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AN ECONOMETRIC MODEL FOR THE FINNISH EGG INDUSTRY

Selostus: Suomen kananmunasektoria kuvaava ekonometrinen malli

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TO BE PRESENTED, WITH THE PERMISSION OF THE FACULTY OF AGRICULTURE AND FORESTRY OF THE UNIVERSITY OF HELSINKI, FOR PUBLIC CRITICISM IN AUDITORIUM XII ON FEBRUARY 25, 1977 AT 12 O'CLOCK

SUOMEN MAATALOUSTIETEELLINEN SEURA HELSINKI

Preface

The present study has been conducted mainly at the Agricultural Economics Research Institute. As to be expected, my acknowledgements of indebtness on completing this study are substantial, and I wish to acknowledge my debt of gratitude to all those who have contributed to its completion.

First of all, I wish to express my gratitude to Professor Matias Torvela, Head of the Agricultural Economics Research Institute, for the support and encouragement he has given me firstly in this research project, and secondly in my entire study program during my employment at the Institute. It is also my pleasure to express my sincerest thanks to Professor Lauri Kettunen, Head of the Marketing Research Department of the Institute, for his continual guidance and undivided interest throughout the development of this study, and for the comments he has made on the first drafts of the manuscript.

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As always, my greatest debt is to my children, Samuli and Hannaleena, who in the final phase of the study kept asking me whether I had already finished the manuscript or not. To them I wish to dedicate this study.

Helsinki, October 1976

Markku Nevala

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Abstract. An econometric model for the Finnish egg industry was derived in this study to provide information concerning the impact of alternative price policies on the development of the egg industry for price policy analyses. The basic model specified in this study is an eight-equation model including distributed lag formulations and consisting of three different blocks. The basic assumption behind the model specification is that the price levels of eggs are mainly determined by the target price level (set up by the government) and the domestic market situation. Producers are assumed to respond to changes in the producer price of eggs and in the other factors influencing the profitability of egg production. The basic model was estimated on the basis of semiannual observations from period 1956—70. In addition, the stability of the coefficients of production equations in the model over the years was tested by using the stepwise regression method. The structure of the basic model was evaluated by means of deterministic simulations to gain some idea of the model's ability to simulate the actual development of the egg industry. Both historical simulations and ex-post forecast simulations were conducted and the »goodness of fit» was tested by the use of Theil's inequality coefficients and graphical examinations.

The basic model was also used for analyzing the price policy pursued by the government in period 1956—70 in order to illustrate the type of analyses that can be conducted by the basic model. An alternative policy mix consisting of the target price system for maintaining the domestic market balance and the direct payment scheme for attaining the income target of producers was defined. Given the assumptions made in this study this policy mix would have been a more effective policy tool from the standpoint of society for attaining the policy goals than the target price system as implemented in that period. Similar conclusions can be also drawn from the results of the ex-post price policy simulations, in which the target price level was assumed to be used for adjusting the domestic egg production gradually to the domestic consumption. Also in this alternative the government was assumed to bear the burden of attaining the income target of producers in the system by the use of direct payments. However, we must point out that results depend on the assumptions necessary for computations of this type.

1. Introduction

1. 1. Background to the Problem

According to the total accounts of agriculture the value of annual egg production in Finland at the producer price level has somewhat more than quadrupled during the last two decades: from some 70 mil. Fmk in 1956 to 328 mil.

Fmk in 1974.[1] The growth in the total value is due to the fact that both the production volume and producer price of eggs has approximately doubled during this period. This kind of development has also increased the relative importance of eggs within the agricultural production. Eggs accounted for some six percent of the total value of agricultural production in 1974, while the corresponding proportion in 1956 was some four percent.

The average growth rate of egg production during the above mentioned period was 4.2 percent per year computed by using a least squares exponential curve fit.[2] Accordingly, egg production has increased from 35.5 mil. kg to 77 mil. kg (See Appendix 2). The annual growth rate of production has not, however, been stable but varied from year to year (Figure 1.1). Yearly increases in production were relatively high in the late 1960's and in the early 1970's: for example, in the period 1969—1974 the production grew at a yearly rate of 6.7 percent. On the other hand, the domestic consumption of eggs has increased at a slower rate than the egg production. The per capita consumption has during the last two decades risen by some 3 kg. Accordingly, the total consumption increased by some 17 mil. kg within this period: from 33 mil. kg to 50 mil. kg. The average growth rate of egg consumption was 2.5 percent per year computed from the period 1956—74 by using the exponential curve fit.

This kind of development has also led to increases in the egg surpluses on the domestic market. In the early 1950's the domestic egg production and consumption were almost in balance: the level of self-sufficiency for eggs varied in the range of 99 and 106 percent in these years. Since then, the surpluses on the domestic markets have increased at varying annual rates such that in the early 1970's the domestic production exceeded the domestic consumption by some 50—57 percent.[3] As can be seen in Figure 1.1, the egg exports amounted to some 27 mil. kg in the years 1973 and 1974.

There are, of course, many reasons for the growth of the total egg production described above. First of all, it seems reasonable to argue that recent changes in the structure of the egg production sector and price development are the main factors for the continuity of production increases. Especially the structure of egg production has changed drastically during the last two decades. Improvements in production technology have been remarkable and they have contributed to changes in the producing sector towards bigger and more efficient producing units. FLYGARE (1972, p. 252) states that this phenomenon is universal and hardly in any other sector in agriculture has the structural change been as rapid as in the egg industry.

The graphs in Figure 1.2 illustrate the structural change which has taken place in the Finnish egg industry in period 1950—74. According to these estimates, for example, some 55 percent of the total number of laying hens belonged

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[1] These figures are based on the total accounts of agriculture prepared by the Agricultural Economics Research Institute, Finland.

[2] The formula used is: $y = be^{mx}$, where y = yearly production of eggs, x = trend (1, 2, 3, . . .), b and m are the coefficients to be estimated.

[3] In this context it is also worth mentioning that in the 1920's and 1930's the level of self-sufficiency for eggs was, on the average, even higher than in the recent years. In some years of the 1930's over half of the total egg production was exported.

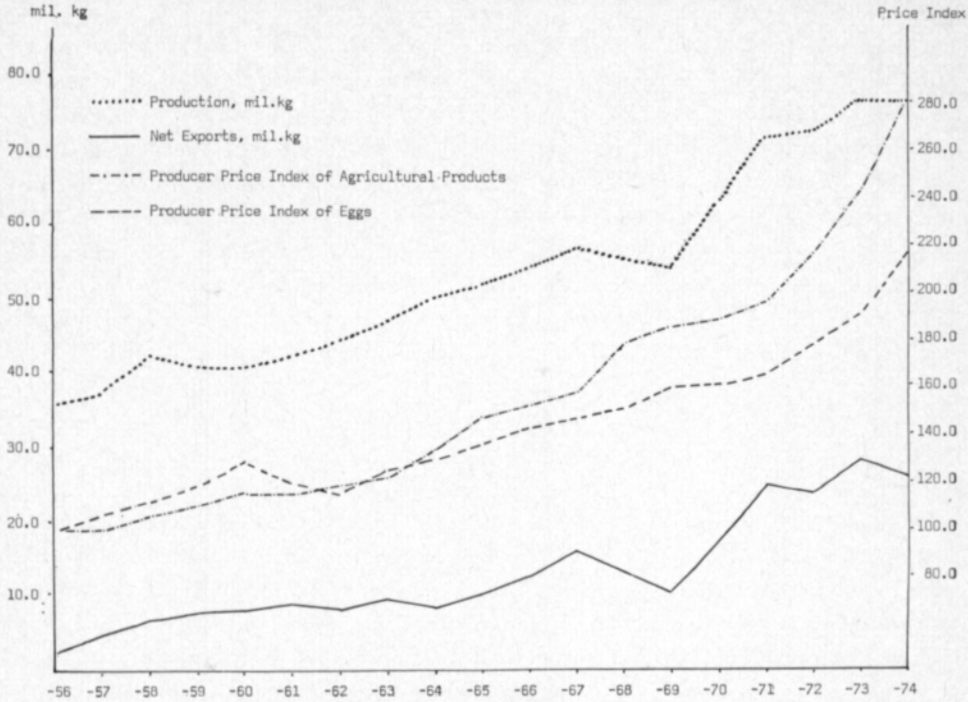

Figure 1.1. Production, Net Exports and Producer Price Index of Eggs as Well as the Producer Price Index of Agricultural Products (1956/57 = 100) in 1956–74.

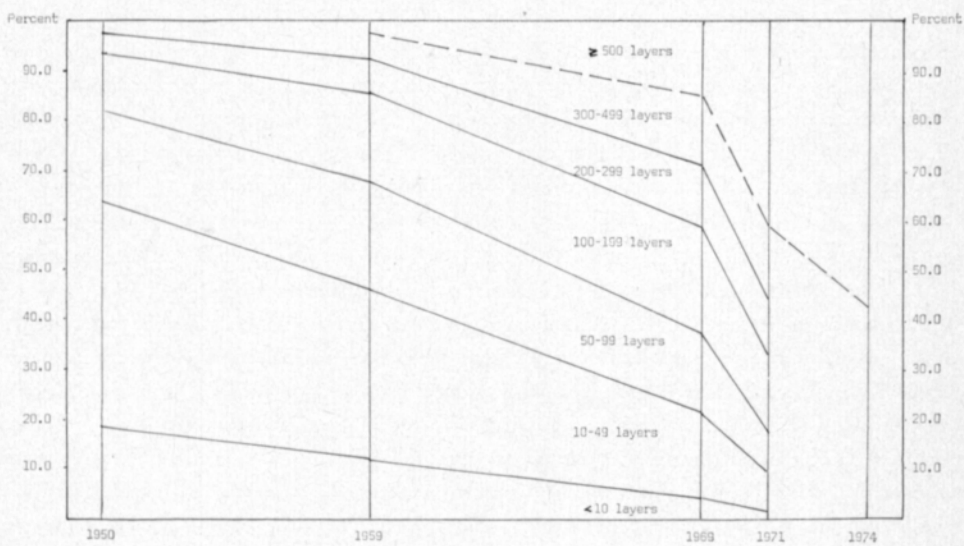

Figure 1.2. The Distribution of Laying Hens Between Different Size Gategories of Producing Units. Estimates are Based on the Censuses of Agriculture. Sources: The Official Statistics of Finland III: 45, 53, 66 and Unpublished Data Prepared by the Board of Agriculture.

to producing units larger than 500 hens in the year 1974, while the corresponding percentage in the year 1959 was some 2–3 percent. Thus, egg production on a small scale on family farms has decreased significantly: while about 82 percent of the layers in the year 1950 belonged to producing units smaller than a hundred laying hens, in the year 1971 the share of this size gategory accounted only for some 18 percent of the total number of laying hens. These graphs also clearly indicate that the structural change has been especially rapid in the late 1960's and early 1970's. The recent concentration of egg production can also be illustrated by the fact that 23 percent of laying hens in the year 1971 belonged to some 600 producing units, which accounted only for some 1.2 percent of the total number of the producing units in the country.

As to the development of egg prices, the recent trend has been based mainly on the government's intervention in the egg market in order to regulate the price level. To attain its agricultural policy goals the Finnish government adopted the so-called target price system for the main agricultural products in the 1950's. Since crop year 1956/57 this program has been implemented under several Agricultural Price Acts. The contents of the Price Acts have been changed to some extent in the course of time.[1] However, the main policy tool — the target price system — has remained the same as have also the two main objectives of the price policy (given explicitly or implicitly in the Acts): 1) to promote development of incomes for agricultural producers to a level comparable with the other sectors of the economy, and 2) to stabilize prices in order to maintain a level of self-sufficiency for the products which can be produced within the country at reasonable costs.

In this system the target prices for the main agricultural products are set annually such that the income objective can be attained. However, the general principle — common to all the past Acts — is the fact that only the average income level of producers is, in one way or other, tied to the development of the incomes of other population groups. Accordingly, the policy makers are relatively free to change the target prices for individual products: they can be raised proportionately or disproportionately to the change in the average target price level required. This kind of flexibility is mainly due to the government's desire to guide the allocation of resources in agriculture according to market considerations. On the other hand, this freedom enables policy makers to take into account the possible differences in the development of the production costs of different products when fixing target price levels for a given period. Within this framework, the government has achieved and maintained the target price levels by paying export subsidies to exporters so as to enable them to dispose of surpluses on world markets if production exceeds the domestic needs of the target price, and allowing imports if the producer price is over the target price level. Every Price Act has included specific provisions on the conditions which must be met before the government intervenes in the market. For most products (for example, eggs) the producer prices have been allowed to fluctuate within ± 5 percent range around the target price level without state intervention. In this system domestic production is protected against relatively low world market prices for agricultural products by means of variable import levies.

[1] Good descriptions of the contents of different Price Acts are given by Sauli (1971, p. 48—71), Kettunen (1972, p. 135—150) and Ihamuotila (1972 c, p. 10—11).

There is no question about the basic applicability of this program in supporting agricultural prices in Finland. Under certain conditions the system can serve as a very effective policy measure (See GULBRANDSEN and LINDBECK 1973, p. 245). However, measuring the necessary changes in the target prices of different products such that the basic policy goals could be attained, seems to have been difficult in the past for many different reasons. For some products, setting the target price levels has been successful in this respect, while for other products it has been difficult to find proper target price levels.

Eggs have, without doubt, been one of the products for which measuring the necessary changes in the target price level has been problematic as long as the target price system in its current form has been implemented under the Agricultural Price Acts. Adopting that policy program has certainly stabilized the fluctuations of egg prices which were typical and frequent before the intervention of the government in the egg market (See KAARLEHTO 1964, p. 382—390). Because of the lack of appropriate data, it is impossible to explore how the incomes of the egg producers have developed under this price policy.[1] However, increases in the total egg production imply that production of eggs at least in certain producing units must have been profitable relative to the other production branches of agriculture. Similarly, some book-keeping results from the year 1974 indicate that the profitability of the poultry farms was better than the average profitability in this farm group (See ANON. 1974, p. 32).

As to the efforts to maintain a reasonable balance between domestic production and consumption, the past price policy seems — as we shall argue — to have been rather unsuccessful in this respect. The domestic production of eggs has, as stated, increased under the price policy pursued in 1956—74 at varying yearly rates as shown in Figure 1.1. This has happened in spite of the fact that yearly increases in egg prices have, on the average, been smaller than increases in the average price level of agricultural produce (Figure 1.1). It seems obvious that one of the most difficult problems in fixing target price levels for eggs has been assessing the impact of the remarkable structural change of egg production on a necessary increase in the target price level of eggs in a given period. Increases in productivity have resulted in improvements in the competitive position of egg production in spite of smaller increases in the target price of eggs than on the average in other agricultural product prices. Due to relatively free entry into the industry, big firms — using the best technology available — have been set up; thereby, increasing the production potential (Figure 1.2). On the other hand, egg production on a small scale on family farms has not decreased sufficiently to outweigh this kind of growth in production potential. That is why, an increasing proportion of the total egg production has been exported annually at relatively low world market prices.

Since egg prices on the world market have remained at a relatively low level during the last two decades (See Appendix 2), the growth in export volume of eggs has led to increases in government expenditure on export subsidies (See

[1] In this connection we have to point out that there are studies on the profitability of egg production in the last two decades conducted by WESTERMARCK. However, these results may not be generalized since they are not based on a random sample of the Finnish egg industry (See WESTERMARCK 1975 and TORVELA 1959).

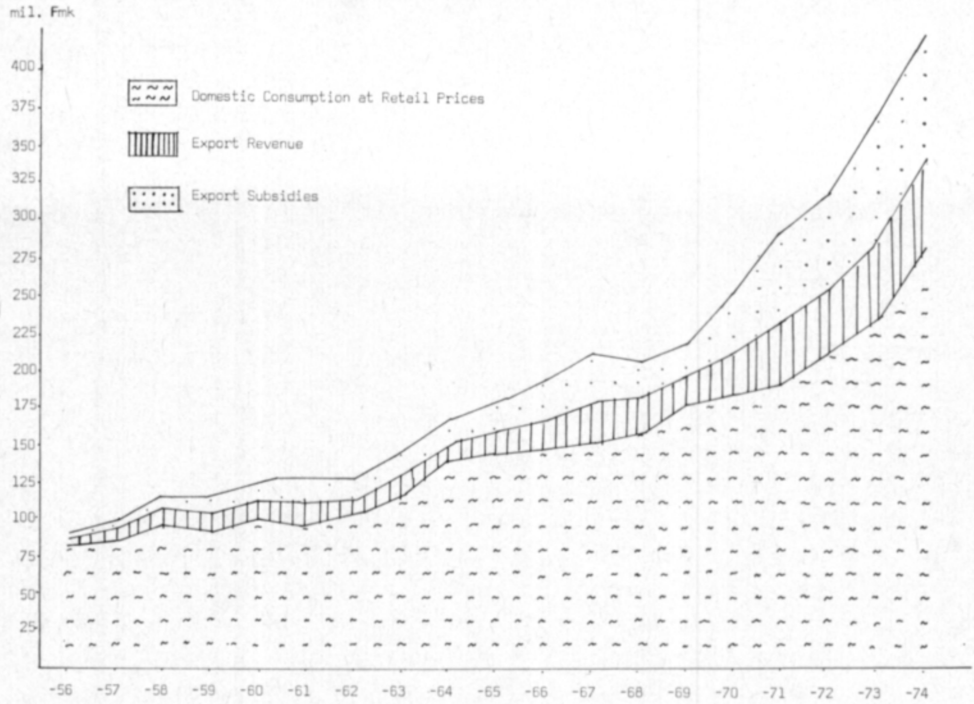

Figure 1.3. The Estimated Total Value of Egg Production at the Retail Price Level and the Components of the Total Value in 1956—74, mil. Fmk.

Appendix 2). The problem can be illustrated by the graphs in Figure 1.3, which indicate the value of the total egg production at the retail price level and how it is composed of different items in period 1956—74.[1] As can be seen from the figure, the domestic consumption accounted for some 95 percent of the total value of egg sales in 1956, whereas in 1973—74 the same proportion was only some 63—65 percent. Egg exports in the early 1970's amounted to some 34—36 percent of the total production volume. However, in the same time period total export revenues from eggs accounted only for some 14 percent of the total sales of eggs. Accordingly, export subsidies by the government have increased substantially: in the years 1973 and 1974 they amounted to 21—23 percent of the total value of egg production.

Because of failure in maintaining a reasonable balance between production and consumption by the use of the target price system, some additional measures have been adopted recently to curb the growth of egg production (Anon. 1971 b, 1975, 1976). Since they are assumed to have exerted only a minor influence on the egg industry during the period this study covers we will not discuss them in more detail here. It may, however, be mentioned that the purpose of these measures is to protect the continuity of egg production on family farms by restricting the freedom to set up new large producing units. Also a

[1] The total value of egg production has been computed by adding the export subsidies paid by the government and export revenues to the value of domestic consumption (including the home consumption on farms) at the retail price level.

progressive marketing fee is levied on the production of large producing units (over 5 000 laying hens) to curb the egg production of these firms. As a temporary measure for reducing the egg production the government adopted a slaughter levy scheme. On the other hand, the government has also supported the advertisement campaigns for eggs to increase their consumption.

1. 2. Objectives of the Study

The primary objective of this study is to explore the possibilities of generating information by means of an econometric model to help the policy makers in adopting price policy directions for eggs which would be consistent with our major policy goals. If we regard attaining the producers' income target and the reasonable level of self-sufficiency in eggs (Section 1.1) as our main policy goals, we find that past experiences indicate that it has been extremely difficult to reach both of these goals simultaneously by employing only with the target price system. Mainly due to the low mobility of agricultural resources, the policy makers have been most commonly faced by conflicting decision alternatives concerning the future target price levels: the necessary change for attaining a better balance between domestic production and consumption (or maintaining domestic market equilibrium) conflicts — at least in the short run — with the change required for achieving the income objective of egg producers. Since the income objective — established by law — has been the most important, the target price levels have been fixed mainly according to this kind of consideration in the past; thereby, leading to serious surplus problems as stated previously.

At the same time the role of the target price system in the case of eggs — as we shall argue — has changed: it no longer serves as a mere stabilization vehicle by which the government eliminates temporary downward and upward fluctuations of egg prices to stabilize the domestic egg market as orginally implicitly planned when the system was introduced for supporting egg producers. Nowadays it can rather be regarded as an income support program the government applies to the egg industry.[1] However, it is not without question clear that this kind of program is the most effective and best policy instrument available for supporting incomes of producers from the standpoint of the whole of society in the case of the egg industry. There are many other policy tools, which are, in theory, available to the government and which may be more effective in attaining our major policy goals than the target price system as implemented for the egg industry during the last two decades.

Selecting an optimal policy mix for a certain agricultural product is a comprehensive and complex issue influenced by many factors and considerations,

[1] We know that this kind of classification of policy programs is a simplified view of reality, because the prices and producers' incomes are positively related to each other. However, by making this distinction we want to emphasize the fact that — given a certain flexibility — the target prices could, at least in theory, have been fixed at such a level that the target price system would have functioned as a mere price stabilization vehicle associated only with minor exports and imports of eggs.

which are not discussed in more detail in this context.[1] In this study we concentrate on only a few concrete policy alternatives which — we believe — can be considered as alternatives to the actual price policy of eggs which have been pursued by the government. We recognize that the policy makers certainly need more information on the probable outcomes and consequences of a certain policy action in order to implement effectively the alternative policies than they necessarily need to employ with the target price system in its current form. It is one of the main purposes of this study to provide the policy makers with an aid to generate this kind of information for the basis of their policy decisions in order that they may avoid major errors in target price fixing, which may in the long run lead to structural bias in the producing sector: an econometric model based on the data currently available and including the necessary policy instruments as its variables.

To specify our policy alternatives we assume that there are two major policy goals, which have to be attained under alternative price policies: 1) the income objective as defined in the previous chapter and 2) maintaining a reasonable balance between the domestic egg production and consumption. We assume that the target price system should be used only as a stabilization tool; i.e. for maintaining (and attaining) the balance between domestic production and consumption so that the target price of eggs is always attempted to set at a level which would lead to a reasonable market equilibrium in future periods. If the income target of egg producers is not reached at this price level, we assume that the government makes up the difference between the actual and target income levels in the form of direct cash payments to the producers employed in the egg industry. In order that this scheme be effective, payments to individual producers must not be related to the production volumes of their firms or there must be a certain upper limit in the payment to an individual producer.

This kind of policy mix can be considered as a plausible policy alternative especially in the case of the egg industry due to the current development of the structure of the egg industry. On one hand, the number of big »industrialized» producing units, where production costs are obviously relatively low compared with the average level in the sector as a whole (and also with the level of the target price), have been increasing during the last few years. On the other hand, however, a great proportion of the total egg production is still produced on small family farms. It seems reasonable to argue that, because of the relatively few big firms, the target price system in its current form is no more a plausible and fair vehicle for supporting the incomes of egg producers, because a great deal of the support actually goes to these big firms which may not need that much support.

In this study we will evaluate empirically the comparative effectiveness of the policy mix mentioned above and the actual price policy implemented by the government through the target price system in attaining the two policy goals specified above. The main question in the following analyses is whether

[1] We only suggest consulting the studies of NERLOVE (1958, p. 222—225), JOSLING (1969, p. 175—191) or GULBRANDSEN and LINDBECK (1973, p. 243—247).

adopting this policy mix instead of the actual price policy would have resulted in any net savings to society as a whole proceeding from different situations in the egg industry in the past.

Accordingly, to complete these research objectives our intentions in this study are to:

1) construct econometric models which can be used for analyzing and forecasting the impact of changes in the values of the policy instruments of the government (the target price) and other socio-economic forces faced by the egg producers in a given period. Due to its crucial importance in the following price policy analyses, relatively much attention is paid to the specification and estimation of the model in this study. For the same reason, our intention is also to evaluate the model's validity by the use of different tests in order to get some ideas about the model's ability to simulate the behavior of the real system (Sections 2—5).
2) conduct historical price policy simulations with this model for analyzing the effectiveness of the policy mix defined above compared with the actual price policy in period 1956—1970. In this attempt, we will use the model to find the target price path which would have kept the domestic production and consumption of eggs in reasonable balance during that period. The evaluation of these policy alternatives from the standpoint of society is then based on the values generated by the model (Section 6).
3) perform ex-post price policy simulation with the model in order to show the nature of the policy analyses that can be made by means of this model in a »real» decision situation and, also, to evaluate the effectiveness of different policy alternatives in period 1971—74 compared with the actual price policy (Section 7).

There are some earlier econometric studies on the Finnish egg industry. The main attention in most studies has been focused on estimating the production response of eggs or the price and income elasticities of demand for eggs only (Pihkala 1941, Kaarlehto 1958 and 1961) or on explaining variations in the marketing margins of eggs (Waananen and Kaarlehto 1965). The only multi-equation model for the egg industry in Finland taking into account the most important phenomena of the sector has been developed by Koponen (1964). However, since these studies are based on relatively remote time periods, their results cannot directly be used for the purposes of this study. Nevertheless, these studies provided valuable *a priori* information on the relationships between variables in the system for building models in this study.

As for the problem formulation and methodology used, this study has some similarities with those made by Agarvala and Ball (1970) and Chayat et. al. (1974). The former study deals with econometric model building for the egg market in the U.K. and with policy analyses using this model (the policy instrument of the Egg Marketing Board is the proportion of the total supply that is sold on the shell market). The latter study is an interesting econometric determination of the welfare impact of giving bargaining power to egg producers (so that they could stabilize the market prices).

In addition, many other interesting ideas and procedures in the art of model building for the egg market can be found in the recent literature. It may not be necessary to describe these models in more detail here. Building an econometric model for whatever purpose is usually a form of tailoring: the individual solutions usually depend on the use of the model (See NIITAMO and SOIVIO 1964, p. 137), institutional circumstances in the country, data availabilities, etc. However, in this context it is worth mentioning GERRA's (1959 a and 1959 b) and FISHER's (1958) works, which are among the earliest efforts to quantify the reactions of egg producers and consumers by means of multi-equation models. More recently, HARTMAN (1974) identified an egg cycle in the U.S. by use of spectral analysis and built different kinds of recursive models for explaining this cycle. The study by BANGE and BENDER (1969) can be mentioned among the recent demand analyses for eggs. Interesting applications of econometric models and other methods for forecasting egg production, consumption and prices can also be found in the studies of ROY and JOHNSON (1973), MILLER and MASTERS (1973), STOJKOVIC (1971), WINFRIDSON (1974)[1], BRÖCKER (1973) and KERSTEN (1973).

2. Econometric Model Building

2.1. On the Methods for Assessing the Impact of Alternative Policies on Agricultural Production

One of the primary objectives of this study is to build models for simulating and forecasting the reactions of egg producers and consumers to changes in various economic forces, among which the price level of eggs — as a policy instrument of the government — is the most important. For predicting and simulating agricultural production responses, several kinds of techniques have been developed and tested in empirical analyses in the past. In this study, an econometric model approach was chosen for assessing impact of alternative policy directions on the egg industry. The alternative methods fcr simulating the reactions of egg producers are different kinds of programming models, such as representative farm programming and recursive programming.

Much attention was paid to representative farm programming[2] (i.e. deriving aggregate supply response from the supply functions of the representative farms) in the estimation of aggregate supply response in the 1960's. In spite of an appealing idea — to predict aggregate response via the micro route — the empirical applications of this method were not very successful (See SHARPLES

[1] This is a good example from among the econometric models built for short-term forecasting of egg production.

[2] Applications of this method and discussion about its applicability can be found for example in the articles by SHARPLES (1969, p. 353—361), SHEEHY and MCALEXANDER (1965, p. 681—695), FRICK and ANDREWS (1965, p. 696—700). The study of WIPF and BAWDEN (1969, p. 170—178), in which the aggregate supply curve is derived from the production functions of single firms, also, belongs to this type of approach to aggregate supply analyses.

1969, p. 360). According to BARKER and STANTON (1965, p. 711) and SHARPLES (1969, p. 355), the main difficulties of this approach can be classified as follows: 1) interdependence or externalities, 2) changes in farm size, 3) unrealistic firm-level assumptions, 4) the selection of representative farms, and 5) mechanical problems. They considered many of these problems very difficult ones to solve and, accordingly, SHARPLES (1969, p. 360) was pessimistic with respect to the applicability of this method stating that »what we do need (instead of this approach) is to further explore less cumbersome models that identify and better utilize stable aggregate relationships».

Recursive programming (the introduction of flexibility constraints into regular programming models) was initially used as an alternative when efforts to build all the behavioral constraints explicitly into the model led to unsatisfactory results.[1] This technique has, as stated by many economists,[2] certain advantages over econometric models: 1) it is more effective in dealing with dramatic changes in production technology or in agricultural policies, 2) data problems — at least in regional supply analyses — are easier to solve when using programming models,[3] 3) econometric analysis may lead to forecasts that are inconsistent with resource availabilities, while a constrained optimization framework such as resursive programming might solve this dilemma, 4) the use of recursive programming gives the analyst a better understanding of the reasons for changes in production than econometric analysis, etc. However, building plausible flexibility constraints into the model has proved to be difficult. This dilemma has led to more complex methods (such as that of SAHI and GRADDOCK 1974) in estimating these coefficients, thereby, making the use of the model more difficult.

In the past studies, econometric production response models have performed somewhat better than recursive programming models (See, for example, SCHALLER and DEAN 1965, p. viii) and, that is why, the econometric model approach was chosen in this study. However, as some economists have pointed out, neither method has provided completely satisfactory results. The most difficult problems in production response analysis via econometric models are according to NERLOVE (1961, p. 31): 1) the complex structure of production, 2) technological change, 3) aggregation, 4) investment in fixed and quasifixed factors and 5) uncertainty and expectations. No general solutions to these problems have been found thus far and, therefore, this study also involves these shortcomings. Individual solutions to these problems made in this study are discussed in the following sections.

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[1] The pioneering work was made by DAY (1961 and 1962) in the field of recursive programming. Among the most interesting applications of this method is that of SCHALLER and DEAN (1965) for prediction of regional crop production. More recently, SAHI and GRADDOCK (1974, p. 344—350) have made their contribution in developing recursive programming by introducing new techniques of estimating flexibility coefficients.

[2] For example, HEADY (1961, p. 16—19), DAY (1962, p. 139—148), SCHALLER and DEAN (1965).

[3] However, recent applications (for example, that by SAHI and GRADDOCK) use time series data for estimating the flexibility coefficients of the recursive programming model.Thus, this advantage becomes less important when discussing more complex recursive programming models.

2.2. General Framework for Econometric Model Building

Before we start building an econometric model for evaluating the effects of alternative price policies on the behavior of the egg industry, one of the most important questions to be solved from the methodological standpoint is the definition of our policy problem. This relates closely to the question of the kind of information we are able to generate for the policy maker by means of an econometric model, and how reliable and useful this kind of information is.

As stated by NAYLOR (1970, p. 263—265), three alternative approaches have been suggested by economists for using macro-econometric models for policy analyses; each producing different kinds of information for policy decisions: 1) the Theil approach, 2) the Tinbergen approach, and 3) the policy simulation approach. Each of these approaches assumes that we start with a given econometric model. In the Theil approach the policy problem is defined as one of maximizing a welfare function which contains a set of policy goals ranked by the decision maker and which is subject to the constraints imposed by the model. The Tinbergen approach assumes that the policy maker has specified a fixed target value for each of the endogenous variables and, then, for given values of exogenous and lagged endogenous variables, the equations of the model are solved for the set of values of the policy variables that are consistent with the targets (the policy instruments are endogenous variables in the model). On the other hand, the policy simulation method determines values for the endogenous variables from the reduced form or structural form of the model based on the given values of the policy instruments and other predetermined variables (thus, the policy instruments are exogenous variables in this approach).

Theoretically, all of these approaches are also applicable in evaluating the impact of policy alternatives on a commodity economy (See LABYS 1973, p. 113) like the Finnish egg industry. As to their usefulness for real world policy analyses, empirical evidence, however, suggests that the policy simulation approach may represent the only methodology currently available for policy analyses (NAYLOR 1970, p. 265). Although Theil-Tinbergen approaches may be appealing to economists from a purely theoretical standpoint, they have not, in general, provided any operational solutions to the policy problems because of many difficulties in applying these methods.[1]

Accordingly, the policy simulation method was chosen in this study for the reasons mentioned above. Policy instruments — the target price of eggs in this study — are exogenous variables in the model, and we can generate the time paths of the endogenous variables (those variables that the policy maker is assumed to be interested in) for any given values of these policy instruments proposed by the policy maker. On the other hand, we may ourselves analyze some policy alternatives, and based on these analyses we may propose a few

[1] The Theil approach suffers from one major shortcoming: in the real world we do not know the functional form and parameters of the social welfare function of the policy maker. The main problem in applying the Tinbergen approach is that we have to specify the targets of the policy maker explicitly in the model and, thus, before we can start model building we have to try to find out what the goals of the policy maker are. In general, this task has proved to be difficult.

policy directions of our own — which to our mind seem to be appropriate — for consideration by the policy maker. Thus, since we can with simulation show the consequences of different policy directions, we can help the policy maker to select the policy that is most compatible with his preferences, minimize conflicts, etc.

Econometric model building for the production response of eggs is based on the assumption that producers react to changes in the profitability of production when planning the output volumes of their firms at different points in time. One of the main determinants of the profitability of egg production is the producer price level of eggs, which can be controlled by the government through the target price system. In addition, consumers are assumed to react to changes in the retail price of eggs and change the consumption level of eggs according to changes in the price level of eggs and other socio-economic forces. This is the general framework for building an econometric model for policy analyses defined above.

As to the production response of eggs, the total change of egg production in a given period depends on how producers — as a single group — react to changes in the economic circumstances where they operate. On the basis of the biological characteristics of egg production it appears reasonable to argue that there are three major production decisions through which the producers are able to influence the production volumes of their firms. These decisions, which producers make at different stages of the production process, deal with

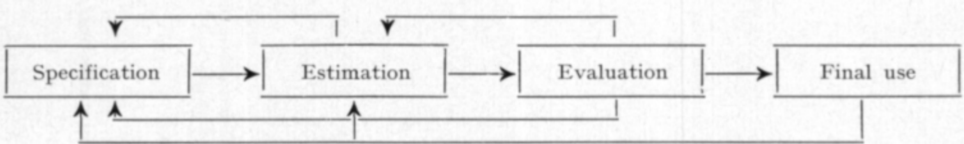
1) purchasing chickens
2) culling layers
3) changing efficiency to influence the output per layer.

It seems reasonable to assume that identifying and assessing producers' reactions in these three decision situations separately will serve as a plausible point of departure for building an econometric model for egg production response. Accordingly, a behavioral equation, describing producers' reactions to changes in the values of the likely decision variables, will be specified for each decision situation in this study. The total response of egg production is then derived from these equations through an identity. For these reasons, the single equation approach (such as that of CHAYAT et. al. 1974, p. 5—6) for describing production response of eggs is not applicable in this study. We believe that this approach has some advantages over the typical single-equation production response model. First of all, it may give us a better understanding of the reasons for changes in the production levels and, in addition, estimating the production response may be easier in this approach due to greater variations in the values of the above mentioned variables than in the total egg production.

In this context it will be pointed out that the potential chances of egg producers to change the output in these decision situations are not similar due to the differences between economic alternatives faced by the producers in each of these decision situations. It is clear that producers have the greatest chances to adjust production volumes of their firms according to their targets when they plan to purchase baby chicks: new building capacity can be built or — in the opposite case — the existing capacity may be utilized more inefficiently than earlier. On the other hand, this decision is also the most difficult to pro-, ducers. Since raising baby chicks to the laying maturity takes some 5—6 months, in the decision situation producers do not know what the prices of eggs and production inputs will be in the period when these chickens reach the laying stage. That is why, they have to base their decisions on expected profitability.

On the other hand, culling of layers is always directed to the existing laying flock. *A priori*, we can assume that by changing the culling pattern between periods producers can to a certain extent influence the total output of eggs. However, taking into account the economic and biological aspects, we can argue that the potential changes of total egg output through changing culling rates are smaller than those through the decisions dealing with purchasing baby chicks. Similarly, we can *a priori* suppose that the importance of the third type of decision (changing output per layer) in changing the total output of eggs in the short run is, in practice, negligible (See Section 2.3).

Within this framework, a typical iterative procedure of econometric model building for a certain type of policy analyses has been followed in this study. This procedure, which has been described, for example, by NAYLOR (1971, p. 11—36) in an illustrative way, can from the technical point of view be divided into subsequent stages as follows:



Proceeding from the problem formulation and model specification, the model goes through the stages of estimation and evaluation towards the »final» model. Each successive stage provides feedback information to the researcher for improving the decisions made at the previous stages. There is no exact scientific criterion for choosing the best model structure among many alternatives. Therefore, the iterative rounds described above can be thought to continue almost endlessly: new data will be published and, on the other hand, the econometric theory tends to make progress in the course of times. The rule: the best possible explanation or results with the minimum number of explanatory variables — which BOX and JENKINS (1970, p. 17) call the principle of parsimony in model building — may provide some guidance in the different stages of the procedure. On the other hand, the ease of computing and forecasting values of exogenous variables may be another criterion in choosing explanatory variables. This usually leads to the introduction of lagged endogenous variables into the model and recursive ordering of the equations of the model.

To start the procedure described above, the model specifications developed in the present study are introduced in the following section with short comments on each equation. We have to point out that the model — as presented in this chapter — has already undergone several iterative rounds of model building. However, we have to bear in mind when evaluating the model that these models — like econometric models in general — include only the most important variables and relationships of the actual economic system whose behavior it attempts to explain, namely, the Finnish egg industry.

2. 3. Basic Model

The basic model which emerged from this study was developed for semiannual data.[1] The main reason for this was the availability of data: for several key variables in the model the observational values are available only on a semiannual basis. On the other hand, taking into account the characteristics of the egg production process, it seems reasonable to argue that a semiannual model is rather plausible in analyzing producers' responses for policy purposes.

The specification of the model — to be tested in the following stages of estimation and evaluation — can be presented as follows (the sign of each coefficient reflects *a priori* expectations of the logical signs):

Endogenous Variables of the Basic Model

SP_t = Number of chickens at the end of period t.
KK_t = Number of layers culled in period t.
SK_t = Number of layers at the end of period t.
TS_t = Total production of eggs in period t.
PKT_t = Producer price of eggs in period t.
PKV_t = Retail price of eggs in period t.
CO_t = Consumption of eggs per capita in period t.
UK_t = Net exports of eggs in period t.

Exogenous Variables of the Basic Model

PR_t = Price of commercial feed in period t.
RVS_t = Total availability of feedgrain in period t.
TAV_t = Target price of eggs set by the government in period t.
Y_t = Consumers' disposable incomes in period t.
YM_t = Wage index in commerce in period t.
EI_t = Consumer price index in period t.
T = Time trend (1952/I = 9 . . . 1974/I = 54).
H_t = Total population in period t.
D_2 = Seasonal dummy. $D_2 = 1$ in the second half of the year, otherwise, $D_2 = 0$.
D_2T = Product of variables D_2 and T
a and b = Coefficients to be estimated.
u_i = Random variable.

Equations of the Basic Model

Number of chickens at the end of period t:

$$(2.1) \quad SP_t = a_1 + \sum_{i=0}^{n-1} b_{11i}\, PKT_{t-i} - \sum_{i=0}^{n-1} b_{12i}\, PR_{t-i} + b_{13}T - b_{14}D_2 - b_{15}D_2T + u_1$$

Number of layers culled in period t:

$$(2.2) \quad KK_t = a_2 + \sum_{i=0}^{n-1} b_{21i}\, SP_{t-k-i} - b_{22}PKT_t + b_{23}PR_t - b_{24}RVS_t + b_{25}D_2 + u_2$$

---

[1] Selecting the time unit of observations is a relevant aspect in the process of model building, since the length of observation period usually influences the specification and nature of the model (See THEIL 1971, p. 462).

Number of layers at the end of period t (identity):

(2.3) $SK_t = SK_{t-1} + SP_{t-1} - KK_t$

Egg production in period t:

(2.4) $TS_t = a_4 + b_{41}\ (SK_{t-1} + 0.5SP_{t-1} - 0.5KK_t) + b_{42}T + b_{43}D_2 + u_4$

Producer price of eggs in period t:

(2.5) $PKT_t = a_5 + b_{51}\ TAV - b_{52}\ (UK/H)_t + b_{53}D_2 + u_5$

Retail price of eggs in period t:

(2.6) $PKV_t = a_6 + b_{61}PKT_t + b_{62}YM_t + b_{63}D_2 + u_6$

Consumption of eggs in period t:

(2.7) $CO_t = a_7 - b_{71}\ (PKV/EI)_t + b_{72}\ (Y/EI)_t + b_{73}D_2 + u_7$

Net exports in period t:

(2.8) $UK_t = TS_t - (CO \cdot H)_t$

Number of Chickens at the End of Period t: Equation (2.1) is a behavioral equation including the main factors on which egg producers are assumed to base their decisions when purchasing chickens. The main assumption behind this formulation is that chick placings depend on the profitability of egg production. Accordingly, the number of chickens purchased in a given period is hypothesized as a function of the producer price of eggs, the price of feed and the existing state of production technology.

However, since the decisions of purchasing chickens at a given moment always refer to the future egg production and producers, therefore, have to base their decisions merely on their expectations of the future price development,[1] we assume that there is a lagged response to change in the prices affecting the profitability of production due to this imperfect knowledge. This assumption of a lagged production response can also be justified on the basis of the nature of the production process underlying the decisions. Some adjustments can be made in a short period, while others require considerably more time due to capital restrictions of firms, amount of fixed production resources, etc. (See HEADY and TWEETEN 1964, p. 68—79).

Hence, distributed lag formulations including several lags of both the producer price and feed price are used for describing producers' responses to price changes in purchasing chickens. As equation (2.1) indicates, the length of the lag structure for neither variable has been specified in this stage. Practically, the only way to find the most appropriate length of lags and estimation method for this equation is estimation experiments using different lengths of lags and

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[1] Due to its crucial importance, much attention has been paid to this question in the past supply analyses of agricultural products. Besides the use of typical cobweb models, different kinds of modifications — for example, incorporating equations for producers' price expectations into the model — have been developed. Among them, NERLOVE's partial adjustment model (1958, p. 45—65) and LARSON's harmonic motion model are the most well known (1964, p. 375—386). Because of its special interest with regard to this study, it should also be mentiond the model formulated by MILLER and MASTERS for the price expectation of egg producers: $X^* = B_2 + \alpha\,(X_t - X_{t-1}) + X_{t-1}$, where X_t^* = the expected price of eggs and X_t = the current price in period t respectively and B_2 and α are coefficients to be estimated (1973, p. 485).

estimation methods.[1] On the basis of *a priori* information, however, we expect that the shapes for coefficient vector b_{11i} (coefficients of different lags of the producer price) as shown in Figure 2.1 would be the most probable.

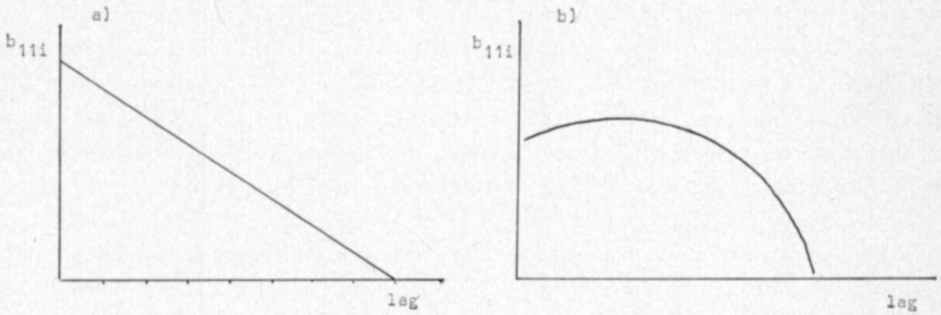

Figure 2.1. Alternative Shapes for Coefficient Vector b_{11i} in Equation (2.1) Reflecting Different Kinds of Lagged Response to Producer Price Change.

The shape of the coefficient vector in Figure 2.1 a indicates that the response to a price change is strongest in the period when the price change occurs decreasing gradually with time. Instead of that, Figure 2.1 b reflects a relatively small response in the first period and, accordingly, the effect of a certain price change is at its highest some periods later. Without empirical testing it is impossible to decide, which kinds of coefficients vectors are the most probable for the producer price of eggs and the feed price in equation (2.1). Therefore, we will explore different kinds of estimation methods and lengths of lags for selecting the »best» alternative. In addition, in this context we will point out that response to rising prices may be different from response to price decreases.[2]

In this formulation prices of production inputs other than feed (such as capital, wages, etc.) are ignored. This is mainly due to 1) their relatively small importance in the total production costs of eggs, and also 2) difficulties in computing operational variables for these cost items. It will be pointed out that feed costs alone account for about two-thirds of the total production costs of eggs[3] and these in relation to egg prices should exert a major influence on chick placings.

Changes in production technology may have had substantial impacts on the profitability of production through the sample period. As stated before, the problem of how to take these changes into account is a difficult problem in the

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[1] See Almon (1965, p. 178—180). He states, for example, that one can start by computing simple correlation coefficients between the dependent variable and different lags of the explanatory variables when seeking the most appropriate length of lags.

[2] This phenomenon, which is called the irreversibility of the supply function (Gerra 1959 a, p. 12—17), has been an interesting problem in supply analyses in the past. This kind of producers' behavior has been verified by some empirical analyses. See, for example, Tweeten and Quance (1969, p. 351—352) and Hartman (1974, p. 259).

[3] See Westermarck (1972, p. 264) and Torvela (1959, p. 42—43).

time series supply analysis and there is no general solution to this problem.[1] In this study, perhaps the most typical method — introducing a time trend variable (T) into the equation as a proxy for technological changes — has been applied. The chick placings have significant seasonal variation and this may have been changing over the years. It is this type of seasonal variation that is taken into account by dummy variables D_2 and D_2T in the basic model.[2]

Number of Culled Layers (Equation 2.2): On the basis of the biological aspects of egg production, we assumed that the potential number of layers to be culled in a certain period is mainly determined by the size of the oldest age groups of the laying flock.[3] Unfortunately, no homogenous data exist on age distribution of laying hens for the entire research period. However, chick placings lagged in an appropriate way may provide good estimates for the sizes of those age groups that are supposed to form the culling potential in a given period. Therefore, variables SP_{t-k-i} $(i = 0 \ldots n - 1)$ have been introduced into the model.

The length of the lag structure (values for k and n) was not yet specified in this stage, but the decision on the length of lags — and also on the estimation method — will be made on the basis of estimation experiments using different lengths of lags and estimation methods for reasons discussed above (See the equation for chick placings). In practice, it seems plausible to assume that, on the aggregate level, the culling operations by producers may be directed to many age groups, because the objectives and production technology — both most probably affecting the pattern of removing layers from production activity — are likely to vary among the firms in the egg industry. Some producers cull layers regularly after one year of laying, while others consider it profitable to keep their layers in production for two or even more years (some producers may also use more flexible rules when deciding culling operations). This kind of consideration suggests relatively long lag structures for variable SP_{t-k-i} in the estimation experiments. Thus, *a priori* information suggests that the relevant shape of coefficient vector of this variable (b_{21i}, $k = 3$, $i = 0 \ldots 3$) would be something like presented in Figure 2.2.

It has been hypothesized, however, that egg producers do not adhere strictly to the age criterion in removing layers from the laying flock, but they tend to change their »normal» pattern of culling layers according to the price situations. If egg prices are low or feed prices high in a certain period, they tend to remove more layers than in periods of favorable prices. Also, available supplies of domestic feed grain may be a determinant in culling layers. That is why, the current producer price (PKT_t) and feed price (PR_t) as well as supp-

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[1] Different kinds of proxy variables such as accumulated investments, variables indicating levels of education, trend variables, etc. has been included to the supply and production functions to solve the problem of technological change in recent time series analyses. As to the application of these methods in production function and supply analyses in Finland, see IHAMUOTILA (1972 a, p. 56—58) and (1972 b, p. 17—18).

[2] Elimination of seasonal variation is further discussed in Section 3.2.

[3] For example, when building their model, AGARVALA and BALL (1970, p. 537—555) implicitly assumed that the age of layers is the only criterion for removing them from the laying flock.

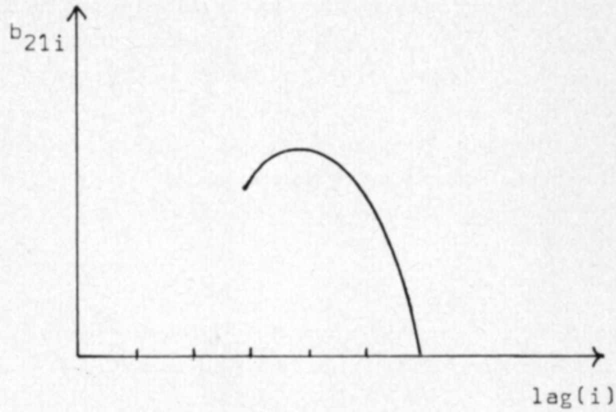

Figure 2.2. The Expected Shape of Coefficient Vector b_{21i} Reflecting the Age Distribution of Culled Layers in a Given Period.

lies of domestic feed grains (RVS_t) has been introduced into the model. In this context it is to point out that the variables mentioned above cannot exert very strong influence on the number of culled layers. Prices have not fluctuated widely enough in the past and therefore, for example, high price level may not have outweighed the deteriorating productivity of old age groups. On the other hand, the continuation of production in periods of low prices would in many cases be a better alternative than removing very young age groups of the existing flock from the economic standpoint of producers.

In order to take into account the impact of changes in production technology and the structure of the egg industry, a trend variable (T) was originally included into the model. However, after the preliminary estimation experiments it was deleted from the equation due to its statistically insignificant coefficients. A seasonal pattern of culling exists and, that is why, seasonal dummy variable D_2 has been introduced into this model.

Number of Layers: Equation (2.3) is an identity. The number of layers at the end of a given period can be derived from the number of layers at the end of the previous period (SK_{t-1}) by adding the number of chickens at the end of the previous period (time unit = six months) to that figure and subtracting the number of layers culled in the current period (KK_t) from that figure.

Output per Layer: Although originally planned, no equation for output per layer was included into the basic model. This is mostly due to the fact that preliminary analyses of the data of this study (See NEVALA 1974, p. 11) could not bear out hypotheses of producers' attempts to change output per layer according to the price situation (for example, by changing feeding rates). On the other hand, all the models developed for output per layer using existing data could not explain variations in the output per layer in the sample period any better than a simple trend model. Obviously, there are so many factors influencing the rate of lay which can be grouped into trend in genetics and management practices that we could not estimate the separate effects of these factors on the output per layer. On this basis, the equation for output per layer was removed from the original model and total egg production equation was reformulated according to this change: a trend variable as a proxy for improvements in genetics and management was included into this equation to take into account the influence of increase in output per layer on the total production.

Total Egg Production: Equation (2.4) expresses technical relationships between total egg production and the laying flock in a given period. The total egg production is hypothesized as a function of the average number of layers and the output per layer in that period.

The average number of layers is computed according to the following formula:

$$SK_t = SK_{t-1} + 0.5SP_{t-1} - 0.5KK_t$$

where SK_{t-1} and SP_{t-1} are the number of layers and chickens at the end of the previous period respectively, and KK_t is the number of culled layers in the current period. As to estimation, this variable is interesting. The main question in this respect is, whether 1) to use the original specification as such and estimate coefficient b_{41} for variable $(SK_{t-1} + 0.5SP_{t-1} - 0.5KK_t)$ or 2) to estimate separate coefficients for each of the variables included to this combination.

In practice, when using the first procedure, the coefficients are restricted to be the same for each variable included. However, there are certain reasons for assuming that the coefficients most probably differ from each other. For example, the output per layer in the youngest age group (indicated by SP_{t-1}) is likely to be different from the average rate of lay and, on the other hand, the total output of this age group in period t also depends on the average number of days after reaching laying maturity. In the first procedure, we assume that purchases of chickens are equally distributed over a given period and, thereby, the chickens purchased in period t—1 is assumed to lay eggs, on the average, for half of the period t and their rate to lay is the same as the average rate for the whole laying flock (therefore variable $0.5SP_{t-1}$). Similar arguments can also be raised against restricting the coefficient of variable $0.5KK_t$ (number of culled layers) to be the same as that of variable SK_{t-1}.[1] The major advantage of the first alternative is the fact that, when using this approach, there is only one coefficient to be estimated instead of three coefficients in the second approach. Because of this kind of consideration both estimation procedures were used to find out the most appropriate method.

Producer Price Equation (2.5): As stated before, the target price fixed by the government (TAV) is the main determinant of the producer price of eggs. According to the Price Acts, however, the producer prices have been permitted to vary within a certain range around the target price level (generally within $\pm$ 5 percent range). Every Price Act has included specific provisions on the conditions, which have to be fulfilled, before the government can intervene in the egg market (paying export subsidies or allowing imports).

Without describing these provisions in more detail — and to make things operational — we simply assumed here that the discrepancy between the domestic egg production and consumption also exert an influence on the producer

[1] Usually, layers to be culled in a certain period have passed the most productive stage, and therefore, the output per layer in this group is likely to be lower than the average rate of lay.

price in a given period.[1] For example, if egg production increases more than domestic consumption in a certain period, the producer price falls under the target price level. The impact of this discrepancy between production and consumption will last until the government is allowed (according to the Act) to take actions to restore the current producer price to the target price level. For these reasons, variable UK_t [$= TS_t - (CO \cdot H)_t$; net exports, and when negative; net imports] indicating the magnitude of the discrepancy between domestic production and consumption was introduced into the model. As can be seen from the model, a negative sign is, *a priori*, expected for this variable.

Retail Price Equation (2.6):[2] Above we specified an equation for the determination of the producer price of eggs and — operationally — the retail price of eggs in a given period can be computed by adding a marketing margin to the producer price in that period. Hence, the problem in building econometric models for the retail price of eggs is to formulate operational hypotheses on the determination of the marketing margins for eggs.[3]

An earlier study on marketing margins for eggs in Finland, made by WAANANEN and KAARLEHTO (1965), provided an excellent starting point for hypothesis formulation. They concluded, for example, that 1) the marketing margin was primarily a linear function of the price level in absolute terms. 2) However, the market situation influences the magnitude of the marketing margins: when prices were moving up the marketing margin was smaller than when prices were falling (p. 12). On the basis of these findings — besides the variables included in the final model — a dummy variable (= 1 for rising prices and = 0 for falling prices) was also initially incorporated into the model to take into account the above suggested behavior of the marketing sector in fixing retail prices. However, the coefficient of this dummy variable in the preliminary estimation experiments was not statistically significant in any model formulation. In addition, fixing values for this type of variable — when using the model for forecasting or policy analysis — might have given problems and; therefore, it was deleted from the final model.

Thus, the remaining explanatory variables in the retail price equations are: the producer price, the wage level in commerce (to take into account the increases in the marketing costs) and the seasonal dummy. This is a rather simple model for retail price formation. Many factors which might have been relevant

[1] In this context it will be pointed out that numerous hypotheses were tested and different models were used in order to find an appropriate model for the producer price of eggs. Initially, some efforts to incorporate certain regulations of the Price Acts explicitly into the model were made. In addition, a somewhat different model formulation: $PKT_t = TAV_t + \Delta p_t$, $\Delta p_t = f(UK_t, \ldots)$, where Δp_t = the difference between the producer price and target price for eggs in period t, was tested. However this model did not perform any better in the validity testing than the model described above.

[2] The wholesale price is ignored in the model building for the price determination of eggs, because there exists no homogenous time series on the wholesale prices of eggs for the entire research period.

[3] Relatively much attention has recently been paid to the marketing margins of agricultural producers in Finland. KETTUNEN (1968) and PÖLKKI (1971) have built different kinds of econometric models for exploring variations in the marketing margins for pork and beef. Also, two special committees set by the government have investigated marketing margins; for eggs, see: ANON. 1966, 1971 a.

in the determination of the marketing margins have been ignored mairly because of lack of data or difficulties in making any operational variable for these factors.

Consumption of Eggs: Equation (2.7) refers to the total per capita consumption of eggs in a given period. Building separate models for different components of the total egg consumption, whose determinants may be different, was not possible in this study, because no data on these components were available.[1] It is, however, reasonable to argue that this is not a very serious shortcoming in the structure of the model with respect to the purposes of this model building: an appropriate model for the total egg consumption is likely to be sufficient for policy analyses in this study.

Equation (2.7) is a typical demand function used in many empirical studies. The consumption of eggs is assumed to depend on the retail price of eggs (PKV_t), disposable income of consumers (Y_t) and the prices of all other consumer goods (EI). The effect of the prices of competing and complementary products was assumed to be insignificant, this assumption being based on the statistical findings of preliminary analyses of this study and these of earlier studies (Koponen 1964, p. 21). As it can be seen from the model, the price index of consumer goods has been included into the model as a deflator of price and income variables. This was done after using these three variables as separate variables in the model which led to unsatisfactory results due to high intercorrelations between these explanatory variables. However, at the same time a very restrictive assumption of consumers' behavior was made: the reaction to changes in the price ratio $(PKV/EI)_t$ is the same irrespective of whether the change is due to a change in egg prices or in consumer price index (the same holds also to variable $(Y/EI)_t$).

Net Exports: Equation (2.8) is an identity: equations for the determination of both the domestic production and consumption have been specified earlier and, thus, the net exports of eggs in a given period can be calculated by subtracting total consumption from total production in that period. Net storage movements were not allowed in this model mainly because of lack of data and, on the other hand, since it was assumed that this item comprises only a minor portion of the total volume of eggs in a given period (semiannual data).

2. 4. Characteristics of the Basic Model

The eight-equation model including eight endogenous variables was presented above without considering mutual relationships between the endogenous variables. Since current endogenous variables appear also on the right-hand side of the equations, there might be jointly dependent variables[2] in the model which will require the use of simultaneous estimation methods. Because of the

[1] In many empirical demand studies, separate models have been specified for the consumption of shell eggs and for other consumption (such as the use for breaking, hatching). See, for example, Bange and Bender (1969, p. 29) and Roy and Johnson (1973, p. 209).

[2] Theil (1971, p. 429—436) calls the current endogenous variables, whose values are determined jointly and simultaneously by predetermined variables and disturbances in the way prescribed by the equations of the system, jointly dependent variables.

complexity of those methods in large models, recursive ordering of the equations of the basic model to identify the simultaneous equation system(s) of minimum size in this model may be useful (i.e. checking which equations are to be solved simultaneously and which equations or subsystems are to be solved before a particular subsystem can be solved).[1]

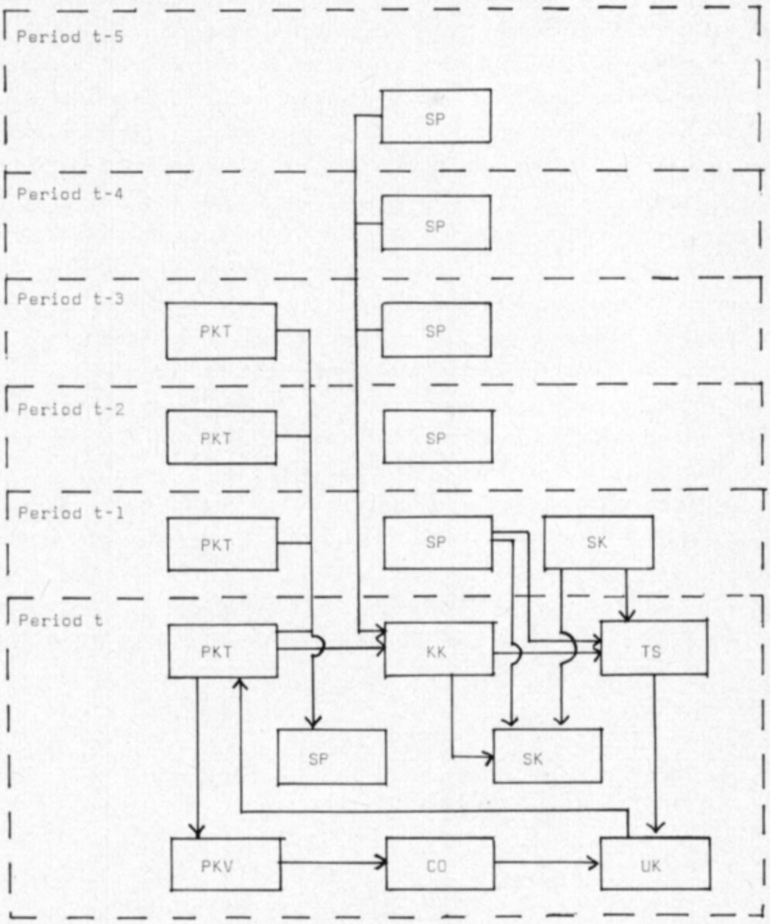

Figure 2.3. Relationships Between the Endogenous Variables of the Basic Model Indicating the Dynamics of the Model. (PKT = producer price of eggs, SP = number of chickens, KK = number of culled layers, SK = number of layers, TS = egg production, PKV = retail price of eggs, CO = per capita consumption of eggs, UK = net exports).

An arrow scheme is a convenient way to illustrate relationships between endogenous variables for purposes of recursive ordering of the equations (Figure 2.3).[2] On the basis of arrows indicating the directions of the influence of

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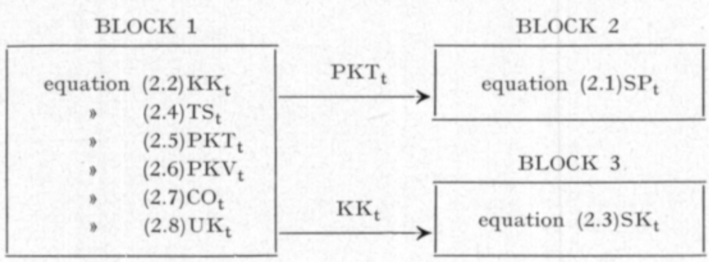
[1] See Holt et.al. (1967, Chapter 5).

[2] Also, special computer programs have been developed for this purpose. For example, program SIMULATE II — also used in this study — analyzes the recursive ordering of the equations in a given econometric model. This program is especially useful in the case of large econometric models (See Holt et.al. 1967, Chapter 5).

each variable, we can conclude that the following endogenous variables are jointly dependent in the basic model: PKT_t, KK_t, TS_t, PKV_t, CO_t and UK_t. The model assumes that the current producer price influences the number of layers to be culled in period t and the latter, in its turn, is the determinant of the total egg production in the same period. On the other hand, the producer price is, according to the model, the main determinant for the retail price, which — in its turn — influences the egg consumption in period t. Thirdly, the net exports (UK_t), which are determined by the production and consumption of eggs, are assumed to influence the producer price in this model. Thus, these equations form a simultaneous block of six equations in the basic model.

As to equation (2.1), two endogenous variables (SP_t and PKT_t) are included into this equation: producer price of eggs is one of the determinants of chicks placings, but on the other hand the number of chickens purchased in period t does not exert any influence on the other endogenous variables in the model (only lagged SP's have been included in the other equations). Accordingly given the predetermined values, the number of chickens is determined by PKT_t (producer price) and u_1 (disturbance). Assuming that the disturbances in the model are stochastically independent, we can expect that the values of PKT are predetermined with respect to SP_t. Therefore, equation (2.1) including only predetermined variables on the right-hand side can be estimated separately. Similarly equation (2.3), which is an identity, can be solved for SK_t after the value of variable KK_t is determined from the simultaneous block mentioned above.

Hence, this eight-equation model can be considered as a block-recursive equation system containing three blocks,[1] which link each other as follows:



The model is dynamic; the typical feature of this model is numerous lagged endogenous variables. On the other hand, an attempt has been made to keep the number of exogenous variables to a minimum to facilitate forecasting and simulation experiments with the model. The other characteristics which are to be considered before estimation of the model are the linearity of the relationships between variables and the identification of the simultaneous equation system.

Both the one-equation subsystems of the basic model (equations 2.1 and 2.3) are linear in variables and parameters (in absolute terms). On the other

[1] We have a block-recursive equation system, when the coefficient matrix of the endogenous variables is block-tritangular (with square diagonal blocks) and when the variance-covariance matrix of the disturbances is block-diagonal with conforming blocks (See, for example, Theil 1971, p. 460–461).

hand, the simultaneous subsystem includes some nonlinear elements. Since the equation of egg production has been specified for the total output and the consumption equation on per capita basis respectively, the identity for net exports of eggs is to be nonlinear in variables (including the nonlinear combination of one endogenous and one exogenous variable $(CO \cdot H)_t$). Similarly, one nonlinear combination of an endogenous and an exogenous variable $(PKV/EI)_t$ was included in the consumption equation instead of using these as separate variables in order to reduce intercorrelation of the variables on the right-hand side of this equation. Moreover, equation (2.6) includes a nonlinear combination of variables UK_t and H_t.

This is a typical situation in practical model building (See, for example, NAYLOR 1971, p. 139), and problems may arise from these kinds of nonlinearities in the estimation and simulation experiments with the model. However, since all the nonlinear elements in the model are combinations of one endogenous and one exogenous variable, relatively easy solutions can be found to these problems (such as polynomial approximations of these variables; see NAYLOR 1971, p. 181). These will further be discussed in the stages of estimation and model evaluation through simulation experiments.

Generally speaking, the identification of an econometric model can be considered as a problem of deriving the coefficients of the structural form from the reduced form coefficients of the system.[1] In the case of linear models simple rules have been developed for checking the identification of a certain equation system. However, as stated above, the simultaneous subsystem of this study is nonlinear in variables and these rules do not apply to this model. The identification theory for nonlinear models is difficult and has only been partially developed (JOHNSTON 1972, p. 372). Therefore, we will ignore the identification problem of the present model. Before estimation of the simultaneous submodel, we need only check whether this model satisfies the specific conditions necessary for using a typical simultaneous equation estimation method in the case of this model (See Section 3.3.1).

2. 5. Recursive Production Response Model

Analyzing different specifications and the stability of the structural coefficients of the model over periods of time is an important part of model evaluation. As stated by many economists, the coefficients are not likely to remain constant over long periods of time. As to this study, especially producers' responses to changes in socio-economic forces may have changed over the years of the sample period due to the technological changes in production. Therefore, to get some kind of idea as to the trends of these changes over periods of time, the model should be estimated from different time periods.[2]

[1] For more detail, see JOHNSTON (1972, p. 341—356).

[2] TERÄSVIRTA (1971, p. 4) states that in this way we obtain many estimates of the structural coefficients, and by examining the coefficients estimated from different time periods we can obtain information about the changes in the process which have generated the values of the endogenous variables.

However, the eight-equation model presented above is rather inconvenient for this kind of testing because of the complexity of estimating the coefficients of the simultaneous subsystem. That is why — to facilitate the computational procedure — a simple model for the egg production was derived from the basic model. If we ignore our initial assumption on the relationship between the producer price of eggs and the current market situation (i.e. variable UK_t is deleted from equation (2.5)), the producer price becomes an exogenous variable in the model. Therefore equation (2.2), explaining the number of culled layers, includes only one endogenous variable. In this case we can write the equation system for the egg production determination in matrix notation as follows:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & b & 1 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} SP_t \\ KK_t \\ TS_t \\ SK_t \end{bmatrix} + \begin{bmatrix} \\ C \\ \\ \end{bmatrix} \begin{bmatrix} \\ Z \\ \\ \end{bmatrix} = \begin{bmatrix} u_{SP} \\ u_{KK} \\ u_{TS} \\ 0 \end{bmatrix}$$

Where B and C are the coefficient matrices for the endogenous and predetermined variables respectively, and Z is the vector of the predetermined variables. As can be seen from the matrix presentation of the model, which is henceforth called the recursive production response model, the coefficient matrix of the endogenous variables is subdiagonal (i.e. it has only zero elements above the diagonal) and, therefore, this set of equations can be regarded as a recursive system.[1] The two first equations, determining the values of SP_t and KK_t respectively, include only one endogenous variable each. The third equation implies that, given the predetermined values, TS_t is determined by KK_t and u_{TS}. If we assume that the disturbances are stochastically independent, we can expect that KK_t is predetermined with respect to TS_t. The fourth equation is an identity including two endogenous variables (KK_t and SK_t). However, the value of KK_t is determined by the second equation and, thus, the fourth equation explains the values of SK_t in terms of predetermined variables only.

Accordingly, assuming that the variance-covariance matrix of disturbances is diagonal this equation system can be considered as four one-equation systems, and the ordirary least squares method can be used for estimation of the parameters.

3. Data and Estimation Methods

3. 1. Estimation Period

The estimation of the basic model was based on semiannual time series from the year 1952 to 1970. Thus, taking into account the lagged variables incorporated into equations (2.1) and (2.2), this period provided some thirty

[1] According to WOLD (1964, p. 17), the recursive system consists of a set of equations which form a causal chain so that the first equation contains only one endogenous variable Y_1 and the second explains Y_2 in terms of Y_1 and other predetermined variables and so on. The key point is that each successive equation may include only those endogenous variables that have appeared in the previous equations.

observations for regressions depending on the lengths of lags applied to variables PKT_{t-i}, PR_{t-i}, and SP_{t-k-i} in each estimation experiment. The reason why the latest observation periods (from the year 1970 on) were not included was to provide a comparatively long time period for the evaluation of the model via ex-post forecasting and, also, for comparing the outcomes of ex-post simulations of different price policies generated by the model to those under the actual price policy. Accordingly, time period 1971—74 was used for testing the model by means of predictive tests.

However, besides the estimation from the base period, stepwise regressions with regard to observations[1] were applied to the recursive production response model (See Section 2.3) in order to explore the stability of the coefficients over periods of time.

Sources of the data used in this study as well as the main principles for computing observational values for the variables of the model are described in Appendix 1. In order to obtain homogeneous time series for the entire research period, some adjustments to the official figures published for certain periods had to be made due to changes in the system for compiling these statistices over time. Generally speaking, data availabilities for this study were not, in part, quite satisfactory with regard to the coverage of certain phenomena in the egg industry nor, on the other hand, with regard to the accuracy. Due to the lack of data, some — probably relevant — factors had to be excluded from the model. This is, however, a rather typical situation in the practical model building for policy purposes: one can hardly find a empirical econometric study, in which no complaints about the data shortages have been presented.

3. 3. Elimination of the Seasonal Variation

As the estimation of the model will be based on the semiannual data, an additional problem arises from the seasonal patterns of those phenomena of the egg industry that the model describes. Some of the time series, such as the number of chickens (SP_t) and the number of layers (SK_t) seem to have very clear seasonal components. As can be seen from the equations of the basic model, seasonal dummies (D_2) were included into the model to take into account this kind of seasonality in the observed values. Another approach to the seasonality problem that was tested before selecting the seasonal dummy method, was eliminating seasonal variations from the time series and using these seasonally adjusted series as a statistical basis for the model.[2]

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[1] The stepwise regressions with regard to observations is in this study defined as several successive estimations of the parameters of the model such that the estimation period is systematically changed by dropping one or more of the oldest periods from the beginning and adding a similar number of new periods to the end of the estimation period (See Teräsvirta 1971).

[2] There are many alternative methods for computing seasonally adjusted series (See Kukkonen 1968 and Saito 1972). In this study the iterative method developed by Kukkonen was used to eliminate seasonal variation from the semi-annual time series. The applied model was multiplicative: the original time series (O_t) were divided into three components; $\log O_t = \log P_t + \log S_t + \log I_t$, were P_t is trend-cycle, S_t seasonal and I_t residual component res-

However, since the estimation results of these two methods did not in essence differ from each other, the seasonal dummy approach was chosen mainly for two reasons. The main advantage of this approach over the use of seasonally adjusted series is that the model directly generates the final values of the endogenous variables in the seasonal dummy approach. On the other hand, when seasonally adjusted data is used the model generates seasonally adjusted forecasts and, therefore, an additional block of equations has to be included into the model for forecasting values of the seasonal components of the time series in which we are interested. In addition, KLEIN (1965, p. 35) for example suggests the use of explicit dummy variables, because in this way one avoids using seasonally adjusted time series that have already had systematic computations built into them. On the other hand, the main advantage of the separate elimination of seasonal variation is that, unlike in using the seasonal dummy approach, we can take into account possible changes in the seasonal components of time series by applying some specific methods developed for this purpose (such as that by KUKKONEN 1968. See also SAITO 1972).

This dummy variable ($D_2 = 1$ in the second half of the year, otherwise $D_2 = 0$) is a kind of shift variable. Its coefficient indicates how much the level of the function has to be adjusted in the second half's seasonal influence. In addition, to take into account changes in the seasonal pattern of purchasing chickens over periods of time, variable D_2T (the product of the seasonal dummy variable and the trend variable) was incorporated into equation (2.1).

3. 3. Estimation Methods

3. 3. 1. General

The following step in the model building — selecting the estimation methods — refers to the problems of obtaining parameter estimates, which would have desirable statistical properties (unbiasedness, consistency, efficiency, etc.). In this respect the ordinary least squares method (OLS) can be applied to the one-equation subsystem (Block 2) in the block-recursive basic model of this study as well as to the estimation of the four-equation recursive production response model described in Section 2.5 under certain conditions.

As for the recursive production response model, the application of the OLS-method to the structural equations leads to consistent and asymptotically efficient estimates, if this model is diagonally recursive: that is, if besides the tritangularity of the coefficient matrix of the endogenous variables also the variance-covariance matrix of the structural disturbances is diagonal

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pectively. Seasonally adjusted series were computed according to the following formula: $OS_t = O_t/S_t$. Also, the regression method has been used to estimate seasonal components (as for eggs; see, for example, KERSTEN 1975, p. 89—97). In this context it will be shown out that LOVELL has proved that, when the time series adjusted by means of the least squares regression on seasonal dummy variables are used, the same estimates of the coefficients of the model are obtained as when using the seasonal dummy variables in the original equation (JOHNSTON 1972, p. 189—190).

(See KMENTA 1971 p. 586).[1] Similarly, the variance-covariance matrix of the disturbances of the basic model has to be block-diagonal to obtain OLS-estimates with desirable statistical properties for equation (2.1) of the basic model. *A priori*, there were no reasons why these basic assumptions on the disturbances of these models could not be made in the case of these equations.

Instead of that, the OLS-method applied to simultaneous equation systems generally leads to inconsistent estimates, because one of the basic conditions is violated in this case: the endogenous variables on the right-hand side of the equations are, in general, correlated with the disturbance of the equation in which they appear (KMENTA 1971, p. 533). Therefore, the two-stage least squares estimation method (2 SLS, see THEIL 1971, p. 451—460) was applied to estimation of the six-equation simultaneous subsystem of the basic model (Block 1). Being a single-equation method it provided a relatively flexible and easy method for estimating different model specifications when searching for the »best» model structure. In the case of linear models the 2 SLS-method can be described as a two-step procedure, in which 1) the first stage consists of obtaining proxies of the right-hand side endogenous variables (Y_{jt}) from the i-th reduced form equation as estimated by the OLS-method and 2) the second stage uses these proxies ($\hat{Y}_{jt}$) in the place of the right-hand endogenous variables in regressions using structural equations.

However, the simultaneous subsystem of the basic model is nonlinear in the variables (including nonlinear combinations of endogenous and exogenous variables such as $(PKV/EI)_t$, $(UK \cdot H)_t$). Problems arise from these nonlinearities in the estimation, since in nonlinear models the reduced form is, in general, nonlinear in the parameters (See EDGERTON 1972, p. 27). To avoid difficulties of this kind in applying the 2 SLS-method to models nonlinear in the variables, the econometric theory proposes using polynomial approximations to the reduced form in the first stage of the procedure (See KELEJIAN 1971, p. 373—374 and EDGERTON 1972, p. 26—32). EDGERTON explored two such approximations: 1) a method which used a linear function of the predetermined variables in the first stage and 2) a method which used a second order polynomial in the first stage. The consistency of these methods is established in his paper by showing that they are equivalent to the instrumental variables method and, also, conditions for their application are given.

The first variant of the 2 SLS-method[2] is used for the six-equation simultaneous subsystem. According to EDGERTON (p. 30), the condition that must be met for this method to be applied to the i-th equation of a nonlinear model is that the total number of variables and functions on the right-hand side of the i-th equation is less or equal to the number of predetermined variables in

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[1] Of course, also the other assumptions on the nature of the disturbances necessary for applying the OLS-method have to hold in these structural equations: 1) the disturbances are normally distributed with zero mean and constant variance, 2) not serially correlated and 3) independent of the explanatory variables (See JOHNSTON 1972, p. 12, and 122—123).

[2] In fact, this variant is the 2 SLS-method for the nonlinear situation, if we define 2 SLS for the linear case as a two-step regression method (See EDGERTON 1972, p. 27).

the system.[1] Fulfilling this condition in the case of the present simultaneous submodel does not seem to be any problem; even though we do not take into account the lags of SP_{t-k-i} in equation (2.2), there are ten predetermined variables in the system. Hence, for example, in the case of equation (2.2) which is the most critical equation in this respect, the above condition will be easily fulfilled when using alternative estimation methods for lagged variables SP_{t-k-i}.

3. 3. 2. Polynomial Lag Formulations

The number of chickens at the end of a given period (equation 2. 1) was assumed to be determined by several past values of predetermined variables PKT (the producer price of eggs) and PR (the feed price). Similarly, equation (2.2) is a distributed lag model consisting of several lags of variable SP. The straightforward estimation of these equations by the use of ordinary estimation methods (such as OLS, etc.) is possible, but on the other hand, intercorrelations between explanatory variables may be a problem in this case: it may disturb the »natural» pattern of the coefficient vectors of these variables.

An alternative estimation procedure, suggested first by ALMON (1965, p. 178—196) to the above is a finite distributed lag formulation in which the coefficients of different lags are restricted to lie on a polynomial of low order. By making this restriction the number of parameters to be estimated can be reduced, because a polynomial of low order can be defined by a few parameters. The individual lag coefficients can be then computed from these estimated parameters.

Initially both methods were used in this study. The latter approach was, however, chosen for the final model; this decision being based on the estimation experiments by using both the alternatives. Because there are computationally different procedures for estimating finite polynomial lag models[2], the method used in this study is described in detail in Appendix 3. Only polynomials of first and second order were used in this study. The main idea of the procedure is to include transformations from the original explanatory variable into the equation instead of the separate lags of that variable as shown in Appendix 3. The OLS-method (or 2 SLS-method in the case of simultaneous equation systems) can be applied to the estimation of these equations. After estimation, the individual lag coefficients can be computed from the estimated coefficients of the transformed variables according to the formula given in Appendix 3. If the disturbances (u_t) satisfy all the assumptions of classical regression models, the resulting estimates will have all the desirable properties (KMENTA 1971, p. 493).

This method provides a flexible procedure for estimating distributed lag models: the length of the lag and the degree of a polynomial can be easily altered to find the »best» lag structure. On the other hand, one of the disadvantages

[1] Functions are, in this case, defined as $g(Y_t, Z_t)$, where Y_t and Z_t is an endogenous and exogenous variable respectively and that it contains no unknown parameters. If this condition does not hold then a singular matrix will be required to be inverted in the second stage.

[2] For example, estimation by Lagrangian interpolation polynomials (ALMON 1965) or by the use of simple polynomials (CHEN et. al. 1972, p. 78—79).

of this method is that alternative choices to be tested increase rapidly: we have to specify *a priori* both the degree of a polynomial and the length of the lag for each variable.

4. Estimation of the Models

As stated, the recursive production response model was developed in order to evaluate different specifications of the production response equations and to explore the stability of their coefficients over periods of time. Accordingly, the final decisions on the structure of the basic model of eight equations were, in part, based on the estimation results of the above mentioned model. Thus, to be consistent with this order in this section, the estimation of the recursive production response model is first presented: the estimates of the parameters of the model — selected after many estimation experiments with different specifications — are first discussed with some comments on alternative specification possibilities (Section 4.1.1). Section 4.1.2 deals with variations in the parameter estimates of the same model over periods of time. Finally, the estimates of the basic model are given in Section 4.2.

In this context, it should be also mentioned that due to a great number of alternative choices (such as different variable combinations, distributed lag formulations, estimation methods and periods, etc.), it is almost impossible to test all the choice alternatives that *a priori* seem plausible. Therefore, in interpreting the estimation results one has to bear in mind that if some choices during the model building of this study had been done differently, perhaps, we would have ended up with different model structures for the Finnish egg industry.

4. 1. Recursive Production Response Model

4. 1. 1. Estimates from the Period 1956—74

The different specifications of the recursive production response model were tested on the entire research period. Accordingly, the OLS-estimates for the selected model from period 1956/I—74/I are as follows[1]:

Number of Chickens:

$$(4.1)\quad SP_t = \underset{}{0.432} + \underset{2.2^{**}}{0.551PKT_t} + \underset{2.2^{**}}{0.367PKT_{t-1}} + \underset{2.2^{**}}{0.184PKT_{t-2}} - \underset{-2.4^{**}}{2.662PR_t}$$

$$- \underset{-2.4^{**}}{1.775PR_{t-1}} - \underset{-2.4^{**}}{0.887PR_{t-2}} + \underset{3.6^{***}}{0.063T} - \underset{-5.0^{***}}{0.036D_2T} - \underset{-5.1^{***}}{1.366D_2} + u_{SP}$$

$$R^2 = 0.98 \quad s_u = 0.228 \quad d = 1.67$$

[1] Numbers below regression coefficients are Student t-values. The significance levels are indicated as follows:

* statistically significant at the 90 percent level

** statistically significant at the 95 percent level

*** statistically significant at the 99 percent level.

R^2 = the coefficient of determination, s_u = the standard deviation of the residual and d = the Durbin-Watson test statistic.

Number of Culled Layers:

(4.2) $$KK_t = 0.748 - \underset{1.7^{**}}{0.608PKT_t} + \underset{2.1^{**}}{3.046PR_t} - \underset{-1.1}{0.148SP_{t-2}} + \underset{1.8^{**}}{0.137SP_{t-3}}$$

$$+ \underset{2.8^{***}}{0.256SP_{t-4}} + \underset{2.8^{***}}{0.210SP_{t-5}} + \underset{0.8}{0.259D_2} + u_{KK}$$

$R^2 = 0.81 \quad s_u = 0.258 \quad d = 2.03$

Egg Production:

(4.3) $$TS_t = -3.594 + \underset{12.5^{***}}{4.795SK_{t-1}} + \underset{3.4^{***}}{1.756SP_{t-1}} - \underset{-1.5^{*}}{0.943KK_t} + \underset{4.6^{***}}{0.167T}$$

$$+ \underset{0.7}{0.814D_2} + u_{TS}$$

$R^2 = 0.99 \quad s_u = 0.825 \quad d = 1.40$

Number of Layers (Identity):

(4.4) $$SK_t = SK_{t-1} + SP_{t-1} - KK_t$$

The coefficients of PKT_{t-i} (producer price for eggs, $i = 0 \ldots 2$) and PR_{t-i} (feed price, $i = 0 \ldots 2$) in equation (4.1) were estimated by using a polynomial of first order, because this formulation proved to yield the most plausible results in the experiments using different lengths of lags and degrees of the polynomial. Hence, there were only six coefficients to be estimated by OLS in this equation. The estimated coefficients[1] were, however, unscrambled (See Section 3.3.2) in order to present the model in the original form. Similarly, the coefficients of $SP_{t-2} \ldots SP_{t-5}$ in equation (4.2) were estimated by using a polynomial of second order.[2]

Assessing on the basis of the R^2-values and the standard deviations of the residuals, the equation system seems to explain producers' reactions rather well. In order to test the assumption on the non-correlation of the disturbances of this recursive model, a linear correlation matrix of the computed residuals was calculated:

	u_{SP}	u_{KK}	u_{TS}
u_{SP}	1.0		
u_{KK}	0.30	1.0	
u_{TS}	0.29	0.01	1.0

As can be seen from the figures, the highest correlation coefficient (r) was obtained for residuals u_{SP} and u_{KK} (equations 4.1 and 4.2). However, it is not statistically different from zero even at the 5 percent level of significance[3]

[1] The estimated coefficient for (PKT) Dgl was 1.102 (t-value = 2.2) and for (PR)Dgl − 5.324 (t-value = −2.4) respectively.

[2] The coefficient for (SP)Dgl was 2.929 and for (SP)Dg2 − 2.474 with t-values 2.8 and −2.6 respectively.

[3] The number of observations (n) is in this case 37. For n = 30, r has to be ≧ 0.36 and ≧ 0.31 for n = 40 at the five percent level of significance to be statistically different from zero (See DIXON and MASSEY 1957, p. 468).

and, accordingly, we can conclude that the residuals belonging to this recursive model are not at least linearly correlated with each other.[1]

All the coefficients in equation (4.1) are statistically significant at least at the 95 percent level; thus, bearing out our basic hypotheses on the criteria of producers in deciding the quantities of chickens to be purchased in a given period. These results also indicate comparatively sensitive and rapid producers' reactions to changes in the prices affecting the profitability of egg production; at the mean level of the variables, the elasticity of chick placings with regard to the producer price of eggs (PKT_{t-i}, $i = 0 \ldots 2$) is 1.89 and with regard to the feed price (PR_{t-i}, $i = 0 \ldots 2$) -1.73 respectively.[2] Thus, in absolute values they are almost the same.

The elasticities above are cumulated price elasticities referring to the entire response period (3 periods in this case). As to the distribution of the response between periods, the results indicated that the producers' response to a price change is at its highest in the same period during which the price change occurs declining gradually with time. In testing different lengths of lags and degrees of polynomials, a polynomial of first order proved to give the most plausible results for every length of lag tested in these experiments (2—6 periods). The tests also proved that the extension of the lag structure over three periods did not essentially change the estimated total response to price changes as indicated by the lag coefficients below, which were estimated using 3 and 4 periods as a length of lag for the price variables in equation (4.1):

Lag		Coefficient				
Period	Variable	t	t−1	t−2	t−3	Σ
3	PKT	0.551	0.367	0.184	—	1.102
4	PKT	0.496	0.372	0.248	0.124	1.240
3	PR	−2.662	−1.775	−0.887	—	−5.324
4	PR	−2.247	−1.685	−1.123	−0.562	−5.617

In this context, it must be pointed out that a number of efforts were made to incorporate the producer price index of agricultural products into equation (4.1) to represent the prices of alternative agricultural products, but in every case the estimation results were not consistent with *a priori* expectations — partly due to the high correlation between the producer price of eggs (PKTDg1) and the producer price index of agricultural products. In addition, it was attempted to incorporate a variable indicating the feed grain availabilities (RSV_t) into the model. However, its coefficients were not statistically signifcant.

In the second equation (explaining the number of culled layers in a given period), the R^2-value remained relatively low compared to those of the other

[1] However, as KETTUNEN (1968, p. 61—62) points out, we cannot conclude that the theoretical assumption of non-correlation of disturbances is valid since the test above concerns only linear correlations.

[2] These elasticities were computed as: $e = \sum_{i=0}^{2} b_i \cdot \overline{X}/\overline{Y}$, where b_i = the regression coefficients of different lags of the explanatory variable X, $\overline{X}$ = the mean of the explanatory variable X and $\overline{Y}$ = the mean of the dependent variable computed from the entire estimation period.

equations. This does not necessarily refer to the failure of the specification.[1] The time series for KK_t was derived from the other time series (SK_t and SP_t) computationally and, thus, it may contain some errors. On the other hand, it seems reasonable to argue that the number of layers culled in a given period is subject to unpredictable variations due to the total effect of several minor factors such as health conditions, feed grain situations, etc.

In order to choose an appropriate lag structure for SP_{t-k-i} (lagged number of chickens), the equation (4.2) was estimated many times using different lengths of lags (from $t-2$ to $t-7$) and degrees of a polynomial. Lags SP_{t-2} ... SP_{t-5} and a polynomial of second order proved to be the most appropriate for this variable, although logic suggests that SP_{t-2} not be included in the equation on the basis of the age criterion.[2] However, the estimation of the equation without SP_{t-2} (i.e. using lags from $t-3$ to $t-5$) did not yield statistically significant coefficients for transformed variables (SP)Dg1 and (SP)Dg2.

The signs of the coefficients of the current producer price of eggs (PKT_t) and the feed price (PR_t) are also logical, but on the other hand, the coefficient of PKT_t is statistically significant only at the 90 percent level. High intercorrelations between the explanatory variables obviously disturbed the estimation of this equation leading to the relatively large standard errors of the coefficients. Therefore, some modifications of this model (polynomial lag formulations for PKT and PR) were also estimated. However, the results did not give us any reasons to change the model specification. It should also be mentioned that variable RVS_t (feed grain availability) was deleted from the equation because of the statistical insignificance of its coefficients in every model formulation tested in this stage.

According to these results, the elasticity of culling layers with respect to the producer price of eggs is -1.2 at the mean levels of variables and with respect to the feed price 1.1 respectively. Thus, in absolute values they are almost the same; an increase of one percent in the producer price of eggs or a decrease of the same size in the feed price reduces the number of culled layers by just over one percent.

In estimating the egg production equation no restriction were here imposed for the parameters of variables SK_{t-1}, SP_{t-1} and KK_t[3] to find out the separate impacts of variations in these different components of the total laying flock on the egg production. All those variables had logical signs and the magnitudes of the coefficients reflect comparatively well *a priori* assumptions. However, the coefficient of KK_t was not statistically significant in this structure. One reason for this may have been the high correlation between SK_{t-1} and

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[1] In this context it should be mentioned that the Durbin-Watson test value computed from the residuals of this equation was 2.03; thus, indicating no autocorrelation of the residuals.

[2] Incorporating SP_{t-2} into the equation is not consistent with the age criterion. However, the negative sign of this lag is logical, indicating a negative relationship between the number of layers removed in a given period and the number of chickens purchased two periods earlier.

[3] When the coefficients are restricted so that the coefficient both for SP_{t-1} and for KK_t is assumed to be half of the coefficient of SK_{t-1}, estimation yields the following equation:

$$TS_t = 3.318 + \underset{13.2^{***}}{4.971}\,(SK_{t-1} + 0.5SP_{t-1} - 0.5KK_t) + \underset{5.2^{***}}{0.176T} + \underset{1.3}{0.322D_2} + u_{TS}$$

$R^2 = 0.99 \quad s_u = 0.781 \quad d = 1.38$

KK_t in the estimation period. In addition, we have to point out that the Durbin-Watson test applied to this equation is inconclusive (d = 1.40, in this case the lower and upper bounds of the 1 percent points of the D-W test statistic are 1,00 and 1.59 respectively). Therefore, one needs further observations to be able to conclude whether the residuals are positively autocorrelated or not.

The coefficient of the trend variable (T) in equation (4.3) is statistically significant at the 99 percent level indicating the importance of the growth in output per layer for the growth of the total production. Because the model seemed to underestimate the total egg production in the years 1964—1968 and, respectively, overestimate in the years 1969—1970, some additional variables were included into the model in order to explain these variations (variables indicating variations in the age structure of the laying flock, feed grain availability). Unfortunately, these additional variables could not reduce the residual variations of the model in those years.

4.1.2. Variations in the Coefficients of the Recursive Production Response Model in Time

The method for exploring variations in the production response over periods of time was stepwise regression with respect to observations. In the beginning, the model was estimated from the first 25 observations of the research period and, after that, three successive estimations of the parameters were performed such that in each stage the four oldest observations were dropped from the regression and four new observations were included in the regression analysis. Thus, four different model structures were obtained from the entire research period. In addition, for price policy simulation purposes two different estimation periods ending in the year 1970 were also used.

The results are summarized in Table 4.1 (the more detailed results are given in Appendix 4). As can be seen from the Table 4.1, the coefficient of determination of any equation does not vary widely over the years, the greatest difference between R^2-values is in the equation explaining the number of culled layers: the difference between R^2 max and R^2 min is 0.052. The standard deviation of the residuals seems to grow in absolute terms. However, since the values of the dependent variables also grow over the years, the standard deviations of each equation measured by percentages remain almost at the same level for every estimation period.

Table 4.1. Variations in the Coefficients of the Recursive Production Response Model with Respect to the Estimation Period. The Coefficients Estimated from Period 1956/I — 70/II = 100.

Equation (4.1): SP (= number of chickens) as the Dependent Variable[1]

Period	Coefficient of					R^2	s_u
	(PKT)Dgl	(PR)Dgl	T	D_2T	D_2		
56/I —69/I	76	133	119	70	128	0.980	0.195
58/I —70/I	108	111	96	91	112	0.971	0.261
60/I —72/I	102	102	80	73	134	0.973	0.265
62/I —74/I	77	93	98	77	126	0.975	0.266
56/I —70/II	100	100	100	100	100	0.974	0.237
57/II—70/II	104	110	100	51	110	0.973	0.250
56/I —74/I	97	119	112	82	117	0.977	0.288

Equation (4.2): KK_t (= number of culled layers) as the Dependent Variable.

Period	Coefficient of							R^2	s_u
	SP_{t-2}	SP_{t-3}	SP_{t-4}	SP_{t-5}	PKT_t	PR_t	D_2		
56/I –68/I	75	136	123	120	127	97	114	0.858	0.201
58/I –70/I	70	84	81	81	90	93	161	0.838	0.220
60/I –72/I	–85	49	20	13	63	65	362	0.862	0.202
62/I –74/I	47	58	56	56	37	62	236	0.813	0.274
56/I –70/II	100	100	100	100	100	100	100	0.825	0.222
57/II–70/II	126	92	99	101	96	93	79	0.804	0.234
56/I –74/I	130	89	98	100	100	114	96	0.811	0.259

Equation (4.3): TS_t (= egg production) as the Dependent Variable

Period	Coefficient of					R^2	s_u
	SK_{t-1}	SP_{t-1}	KK_t	T	D		
56/I –68/I	96	91	106	128	161	0.979	1.28
58/I –70/I	124	168	197	51	–117	0.977	1.12
60/I –72/I	104	92	118	76	259	0.982	1.21
62/I –74/I	105	96	68	66	735	0.976	1.39
56/I –70/II	100	100	100	100	100	0.978	0.98
57/II–70/II	108	104	110	78	141	0.980	1.06
56/I –74/I	98	82	56	99	144	0.985	1.39

[1] The index numbers are computed for the coefficients of transformed variables (PKT)Dgl and (PR)Dgl, because the coefficients of different lags are proportional to them in the case of a polynomial of first order.

In order to illustrate better the variations in the regression coefficients, these were transformed into index numbers (coefficients from period 1956/I–1970/II = 100). Although there are rather wide fluctuations in the coefficients of some variables, no clear systematical changes with respect to time can, however, be perceived in the magnitudes of the coefficients. For example, the coefficients of PR_{t-i} and PKT_{t-i} in the first equation seem to have some kind of downward direction with respect to time; possibly referring to a weakening in the sensitivity of producers' reactions to changes in prices in purchasing chickens over the observed periods. On the other hand, the standard errors of the coefficients estimated from the latest periods are relatively large.[1]

In the second equation, in which the number of culled layers served as the dependent variable, especially the coefficients of $SP_{t-2} \ldots SP_{t-5}$ estimated from observations 1960/I–1972/I and 1962/I–1972/I seem to differ significantly from those obtained from the other estimation periods. In addition, the t-values of the coefficients estimated from those periods remained relatively low (See Appendix 4). No clear explanation for this phenomenon could be found (in-

[1] One reason for the growth of standard errors of these coefficients is that intercorrelations of the explanatory variables are higher in the regressions from later periods than from earlier periods.

tercorrelations between explanatory variables were in those regressions higher than in the rest, which is certainly one reason). However, because coefficients estimated from the base period (1956/I—1970/II) and from the entire period (1956/I—1974/I) were almost the same, the specification of the equation (4.2) was not changed.

The »fit» of the egg production equation (equation 4.3) is rather good for every estimation period and the coefficients of the key variables (SK_{t-1} and SP_{t-1}) do not vary widely over time. On the other hand the coefficient of KK_t (the number of culled layers) is not stable: the most exceptional coefficients for KK_t were obtained from periods 1958/I—1970/I and 1962/I—1974/I.

To summarize the results of the stepwise regression we may conclude that the estimates of some parameters were not stable but varied depending upon the estimation period. It is obvious that the sensitivity of producers' reactions, for example, to changes in prices have changed over periods of time due to changes in the production technology and the other economic circumstances of production. However, these results did not give us any clear indication of systematical changes in the parameters of the model over the research period. Reasons for this may be numerous; such as a relatively short research period which limited the number of observations available for the analysis. On the other hand, the irregular variations of the coefficients of the model may be due to multicollinearity problems, which disturbed the estimation of the coefficients from certain periods. In any case, the results obtained in this section reflect the problems of econometric model building: the specification of the basic model might have been different, if the model had been developed on the basis of other time periods that used in the case of this model.

4. 2. Basic Model: Estimates from the Period 1956—70

Although many different specifications of the basic model were tested in the estimation experiments and many estimation periods were used, only one structure of the basic model is given below: the structure whose coefficients were estimated from semiannual observations for period 1956—1970 (called the base period). This is the structure of the model which will be used for policy simulation experiments in this study.

One of the three blocks (Block 2) can be estimated by the OLS-method as stated in Section 3.3.[1] In fact, OLS-estimates for this equation from period 1956—70 are given in Appendix 4, where the results of the stepwise regressions of production response model are presented. However, the whole structure of the basic model to be used for the price policy simulation is presented in this section to avoid confusion.

In the estimation of the simultaneous subsystem (Block 1) by the 2 SLS-method, a polynomial of second order was again used for the estimation of the coefficients of $SP_{t-2} \ldots SP_{t-5}$ in equation (4.5). Accordingly, the transformations of variable SP as shown in Appendix 3 [(SP)Dg1 and (SP)Dg2] were included in the first stage of the 2 SLS among the other predetermined

[1] Block 3 included only an identity and needed no estimation.

variables of the simultaneous equation system. However, in order to present the model in the original form, the coefficients of (SP)Dg1 and (SP)Dg2 estimated in the second stage of the procedure were unscrambled according to the formula presented in Appendix 3.

The estimated structure of the basic model is:

Block 1: Simultaneous Six-Equation Subsystem (2SLS-estimates)[1]:

Number of Culled Layers:

$$(4.5)\quad KK_t = 1.927 + \underset{2.1^{**}}{0.190}SP_{t-5} + \underset{2.1^{**}}{0.229}SP_{t-4} + \underset{1.7^{*}}{0.115}SP_{t-3} - \underset{-1.1}{0.152}SP_{t-2}$$

$$- \underset{-1.9^{**}}{0.217}(PKT/PR)_t + \underset{0.6}{0.238}D_2 + u_2$$

Egg Production:

$$(4.6)\quad TS_t = -2.236 + \underset{7.1^{***}}{4.595}(SK_{t-1} + 0.5SP_{t-1} - 0.5KK_t) + \underset{5.2^{***}}{0.192}T$$

$$+ \underset{1.5^{*}}{0.375}D_2 + u_4$$

Producer Price of Egg:

$$(4.7)\quad PKT_t = -0.405 + \underset{8.7^{***}}{1.190}TAV_t - \underset{-1.9^{**}}{0.237}(UK/H)_t + \underset{1.8^{**}}{0.069}D_2 + u_5$$

Retail Price of Eggs:

$$(4.8)\quad PKV_t = 0.408 + \underset{5.9^{***}}{0.854}PKT_t + \underset{2.5^{***}}{0.639}YM_t + \underset{1.0}{0.050}D_2 + u_6$$

Consumption of Eggs:

$$(4.9)\quad CO_t = 5.032 - \underset{-2.1^{**}}{1.261}(PKV/EI)_t + \underset{3.8^{***}}{2.686}(Y/EI)_t + \underset{1.5^{*}}{0.221}D_2 + u_7$$

Net Exports (Identity):

$$(4.10)\quad UK_t = TS_t - (CO \cdot H)_t$$

Block 2: One-Equation Subsystem (OLS-Estimates):

Number of Chickens:

$$(4.11)\quad SP_t = 0.164 + \underset{1.8^{**}}{0.568}PKT_t + \underset{1.8^{**}}{0.379}PKT_{t-1} + \underset{1.8^{**}}{0.189}PKT_{t-2} - \underset{-1.8^{**}}{2.223}PR_t$$

$$- \underset{-1.8^{**}}{1.482}PR_{t-1} - \underset{-1.8^{**}}{0.741}PR_{t-2} + \underset{2.4^{**}}{0.056}T - \underset{-4.2^{***}}{0.044}D_2T - \underset{-3.4^{***}}{1.164}D_2 + u_2$$

$$R^2 = 0.97 \qquad s_u = 0.237 \qquad d = 1.69$$

Block 3: One-Equation Subsystem (Identity):

Number of Layers:

$$(4.12)\quad SK_t = SK_{t-1} + SP_{t-1} - KK_t$$

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[1] Due to the ambiquity of the coefficient of determination (R^2) in the case of 2SLS-method, no R^2-values for the estimated equation are given above (See TOMEK 1973, p. 670). For comparison purposes it may, however, be worth mentioning the R^2-values computed from the second stage of the 2SLS procedure: eq. (4.5) 0.82, eq. (4.6) 0.97, eq. (4.7) 0.93, eq. (4.8) 0.98 and eq. (4.9) 0.78. The alternative values for R^2 — based on the residuals of the equations when actual values for the explanatory endogenous variables are used — were not calculated in this study. Numbers below the coefficients are Student t-values. As to significance levels, see Section 4.1.1.

As for the production response equations in Block 1, their specification was changed a little on the basis of the estimation results of the recursive production response model. In equation (4.6), parameters of SK_{t-1}, SP_{t-1} and KK_t were restricted so that the coefficients of SP_{t-1} and KK_t (number of chickens and culled layers, respectively) were assumed to be one-half of the coefficient of SK_{t-1} (number of layers at the end of period $t - 1$) because of multicollinearity problems in estimating this equation. For the same reason, instead of using the producer price of eggs and feed price as separate variables, price ratio $(PKT/PR)_t$ was incorporated into equation (4.5). Thus, another nonlinear combination of an endogenous and an exogenous variable was incorporated into the model. However, equation (4.5) still satisfies the condition given in Section 3.3 for applying the 2 SLS method to this nonlinear model.

The production response equations of the basic model need no further comment: all the coefficients of the variables — except that of SP_{t-2} — are statistically significant at least at the 90 percent confidence level according to the t-ratios computed[1] and, in essence, they are similar to those of the recursive production response model (to the extent they are comparable).

The producer price relation seems to be a plausible model for determination of the producer price level of eggs in a given period. As expected, the target price is the main determinant of the producer price level. Negative sign for variable UK_t (net exports) is also logical. It expresses the influence of the market situation on the producer price level compared to the target price level in a given period: surpluses in the domestic market tend to reduce the producer price level below the target price level, and on the other hand, domestic market prices are over the target price level in the periods of shortages. Also, in the equation for the retail price determination (4.8) the coefficients of the producer price and the wage index in commerce are statistically significant and acceptable from the theoretical standpoint.[2]

In the equation for the per capita consumption of eggs, the retail price of eggs and the disposable income of consumers were deflated by the consumer price index to reduce the intercorrelation between the explanatory variables (the linear correlation coefficient between Y_t and EI_t was 0.99). In this case, statistically significant coefficients were obtained for both the variables. According to these results, the demand for eggs is rather inelastic: at the mean level of variables, the price elasticity of demand is —0.60 and the income elasticity 0.37 respectively. Thus, a change of one percent in the deflated retail price of eggs changes, *ceteris paribus*, egg consumption by some 0.6 percent. Due to different model specifications, these price and income elasticities are hardly comparable to those given in some other sources (Koponen 1964 and Kaarlehto 1958).[3]

In this context, it should also be mentioned that an attempt was made to include the linear trend (T) into the consumption equation to take into account

[1] As to the use of the t-ratio in the case of simultaneous estimation methods; see Kmenta (1971, p. 584).

[2] The results, however, differ from those obtained by Kaarlehto and Waananen (1965). The main reasons for this are obviously different model specificiations and estimation periods.

[3] For example, Koponen (1964) did not include the consumer price index into his model.

possible changes in consumers' preferences. However, the estimation did not yield statistically significant coefficients for this variable.

The linear correlation matrix of the equation residuals of the basic model is given in Appendix 5. As can be seen from the correlation coefficients, this model structure does not satisfy the assumption of the block-diagonal variance-covariance matrix of the disturbances, which should hold for estimating equation (2.1) separately by the OLS-method. The correlation coefficient between the residuals of equation (4.6) and (4.11) differs from zero even at the 1 percent level of significance. However, since the correlation does not seem to be very high, we did not change the estimation of the basic model.

5. Evaluation of the Basic Model

5. 1. On the Methods for Evaluating Econometric Models[1]

Even though the structure of the basic model seems — assessed on the basis of the test values computed in estimation stage — to be rather plausible and even though many alternative specifications were tested, we cannot without further tests be certain, whether this model structure is a good instrument for assessing alternative price policy directions. There is some evidence in the field of econometric model building that the model — even though estimated properly and based on sound economic theory — may yield simulation results that are nonsensical. Therefore, further testing is needed for evaluating the validity of the present model for price policy analyses and this testing has close linkages to the previous stages of the model building: specification and estimation.[2]

The problem of evaluating the validity of an econometric model is a difficult one including many practical, statistical, theoretical and even philosophical complexities (NAYLOR 1971, p. 21—22). Without dealing with these problems in detail in an applicative study of this kind[3], we will only discuss the methods available for evaluating the validity of the basic model of this study below.

In general, the nature of the stability properties of an econometric model constitutes an important measure of its validity, and therefore the analysis of dynamic stability of the model is useful in the evaluation process (See LABYS

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[1] Some authors use the term validation in this context, while others speak about the evaluation of a model; thereby, emphasizing the fact that the validation of an econometric model (= to prove that the model is true) is, in practice, impossible. In this study, we use the term evaluation of a model, since we are in this stage interested only in the model's ability to forecast the values of the endogenous variables when values for the exogenous variables are changed.

[2] For example, in this study the producer price relation was entirely respecified after simulation experiments with the original model. Although the estimation yielded plausible and statistically significant coefficients for the variables included in the original specification, the simulation of this model »exploded»: after some observation periods, the simulated values of the endogenous variables were in complete conflict with the actual values.

[3] We refer to NAYLOR's presentation (1971, p. 153—163).

1973, p. 169). Two different approaches — depending upon the characteristics of the model — have been used for exploring the stability conditions: 1) analytical methods, and 2) simulation methods.[1] Because of difficulties in using the first approach in the case of the present model, which includes nonlinearities and lags of five periods, no efforts were made to derive the analytical solution of the model in this study. As stated, for example, by NAYLOR (1971, p. 299), the analytical solutions for models of this kind are difficult if such a solution exists in the first place. Therefore, the simulation remained the only method for evaluating the basic model.

For the model evaluation purposes, two tests of the basic model were performed in this study using the simulation approach: 1) How well do the simulated values of the endogenous variables compare with known historical values in the estimation period (Section 5.2). 2) How accurate are the model's predictions of the behavior of the system in the future observation periods (Section 5.3).

Because the basic model is nonlinear in the variables, solving the values of the endogenous variables from this model is not as straightforward as in the case of linear models for which the reduced form can be easily derived from the structural form. However, since the only nonlinear elements the basic model includes are the products or ratios of one endogenous and one exogenous variable, the reduced form solution approach is still applicable to solving this nonlinear model for the endogenous variables of a given period.[2]

Assuming that the values of the exogenous variables are known, the basic model can for a given period t be expressed in terms of a linear equation system (in matrix notations):

(5.1) $$B_t^* Y_t + \sum_{i=1}^{5} B_i Y_{t-i} + CZ_t = U_t$$

where B_t^* is the coefficient matrix of the endogenous variables, in which the coefficients of those endogenous variables belonging to the nonlinear variable combinations have been adjusted by the values of the corresponding exogenous variables (for example, coefficient b^* for PKT_t in equation (4.5) is $-0.217/PR_t$). Y_t is the vector of the endogenous variables, B_i's ($i = 1 \ldots 5$) are the coefficient matrices of the lagged endogenous variables (Y_{t-i} are the vectors of the lagged endogenous variables) and C is the matrix of the coefficients of the exogenous variables (including the intercept terms). Z is the vector of the exogenous variables (including 1 for intercept terms of the equations) and U_t is the vector of the structural disturbances. Therefore, with simulation at time period t, the equation system (5.1) can be solved for Y_t and these endogenous variables

[1] In analytical method, the stability conditions of an equation system are determined by solving a set of difference equation system derived from the deterministic part of the model. Simulation methods permit examination of the response of the endogenous variables to discover whether the latter converge to their equilibrium values after the exogenous variables undergo impact changes.

[2] Alternative approaches, which could have been used, are so-called structural form solution methods, among which the GAUSS-SEIDEL method is the most used in the cases of nonlinear equation systems (See HOLT 1967).

can be expressed in terms of the coefficient matrices, predetermined variables and disturbances, whose values we already know:

$$Y_t = - B_t^{*-1} \sum_{i=1}^{5} B_i Y_{t-i} - B_t^{*-1} C Z_t + B_t^{*-1} U_t \tag{5.2}$$

In this way, when solving values of the endogenous variables for subsequent periods, the B_t^* matrix changes according to the changes in the exogenous variables of the nonlinear combinations. Because the inverse of B_t^* has to be computed separately for every period, this is a relatively costly method. However, B_t^* being a small matrix (6 by 6), the computation of the inverses of B_t^*'s was not any big problem in this study.

Program SIMULATE II — a simulation language developed by HOLT et. al. (1967) — was used in this study to solve values for the endogenous variables for different time periods. Only the deterministic simulation procedure was applied to the basic model (disturbance vector U_t was set to its expected value = 0). SIMULATE II is also capable of performing stochastic simulations of an econometric model, but — because of a great number of computer runs necessary in stochastic simulation procedures — this approach was not applied to the present model due to the limited resources available for this study.[1] For the same reason, simulating the model for several time periods (for example, 50—100) with the same values of the exogenous variables in order to test whether the endogenous variables converge to their »equilibrium» values, was not performed in this study. However, we believe that the two tests taken in this study will reveal the most essential properties of the model for evaluating the validity of the model.

5. 2. Historical Simulation

For the purpose of the historical price policy analysis that will be conducted later in this study, it is important to test, how well does the basic model simulate historical time paths of the actual system. Therefore, the basic model was simulated to generate the values of the endogenous variables for the estimation period (1956/I—1970/II). In this simulation, we treated the model as a closed-loop simulation model. That is, for given starting values of the lagged endogenous variables and given values of the exogenous variables, we solved the model each period for the current values of the endogenous variables.[2] Thus, in this method also values for the lagged endogenous variables are generated by the model (except the starting values for them).

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[1] This may be a shortcoming of the model evaluation process, for HOWREY and KELEJIAN (1971, p. 299—319) suggested that the properties of dynamic nonlinear models should be studied in terms of stochastic simulation procedures. They also stated that nonstochastic simulation of nonlinear models yields results that are not consistent with the properties of the reduced form of the model.

[2] In dealing with different kinds of methods of generating simulated values LABYS (1973, p. 201) calls this approach the final method.

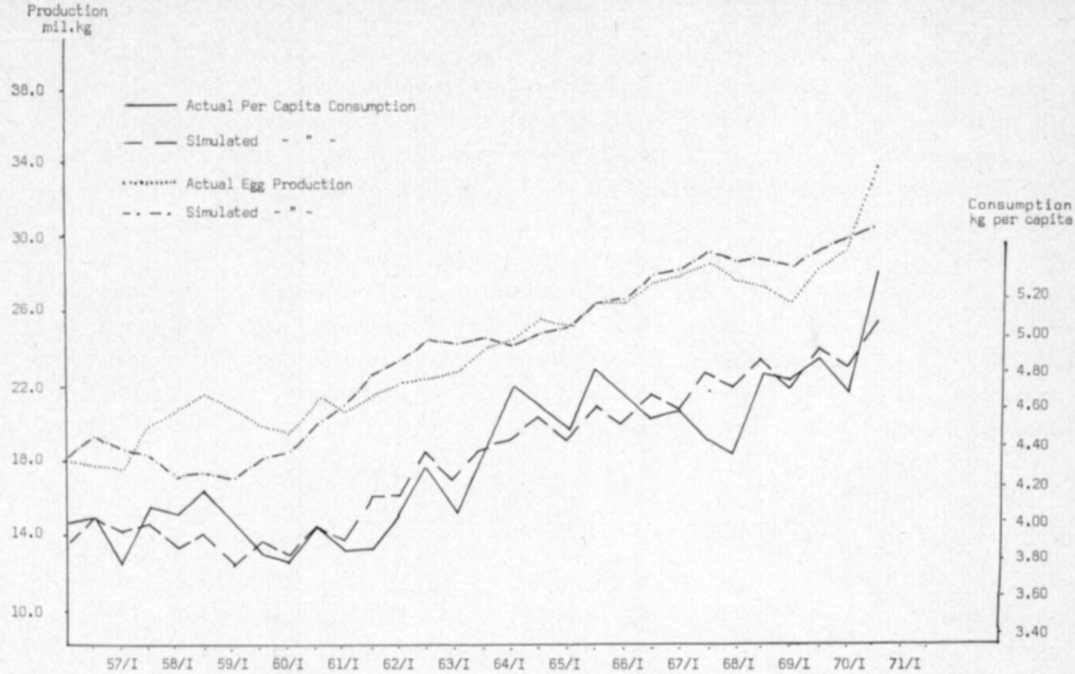

Figure 5.1. Egg Production and Per Capita Consumption in 1956—70: Actual and Simulated Values.

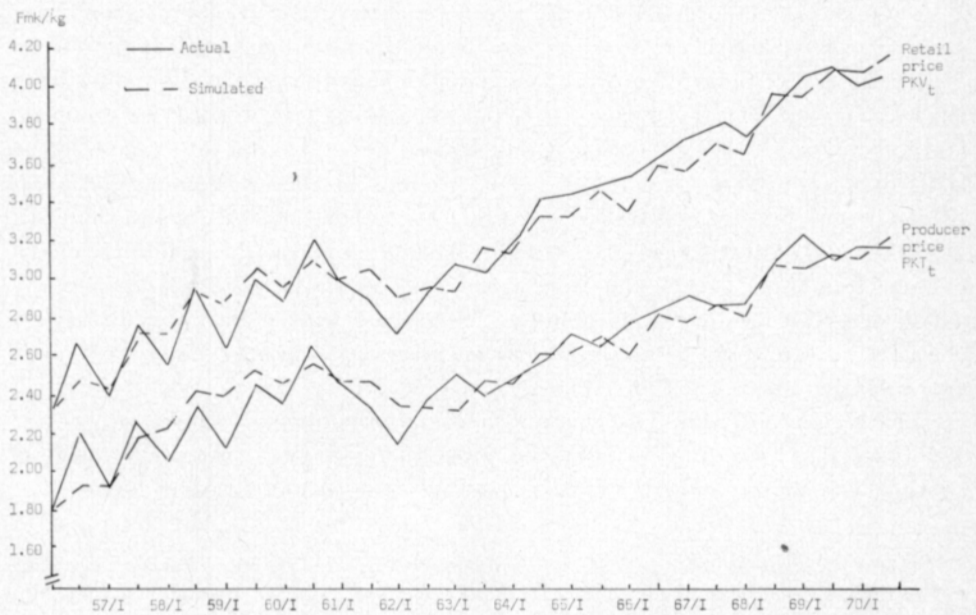

Figure 5.2. Egg Prices in 1956—70: Actual and Simulated Values, Fmk/kg.

Figures 5.1 and 5.2 contain graphical comparisons of the simulated time paths and the actual time paths of the key endogenous variables: egg production (TS_t), per capita consumption (CO_t) and prices (PKT_t and PKV_t). A casual observation of these results would lead us to the tentative conclusion that the basic model does a reasonably good job of simulating the behavior of the egg industry — especially in the latter part of the sample period. On the other hand, the model seems to underestimate both the production and consumption of eggs in the last periods of the 1950's. One reason for this underestimation may be the fact that the starting values of the lagged endogenous variables are not in accordance with this model structure leading to the underestimation of production and consumption in the first periods of simulation.

To provide a better criteria for the evaluation of the model's performance than the visual examination, Theil's inequality coefficients were computed for the endogenous variables.[1] Since there are two different inequality coefficients (U_1 and U_2) suggested by THEIL (1958, p. 32 and 1966, p. 28), the formulas of both the coefficients are given below:

$$(5.3) \qquad U_1 = \frac{\sqrt{\Sigma (P_t - A_t)^2}}{\sqrt{\Sigma P_t^2} + \sqrt{\Sigma A_t^2}} \qquad U_2 = \frac{\sqrt{\Sigma (P_t - A_t)^2}}{\sqrt{\Sigma (A_t - A_{t-1})^2}}$$

Where P_t is the model prediction and A_t the corresponding actual value. The value of U_1 is bound to the interval 0 and 1. A value of 0 for U_1 indicates perfect prediction, while a value of 1 corresponds to perfect inequality. U_2 is also bound by 0 with perfect forecasts, but U_2 has no upper bound. $U_2 = 1$ when the prediction model is the naive no-change extrapolation ($P_t = A_{t-1}$).[2]

There is only one model structure to be evaluated and, therefore, the interpretation of U_1 and U_2 test values is a little difficult because of the lack of an explicit reference point.[3] As for U_2, one possibility is to compare U_2 values from the basic model with those from the hypothesized naive no-change extrapolation method referred to above (where U_2 is always $= 1$). Taking into account that with this simulation we actually predict values of the endogenous variables fifteen years onward by the use of the basic model, we can argue that this alternative U_2 value ($= 1$) provides a reasonably rigorous basis for the model evaluation. Since actual changes in the endogenous variables are relatively small, one may need a rather complete model to predict endogenous values for the next fifteen years as accurately as does the hypothesized naive no-change extrapolation model defined above.

The U_1 and U_2 statistics computed from the simulated values for periods 1956/I—1970/II are given in Table 5.1. Since the graphical comparisons suggested that the discrepancy between the actual and simulated values for the key

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[1] Many different techniques, such as the analysis of variance, regression analysis, nonparametric tests, spectral analysis, etc., have been suggested for testing of simulation models (See NAYLOR 1971, p. 159—163).

[2] As to the advantages and disadvantages of these two coefficients, see LEUTHOLD (1975, p. 344—346). THEIL suggests two reasons why one might prefer U_2 over U_1: 1) U_2 is related more directly to the concept of the failure of the forecast and 2) the denominator of U_1 depends on the forecasts and it is therefore not true that the coefficient is uniquely determined by the mean square predictive error (ref. LEUTHOLD 1975, p. 345).

[3] Of course, comparisons between the inequality coefficients of the final version of the basic model and the initial specifications of that model would have been possible but probably not very interesting.

endogenous variables is greater in the early part than in the latter part of the estimation period, U_1 and U_2 coefficients were also computed for the simulated values of periods 1963/I—1970/II.

Table 5.1. Theil's Inequality Coefficients (U_1 and U_2) for Evaluating the »Goodness of Fit» of the Basic Model for Period 1956—70.[1]

Period	Endogenous Variable						
	SP_t	KK_t	TS_t	PKT_t	PKV_t	CO_t	UK_t
1956—70							
U_1	0.054	0.076	0.034	0.022	0.017	0.023	0.129
U_M	0.002	0.007	0.002	0.000	0.000	0.001	0.002
U_S	0.019	0.030	0.131	0.050	0.047	0.015	0.085
U_C	0.979	0.963	0.867	0.950	0.952	0.984	0.913
U_2	0.082	0.268	1.345	0.620	0.590	0.773	1.255
1963—70							
U_1	0.056	0.060	0.019	0.015	0.014	0.023	0.075
U_M	0.019	0.031	0.175	0.191	0.194	0.000	0.218
U_S	0.007	0.055	0.037	0.002	0.117	0.111	0.241
U_C	0.974	0.914	0.788	0.807	0.689	0.889	0.541
U_2	0.086	0.205	0.733	0.868	0.924	0.736	0.741

[1] The numerator of U_1 has been decomposed into its bias component U_M, variance component U_S, and covariance component U_C (See THEIL 1958, p. 34—35) for evaluation of the source of the forecast error. The optimal values are: $U_M = 0$, $U_S = 0$ and $U_C = 1$ and the following equation holds for these components: $U_M + U_S + U_C = 1$.

All the U_2 statistics for the latter part of the sample period are smaller than one; thereby, indicating that the basic model predicts the values of the endogenous variables more accurately than the naive no-change extrapolation model for this period. This also holds for the U_2 statistics computed from the entire period except for those of production (TS_t) and net exports (UK_t). As stated, this is mostly due to the discrepancy between the actual and simulated values in the first years of the sample period. Decomposition of U_1 into U_M, U_S and U_C leads us to the same kind of conclusions on the model's ability to forecast the values of different endogenous variables as the U_2 coefficients. The covariance component, U_C, got its lowest values from production and net export forecasts and, in the latter period, also from the retail price forecasts. It should also be mentioned that regressing the actual values on the generated values — the test of the »goodness of fit» suggested by COHEN and CYERT (1961, p. 120) — also led to the similar results from the standpoint of the model's validity to forecast the endogenous values.[1]

[1] For example, when regressing the actual values of KK_t (the number of culled layers) on the generated values ($K\hat{K}_t$), the resulting regression equation is

$$KK_t = \underset{(0.1358)}{0.0286} + \underset{(0.095)}{0.966}K\hat{K}_t + u_t,$$

where the intercept does not differ statistically from zero ($t_a = 0.21$) and the regression coefficient from unity ($t_\beta = 0.36$), which are the optimal values of the parameters.

5. 3. Ex-Post Forecast Simulation

To evaluate the performance of the basic model outside the estimation period, ex-post forecasts for the endogenous variables for periods 1971/I—1974/I (seven periods = 3.5 years) were generated. Similar to the historical simulation, only the actual values of the exogenous variables and the starting values for the lagged endogenous variables were given in the model and all the other variable values were generated by the model. Since the main field which the basic model will be applied to, is to forecast the future outcomes of different price policy alternatives for the basis of policy decisions, this test is one of the most important parts of the model evaluation. In this way we are able to explore how the model behaves when the exogenous variables (including the control variable of the policy maker) take value combinations which diverge from those typical to the estimation period. As stated by NAYLOR (1971, p. 158), the final decision concerning the validity of the model must be based on its predictions.

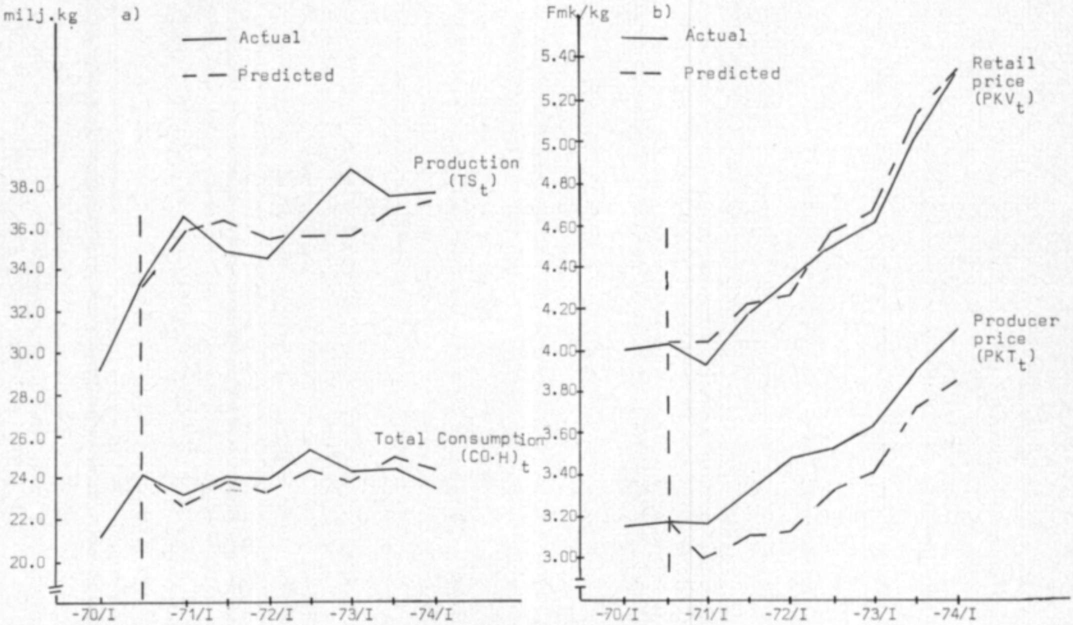

Figure 5.3. Ex-Post Forecasts for the Most Important Endogenous Variables Generated by the Basic Model and the Actual Values of These Variables in 1971—74/I.

The ex-post forecasts and forecasting errors are given in Appendix 6 and, in addition, Figure 5.3 contains the graphs of four of the variables whose time paths were predicted as well as the actual time paths of these variables. As can be seen from Figure 5.3 a, the production forecasts compare reasonably well with the actual production except in the first half of the year 1973, for which the forecast error is some —8 percent (the errors of the other periods are all smaller than five percent).[1] As to the egg consumption (the total consumption

[1] On the other hand, there is always a possibility that errors occur also in the actual production figures.

$(CO \cdot H)_t$ in Figure 5.3 a to ease the scaling problems of the figure), the forecast errors of the model are under five percent of the actual values in all the periods. Similarly, the model simulates rather well the actual time path of the retail price of eggs: the largest forecast errors account only for some 2.5 percent of the corresponding actual values.

On the other hand, the model consistently underestimates the producer price over the entire prediction period: the predictive values are, on the average, some 6 percent lower than the actual values. One reason for this kind of underestimation is certainly the remodification of the target price rules for eggs in the early 1970's due to serious surplus problems.[1] Without taking into account this rule change, the model continues to generate the producer price values which are consistent with the earlier provisions of the Price Acts (in the surplus situation: producer price $PKT_t = TAV_t - 0.05TAV_t$). This problem will be further discussed in Section 7.1.

Theil's inequality coefficients, U_1 and U_2, were also computed for these forecasts (Table 5.2).

Table 5.2. Theil's Inequality Coefficients from the Ex-Post Forecasts Generated by the Basic Model for 1971/I–1974/I.

	Endogenous Variable						
	SP_t	KK_t	TS_t	PKT_t	PKV_t	CO_t	UK_t
U_1	0.058	0.093	0.023	0.035	0.008	0.014	0.061
U_M	0.305	0.047	0.168	0.936	0.421	0.000	0.208
U_S	0.214	0.247	0.260	0.001	0.000	0.089	0.192
U_C	0.480	0.706	0.572	0.063	0.579	0.911	0.600
U_2	0.099	0.268	1.000	1.453	0.303	0.505	0.911

The U_2 values suggest that the basic model could predict the values of most endogenous variables, on the average, more accurately than the hypothesized naive no-change extrapolation model. In the case of forecasting egg production the models are equally efficient and, as expected on the basis of graphs, U_2 computed from the producer price forecasts is greater than one referring to the poor fit of the forecasts made by the basic model. The high value of U_M (the bias component of the numerator of U_1) for the producer price forecasts indicates the source of the inequality: the difference between the means of the actual and predicted values.

Although evaluation of the model via predictive tests remained imperfect, we may summarize the above test results by stating that the basic model seems to have some good properties for price policy analyses and its forecasting accuracy is at least satisfactory. These results cannot, however, be interpreted

[1] The provisions concerning the computing export subsidies were changed such that the price paid to producers can reach the average target price level even in the surplus situations. According to the earlier provisions export subsidies were computed on the basis of the lower limit of the target price range ($= 0.95TAV_t$).

in such a way that the same model structure — once estimated — is valid for price policy analyses for a long time in the future. The efficient use of this econometric model requires continuous development of the model: testing alternative specifications, and re-estimating coefficients, when the model is used for analyzing policy alternatives in the course of time.

6. Price Policy Analysis for the Period 1956–70 by Means of the Basic Model

6. 1. General Framework

The econometric model developed and tested above allows us to conduct historical price policy simulations of certain kinds and, thus, enables us to assess the outcome of alternative price policies. In this section we will use the basic model for evaluating the price policy the government had pursued in period 1956—70 when implementing the target price system under the Agricultural Price Acts. In this task we will concentrate on the question: would some other price policy or policy mix have been more effective from the standpoint of society than the actual price policy for achieving the main policy goals (Section 1). This kind of analysis might be of interest, because the price policy applied to the egg industry in the above mentioned period has resulted in surplus problems and, accordingly, in increases in government expenditures on export subsidies.

There are, in theory, a great number of different policies or policy mixes available to the government to be applied to the egg industry (different kinds of price support programs, production quota schemes, marketing fees, etc.). That is why, we wish to emphasize in this connection that the following price policy analysis does not purport to have discovered an optimal policy for the egg industry in the above mentioned period. Selecting an optimal policy or policy mix for a given agricultural product is, in itself, a comprehensive and complex issue involving many kinds of aspects and considerations. On the other hand, even the available econometric model restricts our possibilities in this respect: we can only use the instruments included in the model (and instruments whose impact on the endogenous variables can be assumed to be negligible). Accordingly, the following analysis can better be viewed as an illustration of the type of simple price policy analyses that can easily be conducted by means of the basic model in a real decision situation.

Hence, in this section we will concentrate only on one alternative to the actual policy and compare these alternatives with each other as to their effectiveness in reaching the two price policy goals. The alternative policy is a policy mix consisting of: 1) the target price system for maintaining a reasonable balance between domestic production and consumption. In our policy analysis, we assume that the domestic egg production should exceed the domestic consumption by five percent as suggested by the Agricultural Committee in 1969. 2) making direct cash payments (which are not related to the production volume of firms) to producers to attain the income objective if the target income level is not reached at the prevailing target price level in a given period.

This policy alternative — henceforth called the equilibrium price policy alternative — consists of two policy instruments for attaining two quantitative policy objectives. Thus, this policy mix is consistent with the theory of economic policy: a necessary (but not sufficient) condition for reaching a number of quantitative objectives is that the policy maker employs with a similar number of policy instruments (JOSLING 1969, p. 188–189).

Before we can draw conclusions from the desirability of these two policies, we have to provide some kind of criterion for evaluating alternatives from the standpoint of society. Some authors (for example, WALLAGE 1962, p. 590–594, DARDIS 1967, p. 597–609, JOSLING 1969, p. 175–191, CHAYAT et. al. 1974, p. 1–44) have used certain concepts of welfare economics — such as the net social cost[1] associated with a given policy — as a criterion for ranking the policy alternatives. Since the objective of our agricultural price policy is mainly to guarantee the stability of domestic food production and to improve unequal income distribution in society,[2] this criterion — taking into account only the economic efficiency — does not seem to be appropriate for the purposes of this study.[3] In addition, the net social cost of a policy program is difficult to measure empirically (See, for example, WALLACE 1962, p. 580–594).

That is why, the evaluation of alternative price policies in this study will be made on the basis of more concrete criteria: changes in producers' incomes, government and consumers' expenditure associated with the policy alternative. An additional reason for using these criteria is that usually the policy makers are interested in just these issues when making decisions concerning future policy.

The problem formulation of the price policy analysis of this section can be illustrated by means of supply and demand schedules in Figure 6.1.[4] The actual price policy alternative can be characterized by price level p_1: the target prices have been set in excess of the level that would have sustained the domestic market balance in each period. Therefore, to maintain the price level p_1 the government has to pay subsidies such that egg exporters are able to export surpluses (= EC in Figure 6.1, the subsidy per unit = $p_1 - p_w$, where p_w

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[1] The social cost concept can be viewed as the amount of resources or utility forgone when an unstable system either produces too much or too little (for more detail; see TWEETEN and TYNER 1966, p. 33–38).

[2] In this context we have to point out that even though our target price system certainly improves the income distribution between the agricultural and non-agricultural sectors, it is not obviously a good measure to reduce income inequality within the agricultural sector.

[3] RAY and TWEETEN (1976, p. 28) in dealing with different criteria for ranking policy alternatives state, for example, that »the chief weakness of net social costs is failure to account for equity and stability in the system. In general, society seems willing to trade some efficiency for more equity and stability.»

[4] Since the purpose of Figure 6.1 is only to illuminate the problem, the supply and demand curves have been drawn arbitrarily and, therefore, they may not correspond exactly to the estimated relationships in this study. The demand curve in Figure 6.1 refers to demand at the producer price level, which can be derived from the original demand relation (See TOMEK and ROBINSON 1975, p. 44–49).

is the world marked price of eggs). Accordingly, the total revenues of egg producers are represented by area OABC, consumer expenditures (at the producer price level) by area OADE, export revenues by area ENKC and export subsidies by area NDBK, respectively.

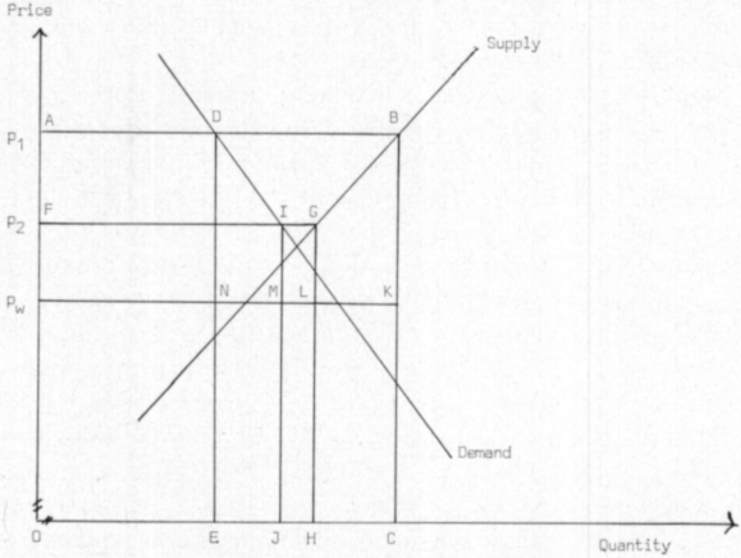

Figure 6.1. Supply, Demand and Net Exports of Eggs at Different Price Levels.

In the case of the equilibrium price policy direction we assume that the target price level could have been fixed such that domestic production would have exceeded domestic consumption by only some 5 percent in each period. Assuming that price level p_2 corresponds to this objective, area OFGH represents the total revenues of egg producers in this alternative. Consumer expenditures, export revenues and export subsidies are represented by areas OFIJ, JMLH and MIGL respectively. The excess resources corresponding to egg production HC could have been used for producing other goods in the case of the equilibrium price policy. Due to the low producer price level of eggs, the net incomes of producers associated with the equilibrium price policy is most likely to be lower than in the case of actual price policy and; therefore, we assume that the government will make up the difference in the form of direct payments to producers to attain the income target. In this analysis we assume that direct payments do not influence the quantity of egg produced, since the direct payment scheme is considered to function so that payments to a single producer are not related to the production volume of his firm.

There are many difficulties in this kind of analysis and, therefore, many simplifying assumptions have to be made. In addition to problems in deriving the equilibrium target price path for period 1956—70 (discussed in the following section), difficulties also arise from estimating the net incomes generated by those production resources that would have been donated to other production activities in the case of the equilibrium price policy. The easiest — and perhaps the most frequently used — way to solve this problem would have been to make an assumption that they would have generated the same net income for producers in their alternative use without government subsidies as they have actually generated in the egg industry.

However, since there have been excess capacity in the agricultural sector as a whole, and since many production factors have had no alternative use outside agriculture, it may be more realistic to assume that these excess resources would have been devoted to the production of other agricultural products, whose domestic production may, in reality, have exceeded the domestic consumption in period 1956—70. To simplify the problem, we assume here that they would have been devoted to pork production only. In practice, another econometric model would have been necessary to forecast and assess the impacts of this kind of shift in resource use on prices and consumption of pork and other agricultural products. However, instead of building an econometric model for these purposes, we made some simple assumptions concerning these impacts which are discussed later in this study.

6. 2. Derivation of the Equilibrium Price Policy Alternative

The equilibrium price policy alternative was above defined as a policy under which the domestic egg production would have exceeded the domestic consumption by five percent in each observation period. Since the target price is assumed to be the only policy instrument available to the policy maker for guiding domestic production and consumption, problems in determining the equilibrium values of the endogenous variables for period 1956—70 relate to those of finding the target price path that would have led to the above defined policy goal. Since the target price is an exogenous variable in the model, a straightforward solution of the equilibrium price levels is not possible: we can only simulate the impact of different target price levels on the development of the egg industry.

Therefore a kind of iteration approach — successive simulation runs by the model — was used to find out the equilibrium target price path for period 1956—70. After selecting the starting path of the target price development[1] and solving the values of the endogenous variables associated with this price path, we made several successive simulation runs devising the target price path in each run on the basis of the balance between domestic consumption and production generated by the previous run. The time paths for the other

[1] Actually, the initial target price path to be used in the first simulation run was determined by solving it from the model which was derived from the basic model through the following transformations: net exports (UK_t) were defined to account for 5 percent of the total consumption (the equation for net exports: $UK_t = 0.05\ (CO \cdot H)_t$) and the target price was defined to be an endogenous variable in this model. These transformations allowed us to use the model for solving the equilibrium target price path for the sample period. However, due to the distortion of the model through these transformations, the model solution resulted in a target price path with widening fluctuations. The linear trend values based on the generated target price path were, therefore, used as starting values for the target price in the iteration procedure.

exogenous variables were not changed in these simulation procedures. Finally, we ended up with solutions which yielded the production and consumption paths as shown in Figure 6.2 and producer price development as shown in Figure 6.3 (the values of the most important endogenous variables are given in Appendix 7).

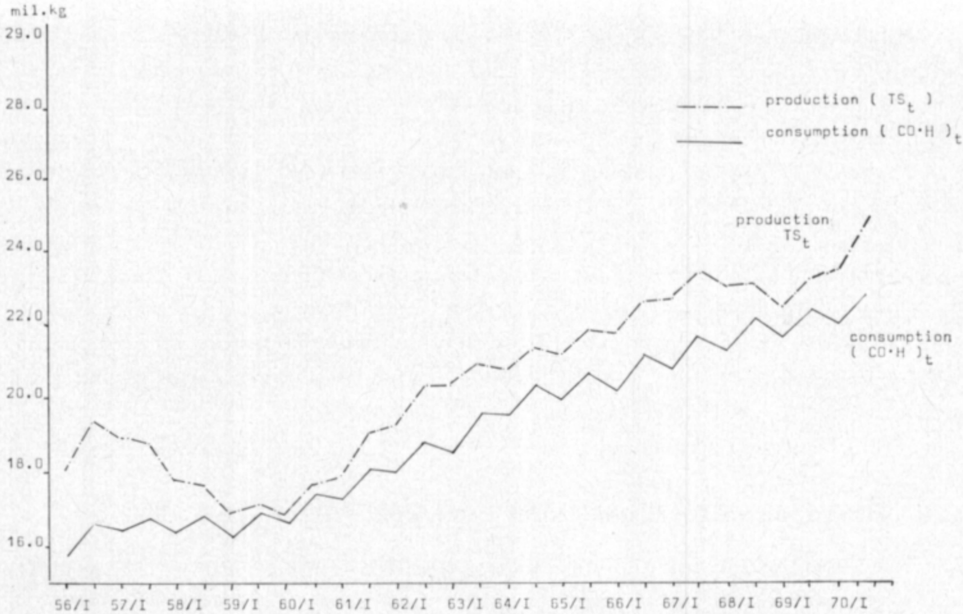

Figure 6.2. Production and Total Consumption of Eggs Under the Hypothesized Equilibrium Price Policy in 1956–70, mil. kg. The Time Paths are Generated by the Basic Model.

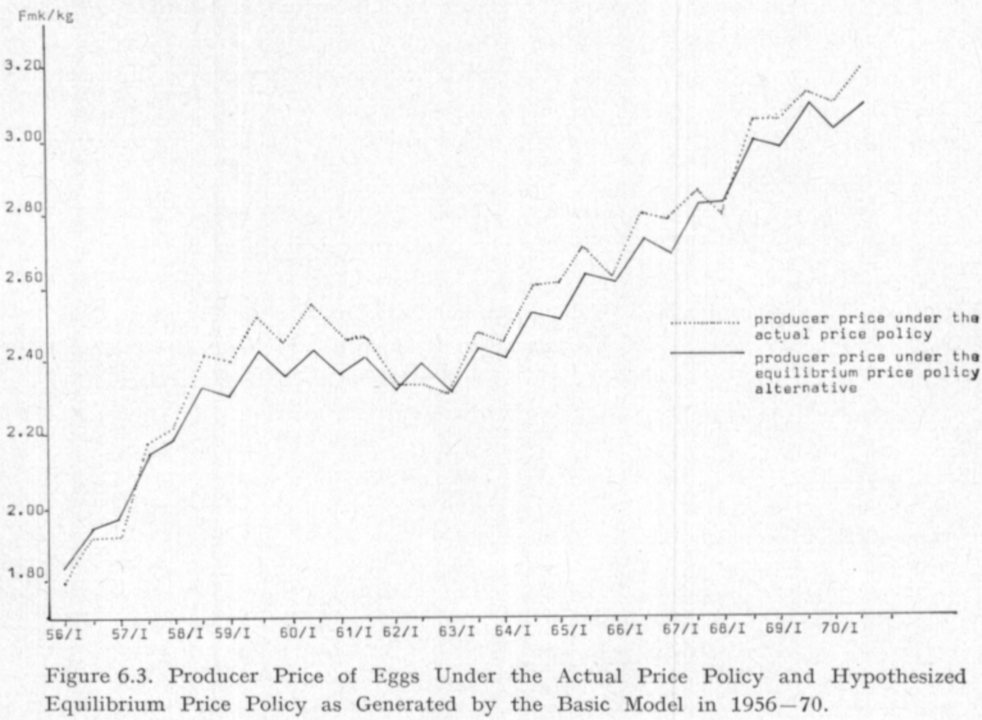

Figure 6.3. Producer Price of Eggs Under the Actual Price Policy and Hypothesized Equilibrium Price Policy as Generated by the Basic Model in 1956–70.

As can be seen from the Figure 6.2, this solution does not exactly satisfy our original assumption of the equilibrium policy alternative. The proportion of net exports varies around its target value — five percent of the total consumption — averaging 6.8 percent in the entire period. However, since the resulting balance between production and consumption is reasonably close to our original definition of this policy alternative, and since the solution in any case remains a tentative effort to describe the development of the egg industry under a price policy different from the actual one in period 1956—70, this solution was considered as sufficient to represent the development of the egg industry under the hypothesized equilibrium price policy.[1]

In this context we also want to emphasize the tentative nature of policy simulations of this type. Due to many simplifying assumptions, which have had to be made, one should be very careful in drawing conclusions from the simulation referred to above. First of all, we have assumed that the egg industry resulting from the equilibrium price policy would have reacted and behaved in the same way as the actual egg industry has done in the sample period. However, since the equilibrium price policy would have resulted in different structure and scale of the egg industry, the production responses to price changes might have been quite different from the actual one in this case. Another question to be considered at this stage is the values of the exogenous variables; for example, the feed price developments might have been different from each other in these two policy alternatives.

In interpreting the results we should also bear in mind that the equilibrium solution is based on the assumption that the government would have consistently pursued the equilibrium policy alternative over the entire period. Thus, the solutions associated with the policy alternatives gradually turn separate over periods of time as the values of the lagged endogenous variables of a given period associated with the policy alternatives diverge from each other. Accordingly, for example, the generated price paths must be interpreted separately. Therefore, on the basis of these results we cannot conclude that, for example, adjusting the prices to the level of the equilibrium policy only in the latter part of the sample period would have resulted in a reasonable equilibrium between production and consumption, because the states of the egg industry associated with the solutions of the endogenous values of the policy alternatives for that period differ from each other.

6. 3. Development of the Egg Industry Under the Alternative Price Policy Directions

To get a more detailed view of the differences between the actual and the hypothesized equilibrium price policy, we will in this section discuss briefly the development of prices, production and consumption of eggs under these

[1] On the other hand, the use of this solution to represent the equilibrium price policy alternative may be justified on the basis of the desirability of consistent price policy in the long run. Without permitting any flexibility in the production-consumption ratio, we might have ended up in fluctuating price paths with large, casual, downward and upward swings as indicated by the simulation of the model referred to in the first footnote of this section.

alternative price policy directions. Due to its crucial importance in the evaluation of the effectiveness of the policy alternatives, the main attention is focused upon the differences between the producer price paths generated by the model in the simulation of the price policy alternatives (Figure 6.3)[1] to identify those decision situations, in which the changes in the target price level have most likely been overmeasured from the standpoint of the domestic market equilibrium for eggs; thereby, leading to the surplus accumulation in future periods.

Our general conclusion from these results is that they reflect clearly the sensitiveness of the egg producers reactions to changes in the producer price level and, in this way, also the difficulties of the policy makers in setting the target price of eggs such that the domestic market equilibrium can be maintained. According to these results, only slightly smaller price changes compared to the actual ones during the period 1956—70 would have been required for maintaining a reasonable market balance in that period assuming that the policy makers could have adhered strictly to this policy alternative in every decision situation. On the other hand we have, however, to bear in mind that the state of the egg industry in the middle of the 1950's would have provided the policy makers with a good starting point for this kind of price policy: in this period net exports namely accounted for some 5—7 percent of the total consumption; thus, being almost in accordance of our definition of the equilibrium policy.

As to differences in the producer price paths in the individual periods, the results suggest that the price level was in periods 1956/I—1957/I too low from the standpoint of sustaining the market equilibrium in the long run. On the other hand, beginning from the latter part of the year 1957, the target price changes have been overmeasured leading to the surplus problems and, finally, to drastic price declines in the early 1960's. One reason for this kind of relatively high increase in the target price of eggs in the late 1950's was obviously the imperfect knowledge of egg producers' reactions in that situation. On the other hand, one can argue that these increases were also due to the government's efforts to adjust the structure of agricultural production according to the existing export possibilities through the use of price policy measures. The possibility of exporting the dairy products surpluses significantly deteriorated during this period (See SAULI 1971, p. 58). That is why — to pull excess resources out of the dairy industry — target price levels for the rest of the products included in the target price group were raised relative to that of milk.

Accordingly, the target price of eggs was raised by 0.35 Fmk through several separate decisions from September 1957 to September 1960. The simulation analysis of this study suggests that the balance in the domestic egg market could have been maintained through a producer price level some 0.10—0.15 Fmk lower than the actual price level.[2]

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[1] We have to point out that the producer price path under the actual price policy in Figure 6.3 refers to that generated by the model and not to the historical producer price. The differences between these two last mentioned paths can be evaluated on the basis of Figure 5.2.

[2] It should be mentioned that the increase of 0.35 Fmk in the target price level also resulted in the increase in the price ratio between the producer price of eggs and the feed price. A 0.10—0.15 Fmk lower increase in the producer price would have sustained the price ratio approximately unchanged.

Due to the deterioration of exports possibilities and to increasing surpluses, the producer price of eggs could no longer be supported at its 1960/II level (2.65 Fmk) in the following periods. Therefore, egg prices began to fall reaching their minimum in the first half of the year 1962 (2.14 Fmk). Because of these difficulties in maintaining the producer price of eggs within the stipulated target price range, the target price of eggs was decreased by 0.10 Fmk both in the year 1961 and 1962. According to the policy simulations of this study, the actual producer prices in these years were lower than the equilibrium producer prices generated by the model (Figure 6.3).[1]

The comparability of the two producer price paths degenerates over periods of time, because they are in the latter periods associated with quite different states of the egg industry (i.e. the values of the lagged endogenous variables differ from each other). However, it seems obvious that the decisions to raise the target price of eggs by 0.20 Fmk in the year 1966 and 0.15 Fmk in 1968 have especially contributed to the continuity of the surplus situation in the egg market. It is also interesting to note that, according to these results, the consistent equilibrium price policy for eggs in period 1956—70 would have resulted in only about a 0.10 Fmk lower producer price level in 1970 than the actual producer price level for this year.

The production of eggs under the equilibrium price policy (Figure 5.3) increases steadily from 37.58 mil. kg in 1956 to 43.39 mil. kg in 1970. The average growth rate per period is 1.2 percent compared to the corresponding actual growth rate of some 2 percent.[2] The results also suggest that only a minor upward shift would have taken place in the total consumption of eggs in the case of the equilibrium price policy: the estimated growth rate of both the time series is 1.3 percent per observation period.

6. 4. Effectiveness of the Policy Alternatives

Under both the price policy alternatives the self-sufficiency objective would have been attained in period 1956—70. As for reaching the other policy goal — the income objective — we have first to define the target development of the net incomes of producers employed in our system for the entire period to be able to assess the effectiveness of these policy alternatives in attaining our policy goals. Since we have no possibility of defining objectively the target income of these producers, for comparison purposes we simply assumed that the actual price policy had been successful in this respect and, accordingly, the income objective of producers has been reached under this price policy. Hence, the amount of direct payments which would have been necessary in the case of the equilibrium price policy can be computed on this basis: such that this policy alternative would have guaranteed the same income development as the actual policy. In this respect we have to point out that the evaluation of the policy alternatives is based on the total target income of the producer

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[1] As for Figure 6.3, we have to bear in mind that the model overestimates the producer price for those periods in the case of the actual price policy.

[2] Computed from a least squares exponential curve fit.

group in our system and, thus, the net income of an individual producer need not be the same under these two policy alternatives. Accordingly, as a criterion for evaluating the comparative effectiveness of these policy programs we use total net savings in export subsidies and consumer expenditures compared with the total decrease of the incomes of the producers in the system associated with adopting the equilibrium policy alternative instead of the actual price policy. Thus, in this analysis we compare whether the net savings mentioned above are sufficient to compensate the producers for the decreases in their incomes by making direct cash payments. The figures given in Table 6.1 help us to assess this question. For conformity, they are based on the values of the endogenous variables generated by the model in both the alternatives and refer to the entire period.

Table 6.1. Producers' Gross Revenue, Government and Consumers' Expenditure as well as Export Revenue Under the Actual Policy and Their Changes Associated with Adopting the Hypothesized Equilibrium Price Policy Alternative in Period 1956—70, mil. Fmk.[1]

	Actual Policy	Equilibrium Price Policy			
		Eggs		Pork	Total
			Change	Change	Change
	mil. Fmk	mil. Fmk	mil. Fmk	mil. Fmk	mil. Fmk
1) Producers' Gross Revenue	1848.50	1555.01	−293.49	260.84	−32.65
2) Export Revenue	220.83	60.70	−160.13	138.79	−21.34
3) Consumers' Expenditures	1863.73	1855.99	−7.74	—[2]	−7.74
4) Government Expenditures: Export Subsidies	261.83	65.49	−196.34	146.23	−50.11[3]
5) Net Change in Consumers' and Government Expenditures (items 3 + 4)	—	—	−204.08	146.23	−57.85
6) Net Savings[4]	—	—	—	—	25.20

[1] Data, on which the figures are based, is given in Appendices 1, 2, and 7.

[2] A part of the increase in pork production could have been consumed at home: in periods when pork has been actually imported. But the total consumption expenditures on pork would not have changed since the increase in domestic production would have only been substituted for imports.

[3] Actually this is a net change. Since pork imports would have decreased during some periods, government revenues from import levies would have decreased by 4 mil. Fmk. This decrease has been subtracted from the total net savings in export subsidies.

[4] Assuming that the production costs of the system would not have changed. Computed by subtracting item 1 from item 5.

The main assumptions which have been made during these computations are:

1) The excess resources actually used in egg production would have been donated to pork production in the case of the equilibrium price policy alternative.[1] The transformation coefficient between pork and eggs was

[1] In the first few observation periods the egg production of the equilibrium price policy is a little higher than that of the actual price policy alternative. In these cases we assumed that resources necessary to produce the additional egg output in these periods would have been taken from resources actually assigned for pork production.

estimated to be 0.8 (i.e. in terms of resource requirements 8 units of pork are equivalent to 10 units of eggs).

2) Changes in pork production do not change the prices and domestic consumption of pork. Therefore, changes in pork production influence exports and imports of pork only.
3) Although the consumption level of eggs under the equilibrium policy is higher than under the actual policy, we assumed that this would have exerted no influence on the consumption levels of other agricultural products for two reasons: 1) the differences in egg consumption levels are small (on the average, the egg consumption under the equilibrium policy alternative would have been 0.7 percent higher than under the actual price policy), and 2) it was difficult to identify the products for which eggs would have been substituted.
4) In computing the gross revenue of producers in the system we took into account only the final products (eggs and pork). The gross revenue figures are based on the total production including the direct home consumption on farms. Similarly, consumer expenditures include also the home consumption on farms.
5) The prices of the exports and imports of eggs and pork were assumed to be independent of the agricultural policy pursued in Finland. Thus, the differences between per unit subsidies for eggs associated with the policy alternatives are determined by the differences between domestic price levels associated with the policy alternatives.

Under these assumptions, the gross revenue of producers in this system would have decreased in all by some 32.7 mil. Fmk in period 1956—70, if the government had adopted the equilibrium price policy alternative instead of the actual policy (i.e. 1.6 percent of the actual gross revenue in that period). The decrease is mainly attributable to the lower price level of eggs; the excess resources assumed to have been devoted to pork production would have generated approximately the same gross revenue as they have actually done in the egg industry under the actual price policy. Changes in the intermediate production costs of the system due to the policy shift are difficult to estimate. However, if we simply assume that they are approximately the same under both the policy alternatives, we end up with the conclusion that the net incomes of the producers under the equilibrium price policy would have been some 32.7 mil. Fmk lower than under the actual policy. This is the amount which the government ought to have paid to producers in the form of direct payments in order to attain the income objective of the producers in the entire period.

According to these results, the total export subsidies for eggs which the government ought to have paid in the case of the equilibrium price policy would have totalled some 65 mil. Fmk in the entire period. Since almost all the pork produced by this system would have been exported, the government subsidies for pork exports would have increased by 142.5 mil. Fmk. Moreover, the total amount of the import levies from pork imports would have reduced by some 4 mil. Fmk in the case of the equilibrium policy alternative. Thus, the policy shift would have resulted in a net savingos to the government of 50.1 mil. Fmk.

Moreover, domestic consumers could have obtained eggs at lower prices in the case of the equilibrium policy than under the actual policy. However, consumers' total expenditures on eggs would have decreased only moderately (by 7.7 mil. Fmk in the entire period), because the total egg consumption would have increased in the equilibrium policy alternative. As stated before, we have not taken into account the substitution effect between eggs and other agricultural products in computing this change in consumer expenditure due to a policy shift.[1]

Thus, the net savings to the government and consumers, resulting from the adoption of the equilibrium price policy would have been sufficient to compensate the losses of the egg producers incurred by the lower producer price level of eggs resulting from that alternative. If the government had made up the difference of 32.7 mil. Fmk between the net incomes of producers under the policy alternatives in the form of direct payments, the net savings to the government would have totalled some 17 mil. Fmk in the entire period. This together with the decrease in consumers' expenditure suggests that the net savings to society through adopting the equilibrium price policy alternative instead of the actual policy would have been some 25.2 mil. Fmk in period 1956—70 under the assumptions mentioned above.[2] The net savings discussed above refer to period 1956—70 only. In practice, the actual price policy resulted in an excess capacity of some 40 percent in the egg industry by the year 1970. Since the rapid downward adjustment of the price level is not possible without causing unfair losses to some producer groups, the government will most likely continue to pay export subsidies for eggs also in the future. Therefore, in evaluating the policy alternatives we should also take these future periods into account. However, there are many difficulties in estimating the future savings of the equilibrium price policy and, so, we will not deal with them in this context. To get some idea of their likely magnitude, we will only refer to the net savings of the equilibrium price policy in 1970, which is the last year of our simulation period. The reduction in the producers' gross revenues would have been some 3 mil. Fmk, while decreases in government and consumer expenditure would have totalled to some 15 mil. Fmk. Thus, the net savings resultings from the adoption of the equilibrium price policy would have been some 12 mil. Fmk in the year 1970 only. However, we must point out that future net savings depend on the world market prices of eggs and pork (in the year 1970 they were comparatively favourable to pork).

To summarize the results discussed above we may conclude that the equilibrium price policy alternative — the target price system together with the direct payment scheme — would have been a more effective vehicle for attain-

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[1] Consumers' expenditure under the equilibrium price policy would have been some 21 mil. Fmk lower than the same consumption level at the actual retail prices. Assuming that the price ratios between foodstuffs would have been »correct» from the standpoint of consumers' welfare, this difference can be regarded as a net saving to consumers from the equilibrium price policy alternative, if we also take into account the substitution effects.

[2] The net savings are mainly due to the fact that supporting consumers abroad in the form of export subsidies for eggs and pork would have decreased if the government had adopted the equilibrium price policy for eggs.

ing our price policy goals in the case of the egg industry during the period 1956—70. This conclusion is based on the net savings throughout the entire period. As to individual observation periods, only in a few periods net savings resulting from the equilibrium price policy are not positive which is mainly due to the low world market price of pork.

7. Ex-Post Simulation of Alternative Price Policy Directions and Their Evaluation

7. 1. Policy Alternatives and the Simulated Outcomes of These Policies

In this section we will discuss in brief the results of the ex-post simulations of different policy alternatives for period 1971—74 generated by the basic model of this study. These ex-post simulations were done above all to get some idea of the nature of policy analyses that can be conducted by the model and, also, to evaluate the actual price policy the government has been pursuing in that period. We concentrated on only a few alternatives in which the policy makers would — we suppose — have been interested in fixing the target price level of eggs for the year 1971.

For defining the policy alternatives to be analyzed in this section, we assume that the policy makers in that situation anticipated — because the number of layers in the end of the year 1970 was relatively high — that the domestic egg production would grow substantially also in the year 1971 and exceed the domestic consumption by some 50 percent at almost any reasonable price level. Because such production increases are most likely to lead to a substantial growth in government expenditures on export subsidies in the future, we assumed that the policy makers would have been interested in the possibilities of changing the direction of the price policy for eggs: in such a way that a better balance between the domestic production and consumption could be attained in the future. In this respect we assumed that they would have been considering adjusting the domestic production gradually to the domestic consumption by using target price levels as their policy instrument. Since the other objective of our agricultural policy — to promote producers' net incomes to a level comparable with those of the other sectors in the economy — most probably cannot be achieved at the price level required for the adjustment of egg production and consumption, we assumed that the policy makers would have been ready to adopt some kind of direct payment scheme for attaining this policy objective.[1]

Let us assume that the policy makers would have specified their alternative policy goals in terms of annual adjustment rates: to attain a reasonable equilibrium between the domestic production and consumption

1) in 5—6 years (alternative 1),
2) in 7—8 years (alternative 2),
3) in 10—11 years (alternative 3),

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[1] Again we have to point out that direct payments to an individual producer must not be related positively to the production volume of his firm in order that this policy alternative should be effective.

and simultaneously taking care to reach the income objective of the producers in the system (= to raise the total net income of the producers at the same rate as the average incomes of employees in the other sectors of the economy increases). Let us further assume that the policy makers could have used the basic model of this study in searching for the target price paths which would have led the egg industry towards the above mentioned goals and for simulating the future production and consumption paths as well as the price levels associated with each alternative.

The solutions of the endogenous variables which correspond to the above mentioned adjustment target of each policy alternative, were generated by the model using the same kind of iterative procedure as was used in the previous chapter to find out the equilibrium target price path.[1] Again, we have to emphasize that these solutions only approximate the policy directions specified above: the adjustment rate varies between periods in each policy alternative, however, the average rate in each solution is such that the equilibrium objective could be attained within the defined time period.

Figures 7.1 a and 7.1 b indicate the simulated development of egg production and net exports under each policy alternative (values for the most important endogenous variables are given in Appendix 8). Since we already

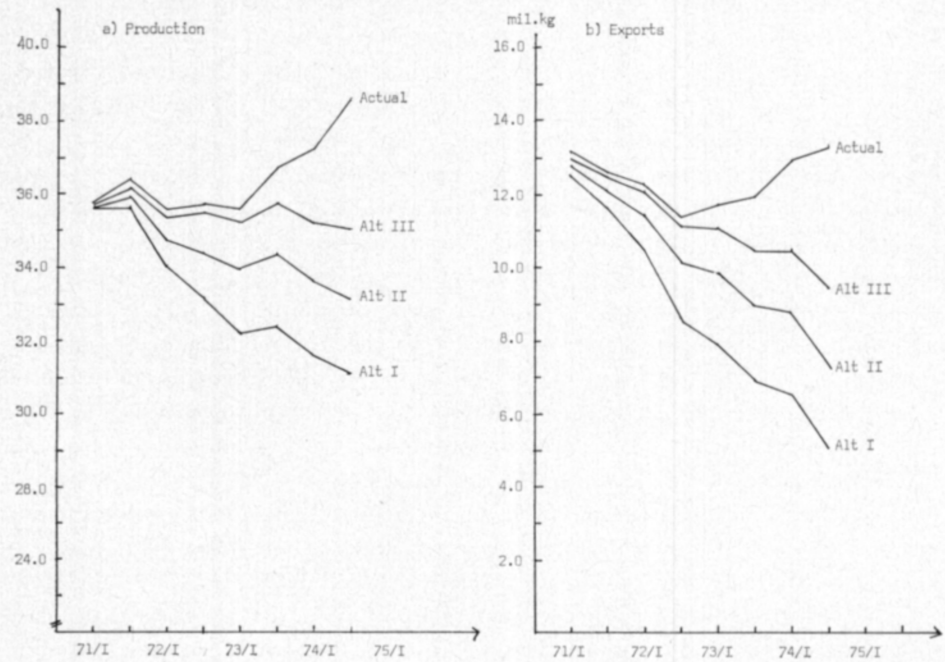

Figure 7.1. Production and Net Exports of Eggs Under Different Policy Directions in 1971—74. Production and Net Exports Figures are Generated by the Basic Model, mil. kg.

[1] To get starting values for the target price paths for the iteration procedures, the model was reformulated by fixing the net exports and consumption to each other with the following equation: $UK_t = K_t \cdot (CO \cdot H)_t$, where K_t is an exogenous variable, whose values were specified separately for each adjustment alternative. For example, in the first alternative K = 0.55 for 1971/I, K = 0.50 for 1971/II, etc. In this model the target price (TAV) was an endogenous variable, whose values could be generated by the model.

know the actual price policy the government has pursued in period 1971—1974, we use the values generated by the simulation of the actual price policy as a reference point in evaluating the effectiveness of these policy alternatives in the next section. One reason[1] for using generated values rather than actual ones is to provide a better consistency between the outcomes of different policy alternatives, because the model seemed to underestimate the producer prices in the simulation of the actual price policy for periods 1971/I—1974/II, as stated in Section 5.3.

The differences between producer price time paths associated with the actual policy and the above specified policy alternatives are as follows:

Period		Alternative 1	Alternative 2 Fmk/kg	Alternative 3
1971	I	−0.21	−0.12	−0.05
	II	−0.13	−0.04	0.04
1972	I	−0.12	−0.04	0.02
	II	−0.13	−0.08	−0.06
1973	I	−0.18	−0.17	−0.17
	II	−0.36	−0.34	−0.31
1974	I	−0.42	−0.35	−0.19
	II	−0.49	−0.34	−0.19

As a general conclusion from these figures we can state that a comparatively big downward adjustment of the actual price level would have been necessary to adjust domestic egg production to domestic consumption within the 5—6 years proceeding from the situation at the end of the year 1970. Accordingly, the producer price level for the latter part of the year 1974 is some 0.50 Fmk lower under the first policy alternative than under the actual policy. However, the results suggest that policy alternative 3 (adjusting production to domestic consumption within 10—11 years) would have required only a minor downward adjustment of the actual price level during these first years assuming that the policy makers would have adhered consistently to this alternative from the year 1971: at the end of the test period (1974/II) the producer price of this alternative is only 0.19 Fmk lower than that of the actual policy.

The average changes in the values of the key variables per year in different alternatives are as follows:[2]

Alternative	Production TS_t	Net Exports UK_t Average change per year, percent	Total Consumption $(CO \cdot H)_t$
Alternative 1	−4.3	−24.2	+2.7
Alternative 2	−2.2	−14.5	+2.7
Alternative 3	−0.8	− 8.2	+2.6

[1] Using the generated values of the endogenous variables to represent the outcomes of the actual policy is also consistent from the standpoint of analyzing future policy directions in a real decision situation which we are, in fact, attempting to do in this section.

[2] Average changes per year have been computed by using a least squares exponential curve fit (estimated from yearly observations).

For comparison purposes it may be worth mentioning that the average growth rate of egg production under the actual policy is +1.6 percent per year computed from the generated values for egg production. Accordingly, also the average growth in net exports is positive but small; some 0.2—0.3 percent.[1] The average growth in egg consumption is almost the same in each alternative: 2.6—2.7 percent per year.

In practice, there is no way to analyze empirically the reliability of these solutions (i.e. whether the adjustment target of each alternative would have been attained under the corresponding producer price paths generated by the simulations or not). The question remains open in this study as it will remain open also in analyzing and evaluating alternative policy directions for future periods in a real decision situation. Changes in egg production in a given period can be assumed to depend on changes in the relationship between the marginal cost of producing one unit of eggs and the producer price of eggs. Estimating the marginal costs of the entire egg industry associated with different scales of the industry is, however, difficult (if not impossible)[2]. Therefore, in this respect we must rely merely on the model's validity to forecast producers' and consumers' reactions to changes in price levels. Evaluating the model indicated that the model was able to forecast rather well the development of the egg industry for period 1971—74 under the actual price policy. Assuming that the reactions of producers and consumers under the alternative price policy directions would not have been quite different from their actual reactions, the solutions associated with alternative price policies can be considered to represent the development of the egg industry under these policy alternatives.

7. 2. Evaluation of the Effectiveness of the Policy Alternatives in Attaining Policy Goals

In order to evaluate the effectiveness of the policy alternatives defined above in attaining our policy goals (producers' income target and the self-sufficiency) we made calculations similar to those in the previous chapter in comparing the equilibrium policy alternative to the actual price policy. Thus, for comparison purposes we assumed that the income target of producers in the system had been reached under the actual price policy in period 1971—74. As to the alternative use of the excess resources which would have been released from the egg industry if the government had adopted one of the price policy alternatives 1—3, we made two different assumptions: 1) they would have

[1] Actually, the exponential growth curve did not fit very well to the observational values of net exports.

[2] Some book-keeping results on the profitability of the egg production (See Westermarck 1973, p. 230—232) suggest that the average production costs of producing eggs were 3.12 Fmk per kg in 1971 and 3.21 Fmk per kg in 1972. However, since these results are based on a comparatively small group of firms which is not a random sample from the Finnish egg industry, these results cannot be generalized. Moreover, the variations of the production costs were wide even in this group: in 1972 the production costs of ten most profitable firms were some 14 percent below and those of ten less profitable firms was 15 percent above the average level.

been devoted to pork production (See Section 6.4), and 2) the excess feed grain would have been exported directly without processing it into eggs. Also, the entire increase in pork production that would have been produced by these recources, would have been exported since, in reality, the domestic pork production already exceeded the domestic consumption in that period.

Given these policy goals and assuming that all the other effects associated with each policy alternative[1] are approximately equal from the standpoint of society, the desirability of these policy alternatives depends on government and consumers' expenditures necessary to attain the specified policy goals under these policy alternatives. In this respect, we can evaluate the comparative effectiveness of policy alternatives 1—3 and the actual policy in period 1971—74 by exploring the net savings to society associated with adopting hypothesized policy alternatives 1—3 instead of the actual price policy, and which are presented in Tables 7.1 and 7.2. Again we have to point out that these figures are based on many assumptions whose validity in the real world is difficult to verify. However, we believe that these figures indicate at least the magnitudes of the net savings associated with each price policy alternative for assessing the desirability of these policy tools in guiding the egg industry according to the goals of our agricultural policy.

As can be seen from Table 7.1, producers' gross revenue would have decreased altogether by some 55 mil. Fmk in the entire period, if the government had fixed the target prices of eggs according to alternative 1 and the excess resources had been devoted to the production of pork. On the other hand, the government would have saved some 46 mil. Fmk in export subsidies by adopting policy alternative 1 instead of the actual policy, since egg exports would have decreased and exporting pork would not have required the same amount of export subsidies as the equivalent amount of eggs (in terms of resource requirements). Moreover, consumer expenditures on eggs would have decreased by some 26 mil. Fmk. Assuming that the intermediate production costs of the system would not have changed due to the policy change, the income target of producers in the system would have been possible to attain by compensating producers by some 55 mil. Fmk in the form of direct cash payments.

Hence, the net savings to society from adopting policy alternative 1 instead of the actual policy would have totalled some 17 mil. Fmk in period 1971—74. As to their distribution between the individual years within this four year period, our results suggest that the net savings would have grown with time. However, there would have been some casual variations around this general trend depending mainly on the variations in the export prices of eggs and pork: the biggest net savings would have been obtained in 1973 (11.2 mil. Fmk) and they would have been negative in 1971 (—2.5 mil. Fmk). In this context no attempts were made to measure net savings associated with the adoption of policy alternative 1 beyond the year 1974 because of difficulties

[1] Adopting totally different policy directions may in the short run result in some side-effects — negative or positive — such as unfair losses to some individual producers, capacity problems in the marketing sector, changes in feed imports etc.

Table 7.1. Estimated Producers' Gross Revenue, Export Revenue as well as Government and Consumer Expenditures under the Actual Price Policy in 1971—74 and their Changes Associated with Adopting Price Policy Alternatives 1—3. Excess Resources Were Assumed to Be Used in Pork Production.

	Actual Policy mil. Fmk	Price Policy Alternative 1	2	3
		Change, mil. Fmk		
1) Producers' Gross Revenue				
Eggs	1012.49	−163.65	−109.37	−60.82
Pork	—	108.16	65.53	31.79
Total & Net Change	1012.49	− 55.49	− 43.84	−29.03
2) Export Revenue				
Eggs	185.82	− 60.25	− 37.45	−19.01
Pork	—	79.30	48.12	23.59
Total & Net Change	185.82	19.05	10.67	4.58
3) Domestic Sales				
Eggs	919.76	− 25.85	− 18.67	−11.83
4) Government Expenditures[1]				
Egg Exports	285.40	−104.53	− 67.94	−36.58
Pork Exports	—	58.27	36.13	18.31
Total & Net Change	285.40	− 46.26	− 31.81	−18.27
5) Consumers Expenditures	519.76	− 25.85	− 18.67	−11.83
6) Net Change in Government and Consumers' Expenditures (items 4 + 5)	—	− 72.11	− 50.48	−30.10
7) Net Savings[2]	—	16.62	6.64	1.07

[1] Only export subsidies have been taken into account in computing government expenditures.

[2] Assuming that the production costs do not differ between the alternatives.

in forecasting the prices and exports of pork for which we had no econometric model.

Similarly, adopting policy alternative 2 instead of the actual policy would have resulted in net savings to society. The estimated savings are — quite logically — a little smaller than those in the first policy alternative: some 6.6 mil. Fmk in the entire period. In terms of government and consumers' expenditures in supporting producers' incomes and maintaining self-sufficiency in eggs, policy alternative 3 and the actual policy do not differ substantially from each other, because the development of the egg industry under these alternatives would not have been very different due to the long adjustment period allowed in alternative 3. Net savings associated with adopting policy alternative 3 would probably have grown in the future periods. However, even evaluating on the basis of period 1971—74 policy alternative 3 would have been a little more effective than the actual policy in attaining the policy goals.

When we, on the other hand, assumed that producers would have sold the excess feed grain at prevailing producer prices and all this feed grain had been exported directly — without processing it into livestock products — we ended up with the results given in Table 7.2. In these calculations the feed requirements per kg of eggs in the withdrawing egg production was assumed to be 4.0 feed units (prices, export subsidies for feed grain used in the analysis are given in Appendix 9).

Table 7.2. Estimated Changes in Producers' Gross Revenue, Export Revenue, as well as in Government and Consumers' Expenditures Associated With Adopting Policy Alternatives 1—3 Instead of the Actual Policy in 1971—74. Feed Grain Released from Egg Production is Assumed to be Exported.

	Price Policy Alternative		
	1	2	3
	Change, mil. Fmk		
1) Producers' Gross Revenue			
Eggs	−163.65	−109.37	−60.82
Feed Grain	43.78	27.67	3.36
Net Change	−119.87	− 81.70	−57.46
2) Export Revenue			
Eggs	− 60.25	− 37.45	−19.01
Feed Grain	42.13	27.14	3.50
Net Change	− 18.12	− 10.31	−15.51
3) Domestic Sales			
Eggs	− 25.85	− 18.67	−11.83
4) Government Expenditures			
Egg Exports	−104.53	− 67.94	−36.58
Feed Exports	7.53	4.44	0.26
Net Change	− 97.00	− 63.50	−36.32
5) Consumer Expenditures	− 25.85	− 18.67	−11.83
6) Net Change in Government and Consumers' Expenditures (items 4 + 5)	−122.85	− 82.17	−48.15

As to Price Alternative 1, producers' gross revenue would have decreased by some 120 mil. Fmk in 1971—74, which accounts for some 12 percent of the actual gross revenue in this period (Table 7.1). Likewise, the export revenue would have decreased by some 10 percent. However, on the other hand decreases in government expenditures on export subsidies and in consumers' expenditures would have totalled to some 123 mil. Fmk in the corresponding period. Thus, our calculations suggest that net decreases in export subsidies and consumers' expenditures would have been sufficient for compensating producers' losses due to adopting price policy alternative 1 instead of the actual price policy in period 1971—74. Even the gross revenue of the producers could have been raised to the same amount as under the actual price policy by paying direct cash payments from the net savings of the government and consumers. In addition, we have to point out that some of the processing costs of egg production could have been eliminated (such as labor, maintenance costs, etc.). In this study we did not, however, estimate these savings. Their magnitude is mainly determined by the possibilities to allocate these inputs to alternative uses. For example, these savings can be estimated differently depending upon the assumption of the impact of price policy alternative 1 on the structural development of egg production (alternative assumptions in this context are, for example, that price policy alternative 1 had reduced investments in new producing units or that this alternative had eliminated existing producing units). We have no knowledge of these impacts and, therefore, we have to bear in mind that the above mentioned 120 mil. Fmk can be regarded as an approximate maximum for a necessary compensation in order to maintain the net incomes of producers in the same way as the actual price policy has done.

Similar conclusions can be also drawn from the results concerning price policy alternative 2 in this analysis. On the other hand, our results suggest that price policy alternative 3 associated with exports of excess feed grain would have resulted in a net reduction of 48 mil. Fmk in the government and consumers expenditures in 1971—74, while the decrease in producers' gross revenue is some 57 mil. Fmk. Thus, when ranking the actual price policy and price policy alternative 3 — as defined in Table 7.2 — in terms of their effectiveness, decreases in the production costs of the sector are an essential question. In addition, differences in the future development of the egg industry between policy alternatives are an important aspect in this regard.

Hence, on the basis of these analyses we would recommend a new policy mix for supporting egg production in Finland instead of employing only the target price system: 1) using the target price system for adjusting the domestic egg production gradually to the domestic consumption and for maintaining a reasonable market balance after the adjustment period, and 2) introducing a direct payment scheme for attaining producers' income target if the target income level cannot be attained at the existing target price level in a given period (in this scheme the yearly payments per firm must not be related to its production volume). The results imply that the faster the adjustment rate, the greater the net savings to society under the relatively strict assumptions made in this study. However, there are many factors other than discussed above which influence the desirability of a certain adjustment policy (for example, equity considerations among producers and consumers). Moreover, we have analyzed only one type of policy mix above, and we do not know the effectiveness of other policy instruments available to the government. On the other hand, many kinds of assumptions can be made on the alternative uses of excess resources and the results of our analysis might change depending on these assumptions. Therefore, we may conclude from these results that adjusting the egg production to domestic consumption would have provided net savings to society in period 1971—74, but further analyses may be necessary to decide what instruments are the most effective in this situation. But such analyses are beyond the objectives of this study.

These empirical results conform with earlier theoretical findings that in terms of government expenditures the guarantee price system like our target price system, in which the price level is controlled by exports (and imports), is not as effective as the direct cash payment scheme in supporting agricultural prices if the supply and demand for those products is elastic.[1] Moreover, one of the goals of our agricultural policy should be improving the income distribution among the agricultural producers, and in this respect the target price system is also inefficient (it may even worsen the income distribution within agriculture). Therefore, the additional advantage of adopting a direct payment scheme for supporting producers' incomes is that it provides the government with a vehicle to equalize the income distribution among producers. There are, of course, difficulties in implementing the direct payment scheme (See SISLER 1966, p. 49) but we do not think they are unsolvable.

8. Summary and Conclusions

Providing appropriate information for price policy decisions concerning the Finnish egg industry was the primary purpose of this study. As described in Section 1, the egg industry has been one of those sectors in Finnish agriculture, where in order to attain our major policy goals an price policy employing only a target price system — as established in the Agricultural Price Acts — at reasonable government and consumer costs has been problematic during the last two decades. The difficulties can be attributed to a number of reasons, among which the sensitivity of egg producers' responses to price changes and the recent rapid technological development in egg production are probably the most relevant.[2] This is why, in order to ease the problems of the policy makers in measuring the necessary changes in the target price of eggs we derived an econometric model for the Finnish egg industry. This model can be used in decision situations for assessing the impact of alternative target prices (and those of the other exogenous variables, too) on the future development of the egg industry. After that, we used the model for simulating the development of the egg industry under the hypothesized price policies and the actual price policy proceeding from the different situations of the egg industry in the past in order to evaluate the effectiveness of certain policies/policy mixes in attaining the major policy goals: producers' income target and a reasonable level of self-sufficiency in eggs.

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[1] As to the effectiveness of different support programs in terms of government expenditures; see GULBRANDSEN and LINDBECK (1973, p. 243—247).

[2] We certainly recognize that one of the basic reasons is also the excess capacity of the Finnish agriculture as a whole because of the mechanism of the target price system itself. We may assume that the policy makers have tried to minimize the total costs of supporting agricultural prices, and therefore measuring changes in the target price of eggs has also depended on the market situation of the other target price products. We have not, however, paid much attention to such considerations in this study mainly due to the fact that it is in practice possible to analyze the comparative effectiveness of alternative price policies for the egg industry separately.

The specification of the basic model is given and discussed in Sections 2.3–2.4. It is an eight-equation model consisting of three blocks: a six-equation simultaneous block and two single-equation blocks, which link together as shown in Section 2.4. As to the production response, it was assumed that producers are able to influence the total egg production via two major production decisions: purchasing chickens and culling layers. Accordingly, behavioral equations including the factors which influence the profitability of egg production were specified for these activities. It was assumed that there is a lagged response to price changes in purchasing chickens and, therefore, polynomial lag formulations were applied in describing the relationships between the number of chickens and the prices of eggs and feed. Our policy instrument — the target price of eggs — was included in the producer price relation besides the variable reflecting the discrepancy between domestic production and domestic consumption of eggs (net exports). In addition, the basic model includes equations for per capita consumption, retail prices and for net exports of eggs. It is a dynamic model with lags of five periods (the model is built for semiannual data) and nonlinear in variables (Section 2.4).

Due to its crucial importance, relatively much attention was paid to the estimation of the basic model (Section 4). In addition to testing many kinds of alternatives for the final specification through estimation experiments, the stepwise regression method with regard to observations was applied to explore possible time-related trends in the coefficients of the equations concerning the determination of egg production (the recursive production response model of four equations was derived for this purpose; see Section 2.5). A variant of the 2 SLS-method was applied to the estimation of the six-equation simultaneous block (Section 3.3.1). Otherwise, the OLS-method was applied to the estimation of the coefficients.

The validity of the basic model in simulating the actual behavior of the egg industry was tested through deterministic simulations (Section 5) using two types of tests: 1) historical simulation for the estimation period and 2) ex-post simulation for period 1971–74/I. The time paths of the endogenous variables were generated by giving only the values of the exogenous variables and the starting values of the lagged endogenous variables to the model. Figures 5.1, 5.2 and 5.3 contain the graphical comparisons of the simulated time paths of the key endogenous variables (See also Appendix 6). Theil's inequality coefficients (U_1 and U_2) were also computed to evaluate the »goodness of fit» (Tables 5.1 and 5.2).

We evaluated the comparative effectiveness of two alternative price policy directions for the period 1956–70 in attaining the main goals of our agricultural price policy: 1) the actual price policy the government has implemented under the Price Acts and 2) the hypothesized equilibrium price policy (Sections 6.1 and 6.2). According to this alternative, the policy makers were assumed to use two policy instruments: the target price system and a direct payment scheme, in which payments to an individual producer are not related to the production volume of his firm. We defined attaining producers' income target (as established by the Price Acts) and maintaining a reasonable level of self-sufficiency in eggs (surpluses to be exported were defined as five percent of the total consumption) as our price policy goals. Thus, the equilibrium price policy alternative is consistent with the theory of economic policy: the necessary condition for attaining two objective policy objectives is that we employ two policy instruments. The policy mix with these instruments is clear: setting the target price of eggs to a level which will maintain the domestic market balance, and making direct cash payments to producers if and when the income target cannot be achieved on the resulting producer price level.

The basic model was used for deriving the equilibrium target price path for 1956—70 (Section 6.2) and for generating the development of the egg industry under these policy alternatives (Section 6.3) proceeding from the state of the egg industry at the end of 1955. Our results suggest that, as a whole, only a comparatively small downward adjustment of the actual price level would have been required for maintaining the market balance of eggs in the period 1956—70 assuming that the target price levels would have been set consistently according to the market balance considerations through the entire period. The criteria we used for ranking our policy alternatives were government and consumer expenditures associated with these alternatives in attaining our policy goals. Due to the complex nature of this kind of evaluation of different policy alternatives we had to make many simplifying assumptions, which are described in Section 6.4. We assumed, for example, that the excess resources which would not have been devoted to the egg industry in the case of the equilibrium price policy would have been employed in the pork sector. Given these assumptions, our analysis suggested that the equilibrium price policy alternative would have been a more effective policy mix than the actual price policy (Section 6.4). The net savings resulting from the adoption of the equilibrium price policy alternative instead of the actual price policy is, however, relatively small in the test period — mostly due to our realistic assumptions of the alternative use of the excess resources. On the other hand, we may argue that the net savings through adopting this policy would have grown in the future (beyond the year 1970). But due to many difficulties we did not estimate the future savings of the equilibrium price policy.

We also conducted ex-post price policy simulations with the basic model to evaluate the alternative price policies for the period 1971—74 (Section 7) and, again, to give some idea of the type of the price policy analyses which can be done by means of the basic model in real decision situations. In order to define our policy alternatives, we assumed that the policy makers would have been interested in adjusting the domestic production gradually to the domestic consumption by the use of the price policy measures and simultaneously taking care to attain the income target of producers in the system by paying direct cash payments to producers if and when necessary. The adjustment alternatives were defined as attaining a reasonable balance between production and consumption of eggs 1) in 5—6 years, 2) in 7—8 years and 3) in 10—11 years. The basic model was used for generating the hypothesized development of the egg industry under those policy alternatives for period 1971—74 proceeding from the state of the egg industry at the end of the year 1970 (Section 7.1). The comparative effectiveness of the policy alternatives and the actual policy in attaining our two policy goals was then evaluated on the basis of similar calculations as was used in evaluating the price policies in the period 1956—70 (the criterion for ranking alternatives was government and consumer expenditures necessary to attain the policy goals). The income path generated by the simulation of the actual price policy was regarded as a target income development in this period.

The results implied that, proceeding from the situation at the end of the year 1970, the target price changes ought to have been measured much smaller compared with the actual ones in order to attain a reasonable balance between production and consumption of eggs within 5—6 years: in the latter part of the year 1974 the producer price of this alternative is some 0.50 Fmk lower than that under the actual price policy. However, in terms of government and consumer expenditure this adjustment policy alternative would have been more effective in attaining the policy goals than the actual price policy under the assumptions made in this study. Similar conclusions can be also drawn from the results concerning price policy alternative 2 in this analysis. As to price policy alternative 3, the results were inconclusive in the case when we assumed that the excess feed grain would have been exported directly. The final ranking of this alternative and the actual price policy would have also required information about reductions in production costs in the system associated with adopting alternative 3 instead of the actual price policy.

Thus, these computations suggest that the adjustment policy alternatives would have been more effective than the actual price policy in period 1971—74. Moreover, the direct payment scheme would have provided the government with a vehicle to equalize the income distribution within the producers in the system. This is also an important aspect in evaluating the policy alternatives, because the target price system — as implemented thus far — has its disadvantages in this respect.

As stated in Section 6, selecting an appropriate policy or policy mix is a complex issue involving many political and economic considerations. In this study we have only compared two different policies for attaining the objectives of the agricultural policy from the economic standpoint. When writing these conclusions, we already know that the government has introduced policy measures different from those discussed above to curb the further growth of egg production[1] (See Section 1.1). The policy mix the government has adopted may be characterized by stating that the domestic price of eggs is kept at a relatively high level under this policy and part of the support costs is paid by means of revenues from the marketing fees mentioned in Section 1.1. This may be an effective policy program for curbing production increases, but there are also negative impacts associated with this policy mix. First of all, the domestic price level for eggs is artificially maintained at a higher level than would be the case, for example, under the policy directions suggested in this study. On the other hand, we may argue that measuring the levels of the policy instruments is in such a policy program as this problematic, if attaining policy goals accurately is regarded as important.

[1] We wish to emphasize that all the analyses concerning alternative policies has been conducted before the introduction of these policy programs.

REFERENCES

AGARVALA, R. & BALL, R. J. 1970. Econometric Model Building for the Egg Market in the U. K. Farm Economist 11: 537—555.

ALMON, S. 1965. The Distributed Lag between Capital Appropriations and Expenditures. Econometrica 33: 178—196.

ANON. 1966. Komiteanmietintö 1966: B 12. Maataloustuotteiden hinnanmuodostuskomitean osamietintö 2. VIII + 89 s.

— » — 1969. Komiteanmietintö 1969: B 40. Maatalouskomitean mietintö III. X + 27 p.

— » — 1970. Massager '70. User's Manual. Bank of Canada. 1970. Mimeograph.

— » — 1971 a. Komiteanmietintö 1971: B 104. Maataloustuotteiden hintamarginaaleja selvittelevän neuvottelukunnan osamietintö I. 1964—1971. VIII + 55 p.

— » — 1971 b. Suomen Asetuskokoelma 1971; 977, 978.

— » — 1974. Eri tuotantosuuntaa harjoittavien kirjanpitotilojen tuloksia. Tilivuosi 1974. The Agr. Econ. Res. Inst. Research Reports 35: 1—32.

— » — 1975. Suomen Asetuskokoelma 1975; 302, 354.

— » — 1976. Suomen Asetuskokoelma 1976; 360.

BANGE, G. H. & BENDER, F. E. 1969. An Estimate of Monthly Demand for Shell and Breaker Eggs. Univ. of Maryland Agr. Exp. Sta. Miscel. Publ. 703: 1—45.

BARKER, R. & STANTON, B. F. 1965. Estimation and Aggregation of Firm Supply Functions. J. Farm Econ. 47: 701—712.

BOX, G. E. P. & JENKINS, G. M. 1970. Time Series Analysis. Forecasting and Control. 542 p. San Fransisco.

BRÖCKER, R. 1973. Marktprognosen für Eier und Shlachtgeflügel. Bonner Hefte für Marktforschung 7: 1—127. Stuttgart.

CHAYAT, M., FORKER, O. D. & PADBERG, D. I. 1974. An Econometric Determination of the Welfare Impact of Giving Bargaining Power to Farmers: A Case Study ot the Egg Industry. Search Agriculture 4; 4: 1—44. Cornell University Agricultural Experiment Station.

CHEN, D., COURTNEY, R. & SCHMITZ, A. 1972. A Polynomial Lag Formulation of Milk Production Response. Am. J. Agr. Econ. 54: 77—83.

COHEN, K. J. & CYERT, R. M. 1961. Computer Models in Dynamic Economics. The Quarterly Journal of Economics 75: 112—127.

DARDIS, R. 1967. The Welfare Cost of Grain Protection in the United Kingdom. J. Farm Econ. 49: 597—609.

DAY, R. H. 1961. Recursive Programming and Supply Prediction. In Agricultural Supply Functions ed. by HEADY et al. p. 108—125. Ames.

— » — 1962. An Approach to Production Response. Agr. Econ. Research 14 (1962): 134—148.

DIXON, W. J. & MASSEY, F. J. 1957. Introduction to statistical Analysis. 488 p. York.

EDGERTON, D. L. 1972. Some Properties of Two Stage Least Squares as Applied to Nonlinear Models. Int. Econ. Review 13: 26—32.

FISHER, M. R. 1958. A Sector Model. The Poultry Industry of the U.S.A. Econometrica 26: 37—66.

FLYGARE, B. 1972. Kananmunakaupan kansainvälinen markkinakehitys. Siipikarja 1972: 251—255.

FRICK, G. E. & ANDREWS, R. A. 1965. Aggregation Bias and Four Methods of Summing Farm Supply Functions. J. Farm Econ. 47: 696—700.

GERRA, M. J. 1959 a. The Demand, Supply and Price Structure for Eggs. U. S. Dep. Agr. Techn. Bull. 1204: 1—157.

— » — 1959 b. An Econometric Model of Egg Industry. J. Farm Econ. 41: 284—301.

GULBRANDSEN, O. & LINDBECK, A. 1973. The Economics of the Agricultural Sector. 264 p. Stockholm.

HARTMAN, D. G. 1974. The Egg Cycle and the Ability of Recursive Models to Explain it. Am. J. Agr. Econ. 56: 254—262.

HEADY, E. O. 1961. Uses and Concepts in Supply Analysis. In Agricultural Supply Functions ed. by HEADY et al. p. 3—25. Ames.

— » — & TWEETEN, L. 1963. Resource Demand and Structure of the Agricultural Industry. 515 p. Ames.

Holt, C. C. et. al. 1967. Program Simulate II. A User's and Programmer's Manual. University of Wisconsin. Programming Series 2. Mimeograph.

Howrey, E. P. & Kelejian, H. H. 1971. Simulation versus Analytical Solutions. In Computer Simulation Experiments with Models of Economic Systems (by Naylor). p. 299—319. New York.

Ihamuotila, R. 1972 a. Productivity and Aggregate Production Functions in the Finnish Agricultural Sector 1950—1969. Publ. of the Agr. Econ. Res. Inst. 25: 1—87.

— » — 1972 b. Leipäviljan tarjonnasta ja tarjontaan vaikuttavista tekijöistä Suomessa vuosina 1951—1970. (Summary: On Bread Grain Supply Functions in Finland in 1951—1969). Publ. of the Agr. Econ. Res. Inst. 26: 1—60.

— » — 1972 c. Maatalouden hintajärjestelmistä ja niiden merkityksestä Suomessa. Käytännön Maamies 1972, 4: 10—11 and 52.

Johnston, J. 1972. Econometric Methods. 437 p. New York.

Josling, T. 1969. A Formal Approach to Agricultural Policy. J. Agr. Econ. 20: 175—191.

Kaarlehto, P. 1958. Kananmunien kysynnän joustavuudesta kokonaismarkkinatilastojen valossa. Suomen Osuustoimintalehti 50: 299—308.

— » — 1961. Tulotason vaikutuksesta elintarvikemenoihin ja kulutusmääriin. (Summary: Income Elasticity of Food Expenditure and Consumption). Journal of the Scientific Agricultural Society of Finland 33: 17—31.

— » — 1964. Maataloustuotteiden markkinointi. Maanvilj. Tietok. 3: 359—400. Porvoo.

Kelejian, H. H. 1971. Two-Stage Least Squares and Econometric Systems Linear in Parameters but Nonlinear in the Endogenous Variables. Journal of the American Statistical Association 66: 373—374.

Kersten, L. 1973. Ein Demographisches Modell Zur Vorausberechnung der Hühnerbestände. Agrarwirtschaft 1973: 302—305.

— » — 1975. Mengen und Preisschwankungen am westdeutschen Eier Markt. Agrarwirtschaft 1975: 89—97.

Kettunen, L. 1968. Demand and Supply for Pork and Beef in Finland. Publ. the Agr. Econ. Res. Inst. 11: 1—93.

— » — 1972. Hintalait maatalouden tulopolitiikan välineenä. Kansantaloudellinen aikakauskirja 1972: 2: 135—151.

Klein, L. R. 1965. An Introduction to Econometrics. 280 p. Englewood Cliffs.

Kmenta, J. 1971. Elements of Econometrics. 655 p. New York.

Koponen, V. 1964. Kananmunien kysynnästä ja tarjonnasta. (Summary: On Demand and Supply for Eggs). Publ. of the Marketing Research Institute of Pellervo-Society 8: 1—29.

Kukkonen, P. 1968. Analysis of Seasonal and Other Short-term Variations with Applications of Finnish Economic Time Series. Bank of Finland Inst. for Econ. Res. Publ. B: 28: 1—136.

Labys, W. C. 1973. Dynamic Commodity Models: Specification, Estimation, and Simulation. 351 p. Lexington.

Larson, A. B. 1964. The Hog Cycle and Harmonic Motion. J. Farm Econ. 46: 375—386.

Leuthold, R. M. 1975. On the Use of Theil's Inequality Coefficients. Am. J. Agr. Econ. 57: 344—346.

Miller, B. R. & Masters, G. C. 1973. A Short Run Price Prediction Model for Eggs. Am. J. Agr. Econ. 55: 484—489.

Naylor, T. H. 1970. Policy Simulation Experiments with Macroeconomic Models: The State of the Art. Am. J. of Agr. Econ. 52: 263—271.

— » — 1971. Computer Simulation Experiments with Models of Economic Systems. 502 p. New York.

Nerlove, M. 1958. Dynamics of Supply: Estimation of Farmers' Response to Price. 267 p.

— » — 1961. Time-series Analysis of the Supply of Agricultural Products. In Agricultural Supply Functions ed. by Heady et al. p. 31—60. Ames.

Nevala, M. 1973. Kananmunien tuotanto, kulutus ja hinnanmuodostus. Mimeograph. 87 p. (Available at the Agr. Econ. Res. Inst.).

— » — 1974. Prognosteknik för eggproduktion. Nordisk statistisk sekretariat. Tekniske rapporter 13. Kobenhagen.

NIITAMO, O. E. & SOIVIO, A. 1964. Kokeita yksinkertaisilla simultaanisilla moniyhtälömalleilla. (Summary: Experiments with Simple Simultaneous Equation Systems). Kansantaloudellisia tutkimuksia 25: 134—164 and 211—212.

PIHKALA, K. U. 1941. Suomen kananmunahintojen muodostumisesta maailmansodan jälkeen. (Summary: On the Formation of Egg Prices in Finland after the World War). Acta Agralia Fennica 46: 1—277.

PÖLKKI, L. 1971. Naudan- ja sianlihan hintojen ja marginaalien lyhytaikaiset vaihtelut Suomessa vuosina 1963—70. (Summary: The Short-Run Changes in Prices and Marketing Margins for Beef and Pork in Finland 1963—1970). Publ. of the Agr. Econ. Res. Inst. 24: 1—144.

RAY, D. & TWEETEN, L. 1976. Alternative Agriculture and Food Policy Directions for the U. S. — With Emphasis on Continuation of Minimal Provisions of the 1973 Agriculture and Consumer Protection Act. Mimeograph. 30 p.

ROY, S. K. & JOHNSON, P. N. 1973. Econometric Models for Quarterly Shell Egg Prices. Am. J. Agr. Econ. 55: 209—213.

SAHI, R. K. & GRADDOCK, W. J. 1974. Estimation of the flexibility Coefficients for Recursive Programming Models — Alternative Approaches. Am. J. Agr. Econ. 56: 344—350.

SAITO, T. 1972. Comet User's Manual. Nippon Univac Sogo Kenkyusho Inc. Mimeograph.

SAULI, L. 1971. Maatalouden hintapolitiikasta ja hintajärjestelmistä Suomessa. Talonpojan asialla, Veikko Ihamuotila kuusikymmentä vuotta 17. 12. 1971. Published by Maataloustuottajien Keskusliitto. Helsinki.

SCHALLER, N. W. & DEAN, G. W. 1965. Predicting Regional Crop Production: An Application of Recursive Programming. U. S. Dep. Agr. Techn. Bull. 1329: 1—110.

SHARPLES, J. A. 1969. The Representative Farm Approach to Estimation of Supply Response. Am. J. Agr. Econ. 51: 353—361.

SHEEHY, S. J. & MCALEXANDER, R. H. 1965. Selection of Representative Benchmark Farms for Supply Estimation. J. Farm. Econ. 47: 681—695.

SISLER, D. G. 1966. Direct Payments as a Policy Tool in the Feed Grain Livestock Sector. Cornell University Agr. Ex. Sta. Bull. 1011: 1—35.

STOJKOVIC, G. 1971. Market Models for Swedish Agriculture. 83 p. Uppsala.

TERÄSVIRTA, T. 1971. Tillämpning av stegvis regression analys. Föredrag vid den fjärde nordiska konferensen i matematisk statistik. Mimeograph. 11 p.

THEIL, H. 1958. Economic Forecasts and Policy. 567 p. Amsterdam.

— » — 1966. Applied Economic Forecasting. 474 p. Chicago.

— » — 1971. Principles of Econometrics. 736 p. New York.

TOMEK, W. G. 1973. R^2 in TSLS and GLS Estimation. Am. J. Agr. Econ. 55: 670.

— » — & ROBINSON, K. L. 1975. Agricultural Product Prices. 376 p. Ithaca.

TORVELA, M. 1959. Kotieläintalouden tuotoksen riippuvuus käytetyistä tuotantovälineistä. Maatal. Tal. Tutk.lait. Tied.ant. 1/1959: 1—64.

TWEETEN, L. G. & TYNER, F. H. 1966. The Utility Concept of Net Social Cost — A Criterion for Public Policy. Agr. Econ. Research 18, 2: 33—42.

— » — & QUANCE, C. L. 1969. Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches. Am. J. Agr. Econ. 51: 342—352.

WAANANEN, M. & KAARLEHTO, P. 1965. Marketing Margins for Eggs in Finland. Washington Agr. Exp. Sta. Techn. Bull. 45: 1—26.

WALLACE, T. D. 1962. Measures of Social Costs of Agricultural Programs. J. Farm Econ. 44: 580-594.

WESTERMARCK, N. 1972. Munantuotannon kannattavuus tilivuonna 1971. Siipikarja 1972: 160-165.

— » — 1973. Munantuotannon kannattavuus kirjanpitokanaloissa tilivuonna 1972. Siipikarja 1973: 228—232.

— » — 1975. Mitä osoittaa kanatalouden kannattavuustutkimus neljännesvuosisadan ajalta. Erip. Siipikarja 1975; 3. 8 p. Hämeenlinna.

WINFRIDSON, O. 1974. Prognoser för den svenska äggmarknaden. Nordisk Statistisk sekretariat. Tekniske rapporter 13. Kobenhagen.

WIPF, L. J. & BAWDEN, D. L. 1969. Reliability of Supply Equations Derived from Production Functions. Am. J. Agr. Econ. 51: 170—178.

WOLD, H. 1964. Forecasting by the Chain Principle. In Econometic Model Building. Contributions to the Economic Analysis 36 ed. by WOLD: 5—36.

SELOSTUS

Suomen kananmunasektoria kuvaava ekonometrinen malli

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Käyttökelpoisen tiedon tuottaminen kananmuniin kohdistuvan hintapoliittisen päätöksenteon perustaksi tavoitehintajärjestelmää sovellettaessa on ollut tämän tutkimuksen perimmäinen tavoite. Tätä tarkoitusta varten on tutkimuksessa rakennettu kananmunien tuotannon, kulutuksen sekä hintojen määräytymistä kuvaava ekonometrinen malli ja käytetty sitä hintapoliittisiin analyyseihin. Tällaisen ekonometrisen mallin avullahan voidaan simuloida ja analysoida eri hintapoliittisten vaihtoehtojen vaikutuksia kananmunasektorin tulevaan kehitykseen olettaen, että mallin eksogeenisten muuttujien kehitysurat voidaan tavalla tai toisella ennakoida ja että sektorin reaktiot myös tulevaisuudessa noudattavat niitä lainalaisuuksia, joita rakennettuun ekonometriseen malliin sisältyy. On perusteltua väittää, että tällainen apuväline olisi hyödyllinen hintapolitiikan päätöksentekijöille erityisesti kananmunien kohdalla, jossa maatalouspoliittisten tavoitteiden toteuttaminen kohtuullisin kustannuksin on viime aikoina monesta eri syystä osoittautunut vaikeaksi.

Tässä tutkimuksessa johdettu perusmalli, jonka spesifikaatiota on esitelty tutkimuksen toisessa luvussa on ns. sektorimalli, joka käsittää kaikkiaan kahdeksan yhtälöä. Se on luonteeltaan block-rekursiivinen jakautuen yhteen kuuden yhtälön simultaaniseen lohkoon ja kahteen yhden yhtälön lohkoon. Mallin perusajatuksena on se, että valtiovallan asettama tavoitehinta yhdessä kotimaisen markkinatilanteen kanssa määräävät tuottajahintatason kullakin ajanjaksolla. Tuottajien on oletettu reagoivan kananmunien tuotannon kannattavuuden muutoksiin. Mallin muuttujia valittaessa on lähdetty siitä, että muutokset kananmunien tuottajahinnoissa, rehujen hinnoissa sekä tuotantotekniikassa ovat tärkeimmät tekijät tuotannon kannattavuuden muutoksiin. Tuotannon vaihteluita selittäviä yhtälöitä spesifioitaessa on oletettu, että kananmunien tuottajat voivat muuttaa yritystensä tuotostasoa vaihtelemalla kananpoikasten hankintamääriä ja karsittavia kanojen määriä. Tämän perusteella malliin on kehitetty yhtälöt selittämään näiden suureiden vaihteluita ja kyseisissä yhtälöissä selittävinä muuttujina toimivat muun muassa em. tuotannon kannattavuuteen vaikuttavat tekijät. Kananmunatuotos on mallissa johdettu kanakannan, kananpoikasten määrän ja karsinnan perusteella määritelmäyhtälön ja teknisiä riippuvuuksia sisältävän yhtälön avulla. Olettamukset tuottajien reaktioiden viivästymisestä hintojen muutoksiin johtivat jakautuneita viiveitä sisältäviin malleihin kananpoikasten hankintaa selitettäessä. Kananmunien vähittäishinta on mallissa oletettu määräytyvän tuottajahintatason ja kaupan marginaaleihin vaikuttavien tekijöiden perusteella. Lisäksi malliin kuuluu kananmunien ulkomaankaupan määräytymistä selittävä määritelmäyhtälö sekä kulutuksen vaihteluita selittävä yhtälö, jossa selittävinä muuttujina ovat tulotaso ja kananmunien vähittäishinta. Malli on rakennettu puolivuosittaista havaintoaineistoa varten. Se on dynaaminen pisimmän viiveen ollessa 5 havaintokautta (Kuvio 2.3).

Perusmalli on estimoitu ajanjaksolta 1956—70 soveltaen 2 SLS-metodia simultaaniseen lohkoon ja muihin yhtälöihin vastaavasti OLS-metodia (Luku 4). Jakautuneita viiveitä sisältävät yhtälöt estimoitiin polynomiaalisia viiveformulointeja käyttäen. Kananmunien tuotantoa selittävien yhtälöiden kertoimien ajallista vaihtelua pyrittiin tutkimaan myös estimoimalla kertoimet havaintojaksojen suhteen askeltaen. Tätä tehtävää varten johdettiin rekursiivinen tuotannon vaihteluita selittävä malli tutkimuksen perusmallista estimointityön helpottamiseksi. Suurin osa selittävistä muuttujista sai tilastollisesti merkitsevät kertoimet. Tuotantoa selittävien yhtälöiden kertoimissa ei havaittu mitään systemaattista vaihtelua ajan suhteen, joskin eräiden kertoimien lukuarvot vaihtelivat verrattain laajalla alueella, kun estimointiperiodia vaihdettiin (Taulukko 4.1).

Mallin kykyä jäljittää kananmunien tuotannon, kulutuksen ja hintojen todellista kehitystä on tutkimuksessa testattu kahdella kyseiseen malliin soveltuvalla testillä: 1) historiallisella simuloinnilla, jossa endogeenisten muuttujien kehitysurat estimointiperiodille tuotettiin mallin avulla antamalla siihen vain eksogeenisten muuttujien todelliset arvot ja alkuarvot viivästetyille endogeenisille muuttujille, sekä 2) ex-post ennustesimuloinnilla havaintojaksoille 1971/I—

1974/I vastaavaa menettelyä käyttäen saadaksemme käsityksen siitä, millä tavalla malli simuloi todellista kehitystä, kun eksogeeniset muuttujat saavat arvoja, jotka poikkeavat niiden arvoista estimointikaudella. Tuotettuja endogeenisten muuttujien kehitysuria on sitten verrattu todellisuudessa tapahtuneeseen kehitykseen graafisin tarkasteluin (Kuviot 5.1—5.3) sekä Theil'in erisuuruuskertoimien (U_1 ja U_2) avulla. Näissä vertailuissa voitiin todeta, että malli jäljitti endogeenisten muuttujien tasot eri ajanjaksoilla verrattain hyvin, jota voidaan pitää eräänä ilmauksena mallin soveltuvuudesta kuvaamaan kananmunasektorin reaktioita eksogeenisten muuttujien vaihteluihin ja siten myös apuvälineeksi hintapoliittisiin analyyseihin.

Edellä mainitulla tavalla estimoitua ja testattua perusmallia on sitten käytetty hintapoliittisten vaihtoehtojen analysointiin. Ensinnäkin on mallin avulla pyritty arvioimaan minkälaista hintapolitiikkaa olisi estimointikaudella (1956—70) täytynyt harjoittaa, jotta kotimaiset kananmunamarkkinat olisivat pysyneet tasapainossa. Käyttämällä iteratiivista lähestymistapaa on tutkimuksen perusmallilla tuotettu sellaiset ratkaisut, jotka vastaavat suunnilleen kotimaisen tuotannon ja kulutuksen tasapainotavoitetta havaintokausittain kyseisenä ajanjaksona (Kuviot 6.1 ja 6.2). Saatujen tulosten mukaan tasapainoon tähtäävä tuottajahintaura poikkeaa vain suhteellisen vähän todellisesta tuottajahintaurasta, mikä suurimmaksi osaksi johtuu tuotannon reaktioiden herkkyydestä hintojen muutoksiin. Näin saatua hintapoliittista vaihtoehtoa on sitten verrattu todelliseen hintapolitiikkaan vuosina 1956—70 sen selvittämiseksi, olisiko kyseinen hintapolitiikka yhdistettynä suoriin maksuihin tuottajille ollut yhteiskunnan kannalta tehokkaampi vaihtoehto hintapoliittisten tavoitteiden toteuttamiseen kuin todellisuudessa harjoitettu hintapolitiikka. Tässä vertailussa hintapolitiikan tavoitteiksi määritettiin tuottajien tulotason turvaaminen ja kananmunien omavaraisuuden säilyttäminen. Kriteerinä tehokkuusvertailussa käytettiin valtiovallan ja kuluttajien menoja kussakin vaihtoehdossa. Tässä analyysissa niiden — todellisuudessa kananmunien tuotantoon sijoitettujen — resurssien osalta, joita ei tuotannon ja kulutuksen tasapainoon tähtäävän politiikan vallitessa olisi käytetty kananmunien tuotantoon, on vaihtoehtoiseksi käytöksi oletettu sianlihan tuotanto. Laskelmien tulokset osoittivat, että edellä määritelty hintapoliittinen vaihtoehto olisi ollut yhteiskunnan kannalta tehokkaampi hintapoliittisten tavoitteiden saavuttamiseksi kuin todellinen hintapolitiikka (Taulukko 6.1). Toisaalta tässä kohdin on huomautettava, että analyysin tulokset riippuvat tehdyistä olettamuksista ja hintatilanteesta maailmanmarkkinoilla.

Niinikään on tutkimuksessa suoritettu ex-post analyyseja erilaisista hintapoliittisista vaihtoehdoista lähinnä sen osoittamiseksi, minkälaisiin analyyseihin malli soveltuu todellisessa hintapäätöstilanteessa. Tätä tarkoitusta varten määriteltiin kolme erilaista vaihtoehtoa kotimaisen tuotannon ja kulutuksen sopeuttamiseksi paremmin toisiaan vastaavaksi lähtien tilanteesta vuoden 1970 lopussa. Sopeuttamisajanjaksoiksi määriteltiin 5—6, 7—8 ja 10—11 vuotta ja mallin avulla tuotettiin näitä vaihtoehtoja vastaavat ratkaisut vuosille 1971—74 em. iteratiivista menettelyä käyttäen ja saatiin selville eri vaihtoehtoja vastaavat tuottajahintaurat. Edellä esitetyn kaltaiset tehokkuusvertailut näiden vaihtoehtojen ja todellisen hintapolitiikan välillä suoritettiin myös tässä analyysissa. Ylituotantoresurssien vaihtoehtoisesta käytöstä tehtiin kaksi erilaista olettamusta: sopeuttamisvaihtoehdoissa nämä resurssit oletettiin käytetyn 1) sianlihan tuotantoon ja 2) rehuvilja olisi suoraan viety ulkomaille jalostamatta sitä kotieläintuotteiksi. Laskelmien tulokset viittaavat siihen, että nopea tuotannon ja kulutuksen sopeuttaminen hintapoliittisin keinoin ja suorien maksujen käyttö tulotavoitteen toteuttamiseen olisi ollut yhteiskunnan kannalta edullisempaa kuin harjoitettu hintapolitiikka kyseisenä ajanjaksona niiden olettamusten vallitessa, joita laskelmissa tehtiin (Taulukot 7.1 ja 7.2).

Appendix 1. List of the Variables Used in the Analyses of This Study and Sources for the Data

The variables used in the analyses of this study are listed below. Also, the sources of the data are shortly indicated for each variable. The data are predented in Appendix 2.

SP_t = number of chickens at the end of period t, milj. pcs. Sources: for 1960—74, the Monthly Bulletin of Agricultural Statistics published by Board of Agriculture. Since the published numbers beginning from 1969 do not include chickens on farms under one hectare of arable land, we transformed the official figures for 1969—74 by the estimated numbers of chickens on those farms (For more detail, see NEVALA 1973, p. 44). The data for 1952—59 were taken directly from the study by KOPONEN (1964).

SK_t = number of layers at the end of period t, mil. pcs. Data sources and the manipulation of the data are the same as for variable SP.

KK_t = number of culled layers in period t, mil. pcs. Since no official data were available for this variable, we computed its values according to the following formula: $KK_t = SK_{t-1} + SP_{t-1} - SK_t$.

TS_t = egg production in period t, mil. kg. Source: Board of Agriculture, Statistical Office. Although based on the same sources, the total production figures of this study deviate a little from those published by Board of Agriculture due to different methods in deriving the total egg production from the statistical sample in a given period (See NEVALA 1973, p. 45).

CO_t = total per capita consumption of eggs in period t, kg. The quantities of eggs consumed have been derived by subtracting the net exports from the total production of eggs. Thus, the consumption figures refer to the total domestic disappearance of eggs (i.e. the figures include also nonfood utilisation, such as eggs used for hatchings).

UK_t = net exports of eggs in period t, mil. kg. Source: the Statistical Office, Board of Customs.

PKT_t = producer price of eggs in period t, Fmk/kg. Source: the Agricultural Economics Research Institute. For 1952—55 the data were obtained from the study by KOPONEN (1964).

PKV_t = retail price of eggs in period t, Fmk/kg. Source: the Bulletin of Statistics published by the Central Statistical Office of Finland.

TAV_t = target price of eggs fixed by the government, Fmk/kg. Since the target price has been changed in different time points of the year, the semiannual values for this variable have been computed as the simple averages of the monthly target price levels (= the price which has been in force in a given month). Sources: KETTUNEN (1972) and the Agricultural Economics Research Institute.

PR_t = price of commercial feed, Fmk/kg. The wholesale price of one of the most common commercial feed mix served as a proxy for farm prices of the commercial feed used in the egg industry. Sources: the data for 1960—74 were provided by the manufacturer of this feedmix, and the time series were extended to the previous observation periods by assuming that the semiannual changes in this time series would have been the same as in the corresponding time series developed by KOPONEN (1964).

RVS_t = total availability of domestically produced feed grain (oats and barley). Total production of oats and barley was used as a proxy for this variable. Source: the Monthly Bulletin of Agricultural Statistics published by the Board of Agriculture.

Y_t = consumers' disposable incomes. The wage index of all the salary and wage earners served as a proxy for this variable. Source: the Bulletin of Statistics published by the Central Statistical Office of Finland.

YM_t = wage index in commerce. Source: the Bulletin of Statistics published by the Central Statistical Office of Finland.

EI_t = consumer price index in period t. Source: the Bulletin of Statistics published by the the Central Statistical Office of Finland.

H_t = total population in Finland. Source: the Bulletin of Statistics, the Central Statistical Office of Finland. Some minor adjustments were made to the published figures (See NEVALA 1973, p. 47).

T = trend. T = 9 for 1952/I . . .

D_2 = seasonal dummy, $D_2 = 1$ for the second half of the year, otherwise $D_2 = 0$.

ESK_t = export subsidy paid by the government for eggs in period t, Fmk/kg. Source: the Agricultural Economics Research Institute.

VHK_t = export price of eggs in period t, Fmk/kg. Source: the Agricultural Economics Research Institute.

PST_t = producer price of pork in period t, Fmk/kg. Source: the Agricultural Economics Research Institute.

ESS_t = export subsidy paid by the government for pork in period t, Fmk/kg. Source: the Agricultural Economics Research Institute.

VHS_t = export price of pork in period t, Fmk/kg. Source: the Agricultural Economics Research Institute.

Appendix 2. Observed Values of the Variables Used in the Analysis.

	SP	KK	SK	TS	CO	UK
1952 I	1.35	0.01	3.46	15.25	3.76	−0.04
II	0.08	1.23	3.58	15.77	3.86	−0.04
1953 I	1.73	0.41	3.25	15.15	3.68	0.00
II	0.14	1.16	3.92	17.09	4.12	0.00
1954 I	1.67	0.55	3.52	17.30	4.14	0.08
II	0.07	1.01	4.17	18.74	4.42	0.13
1955 I	1.72	0.70	3.54	18.64	4.16	1.03
II	0.11	1.34	3.92	18.35	4.19	0.60
1956 I	1.84	0.65	3.39	17.90	3.86	1.40
II	0.17	1.14	4.09	17.60	3.88	0.90
1957 I	2.06	0.82	3.44	17.50	3.63	1.80
II	0.10	1.10	4.39	19.80	3.94	2.70
1958 I	2.02	0.87	3.62	20.60	3.91	3.50
II	0.11	1.21	4.43	21.40	4.16	3.20
1959 I	2.14	1.20	3.34	20.70	3.86	3.70
II	0.09	1.35	4.13	19.70	3.63	3.70
1960 I	2.29	0.76	3.46	19.40	3.60	3.40
II	0.14	1.57	4.18	21.19	3.84	4.20
1961 I	3.09	0.95	3.37	20.54	3.71	4.00
II	0.32	2.15	4.31	21.42	3.71	4.80
1962 I	2.83	0.95	3.68	22.01	3.90	4.50
II	0.29	1.94	4.57	22.29	4.18	3.50
1963 I	2.97	0.99	3.87	22.68	3.91	5.00
II	0.37	2.09	4.76	23.94	4.28	4.50
1964 I	2.72	1.27	3.87	24.41	4.67	3.10
II	0.19	1.79	4.79	25.53	4.49	5.00
1965 I	2.79	0.90	4.09	25.14	4.35	5.20
II	0.18	1.93	4.95	26.36	4.72	4.70
1966 I	2.79	0.96	4.17	26.42	4.55	5.50
II	0.21	1.85	5.11	27.34	4.41	7.00
1967 I	2.79	0.82	4.50	27.91	4.48	7.20
II	0.19	2.04	5.25	28.55	4.31	8.60
1968 I	2.60	1.10	4.34	27.61	4.27	7.80
II	0.24	1.77	5.17	27.13	4.65	5.50
1969 I	3.55	1.33	4.08	26.03	4.62	4.50
II	0.34	2.28	5.40	28.12	4.74	6.10
1970 I	3.99	1.03	4.71	29.27	4.57	8.10
II	0.20	1.67	6.83	33.37	5.24	9.20
1971 I	3.21	1.50	5.53	36.71	5.02	13.60
II	0.41	1.99	6.58	34.85	5.20	10.90
1972 I	3.62	1.28	5.71	34.52	4.94	11.70
II	0.57	2.64	6.69	37.60	5.46	12.30
1973 I	3.93	1.38	5.88	38.88	5.23	14.62
II	0.56	2.83	6.98	37.58	5.21	13.16
1974 I	3.43	0.93	6.11	37.51	4.99	14.20
II	0.54	2.93	6.61	39.24	5.79	12.10

Appendix 2. (Continued). Observed Values of the Variables Used in the Analysis.

		PKT	PKV	RVS	PR	Y	YM
1952	I	2.03	2.36	1.02	0.26	—	—
	II	2.25	2.80	1.06	0.29	—	—
1953	I	1.89	2.39	1.06	0.29	—	—
	II	1.95	2.49	1.27	0.28	—	—
1954	I	1.59	2.02	1.27	0.28	—	—
	II	1.86	2.35	1.11	0.27	—	—
1955	I	1.72	2.10	1.11	0.28	—	—
	II	2.02	2.49	0.96	0.28	—	—
1956	I	1.79	2.29	0.96	0.28	0.56	0.57
	II	2.19	2.69	1.02	0.31	0.60	0.60
1957	I	1.91	2.40	1.02	0.33	0.61	0.60
	II	2.26	2.77	1.01	0.36	0.61	0.61
1958	I	2.05	2.56	1.01	0.40	0.63	0.64
	II	2.32	2.85	1.23	0.40	0.65	0.65
1959	I	2.11	2.64	1.23	0.41	0.66	0.67
	II	2.44	2.96	1.04	0.42	0.68	0.67
1960	I	2.36	2.88	1.04	0.43	0.70	0.70
	II	2.65	3.18	1.57	0.41	0.72	0.71
1961	I	2.45	3.00	1.57	0.41	0.75	0.74
	II	2.33	2.89	1.34	0.42	0.77	0.75
1962	I	2.14	2.70	1.34	0.42	0.80	0.78
	II	2.36	2.92	1.08	0.42	0.82	0.80
1963	I	2.49	3.08	1.08	0.44	0.86	0.87
	II	2.39	3.04	1.36	0.45	0.91	0.88
1964	I	2.48	3.20	1.36	0.45	0.99	0.99
	II	2.58	3.41	1.18	0.48	1.02	1.01
1965	I	2.70	3.44	1.18	0.50	0.08	1.07
	II	2.64	3.47	1.63	0.50	1.09	1.07
1966	I	2.76	3.52	1.63	0.51	1.14	1.13
	II	2.81	3.61	1.53	0.53	1.19	1.15
1967	I	2.90	3.72	1.53	0.55	1.25	1.21
	II	2.85	3.78	1.76	0.61	1.29	1.24
1968	I	2.85	3.69	1.76	0.61	1.38	1.33
	II	3.05	3.87	1.91	0.62	1.44	1.37
1969	I	3.20	4.02	1.91	0.63	1.50	1.44
	II	3.08	4.07	1.92	0.63	1.53	1.44
1970	I	3.15	3.99	1.92	0.63	1.62	1.53
	II	3.17	4.04	2.21	0.65	1.66	1.55
1971	I	3.16	3.93	2.21	0.66	1.81	1.69
	II	3.32	4.16	2.45	0.67	1.90	1.76
1972	I	3.47	4.32	2.45	0.68	2.01	1.87
	II	3.52	4.49	2.35	0.69	2.13	1.99
1973	I	3.63	4.61	2.35	0.77	2.29	2.13
	II	3.87	5.00	2.16	0.81	2.50	2.34
1974	I	4.09	5.30	2.16	0.85	2.71	2.55
	II	4.43	5.71	2.07	0.99	2.99	2.81

Appendix 2 (Continued). Observed Values of the Variables Used in the Analysis.

		EI	TAV	H	ESK	VHK	PST	ESS	VHS
1952	I	—	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	—	—
1953	I	—	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	—	—
1954	I	—	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	—	—
1955	I	—	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	—	—
1956	I	1.08	1.95	4.28	1.00	1.25	2.18	—	—
	II	1.11	2.02	4.30	1.26	1.26	2.27	—	—
1957	I	1.21	2.05	4.32	1.22	1.07	2.48	—	—
	II	1.26	2.18	4.34	1.00	2.13	2.15	1.12	1.49
1958	I	1.31	2.25	4.37	0.98	1.62	2.06	1.33	1.26
	II	1.32	2.35	4.38	1.18	1.76	2.49	1.40	1.30
1959	I	1.33	2.40	4.40	1.30	1.34	2.30	1.21	1.60
	II	1.35	2.47	4.41	1.52	1.67	2.56	1.28	1.77
1960	I	1.37	2.50	4.44	1.56	1.34	2.85	—	—
	II	1.39	2.57	4.43	1.53	1.87	2.87	—	—
1961	I	1.40	2.60	4.46	1.56	1.64	2.62	1.15	1.65
	II	1.41	2.56	4.48	1.55	1.41	2.67	1.20	1.63
1962	I	1.45	2.55	4.49	1.55	1.20	2.72	1.25	1.59
	II	1.49	2.48	4.50	1.39	1.56	2.68	1.25	1.59
1963	I	1.52	2.53	4.52	1.24	1.82	2.81	1.46	1.66
	II	1.56	2.59	4.54	1.72	1.35	2.99	1.59	1.55
1964	I	1.68	2.60	4.56	2.08	1.13	2.99	1.41	1.91
	II	1.72	2.67	4.57	2.02	1.33	3.02	1.77	1.74
1965	I	1.76	2.77	4.58	2.02	1.33	3.31	1.98	1.66
	II	1.80	2.80	4.59	1.79	1.64	3.35	2.16	1.49
1966	I	1.83	2.80	4.60	1.96	1.49	3.40	1.71	1.70
	II	1.87	2.93	4.61	2.08	1.51	3.32	1.74	1.84
1967	I	1.93	3.00	4.62	2.24	1.39	3.24	2.20	1.73
	II	1.98	3.00	4.63	2.04	1.62	3.28	2.27	1.83
1968	I	2.10	3.00	4.64	1.91	1.71	3.44	2.53	1.74
	II	2.14	3.15	4.65	1.85	1.97	3.85	2.64	1.81
1969	I	2.16	3.20	4.66	2.15	1.73	3.84	2.60	2.05
	II	2.18	3.20	4.65	2.02	1.88	4.04	2.63	1.97
1970	I	2.21	3.27	4.64	2.33	1.72	4.00	1.82	2.76
	II	2.24	3.35	4.61	2.42	1.69	4.01	1.73	2.85
1971	I	2.32	3.35	4.60	2.69	1.45	4.18	2.72	2.22
	II	2.43	3.35	4.61	2.47	1.82	4.31	2.91	2.34
1972	I	2.49	3.42	4.62	2.72	1.68	4.37	2.83	2.33
	II	2.59	3.50	4.63	2.79	1.71	4.69	3.11	2.22
1973	I	2.72	3.62	4.64	3.07	1.63	4.67	1.78	4.13
	II	2.96	3.85	4.66	3.02	2.06	5.11	1.82	4.14
1974	I	3.20	4.05	4.67	3.02	2.35	5.34	2.18	4.31
	II	3.47	4.40	4.68	3.54	2.30	5.98	4.25	4.23

Appendix 3. Estimation Method for the Finite Distributed Lag Models Used in This Study (See ANON. 1970).

The distributed lag models of this study can be written as a relationship of the form (excluding all the other explanatory variables):

$$Y_t = \sum_{i=0}^{m-1} \beta_i X_{t-i} \tag{1}$$

In order to reduce the number of parameters to be estimated, the coefficients β_i are constrained to lie along a polynomial of specified degree that passes through zero at $i = m$. Thus, we write:

$$\beta_i = \sum_{j=1}^{q} b_j \frac{(m-i)^j}{s_j}, \tag{2}$$

where q is the degree of a polynomial and s_j is a scaling factor defined by

$$s_j = \sum_{i=0}^{m} (m-i)^j \tag{3}$$

Substituting (2) in (1), we obtain

$$Y_t = \sum_{i=0}^{m} \left[\sum_{j=1}^{q} b_j \frac{(m-i)^j}{s_j} \right] X_{t-i}, \text{ or} \tag{4}$$

$$= \sum_{j=1}^{q} b_j \,(X)Dg_j \tag{5}$$

where

$$(X)Dg_j = \sum_{i=0}^{m} \frac{(m-i)^j}{s_j} X_{t-i} \tag{6}$$

Coefficients b_j for transformed variables $(X)Dg_j$ ($j = 1 \ldots q$) are estimated by OLS. The coefficients for individual lags β_i are then computed according to formula (2).

Appendix 4. OLS-estimates for the Recursive Production Response Model Estimated from Different Time Periods.[1]

Equation (4.1): SP_t (= number of chickens) as the dependent variable

Period	Coefficients for										R^2	d
	Constant	PKT_t	PKT_{t-1}	PKT_{t-2}	PR_t	PR_{t-1}	PR_{t-2}	T	D_2T	D_2		
1956/I –68/I	1.086	0.435	0.290	0.145	–2.960	–1.973	0.987	0.067	–0.031	–1.487	0.980	1.37
		1.6	1.6	1.6	–2.7	–2.7	–2.7	3.1	–2.6	–4.3		
1958/I –70/I	0.240	0.614	0.410	0.205	–2.460	–1.640	–0.820	0.054	–0.040	–1.299	0.971	1.37
		1.7	1.7	1.7	–1.7	–1.7	–1.7	2.1	–2.6	–2.5		
1960/I –72/I	0.552	0.581	0.387	0.194	–2.258	–1.505	–0.753	0.045	–0.032	–1.564	0.973	1.69
		1.6	1.6	1.6	–1.2	–1.2	–1.2	1.3	–2.1	–2.7		
1962/I –74/I	0.707	0.440	0.294	0.147	–2.068	–1.378	–0.689	0.055	–0.034	–1.464	0.975	1.59
		1.0	1.0	1.0	–1.1	–1.1	–1.1	1.2	–2.3	–2.4		
1956/I –70/II	0.164	0.568	0.379	0.189	–2.223	–1.482	–0.741	0.056	–0.044	–1.164	0.974	1.69
		1.8	1.8	1.8	–1.8	–1.8	–1.8	2.4	–4.2	–3.4		
1957/II–70/II	0.297	0.589	0.393	0.196	–2.442	–1.628	–0.814	0.056	–0.040	–1.277	0.973	1.71
		1.7	1.7	1.7	–1.8	–1.8	–1.8	2.2	–3.2	–2.9		

[1] Numbers below the coefficients are Student t-values. Coefficients for PKT_{t-i} and $PR_{t-i}(i = 0 \ldots 2)$ were estimated through the use of a polynomial of first order but they are presented above in an unscrambled form.

Appendix 4. (Continued). OLS-estimates for the Recursive Production Response Model Estimated from Different Time Periods.[1]

Equation (4.2): KK_t (= number of culled layers) as the dependent variable

Period	Coefficients for								R^2	d
	Constant	SP_{t-2}	SP_{t-3}	SP_{t-4}	SP_{t-5}	PKT_t	PR_t	D_2		
1956/I –68/I	0.992	−0.085	0.210	0.323	0.253	−0.771	2.594	0.308	0.858	1.67
		−0.5	3.0	3.0	2.7	−2.3	2.0	0.8		
1958/I –70/I	0.811	−0.080	0.129	0.213	0.170	−0.544	2.483	0.435	0.838	1.79
		−0.5	1.7	1.9	1.8	−1.5	1.8	1.1		
1960/I –72/I	0.758	0.097	0.076	0.053	0.028	−0.384	1.724	0.980	0.862	2.07
		0.7	1.1	0.6	0.4	−1.0	1.2	2.8		
1962/I –74/I	0.478	−0.054	0.090	0.148	0.118	−0.224	1.643	0.636	0.813	2.23
		−0.3	0.8	1.0	0.9	−0.3	0.6	1.2		
1956/I –70/II	0.825	−0.114	0.154	0.262	0.211	−0.605	2.669	0.270	0.825	1.59
		−0.8	2.2	2.6	2.4	−1.7	2.0	0.8		
1957/II–70/II	0.958	−0.144	0.141	0.256	0.213	−0.582	2.470	0.212	0.804	1.56
		−0.8	1.8	2.8	2.2	−1.5	1.7	0.5		

[1] Numbers below the coefficients are Student t-values. Coefficients for SP_{t-k-i} $(i = 0 \ldots 3)$ were estimated through the use of a polynomial of second order but they are presented above in an unscrambled form.

Appendix 4. (Continued). OLS-estimates for the Recursive Production Response Model Estimated from Different Time Periods.

Equation (4.3): TS_t (= total egg production) as the dependent variable

Period	Coefficients for							
	Constant	SK_{t-1}	SP_{t-1}	KK_t	T	D	R^2	d
1956/I –68/I	−3.737	4.692	1.939	−1.775	0.217	0.914	0.979	1.28
		5.7	1.8	−1.7	4.5	0.6		
1958/I –70/I	−5.035	6.093	3.590	−3.303	0.087	−0.668	0.977	1.12
		7.7	4.0	−3.6	1.9	0.5		
1960/I –72/I	−2.807	5.128	1.968	−1.973	0.128	1.466	0.982	1.21
		10.6	3.7	−2.6	2.6	1.0		
1962/I –74/I	−3.118	5.160	2.056	−1.138	0.111	0.417	0.976	1.39
		8.1	2.9	−1.3	1.5	0.2		
1956/I–70/II	−3.555	4.907	2.138	−1.674	0.169	0.567	0,978	0.98
		6.1	4.8	−2.7	3.5	0.5		
1957/II–70/II	−3.940	5.301	2.227	−1.843	0.131	0.797	0.980	1.06
		7.5	5.4	−3.4	3.1	0.8		

[1] Numbers below the coefficients are Student t-values.

Appendix 5. Linear Correlation Matrix of the Equation Residuals of the Basic Model Estimated from Period 1956–70.

Equation Dependent Variable	(4.11) SP u_1	(4.5) KK u_2	(4.6) TS u_4	(4.7) PKT u_5	(4.8) PKV u_6	(4.9) CO u_7
u_1	1.00	0.36	−0.47	−0.20	−0.34	−0.25
u_2		1.00	−0.36	−0.39	−0.18	−0.30
u_4			1.00	−0.12	0.24	0.25
u_5				1.00	0.64	0.10
u_6					1.00	0.10
u_7						1.00

For n = 30 (n = number of observations), r has to be $\geqq 0.46$ at the 1 percent level of significance and $\geqq 0.36$ at the 5 percent level of significance in order to be statistically different from zero (See DIXON and MASSEY 1957, p. 468).

Appendix 6. Ex-post Forecast for the Endogenous Variables and Forecast Errors in 1971–1974/I Generated by the Basic Model (As to units of measurement; see Appendix 1).[1]

Period	SP_t		KK_t		SK_t		TS_t		PKT_t		PKV_t		CO_t		UK_t	
	Fore-cast	Error	Fore-cast	Error	Fore-cast	Error	Fore-cast	Error	Fore-cast	Error	Fore-cast	Error	Fore-cast	Error	Fore-cast	Error
1970 I	3.99		1.03		5.80		29.27		3.15		3.99		4.57		8.10	
II	0.20		1.67		5.78		33.37		3.17		4.04		5.24		9.20	
1971 I	3.39	−0.18	1.24	0.26	5.79	−0.26	35.79	0.92	2.98	0.18	4.04	−0.11	4.93	0.09	13.09	0.51
II	0.11	0.30	2.35	−0.35	6.84	−0.25	36.37	−1.52	3.08	0.24	4.21	−0.05	5.17	0.03	12.54	−1.64
1972 I	3.41	0.21	1.42	−0.14	5.52	0.19	35.55	−1.03	3.11	0.36	4.26	0.06	5.04	−0.10	12.25	−0.55
II	0.20	0.37	2.30	0.34	6.63	−0.05	35.65	1.95	3.32	0.20	4.56	−0.07	5.24	0.22	11.38	0.92
1973 I	3.54	0.39	1.29	0.09	5.55	0.33	35.53	3.35	3.37	0.26	4.65	−0.04	5.14	0.09	11.69	2.93
II	0.18	0.38	2.20	0.63	6.89	0.09	36.70	0.88	3.71	0.16	5.12	−0.12	5.34	−0.13	11.82	1.34
1974 I	3.70	−0.27	1.23	−0.30	5.84	0.27	37.19	0.32	3.84	0.25	5.31	−0.01	5.21	−0.22	12.83	1.37

[1] Figures for the year 1970 are actual values, which are presented for comparison purposes.

Appendix 7. Simulated Time Paths for the Key Endogenous Variables under the Actual and Hypothesized Equilibrium Price Policies. Variable Values Are Generated by the Basic Model (As to the measurement units; see Appendix 1).

		Production (TS_t)		Total Consumption $(CO \cdot H)_t$		Net exports (UK_t)	
		actual policy	equilibrium policy	actual policy	equilibrium policy	actual policy	equilibrium policy
1965	I	18.06	18.14	15.96	15.77	2.10	2.37
	II	19.19	19.44	16.68	16.60	2.51	2.84
1957	I	18.51	18.99	16.60	16.42	1.91	2.57
	II	18.06	18.74	16.67	16.78	1.39	1.96
1958	I	17.01	17.70	16.19	16.34	0.82	1.36
	II	17.21	17.64	16.50	16.82	0.71	0.83
1959	I	16.95	16.86	15.97	16.28	0.98	0.58
	II	17.94	17.16	16.58	16.95	1.36	0.21
1960	I	18.38	16.88	16.35	16.67	2.03	0.21
	II	19.92	17.88	16.97	17.41	2.95	0.27
1961	I	20.88	17.90	16.83	17.24	4.05	0.66
	II	22.66	19.03	17.93	18.10	4.73	0.93
1962	I	23.37	19.30	17.90	17.97	5.47	1.33
	II	24.47	20.32	19.02	18.81	5.45	1.51
1963	I	24.20	20.33	18.59	18.53	5.61	1.80
	II	24.47	20.96	19.43	19.58	5.04	1.38
1964	I	24.09	20.75	19.45	19.55	4.64	1.20
	II	24.85	21.39	20.15	20.33	4.70	1.06
1965	I	25.05	21.18	19.68	19.98	5.37	1.20
	II	26.26	21.83	20.49	20.66	5.77	1.17
1966	I	26.65	21.75	20.23	20.20	6.42	1.55
	II	27.80	22.61	20.95	21.14	6.85	1.47
1967	I	28.11	22.72	20.56	20.77	7.55	1.95
	II	29.03	23.44	21.56	21.61	7.47	1.83
1968	I	28.69	22.94	21.40	21.31	7.29	1.63
	II	28.86	23.05	22.01	22.16	6.85	0.89
1969	I	28.34	22.46	21.44	21.61	6.90	0.85
	II	29.16	23.14	22.31	22.37	6.85	0.77
1970	I	29.77	23.48	21.82	21.97	7.95	1.51
	II	31.55	24.91	22.56	22.76	8.99	2.15

Appendix 7. (Continued). Simulated Time Paths for the Key Endogenous Variables under the Actual and Hypothesized Equilibrium Price Policies. Variable Values Are Generated by the Basic Model (As to the measurement units; see Appendix 1).

	Producer price (PKT_t)		Retail price (PKV_t)	
	Actual policy	Equilibrium policy	Actual policy	Equilibrium policy
1956 I	1.80	1.84	2.31	2.35
II	1.93	1.95	2.48	2.51
1957 I	1.93	1.98	2.44	2.48
II	2.18	2.15	2.71	2.69
1958 I	2.23	2.19	2.72	2.69
II	2.42	2.33	2.94	2.87
1959 I	2.40	2.31	2.88	2.81
II	2.53	2.43	3.05	2.96
1960 I	2.46	2.37	2.96	2.88
II	2.56	2.43	3.10	2.99
1961 I	2.47	2.36	2.99	2.89
II	2.46	2.41	3.04	3.00
1962 I	2.34	2.32	2.91	2.89
II	2.33	2.39	2.96	3.01
1963 I	2.31	2.33	2.94	2.96
II	2.48	2.44	3.14	3.10
1964 I	2.45	2.41	3.13	3.10
II	2.60	2.54	3.32	3.27
1965 I	2.61	2.51	3.32	3.23
II	2.70	2.64	3.45	3.40
1966 I	2.60	2.61	3.35	3.36
II	2.80	2.73	3.58	3.52
1967 I	2.78	2.70	3.55	3.48
II	2.85	2.83	3.69	3.67
1968 I	2.79	2.83	3.64	3.68
II	3.06	3.00	3.95	3.89
1969 I	3.05	2.98	3.94	3.87
II	3.12	3.10	4.05	4.03
1970 I	3.09	3.03	4.03	3.97
II	3.19	3.10	4.17	4.10

Appendix 8. Simulated Time Paths of the Most Important Endogenous Variables for 1971–74 under the Actual Price Policy and Different Price Policy Alternatives as Specified in Chapter 7. Variable Values Are Generated by Ex-Post Simulations with the Basic Model.

	Actual policy	Alternative 1	Alternative 2	Alternative 3
Production (TS_t), mil. kg				
1971 I	35.79	35.63	35.69	35.75
II	36.37	35.67	35.98	36.25
1972 I	35.55	34.00	34.76	35.40
II	35.65	33.13	34.44	35.51
1973 I	35.53	32.13	33.90	35.27
II	36.70	32.40	34.38	35.85
1974 I	37.19	31.57	33.61	35.14
II	38.56	31.04	33.18	35.01
Net Exports (UK_t), mil. kg				
1971 I	13.09	12.49	12.73	12.94
II	12.54	11.58	12.08	12.50
1972 I	12.25	10.45	11.37	12.13
II	11.38	8.61	10.03	11.14
1973 I	11.69	7.95	9.74	11.11
II	11.82	6.91	8.92	10.43
1974 I	12.83	6.56	8.71	10.48
II	13.23	5.00	7.37	9.41
Total Consumption $(CO \cdot H)_t$, mil. kg				
1971 I	22.70	23.14	22.96	22.81
II	23.83	24.09	23.90	23.75
1972 I	23.30	23.55	23.39	23.27
II	24.27	24.52	24.41	24.37
1973 I	23.84	24.18	24.19	24.16
II	24.88	25.49	25.46	25.42
1974 I	24.36	25.01	24.90	24.66
II	25.33	26.04	25.81	25.60

Appendix 8. (Continued). Simulated Time Paths of the Most Important Endogenous Variables for 1971—74 under the Actual Price Policy and Different Price Policy Alternatives as Specified in Chapter 7. Variable Values Are Generated by Ex-Post Simulations with the Basic Model.

	Actual policy	Alternative 1	2	3
Producer price (PKT_t), Fmk/kg				
1971 I	2.98	2.77	2.86	2.93
II	3.08	2.95	3.04	3.12
1972 I	3.11	2.99	3.07	3.13
II	3.32	3.19	3.24	3.26
1973 I	3.37	3.19	3.20	3.20
II	3.71	3.35	3.37	3.40
1974 I	3.84	3.42	3.49	3.65
II	4.31	3.82	3.97	4.12
Retail price (PKV_t), Fmk/kg				
1971 I	4.04	3.86	3.93	3.99
II	4.21	4.10	4.18	4.24
1972 I	4.26	4.15	4.22	4.27
II	4.56	4.45	4.50	4.52
1973 I	4.65	4.49	4.50	4.50
II	5.12	4.82	4.83	4.85
1974 I	5.31	4.95	5.01	5.15
II	5.93	5.52	5.65	5.77

Appendix 9. Producer Price, Export Subsidies and Export Price for Feed Grain used in Table 7.2, Fmk/kg.

Period	Producer Price Fmk/kg	Export Subsidy Fmk/kg	Export Price Fmk/kg
1971 I	0.41	0.21	0.23
II	0.39	0.24	0.23
1972 I	0.40	0.25	0.22
II	0.39	0.25	0.22
1973 I	0.40	0.12	0.37
II	0.41	0.12	0.37
1974 I	0.48	—	0.52
II	0.48	—	0.54

Source: The Agricultural Economics Research Institute. The producer price of feed grain refers to the average price of feed barley and oats.