linear

3 L. H. Bean : The Farmers Response to Price, *Journal of Farm Economics*, Vol. XI., 1921, Pp. 368-385.

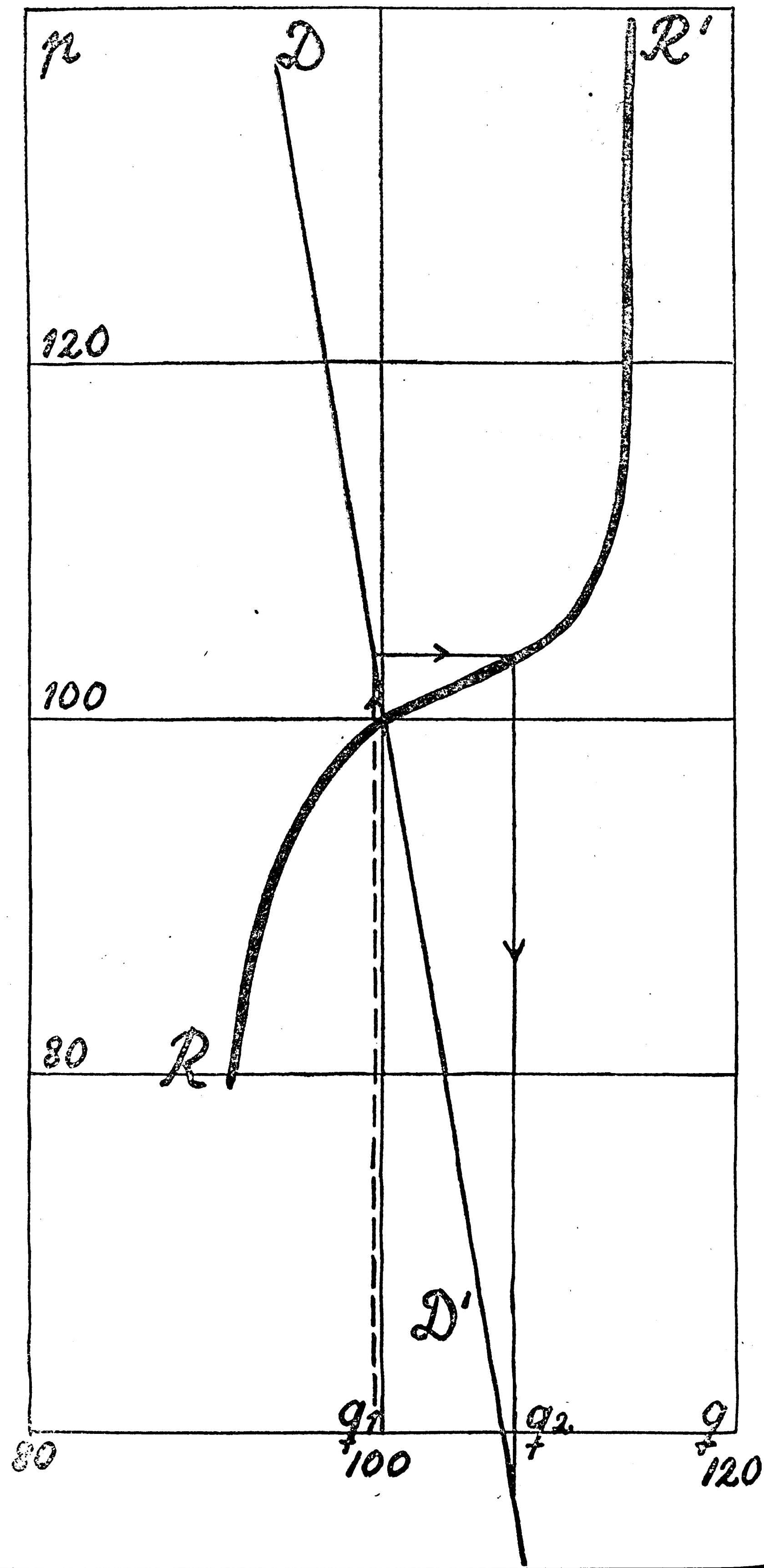
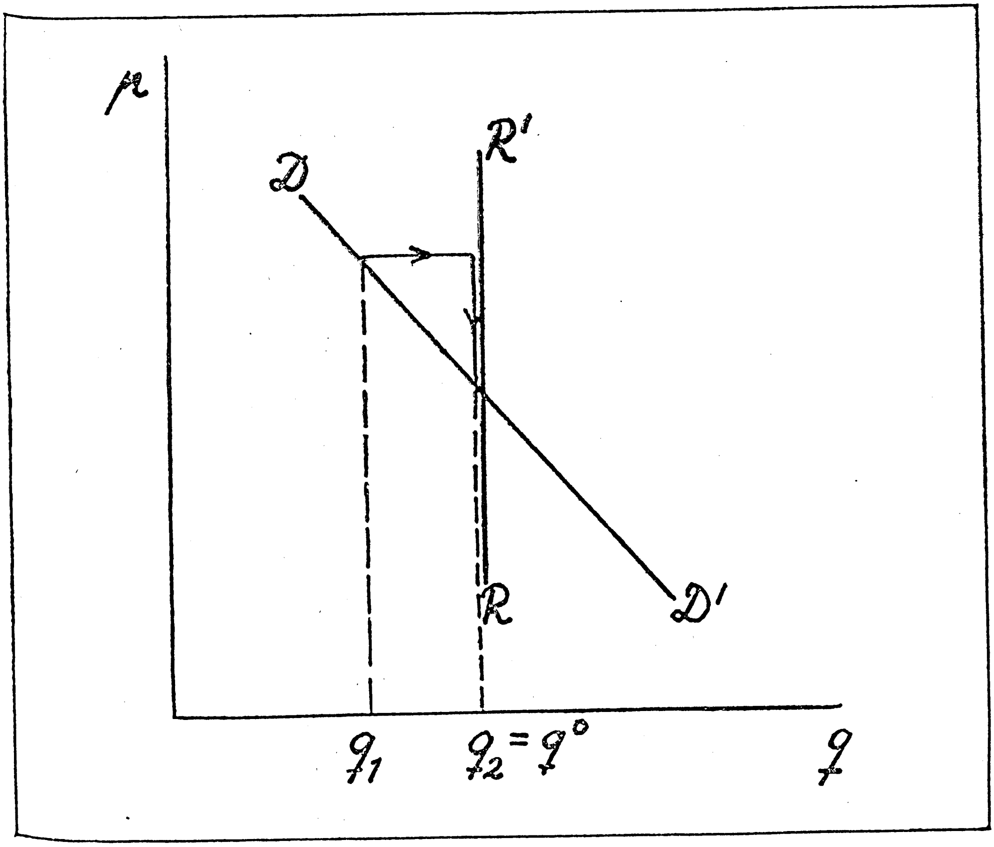


Figure 2—The nonlinearized Cobweb of winter wheat when the producers' reaction curve RR′ is Bean's curve and the elasticity of demand DD′ in the Cobweb centre is, according to the investigations of Henry Schultz, —0.15.

Figure 3—The reaction of wise producers is exactly opposite to the general reaction, whereby the Cobweb becomes correspondingly "immediately dying".



demand function DD', the elasticity of demand in the Cobweb centre corresponding to the result of Schultz, —0.15.

As we see from the numerical values of the elasticities presented in the Figure, the Cobweb of winter wheat is surprisingly explosive. Our elasticity ratio receives according to *graphic* estimation the unexpectedly high value of 10.0. The nonlinearism of the reaction curve of production limits, however, the area of explosion.

The value of the elasticity ratio of hog, worked out by means of similar method by the present Author, is about 1.15. According to this, the specific cycle of hog would be very near to the limit which decides the nature of the wave movement. (See (2)). According to the Author's own investigations the elasticity ratio of hog is, under the conditions prevailing in Finland after World War II, about 0.8 and nature of the specific cycle of hog is thus dying.

The stabilization of the Cobweb wave is a very difficult task. An impressive representation of the problems connected herewith is found in a paper by Goodwin.[4] But already Goodwin spoke of so called wise producers who operate in a way opposite to the vast group of producers. Beside that these wise producers earn well themselves, they have a strong stabilizing influence on the specific cycles of the product in question. As a kind of limit case we may here present a situation where the integrated reaction of wise producers is exactly opposite to the others' reaction. In Figure 3, which represents this situation, q_2 already equals q^o so that a stable equilibrium of production is reached immediately.

In the case where the specific cycle of an agricultural product happens to be a limit case between the explosive and dying state, or near to it, *i.e.*, $\left|\frac{R^o_p}{D^o_p}\right| \approx 1$, the effect of wise producers becomes decisive. Even the least movement in the reaction of producers to the side of wise reaction has an essential effect upon the development of the wave movement. Particularly in Finland, where the co-operative dairies owned by agricultural producers produce as by-product about 15 per cent of all marketed hog, the possibilities of dairy pigsties to influence stabilizingly on hog production are evident. If these dairy pigsties could, in one way or another, be persuaded to submit under "one hand leadership", the development of hog production could be essentially influenced by means of changing their reaction. If we suppose that the dairy pigsties would unnoticeably change from common producers to wise producers, *i.e.*, they would change the direction of their reaction, the above mentioned value of the elasticity ratio would decrease from 0.8 to 0.56. It is, however, evident that even this measure would not preserve its effectivity a long time in the searchlights of publicity and performed under trumpet signals. A condition of success is an unnoticed, silent operation and an *incessant* observation of the market. Figure 4 gives a theoretic illustration of the dying of a price disturbance of the magnitude of 10 units in both cases mentioned above, *i.e.*, when the elasticity ratio has the values of 0.8 and 0.56.

The dying of a disturbance of equilibrium of 10 units ; p_1—without stabilization effect of the dairy pigsties, p_2—when the dairy pigsties become so called wise producers.

The theory of wise producers makes it possible to improve the Cobweb model. The practical experiences seem namely to indicate that the relative number of wise producers as compared with the total number of producers is varying. If we suppose that this variation is in direct ratio to the magnitude of disappointment, *i.e.*, of the magnitude of $\left|\frac{p_{t-1} - p_{t-2}}{p_{t-2}}\right|$, we get a model of the following basic type :

(a) $p_t = \alpha d_t + \alpha_o$ (where p is now measured from its natural O-point)

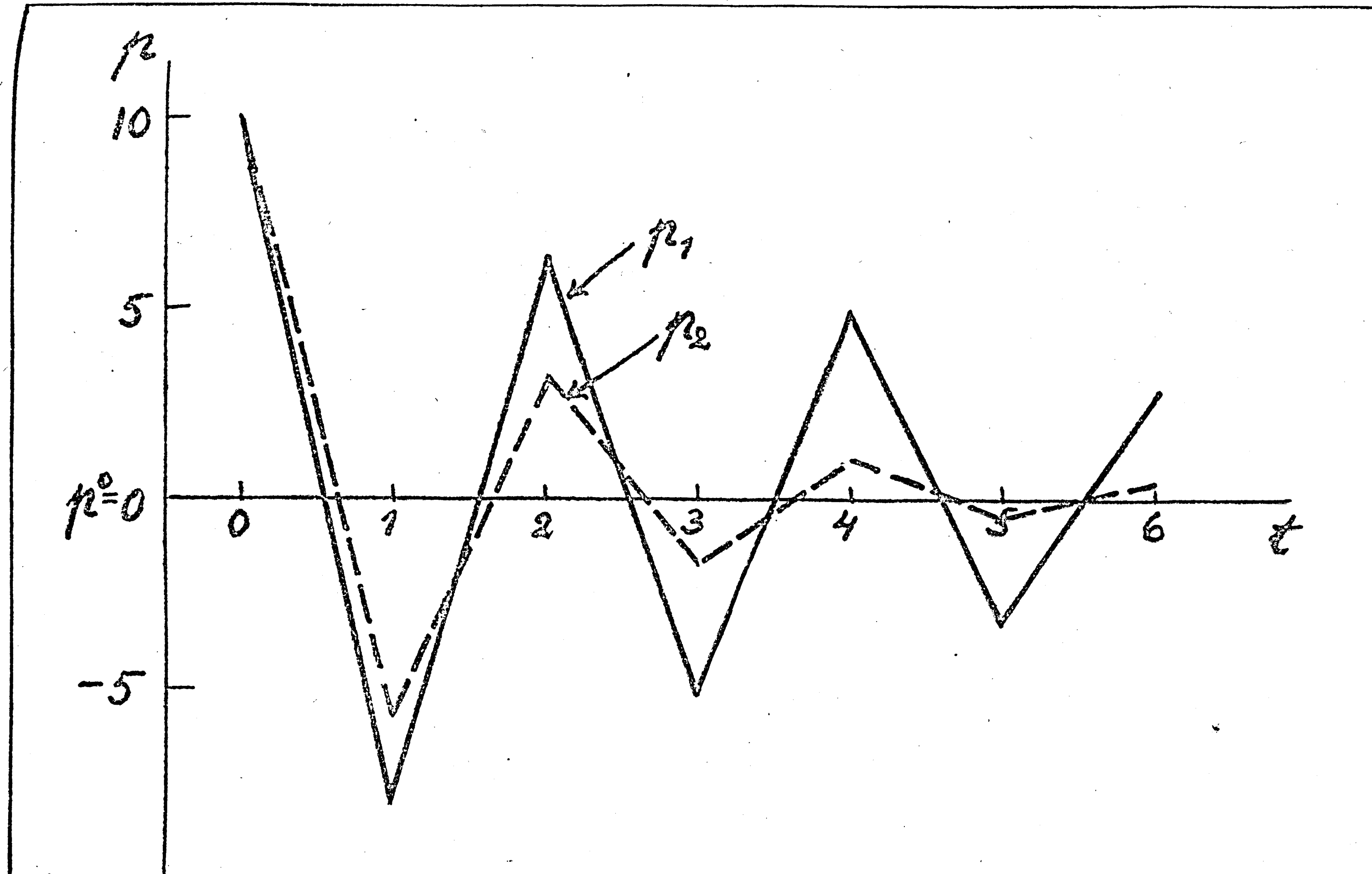
(3) (b) $r_t = \beta_1 p_{t-1} + \beta_2 \left|\frac{p_{t-1} - p_{t-2}}{p_{t-2}}\right| p_{t-1} + \beta_3 \left|\frac{p_{t-1} - p_{t-2}}{p_{t-2}}\right| + \beta_o$

(c) $d_t = r_t$

4 Richard M. Goodwin : "Dynamical Coupling with especial reference to Markets having Production Lags," *Econometrica*, Vol. 15, 1947, Pp. 181-204.

Figure 4—The theoretically calculated stabilization possibility of the dairy pigsties in hog production in Finland.

Figure 4—The theoretically calculated stabilization possibility of the dairy pigsties in hog production in Finland.



The present Author has not, however, succeeded in finding an essentially better explanation for hog production under the conditions prevailing in Finland on the basis of model (3) than using the original Cobweb model (1). The scantity of observations under similar institutional conditions, the inexactness of statistics and the degrees of freedom vanishing with the new parameters are, perhaps, the factors which render the improvement suggested by Model (3) questionable.

Conclusions

The present Author desires to emphasize that the Cobweb model can, either in its original form or somewhat improved, for instance, by means of nonlinearism, additional variables or other factors, be successfully used as an explanation of the specific cycles of agriculture.

The nature of the specific cycle of old, already stable agricultural products may, in spite of old rules, be explosive.

The effect of so called wise producers may be of great significance for the stabilization of the specific cycles of agriculture, particularly when the specific cycle in question is near to the limit of the explosive and the dying state.