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Determinants of control policy and quantitative and economic efficiency of dairy restrictions

Jukka Kola

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PRODUCTION CONTROL IN FINNISH AGRICULTURE

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Abstract. The primary goal of the study is to assess quantitatively the efficiency of production control programs applied in milk production in Finland. In addition, an attempt is made to identify qualitatively the central principles of and decisions inherent in control policy through e.g. political economy analysis.

Econometric and ARIMA supply functions for milk were estimated from the uncontrolled period prior to 1981 and simulated to the control period of 1981-89. The difference between the actual controlled production and the free production provided by the composite forecast of the two models was considered the control effect. Economic efficiency analysis in the form of cost-benefit calculations was based on the production quantity examination. The analyses indicate that the low efficiency of dairy control programs in the beginning of the 1980s has improved considerably when approaching the 1990s. Surplus transformation analysis showed that the applied quota system is more efficient in income redistribution than price reduction. According to the results of the qualitative and quantitative analyses, adjustment of agriculture to control programs was assessed and alternatives to present control practices were explored.

Index words: agricultural policy, production control, milk supply, surplus transformation, income redistribution, political economy

Contents

1. Introduction

Overproduction of agricultural products is a common problem in industrialized western world countries. There are many reasons for it. Technological development and productivity growth have accelerated agricultural production. Simultaneously, consumption of basic food stuffs has stagnated in industrialized countries.

One reason for overproduction is agricultural policy. In most countries, central goals of agricultural policy have been self-sufficiency in food and adequate income for farmers. In order to achieve the goals, prices of agricultural products have been set above the equilibrium price determined by demand and supply. The high price level has been safeguarded through border protection and trade restrictions.

Overproduction is a many-sided problem. There has been no willingness to slacken technological development or to abandon price support, and it is difficult to increase consumption. Instead, the heavy imbalance between domestic demand and supply has been taken care of by storage and export operations. Stocks are expensive to maintain. Expanding subsidized exports have dropped the world market prices of farm products. Consequently, the need for export subsidies has increased as the gap between national and international prices has widened.

Overproduction has led to ever-increasing budgetary costs. As a result, it has been necessary to introduce numerous production control and restriction measures. In the course of time, expanded production regulation has evolved into a special *control policy* within agricultural policy.

1.1. Definition of control policy

To start with, it is expedient to define agricultural policy in general terms and within the framework of representative governmental decision making. According to HALCROW & SPITZE (1989, chp. 1), "public agricultural and food policy is a decision and a subsequent action by a representative government about a problem centered in or related to the production, distribution, and consumption of food and fiber". Furthermore, the *determinants of policy* can be expressed in an equation as follows:

(1.1) $$AP_t = f(P_{t-i}, VB_{t-i}, ES_{t-i}, K_{t-i}, I_{t-i}); \quad i = 0,1,2,...$$

Thus, public agricultural policy (AP) is a function of past and current (not only agricultural) policies (P_{t-i}), values and beliefs (VB), economic and social conditions (ES), knowledge of alternative policies and their consequences (K), and influence levels of private interest groups (I) affected by the alternative policies. Evidently, it is difficult to measure or quantify some of these variables empirically.

From the general concept of agricultural policy it is necessary to move to a more specific *definition of control policy*. In a limited sense, production control is a means of production policy. In a broader sense, dealing with production control as *policy* is justified because, while pursuing policy, we are looking for and applying appropriate means to achieve the goals. It is evident that interdependencies between production policy, agricultural policy and national economy require an abundant assortment of means when pursuing control policy. The means of production policy can be divided into three broad groups (Figure 1.1).

There is no unambiguous definition for production control or, in the broader sense, for control policy. According to Aanesland (1987, p. 77), production control is government action which can directly affect production volume. In its purest form, production is controlled by quotas, through which maximum limits can be determined either for production or for use of inputs. The restrictive factor in quota application is profitability because it is usually unprofitable to exceed individual or collective quotas. On the other hand, the number of producers, inter alia, can also be affected directly by control measures. Then, instead of profitability aspects, the decisive factor is the importance of rural population and development in agricultural and social policy.

Because of its relation to production policy, control policy can be approached and defined through the definitions of production policy. Ihamuotila (1981, p. 43) states that "agricultural production policy, as a sub-section of science, examines determinants of production and consumption, predicts production and consumption, defines normatively a production objective, analyzes effects of policy measures, and studies new means". Studies on production control concentrate on the analysis of factors affecting production and effects of applied means.

As a sub-section of agricultural policy in practice, production policy is, according to Ihamuotila (1981, p. 42), "considered operations to define the production objective and to apply such measures as effectively as possible, which contribute to the realization of other policy objectives, or, at least, prevent their realization as little as possible". Control policy is or has to be pursued when the production objective or target is exceeded. It is problematic to apply control programs so that they would not impede the pursuit to achieve the other objectives of agricultural policy.

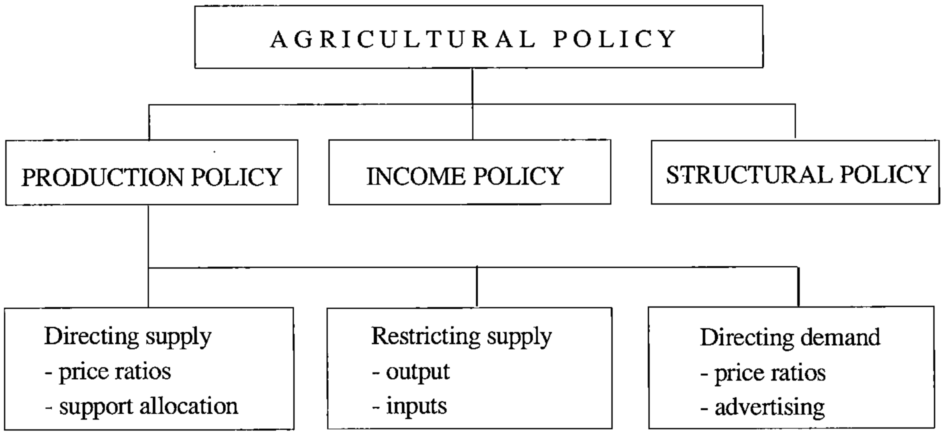

Figure 1.1. Position of production control in the classification of agricultural policy.

1.2. Background of control policy

Control policy often arises from the problem of surplus production. Countries have not aimed at restricting production, they have been forced to do so. As a result, control is not an objective in the same sense as the objectives of self-sufficiency, income level, and farm size set for the central areas of agricultural policy, i.e. production, income and structural policy.

Prevention of surpluses is the basic objective of production control. On the other hand, there would be no need to take immediate actions due to surpluses if they were not a source for undesired consequences. The nature of market competition and price formation determine the background according to which the objects of control policy can be divided into two broad categories: 1) price and income problems due to surpluses in free price formation, and 2) a cost problem due to surpluses in an administered price system.

Competitive markets and free price formation are central elements of a *theoretical* analysis of production control. Markets should automatically seek a balanced stage, but disturbance can be caused by e.g. accelerating growth of productivity and immobility of resources (e.g. Tweeten 1979, chp. 6). Consequently, control measures aim at increasing agricultural prices and income, which have fallen due to overproduction. Need and support for administrative control have been obvious because free price formation has not worked satisfactorily in agriculture (Cochrane 1958). A just market price level with respect to farmers' income development has been set as the goal of control. It should be achieved by consciously adjusting supply to demand, product by product, year by year. This requires adequate awareness of and ability to affect the determinants of supply and demand.

In *practice*, control policy most often aims at cutting government expenditure due to high overproduction. This applies especially to the administered price system, of which Finland is a typical example. In this case, agricultural products usually have a price and sales guarantee independent of production volume. Surpluses grow easily, and taking care of them by, for example, exports is expensive. The effect of overproduction on agricultural income depends on the division of marketing responsibility between the state and producers.

In Finland overproduction of agricultural products has been a problem since the 1950s. However, control policy has been pursued extensively only during the past two decades. Production control has been the central issue of agricultural policy, with some modifications: a shift from directing production to restrictions on production volume and curtailment of production capacity has occurred.

The growth of government expenditure due to expensive marketing of surpluses is the most essential reason for the use of control programs. Because the self-sufficiency target has been set higher than 100% due to e.g. seasonal variation, the need for exports of surpluses, especially from animal husbandry, has been permanent. It creates a cost burden, which has been widely accepted, however. Unprofitability of exports follows from the low world market prices, which cover only part of production costs. In addition, the change of the international market situation (trade liberalization, GATT Uruguay round) may require considerable cuts in subsidized surplus exports in Finland, too.

Finland has applied numerous and versatile means to control production. Nevertheless, overproduction has remained at a high level. The voluntary basis of control programs is one reason for their inefficiency. Steady price development, technological improvements and investment support in agriculture have increased production: the countereffect deteriorates the efficiency of the control programs. The cost burden of overproduction and surplus disposal has persisted.

1.3. Objective of the study

The control of agricultural production has dominated agricultural policy for the past few decades in Finland as well as in other western countries. In Finland, however, the scientific research concerning control policy and programs has been quite limited. This is especially true in the case of quantitative examination. The lack of research in this field is caused by the difficulty to carry it out e.g. for the following reasons:

- great variation in duration and form of control programs
- cumbersome measurement of real effects of programs
- limited availability of data
- insufficient follow-up of programs.

Overproduction is the basic reason for production control. The pursued agricultural policy leads to overproduction. Administered interventions have displaced market forces. Several questions can be posed: 1) why have we come to the present situation; 2) what are the best forms of production control, if necessary; 3) are production restrictions effective; 4) why have we not changed the pursued policy, if it leads, as often argued, to macro- and microeconomic problems?

In a search for answers to the questions, this study makes an attempt to

1) identify the principles and background of production control policy in agriculture, and
2) assess the quantitative efficiency in terms of production volume, as well as
3) evaluate the economic efficiency in terms of costs and income redistribution of the dairy control programs.

The first part is a qualitative general examination of control policy. The latter parts aim at quantifying the effects of control policy in Finland. The quantitative analyses are confined to milk production, which is the main line of production in Finnish agriculture.

1.4. Plan of the study

The study concentrates on providing additional quantitative evidence of the effects and effectiveness of control programs in milk production. To complete this task, the most suitable quantitative methods are explored. Qualitatively, further understanding of agricultural policy and background of control policy is enhanced through political economic examination of the decision making process.

The framework of the causal chain, which leads to control policy, is formulated in Chapter 2. The decision making process and the factors affecting it play a key role in the examination of the resolutions made between price and supply management and between voluntary and mandatory control programs. Then the framework of the causal chain is modified to fit the Finnish situation. The historical background of Finnish agricultural policy and the fundamental goals determined through it tie production control policy to a wider context. In addition to agriculture, social policy is concerned. This is emphasized when the division of marketing responsibility of surpluses or the principles behind the nature of control programs are examined.

Control policy has diverse consequences. Directly, it affects the volume and structure of production. Farm income, production costs, budget outlays for agriculture, agricultural population, processing and input manufacturing industries, foreign trade, and national economy as a whole are indirect objects of control policy. All of these cannot be examined simultaneously in one analysis. Hence, the study is restricted to assessing the effects of control policy on production volume and sectoral costs of the Finnish milk market. Alternative theories, methods and applications to examine impacts of control policy are presented in Chapter 3. The methods have been evaluated especially with respect to their applicability to a quantitative analysis.

In order to be able to examine the quantitative effect of control programs, the realized, controlled development in production has to be compared with the hypothetical development without control measures. Hence, the estimation of the supply function for milk, made in Chapter 4, is the crucial part of the study. It forms the basis for the actual analysis of effectiveness of control programs. It is necessary to know the factors which have affected production decisions prior to control programs, and which would still affect them, if production were not administratively controlled.

The estimated supply function for milk forms the basis for the analysis of the effects of dairy restrictions. In the examination of quantitative efficiency in Chapter 5, realized milk production in the control period is compared with the production which is simulated according to the estimated supply function. The hypothesis is that the actual controlled milk production has been lower than the predicted uncontrolled production. The difference between the actual production quantity and the predicted quantity is regarded as the impact of dairy restrictions applied during the control period.

The first part of the economic efficiency examination in Chapter 6 depends directly on the results of the production quantity examination. Profitability is evaluated through the comparison of costs generated by control programs and marketing of dairy products in surplus of domestic consumption. The examination is carried out for an individual control measure as well as entire control policy. In Chapter 7, relative efficacy of alternative programs to cut surpluses and redistribute income is assessed. In this section, the welfare economics analysis in the form of surplus transformation approach is employed.

Chapter 8 presents the results and conclusions of the study along with the implications for future research. Finally, a brief summary of the entire study is included.

2. Determinants of control policy

Prevention of overproduction is the usual objective of production control. Decrease in government costs or increase in prices are among the reasons in the desire to eliminate surpluses. There are many reasons for overproduction. Similarly, there are many ways to curtail surpluses. This study examines the principles and realization of production control, i.e., in the broader sense, *control policy.*

Dealing with the subject as policy is justified because of the extensive effects of and the various alternatives available for control programs. When introduction of control measures is planned and their possible impacts evaluated, the examination has to be extended over the object proper to accumulative effects in other sectors as well.

There is no straightforward solution that would determine the one and only means to a certain surplus problem. On the contrary, the special characteristics of each situation determine the choice and application of means. The solution is a result of a decision making process operating in dynamic conditions. Various interest groups and participants, according to their power status, affect or make an attempt to influence the process. Therefore, political economic analysis contributes to evaluating the determinants of control policy.

The policy aspect is stressed by the phenomenon that production control has evolved into an *adjustment mechanism.* Production control is intended to correct the consequences caused by the measures taken to achieve the primary objectives of agricultural policy. However, at the same time, control policy often aims at safeguarding the continuity of the policy pursued earlier, i.e. status quo is preferred to changes in policy.

2.1. The causality between farm programs and overproduction

Rapid technological development and saturation of demand have been presented as the general reasons for the surpluses of agricultural products. In addition, safeguarding of the primary goals of agricultural policy, i.e. self-sufficiency and farm income, by high producer prices have partly resulted in overproduction.

Especially countries that do not have a comparative advantage in agricultural production but strive for a high self-sufficiency have to use strong price support for producers. While applying a *high price system,* agriculture has to be protected from foreign competition through border protection. Domestic markets are separated from the world market. The price level in the world market does not affect the price level in domestic markets. The price level above the equilibrium slackens demand and accelerates supply. It results in an imbalance between supply and demand, i.e. production exceeds domestic consumption.

If the income goal, and, accordingly, price support, are maintained, there are two ways to approach the surplus problem: 1) creation of surpluses is prevented in the first place, or 2) surpluses are allowed, but the best solution is sought for their management.

Provided that there is no ability or willingness to lower the producer price, surpluses have to be prevented by quantitative production control measures. This applies to the first alternative. For the second alternative, there are various choices. One way to deal with the overproduction is to increase either traditional food consumption or alternative uses of farm products. Other forms of surplus management are stocks and exports.

It is difficult to increase consumption. This is especially true in the countries burdened with surpluses, in which demand elasticities for basic food stuffs are low and demand is close to the saturation point. Alternative uses, e.g. energy, are still rare, often because of an unfavorable price ratio. Storing is not suitable for all surplus products. Moreover, it is only a short-term solution, and expensive even as such. After a certain period, a necessary disposal of stocks easily causes downward pressure on prices. Strategic storing with respect to food security is an independent solution of a different nature. However, it has also been utilized for a short-run alleviation of the surplus problem. An extreme choice of destroying food is ethically, but also technically, difficult to cope with.

The most common decision is the export of surpluses. It is expensive, given the low level of world market prices and the subsequent high level of export subsidies. Moreover, its justification can be questioned. First, is it just to subsidize foreign consumers instead of domestic ones? Secondly, if the channel is food aid programs, who is the intended beneficiary? Instead of the recipient country, primary benefits may accrue to the supplying country disposing surplus stocks. Food aid has also been used as a political tool (e.g. SPERO 1990, chp. 5).

Present agricultural policy, characterized by overproduction and its control measures, has led to paradoxes (e.g. NIELSEN 1988). One of the most crucial paradoxes prevails between the food surplus problem in industrialized countries and food shortage in less developed countries (LDCs). At the same time, opportunities for export revenues of LDCs have deteriorated due to low world market prices. Poverty and misallocation of food (production) cannot be solved, but may be alleviated by changes and coordination in global agricultural policies.

The more commonly the present kind of agricultural policy, which loads world markets with surpluses, is practiced, the lower the world market prices and the higher the export subsidies become. The amount of export costs naturally depens on the domestic level of production costs and prices.

The direction and effects of export costs vary in different countries, mainly depending on the division of marketing responsibility between the government and producers. In practice, however, it is a rule of procedure that the higher the export costs are, the stronger the pressure is to cut costs. Usually, this results in production restrictions.

2.2. Effects of price support

The fundamental dilemma between objectives and results of agricultural policy can be presented as follows: high producer prices, raised due to the income goal, inevitably lead to larger production volume, which, consequently, requires an ever-increasing number of government interventions in farm product markets (e.g. KNUTSON, PENN & BOEHM 1983, p. 208). Figure 2.1 illustrates the chain reaction.

According to the economic theory, price support distorts market equilibrium. Equilibrium exists at the point where the demand and supply curves intersect. At that point,

GOAL →	MEANS →	RESULT →	ADJUSTMENT
income level	price support	over-production	production control

Figure 2.1. Causal chain leading to production control.

the price equals P_e and the quantity equals Q_e (Figure 2.2). When the price is raised through an administratively set support to P_g, producers' response increases accordingly the production quantity to Q_g. Due to the higher price, consumption drops to the level of Q_d. Hence, price support leads to the surplus of Q_g-Q_d. New administrative operations are needed to deal with the surplus. If the objective is to remove surpluses and maintain the same level of price support, the original purpose of control is to shift the supply curve as a whole so that it intersects the demand curve prevailing at the price level. In the figure, the supply quantity declines from Q_g to Q_d when the new supply curve is S_2. In theory, this is quite clear. But in practice, the shift of the supply curve is a rather complicated task. Usually it means restrictions on production. There is also a goal conflict connected with production restrictions, because they, in turn, may deteriorate income development.

It is also worth pondering whether the widely applied price support mechanism has really improved farmers' income level as intended. It is commonly argued that price support policies lead to increases in the prices of production factors, e.g. land and cattle. In Finland, the very Farm Income Act has exacerbated this kind of development of input prices in general as cost increases are fully compensated to farmers in the form of

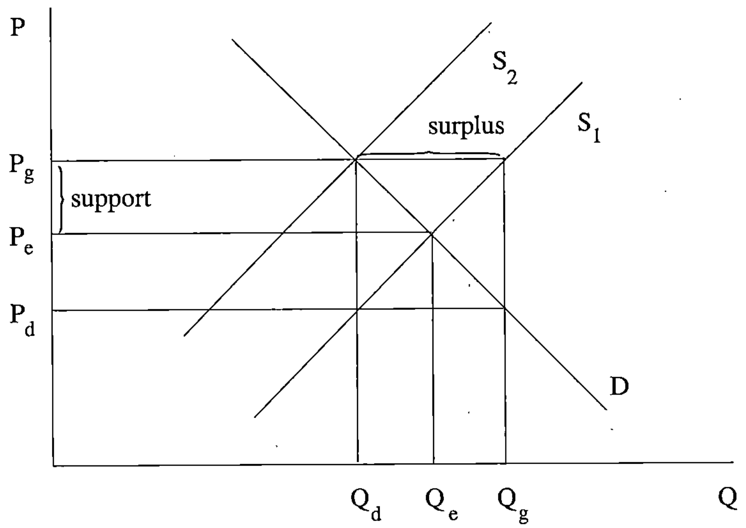

Figure 2.2. Effect of price support on market equilibrium.

higher target prices for farm products. Hence, higher production costs may absorb any potential increase in farm income. Again, the distinction between short and long term effects is necessary. The wealth of current farmers, provided that they are also owners of production factors, e.g. land, is increased by price support policies capitalized in production factors. Future farmers, however, suffer from the capitalization process, when they have to buy highly priced farms.

In a perfectly *competitive* market (e.g. KREPS 1990, chp. 8), price formation takes place and market equilibrium is achieved according to the laws of demand and supply. There are many sellers and buyers, homogenous products, full information, and free entry and exit in markets. Perfect competition is seldom observed in the price formation of farm products. In a *contestable* market (e.g. BAUMOL 1982), which is perhaps more likely to exist, the market equilibrium conditions are enforced by the threat of potential new entrants into the industry. Evidently, in the heavy regulation of Finnish agriculture, neither of these conditions prevails.

In terms of differences between agricultural policies, Australia and New Zealand seem to rely on the free market mechanism to the largest extent. This holds, if the criterion is based on the examinations of agricultural support in the context of producer subsidy equivalent (PSE) calculations (OECD 1988).

The PSE-figures are the lowest in Australia and New Zealand. These countries have seldom applied supply management by the government. According to the conclusions of the causal chain drawn earlier, this is a result of a low level of price support, which is possible because of low production costs in these countries. However, low production costs do not provide a full explanation. As an interesting example, the percentage PSEs for milk have been higher in the U.S. and Canada than in Finland in 1985-86 (OECD 1988).

Although perfect competition is rare in real life, its assumptions are still important in research work. DOLL & ORAZEM (1978, p. 16) pay attention to the fact that perfect competition, in terms of the economic theory, is closer to the market conditions of agriculture than any other type of market mechanism. Applicability of the theory is underpinned by the feature that profit in agriculture is derived more from natural scarcity of resources than from planned scarcity. No producer alone owns so much production resources, e.g. arable land, that he could artificially create scarcity.

However, production control measures *particularly* represent artificial means. In a quota system, only farms with the originally granted permit are allowed to produce. Production rights are capitalized in a quota. This is especially evident with freely transferable quotas, e.g. in Canada. In jargon, the scarcity of production possibilities generates additional, extra profits for producers with production permits. The phenomenon is also observed in empirical studies, e.g. in Canada (USDA 1987a) and in the FRG (BRAATZ & SCHRÖRS 1988).

Government regulation and control policy is widely practiced in agriculture because it has been perceived that farmers' income level cannot be secured by market forces (e.g. COCHRANE 1958). However, the question of great relevance is whether administrative control is really needed, and if it is needed, in which form. In the search for solutions to excess supply problems in agriculture, in Chapter 2.3, a pairwise evaluation of supply management by price mechanism or quantitative restrictions and compulsory or voluntary control programs is made.

2.3. Realization of control policy

The principles of the solutions made between price mechanism and quantitative supply regulation and between mandatory and voluntary control policy are examined in the following. Because control policy is often a consequence from the achievement of the primary goals of agricultural policy, the decision making process and its participants, alternative solutions, effects, and match of objectives are underlined.

2.3.1. Price mechanism or quantitative restrictions

Farmers' income level has been secured by price support, as illustrated in the causal chain (Figure 2.1). It causes expenses, the quantity and payers (consumers, taxpayers) of which vary depending on the way of realization. Price support may widen the gap between consumption and production as it accelerates supply and slackens demand due to higher prices.

Instead of dealing with the consequence, i.e. surplus production, it would be possible to affect the reason, i.e. price formation, directly. The quantitative means affecting production and supply, e.g. restrictions on production, are most often used to balance domestic supply and demand. A price, or a market mechanism, is seldom used, although the economic theory strongly supports it.

The decision making process, as a political process, supplies resolutions, which may depart from solutions based on the economic theory. A result may be an agricultural policy which is expensive and lies on non-economic grounds rather than economic principles (Thomson 1985; Winters 1987; Petit et al. 1987). Evidently, and by experience, it can be stated that the reasons behind the chosen farm policies are wider in scope than economic principles as such. Consequently, understanding of farm policies can be enhanced by *political* economic analysis (Chapter 2.4).

Criticism of quantitative restrictions is often based on the economic and international trade theory. This criticism takes place in international fora, e.g. GATT and OECD, when the proposed plans for an agricultural and trade policy reform are evaluated in a global perspective. Supply management via quantitative restrictions in combination with price support is opposed by the following general arguments:

- comparative advantage is rejected and international trade is distorted
- planned market orientation and workability of a price mechanism is depressed
- demand is often totally ignored
- ineffectiveness of control measures can result in worse market disequilibria
- price support is maintained by quantitative restrictions

The advantage of a price mechanism over quantitative restrictions can be highlighted by the following drawbacks of supply management by quantitative restrictions (e.g. Rabinowicz & Bolin 1986; Finnish examples in parentheses):

- only the existing farmers benefit; successors have to pay a high price for their production rights (purchase of a farm in a change of generation)
- production technology and structure freeze (establishment permits)
- increased and unpredictable bureaucratic power (allocation of milk bonus agreements and additional quotas)

- increased risks for black markets, if the price gap between the two prices in a two-price (quota) system enlarges (farm-gate selling of eggs)
- increased surpluses in other markets not subject to supply management (restrictions on animal husbandry increase feed grain surpluses)
- abolition of a control system is difficult (quotas)

Inefficacy of quantitative restrictions, independent of whether they are voluntary or mandatory, can transparently be shown by using widely applied acreage restrictions in terms of fallowing schemes as an example (e.g. MÄKINEN 1990, pp. 157-160). Experience with the U.S. set-aside program in the 1970s exemplifies the so called slippage phenomenon: a 15 percent reduction (set-aside) in the cultivated area resulted only in a 3 percent drop in production (KNUTSON et al. 1983, p. 219). Common flaws of fallowing schemes are:
- increased intensity in the area remaining in cultivation
- the least productive fields are fallowed
- productivity improvements are made during temporary fallowing contracts
- land values rise due to limitation on supply and capitalization of fallowing contract premiums or compensations

The aforementioned criticism and drawbacks are mainly based on economic arguments. Following the criticism, the common perception and recommendation is that if quantitative restrictions are applied they should be limited to 1) *temporary*, short-term solutions, which 2) affect *output* instead of inputs, and 3) are *voluntary*, not compulsory (OECD 1990a). In general, *flexibility* is favored.

Despite the criticism, various supply management measures from price support programs to mandatory restrictions on production have often been applied, and in an increasing amount when approaching the present time. In some countries, in spite of extensive application of control programs, the price formation has been quite free, e.g. in the United States. The objective has mainly been to prevent prices from dropping due to overproduction.

Alternative solutions for the price problem have been analyzed extensively in the course of time (e.g. SHEPHERD 1964; KNUTSON et al. 1983). The main conclusion has been that the price support programs have not succeeded in raising the price (and income) level in the long run, but they may alleviate the symptoms, i.e. low prices, of the causative problem of supply and demand in the short run. But the disease itself, i.e. market imbalance, only worsens. Evidently, output restrictions would have a better cure for the "disease" itself than price support programs.

The diagnosis of farm problem went wrong in the very beginning, e.g. in the 1920s in the United States (KNUTSON et al. 1983, pp. 202-238). Weak demand was considered a reason for the low prices and income in agriculture. The correct object would have been the excess resources in agriculture. For a firm verbal statement, one cannot do better than quote SHEPHERD (1964, p. 211):" ... the basic farm problem is not a price problem resulting from a chronic oversupply of *farm products*; it is an income-per-farmer problem resulting from a chronic oversupply of *farmers*." Yet, instead of resource cuts, price support programs have dominated.

Unfair and unstable prices in the world market, but also in domestic markets, have been the usual reason for the need for administrative supply management instead of a market mechanism. One source of instability is weather variation, to which agricultural output is very sensitive. Drastic changes in market conditions, e.g. the energy crisis in the mid-1970s, support the application of supply management instead of the price mechanism. Government intervention has also acted as an alleviation means for the (resource) adjustment process in terms of regional and structural development, inter alia.

Already the famous treadmill theory (COCHRANE 1958) preferred control measures to a price equipment. The theory suggested that new technology enables output to grow continuously, which results in ever-decreasing prices. Consequently, only the fastest adaptors can succeed. This applies both in national and international perspective: wealth and success accumulate to few. Cochrane's opinion was that a price mechanism cannot function well because farm product markets are too volatile and their participants too slow to adjust themselves. The permanent overcapacity problem of agriculture can only be solved by effective government interventions controlling production. Furthermore, Cochrane preferred mandatory controls to voluntary ones.

2.3.2. Compulsory or voluntary restrictions

Compulsory control measures must have been considered and applied widely, especially because of increasing budget outlays. Recent examples are the EC realization of milk quotas (PETIT et al. 1987) and the discussion on the need for mandatory programs in connection with the U.S. 1985 and 1990 farm legislature (SPITZE 1987, 1990). In Finland, the last application of mandatory restrictions is the semi-obligatory fallow scheme introduced in 1991 (KETTUNEN 1991, p. 37).

Production or market quotas are the most common means of mandatory control programs. However, quotas are not binding because it is not forbidden to exceed them. But it is usually unprofitable. In the case of processed products, e.g. milk, it works, but in the case of eggs or feed grain excesses can be marketed through other channels. Hence, a sanction system cannot cover all production.

Quotas have been widely applied in milk production. The characteristics of quota systems, e.g. mobility and sanctions, vary considerably in different countries (OECD 1990b). Canada introduced milk quotas in 1965, Switzerland in 1977, Austria in 1978, Norway in 1983, the EC in 1984, and Finland in 1985. Sweden had an exceptional voluntary quota system since 1985 until its as exceptional abolition in 1989. Even Australia, the strong supporter of market forces, has applied milk quotas. Instead, the United States, the third largest producer of milk after the Soviet Union and the EC, has not applied milk quotas. However, milk quotas have been dealt with in conjunction with the last two farm acts (SPITZE 1987; HAMM 1990).

Oversupply problems have the longest history in the United States. Therefore, it is worth examining the American control program choices. The *compulsory* control of agricultural production gained support in the United States in the beginning of the 1960s. It was mainly a result of an effort made by W.W. Cochrane, the agricultural chief advisor in the J.F. Kennedy administration.

The congress passed an extensive control program based on mandatory measures, but its wider use collapsed to the strong opposition of farmers in 1963 (Knutson et al. 1983, p. 218). Thereafter, voluntary programs have been favored.

Cochrane's (1958) support for mandatory control partly included a worry of centralization of agriculture and destruction of the family farm structure. In the 1970s, Raup (1978) repeated the same kind of thinking in the concept of "economic cannibalism". A few large factory-type farms, taking advantage of the scale of size, have the capability to gradually swallow smaller farms.

The discussion on the need for mandatory control measures was renewed in connection with the 1985 Food Security Act. The important impulse, contrary to the 1960s, was the expansion of farm program costs. It was considered that mandatory programs can cut the costs (USDA 1987b). On the other hand, advantages of mandatory control are ambiguous (Thompson 1986), even if it will result in increased income through higher prices in the short run.

Gradually, however, higher prices will capitalize on land values. In practice, capitalization will prevent new farmers from entering the industry. Exports and some joint groups of agriculture will suffer from the price rise, too. Consumers experience higher prices as a regressive tax because those pay the most whose food expenditure is relatively the highest. As voluntary programs have been financed by a progressive income taxation, compulsory programs shift the burden from taxpayers to consumers.

Low budgetary cost is the biggest *advantage* of mandatory measures like quotas. Consumers usually pay the expenses in higher prices as supply falls. However, administrative costs may grow due to the difficulty to enforce and supervise these programs. *Good efficiency* in curtailing production is the other important benefit. Mandatory programs contribute to an *equalized division of cons and pros* between producers, because the possibility of enlarged output by non-participants in voluntary programs is eliminated.

Finally, there is an interesting possibility in the free price formation that farmers may gain from mandatory controls if the increase in price they receive is relatively larger than the amount they are required to cut down production. All this is directly dependent on the price elasticities of demand and supply. However, per unit cost of output obviously increases as the farmer is forced to move to diseconomies of scale.

According to productivity aspects, compulsory measures should not be used. Average *production costs increase* because the most efficient producers have to cut their production relatively as much as inefficient farmers. Measures like quotas *stagnate production structure and prevent low-cost, efficient production* from spreading. Instead, a price drop would eliminate the most expensive production. *Drawbacks* are particularly serious if inputs are controlled, i.e. optimal use of inputs is prohibited. Should mandatory programs be applied, they should affect output instead of inputs (OECD 1990a; Wallace 1962, p. 585).

Typical *drawbacks* in compulsory programs are that they *limit farmers' decision* sphere and farmers are often faced with *inadequate time to adjust* to the changes necessary due to compulsory restrictions.

The effects of mandatory programs on trade are negative because the *market share* may be *reduced* due to implied price increase, not only temporarily but perhaps permanently, when other exporters of the restricted product expand their sales.

Negative attitudes of farmers to compulsory programs (e.g. Tweeten 1979, pp. 513-

516; Knutson et al. 1983, p. 218; Suojanen 1977 and 1983) have often affected decision making, resulting in wider application of voluntary programs.

In conditions of a free market, the success of *voluntary* control measures requires suitable circumstances. First, demand for the controlled product has to be relatively inelastic. The restricted product must not have a close demand substitute. The above conditions maintain the level of demand for the product. Otherwise, without price regulation, restrictions on output increase prices, which would lead to lower consumption. Secondly, inelastic supply is required to prevent supply of non-participants from increasing when prices go up due to restrictions. No supply substitute is allowed, either. Most farm products meet the requirements.

The principle prevails in voluntary control programs that it pays for a farmer to cut production, if the compensation he receives equals the difference between return and variable costs, i.e. it covers fixed costs. According to the neoclassical economic theory, it is profitable to continue production as long as variable costs can be covered by returns of the enterprise. In Figure 2.3 this functioning area is located above the intersection point A (shutdown point) of marginal costs (MC) and average variable costs (AVC). Then, production losses equal average fixed costs (AFC) up to the intersection point B (breakeven point) of average total costs (ATC).

It is difficult to determine the correct level of compensation in voluntary programs because relative shares of variable and fixed costs vary a great deal between farms according to production lines and, partly, farmers' subjective points of view. Applicability of programs providing compensations to cover fixed costs, e.g. the agreements for decreasing animal production, so called bonus agreements, depends on the farmer's evaluation whether the compensation guarantees a satisfactory livelihood in comparison with

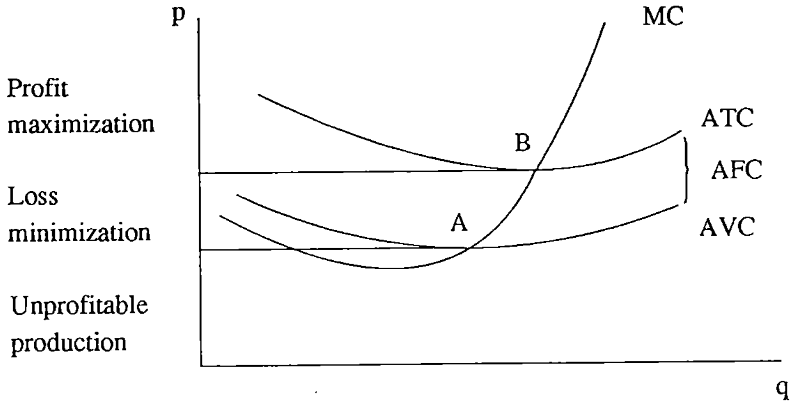

Figure 2.3. Profitability of a firm in the short run.

livelihood earned from active production. In Finland, inefficiency of small farms, old farmers, and programs of a short duration have encouraged farmers to make control agreements. In addition, sometimes the contract period may have been used for renewal of production facilities.

Flexibility and freedom in decision making are the essential *benefits* of voluntary control programs compared with mandatory restrictions. Moreover, if voluntary programs are intentionally directed to older farmers with small, inefficient farms, structural development can be enhanced remarkably.

But the government *costs rise* higher than those of compulsory programs as voluntary programs usually involve compensations to participating farmers. Costs increase also due to *inefficiency*, a typical *disadvantage* of voluntary programs. The net effect may remain low, if farmers had also given up production without the incentive based programs. Programs may be designed on social rather than efficiency grounds. Often the result is that production shifts from a restricted product to an unrestricted one. A typical example is the growing surplus of feed grain as a consequence of the restrictions on animal husbandry.

The criterion for a comparison between various voluntary programs is their cost burden in terms of government expenditure at the macro level and their effect on profitability of production at the micro level. Flexibility in introducing, using and quitting programs is important, both for the object (producer) and the executor (administration). Special attention has to be paid to other extensive effects of control measures on e.g. rural population and environment when evaluating control policy.

2.4. Decision making process

In the previous chapters, the choices of alternative means with respect to agricultural policy in general and control policy in particular were dealt with. Decisions are made through a joint effect of various factors, and, accordingly, they affect many objects. Extensive control of agricultural production has dominated the pursued policy, and it has eliminated market forces. The objectives of the national food security and adequate income for farmers have directed agricultural policy. These choices in agricultural policy are political decisions made by elected officials in the political arena.

Hence, decision making and factors affecting it have to be evaluated according to principles and concepts wider in scope than those solely and traditionally attached to economics. Models which include economic variables only do not acknowledge the political setting. Consequently, alternative theories and models are needed to examine the agricultural policy process as part of the overall public policy formation.

Political economy theory offers a suitable framework to incorporate both the economic and political aspects involved in agricultural policy formation. Political economy theory is defined as the economic study of non-market decision making (MUELLER 1979, p. 1). In its most basic form, political economy theory analyzes the interactions among special interest groups, elected legislative officials (parliament) and administrative bureaucrats (executive branch). Basic references are DOWNS (1957), TULLOCK (1959), OLSON (1965), BUCHANAN (1968), MUELLER (1976).

In general, a *political economy model* is intended to identify variables which may influence policymakers' decisions, and by doing so, to endogenize government behavior. Instead of focusing on evaluating the welfare consequences of given, say, agricultural policy scenarios, political economic analysis examines how policy responds to the welfare of market participants. The political economy model considers preferential political policies as public goods, which are supplied by politicians and bureaucrats, and demanded by special interest groups. Both qualitative and quantitative approaches apply to political economic analysis.

The importance of political influence of special interest groups in the political decision making process is emphasized by the *public choice* theory. It is one approach in the framework of political economy theory to examine the versatile decision making process and its elements such as the participants of the process, interest groups, rules and bureaucracy of the process, general economic development, and parliamentary situation.

Becker (1983) states in his theory of competition among pressure groups for political influence that governments correct market failures with the view that they favor the politically powerful, who are not necessarily the most numerous in the society. Political power is affected by the size, political efficiency and political expenditures of the group. Becker's model is set in a Cournot-Nash noncooperative game (see Kreps 1990, chp. 12) in political expenditures. The agents aim at maximizing their income.

The *qualitative* approach is employed in the study of the EC milk quotas by Petit et al. (1987). They call their approach as one of *new political economy*, which heavily overlaps the public choice theory. The entire decision making process has been analyzed through four stages:

- identification of the most important participants and their institutional background and goals
- determination of limitations for operation of the participants
- listing of the effective means and channels available for the participants
- comparison of the participants' behavior in the different phases of the process

The claims for restrictions on milk production in the EC strengthened parallel to the expansion of the agricultural budget. The original positions of selected EC-countries are illustrated in Table 2.1, which is combined from Petit et al. (1987, pp. 135, 160).

Table 2.1. The goal preferences with respect to the alternative dairy restrictions in the European Community in 1983.

Goal	France	FRG	Italy	Netherl.	UK	Denmark
Farm income	++	++	++	+	+	+
Price reduction	0	--	0	+	++	0
Quotas	-	+	-	-	-	0

++ very important, + important, 0 neutral, - against, -- strongly against

Source: Petit et al. 1987, pp. 135, 160.

Finally, there were only two alternatives to curtail overproduction, either a price drop or production quotas. The final decision was supply management in the form of milk quotas. As a summary it can be stated that the choice between the two difficult alternatives was evaluated and made by the motive of loss minimization, in terms of both politics and economics. There was not much to gain for anyone, either for the member states or their internal participants of the decision making process.

The abundance of the factors in the EC process is illustrated by the fact that only within one participant, i.e. agriculture, there were several interest groups with their different goals: many farm unions, product groups, marketing organizations, and regional federations in each member country.

In the *quantitative* approach, in addition to identification, the magnitude and direction of effects of variables affecting the decision making process are examined. The main interest is to analyze the policy result and to find out how policy changes when the variables change to enhance understanding of agricultural policy choices. In order to do so, i.e. to endogenize government behavior, political decisions have to be quantitatively incorporated into economic models. The studies by DE GORTER (1983), GARDNER (1987a), LOPEZ (1989) and MARCHANT (1989) represent this approach.

Empirical government behavioral models can be categorized into two groups (RAUSSER, LICHTENBERG & LATTIMORE 1982): 1) analytical derivation followed by estimation of policy instruments from policy preference or criterion function: *criterion function models*, and 2) direct estimation of policy instrument behavioral equations: *behavioral models*.

Purely economic principles often do not support the use of administrative production control compared with the alternative of market forces. Admitting the interdependencies between economic and political factors, it can be stated that popularity of control is based on political economic factors, rather than so called non-economic factors alone. EHRENHEIM (1984), applying public choice, has suggested that in Sweden the decision making in agricultural policy has shifted to the responsibility (or privilege) of fewer and fewer people. This implies that democracy does not work. A certain group can pursue agricultural policy as it desires, as long as others receive corresponding benefits in the sectors they consider important for themselves.

Contrary to the concentration evolution, it has also been thought that agricultural policy has become so important for all sectors of the society that it cannot be left to agriculture or narrow administration to take care of. In addition to food production, agricultural policy affects various other matters. At the moment, rural development and environmental management, representing economic as well as ecologic issues, are central objectives of agricultural policy. More and more groups with different interests try to affect the decision making process. The traditional "triangle of power", i.e. the congress - administration - producer organization, has fallen under the weight of conflicting interests of the greatly increased number of actors (BONNEN 1977).

Decision making in agricultural policy has become more difficult because of heterogenous national factors, but also due to increasing internationalization. In the 1970s, energy crisis changed the foundations of agricultural policy, both nationally and globally. In the 1980s, assumed advantages of trade liberalization have increased criticism on protectionism in agricultural policy, which has been practiced widely and designated to a special privileged position. International agreements, e.g. the GATT and EES decisions, regulate national policies of the member countries. Formation and integration of the free market area of the European Community affects also non-member countries' agriculture and food industry.

Furthermore, tendency to use food, and accordingly agricultural policy, as a means to achieve local and global political influence ("food as a weapon", "supplier of the last resort", food aid programs) extends the sphere of decision making analysis beyond the traditional economic factors. Finally, the basic global question whether the world can feed its population will play an important role when national agricultural policies are formulated. Predicted climatic changes may alter production capabilities.

The political and economic characteristics of Finnish control policy are examined in the following chapter. National factors, strongly influenced by the political setting, have mainly directed decisions. Dependence on international development, however, will have greater influence on agricultural policy decisions also in Finland.

2.5. Finnish control policy

The fundamental causal relationships of Finnish control policy can be derived from World War II and the first post-war decade. At that time, decisions were made under extremely exceptional conditions and lack of alternatives. However, overproduction, which started soon and grew rapidly, could have been taken care of by price policy instead of the chosen control policy. But wider goals of agricultural and social policy determined a different direction. In the following, the phases and principles of agricultural policy and decision making in Finland are examined. The causal chain leading to control policy, presented earlier in a general form (Figure 2.1), is modified to better illustrate the Finnish situation (Figure 2.4).

2.5.1. The central objectives of agricultural policy in relation to control policy

Self-sufficiency is the central goal of agricultural policy in Finland, as well as in many other countries. Hence, it must be added to the general form of the causal chain (Figure 2.1) in the goal section parallel to the farmers' income level (Figure 2.4). Self-sufficiency has a special meaning in Finland, because extraordinary efforts have been required to achieve it in comparison with countries enjoying more favorable natural conditions and steady historical and social development. Another reason of great importance for food security has been the political neutrality of Finland. In crisis situations, we do not have political or military allies. Hence, self-sufficiency as such guarantees independence to some extent.

In Finland, however, the focus has been on self-sufficiency of output. Accordingly, self-sufficiency of production inputs has received less attention, or it has not been achieved, in spite of the objectives. In the case of fuel and lubricants of farm machines and important pesticides, Finland relies on imports to a large extent. On the average, self-sufficiency of production inputs is 74 percent (Ihamuotila 1985).

According to Tweeten (1979, p. 518), the principal purposes of production control are to stabilize production and to create an orderly economic environment for agricul-

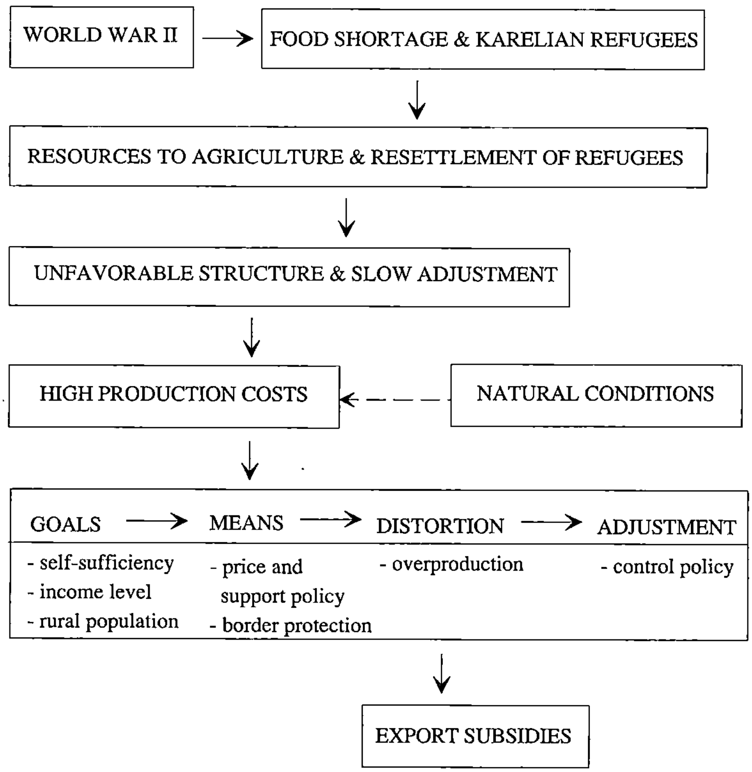

Figure 2.4. Causal chain leading to control policy in Finland.

ture, in which a strategic reserve of production capacity can be maintained. A reserve of production capacity has not been considered sufficient in Finland, but the goal has been continuous self-sufficiency in basic food stuffs.

The 100 percent self-sufficiency target in basic food stuffs set in the 1950s by the agricultural committee (Anon. 1962) has later been modified, mainly upwards (Table 2.2), by several committees (Anon. 1969; Anon. 1980a; Anon. 1983). In principle, the Agriculture 2000 committee (Anon. 1987) reintroduced the targets set a quarter of a century ago. The objective is the best possible balance between domestic production and consumption, taking seasonal variation into account.

Parallel to food security, the other important goal has been to secure the level and development of *farmers' income*, and to equalize income disparities within agriculture. The income goal has indirectly the same effect as the self-sufficiency goal, because they involve the same primary means, price support, which results in overproduction. In principle, the goals of self-sufficiency and income can be achieved together without major conflicts between them. In practice, their realization has also proved successful to a satisfactory extent.

Maintaining *rural employment and population* has been the third goal of great importance, although its background has varied in the course of time. It reflects the strong

Table 2.2. Self-sufficiency targets (%) as presented in various agricultural committees.

Product	1962	1969	1980	1983	1987
Milk	100	105	115	115	115
Beef	100	105	100	100	100
Pork	100	105	105	105	105
Eggs	100	105	110	110	105
Bread grain	75-100	100	105-110	100	100
Feed grain	100	100	-	-	-
Sugar	25	20	60	60	60
Oil seeds	20	20	100	85	85

influence of *regional policy* in Finland. In addition to the goals of labor and social policy, national security in terms of utilization of resources in the whole country has been taken care of by regional policy. In the 1980s, wider adoption and underlining of *rural policy* underpins the position of regional policy among the central goals of agricultural policy. Agriculture is still the central, but not the only factor in the comprehensive development of the countryside.

The common feature of the three central goals is the assortment of means used in our agricultural policy, which has been dominated by price and support policy as well as border protection (see Figure 2.4). They have secured the price and sales guarantee for the entire farm output in the whole country, independent of the domestic consumption level.

Instead, the efforts to achieve the other objectives, e.g. *structural development, reasonable prices* and *high quality* of food stuffs and *environmental sustainability*, are more complicated to outline. Their efficiency may even be hampered by the strong priority of the central goals.

It is quite self-evident that when an attempt is made to achieve *several, and quite different, goals* by using mainly *one and only means*, price support, problems will arise (e.g. SOHLMAN 1990). Because of the evident *goal conflicts*, it has usually been possible to concentrate only on the *three central goals*: 1) self-sufficiency, 2) income, and 3) rural population.

Control policy has been introduced to correct distortions brought about by the primary means in achieving the central goals. Control policy hampers structural development (MÄKINEN 1990), when it prevents farms from growing. On the other hand, natural or administered direction of control measures to old farmers with small farms has promoted structural development. Moreover, in some cases, control programs have been aimed at securing the livelihood of family farms by preventing industrial-type production (establishment permit system; KOLA 1987).

In principle, the effect of production restrictions on income development corresponds to that on structural development above. Inevitably, restrictions have impeded income development in many cases. However, control policy is also a condition for maintaining the high price system and the income level in agriculture. In addition, it can reduce surplus marketing costs, which affect farm income negatively, given the marketing responsibility system (see Chapter 2.5.2).

Why have the three central goals been on the forefront? Why have such means to achieve the central goals been used that create surplus problems? Why have surpluses not been cut via reductions in support prices? To answer the questions, the conceptual framework of the causal chain is followed (Figure 2.4). However, the interesting question why policies have not been altered as problems (surpluses) accumulated can better be examined in the political economic analysis (see Chapter 2.5.4).

The background for Finnish agricultural policy can be derived from World War II and from the necessary arrangements of the post-war period. Especially the effects of the resettlement process (1945 Act on Land Acquisition) are reflected to the present-day situation (Figure 2.4). Food shortage required increases and improvement in domestic farm production. Possibilities to live had to be established for the refugees of the ceded areas, half of whom were agricultural population. According to HAATAJA (1987), the resettlement process was social policy of the agrarian society. One aim was also to prevent unrest in the society. Expansion of agriculture supported the goals set for agricultural production and resettlement. These operations also supported the security strategy in terms of maintaining inhabitation in the remote areas. Agriculture, at the cost of its internal development, acted as the society's buffer necessary for the adjustments in the difficult situation.

As a result, agricultural structure became unfavorable in Finland. More resources, especially land and labor force, were tied to agriculture. The rapid structural development and rationalization of agriculture, which started immediately after the war in other Western European countries, could not take place in Finland. On the contrary, the average farm size decreased and the number of farms increased.

In 1966, when the Resettlement Fund was replaced by the Agricultural Development Fund, the focus of policy shifted from enlargement of production capacity to improvement of livelihood on the *existing* farms. However, a new obstacle for structural development was already under formation, i.e. increasing production control with e.g. restrictions on the unit size of enterprises. Unfavorable structural development, combined with the northern location, easily explains high production costs. Consequently, profitability of individual farms has been secured by high product prices, corresponding to high costs.

Income policy, managed by price and support policy, has been a major factor in the realization of the three central goals. To increase output and create willingness to cultivate, reasonable conditions had to be provided in agriculture compared to other industries. The income goal has been taken care of by the farm income system, which has been directed by income settlements and laws since the 1950s (KETTUNEN 1972, 1981; IHAMUOTILA 1979; SAULI 1987).

The system secured the production goal as early as in the late 1950s, and led to growing excesses in the 1960s. The development was fostered as production became more effective and productivity regained the "normal" pre-war pace of growth at the same time when consumption growth started to slacken. In spite of the threat of gradually emerging overproduction, the income goal of farmers did not allow price reductions. Moreover, the parity principle between farmer and wage-earner incomes, especially in conditions of a rapidly rising wage rate, required the continuation of the high price system adopted earlier in the farm income system.

As a summary of the events in the post-war decades it can be concluded that farmers were provided conditions to live and produce in their industry by the state. It was necessary because of the extensive objectives of food security, employment and social development. It was widely accepted in the society of the post-war era. Consequently, abundant resources were allocated to agriculture. Instead, their adjustment to the quickly changing circumstances has not been as successful as the achievement of self-sufficiency in agricultural production in the difficult conditions after World War II. As the surpluses accumulated, *the division of the surplus marketing responsibility* between agriculture and the state became the key issue.

2.5.2. Marketing responsibility of surpluses

In free price formation, surplus production results in a farmer's income problem as prices tend to drop. But in the administered price system, surpluses create an export support problem. Expansion of government expenses due to surplus disposal has been the essential reason to the restrictions on production in Finland.

Since the 1950s, marketing responsibility of farm products has been included in the legislative price system. Methods and division of the cost burden between producers and the state have varied (Siltanen 1988). In the beginning, producers' responsibility was realized through lowering the prices to the world market level for that part of output which exceeded the output of a certain year used in the comparison. In the 1970s, in addition to the price reductions, temporary marketing charges from producers were used.

Since the 1977 Farm Income Act, marketing responsibility has been based on the production and export ceilings for each individual farm product. The share which agriculture is responsible for is collected solely as export cost charges consisting of marketing fees and taxes on inputs, especially to finance surplus exports. As such, the production and export ceilings are not control means but a basis for the division of marketing costs.

As the ceilings have been lowered annually, the state's share of costs decreases, at least in terms of quantity. Changes in value depend on the ratio between the world market and domestic prices, i.e. on the amount of required export subsidies. The 1982 Farm Income Act determined that an allowance, equalling 20 percent of the appropriation granted for export costs of farm products in the state budget, has to be reserved for production control measures. Moreover, the marketing share of agriculture must not exceed the threshold of 10 percent calculated from farm income of the pricing year. Surpassing the threshold was prevented by raising the ceilings higher in 1983. For 1988-89, the threshold was raised to 13 percent.

Instead of a clear designation to the products with the heaviest cost burden, export cost charges have been collected co-responsibly from whole agriculture, e.g. tax on fertilizers and industrial feed. As producers' responsibility is divided to the total volume sold, it has little effect on individual farms, and the expected incentive to reduce production disappears (Aaltonen, Siltanen & Kettunen 1982, p. 31).

Table 2.3. Excesses and shortfalls of production and export ceilings and the share of agriculture of the export costs in 1980-89.

Product		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Milk,	mill. l.	274	193	183	153	175	78	93	-6	-130	-78
Pork,	mill.kg	12.5	26.7	23.1	8.6	4.8	3.4	-3.8	4.1	-2.8	3.0
Beef,	"				2.7	7.2	8.9	8.3	6.4	0.5	-4.0
Eggs,	"	13.8	15.5	18.1	15.2	20.4	20.1	12.5	10.7	8.6	10.0
Bread grain,	"									-100	-100
Feed grain,	"							170	-230	-510	-70
Export costs, FIM mill.		329	229	206	380	510	482	602	274	0	0
% of farm income		8.5	5.0	4.4	8.8	9.8	8.3	8.7	4.6	0	0
% of total export costs		27.1	13.5	13.6	22.8	21.1	17.9	21.2	11.3	0	0

Source: Agricultural Economics Research Institute; Ministry of Agriculture and Forestry

In the 1980s, the costs due to the increases in overproduction mainly devolved upon agriculture because animal husbandry clearly exceeded the ceilings, except in the recent years (Table 2.3). Although the share of agriculture declined to zero in 1988-89, the marketing responsibility of agriculture reduced farm income by 4.4-9.8 percent in 1980-87. At the same time, agriculture covered 11.3-27.1 percent of the total export costs of farm products. About 2/3 of agriculture's marketing responsibility has been collected as taxes on fertilizers and industrial feed (Siltanen 1988). As the cost burden has increased, the need for production restrictions has become more obvious among farmers, too. Chapter 2.5.3 is a review of applied control measures.

2.5.3. Review of applied control programs

In Finland, very versatile production control measures have been applied. Both compulsory and voluntary measures have been used. In addition to restrictions proper, farmers' pension systems have partly contributed to control efforts.

The *voluntary* system has been directed in the 1980s by the Act on Regulating and Balancing Agricultural Production (81/83, earlier 446/77, new 1261/89). The act has allowed the government to decide annually on the various measures to restrict production. The major means have been the *contracts to reduce* agricultural, livestock, milk, pork or egg production as well as withdrawal of arable land through fallow contracts and support of afforestation. The central *compulsory* means have been *quotas* for milk (since 1985) and egg (since 1986) production and the *regulation of the establishment of large production units.* Control measures can be classified according to their direction in the following way (Anon. 1986a, p. 17) with some Finnish examples:

- a short term or a long term *abolition of productive resources* from agriculture: soil bank, afforestation of fields, fallowing, slaughtering of cows and hens

- *shift of resources* from one production line to another: contracts to change the production line
- *direct reduction* of production: contracts to reduce milk, pork and egg production
- *quotas* or dual price systems: quotas for milk and egg production

These measures apply to the existing production and producers. Potential new entrants are affected by entry barriers, e.g. in the form of the establishment permit system and quotas. In the following, the control measures are illustrated by production lines in addition to restrictions on arable land. Earlier references are e.g. AALTONEN et al. (1982), ANON. (1985a) and SEREN (1986). Appendix 1 lists the control measures used in Finland in 1969-90.

In 1969, *milk production* was first affected by *the slaughter system* connected with the soil bank system and its purpose to curtail production capacity. The premium of FIM 1/meat-kg was paid provided that all animals were sold for slaughtering. Next year, the slaughter system was extended to all farms, and the premium was changed to FIM 500 per dairy cow. In order to get the premium, a farm had to have at least two cows and make a commitment to quit milk production for three years. Slaughter premiums were also paid in 1980 to eliminate cows with udder diseases. In these systems, altogether 108,000 cows were slaughtered. However, the *net effect* of the slaughter systems on milk production is difficult to estimate. A direct consequence was the increase in milk yield per cow because cows with low productivity were removed (AALTONEN et al. 1982, p. 8).

The beef production contracts have partly served the purpose of dairy control. A farmer keeps the minimum of two cows only for the liquid milk feeding of slaughter calves. Contracts were made in 1980-83 and they were continued in 1985 and 1987, when new contracts were also made.

The contracts to reduce milk production (so called milk bonuses), were first made in 1981-83. They required that a producer cuts his dairy deliveries by 25 percent, at least 10,000 liters, from the basis period. In the 1984 contracts made for three years, the limits were lowered to 15 percent and to 5,000 liters, and a compensation was raised from the original 50 p/l to 75-90 p/l (ANON. 1985a, p. 3). In the 1988 contracts there were two alternative ways of giving up milk production. A farmer could stop producing either for five years or completely. The latter choice means giving up a quota. The compensation, paid for five years in both cases, was 90 p/l in the former type, and 120 p/l in the latter. In practice, only the latter type of contracts were made. They reduced milk production by 120 million liters, or 4.5 percent.

In the end of 1990, new 5-year contracts were introduced to withdraw 300 million liters of milk in 1991. A new characteristic was the compensation grading according to the production volume given up: up to 50,000 liters 100 p/l, 50,001-90,000 liters 70 p/l and onwards 40 p/l. The aim is thus to include small-scale producers in the system (KETTUNEN 1991, p. 36).

The regulation of the establishment and enlargement of animal production units, in force 1979 through 1984, was the first *compulsory* control measure applied in milk production. It mainly aimed at securing the family farm structure, but turned later to a restriction means as well (KOLA 1987). According to the system, establishing a production unit with more than, first, 30 cows, then 20 in 1982, and finally 8 cows in 1984, was subject to license.

The investment regulation system ended when the *quota* system was introduced in 1985. A quota was set for each farm on the basis of the level of milk production in either 1981/82 or 1982/83. Free quotas, originally 30,000 liters for the existing milk producers, were raised to 40,000 at the beginning of 1990. If the amount of milk delivered to dairies exceeds the quota, a quota charge, which in 1988 and 1989 was 205 p/l, is collected for the excess (note: the producer price was 293 and 313 p/l).

Fundamentally, the quota system modifies the marketing co-responsibility, which has often been criticized, to a farm- and producer-based responsibility. Thus, the quota system does not immediately curb production, but it makes quota excesses unprofitable for a farmer. Expansion of production is discouraged.

The quota system for dairies was introduced in 1988 to complement the farm quotas and to prevent the dairies from taking advantage of the free quotas. In fact, milk production is supervised through a threefold quota system: farm quotas, quotas for the dairies, and the ceiling for the whole milk production (KETTUNEN 1991, p. 40).

The first *contracts to reduce pork production* were made in 1983 and 1984. Large pork farms which had paid additional marketing fees and sow piggeries were eligible to make contracts, provided that they gave up production for four years. The compensation equalled 15-20 percent of earlier annual returns from pig husbandry. The last contracts expired in 1987, and no new contracts have been made due to reasonably good market balance in the late 1980s.

The regulation of the establishment and enlargement of animal production units, since 1975, has been the only mandatory measure affecting pig husbandry. Only in the early 1980s the purpose of the system shifted from structure policy to production policy as the law was made stricter in terms of the allowed unit sizes (KOLA 1987).

The contracts to reduce egg production, made in 1976 and 1981, also included a slaughter premium system. The compensation was FIM 20-25 per laying hen, if a farmer had the minimum of 100 hens, gave up egg production for 18 months and sold all hens for slaughter. In the 1984 contracts, the compensation was raised to FIM 50 per hen, and the contract term was extended to four years. In the 1987 contracts, the compensation was FIM 60-70/hen, if production was ceded for five years, and FIM 100, if egg production was ended for good. New contracts were made again in 1989 and 1990. The 1984 contracts to reduce animal production included egg production.

The regulation of the establishment and enlargement of animal production units has affected egg production, like pork production, since 1975. Since 1977, additional compulsory measures in poultry husbandry have been *restrictions on hatching and regulation on new or enlarged hatcheries*. Because of a difficult overproduction problem, a mandatory quota system was introduced in 1986. The decisive factor in the quota system is the additional price paid according to production quantity and region. The fundamental idea is the same as in milk quotas, i.e. to make quota excesses unprofitable for producers.

The contracts to change the production line have made it possible for a farmer, in return for a compensation from the state, to shift from a surplus product to non-surplus production (the Act on Directing Agricultural Production 446/1977). In the contracts (of 4§) made in 1977-82, a condition for joining this system was that a farmer gave up all agricultural production, with certain exceptions, for five years. Contracts were made mainly with old farmers, and they could have been continued until a farmer is 65 years of age. According to the 1980 revision of the law, a farmer could give up only animal production, but cultivate plants without limitations. These agreements (of 4a§) made in 1980-82, as well as the similar contracts to reduce animal production made in 1984, provided a compensation of 20-35 per cent of the earlier return from the particular production line. In 1983-84 and 1986-90 *contracts to reduce agricultural production* have also been made. In 1989 and 1990, priority was given to farmers under 55 of age who had the chance to shift to forestry or small-scale industrial activity.

Arable land area grew until the late 1960s as several incentives for land clearing were offered. In the 1960s, the first restricting measure was the *abolition of state supported land clearance* (ANON. 1969, p. 6). As the international market situation deteriorated and national overproduction grew, the *soil bank system* was introduced in 1969. Its primary purpose was to curtail the cultivated land area. It also introduced a shift from direction of production to *restrictions on production capacity*. Old and disabled farmers were the primary receivers of soil bank contracts. Farmers committed themselves, in return for compensations, not to use contracted farm land for agricultural purposes. Until 1974, altogether 36,050 contracts were made, and they covered 239,800 hectares arable land. Since 1974, no new contracts have been made. The system expired in 1989. The effect of the soil bank system on production has been quite limited, because the system concentrated on the fields of low productivity in Eastern and Northern Finland.

Along with the soil bank system, *afforestation premiums* have been paid to afforest marginal land. In the 1970s, 80,000 ha, of which 30,000 ha were land under the soil bank system, were afforested, and in the 1980s, 3,000-4,000 ha annually. *The retirement pension system* also aims at final abolition of marginal farm land. It has been in force since 1974. It is, in a sense, a continuation for the soil bank system, although it includes social and structural objectives wider in scope than only production policy. The 1986 revision of the system increased its popularity remarkably. Instead of selling or afforestation of arable land required earlier, farmers could now commit themselves only to leaving their land uncultivated for six years.

The premium fallow scheme was first applied in 1977. Farmers who made a contract to fallow their fields for a year at a time received compensation from the state funds. In 1977-80, fallow area had to be at least 1/3 of the total hectarage. In 1977-80 fallowing was the most common on crop farms in Southern Finland, which contributed to reasonably good results in terms of reduced production. On the other hand, fallowing conflicted with the simultaneous effort to enlarge bread grain cultivation (AALTONEN et al. 1982, p. 6).

In 1984 the minimum limit was lowered to 1/4, the duration was lengthened to three years, and the premium was doubled, equalling FIM 1,000-1,200/ha according to the region. Since 1986 the scheme has been continued annually and conditions to participate have varied. In 1989 the fallow under contract, 189,100 hectares, was 89 percent of the total fallow area and 8 percent of the total arable land area. The premium, or compensation, was scaled regionally, being the highest in Southern and lowest in Northern Finland, FIM 2,200 and 1,100 per hectare, respectively. In 1991 a semi-mandatory fallow system (KETTUNEN 1991, p. 37) is introduced, through which the fallow area should rise to 350,000-400,000 hectares. At the moment, fallowing is central in production control policy, especially in terms of *restricting production capacity*.

Arable land area declined steadily since the late 1960s, but increased in the late 1980s. This was a result of the vast *land clearing* just before it became subject to *license* and a charge of FIM 30,000/ha in 1987. Cultivated area, however, has continued its downward trend.

Finally, some conclusions on Finnish production control programs can be drawn. Control measures have been very versatile. Nevertheless, overproduction has not decreased very much. One reason for the inefficiency of control measures is probably the lack of a long term consistent policy. Another reason is the voluntary basis dominating in Finnish control policy. Voluntary measures have mainly concentrated on small-scale old farmers, according to their initial purpose. Evidently, they have supported the goals of social policy more than those of production policy (e.g. ANON. 1985a, p. 41).

The most essential effect of *voluntary* contracts has probably been that the *decisions to quit or reduce production* have been made *sooner*. Efficiency has depended on the willingness of farmers to participate in the programs. Furthermore, a net effect may have remained low, if participating farmers have been those who would have given up farming in any case due to, for instance, old age, disability or lack of successors. *Compulsory* measures have not curtailed production directly, either, but they have *prevented expansion* of production.

For the purpose of this study, it is useful to examine qualitatively the preconditions of political decisions related to chosen control policy (Chapter 2.5.4).

2.5.4. Political economy of decision making

In principle, Finland had the opportunity to direct the growing surplus costs steeper to agriculture or to apply strict production restrictions when the production goals with respect to self-sufficiency were achieved already in the early 1960s. The cancellation of the income and price commitment clause and the shifts in the farm income system in 1968 to a partial and in 1977 to a complete negotiatory basis between the producer organizations and the state (e.g. SAULI 1987) created opportune conditions for decisive changes. These conditions were further strengthened because, at the same time, agricultural population and its social and political weight decreased rapidly.

In practice, however, the potential changes did not materialize. The new farm income system strengthened the position of the producer organization as the economic union which aims at securing the livelihood of its members. As farm income decisions have been tied to wage resolutions of other sectors or to overall income settlements, the benefits gained from income development must have been comparable. Wage raises have led to income increases for farmers, mainly through raises in target prices. After the expansion in the negotiation content, farm population has also benefitted from social security improvements.

In principle, it is difficult to assume, like EHRENHEIM (1984) does (see Chapter 2.4), that food expenditure would be a factor of so little importance that it is allowed to develop to the advantage of one group, i.e. agriculture, alone. Ehrenheim's argument may be underpinned by the traditionally strong position of the producer organization, and relative lowering of food expenditure. The counter-argument is based on the evolution in the decision making framework (e.g. BONNEN 1977). More and more interest groups, e.g. consumers, industry, trade, try to affect decisions concerning agricultural policy.

In practice, however, the official decision making of Finnish agricultural policy has been quite stable and supported by strong consensus (VIHINEN 1990; AAKKULA 1991). Obviously, its political framework can be related to the aforementioned Ehrenheim's model on Swedish decision making in agriculture. Other pressure groups secure their vital interests through the consent that agricultural policy is pursued according to the interests of organizations representing agricultural population.

Additional explanation is that agricultural policy and its goals have been widely accepted in different strata of society. The goals have been formulated and maintained during the post-war period without any major changes. In this connection it is worth noticing that the two opposing parties on agricultural issues, the center party of rural population and the social-democratic party of wage earner-consumers, were together in government, almost continuously, for the past few decades. When the right-wing coalition party replaced the center party in the government in 1987, agricultural policy altered hardly at all. *Historical continuity and inertia* in decision making seem to be relevant factors explaining why policies, once in place, do not change drastically (e.g. LAVERGNE 1983).

Moreover, 200 representatives, who are basically all consumers, in the parliament have made and ratified agricultural laws. These laws are reflected in retail prices of food stuffs, e.g. through target price decisions in the farm income settlements. There have been ways available to affect food prices on the farm and retail level. Nevertheless, actions for price reductions are seldom proposed.

Decisions of the members of parliament are hardly formulated on the basis of their general consumer status alone. Instead, they are interested in keeping their jobs. In this context of voting behavior, the political economy theory becomes relevant (see Chapter 2.4). According to the *theory of representative voting* (DOWNS 1957), politicians perform a cost-benefit analysis for potential votes when determining their position on an issue.

Legislators must weigh the benefit of the campaign contribution from different sources. If a legislator accepts a contribution from farm lobby, which hopes that he/she will vote for preferential farm policies, he/she may obtain a potential gain in votes by voters who support the farm industry. But the legislator may face a potential loss in votes by other special interest groups and society as a whole. Evidently, a legislator will support the group providing the greatest number of potential votes (e.g. ABRAMS 1977).

Homogenous and well organized producer groups are usually better sources of potential votes than heterogenous consumers. In Finland the situation is especially advantageous because the one uniform farmers' union with a high degree of membership forms a fertile source for potential votes. In many developed countries several farmer organizations compete with each other (e.g. PETIT et al. 1987) and in developing nations farmers are not organized for collective action (OLSON 1990).

Self-interest is the cornerstone of economic behavior. It seems to dominate political decision making as well. Achievement of a concrete individual benefit, for both the legislators and the participating pressure groups, appears as the most important factor.

Benefits, however, may be seized due to ambiguous collective consequences of the decisions.

Following the parity principle between wages of industrial workers and farm income, wage rises lead to subsequent rises in farm product prices. Increase in labor and raw material costs, e.g. in food industry, accelerate a pressure on price raises for consumer items, e.g. food stuffs. Consequently, part of a wage raise is cut by the higher prices. It is a vicious circle in the contradictory context of cost-push inflation and wage-price spiral. This development is maintained by political horse trading, or logrolling.

Evidently, agriculture has utilized its special position when it has been negotiating with the "anonymous" state and the pro-agriculture ministry. When the decisions are made, the farmers' union does not have a direct counter-power. There is no consumer lobby in negotiations in the same sense as there is between the employers' organization and the labor unions, or in the Swedish or EC agricultural negotiations. Naturally, labor unions try to exert pressure on agricultural policy in Finland indirectly. They are regular members of agricultural policy committees.

One of the major decisions have been the direction of marketing responsibility of surplus products. For this purpose, the system of production and export ceilings was introduced in 1977. If the alternative were the full responsibility of agriculture in surplus disposal, the ceiling system has to be regarded as a negotiation victory for agriculture, although producers originally opposed it (SAULI 1987, p. 229).

In Finland, three major arguments can be identified which have acted in favor of the pursued agricultural policy and have gained quite unanimous approval beyond agricultural interests only. They are *1) food security, 2) family farm structure,* and 3) *forests.*

To appeal to *food security* and neutrality has always been advantageous for agriculture. National food security is an objective of wide acceptance. The three oil crises of the last two decades have revealed the shortages in the input self-sufficiency. Yet, the crises have not eroded the self-sufficiency argument, perhaps even strengthened it.

The desire to maintain the *family farm structure* has been another important argument. The family farm structure is considered essential in maintaining rural population and livelihood in the countryside. Moreover, family farms represent a guaranteed continuity in agricultural output, whereas the food system based on large farms may become overly susceptible to fluctuations in the market (Ref. e.g. HENNEBERRY, TWEETEN & NAINGGOLAN 1991). At the moment, an argument gaining increasing importance is that small family farms are perceived as more sustainable environmentally and ecologically than large-scale industrial farms.

In Finland forests are invaluable as a whole. The *close linkage of farming and forestry* has been used as a means to facilitate the requirements for agricultural sector of the present extent. In remote areas, farmers are needed to utilize raw material resources. Environmental aspects may become more relevant in terms of favoring lumber-jacks over mechanized harvesters. As a whole, as long as timber supply depends to some extent on forest-owner farmers, the dependence is strategically significant for farmer interest groups in competition for political influence.

Nevertheless, agriculture has been forced to accept production restrictions. In addition to high costs of exports, worsening of the market situation was one reason to introduce production restrictions already in the late 1960s. Export markets of Finnish farm products, especially butter, were cut markedly when the United Kingdom joined farm products, especially butter, were cut markedly when the United Kingdom joined the EC in 1973. Even the Soviet market, which used to be a reliable destination for our farm products in the past decades, is tapering off.

Requirements for trade liberalization put pressures on agriculture with protectionism and high levels of production costs and support. Volatility in the international markets may seriously deteriorate surplus marketing possibilities and may lead to, or require, changes in domestic agricultural policy and decision making.

Extensive application of production restrictions proper, especially in the 1980s, has been an inevitable result of the chosen price and support policy in Finland. However, the dominating voluntary basis of control measures and the relatively small share of producers in export costs are clear indications of producers' political power resulting in more favorable consequences than would otherwise be possible.

3. Theoretical models to evaluate the effects of control policy

Control policy has numerous effects. Control measures affect the most directly the quantity produced. They also affect farm income, farm structure, production costs, the number and welfare of agricultural and rural population, input manufacturing and output processing industry, foreign trade, and overall national economy with income distribution and resource allocation issues.

It is not possible to take all of these effects into account in one analysis. Hence, this study concentrates on the effects of dairy control programs on 1) production volume and 2) sectoral costs in the Finnish milk market.

The aim of this chapter is to evaluate methods through which production control policy and its effects can be usefully assessed. According to GARDNER (1987b), there are two main ingredients in such assessment. The first one is positive economic analysis. It can be presented in the following form: if a certain policy is undertaken, certain results for observable economic variables can be expected. The second ingredient is normative economics. It is based on judgements such as: a certain policy is unwise.

In the examination of the effects of restrictions on production volume, the determinants of supply have to be known. Economic theory provides an indication of the direction of the relationship among relevant variables affecting supply. The appropriate approach to analyze and test the relationships is econometrics (e.g. KENNEDY 1985). In the econometric approach, the aim is at understanding, describing and prescribing economic behavior and interdependences prevailing in it (Chapter 3.1).

Application of a well-defined theory in identification of the economic relationships brings positive characteristics into the econometric analysis. However, much of the knowledge in economics is gained by a process of abstraction. Therefore, any model of reality that results from these abstractions reflects an attempt to reconstruct in a simplified way the mechanism assumed to lie behind the economic phenomena (JUDGE et al. 1988, p. 2). The positivism is eroded as the choice under certainty is replaced by the choice under uncertainty (e.g. KREPS 1990, p. 119).

The approach of welfare economics is normative (JUST, HUETH & SCHMITZ 1982, p. 2). According to GARDNER (1987b, p. 5), evaluation of agricultural policies is set in the framework of applied welfare economics. Welfare economics proposes what ought to be done. The difference between a normative and a positive approach is underlined in the concept of welfare. Welfare is not an observable variable, whereas the central variables of price and quantity in the econometric analysis are observable.

The purpose of welfare economics is to help societies to make better choices (JUST et al. 1982, p. 2). The focus is on the optimal use of resources to facilitate the highest possible welfare for the individuals of the society. The analysis is based on the changes in the economic surpluses of the actors affected by certain policies. Welfare economics analysis contributes to macroeconomic planning of, say, agricultural policies and enhances the understanding of their consequences (Chapter 3.2).

In addition to these major approaches, Chapter 3.3 provides a brief look at some supplementary approaches, which may contribute to this study, especially in terms of offering useful means to gain additional information about the versatile nature of the effects of control programs.

3.1. Econometric approach

Econometrics integrates the methods of economics, mathematics and statistics to test hypotheses and to estimate and forecast economic causalities (Kennedy 1985). The regression analysis, in which a dependent variable is related to one or more independent variables, plays a central role in econometrics.

Methodologically, econometrics is divided into three stages (Figure 3.1; following Salvatore 1982, p. 4). In the first stage, the model or the hypothesis is specified to a deterministic, or a stochastic (including an error term), form. The model is based on theoretical a priori expectations about the sign and size of the parameters of the function. In the second stage, the data for the model variables is collected. Then, the parameters of the model are empirically estimated with an appropriate econometric method. The third stage in econometric research involves the evaluation of the estimated model on the basis of the a priori economic criteria, statistical and econometric criteria, and the forecasting ability of the model. The model, and theory behind it, are accepted, if they fit the observed data. If not, the theory is rejected or an attempt is made to revise it. The accepted theory enables us to make forecasts.

As the examination of control measures concentrates on production quantity and the factors affecting it, the focus is on the supply function and economic relationships related to it.

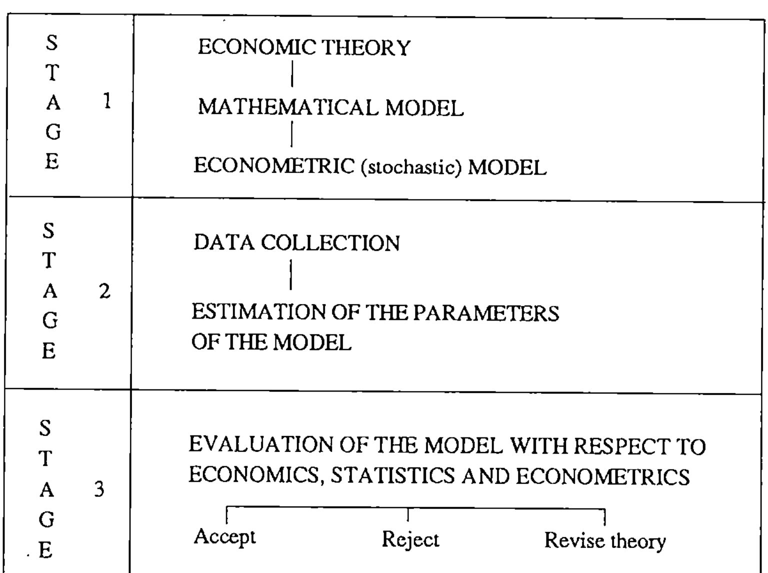

Figure 3.1. Methodological stages of econometric research.

According to the supply theory, the product quantity producers offer (Q_x) is affected, in a simplified form, by three basic relationships. The price of the product *x* and its quantity are positively related, which implies that the parameter $ß_1 > 0$. The price of the input *k* and the product quantity are negatively related, $ß_2 < 0$. The relationship between the price of the substitute product *z* and the quantity of the product *x* is negative, $\beta_3 < 0$. The relationship between the complementary product *z* and product *x* is the opposite. The theory of the three basic factors can be presented in an equation:

$$Q_x = \alpha + \beta_1 P_x + \beta_2 P_k + \beta_3 P_z + \varepsilon$$

The form of the chosen function implies that the relationship between dependent variable (Q_x) and the explanatory variables (P_x, P_k, P_z) is linear. The constant term (α) and the regression coefficients ($ß_1 \dots ß_n$) are estimated from the data.

The random disturbance term ε is an expression for the unsystematic component of the variation which cannot be explained by the systematic component of explanatory variables. Econometricians' concern with the very disturbance term, according to KENNEDY (1985, p. 2), is a major distinction between economists and econometricians. The basic assumptions for the error term ε are (e.g KMENTA 1986, p. 208):

1) normality: ε_i is normally distributed.
2) zero mean: $E(\varepsilon_i) = 0$
3) homoscedasticity: $Var(\varepsilon_i) = \sigma^2$
4) nonautocorrelation: $Cov(\varepsilon_i, \varepsilon_j) = 0 \ (i \neq j)$

The first two assumptions state that for each value of a variable the disturbance is normally distributed around zero. The third assumption of homoscedasticity means that every disturbance has the same variance σ^2, the value of which is unknown. The last assumption requires that the disturbances are uncorrelated. Violations of the basic assumptions lead to distortions of the properties of the least squares estimators.

Especially the last two assumptions are relevant in empirical estimation. Violation of the third assumption reflects the presence of *heteroscedasticity*, i.e. unequal variances. It is not usually considered a problem in time series studies, because changes in the dependent variable and changes in one or more of the independent variables are likely to be of the same order of magnitude (JUDGE et al. 1988, chp. 9.3). On the contrary, regression equations estimated from time series data are frequently characterized by *autocorrelated errors* (KMENTA 1986, p. 260). The fourth assumption is violated.

Autocorrelation can be corrected by several techniques, e.g. by Cochrane-Orcutt iterative least squares (JUDGE et al. 1988, pp. 392-393). In Cochrane-Orcutt method ordinary least squares (OLS) residuals are regressed on themselves lagged one period: $\varepsilon_t = \rho\varepsilon_{t-1} + u_t$ $(0 \leq \rho < 1)$. Regression provides an estimate of ρ, by which data is transformed and then re-estimated.

There are two major sources for the *specification error* of a model: 1) incorrect variables, and 2) incorrect functional form. The latter issue mainly concerns the choice between linear and nonlinear regression equations. The distinction has to be made concerning (non)linearity with respect to variables and parameters to be estimated (KMENTA 1986, pp. 503-526). If non-linearity with respect to *parameters* exists, the ordinary linear least squares (OLS) regression does not apply. For these intrinsically nonlinear models alternative estimation techniques have to be employed, e.g. generalized least squares (GLS) (Judge et al. 1988, chp. 9.5).

The choice of the variables is naturally one of the major concerns in causal econometric estimation. The choice derives from applicable economic theory. Yet, there are deficiencies in the theory or the availability of data that may lead to omission of relevant or inclusion of irrelevant explanatory variables. In both cases, specification error results.

An additional issue in selecting variables is the correlation of independent variables with each other, i.e. *multicollinearity*. It is typical for time series data. Multicollinearity increases the standard deviation of coefficient estimates (Pindyck & Rubinfeld 1981, p. 89). Coefficients can also turn illogical or vary in magnitude. The correlation matrix of the variables is a simple way to detect the degree of multicollinearity. A more sophisticated means is e.g. the ridge regression (Kmenta 1986, p. 440).

The econometric approach is employed here to estimate the supply function for milk in order to assess the effects of production control measures. In this context, there are two alternative ways to carry out the supply analysis:

1) the period of control programs is included in the estimation and independent variables illustrating control measures are included in the model, or
2) supply function is estimated from uncontrolled period of production and no variables describing control measures are included. The control effect is assessed when the estimated function is simulated to the controlled period.

Given the latter choice, the analysis assumes the character of: what would have happened, if there had not been control programs. In terms of the first alternative, several preconditions are set on the variables describing control measures. In the following, some empirical applications of the two alternative approaches are examined.

3.1.1. Supply analysis including exogenous control variables

In order to include the control measures in the model as independent variables, they have to be quantifiable, of long duration, stable and extensive. There are no uniform boundaries or minimum limits for these characteristics, but the solution has to be made according to each individual situation or study objective. Even if these requirements are met, problems may arise, if desired variables are not measurable or observable in a quantitative form.

In Finland, there have been numerous control programs. Milk production and arable land area have been regulated since the end of the 1960s. However, it is difficult to build a model which would include variables describing Finnish production restrictions. For example, in the contracts to reduce milk production, which have dominated in the 1980s, procedures of participation and compensation have varied, and duration of programs has usually been quite short.

In the United States, control programs have a long history. Farm Commodity Programs have been used since overproduction of certain products became a problem in the 1920s (Knutson et al. 1983, p. 205). Some quantitative restrictions, e.g. marketing quotas and fallowing schemes, have continuously, extensively and uniformly been used for several years. This has facilitated supply analysis of their effects with a model *including* an exogenous control variable or variables. Especially since the 1970s, several quantitative studies with this procedure have been made by e.g. HOUCK & RYAN (1972); LIDMAN & BAWDEN (1974); MORZUCH, WEAWER & HELMBERGER (1980); KRAMER & POPE (1981).

In control programs, the compensations are available for producers by joining the program. A common result in these studies has been the acceptance of the hypothesis that, when compensation payments have risen, the incentive to participate in the programs has grown (ceteris paribus). Consequently, acreage, or production, of a controlled product has decreased. Often, *no* separate functions have been estimated for the periods of regulated and free supply. This may have led to distorted results.

LEE & HELMBERGER (1985) have paid attention to *different* supply responses in the examination of U.S. corn supply in 1948-80. The control measure under scrutiny was the acreage-restricting feed grain program. Its compensation payment served as an explanatory control variable. In addition, the *cross-product* effects of corn controls on uncontrolled soybean supply were examined.

The study employed an econometric supply analysis. The time series is temporally disaggregated, which makes it possible to distinguish between control years and normal years. The most important result is the more than doubled own price elasticity of corn supply in the presence of control programs.

The chosen control variable was a compensation payment, the quantification of which was easy. However, to be exact, there were three different types of payments as well, even if the programs were quite homogenous in other respects. Lee and Helmberger have constructed the different types of compensation payment to one variable, which has required certain generalizations. This procedure has made it possible to run the analysis, but, obviously, it has diminished accuracy.

3.1.2. Supply analysis excluding exogenous control variables

Because the use of exogenous control variables in econometric supply analysis is impeded by e.g. heterogeneity of control programs, alternative models have to be employed.

An example is MOSCHINI's (1988) study on the effects of Canadian control policy in Ontario 1961-83. The study has extended the aforementioned cross-product examination of LEE & HELMBERGER (1985) to more comprehensive relationships. However, both studies have underlined that an approach based on a *partial* equilibrium model, common in use, is insufficient for a full-scale analysis of supply management.

The assumptions of *product jointness* and impacts of restrictions on resource allocation have played central roles in Moschini's study. The empirical multiple equation model has no control variables proper. Instead, explanatory variables also include uncontrolled products (milk, poultry, tobacco). In Canada, marketing organizations manage these products. The hypothesis of product jointness has been strengthened by a uniform effect: when supply of controlled products has been forced down, supply of unrestricted products has grown.

Another alternative method for a supply analysis *without* control variables is to estimate a supply from an uncontrolled period and simulate it to a control period. This provides a forecast about production development, if no control measures had been in effect. The hypothesis is that the difference between forecast and actual production in the control period reflects the effect of control measures.

In simulation of estimated supply functions to the control period, either unconditional or conditional simulation forecast can be employed. In a dynamic conditional method, a lagged dependent variable, which is an explanatory variable in a model, is retroactively fed for its *fitted* values. While doing so, it is assumed that producers can freely adjust their production, mainly according to economic and technical factors. In an unconditional simulation, *observed* values of the dependent variable are used.

In the examination of control effects on tobacco production in Greece in 1948-80, ZANIAS & JONES (1985) used an econometric supply analysis without control variables. The programs were mandatory. The uncontrolled period was divided into two periods, and the control period was between them.

The applied conditional simulation was realized by reconstructing the lagged independent variable as a weighted average of an actual value and a forecast value of production quantity of tobacco. If, after effective restrictions in period *t-1* a producer is faced with favorable conditions for expansion of his production in period *t*, he can, in the short run, mobilize only part of the resources pushed out of production in *t-1*.

When the estimated supply function of the uncontrolled period was simulated to the control period 1956-73, production was annually 31 percent higher and acreage 17 percent higher than the observed values. According to the hypothesis, Zanias and Jones concluded that the difference is mainly a result of restrictions. However, the statistical significance of the result remained low.

The approach of estimating a non-control supply function and simulating it to a control period to evaluate the effects of production restrictions on produced quantity is regarded as the most suitable approach to study the Finnish control programs affecting milk production. This is because of the heterogeneity of programs.

3.2. Welfare economics approach

Welfare economics offers a quite useful approach to study the effects of agricultural policy measures. Welfare economics analysis is based on the concepts of *economic surpluses*, changes of which indicate economic gains or losses of different sectors or groups. The concepts of surplus are derived from producer's and consumer's welfare functions through demand and supply curves.

The principles and definitions of welfare economics (cf. JUST et al. 1982, chp. 1; RIMA 1986, pp. 280-337) have evolved from the concept of economic rent presented by *Ricardo* in 1829 when discussing the effects of England's corn laws. *Dupuit* used the notion of consumer surplus in 1844 to analyze the effects of building a bridge. In the beginning of the 20th century, *Marshall* developed these concepts and established the basis for welfare economics.

Thereafter, the method has been developed, evaluated and judged in various ways (see e.g. REDER 1947; CURRIE, MURPHY & SCHMITZ 1971). The concept of consumer surplus, the partial equilibrium analysis and the principle that social gains are maximized by competitive markets have particularly been criticized. The chief difficulties with consumer surplus are, first, that it assumes individual utilities are additive, and, secondly, that it assumes the marginal utility of money is constant (RIMA 1986, p. 292).

Another limitation is the static nature of the method ignoring the time needed for adjustment.

All this said about its limitations, care should be taken when using welfare economics for decision making as such. Yet, welfare economics contributes to planning as an indicative method to evaluate effects of different policy options, and, consequently, to choose between these policies.

3.2.1. Traditional procedure

In agricultural policy analysis, quantification of the effects of policy actions draws heavily on demand and supply elasticities of farm products. In Finland, *elasticities* are often a restricting factor because extensive government intervention distorts supply responses. Technically, the binding dependence on elasticities does not hinder analysis, but it is useful to bear in mind that results from welfare analysis are no better than results from econometric estimation.

Application of welfare economics to agricultural policy has been infrequent in Finland. AALTONEN (1982) has made a qualitative presentation of outlines of the effects due to agricultural policy. HASSINEN (1985) has applied quantitative analysis to examine welfare impacts of alternative farm income systems. KANNIAINEN & VOLK (1982) have studied the effects of price regulation of farm products on consumer surplus.

Some European welfare studies applied to agricultural policy come from, inter alia, the FRG by KOESTER & TANGERMANN (1976), the Netherlands by OSKAM (1986), Sweden by RABINOWICZ & BOLIN (1986) and Norway by AANESLAND (1987). Freer price formation and, accordingly, more clear-cut supply and demand responses, seem to provide better conditions for the application of welfare economics in agricultural policy analysis. This is exemplified by numerous studies made with this approach in the United States, e.g. WALLACE (1962); JOHNSON (1965); SCHMITZ & SECKLER (1970); HUSHAK (1971); CARTER, GALLINI & SCHMITZ (1980); KAISER , STREETER & LIU (1988).

In welfare economics analyses, society is often divided into the groups of producers and consumers of a certain product. This applies suitably to agriculture, too. The objective is to *measure welfare changes* due to applied policy. The following definitions adhere to the principles JUST et al. (1982, chp. 4, 5) have applied in their extensive volume.

In the framework of the neoclassical economic theory and the inherent profit maximization assumption, the most obvious welfare measure for the producer is *profit* (π). It is defined as gross receipts (TR) minus total costs (TC): π = TR - TC. Total costs equal total variable costs (TVC) and total fixed costs (TFC), hence: π = TR - (TVC + TFC). However, profit is not suitable as such for a universal measure of producer welfare, the main argument being that the total benefit to the producer from remaining in business is given by profit plus fixed cost rather than simply profit (JUST et al. 1982, pp. 52-55).

Thus, a better measure is the concept of quasi-rent (R). It is defined as the excess of gross receipts over total variable costs: R = TR -TVC, as well as R = π + TFC. The name *quasi*-rent lends to the idea that it is a rent on fixed factors employed by the producing firm but, unlike factor rent, may not persist over a long period of time.

The *area below the price line and above the supply curve* is used to measure quasi-rent. This geometric area is commonly called *producer surplus* (PS). Although in many

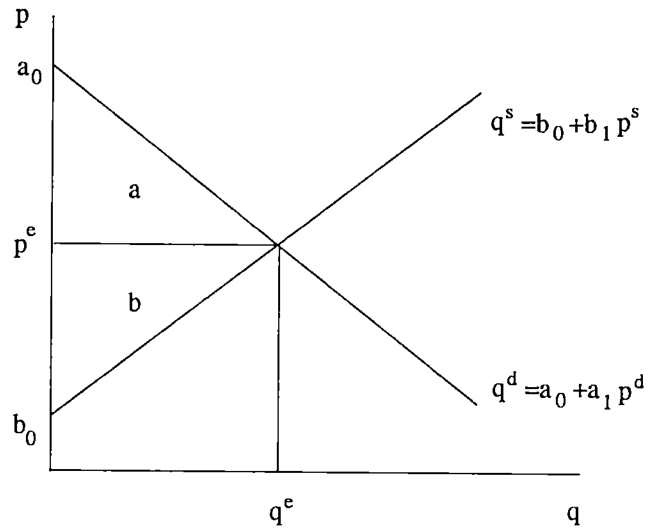

Figure 3.2. Surplus areas in welfare economics (area a = consumer surplus, area b = producer surplus).

cases these two measures are assumed to coincide, the distinction between quasi-rent as an economic concept and producer surplus as a *geometric area* should be emphasized (see JUST et al. 1982, chp. 9).

In Figure 3.2, according to the geometric definition above, producer surplus is *area b*, which is above the supply curve and below the price line p^e.

As distinct from the producer's profit, there is no clear and easily observable yardstick of welfare for a consumer maximizing her utility. In spite of its disputable history, consumer surplus is a concept common in empirical welfare studies, to a large extent due to WILLIG's (1976) justification. Geometrically, *consumer surplus* (CS) is *area a* in Figure 3.2. It is *below the demand curve and above the price line* p^e.

To find the surplus areas in empirical welfare analysis, demand and supply functions have to be derived from observed data, i.e. the procedure becomes econometric. The starting point is market equilibrium, in which marketed quantity is q^e and price p^e. Given specific functional forms of demand and supply curves, surpluses can be calculated by integration.

With linearity, the estimated demand function is presented as $q^d=a_0+a_1p^d$ (Figure 3.2). In the function q is quantity demanded, p is price and a_i are unknown parameters estimated from observed data assuming $a_0 > 0$ and $a_1 < 0$. Consumer surplus can be approximated as a geometric area by Equation (3.1). Correspondingly, the supply function can be presented as $q^s=b_0+b_1p^s$. Assuming $b_0 > 0$ and $b_1 > 0$ makes it possible to calculate producer surplus by Equation (3.2):

(3.1) $CS = \frac{1}{2} \cdot (a_0 - p^e) \cdot q^e$

(3.2) $PS = \frac{1}{2} \cdot (p^e - b_0) \cdot q^e$

The effects of income policy and its subsidiary price and support policies have been central objects of most welfare studies. Examination of production control policy as such has been more limited or it has been only part of more extensive studies. Furthermore, the focus of control policy studies has been on price regulation, not on quantitative restrictions characteristic for Finland.

It is expedient to illustrate the welfare effects of two control measures in competitive markets (Figure 3.3). Output restriction and price policy can be used to maintain market balance while securing farmers' income level. Linear demand and supply curves of equal (but opposite by definition) slopes are assumed. Analysis starts from market equilibrium, in which marketed quantity is q_0 and price p_0. The original producer surplus is *area h+g+k*, and consumer surplus *area m+b+a*.

An output restriction in the form of *quota* is set at quantity q_1, above which producers cannot produce. As supply is controlled, normal demand response of consumers raises the product price to p_2. Because producers' costs are still based on the short run supply curve, they have, in addition to normal surplus of *area h+k* with price p_0, *area a* (or $(p_2-p_0)\cdot q_1$). Producers lose *area g* due to the restriction on output. Hence, the change in producer surplus is *area a-g*. Consumers, in turn, lose *area a+b* due to the higher price p_2. Thus, a quota leads to a net welfare loss (deadweight loss) of a size of *area a+b-(a-g)=b+g*.

Price support has to be combined with consumer subsidy in order to maintain market balance. Producer price is guaranteed at the level of p_2 ($p_2>p_0$), which produces output q_2. This amount is consumed for a price p_1. Producers gain *area a+b+c*, and consumers obtain *area h+g+f+e*. The price difference (p_2-p_1) brings in the third group,

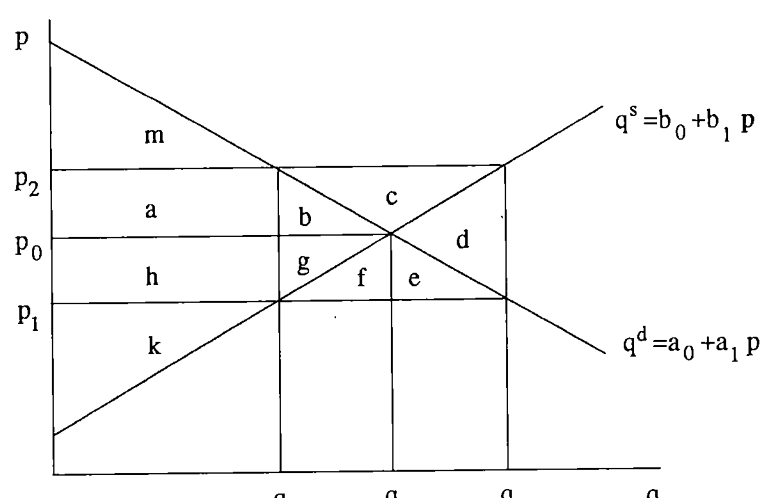

Figure 3.3. Welfare effects of output restriction and price policy program.

taxpayers, who have to provide financing for the price gap. Taxpayers lose the whole *area a+b+c+d+e+f+g+h*, or $(p_2-p_1)\cdot q_2$. The deadweight loss for the price policy program is *area d.*

According to this graphical welfare examination, given equal slopes for the demand and supply curves, *area b+g* = *area d.* This leads to the conclusion that the standard triangles illustrating deadweight losses are equal for both programs. However, there is a difference between the *efficiency* of these programs in transferring welfare from one group to another.

Quota causes an increase in producer welfare by *area a-g* associated with deadweight loss of *area b+g*. Price support program increases producer surplus by *area a+b+c* at the expense of deadweight loss of *area d* (note: d=b+g). Because the ratio of deadweight loss to increase in producer surplus [d/(a+b+c)] is smaller in price support program than with quota [d/(a-g)], the price support program is more efficient in transferring welfare to producers.

This *deadweight loss ratio*, as an indicator of efficiency in welfare redistribution, extends the standard welfare approach to a more systematic and quantitative analysis of agricultural policies and their effects. According to GARDNER (1983), the main contribution of the extended analysis in the form of surplus transformation is to tie deadweight losses based on consumers' and producers' surpluses explicitly to surplus transfers.

In Chapter 3.2.2, this approach is described more in detail. The leading idea is that efficiency in redistribution can be measured by deadweight loss generated per monetary unit of economic *surplus transferred* between consumers and producers of a commodity by means of *government intervention* in markets.

3.2.2. Surplus transformation approach

Agricultural policies redistribute income between producers and consumers. Gains and losses are generated by government intervention in the commodity market. Welfare changes of producers and consumers are measured as changes in their respective surpluses as was shown in the previous chapter. The graphical presentation of welfare changes can be expanded by the surplus transformation approach. The approach, according to GARDNER (1983), ties deadweight losses based on consumer and producer surpluses explicitly to surplus transfers.

Through the surplus transformation method it can be examined how different farm programs transfer income between producers and consumers. Under perfectly efficient redistribution through a given program, producer surplus would increase exactly as much as consumer surplus falls. A common example of perfect efficiency is the so called lump-sum transfer. If additional costs, i.e. deadweight losses, incur in the transfer process, an increase by one markka in producer surplus would imply a decrease by more than one markka in consumer surplus; redistribution is not perfectly efficient.

Deadweight losses may occur due to e.g. administrative costs, resource misallocation, or taxation distortions. Thus, relative efficiency in terms of required transfers and related deadweight losses of various agricultural policies can be studied by the surplus transformation approach.

The presentation of the surplus transformation approach in the present study follows mainly that of GARDNER (1983, 1987b). As the pioneer of the systematic application, Gardner has applied surplus transformation to illustrate the efficiency of redistribution in farm commodity markets due to agricultural policies and production control measures. Other applications of the surplus transformation approach are e.g. BULLOCK (1989, 1990) and ALSTON & HURD (1990).

Surplus transformation curve (STC) is the key analytical tool of the method. An important advantage of STCs is that they allow a broader view of available income redistribution policies and a better analytical comparison of the marginal income trade-offs inherent in different policies (BULLOCK 1990).

The combinations of producer surplus (PS) and consumer surplus (CS) attainable by changing the chosen policy variable define the surplus transformation curve. STC shows the trade-offs between PS and CS for various policies. Consumer surplus is often combined with taxpayer cost to create consumer-taxpayer surplus (CTS), which covers taxes to finance farm programs. The shapes of STCs are defined by the parameters of supply and demand and the opportunity cost of government spending. Given specific functional forms for supply and demand, a formula can be derived to show the exact change in PS which accompanies a change in CS, or CTS.

Consequently, STC can be used to indicate the efficiency of the program under scrutiny in relation to other potential programs and with respect to perfect efficiency. Efficiency comparison of alternative programs A and B follows the criteria that program A is superior to program B if under program A one party can be made better off while making other parties no worse off than under program B.

The general surplus transformation diagram (Figure 3.4) illustrates the relation between producer and consumer-taxpayer surplus. Point E is the competitive equilibrium point, in which no government intervention takes place. Perfect efficiency without deadweight losses in redistribution can be expressed graphically by means of the line segment passing through point E (GARDNER 1987b, p. 187). Then, the marginal rate of transformation between PS and CS, i.e. the slope $\partial PS/\partial CS$, is -1. Thus, on the 45°-line, so called lump-sum transfers are realized so that every markka from consumer-taxpayers is transferred to producers at a rate of 100%. The vertical (or horizontal) distance between STCs and the 45°-line represents the deadweight costs of the specific program.

In general, the extent to which the STC lies left to the efficient redistribution line indicates how far the program falls short of perfect efficiency.

Decisions are made according to certain political preferences in favor of either consumers or producers. Often, in industrialized countries, government intervention has aimed at improving producers' welfare at the expense of consumers or taxpayers. It can be expected that the surplus transformation curves (STCs) for farm programs lie in general below the 45°-line. It means that the gain in producer surplus is smaller than the loss in consumer-taxpayer surplus. Then, the marginal rate of surplus transformation is $|\partial PS/\partial CTS| < |-1|$, which means that deadweight losses incur.

In Figure 3.4, arbitrary surplus transformation curves in the competitive market for two common farm programs, production control in the form of quota (STC^Q) and output subsidy in the form of target price program (STC^T) are sketched. For a small income transfer in either quota or subsidy program, the marginal rate of transformation is close to -1. But in case of larger transfers, both STCs are drawn to be concave to illustrate the growing deadweight cost at margin with regard to producer benefits as income transfers from consumer-taxpayers increase (ALSTON & HURD 1990).

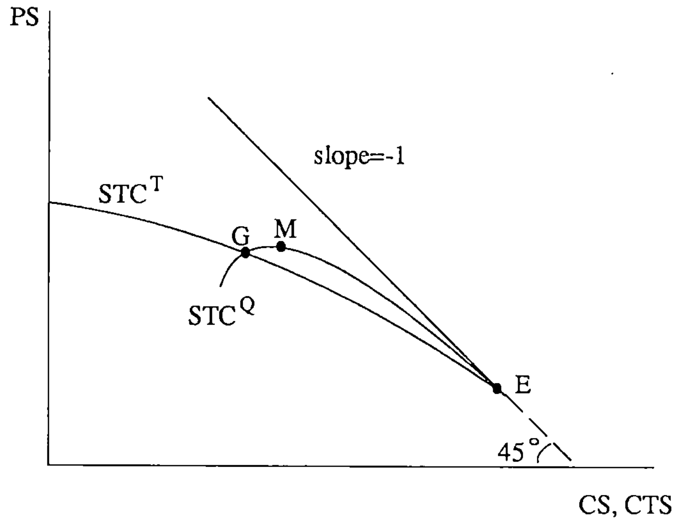

Figure 3.4. Possible surplus transformation curves for programs of quota (STC^Q) and target price (STC^T) in a competitive market.

STC^Q is arbitrarily assumed to turn below STC^T to the left of point G. The shape of STC^Q indicates that marginal producer benefits actually become negative to the left of point M. M is the monopoly maximum profit point, where quota Q^r is chosen to maximize producers' economic rents by setting $\partial PS/\partial Q^r=0$. Hence, between points E and M lie the economically and politically rational surplus possibilities for production control.

Along STC^T, marginal producer benefits remain positive, although they are also declining according to the concavity assumption. With respect to the relative efficiency between quota and target price, quota is preferred within its rational application area from E to M, but thereafter STC^T alone is to apply. Thus, if PS is politically preferred to be raised further than what it is at M, price support has to be used.

The shape of STC depends on the policy. It is useful to illustrate surplus transformation by examining alternative means of production policy: 1) production control in the form of quota, and, 2) price policy in the form of target price and consumer subsidy. Both means are intended to serve the two major goals of agricultural policy: to balance markets and maintain farmers' income level. General equations for surplus transformation curves of quota (STC^Q) and target price (STC^T) are presented. The shapes of the STCs are then examined through derivation of their slopes.

First, a control program which uses the means of direct *production restriction* is examined. As the policy variable is the quantity supplied (Q^r), the price-dependent demand and supply functions are applicable. Let demand and supply relationships be:

(3.3) $P^d = D(Q)$

(3.4) $P^s = S(Q)$

General assumptions of downward sloping demand and upward sloping supply, i.e. $D'(Q) < 0$ and $S'(Q) > 0$, are maintained. In addition, it is also assumed that both demand and supply cross the price-axis at positive price P. The equilibrium price is $D(Q^e)$ and the quantity Q^e. If a quota is imposed at quantity $Q^r<Q^e$, the price is $D(Q^r)>D(Q^e)$ (Figure 3.5). The consumer surplus (CS) and producer surplus (PS) due to restricted production $Q^r<Q^e$ are calculated as follows:

$$(3.5)\quad CS = \int_0^{Q^r} D(Q)dQ - D(Q^r)Q^r$$

$$(3.6)\quad PS = D(Q^r)Q^r - \int_0^{Q^r} S(Q)dQ$$

These equations determine the STC for the quota: CS=f(PS). However, the form of the STC cannot be specified without assumptions about the functional form of the demand and supply curves. This is done for the Finnish dairy market in Chapter 7, where the assumption of linearity is employed.

As a *second* example, a *price policy* program is examined. Let us assume, that government sets the producer price higher than the equilibrium price, and subsidizes retail price in order to balance the market. The policy variable is the politically set price producers face, p^T. If the aim is to balance the domestic market for the product ($Q^s=Q^d$) while maintaining farmers' income level by price support ($p^T>p^e$), domestic consumer price (p^d) has to be lowered below p^T to absorb excess production. Thus, demand is ultimately a function of administratively set producer price, i.e. $p^d=f(p^T)$.

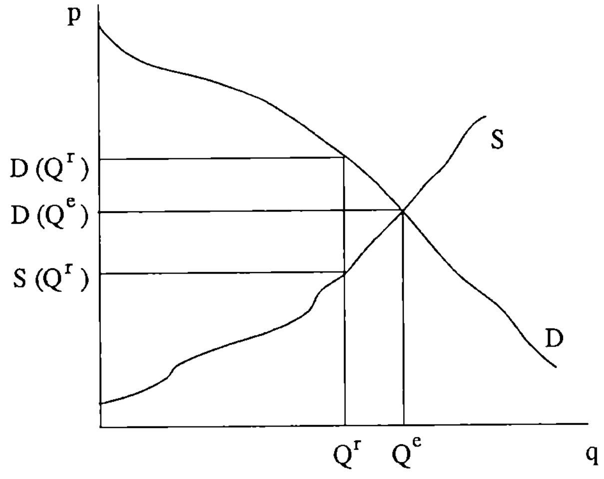

Figure 3.5. The effect of output quota on producer and consumer surplus.

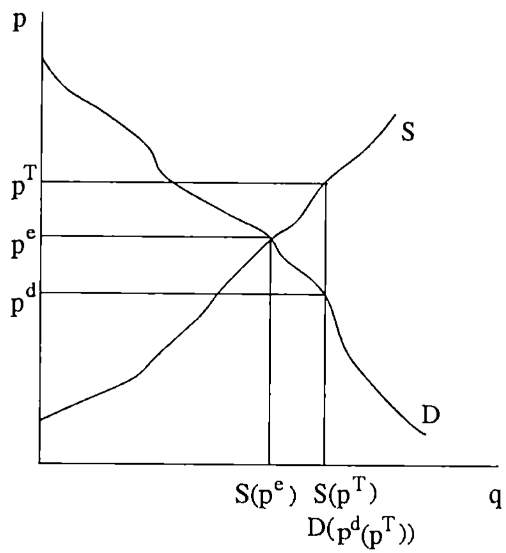

Figure 3.6. The combined effect of target price and consumer subsidy on producer and consumer surplus.

Consumer subsidy, p^T-p^d, is financed by taxation. Demand and supply functions are presented in the quantity dependent form:

(3.7) $$Q^d = D\left(p^d(p^T)\right)$$

(3.8) $$Q^s = S(p^T)$$

A guaranteed target price p^T leads to output $S(p^T)$, which is consumed at price p^d (Figure 3.6). $S(p^T)$ equals quantity demanded $D(p^d(p^T))$. Accordingly, consumer and producer surpluses can be presented as in Equations (3.9) and (3.10):

(3.9) $$CS = \int_{p^d}^{\infty} D\left(p^d(p^T)\right)dp^d$$

(3.10) $$PS = \int_0^{p^T} S(p^T)dp^T$$

In the combined program of target price and consumer subsidy, taxes are collected to finance the domestic price difference p^T-p^d. So, the amount of taxes (TX) is:

(3.11) $$TX = (p^T - p^d)\cdot S(p^T)$$

To maintain the framework of *two* comparable groups of producers and non-producers, CS and TX are combined to result in consumer-taxpayer surplus (CTS):

$$(3.12) \quad CTS = CS - TX$$

Equations (3.9)-(3.12) determine the STC for the price policy program. But it is not possible to identify STC in the absence of the specified functional form of the demand and supply curves. However, the *slope of surplus transformation curve*, i.e. the marginal rate of surplus transformation, can be used to provide additional information.

The slope of STC determines the macroeconomic effectiveness of the program to redistribute income between producers and consumer-taxpayers. The slope is related to the distance because the closer to zero the slope becomes, the greater will be the accumulated distance between the STC and the efficient redistribution line (GARDNER 1987b, p. 187).

The final forms for slopes of surplus transformation curves are shown for both quota and price policy. Derivation of the slopes is performed in detail in Appendix 2. The slope equations are general in the sense that they hold for any functional form of supply and demand.

The slope of STC^Q is:

$$(3.13) \quad \frac{\partial PS / \partial Q^r}{\partial CS / \partial Q^r} = -\left[1 + \left(\frac{D(Q^r) - S(Q^r)}{D(Q^r)} \cdot \frac{\partial Q^r \cdot D(Q^r)}{\partial D(Q^r) \cdot Q^r}\right)\right]$$

The middle term in the brackets is the price distortion parameter, $\tau \geq 0$:

$$\tau = \frac{D(Q^r) - S(Q^r)}{D(Q^r)}$$

The last term is the price elasticity of demand, $e_d<0$:

$$e_d = \frac{\partial Q^r \cdot D(Q^r)}{\partial D(Q^r) \cdot Q^r}$$

So, the *slope of* STC^Q can be presented compactly as follows:

$$(3.13a) \quad \partial PS / \partial CS = -1 - \tau(Q^r) \cdot e_d$$

According to (3.13), if there is no intervention, i.e. $S(Q^r) = D(Q^r)$ implying $\tau=0$, the slope of STC^Q is -1. This would indicate no deadweight loss, i.e. a markka given up by consumers yields a markka gained by producers. This is valid at point E. At any other point on the STC^Q, the slope is less than $|-1|$, i.e. deadweight losses incur.

The slope for STC^T is:

$$(3.14) \quad \frac{\partial PS}{\partial CTS} = \left[-1 - \frac{p^T - p^d}{p^T} \cdot \left(\frac{\partial S(p^T)}{\partial p^T} \cdot \frac{p^T}{S(p^T)} \right) \right]^{-1}$$

Taking account of the price distortion parameter, $\tau = (p^T - p^d)/p^T$, and the price elasticity of supply, $e_s = (\partial S(p^T)/\partial p^T) \cdot (p^T/S(p^T))$, the following equation for the *slope of STC^T* is obtained:

$$(3.14a) \quad \partial PS/\partial CTS = \left[-1 - \tau(p^T) \cdot e_s \right]^{-1}$$

Assuming the normal slopes for demand and supply curves, Equation (3.14a) shows that the slope of STC^T is less than unity in absolute value for any $p^T > p^d$. If there is no intervention implying $\tau=0$, the slope of STC^T is -1. Moreover, it is easy to see that STC^T is always negatively sloped, because $\tau>0$ and $e_s>0$. It means that producers always gain from higher price p^T, i.e. $\partial PS/\partial p^T>0$. Graphically, this characteristic of STC^T is shown in Figure 3.4 as the curve is rising to the left.

This finding of *constantly* negative slope of STC^T is of essential significance. This is because the slope of STC^Q (Equation 3.13a) can *vary* from negative to positive. This depends mainly on the magnitude of the price elasticity of demand (e_d) in Equation (3.13a). In Figure 3.4, STC^Q is negatively sloped until point M, but thereafter it has a positive slope. A positive slope indicates economic and political infeasibility in terms of losses for both producers and consumers.

The derived slopes for STC^T and STC^Q indicate that the relative effectiveness of quota and price support in income redistribution depends on demand and supply elasticities and the amount of transfer we are willing to do. To quantify losses and gains for producers and consumer-taxpayers, STCs have to be traced out via calculated surpluses. This is done for Finnish dairy programs in Chapter 7.

3.3. Supplementary approaches

Existing statistics provide useful and versatile information for the examination of the effects of control measures. *Surveys* can be used to acquire new information via questionnaires and interviews. *Inductive conclusions* drawn from existing and acquired information can clarify the effects of and the attitudes towards control programs.

The efficiency of programs and their versatile effects can be estimated according to demographic features, geographical location and division of farm size, inter alia, of the participating farmers. In the examination, subjective judgments, based on descriptive statistics, play a key role. Hence, let us call this method *descriptive-inductive approach.*

The *descriptive-inductive approach* comprehends an extensive assortment of implements and abundant collection of data. Yet, a shortage of empirical knowledge may become a problem, even if a study were plainly *ex post*, i.e. examination of *realized* effects. This holds good especially in the case of control measures because they have seldom been monitored with adequate accuracy to form a basis for an analysis on observations, instead of personal discretion.

The starting point of production quantity examinations is usually to evaluate the production reduction effect of control measures. An estimate of the reduction in production can be made according to the production factors, e.g. animals and hectares, included in the contracts, and average yields. The estimation of the effects of programs may be impeded by the following factors:

- *temporal allocation* of restrictions distorts estimates made on an annual basis
- use of national *average yields* does not take into account the regional concentration or removal of low-productive production factors
- the *immensity of production and producers returning* to the industry forms an uncertainty factor in temporary production reduction contracts
- *contemporaneousness of several measures* dims effects of a particular program
- *separation of gross and net effects* is ambiguous.

The *net effect*, i.e. if the decision to quit or reduce production is made solely due to contracts, is difficult to determine. Knowledge of the net effect is decisive in terms of economic efficiency of control programs (Chapter 6).

The contracting producers' own statement of whether they would have ceased or reduced production without contracts or not, and at which level of compensation they would have joined programs, is probably the most precise evaluation.

If producers' intentions are not known, net effects can be concluded from the standard deviations of the parameters. If the contracting farms are smaller or producers older than the national average, a researcher is tempted to assume that the decisions to quit or reduce production would also have been made without the contracts.

The best time to examine producer responses in any control measure is evidently the first year of its application. Reception of the program is not yet affected by earlier experience of producers. In addition, the first control year can be the most suitably compared with the uncontrolled production. Thereafter, extensive control programs have had remarkable impacts. Hence, in the following, the focus is on the beginning of the control period.

The effects of the 1981 milk bonus system can be evaluated with the help of the following *characteristics* of participating farms (Table 3.1): distributions of age, herd size and farm size. The reference groups for the contracting farms are all farms (the 1980 population and housing census), all dairy farms (the 1980 farm register) and the farms which have given up production without contracts (the farms removed from the farm register in 1974-80).

The *age distribution* shows that the share of younger farmers has been larger in the

Table 3.1. Distributions of age, herd size and farm size (%) in the 1981 bonus farms and in the reference groups.

Farmer's age, years	Milk bonus 1981	All farms 1980	All dairy farms 1980	Ceased animal farms 1974-80
- 44	23.8	26.5		17.4
45- 54	33.4	25.9		17.8
55- 64	31.8	25.3		31.0
65-	11.0	22.3		33.7
Herd size, no. of cows				
- 3	9.1		22.6	
4 - 6	31.4		28.7	
7 - 9	21.5		21.2	
10- 19	30.2		23.9	
20-	7.8		3.6	
Arable land, hectares				
- 5	6.3	30.9	11.3	38.9
5 - 10	27.7	30.8	33.6	35.0
10- 15	25.4	16.3	23.9	14.6
15- 20	16.3	9.0	14.3	5.5
20- 30	15.6	7.8	11.7	3.8
30-	8.7	5.2	5.2	2.2
No. of farms	1532	212630	85196	10769

Source: National Board of Agriculture

1981 bonus system than in the reference groups. Thus, the net effect of the contracts on milk production was remarkable. But the structural development suffered. OLLILA (1989, p. 222) presents a hypothesis that young farmers are more likely to take the government's offer than old farmers because they have more alternatives outside milk production. In 1982-84 the age distribution of the bonus farms came closer to that of the reference groups (ANON. 1985a, p. 10). This implies a weakened net effect on production, but improved structural development.

The conclusions drawn according to the age distribution are strengthened by the *size distributions* (see also OLLILA 1989, pp. 221-223). The 1981 bonus farms were markedly larger than all dairy farms and ceased livestock farms. The reasonably high share of large farms may indicate that the bonus contracts offered a good chance to shift from milk production to some other product. Similar to the age distribution, the size distributions of the contracting farms have come closer to the distributions of the reference groups in 1982-84 (ANON. 1985a, p. 12).

Surveys indicating farmers' own intentions clarify control efficacy. VEHMAS (1986) has studied farms that made bonus contracts in 1981-82. The low net effect is described by the fact that 1/3 of the producers would have reduced their output with the corresponding amount and 1/2 of them at least with some amount without the contracts, too.

The regional differences in terms of control effects are likely to occur due to different production structures and conditions. In the province of Northern Karelia, the net effect of the 1981 contracts to change the production line and reduce milk production would have been 77 percent according to a survey study by Toivanen (1986).

The most common reason to make a contract in Northern Karelia was producer's illness or weakened ability to work. In addition, lack of labor or a successor, age and poor shape of agricultural buildings were often mentioned in the answers. On the other hand, the producers who made the bonus contracts were younger and their farms larger than the national average.

The descriptive-inductive approach can be used for a versatile evaluation of the effects of control measures. The weakness of the approach is that it is too much based on subjective estimates derived from less-than-perfect statistics. The factors causing uncertainty could be reduced by better follow-up. In spite of the many uncertainties, which depend on both suppliers, collectors and estimators of information, the descriptive-inductive method can supplement the major theoretical models presented in Chapters 3.1 and 3.2. Effective utilization of available information may result in more precise assumptions that match the real world in a more accurate manner.

3.4. Conclusions on applicability of alternative approaches

The approaches dealt with in Chapters 3.1-3.3 represent only part of the means available. However, they rank among the most common methods used in research of agricultural economics. Thus, we are on safe grounds to propose that these approaches as such or in different combinations are suitable for an examination of control effectiveness. The proposal applies especially when the focus is on quantitative analysis.

In order to be able to evaluate the quantitative effects of control measures, the level of production without control measures has to be determined. Econometric analysis provides the best approach as this study aims at determining the factors affecting supply of farm products (Chapter 4). It fulfills the requirements of both the positive approach and quantification. Moreover, it is a suitable means to examine the relationship between price and output. The relationship is the essential component in the causal chain leading to control policy (Chapter 2).

The supply analysis without exogenous control variables (Chapter 3.1.2) is suitable for the analysis of the Finnish production control system, which is heterogenous in nature. The application of the chosen method is not free of problems and shortcomings, either, as will be seen in Chapter 4.

To predict the possible production development had there been no control programs, simulation techniques are applied (Chapter 5). Predicted production is based on the estimated function of the uncontrolled milk production. Because explanatory variables are known both in estimation and simulation periods, their values need not be forecast. Exogenous unconditionality applies for forecast.

Welfare economics, and its component surplus transformation approach, is suitable for the study of economic efficacy of production control policies. This is especially true in the context of income redistribution due to the changes in policy variables (Chapter

7). Again, it should be emphasized that econometric analysis is a precondition for welfare economics analysis as well. The same is true for the so called descriptive-inductive approach, which is utilized in the profitability examination to conduct benefit-cost calculations (Chapter 6).

The chosen approaches are employed to assess the quantitative and economic efficiency of dairy control policy in response to the objectives and questions set for this study in the beginning. Moreover, the results from the quantitative efficiency analysis produce further evidence to evaluate the conclusions presented in connection with the qualitative political economic analysis (Chapter 2.5.4) of Finnish control policy.

4. Empirical estimation of milk supply functions

In Finland milk production is the most important line of production. Surplus problems of milk have the largest extent and longest history. Numerous attempts have been made to restrict milk production. Consequently, there are good reasons to concentrate on the effects of *dairy* control programs.

In the framework of agricultural policy and supply management, it is useful and necessary to understand how dairy farmers make their production decisions, i.e. which factors are affecting the on-farm decision making process and supply response. If these factors are known with high accuracy and confidence, production can be directed more effectively in the way that is preferred.

However, and in spite of the great importance of milk production, research in this field has been quite limited in Finland. In this study, an econometric supply analysis approach is employed to explore the essential relationships within the dairy sector. The results may contribute to better decisions in agricultural policy.

In this chapter, the supply function for milk representing the free period is estimated by the causal econometric model and the non-causal time series model. The model *without* exogenous control variables is employed (see Chapter 3.1.2), because Finnish dairy control programs have been too heterogenous to be included in a model as exogenous variables.

The estimated supply functions form a basis for the evaluation of efficiency and profitability of control measures. Quantitative efficiency of dairy control programs is examined through the production volume comparison (Chapter 5). The estimated supply functions are simulated to the control period to provide a prediction of production volume in the absence of production controls. The difference between the actual and predicted production is considered the effect of control measures. The economic efficiency examination is then based on the results of production quantity examination (Chapter 6).

4.1. The determinants of milk supply

Usually, characteristics of the market mechanism set certain a priori assumptions, or restrictions, for econometric models. If market forces work and supply and demand are determined simultaneously, single-equation methods are inappropriate. Consequently, systems of equations, and moreover, simultaneous equation models are needed. In the case of milk, the studies by LaFrance & de Gorter (1985) and Kaiser et al. (1988) represent the simultaneous approach.

It is almost as common *not* to take into account the demand for milk while estimating the supply for milk. This approach (Cuddy 1982; Oskam & Osinga 1984) seems to be reasonable in the case when the price of milk is politically determined and there is obviously no direct dependence between demand and supply of milk. This is especially true in the short run. The aforementioned price formation is common in Europe. Studies following this approach can also be found in countries with less regulated systems (Levins 1982; Chavas & Klemme 1986).

Taking into consideration the Finnish market mechanism and conditions to produce milk, this study is restricted to supply as such, separately from demand for milk. A further choice has to be made on whether milk supply is estimated through its central components, e.g. yield per cow, herd size and number of dairy farms, or directly as aggregate supply. The latter approach is selected on the basis of the interest in the essential economic relationships affecting milk production as a whole. This makes it possible to use a single-equation supply model. In Finland, earlier studies on milk supply are made by KANANEN (1974), and, in the context of the wider supply studies, by NEVALA & HAGGREN (1976) and KETTUNEN & RYÖKÄS (1984).

The quantification problem (HALLETT 1981, p. 145; TOMEK & ROBINSON 1972, p. 353; TOMEK 1985) has probably been the major reason that most studies have stuck to traditional variables, instead of search for actual reasons for unexplained variation in a dependent variable.

In this study, the factors usually considered essential in the determination of milk supply have to meet the requirement of applicability in the Finnish conditions. The factors can be presented as a supply function in the general and static form:

$$Q^m = f(P^m, P^a, P^i, T, W, G, A); \textit{ in which}$$

Q^m = *quantity of milk supplied*	T = *technology*
P^m = *price of milk*	W = *weather*
P^a = *price of alternative products*	G = *government*
P^i = *price of inputs*	A = *adjustment*

1. *Price of milk.* According to the economic theory, there is a positive relationship between the quantity of a product supplied and its price. However, in the Finnish dairy studies, the correlation has proved very small (KETTUNEN & RYÖKÄS 1984), or even negative (KANANEN 1974). These problems related to declining production (Figure 4.1) and possibility of inverse supply reaction are dealt with later (Chapter 4.4).

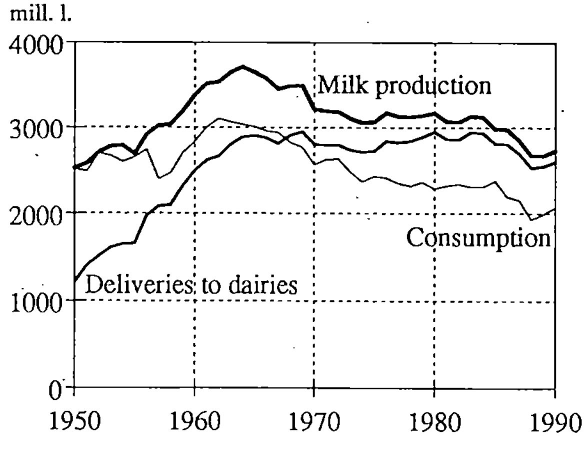

Figure 4.1. Milk production, deliveries to dairies and consumption in 1950-1990.

Nevertheless, price is an essential factor. In this study, price ties the theoretical framework of control policy's principles to the empirical analysis of its effects. Evidently, price development has increased or, at least, maintained milk production in excess of domestic consumption (Figure 4.1). The basic assumption is that producers react to relative prices between the product, alternative products and inputs. This is often realized through deflated prices, but nominal prices of these factors contemporaneously in one equation can serve the same purpose.

Another common assumption is a symmetric producer response to both falling and rising prices. However, in practice, the response to curtail production is probably more inelastic than to increase production (irreversible supply functions; see e.g. HOUCK 1977; TRAILL, COLMAN & YOUNG 1978). This is an obvious characteristic in a production line with high fixed costs.

The hypothesis of a positive correlation between price and supply of milk is maintained. Here, both nominal and real price of milk has been used. The deflator has been the producer price index.

2. *Price of an alternative product.* In Finland, beef, pork and bread grain have been considered alternatives for milk production. Shifts from milk to bread grain production, especially in Southern Finland, took place during the extensive changes of the 1960s in the society and agriculture. However, e.g. wheat price does not usually correlate logically with milk production (KETTUNEN & RYÖKÄS 1984), partly due to the very similar price development. The same is true for pork. Shifts to these production lines from milk are restricted by the high fixed costs such as buildings and machinery in milk production.

Feed grain is an issue of different nature. It has been common to start feed grain production after giving up milk production. But this shift has often been a non-alternative decision. Farmer's choice is affected by conditions, i.e lack of alternatives or entrepreneurial skills, not by a substitute effect in terms of price relations.

Beef, in turn, may prove to be a real alternative for milk production. An increase in beef price is assumed to lead to a decrease in milk production, ceteris paribus, mainly through an effect on dairy herd size. However, the relationship between beef and milk is not so simple. Instead of a substitute product, beef, or bovine meat, can also be regarded as a complementary product bound to milk production. OSKAM & OSINGA (1982) have argued that in the Netherlands the substitution effect is only of marginal importance because of the highly specialized farming. Only significant changes in prices can affect production decisions, and only in the long run.

The traditional substitution effect is the working hypothesis in this study (also in e.g. HALVORSON 1958; PRATO 1973; CUDDY 1982). But it is worth acknowledging that a close linkage between dairy and beef herds in Finland may result in an opposite correlation. Moreover, substitution relationships are likely to vary *regionally* according to natural conditions and off-farm opportunities. Regional effects in terms of disaggregated data are, however, beyond the scope of this study.

3. *Production costs.* Received prices and production costs affect supply. Often, instead of a separate analysis of these factors, price ratios are used to express the relation between a product price and a price (index) of an input or several inputs used in its production. The use of price ratios has limitations, however (see OSKAM 1984, p. 346). Interpretation of results is actually clarified by keeping variables separate.

In milk production, *feed cost* is usually the most important input belonging to variable costs. The basic hypothesis is that if feed cost rises, milk supply declines. This relationship is of smaller significance in Finland because dairy farms rely heavily on feed produced on farms. The share of purchased industrial feed of milk production costs has been quite low, increasing only in the 1980s (Figure 4.2; KOLA 1988, p. 42).

In Finland, the substitution effect is usually the most transparent during the years of good harvest, e.g. in 1990 (KETTUNEN 1991, p. 26). Farmers substitute abundant on-farm feed for higher cost commercial feed. In poor harvest periods of 1981 and 1987, the assumed opposite response has not been realized to the same extent. Use of purchased feed has been inadequate to offset the adverse effects of crop failure on yields per cow. A steady upward trend has been interrupted (Figure 4.3).

Labor cost is another central determinant of milk production. Milk production is very labor intensive, especially on predominating small dairy farms in Finland. Labor costs are more significant in milk than in e.g. grain production, and thus wage increase raises marginal costs more in milk production. On the other hand, *hired* labor cost has a small weight in the total costs of milk production (Figure 4.2).

Additional explanatory power over the primary cost effect can be found for labor in terms of opportunity cost for farmer's labor input. In relation to the producer price, labor cost describes the relation between income, or wage, development in other sectors of economy, and price development in agriculture. Consequently, the price-wage rela-

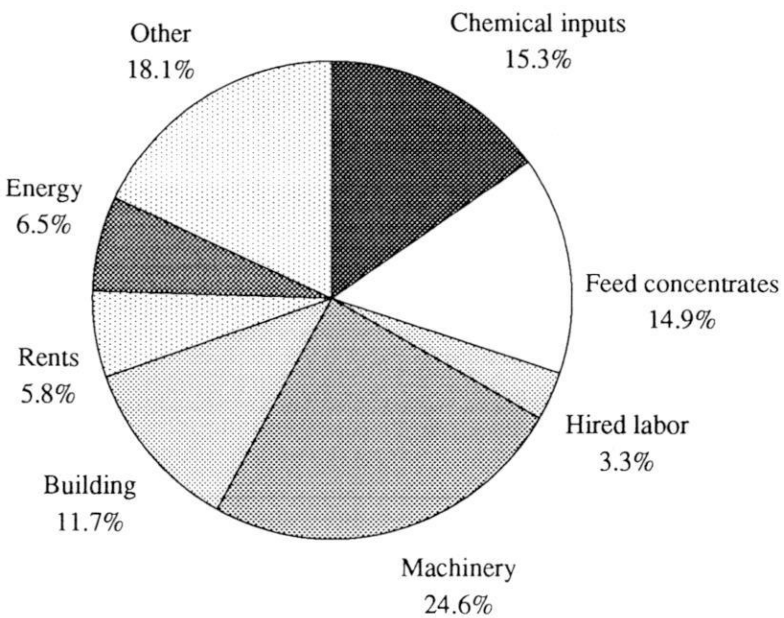

Figure 4.2. Aggregate cost structure of milk production in 1985.

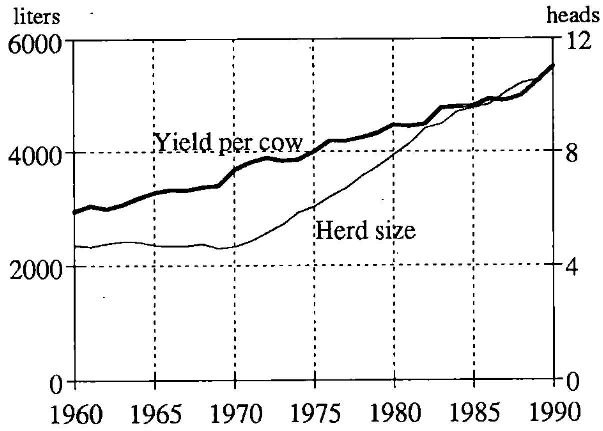

Figure 4.3. Yield per cow and average herd size in 1960-1990.

tionship affects the number of cows farmers keep, i.e. how much time is spent on farming compared with off-farm jobs or whether additional labor is hired to manage larger herd size. Labor cost is included in the cost factors, but, at the same time, its wider implications in terms of income development are recognized in paragraph 7.

4. *Technology*. Machines, equipment and buildings develop, animals become more productive due to breeding and biotechnology, production structure is rationalized as herd size grows and farmers' know-how increases. Technological impact is mainly realized via higher yields per cow (Figure 4.3) and lower cost per unit produced. The remarkable effect of these factors has the most often been illustrated by a simple trend variable fitted to time series. This procedure is also applied in this study.

5. *Weather* effects on milk production are mainly indirect. Favorable conditions improve feed crop and thereby increase milk production, whereas low quality and quantity feed crop due to bad weather has the opposite effect. Poor crop could be mitigated by intensifying commercial feed use, but, due to the heavy reliance of Finnish dairy farms on on-farm feed, it has not offset adverse weather effects. Because milk production as such is directly less sensitive to weather, instead of basic weather indices (temperature, precipitation), deviations of average yields and quality of feed crops from their trend values in normal years should be used. Because of limited availability of feed quality data, quantity of feed is used as an explanatory variable.

The feed variable consisting of barley, hay and silage is constructed. The combined feed variable represents better feeding practices in milk production than one crop alone or total yield. Instead of a crop level, the variable is expressed as a deviation from the trend yields in feed units (Figure 4.4). The hypothesis is that good harvest has a positive impact on milk production through higher yields per cow.

6. *Government* can either support or restrict production. In Finland, both actions have been applied extensively. In milk production, effects of the actions have been realized through both yield per cow and herd size. Support is usually embodied in high prices of products or low prices of inputs. Correspondingly, control measures can be in-

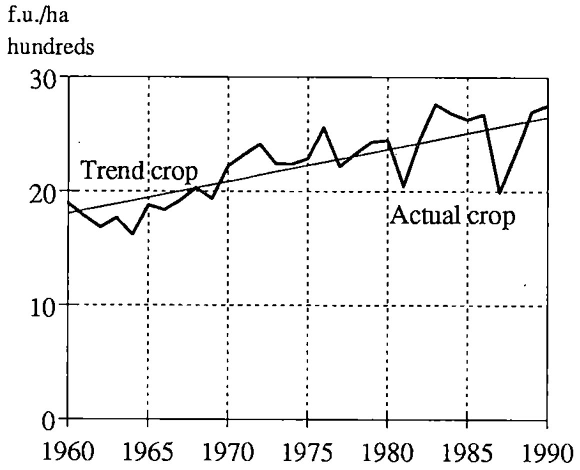

Figure 4.4. Actual and trend development of the combined crop of barley, hay and silage expressed in feed units in 1960-90.

cluded in products as incremental marketing fees or in inputs as levies. Administrative actions can also be reflected in prices individually so that certain products, e.g. not in surplus, are preferred to others for economic reasons. Thus price factors can include these effects.

But overall effects of administrative measures are wider and more complicated to determine. It is especially difficult to model quantitative restrictions. JONES (1981), for example, has made an attempt to solve the problem by index series representing the policy pursued by government. Modelling of short term measures can take place through dummy variables, which illustrate shifts in production due to support and control measures. As explained earlier (Chapter 3.1.2), no variables are used here to describe government measures in the supply analysis proper. But their very effect is evaluated in connection with the efficiency analyses.

7. *Structural change and adjustment* within agriculture and between agriculture and other sectors of the economy have affected the development of agriculture in various ways. This is especially true in the case of milk production, which many farms gave up in turbulent times of the 1960s and early 1970s (Figure 4.5). Some producers changed only the line of production, but many left farming for good. This development was accelerated by simultaneous agricultural policy measures, e.g. the soil bank system.

The unemployment rate and the number of agricultural labor force can be used to represent the adjustment factors in the society. For example, rising unemployment lessens emigration from agriculture to other industries. Decrease in agricultural population makes it more difficult to obtain additional labor to manage e.g. expanded herd size. Yet, the most important factor is obviously the level of income, especially in relation to working hours. Hired farm labor cost (see paragraph 3), as the most familiar indicator for farmers of income development in other sectors, proves to be a suitable multipurpose variable. When wages rise, farmers may acquire off-farm jobs, provided that

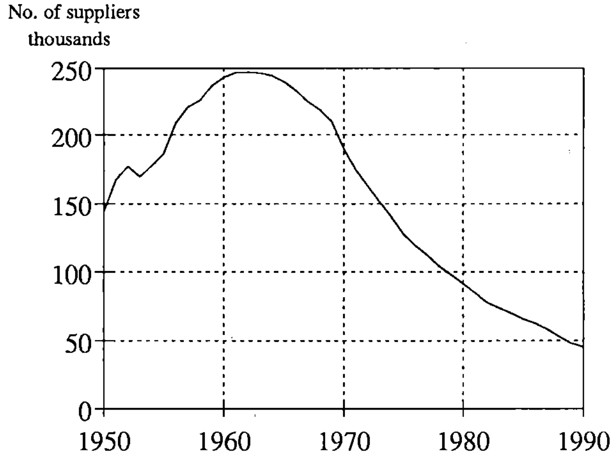

Figure 4.5. The number of milk suppliers in 1950-1990.

they are available. Again, regional variation is considerable.

Within agriculture, it is evident that price relations alone have not caused shifts from milk to other products in Finland. Other important reasons have been farmers' willingness to *lessen* their *work load*, which is the heaviest in milk production, and high costs and *limited availability of hired labor*. Moreover, the decision to give up milk production often leads to quitting all agricultural production. This is particularly true in the case of old farmers, the large share of whom is reflected through the serious *distortion of age structure* among milk producers in Finland.

Changes in the aptitude to quit farming may also reflect general attitudes towards agriculture in the society. These kinds of factors have contributed to the declining trend in the number of dairy farms independently, regardless of the effect of economic factors, but they are difficult to include in a supply model due to lack of theoretical consistency and quantitative measures.

4.2. Data

The production and yield quantity figures are based on the statistics compiled by the National Board of Agriculture. The producer prices are calculated at the Agricultural Economics Research Institute (AERI). The prices include all support, additional prices and retroactive payments. The price indices have also been calculated at the AERI. According to revised calculations, their base year is 1985. The Central Statistical Office of Finland supplies wage and employment statistics. Annual data is used. The important questions related to the choice of the *estimation* period are dealt with in Chapter 4.3. Data are presented in Appendix 3.

4.3. Choice of the estimation period

Usually the choice of the estimation period is affected by the availability of data. Moreover, an adequately long time series has been preferred. The time series should represent a reasonably homogenous period without drastic fundamental changes. The significance of the supply determinants should remain equal throughout the whole estimation period, i.e. variables and relationships should be independent of time. An additional requirement for the estimation period in this study is that it has to represent a period when production has developed without any major impact of control measures.

From the possible time sphere from 1950 to today, the period of *1961-80* is selected to represent the uncontrolled or *free era*. The supply model, estimated from this period, is simulated to the *control period of 1981-89* in Chapter 5.

The 1950s were still a period of the strong post-war reconstruction and as such inappropriate for the estimation purposes. The estimation period is chosen to *begin* in 1961, when the continuous post-war increase in the number of milk suppliers stopped and turned to a steady decline thereafter (Figure 4.5). Hence, there was a decisive and permanent change in development. However, milk production increased until 1964 (Figure 4.1). The *end* point of the estimation period is determined by the more extensive introduction of dairy restrictions, e.g. the contracts to reduce production, especially the so called bonus agreements, in 1981.

The selected free period includes some control measures: the soil bank system in 1969-74 with dairy cow slaughterings in 1970, marketing fees in 1971-74 and in 1977-80, the agreements to change the production line in 1977-80 and the regulation of establishment of animal production units in 1979-80. However, the effect of these measures, although considerable on the number of dairy producers, has been relatively small on production volume. Thus, it does not distort the analysis.

4.4. Implications of declining production for estimation

The declining trend of milk production confuses to some extent the key relationships traditionally valid in supply estimation. Socio- and politico-economic, not purely economic, factors have had a significant impact on the long run development. Producers' expectations on the future of their own industry and on possibilities in other sectors have modified milk production in a way that is difficult to quantify.

The basic relationship between real milk price and milk output is problematic (Figure 4.6). The real price of milk has increased but production has decreased steeply. As a result, instead of a positive price-quantity relation according to the hypothesis, a threat of a negative correlation emerges. Similarly, technological development may receive a negative correlation contrary to the hypothesis. In terms of the crop variable, use of the deviation instead of level should mitigate the problem of an absurd correlation. Visually, the 1970s seem to follow better the hypotheses.

In addition to the possible correlations contrary to assumptions, declining production leads to problems in finding a correct lag structure. Lag structures have usually been fitted to increasing production. A period of several years is required if marked production increases take place through enlarged herd size and investments or through new

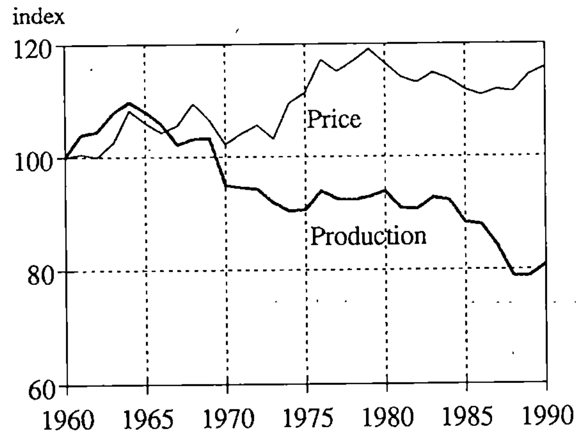

Figure 4.6. Real milk price and milk production in 1960-1990 as an index, 1960=100.

entrants in the industry. In empirical estimation of milk supply, three years has often been considered a sufficient lag (Ryll 1975; Levins 1982; Cuddy 1982). During three years at least existing producers are able to adjust to price changes. This reflects mainly the biological regeneration cycle of a cow. The short-run production changes can be made by culling herds and/or altering feeding practices.

Distributed lag structure can be specified through either separate lagged price variables or a combined distributed lag variable. In the simplest distributed lag structure, a dependent variable is assumed to be a function of an independent variable, which is lagged one, two or more periods:

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \varepsilon_t = \alpha + \sum_{s=0}^{n} \beta_s X_{t-s} + \varepsilon_t$$

Theoretically, the number of lags is infinite, but, in practice, it is usually limited (Pindyck & Rubinfeld 1981, p. 231). As the number of distributed lags grows, estimation is impeded due to, first, loss of degrees of freedom, and second, multicollinearity. To avoid the loss of degrees of freedom, it is possible to construct one variable with weighted lags to substitute for several lag terms. Given a priori knowledge about the form of distributed lags, a geometric lag can be used (Pindyck & Rubinfeld 1981, p. 232). Because the geometric lag model is restricted by its dependence on declining lag weights, a more flexible method is a polynomial distributed lag. Chen, Courtney & Schmitz (1972) have used it in their quarterly model of the highly specialized dairy industry in California.

In Finland the very price system makes it possible to predict the price development quite well. Thus it seems reasonable to assume that the price effect on milk supply within a year is significant, too. This is especially true in declining production because cow slaughterings do not require as long a lag as herd rebuilding to increase production. On the other hand, production can also be raised in the short run by intensifying feeding. Price variables of the same year have been used by e.g. CUDDY (1982) and KETTUNEN & RYÖKÄS (1984).

4.5. Supply estimation

Supply models for milk production are estimated by two structurally different approaches to take advantage of all available information in order to provide the best possible predictions, which will be made in Chapter 5. First, in Chapter 4.5.1, a causal econometric single-equation multivariate model without control variables is estimated. Secondly, in Chapter 4.5.2, a non-causal univariate Box-Jenkins -type time series model is estimated.

4.5.1. Econometric model

Even though the development in the 1960s is different from the 1970s, estimation results for the whole period only are presented to keep econometric consistency and sufficient degrees of freedom. Nevertheless, the objective is maintained to find the very factors explaining milk supply in the 1960s and 1970s, and affecting milk supply also in the 1980s. In that case, simulation would address the development in production the most precisely, had no restrictions on production been in force.

The following *explanatory* variables are used to explain the variation in the *dependent* variable, Q^m = milk production in million liters:

P^m = producer price of milk, FIM/l
P^b = producer price of beef, FIM/kg
P^L = average pay of hired labor, FIM/h
Feed = price index of industrial feed
Crop = deviation from the combined trend yield (=100) of barley, hay and silage expressed in feed units
Tech = linearly growing trend variable

Following the discussion in Chapter 4.4 about various alternative *lag structures*, an attempt was made to introduce explicit dynamics into the model. An empirical search for different lag specifications indicated very limited applicability of lagged independent variables as such. The two-year moving averages with various weights proved appropriate. Due to ambiguous interpretation, the specification of combined lag parameters was rejected in favor of variables with no lags.

Supply functions of different variable combinations are estimated by the method of *ordinary least squares* (OLS) and by applying multiple regression analysis to time series data for the years 1961 through 1980. Estimations of both nominal and real prices, producer price index as a deflator, are performed. Empirical estimation supports the use of real prices.

To determine the *functional form*, interdependences between dependent and explanatory variables are visually examined by scatter plots. No support for any other functional form apart from linear is gained.

If *autocorrelation* in error terms was detected according to the Durbin-Watson (d) statistic obtained from OLS, the data were transformed by the Cochrane-Orcutt iterative least squares procedure (JUDGE et al. 1988, pp. 392-393) and re-estimated. Estimations with statistically significant autocorrelation correction factors (ρ) only were accepted. SHAZAM computer software (WHITE et al. 1990) was used in estimation.

The preferred characteristics of the estimated models can be based on three main criteria: 1) logical regression coefficients (correct signs), 2) estimation accuracy in the *last years* of the period (small residuals and overall low s.e.e.), and 3) high coefficient of determination (high R^2). The model that meets these requirements best will be chosen for forecast purposes.

In connection with estimation results, below each parameter estimate are their t-ratios. In addition, coefficient of determination R^2 and adjusted for the number of explanatory variables $adjR^2$; standard error of the estimate s.e.e.; the F-statistic; Durbin-Watson statistic d, or the runs test statistic (GUJARATI 1978, p. 246) in connection with estimated autocorrelation correction factor ρ; and applicable own price elasticities of milk supply E_{PQ} are specified.

First, the model with three basic variables using real prices is estimated by the Cochrane-Orcutt iterative procedure:

$$(4.1) \quad \underset{4.63}{Q_t^m = 3502} + \underset{1.06}{279.8 P_t^m} - \underset{-1.61}{19.38 P_t^b} - \underset{-2.18}{28.59 P_t^L}$$

$$R^2 = 0.949;\ adjR^2 = 0.939;\ s.e.e. = 55.6;\ F = 98.63;$$
$$\rho = 0.672;\ Runs\ statistic = -0.288;\ E_{PQ} = 0.22$$

All parameter estimates of equation 4.1 have correct signs. The model has a reasonably good fit, R^2 being 0.95. But it suffers from a quite high standard error, s.e.e.=56 million liters. Moreover, residuals are large in the last years of the estimation period, when accuracy is especially preferred to improve the reliability of the model for prediction purposes. The F-statistic indicates the existence of an overall relationship between dependent and independent variables. The runs test statistic shows no evidence for rejection of the null hypothesis of no autocorrelation.

A clear positive relation prevails between the price and supply of milk on the basis of the regression. The price elasticity of supply for milk (calculated at means) is E_{PQ}=0.22. The hypothesis on the substitution effect is confirmed by the correct sign of the parameter estimate for P^b. However, the parameter estimates for P^m and P^b are of low significance. The other variables, i.e. feed price, crop deviation and technological development, if included in the model, obtain illogical or insignificant parameter estimates.

Because of the failure to incorporate explicit dynamics into the model, a *structural adjustment* factor in the form of a *lagged dependent variable* is employed. The inclusion of a lagged dependent variable is a response to the tendency of economic theory to lead to specifications in which the desired rather than the actual value of the dependent variable is determined by the independent variables (KENNEDY 1985, p. 117).

In the *partial adjustment* model the actual value of the dependent variable adjusts by some constant fraction of the difference between the actual and desired values. This can be justified by citing technological, institutional or psychological inertia, inter alia. In Finland, adjustment inertia can be related to unfavorable production structure and heavy external regulation.

The inclusion of a lagged dependent variable among the explanatory variables has several advantages. First, it makes it possible to derive short and long run price elasticities of supply for milk (PINDYCK & RUBINFELD 1981, p. 269). Secondly, it contributes to the efficiency examination by introducing dynamics to the prediction phase of the analysis (ZANIAS & JONES 1985). Thirdly, it provides the partial adjustment coefficient (NERLOVE 1958). The coefficient reflects the limited ability of producers to adjust in contrast to the preferred full adjustment induced by changes in e.g. economic factors. This model specification of *partial adjustment* produces the following results:

$$(4.2)\quad \underset{4.32}{Q_t^m = 2936} + \underset{1.33}{331.3P_t^m} - \underset{-4.47}{38.47P_t^b} - \underset{-1.14}{13.59P_t^L} + \underset{1.45}{0.188Q_{t-1}^m}$$

$$R^2 = 0.970;\ adjR^2 = 0.962;\ s.e.e. = 43.6;\ F = 112.5;$$

$$Durbin\ h = 0.570;\ E_{PQ}^{sr} = 0.26;\ E_{PQ}^{lr} = 0.33$$

Since equation 4.2 contains a lagged dependent variable, instead of the Durbin-Watson test, the Durbin h test has to be used to detect autocorrelation (e.g. KMENTA 1986, p. 333). If the Durbin h statistic indicates no autocorrelation, estimates are consistent, since the error term and the lagged dependent variable are contemporaneously uncorrelated. If otherwise, no statistical properties exist. Here, the value of the test statistic, h=0.570, is well below the critical value of normal distribution (1.645 at the 5% level): the null hypothesis of no autocorrelation cannot be rejected.

All parameter estimates of the independent variables have expected signs, but their significance is low, except in the case of beef price. The inclusion of the lagged dependent variable increased the adjusted R^2, which implies that the new variable brought additional explanatory power. The short run price elasticity of supply for milk, 0.26, does not differ much from the elasticity in Equation 4.1. The slightly larger value of the long run price elasticity, 0.33, indicates the prevailing rigidity in adjustment process regardless of the length of run.

Structural adjustment variable improves responsiveness of the model to the actual practices on dairy farms. Nevertheless, in the 1970s milk production became more specialized and production techniques changed. This development should be forwarded to the 1980s in order to provide reliable predictions. The impact of beef price as a substitute is very strong in Equation 4.2. The impact is obviously beyond its actual effect on Finnish livestock farms and driving milk production lower than the real relationship implies. The distortion is reflected in the last residuals of the estimation. Furthermore, if this model is used for simulation, the predicted uncontrolled production falls *below* the actual one in some years. Consequently, there is sufficient evidence to omit the P^b-variable. Its exclusion may also mitigate the possible multicollinearity problem reflected in low t-statistics.

In terms of the aforementioned changes and development in milk production, technological development should be taken into account. Its effect is the opposite of that of beef price. The problem with technological advancement (see Chapter 4.4) is the continuously declining production, which makes it difficult to fit technological development or the upward trend of yields to the data. The problem is overcome by a combination of time and dummy variables creating an interactiondummy (T_{71}), which is zero in 1960s and grows linearly from 1971 onwards.

A model which suits, and also confirms, the recent development in milk production better than the previous equations is presented below:

$$(4.3) \quad Q_t^m = \underset{3.07}{1270} + \underset{3.63}{493.3} P_t^m - \underset{-8.12}{59.14} P_t^L + \underset{4.48}{43.99} T_{71} + \underset{5.03}{0.464} Q_{t-1}^m$$

$$R^2 = 0.976;\ adjR^2 = 0.970;\ s.e.e. = 38.9;\ F = 155.0;$$

$$Durbin\ h = 0.055;\ E_{PQ}^{sr} = 0.39;\ E_{PQ}^{lr} = 0.73$$

Replacing beef price by technology variable increases remarkably the significance of parameter estimates. Again, all parameter estimates have correct signs. The very low value of the Durbin's h test statistic, h=0.055, leads to the acceptance of the null hypothesis of no autocorrelation.

The standard error of the estimate (s.e.e.=39) shrank about 5 million liters below that of Equation 4.2. Moreover, indicating model's good applicability for prediction purposes, the residuals between observed and estimated values are very small in the last years of the estimation period (Figure 4.7). Hence, the model has captured the prevail-

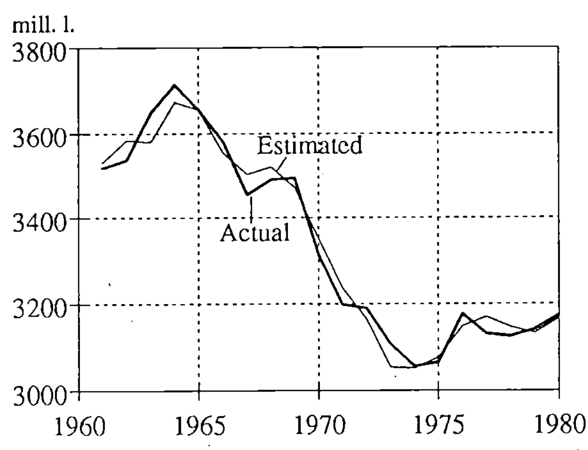

Figure 4.7. Actual and estimated milk production according to Equation 4.3 in 1961-80.

Table 4.1. Model validation measures.

MODEL	AIC	MAE	RMSE
4.1	8.21	39.77	49.88
4.2	7.85	33.46	39.41
4.3	7.54	28.67	33.72

ing characteristics in milk production. The short and long run price elasticities of supply for milk are 0.39 and 0.73, respectively. They are higher than in the previous models. This was anticipated due to the omission of beef price.

Equation 4.3 meets the requirements set for the models better than the other equations. In order to obtain additional evidence to validate the estimated models, an ex post simulation (within the sample) is made. Among the several model selection tests and validation measures available (e.g. JUDGE et al. 1988, chp. 20.4), the Akaike information criterion (AIC) in a logarithmic form, mean absolute error (MAE) and root mean squared error (RMSE) are employed (Table 4.1).

For all of the validation measures the same criterion applies, i.e. the lower the value, the better the model. The RMSE, as a quadratic loss function, penalizes large errors more than the MAE as a linear loss function. Model 4.3 has the lowest values uniformly for all measures. Consequently, it is chosen for forecast purposes.

4.5.2. Time series model

Instead of making an attempt to specify causal relationships between dependent and independent variables, time series analysis, also known as Box-Jenkins analysis, can be employed (BOX & JENKINS 1970). The application of this approach is encouraged by problems in specifying appropriate lag structure or relationships between the key variables, emerged mainly due to the declining trend in milk production.

Especially for forecasting purposes, time series analysis represents an alternative worth considering (e.g. TERÄSVIRTA 1977). In fact, however, time series analysis should not solely be regarded as an *alternative* to building regression models for forecasting. Rather, time series techniques should be *incorporated* into the model building in order to obtain the most efficient forecasts possible (NEWBOLD 1983).

Time series analysis concentrates on construction of a model of the historical evolution through time of the phenomenon to be predicted. The data are allowed to advice us how to specify the model, i.e. an attempt is made to construct a model that fits the data. Hence, time series models rely only on the current and past behavior of the variable under scrutiny. The emphasis on the role of data in determining an appropriate model arose from the recognition that theory turns out to be vague on the question of timing of relationships, which is at least as important as their qualitative nature (NEWBOLD 1983).

Time series approach may prove useful when econometric models are rendered impractical due to e.g. specification error, which may result from excluded relevant explanatory variables or incorrect functional form. Applicability of time series models can further be supported by an argument that the estimation of endogenous variables in the econometric model may change to the estimation of exogenous variables included in a model. GRANGER & NEWBOLD (1977) have stated that the strength and form of dynamic interdependences between variables is often incorrectly interpreted by econometric models. On the contrary, time series models illustrate only the information which is included in the observed data.

The commitment of time series models to data only can be regarded as a shortcoming as well, because interdependences are not analyzed at all. However, in *transfer function-noise* models (BOX & JENKINS 1970) or vector autoregressive processes (JUDGE et al. 1988, chp. 18) multiple time series are used in order to explain, say, consumption by price and income. The structure of these models is more complicated than that of autoprojective univariate models.

Structurally, a time series model consists of autoregressive process of order p, AR(p), and moving average process of order q, MA(q). The processes are presented in the following equations, in which ϕ and θ are the unknown parameters and *e* are independent and identically distributed (i.i.d.) normal errors:

$$AR(p): \quad Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \ldots + \phi_p Y_{t-p} + e_t$$

$$MA(q): \quad Y_t = e_t + \theta_1 e_{t-1} + \theta_2 e_{t-2} + \ldots + \theta_q e_{t-q}$$

If both components are involved in one process, the process is called *autoregressive moving average*, or ARMA (p,q). The use of ARMA-models has certain preconditions. First, *plenty of observations* are needed. Secondly, the technique restricts us to *stationary* time series. Thirdly, the models are *linear* in the sense that predictions of future values are constrained to be linear functions of the observations.

Given the assumptions of stationarity and linearity, the ARMA models have the advantage of *parsimony* of parameterization, i.e. models with relatively few parameters are often sufficient.

Even if linearity often applies to reality, many economic time series are non-stationary due to e.g. growth trends. Stochastic processes are said to be stationary, if the covariance between two members depends only on their distance in time, and the processes have constant mean and finite variance (JUDGE et al. 1988, p. 678). This means that the stochastic properties of time series Y are time invariant. Formally presented, a stochastic process Y_t is stationary, provided that:

$$a)\ E(Y_t) = \mu \text{ for all } t$$
$$b)\ Var(Y_t) < \infty \text{ for all } t$$
$$c)\ Cov(Y_t, Y_{t+k}) = E[(Y_t - \mu)\cdot(Y_{t+k} - \mu)] = \gamma_k \text{ for all } t \text{ and } k$$

If the original time series do not possess the virtue of stationarity, it can be transformed to it by *differencing*, i.e. $\Delta Y_t = y_t = Y_t - Y_{t-1} = (1-B)Y_t$ (B is the lag, or backshift, operator: $B^n Y_t = Y_{t-n}$). Differencing once or twice is usually adequate.

Differencing creates an ARIMA (p,d,q) process *(autoregressive integrated moving average)*, which can be written in a general form as follows:

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \ldots + \phi_p y_{t-p} + e_t + \theta_1 e_{t-1} + \theta_2 e_{t-2} + \ldots + \theta_q e_{t-q}$$

$$\Leftrightarrow (1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p) y_t = (1 + \theta_1 B + \theta_2 B^2 + \ldots + \theta_q B^q) e_t$$

Now, y is expressed in terms of its own past values and with current and past errors. In the ARIMA (p,d,q) model, p is the number of lagged values of y, representing the order of the autoregressive (AR) dimension of the model; d is the number of times Y is differenced to produce y; and q is the number of lagged values of the error term, representing the order of the moving average (MA) dimension of the model. Again, ϕ and θ are the unknown parameters and *e* are i.i.d. normal errors.

Building ARIMA models involves three phases: 1) model selection, 2) parameter estimation and 3) diagnostic model checking. In the first phase, the model has to be *identified*, or selected. The decision is based on the examination of the statistics calculated from the data. The sample autocorrelations (ACF) and partial autocorrelations (PACF) of the original data (or its low order differences) are compared to the patterns of theoretical autocorrelation functions (e.g. PANKRATZ 1983). The choice itself to determine which model the data suggest as the appropriate one is mainly based on personal judgement and experience. In the *second* phase, the parameters (ϕ, θ) of the selected model are *estimated.*

In the *third* phase, the estimated model is *checked* in terms of whether it sufficiently represents the behavior of the data. This diagnostic checking is more exact in its nature than that of the model selection stage. One common way of checking is to fit to the data a more elaborate model, and assess whether the addition of further parameters improved the fit. Another way is to examine the autocorrelations of the residuals from the estimated model. The portmanteau test statistic, which follows the asymptotic chi-square distribution, is commonly used for this purpose (JUDGE, et al. 1988, p. 705). If the model is correctly specified, the residual autocorrelations should be relatively small. If the search for an appropriate model succeeds, it can be projected forward to obtain forecasts of future values of the time series. If it fails, the three stage cycle has to be iterated.

In this study, a univariate model is employed. The analysis consists of estimation and forecasting of time series through the fitting of autoregressive integrated moving average (ARIMA) models to historical data of annual milk production (Q^m) from 1931 to 1989. The estimation uses the first 50 observations, which is barely a sufficient number of observations in a time series analysis. The remaining observations are reserved for forecasting purposes. SHAZAM computer software (WHITE et al. 1990) is used.

In the case of 50 years of milk production, autocorrelation function tails off in the course of time but far too slowly. Still after 12 lags, autocorrelations do not cut off. It shows that the time series is non-stationary. Hence, the first differences of the series (Q^m) have to be taken to make it stationary:

$$(4.4) \quad \Delta Q_t^m = Q_t^m - Q_{t-1}^m = (1-B) Q_t^m$$

As a result, a new series ΔQ^m is obtained, autocorrelation of which cuts off to zero sooner than that of the original data series. The form of the ACF is a sine-wave, which is close to the theoretical ACF of AR(2)-process (PANKRATZ 1983, p. 126). However, because there is only one clear spike in the PACF at lag k=1, reasonable evidence exists to choose an AR(1)-process. Thus, the selected model is ARIMA (1,1,0). There is no support to include an MA-term. This practice also follows the idea of parsimony.

In the *second* phase, the selected ARIMA (1,1,0)-model is *estimated* to obtain the unknown AR(1)-parameter estimate, ϕ_1=0.542. The estimate is highly significant (t-statistic is 4.42). The estimated model is:

$$(4.5) \quad (1-0.542B)\cdot\Delta Q_t^m = 9.03$$

$$Q(11) = 15.2; AIC = 9.78$$

In the *third* phase, the fitted model is *diagnostically checked* as to whether it sufficiently represents the behavior of the data. To assess the adequacy of this model, a less parsimonious ARIMA (2,1,0)-model was estimated. The ϕ_2 was statistically insignificant. The model selection tests, e.g. Akaike information criteria (AIC), gave no evidence of AR(2)-superiority over AR(1)-specification. Moreover, the chi-squared Ljung-Box (Q) statistic (NEWBOLD 1983) did not detect any autocorrelation in the residuals of the estimated AR(1)-process. The null hypothesis of white noise error process was accepted. The estimated ARIMA (1,1,0) model represents an adequate specification.

4.6. Conclusions

In order to be able to assess the quantitative effect of dairy control programs, estimation of supply functions for milk from the uncontrolled period was performed. When proceeding to assess the efficiency of control policy on the basis of the estimation results, the characteristics inherent in the supply analysis have to be taken into account.

The need to obtain an adequate number of observations for an annual time series could lead to inclusion of irrelevant phenomena with respect to the current situation. In the econometric supply analysis, problems emerged due to difficulty to include presumed relevant variables because of the declining trend in milk production.

Equation 4.3 met the requirements set for the econometric models (p. 69) the most suitably. The inclusion of the lagged dependent variable as an explanatory variable generated a partial adjustment model.

Among the non-causal univariate time series models, a parsimonious ARIMA (1,1,0) model (Equation 4.5) was regarded as an adequate specification. The model confirmed the specification of the econometric model with lagged dependent variable. Autoregressive processes seem to predominate. The chosen models are applied for forecasting in Chapter 5.

5. Quantitative efficiency of dairy restrictions

The quantitative efficiency of dairy restrictions is examined by comparing the actual controlled production to the predicted uncontrolled production. The period under scrutiny is 1981-89, when restrictions on milk production were applied to the largest extent in Finland. The prediction on production volume, had there been no restrictions, is obtained, when the estimated supply functions (Chapter 4) are simulated to the control period.

The time horizon of simulation (Figure 5.1) depends on the objective of the study. For example, model validation claims for *ex post* simulation in the estimation period. Forecasting takes place in the horizon after the estimation period. *Ex post* forecasting corresponds to *ex post* simulation in terms of known observations (*unconditional* procedure). Instead, in *ex ante* forecasting, values of independent variables are usually unknown, and they are predicted along with a dependent variable (*conditional* procedure). Yet, explanatory variables can also be known for ex ante *forecasts* depending on the characteristics of the data or the length of the lags in relation to the simulation period (PINDYCK & RUBINFELD 1981, p. 204).

In this study, simulation is based on the equations estimated from the uncontrolled period. In principle, the unconditional *ex post* forecast is obtained by simulating the estimated models to the period 1981-89, in which all variables are known with certainty. However, the production volume without restrictions is *not* known. Accordingly, the simulation of the estimated supply function for milk to the control period is *unconditional ex ante* forecast by its nature.

In order to mitigate possible disadvantages of the quite long simulation period (especially in relation to the estimation period), the models are updated and re-estimated each year before new forecasts are made. The simulation is performed and predictions generated as a one-step-ahead procedure.

5.1. Econometric prediction

The econometric prediction is based on the simulation of Equation 4.3 to the control period. If the factors affecting milk production in the 1960s and 1970s had remained similar in the 1980s and there had been no restrictions, milk production would have

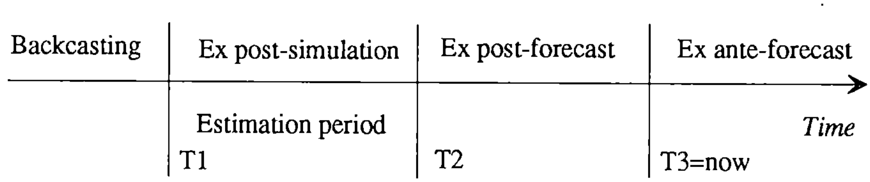

Figure 5.1. Time horizons of simulation.

been 134-577 million liters, or 4-22 percent larger than the observed production annually in the control period 1981-89 (Table 5.1).

The good feed crop in 1983 boosted milk production. But, in the absence of a crop variable, the variables of the supply function lead to a similar development in the predicted production in 1983 and 1984. The increased actual production in 1983 and 1984 involves factors beyond the determinants of milk supply used in the estimation. In addition to good harvest, the growth includes reservations in terms of farmers' evident actions in advance to prepare for and affect the milk production quotas. Quotas came into force in 1985. The observed growth may thus have been affected by factors different from those used in simulation.

In 1980, the last year of the estimation period, the residual between observed and estimated production volume was only 7 million liters. But in 1981, the first year of the simulation period, the gap was already 134 million liters. Another steep threshold occurs in 1985. The conclusion can be drawn that simultaneous new extensive dairy restrictions explain the increase in difference between observed and predicted milk production in 1981 and 1985.

The great difference in 1987 is caused to a large extent by the crop failure, which is not taken into account in the model. This is due to the absence of the crop variable. Moreover, milk production was reduced and farmers' retirement was fostered by the remarkable change in the pension system for farmers giving up production (see Chapter 2.5.3). The difference remained large in the last two years as actual production was considerably cut by the 1988 milk bonus contracts. Yet, predicted production declined, too.

The difference between the predicted and the actual production is regarded as the effect of production control measures, either curbing the growth potential or cutting production. For example, in 1985 both actual and predicted production decreased, but the former drastically more. This is a clear indication of restriction effects as the quota

Table 5.1. Actual controlled and predicted uncontrolled milk production in the control period 1981-89. Econometric model, Equation 4.3.

Year	Milk production, mill. l. actual	predicted	Difference mill. l.	%
1981	3073	3207	134	4.4
1982	3068	3278	210	6.8
1983	3136	3360	224	7.1
1984	3124	3348	224	7.2
1985	2988	3345	357	11.9
1986	2976	3306	330	11.1
1987	2847	3278	431	15.1
1988	2668	3245	577	21.6
1989	2668	3185	517	19.4

system was introduced that year and bonus agreements of the previous year came into full effect.

5.2. Time series prediction

Time series prediction of the free development in milk production is generated in the same way as the econometric one. The estimated ARIMA (1,1,0)-model is simulated to the control period 1981-89.

When there are only 50 years in the estimation period, the nine years' forecast interval is relatively long. This is particularly true for time series models, which are primarily intended to the short term forecast. However, in order to maintain comparability with the econometric forecast, the same forecast period is employed.

The validity of a long term forecast is improved by applying a one-step-ahead forecasting procedure, explained above. In addition, as we have an AR-process, the longer term forecast is on slightly better grounds. This is because in pure MA-models information about past estimated values is soon lost as the forecast proceeds further into the future (PANKRATZ 1983, chp. 10). An MA-process has a more limited memory than an AR-process and converges at a faster pace towards the mean of the series.

The time series model produces a very steady series of gradually growing production. Hence, variation in difference between actual and predicted production, from 126 to 695 million liters, reflects mainly changes in the level of actual milk production (Table 5.2).

In the absence of restrictions, milk production would have risen above the level which was observed in the presence of restrictions. Particularly in the last three years, the forecast production is markedly bigger than the actual one. The outcome of the ARIMA-model forecast follows the results of the econometric forecast. Additional evidence is gained for our hypothesis about dairy control effects.

Table 5.2. Actual controlled and predicted uncontrolled milk production in the control period 1981-89. Time series model, Equation 4.5.

Year	Milk production, mill. l.		Difference	
	actual	predicted	mill. l.	%
1981	3073	3200	126	4.1
1982	3068	3222	154	5.0
1983	3136	3244	107	3.4
1984	3124	3263	139	4.5
1985	2988	3283	295	9.9
1986	2976	3303	327	11.0
1987	2847	3323	476	16.7
1988	2668	3343	675	25.3
1989	2668	3363	695	26.1

5.3. Composite forecast

Two structurally different methods have been applied to estimate milk supply in Finland. The forecasts generated by the estimated multivariate econometric model and the univariate Box-Jenkins time series model are quite similar. They produce results that are consistent with our hypothesis about the effects of dairy restrictions.

Which forecast is better is difficult to verify. Accuracy of the forecasts cannot be compared with actual *uncontrolled* milk production. Accordingly, the common forecast validation methods (e.g. Kost 1980) are not applicable for measuring forecasting accuracy and thereby comparing one model with another. However, this does not impede the analysis. The objective was to see how milk production *would* have developed without production restrictions.

To take advantage of the information incorporated in both models, the predictions are combined (e.g. Bessler & Brandt 1981; Johnson & Rausser 1982). The results of this simple average *composite forecast* are presented in Table 5.3.

As expected on the basis of the quite similar econometric and time series predictions, the difference between the actual production and the predicted production is the largest in the latter part of the forecast. The first striking widening of the gap takes place in 1985, when the actual production declined due to new restrictions, i.e. the 1985 quota and the 1984 bonus contracts. Until the introduction of quotas in 1985, deviations are quite small, around 4-6 percent.

The second drastic change occurs in 1987, when the difference between actual and predicted production grew to 454 million liters, or 16 percent. This was mainly due to adverse effects of crop failure on milk production. The next increase in the gap immediately in 1988 was still influenced by the limited feed supply, and accelerated by the new bonus contracts.

All available information from different models has been taken into consideration in the composite forecast. The implied conclusions are quite clear.

Table 5.3. Actual controlled and predicted uncontrolled milk production in the control period 1981-89. Composite forecast.

Year	Milk production, mill. l.		Difference	
	actual	predicted	mill. l.	%
1981	3073	3203	130	4.2
1982	3068	3250	182	5.9
1983	3136	3302	166	5.3
1984	3124	3306	182	5.8
1985	2989	3314	326	10.9
1986	2976	3305	329	11.0
1987	2847	3301	454	15.9
1988	2668	3294	626	23.5
1989	2668	3274	606	22.7

5.4. Conclusions

Since 1985, dairy control programs resulted in large annual reductions of 326-626 million liters, or 11-24 percent, in milk production. Until 1985, the differences between the actual restricted and the predicted unrestricted production were smaller.

The introduction of the quota system in 1985 constitutes a watershed in the quantitative efficacy of dairy control programs. This change also represents a shift from voluntary restrictions to a major mandatory program.

These quantitative results of control effectiveness are used when the economic efficiency of the control programs is assessed. However, some indication is already obtained through this quantitative effectiveness on the expected scale and timing of the profitability of control programs.

The quantitative effect on production has been considered the result of both voluntary and compulsory control measures. However, only the costs of voluntary programs are taken into account in the following examination of profitability, e.g. administrative costs of compulsory programs are excluded. A similar procedure is applied to administrative costs related to surplus disposal.

6. Economic efficiency of dairy restrictions

The central task of this study is to examine whether it has been efficient to restrict milk production. The examination in terms of production volume (Chapter 5) showed the difference between the actual controlled and predicted free development in milk production.

The quantitative efficacy assessment serves as a starting point for the economic efficacy examination in terms of the assumption that the difference between actual and predicted milk production is caused by the curbing effect of administrative control programs.

6.1. Control policy costs

The data needed in the economic efficacy examination of dairy control policy is divided into three parts: 1) costs of production control programs, 2) costs of milk surplus disposal by subsidized exports, and 3) costs of increased feed grain output due to dairy control programs.

Control costs account for the annual compensations paid in various dairy control programs. They are available in the statistics compiled by the National Board of Agriculture. The statistics also provide the basis for the implied increase in feed grain production due to the effects of dairy restrictions. Surplus disposal or export costs of milk products and feed grain consist of export subsidies, which are based on the statistics of the Ministry of Trade and Industry.

For each cost category, actual annual cash payments, instead of budget appropriations, are used because of their better suitability for annual cost comparisons. The procedure of cash payments is especially convenient for control costs, because it has been possible to make contracts almost continuously and new contracts simultaneously with earlier ones and their schedule of compensation payments.

6.1.1. Costs of control programs

The voluntary contracts to reduce or quit milk production are here included in control measures of milk production. In voluntary programs, the state has paid compensations to contracting farmers.

In the 1980s the contracts 1) to change the production line (4§ and 4a§), 2) to reduce milk production, 3) to reduce agricultural production and 4) to reduce animal production have been this kind of programs. They have exclusively or partially affected milk production (see Chapter 2.5.3).

The contracts to reduce milk production, the so called milk bonuses, have been directed to milk production proper. The same is largely true for the contracts to change the production line (4a§) in 1980-82. Thus, the *total* costs of these contracts are included in the control costs of milk production (Table 6.1).

The 4§ contracts to change production line in 1977-82 and the contracts to reduce agricultural production in 1983-84 and 1986-89 were more general. Nevertheless, they

Table 6.1. The costs of voluntary control programs affecting milk production in 1981-89, FIM million.

Program	1981	1982	1983	1984	1985	1986	1987	1988	1989
Reduce agr. prod. and change prod. line 4§	35.6	56.0	49.3	49.6	49.2	45.1	79.7	97.5	97.5
Change prod. line 4a§	20.5	48.7	66.1	69.4	65.1	44.8	16.5	-	-
Reduce animal prod.	-	-	-	1.7	10.9	10.9	12.0	10.6	8.9
Reduce milk production	8.6	24.1	49.5	88.8	157.2	129.6	74.1	142.8	144.5
Total costs, FIM mill.	64.7	128.8	164.9	209.5	282.4	230.4	182.3	250.9	250.9

Source: National Board of Agriculture

also affected mainly milk production. According to the value of removed production, 100 percent in 1981-82 and 90 percent in 1983-89 of total payments in these programs is included (Table 6.1).

Since the contracts to reduce animal production made in 1984 concentrated on pig and poultry farms, the number of dairy cows abolished remained low (Table 6.2). Based on the value of the reduced output, *one third* of the costs of this program is included in the dairy restriction costs. The beef production contracts, mainly made already in 1980, are excluded due to their minor impact during the control period 1981-89.

The costs of the *mandatory* programs, e.g. administration or supervising, are not included. Dairy restrictions have been dealt with in more detail in Chapter 2.5.3 and they have been listed in Appendix 1.

Table 6.2. The number of dairy cows withdrawn from milk production in voluntary control programs in 1981-89.

Program	1981	1982	1983	1984	1985	1986	1987	1988	1989
Reduce agr. prod. and change prod. line 4§	4977	2350	859	1394	-	6524	3335	1620	1003
Change prod. line 4a§	13108	13261	-	-	-	-	-	-	-
Reduce animal prod.	-	-	-	3570	-	-	-	-	-
Reduce milk prod.	6700	5500	10600	25500	-	-	-	22000	-
Annual, heads	24785	21111	11459	30464	-	6524	3335	23620	1003
Accumulative, heads		45896	57355	87819	87819	94349	97684	121304	122307

Source: National Board of Agriculture

6.1.2. Costs of dairy surplus disposal

Export subsidies, stipulated in the Farm Income Act, belong to the surplus disposal costs. Subsidies are paid for the so called first stage dairy processing products, i.e. butter, cheese and milk powders.

In the wider sense, surplus disposal costs also include support on advertising of farm products, on butter sold to milk producers (expired in 1986) and industry, on storing and on milk used as feed. The profitability of the alternative channels to dispose of surpluses has been discussed in other connections (e.g. ANON. 1985b). The importance of the other forms decreased and that of export support increased in the examination period 1981-89.

Consequently, export support as an individual and distinct item appropriately illustrates the costs incurred due to overproduction of milk. The development of export quantities of dairy products is illustrated in Figure 6.1.

The appropriation in the state budget has been reserved for the surplus marketing of those farm products which have the stipulated target prices. The support, or subsidy, for exports is called the *price difference compensation*. It is the difference between the domestic price and received export price.

The government confirms the *guaranteed export price* for milk products (Table 6.3). Until the processing stage, the procedure mainly follows that of price formation of domestic prices. Thereafter, it is different. Compensation related to sales taxes on primary products, possible compensations for price reductions and the value of side products are subtracted from the target price of the liquid milk quantity used for dairy products. This sum equals to the raw material cost. Then, all costs caused by processing and marketing are added to the raw material cost, e.g. capital costs, estimated entrepreneur's risk and computational income tax are included. The final sum is the guaranteed export price.

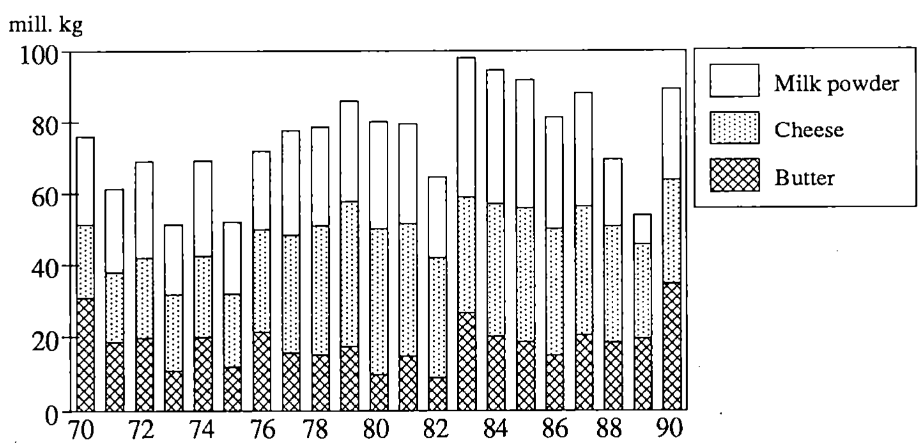

Figure 6.1. Export quantities of dairy products in 1970-90.
Source: Ministry of Trade and Industry.

Table 6.3. Formation of guaranteed export price for dairy products.

Components of guaranteed price	Butter FIM/kg	Emmental FIM/kg	WMP[1] FIM/kg
Whole milk	42.55	17.43	13.52
Skim milk for feed	-	+ 3.07	+ 1.81
Tax reduction (1.9 ·16%)	- 12.93	- 6.23	- 4.66
Side product value	- 10.68	- 0.41	-
Price reduction compensation	- 0.95	-	-
Raw material cost	17.98	13.86	10.67
Processing & wholesale	+ 8.14	+ 9.62	+ 5.62
Guaranteed export price	26.12	23.48	16.29

[1]) WMP = whole milk powder. Source: ANON. 1985b.

The guaranteed export price, as the computational domestic price, is compared with the export price to determine how big export subsidies are required. When the domestic price level is changed in the farm income settlements, the new guaranteed export prices are also confirmed. In 1991, the system of *fixed* price difference compensations was introduced. This system should promote a search for the best available export prices.

Export cost of milk is calculated as an average for the exported liter of milk. This procedure has been valid since the introduction of the production ceiling system in 1979. The calculation procedure is based on the coefficients, which express the quantity of milk used in processing of one product kilo according to the fat content of each product. The coefficient is 18.91 for butter (fat content 81.3 %), 6.73 for cheese (29 %), 6.15 for whole milk powder (26.4 %) and 0.14 for skim milk powder (0.5 %).

Table 6.4. Quantities and costs of dairy product exports in 1981-89.

Dairy exports	1981	1982	1983	1984	1985	1986	1987	1988	1989
Quantity[1], mill. kg	79.5	64.7	98.0	94.7	91.9	81.4	88.3	69.3	53.8
- converted[2] mill.l	714.6	542.7	891.2	845.4	824.5	721.6	806.6	674.6	586.6
Cost[3], FIM mill.	956.8	828.9	1518.7	1588.4	1686.1	1481.3	1740.5	1521.4	1276.7
- per unit, FIM/l	1.34	1.53	1.70	1.88	2.05	2.05	2.16	2.26	2.18
Price difference[4], FIM/l	1.32	1.52	1.69	1.90	2.23	2.37	2.35	2.28	2.38

[1]) includes butter oil; [2])conversion according to the fat content of dairy products; [3])includes sales tax support; [4]) difference between the domestic producer price and the world market price for milk

With the help of the coefficients, the unit export cost of a milk liter is derived (Table 6.4). The calculation is based on the statistics of the Ministry of Trade and Industry. For comparison, the difference between the domestic producer price of milk and the hypothetical world market price is also presented. The world market price is expressed as a so called reference price used in the PSE-calculations (OECD 1989).

The sales tax legislation was revised in 1982 along with the new Farm Income Act. The revision meant that the tax related to the sales tax support of primary products like milk was no longer returned to the state in connection with exports of these products. In the calculation of the guaranteed export price (see Table 6.3), the sales tax support reduced the raw material cost with its full weight. As a result, the guaranteed export prices as well as actual export support decreased. However, in the new arrangement part of export support is paid through the subsection of sales tax income (ANON. 1985b, p. 103). The sales tax support is additive to the export support appropriation. In this study, export costs uniformly include the sales tax support.

6.1.3. Costs of increased feed grain surplus

Production capacity of the restricted product often shifts to another product. In Finland, dairy restrictions are usually followed by *expanded feed grain production.* At least, the balance between domestic supply and demand for feed grain is deteriorated.

In particular, the production shift is realized in the milk bonus contracts and in the 4a§ contracts to change the production line. In these programs only cows need be removed, not arable land. Consequently, feed grain surpluses increase as demand for feed decreases due to cow slaughterings. The question is whether the savings due to the reduced dairy product surplus and export costs are adequate to offset the costs incurred due to the increased feed grain output.

As a rule of procedure, one slaughtered cow releases one hectare field. Due to the limited choice for production alternatives in Finland, the released hectare is usually transferred to feed grain production. However, this rule does not uniformly apply to all control programs affecting milk production. No reliable estimates of the released field area are available. A quite conservative approximation is made that half of the number of withdrawn dairy cows (see Table 6.2) corresponds to the increased feed grain area (in hectares). Output of this area is not consumed domestically.

The costs of the surplus feed grain output are determined according to the annual average yield and the difference between domestic and world market prices per kilogram of barley (Table 6.5). The variation in the unit export cost of barley is mainly caused by the volatility of world market prices, whereas the domestic price has increased steadily.

The inclusion of increased feed grain costs in the dairy control program costs is not free of speculation. Giving up milk production can lead to an increase in feed grain production, regardless of whether a farmer signs a contract to stop producing milk or not. To contribute to the examination of net effects of dairy programs, however, the inclusion of these indirect costs can be done without major inconsistencies.

Table 6.5. Effect of production capacity shift from milk to barley production due to the dairy restrictions.

Program effect	1981	1982	1983	1984	1985	1986	1987	1988	1989
Cows under contract in programs, heads[1]	24800	45900	57400	87800	78890	59200	39500	37700	44900
Acreage released, ha	12400	22950	28700	43900	3944	29600	19750	18850	22450
Barley yield, kg/ha[1]	1900	2960	3210	3050	2870	2910	1870	2360	3150
Export cost, FIM/kg[2]	0.44	0.56	0.77	0.81	1.07	1.31	1.46	1.41	1.18
Export cost, FIM mill.	10.4	38.0	70.9	108.5	121.1	112.8	53.9	62.7	83.5

1) Source: National Board of Agriculture; 2) Source: Ministry of Trade and Industry

6.2. Economic efficiency of a single voluntary dairy control program: the milk bonus contract

Because the contracts to reduce milk production (milk bonuses) are indisputably directed towards milk production alone, the efficacy assessment is made the most precisely for this very program. Moreover, the applicability of the fixed compensation payment used in the bonuses is better in the comparison than the percentage income compensation used in other programs.

The effect on production is obtained when the annual cash payment of the program is divided by the per liter compensation for the reduced milk production in the corresponding year. This computational procedure to derive the effect on production consistently acknowledges the overall program coverage in each year. Nevertheless, some ambiguity remains in assessing production reductions accurately for each year. This is because cows are abolished in different times during a year within the limits of the program. At the annual level, the effect on production is considered the same independent of the removal date. The total export cost corresponding to the reduced milk production due to the bonus program is calculated by multiplying the unit export cost (from Table 6.4) by the reduced production quantity.

The economic efficiency of the milk bonus program is indicated by the cost ratio of the program to surplus disposal, if the withdrawn milk output were exported (Table 6.6). The bonus program cost includes the implied increase in feed grain surplus. In addition to the cost ratio, the absolute cost difference is also presented.

There are several components affecting the efficiency of the milk bonus system. In the first place, variations in the economic efficiency depend on the level of administratively set compensation payment. The other component, export cost, is affected by the changes in the difference between the guaranteed export price and the received export price. When world market prices have dropped, export subsidies have increased. Consequently, relative profitability of production control programs has improved compared with surplus exports. Thirdly, a good harvest results in a heavier export cost burden

Table 6.6. Economic efficiency of the milk bonus system in 1981-89.

Bonus effects	1981	1982	1983	1984	1985	1986	1987	1988	1989
Program costs									
1. Compensation payments									
- unit, FIM/l	0.50	0.65	0.65	0.90	0.90	0.90	0.90	1.20	1.20
- total, FIM mill.	8.6	24.1	49.5	88.8	157.2	129.6	74.1	142.8	144.5
2. Withdrawn from production									
- milk, mill. liters	17.2	43.8	74.3	98.7	174.7	144.0	82.3	119.0	120.4
- cows, 1000 heads	3.9	9.7	15.6	20.6	36.3	29.2	16.8	23.8	23.0
3. Implied feed grain surplus cost, FIM mill.	1.6	8.0	19.3	25.4	55.8	55.7	22.9	39.6	42.7
4. Total, FIM million	10.2	32.1	68.8	114.2	213.0	185.3	97.0	182.4	187.2
Export costs									
5. Subsidy, FIM/l	1.34	1.53	1.70	1.88	2.05	2.05	2.16	2.26	2.18
6. Cost if withdrawn prod. exported, FIM mill.	23.6	68.3	128.5	189.5	365.1	302.4	181.1	268.9	262.5
Cost comparison									
7. Savings (6.-4.) FIM mill.	13.4	36.2	59.7	75.3	152.1	117.1	84.1	86.5	75.3
8. Ratio[1] (4./6.) %	43	47	54	60	58	61	54	68	71

1) the lower the ratio, the better the economic efficiency

through increased feed grain output. The fourth reason is the change in the structure of dairy product exports (see Figure 6.1). E.g. the export subsidy for a kilogram of butter was, on the average, double compared with that of cheese in the 1980s.

The costs (compensation payments) of the bonus contracts as such were clearly lower than the export costs corresponding to the same production quantity annually in 1981-89. On the average, the unit compensation in the bonus program was 40 percent of the unit export subsidy including sales tax support. As the increased feed grain surplus is added, the relative efficiency deteriorates to 57 percent.

The cost ratio indicates the minimum requirement for the net effect of the bonus program. If the program leads to a reduction in milk production of higher percentage than the ratio, control program is profitable for the state. For example, in 1989 the cost ratio indicated the lowest efficiency of 71 percent. It means that 71 percent of the reduced production should have been created by the very program to make it profitable for the state. The so called normal exits, only taking advantage of offered compensations, should have been rare.

The examination above is not adequate to determine the *net effect.* It ignores some important implications. Estimates on how many farmers actually quit because of the program alone and how many would have given up milk production in any case or how soon they would have done so are inadequate. Administration has estimated that the net effect of the voluntary control programs on milk production in 1981-84 was a reduction of only 10-20 percent (Anon. 1985a, p. 15). The estimation is based on the assumptions that the programs affected production with the full weight (net=gross=100 %) or not at all (net=0 %). The estimate means that 80-90 percent of the contracting farmers would also have given up production *without* contract opportunities.

The aforementioned estimation did not include the effect of contracts on temporal adjustment in terms of speeding up the decisions to quit production. If this is included, the degree of efficiency would increase. Instead of a one-year cross-section study based on approximations, a longer period and reliable statistics would be required to conduct a thorough study on the speeding-up effects.

6.3. Economic efficiency of the overall dairy control policy

The comparison of total costs is made between the observed production and predicted unrestricted production in the control period 1981-89. The actual program and export costs were already dealt with in Chapter 6.1.

Freely developed milk production is based on the composite forecast (Chapter 5.3). The cost of the predicted production consists of the export cost for that part of milk production which exceeds domestic consumption. It is calculated in the same relation as in the case of actual surplus. Thus, regardless of larger surpluses of uncontrolled production, it is assumed that 1) milk consumption does not alter, 2) the product structure of dairy exports remains stable, 3) expanding Finnish dairy exports do not affect world market prices and 4) legislation, e.g. in terms of the surplus marketing responsibility, is not revised. The cost comparison, ceteris paribus, is presented in Table 6.7.

Table 6.7. Costs caused by the actual controlled and predicted uncontrolled milk production in 1981-89.

Costs, FIM million	1981	1982	1983	1984	1985	1986	1987	1988	1989
Controlled production									
1. Program cost	65	129	165	210	282	230	182	251	251
2. Export cost, milk	957	829	1519	1588	1686	1481	1741	1521	1277
3. Export cost, feed grain	10	38	71	109	121	113	54	63	84
4. Total cost	1032	996	1755	1906	2090	1825	1977	1835	1611
Free production									
5. Export cost, milk	1211	1059	2043	2006	2706	2261	3145	3805	3076
Cost comparison									
6. Difference (5.-4.)	179	63	289	159	616	437	1168	1970	1465
7. Ratio[1] (4./5.) %	85	94	86	92	77	81	63	48	52

[1] the lower the ratio, the better the economic efficiency

The costs of the pursued agricultural policy affecting milk production were annually 48-94 percent of the costs of the predicted uncontrolled production, which is based on the composite forecast. On the average in 1981-89, the aggregated observed costs were 70 percent of the costs incurred by the predicted production. In other words, pursued policy with its production control measures was 30 percent more profitable, or less expensive, than if production had developed freely in the 1980s. In absolute terms, the difference varied between FIM 63 million in 1982 and FIM 1,970 million in 1988. Temporal allocation of exports impedes the comparison to some extent and is a significant source for the high variability in cost differences.

6.4. Conclusions

The profitability examinations made above are clear and their results are easy to interpret. They showed that dairy control policy has been profitable if compared to surplus disposal of the predicted uncontrolled production. In relation to costs incurred due to the predicted free milk production, the advantage of the overall dairy control policy in force improved continuously in the examination period 1981-89.

However, the advantage deteriorates, when the analysis is extended to take into consideration some often neglected factors impeding control effectiveness. Consequently, an attempt was made to examine the following aspects: 1) *net effects* of a particular measure, 2) shifts to and expanding surpluses of *other products* when one product is restricted, and 3) effects of *simultaneous compulsory measures*. However, in order to study thoroughly the factors, more accurate data are needed. Moreover, the social costs of control programs and surplus production should be taken into account in an economic efficiency analysis of farm programs. Taxes are collected to finance control programs or surplus exports. Taxation causes distortions elsewhere in the economy (BROWNING 1987; ALSTON & HURD 1990). If deadweight costs of taxation are ignored, misleading conclusions may result.

The examinations of a single voluntary dairy control program and the dairy control policy as a whole have been performed above. They are based on the supply analysis. In the next chapter, the welfare economics analysis is employed to assess the relative effectiveness of alternative compulsory control programs in the form of quantitative restrictions and price regulations.

7. Welfare effects of dairy control programs

The purpose of this chapter is to evaluate the *relative effectiveness* of different production control alternatives. The alternative programs are assessed according to their ability to achieve the politically set objectives for production control policy in particular and agricultural policy as a whole.

In order to show the welfare effects of different control programs, the approach of *surplus transformation* is employed (see Chapter 3.2.2). The central element of the approach is the surplus transformation curve (STC). Curves will be derived for each alternative program.

7.1. Empirical surplus transformation model

In the following, surplus transformation under linear supply and demand curves is examined. To quantify losses and gains for producers and consumer-taxpayers from alternative production control measures in Finland, demand D(Q) and supply S(Q) for milk are assumed to take the following linear functional forms with an assumption that $a_0>b_0>0$ and $a_1<0<b_1$:

(7.1) $$D(Q)=P^d=a_0+a_1Q^d$$

(7.2) $$S(Q)=P^s=b_0+b_1Q^s$$

The small country assumption is employed. Finland is only a small exporter/importer and is not able to affect world prices of any agricultural commodity. Thus, rest-of-world excess demand and excess supply functions are excluded in the model. But, were the object a large country, these functions should be included. This is because the slope of a surplus transformation curve depends on prices and elasticities in both domestic and foreign markets.

The major change in applied production policy and related control programs in the Finnish dairy sector was the introduction of the quota system in 1985 (see Chapter 2.5.3 and the efficacy analyses in the previous chapters). Hence, it is worth investigating how the quota system compares with other possible control measures in terms of welfare changes between producers and consumer-taxpayers.

In the following, welfare changes due to the quota system and two alternative measures are shown quantitatively. The alternative programs are producer price reduction and consumer subsidy. They can be considered means to achieve the politically set goal of improved balance between domestic production and consumption of milk. However, the measures result in different welfare changes of affected groups, as shown in the following examination.

In the general examination in Chapter 3.2.2, the starting point was the non-intervention situation. This is not valid in practice due to the entangled skein of extensive regulation. Consequently, an applicable starting point is the actual situation in milk production in 1985, the year when the quota system was launched in Finland.

First, demand and supply functions are determined. This can be done when price elasticities and any point in demand and supply schedule are known. In 1985, milk quantity supplied was Q^s=2,808 million liters, quantity demanded was Q^d=2,374 million liters, p=2.739 FIM/l was the price paid to suppliers (P^s) and paid by demanders of milk (P^d), i.e. $P^s=P^d$. These prices and quantities determine the actual situation, which is denoted by point A in Figure 7.1. In the analysis, price is in FIM per thousand liters and quantity in thousand liters.

The price elasticity of milk supply is the weighted mean of the short and long run elasticities from the estimated Equation 4.3 (p. 71): $e_s=(2/3)\cdot 0.39+(1/3)\cdot 0.73=0.50$. The stronger weight is placed on the short run response corresponding to the length of run of this welfare analysis.

The price elasticity of demand for milk, $e_d=-0.1$, is from ROUHIAINEN (1979). There are some ambiguities in selecting an aggregate price elasticity of demand for all milk consumed. For example, LAURILA's (1990) study indicates more price-elastic demand for individual dairy products than that of Rouhiainen. Because milk is processed to several different dairy products, the Almost Ideal Demand System (AIDS) would be a more consistent technique to estimate the price elasticity of demand (theory of the AIDS by DEATON & MUELLBAUER 1980; applications by EALES & UNNEVEHR 1988; MOSCHINI & MEILKE 1989). The AID-system applies data disaggregated by different products within a product group and their expenditure shares. But this estimation is a task for another study due to its high requirements for availability of data and time.

The parameter vector of the linear model includes four parameters: a_0, a_1, b_0, b_1. They can be estimated using the quantities, prices and elasticities indicated above. Through the price elasticity of demand, $e_d=(\partial Q^d/\partial P^d)\cdot(P^d/Q^d)=(1/a_1)\cdot(P^d/Q^d)$, the slope of the linear demand curve (a_1) is obtained: $a_1=(1/e_d)\cdot(P^d/Q^d)$. Using this result, it is noted that the demand curve intersects the vertical axis at $a_0=P^d-a_1Q^d$. In a similar manner, the parameters for the supply curve (b_0, b_1) are obtained. Hence, the demand and supply equations in the numeric form are, respectively:

$$(7.1a) \quad P^d = 30129 - 0.01154 \cdot Q^d$$

$$(7.2a) \quad P^s = -2739 + 0.00195 \cdot Q^s$$

Figure 7.1 shows this situation. Due to the relatively low price elasticity of supply, $e_s=0.5$, and the assumption of the linear supply function, the constant term b_0 is negative. This would mean that producers would be willing to produce a positive quantity of milk even if price were zero, $P^s=0$. An elasticity greater than unity would produce positive constant b_0. It is rational to operate only in the positive area between p- and q-axis, and thus the appropriate approximated producer surplus is *area dcba* in Figure 7.1.

Point E (Figure 7.1) is the equilibrium point. The non-intervention (equilibrium) price P^e can be derived under the linear demand and supply curves, when $D(P^e)$ is set to equal $S(P^e)$:

$$(7.3) \qquad P^e = \frac{-a_0/a_1 + b_0/b_1}{1/b_1 - 1/a_1} = 2.015\, FIM/liter$$

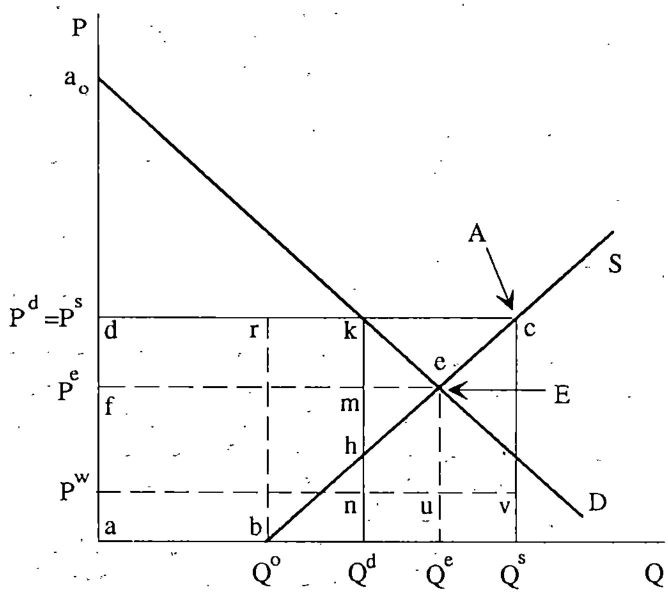

Figure 7.1. Milk market situation in 1985 in Finland.

This non-intervention price implies that domestic supply and demand of milk would have been in balance in 1985 at 2,437 million liters (Q^e). Moreover, according to the supply function, the approximated linear supply curve crosses the horizontal axis at Q^0, corresponding to 1,404 million liters.

To compare the effectiveness of production control measures, surpluses (CS^A and PS^A) for the actual situation in 1985 have to be calculated first. In principle, the areas for surpluses can be obtained through integration with respect to the estimated demand and supply equations regardless of the functional form. In the case of linear demand and supply curves, surpluses can be calculated through geometric areas. Consumer surplus, the *triangle a_0kd* above the price line and below the estimated demand curve, calculated in this way and realizing that $Q^d=0$ for $P^d \geq a_0=30129$ and $Q^d=(P^d-a_0)/b_1$ for $P^d<a_0$, is:

$$(7.4) \qquad CS^A = \tfrac{1}{2}(a_0 - P^d)\cdot Q^d = 32,512 \text{ million FIM}$$

In Finland, taxes are raised to finance the subsidized exports of the production in excess of domestic consumption. According to equation (3.12), taxes are subtracted from consumer surplus to result in combined consumer-taxpayer surplus, CTS=CS-TX. The unit tax is determined by the difference between the prevailing domestic price and the world market price, P^s-P^w. P^w is the reference price for milk used in the PSE-calculations (OECD 1989). The price difference is multiplied by excess supply, Q^s-Q^d, to get the total amount of taxes. The multiplication in 1985 results in TX^A, or *area kcvn*, and, consequently, CTS^A:

$$(7.5)\quad TX^A = (P^s - P^w)\cdot(Q^s - Q^d) = 962 \text{ million FIM}$$

$$(7.6)\quad CTS^A = CS^A - TX^A = 31,550 \text{ million FIM}$$

CTS^A is the combined consumer-taxpayer surplus for the milk market situation in 1985. According to the production and export ceilings, Finnish producers pay the export costs of the amount in excess of the ceilings. This amount should lower producer surplus, but due to the negligible nature of the excesses from 1985 onwards, taxes are included in CTS only. Hence, we assume non-producer taxpayers. When this procedure is applied consistently to each alternative measure, it does not distort the analysis. This is because the primary interest is in relative effectiveness of production control measures, not the absolute levels of surpluses.

In the case of estimated supply curve, the assumption $b_0>0$ is violated, and the approximated producer surplus is the *area abcd* in Figure 7.1. Consequently, producer surplus will be calculated through the areas of *rectangular drba* and *triangle rcb:*

$$(7.7)\quad PS^A = P^s \cdot Q^0 + \tfrac{1}{2}(Q^s - Q^0)\cdot P^s = 5,768 \text{ million FIM}$$

These two surpluses, CTS^A and PS^A, determine the actual market situation as point A in a surplus transformation framework in Figure 7.1.

In addition, using the equilibrium price P^e and quantity Q^e, the surpluses for the equilibrium point E (Figure 7.1) can be calculated. At E, PS^E is FIM 3,870 million *(area feba)*, and CTS^E is FIM 68,514 million *(area a_0ef)*. These surpluses are shown in the context of income redistribution efficiency in Figure 7.2. The 45° surplus transformation curve (STC) originating from point E (slope is $\partial PS/\partial CTS = -1$) represents the income redistribution and welfare changes without deadweight losses as explained in Chapter 3.2.

Now, with the specific functional form of demand and supply curves, the surplus transformation curves can be obtained for each program. The conceptual framework of general surplus equations derived in Chapter 3.2 is utilized. However, the equations have to be modified to meet the special characteristics of the Finnish dairy market.

7.2. Quota program

The surplus equations for the prevailing quota program are derived. The policy variable is the amount of milk output ($\bar{q}$) which producers are allowed to produce for the administratively set price (P^s). Quota is set $Q^d \leq \bar{q} \leq Q^s$.

Departing from the general approach (Chapter 3.2.2), in Finland the market price does not react to restrictions on supply. Hence, given $Q^d \leq \bar{q}$, CS^Q as such remains constant. But taxes affect the combined consumer-taxpayer surplus, CTS^Q. Taxes have to be included in the Finnish quota effect analysis due to excess supply situation. The surpluses are:

$$(7.8)\quad CTS^Q = CS^Q - TX^Q = \tfrac{1}{2}(a_0 - P^d)\cdot Q^d - (P^d - P^w)\cdot(\bar{q} - Q^d)$$

$$(7.9)\quad PS^Q = P^s \cdot \bar{q} - \tfrac{1}{2}S(\bar{q})\cdot(\bar{q} - Q^0)$$

In (7.8), when $\bar{q} = Q^d$, there are no taxes and CTS^Q equals solely CS^Q. This amount is also the maximum attainable CTS^Q. If production quota were lowered below the domestic consumption level, CS^Q would begin to decline due to restricted consumption possibilities. This occurs provided that the excess demand is not fulfilled by imports. In the case of producer surplus, the stricter the quota becomes, the faster PS^Q declines. This happens according to the second degree polynomial of (7.9).

The surpluses with known parameter values and expressed in monetary units are:

$$(7.8a)\quad CTS^Q = 37772.71\cdot 10^6 - 2216\bar{q}$$

$$(7.9a)\quad PS^Q = -1922.78\cdot 10^6 + 5477.96\bar{q} - 9754\cdot 10^{-7}\,\bar{q}^2$$

The surplus transformation curve for the quota program, STC^Q, can be determined by solving equation (7.8a) for $\bar{q}$, and substituting it in equation (7.9a) to yield the STC^Q as $PS^Q = f(CTS^Q)$:

$$(7.10)\quad PS^Q = -1919.47\cdot 10^8 + 12.53\cdot CTS^Q - 198.63\cdot 10^{-12}\cdot (CTS^Q)^2$$

The larger CTS^Q becomes, the faster PS^Q falls. In other words, the more consumer-taxpayers gain as the quota is tightened and excess production cut, the more producers lose, given constant price.

Next, the surplus transformation curve of the quota program, STC^Q, is traced out empirically for the examination of redistribution efficiency. In doing so, the quota is allowed to vary between the actual deliveries to the dairies (Q^s=2,808 mill. l.) and consumption (Q^d = 2,374 mill. l.) in 1985. The corresponding producer and consumer-taxpayer surpluses are calculated. The STC^Q is shown in Figure 7.2. The points A and E represent the corresponding points in Figure 7.1.

According to the estimated supply function, milk output equalling consumption of 2,374 million liters would have been produced for the price 1.892 FIM/l. This is 31 percent lower than the actual 1985 price. When quota is reduced in order to balance milk markets from the level of Q^s=2,808 million liters to the consumption level of Q^d=2,374 million liters, producer surplus decreases by *area kch* (ΔPS) in Figure 7.1. Consumer surplus remains the same. But taxes are eliminated due to the abolition of excess supply and subsequent export subsidies. The change in consumer-taxpayer surplus (ΔCTS) is *area kcvn* in Figure 7.1.

It is possible to use price as a means to achieve the market balance instead of direct output restriction in the form of quotas. Welfare effects of price regulation are assessed in Chapter 7.3.

7.3. Price regulation program

Price regulation is an alternative program for a quantitative means of a quota system in an attempt to balance the milk market. Now, price is the policy variable ($\bar{p}$). The price is set below the current producer price, but above the equilibrium price, i.e. $P^e \leq \bar{p} \leq P^s$. At any price quantities demanded and supplied are determined along the demand and supply curves, respectively. The surpluses in the price regulation program are:

$$(7.11) \quad CTS^P = CS^P - TX^P = \tfrac{1}{2}(a_0 - \bar{p}) \cdot D(\bar{p}) - (\bar{p} - P^w) \cdot (S(\bar{p}) - D(\bar{p}))$$

$$(7.12) \quad PS^P = \bar{p} \cdot Q^0 + \tfrac{1}{2} \bar{p} \cdot (S(\bar{p}) - Q^0)$$

The surpluses, with known parameter values, are:

$$(7.11a) \quad CTS^P = 38708 \cdot 10^6 - 1090614 \bar{p} - 555.95 \bar{p}^2$$

$$(7.12a) \quad PS^P = 1404040 \bar{p} + 256.305 \bar{p}^2$$

According to the surplus equations of second degree polynomial above, it is clear that a decline in price ($\bar{p}$) results in a consumer-taxpayer gain and producer loss.

In order to determine STC^P, the surplus transformation curve for price regulation program, (7.12a) is solved for the policy variable $\bar{p}$. Then, the solved variable is substituted into equation (7.11a) to yield CTS^P as a function of PS^P:

$$(7.13) \quad CTS^P = 33353.58 \cdot 10^6 + 1954858.97 \cdot \sqrt{7502121 + 0.0039 \cdot PS^P} - 2.17 \cdot PS^P$$

If producer surplus is lowered, the result according to equation (7.8) will be growing consumer-taxpayer surplus, but at a decreasing pace.

To trace out the STC^P empirically, $\bar{p}$ is allowed to vary between the non-intervention price P^e and the actual price $P^s = P^d$. Surpluses for producers and consumer-taxpayers are calculated at each price. Consumer price P^d is assumed to decline in direct proportion to producer price P^s.

The effect of the price drop is two-fold: production declines and consumption increases, given the elasticities $e_s = 0.5$ and $e_d = -0.1$. STC^P is shown in Figure 7.2. When price drops from the 1985 support level to the calculated non-intervention price, the change in producer surplus (ΔPS) is negative of *area dcef* (Figure 7.1). The change in consumer surplus (ΔCS) is *area dkef*. Taxes decrease from *area kcvn* at $P^s = 2.739$ FIM/l in the actual 1985 situation to nil at equilibrium with $P^e = 2.015$ FIM/l, given $D(P^e) = S(P^e)$.

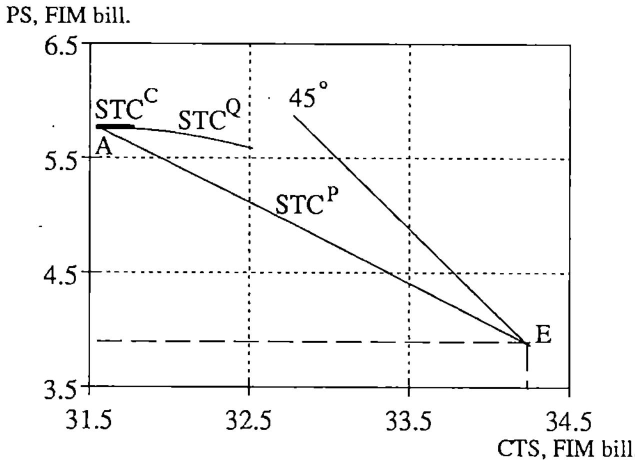

Figure 7.2. Surplus transformation curves of quota (STC^Q), price regulation (STC^P), and consumer subsidy (STC^C) in Finnish milk market in 1985.

7.4. Consumer subsidy program

Another alternative policy to balance the milk market is the consumer subsidy program. It is a modification of price regulation. The policy variable is again price, $\bar{p}$, but affecting consumers only. Producer price, produced quantity, and, consequently, producer surplus (PS^C) remain constant at the actual (A) level. As retail prices decline, consumption is enhanced and consumer surplus (CS^C) increased.

In terms of applicability, the basic problem in this program is the very inelastic demand (e_d=-0.1) for dairy products. Even though the domestic consumer price is lowered, demand does not respond adequately to absorb the prevailing excess supply. Taxpayers have to provide financing for subsidization of both domestic consumption and foreign exports. Consequently, consumer-taxpayer surplus starts stagnating as the gain in consumer surplus is offset by rapidly increasing taxes.

By letting consumer prices fall below the actual price P^d=2.739 FIM/l, i.e. $\bar{p} \leq P^d$, the surpluses can be calculated according to the following equations (note: producer surplus is constant):

$$(7.14) \quad CTS^C = \tfrac{1}{2}(a_0 - \bar{p}) \cdot D(\bar{p}) - \left[\left(P^s - \bar{p}\right) \cdot D(\bar{p}) + \left[\left(P^s - P^w\right) \cdot \left(Q^s - D(\bar{p})\right)\right]\right]$$

$$(7.15) \quad PS^C = P^s \cdot Q^0 + \tfrac{1}{2} \cdot (Q^s - Q^0) \cdot P^s = \tfrac{1}{2} \cdot P^s \cdot (Q^s + Q^0)$$

The surpluses, with known parameter values and expressed in FIM, are:

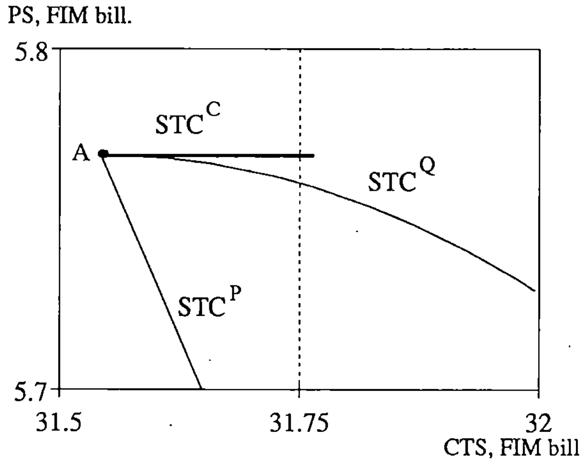

Figure 7.2a. Surplus transformation curves in the immediate vicinity of point A (different scaling in x- and y-axis).

$$(7.14a)\ CTS^C = 31750 \cdot 10^6 + 45330.44\bar{p} - 43.34\bar{p}^2$$

$$(7.15a)\ PS^C = 5768.33 \cdot 10^6$$

If the consumer price is lowered from the 1985 level to the calculated non-intervention price, the gain in consumer surplus (ΔCS) is *area dkef* (Figure 7.1). Taxes change from *area kcvn* in the original 1985 situation to *area dcvuef.*

With equations (7.14) and (7.15), the surplus transformation curve for the consumer subsidy program, STC^C, can be traced out. It is shown along with other STCs in Figure 7.2 and its enlargement Figure 7.2a.

7.5. Conclusions

Consumer subsidy program is basically superior to the other programs: STC^C is constantly above the other STCs (Figure 7.2a). However, the increase in CTS^C is quickly tapering off as taxes increase. The stagnation in CTS^C can be verified by the first order condition $\partial CTS^C/\partial\bar{p}=0$. The result is that CTS^C reaches its maximum FIM 31,762 million at $\bar{p}$=0.523 FIM/l. Thereafter, it starts to decrease. The maximum increase in CTS^C is only FIM 210 million.

The realistic area for operation for the consumer subsidy program is evidently close to point A. Beyond that point the program easily becomes an economically and politically infeasible solution because of high taxes and budget pressures. Were the price elasticity of demand higher, this program would produce considerable gains for consumer-taxpayers and maintain producers' welfare, thus possessing very attractive characteristics for agricultural policy.

The two other programs are more realistic. Quota (STC^Q) is more efficient than price regulation (STC^P) in income redistribution near the actual point A. This is because by a small reduction, if any, in producer surplus, a remarkably bigger gain is obtained in consumer-taxpayer surplus in the quota program. This is shown in Figure 7.2, in which STC^Q is above STC^P and closer to the 45°-curve of efficient redistribution.

However, as the distance extends further southeast from A to the point when $\bar{q}=Q^d$, STC^Q discontinues. This occurs because the gains for consumer-taxpayers diminish relatively as the balance between domestic production and consumption of milk is approached. The tax burden decreases along with diminishing export subsidies.

If a large decrease in PS and a considerable improvement in CTS is preferred, price reduction (STC^P) is a more suitable program than quota (STC^Q).

Hypothetically, if *quota* were set at 100 percent self-sufficiency in 1985, producer surplus would have decreased by FIM 184 million from the actual situation. However, consumer-taxpayer surplus would have increased by FIM 962 million due to the elimination of excess supply and subsidized exports. To achieve an improvement of the same magnitude in CTS in the *price reduction* program, PS has to decrease by FIM 660 million, i.e. 3.6 times more than in the quota program. In *consumer subsidy* program, such an improvement in CTS is never reached, because the growth rate of taxes is higher than that of CS (Chapter 7.3).

With respect to Finnish agricultural policy and its major goals, the quota system can evidently serve its purpose quite sufficiently. The quota program maintains producers' welfare at a higher level than the alternative price reduction program. Quantitative efficiency is improved if the aggregate quota is set appropriately to contribute to achieving the domestic milk market balance.

The performed surplus transformation analysis is intended to show the welfare changes and relative efficacy of alternative programs in income redistribution. The analysis does not take into account some important characteristics of quota systems, e.g. capitalization of quota rights and delimitations on structural development (OLLILA 1989; OECD 1990a). To incorporate these factors to the quantitative analysis is an obvious task for future research in this field.

With respect to farmers income goal, the quota system in particular represents a favorable political choice. Although expansion is constrained, production can be arranged the most efficient way within the allowed quota. In the case of overall price reduction, producers would have been worse off and consumers better off than in the quota system. Thus, additional evidence is gained of farmers' strong influence in the political decision making.

In general, the producer group is bound to lose some of its welfare due to any alteration of present agricultural policies. Accordingly, producers prefer the program of the least losses to programs of larger losses. Loss minimization was also the profound motivation in the adoption of milk quotas in the EC (Chapter 2.4 and PETIT et al. 1987).

At the moment, the pressure is on cutting agricultural expenses. Finding and promoting the programs of minor negative effects is an applicable strategy for producers in the current situation. The choice of increased producer surplus through larger output or higher prices is non-existing. However, there are other channels to maintain producers' welfare and redistribute income effectively. Direct (income) support is a relevant alternative to current farm programs. Unlike price support linked to output, direct support removes the incentive to increase output. Direct support also represents the most efficient income redistribution as a lump-sum type transaction (see Chapter 3.2.2).

8. Conclusions and synthesis of the results

The detailed assessment of the results obtained in the previous chapters is performed and applicable conclusions are drawn in this final chapter of the study.

First, adjustment of agriculture to control policy of various degrees of stringency is examined. Special attention is paid to the drawbacks and benefits of alternative forms of control programs in conjuncture with Finnish conditions. Secondly, potential alternatives are explored in order to alleviate the identified problems of emerging inflexibility and excessive expenses of the applied control measures and surplus disposal channels. Thirdly, the assessment of the correspondence of the general principles and realization of agricultural control programs to the control policy practiced in Finland complements the examination of adjustment and alternatives to control policy. Furthermore, the political economic analysis is applied to identify some of the central determinants of the pursued agricultural policy as a whole and its central component, control policy, in particular.

The quantitative evaluation of efficiency of dairy control programs in surplus management follows the aforementioned qualitative assessment. Efficacy of the prevailing quota system in income redistribution is compared to alternative measures of price reduction and consumer subsidy. In order to efficiently incorporate all information obtained in this study, a synthesis between the qualitative and quantitative approach is formed. Finally, the implications for further research are identified.

8.1. Adjustment of agriculture to control policy

Control policy is primarily intended to cut surpluses. However, the effects of control policy are much broader (Chapters 2 & 3). The adjustment process due to restrictions does not take place in milk production alone, but also in various groups related to it. Yet, the most direct effect has been that milk producers have had to change their production decisions. If there had been no restrictions, more milk would have been produced, ceteris paribus.

The nature of the pursued control policy determines to a large extent how the adjustment process in the restricted line of production takes place. In Finnish control policy, the voluntary nature and versatile means have been dominating (Chapter 2.5). It has been up to a farmer to decide whether to participate in control programs or not.

It has been possible for producers to take advantage of control programs. Temporary contracts could have been utilized to facilitate the necessary changes in rationalization of farms. Farmers who have been planning to quit or reduce production have received an economic incentive to make the decision. The social policy nature of voluntary control programs (e.g. Anon. 1985a, p. 41) has offered flexibility to decision making at the farm level.

The assumption of the utilization of the social policy nature of the control policy is supported by the change made in the retirement pension system in 1986 (Chapter 2.5.3). The change increased considerably the popularity of the system. In this case, the pension system obtained the characteristics of control policy. The situation has usually been the opposite, i.e. voluntary control programs have served the objectives of social policy.

Compulsory restrictions lead to more severe adjustment problems than voluntary ones. Mandatory programs limit freedom for producers' decisions. However, the degree of strictness is decisive.

The establishment permit system prevented development in milk production only in the case of the largest farms. The herd size subject to license was high compared with the average herd size. In 1980, 96 percent of dairy farms and 88 percent of cows were below the license limit (KOLA 1987, p. 41). The limits were made stricter only in the 1984 revision. However, the establishment regulation was substituted by the milk quota system already the next year.

The quota system did not force actual reductions in production, either. Primarily it prevented expansion. Producers were able to affect their quota quantity by producing high output during the years selected for the basic period. This opportunity was very likely to be utilized.

However, after the determination of the quota, the maximum output level for which a farmer receives a full price is fixed. The prevailing quotas prevent farmers from enlarging the herd size. In order to take economic advantage of technological development, the minimum requirement would be that the quota is adjusted to the annual increase in the milk yield per cow. The longer the quota system is in effect without any applicable flexibility, the more difficult adjustment problems become (also OLLILA 1989; OECD 1990a).

The major distinction between the mandatory programs of quotas and license system was that the latter allowed yield growth with the existing herd size. Quotas did not.

The adjustment of Finnish milk production to control policy has had two different aspects. Producers could have taken advantage of *voluntary* programs, whereas *compulsory* programs have restricted the sphere for producers' choices. However, severe adjustment problems have still been rare. Mandatory programs have been applied in an efficient way only since the 1985 quota system, and not very strictly even then.

In principle, the decision to shift from dominating voluntary programs to mandatory quotas in the mid-1980s represents as such a proof of perceived inefficiency of control policy mainly based on volunteering farmers. Economic efficiency of voluntary control programs to manage overproduction has suffered from the low *net effect* (Chapter 6). The output reduction brought about by voluntary programs has been offset by possibilities of non-participating producers to enlarge production and utilize productivity growth.

Mandatory programs are less expensive for the state. But they hinder rationalization process on farms. As the technological and structural development and the subsequent productivity improvement remain unobtainable, the overall economic efficiency of the pursued control policy deteriorates. It is difficult to quantify this trade-off between export cost savings and implied inefficacy in production.

The macroeconomic profitability of control programs improves if resources are released to more productive industries or additional resources are not tied to agricultural production (see Chapter 2). In terms of the national economy, production restrictions would work best if they prevent new investments to agriculture (KETTUNEN 1985, p. 63).

In a search to mitigate the evident problems and redirect effects of the applied control policy, the approaches applied and results obtained in this study are employed in the following evaluation of possible alternatives to control policy.

8.2. Alternatives to control policy and export subsidies

Control policy is used to curb surpluses of agricultural products. Surpluses are exported with the help of subsidies. Control policy and export subsidies have certain drawbacks presented in this study. Hence, it is expedient to seek alternatives for them.

The causal chain formulated in Chapter 2 indicated that prices above market equilibrium are fundamental reasons to surpluses. Accordingly, the prevention of surpluses could be realized by *price reduction*. However, this way has not been chosen. The reasons for rejection of price reduction mainly originate from the political economic characteristics of decision making process. Because of the income goal, the producer price of milk has not been lowered to contribute to a more balanced milk market.

Direct income support could be substituted for the prevailing price support. Direct support represents the decoupling approach, which aims at removing the incentive to increase returns through higher output. Financing of direct support programs occurs through taxation, whereas price support is financed by consumers in consumer prices of food. Taxation of a progressive nature may be perceived as a more just means than high prices for food. Consumers experience higher prices as a regressive tax.

Transparency of farm program costs increases in direct support. Taxpayers carry the costs of direct support and money flows through the state budget. It may result in more difficult decision making. Dependence on annual political decisions creates instability. Farmers' attitudes towards larger direct support have mainly been negative.

Although output linked price support has been the main form of agricultural support in Finland, programs corresponding to the concept of direct income support have also been practiced. The support paid according to the farm size represents closely the output neutral characteristics of direct income support (KETTUNEN 1991, p. 43).

In the framework of the agricultural policy reform, direct income support has been promoted as a favored means in future agricultural policy. Four main objectives of acceptable direct income support have been identified (OECD 1990a):

- structural adjustment
- income stabilization
- minimum income level for farm families
- provision of public goods (e.g. environmental benefits)

These objectives have been of great relevance in Finnish agricultural policy. However, the means to achieve the objectives should be revised into the direction of direct support not linked to output in order to meet the current requirements for policy reform.

The present price support could be modified to contribute to an attempt to achieve a more balanced milk market (see also OLLILA 1989). Through steeper stages in the *seasonal pricing* of milk, supply could be more evenly distributed throughout the year to meet demand in a better balance. Consequently, the need for a self-sufficiency clearly above 100 percent at an annual level would be reduced. In spite of the change in the seasonal pricing of milk, producers would receive the same average price at the annual level. To shift peak production to the indoor feeding season would raise production costs. Increased costs could be compensated during the transition period to farmers through income transfers from the saved export costs.

Another pricing technique is the stronger price *differentiation of fat and protein content.* This technique has already been used for the past couple of years. In the short run, the effects of the price differentiation are negligible. However, in the longer run, milk production can also be adjusted through this method to better correspond to consumption.

The overproduction of milk is subject to the declining trend in milk *consumption.* In Finland milk consumption has been and still is internationally at a high level. Therefore, the decline in consumption is expected to continue. The reduction in consumer price is commonly assumed to be an ineffective way to increase consumption considerably because demand for milk is very price inelastic. This hypothesis has been verified empirically in this study by the surplus transformation approach (Chapter 7).

Milk fat surpluses are especially problematic due to the changing consumer *preferences* towards low-fat products. Instead, fluid and protein intake has better prospects. Maubois (1986, p. 77) has concluded that milk protein consumption will grow globally due to its price advantage compared with meat and eggs, nutritional value and broad product assortment.

In addition to traditional food consumption, milk does not have *alternative uses* in the same way as, for example, grain has in non-food uses (see e.g. Buchholz 1985; Quadflieg 1986).

Investment in *product research and development* can contribute to introduction of new products which meet consumer preferences better. New products may also be more profitable in terms of exports. Yet, prospects for any considerable relief through consumption in fat surplus problem remain weak.

Restrictions on milk as well as other animal production has led to worse feed grain balance. Increased feed grain surpluses have deteriorated the profitability of control measures. *Decrease in arable land* area do not proceed at the same pace as the reductions in animal production would require. To respond to this phenomenon, the emphasis has recently been on intensifying fallow schemes.

Alternative crops not in surplus and also more profitable otherwise should be found to substitute for feed grains. The problem is that *production alternatives* are limited in the major milk producing areas in Finland. However, progressive research and development of alternative forms of production, processing and use could result in permanent and extensive new solutions.

Extensive production is an alternative solution to surplus problems. Surpluses could be reduced by lowering intensity of production with respect to chemical inputs in particular. An advantage of increasing importance of less intensive production is underlined in prevention of environmental problems. The choice has to be made between the ecological and economic direction (Weinschenck 1987; Nevala 1990). Extensive production can be a means to disentangle the skein of numerous regulations affecting agriculture at the moment. This approach would alleviate adjustment distortions caused by restrictions. Extensive production would contribute to favorable regional and social development in the countryside and secure operation possibilities of farming in the remote rural areas. Especially in Finland these issues have been stressed in agricultural policy.

Contract production represents a modification of supply management by government in an attempt to direct production towards more balanced markets. However, experience of the applicability of contract production as a real restrictive measure on production is limited. Contract production has primarily been applied to guarantee sufficient quality and quantity of products.

Basically, contract production only moves the responsibility of supply management from government to contracting parties themselves, i.e. producers and processors. Remarkable annual variation due to natural conditions impedes the applicability of contract production in Finland. However, in milk production variation is smaller. The smooth shift to contract production would be facilitated by the prevailing quota system. The role of farmers' marketing cooperatives in supply management would increase considerably (e.g. OLLILA 1989).

Only some alternatives which could substitute for control measures and surplus exports and reduce their drawbacks and costs have been evaluated here. The purpose of this chapter has not been a thorough analysis of all available alternatives. Rather, it has been an indicative suggestion to new possibilities.

8.3. Quantitative efficiency of dairy restrictions

The hypothesis for the quantitative examination of dairy control policy was that freely developed milk production would have been larger than the actual restricted production in the control period 1981-89. This was also the case. The free production would have been annually 130-626 million liters (4-24 percent) higher than the actual restricted production in the control period 1981-89 (Figure 8.1; see also Table 5.3).

It is worth noting that the free production would also have declined in the last years of the period. The uncontrolled production would have reached its turning point in 1985, i.e. two years later than the actual production. Milk production would have increased from 3,203 million liters in 1981 to 3,274 million liters in 1989, if there had been no restrictions in force.

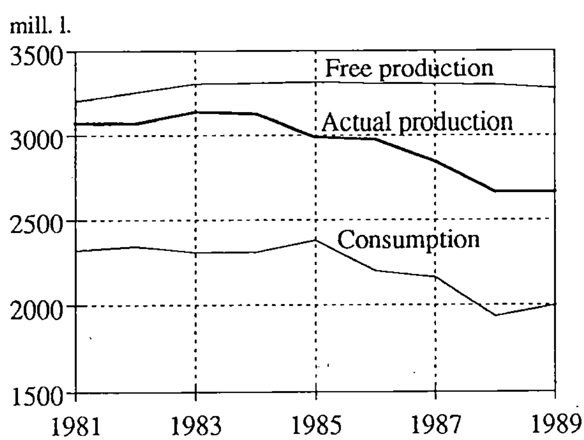

Figure 8.1. Actual controlled and predicted free milk production in 1981-89.

The predicted steady development in free production reflects the absence of incentives for further expansion. However, the difference between the actual controlled and the predicted uncontrolled production has grown considerably (Figure 8.1). According to the econometric model (Equation 4.3), the free milk production would have declined to the level of the actual production in 1989, if the real milk price had been lowered annually by 3 percent since 1980, ceteris paribus.

The effect of the restrictions on production was the most distinct in 1985 and 1988. Then the difference between the predicted free and actual restricted production expanded markedly. In 1985, the actual production was curtailed by the introduction of quotas in 1985 and the bonus contracts made in 1984. In 1988, the new contracts to reduce milk production contributed to a steep decline in the actual production. In 1987 the difference grew as the actual production suffered from the crop failure.

The inclusion of the variable describing technological development has contributed to the growth of the predicted free production. Restrictions have inevitably created technological inefficiency in the actual situation. According to the simulation, it is possible to conclude that the opportunity to rationalize free milk production would have facilitated larger increase in production than the declining real price of milk (see Figure 4.6) would have reduced it in 1981-89. In practice, this would have meant that expanding producers would have fulfilled and exceeded the reduction in production caused by the normal exits of e.g. old milk producers.

The results show that the *quantitative* efficiency of dairy control programs has improved significantly when approaching the 1990s. Compared to the uncontrolled production, the efficiency is especially good since 1985. The expensive disposal of dairy product surpluses has remained considerably smaller. Next, the question is asked whether the reduction in production has been reached with sufficient *economic* efficiency.

8.4. Economic efficiency of dairy restrictions

The combined control and export costs created by the overall dairy control policy were 48-94 percent of the export costs due to estimated free development in milk production in 1981-89 (Table 6.7). In the first years of the extensive application of voluntary control programs the economic efficiency was negligible. The cost advantage was only 6-15 percent in 1981-1984. However, the ratio improved continuously in the control period. In the last two years the costs of the pursued policy were half of the costs which would have incurred in the case of the predicted free production. On the average in the 1980s, the actual costs were 70 percent of the costs that would have been required to export the surpluses due to freely developed milk production.

In absolute terms (Figure 8.2), the cost difference was low until 1985 (FIM 63-289 million), moderate in 1985-86 (FIM 437-616 million), and large in the last three years (FIM 1,168-1,970 million).

Unlike the overall control policy, the profitability of milk bonuses as a single voluntary program has been in decline. The costs of the bonus contracts and increased feed grain surplus were annually 43-71 percent of the export costs of the milk quantity corresponding to the quantity reduced by the bonuses (Table 6.6). In absolute terms, the cost

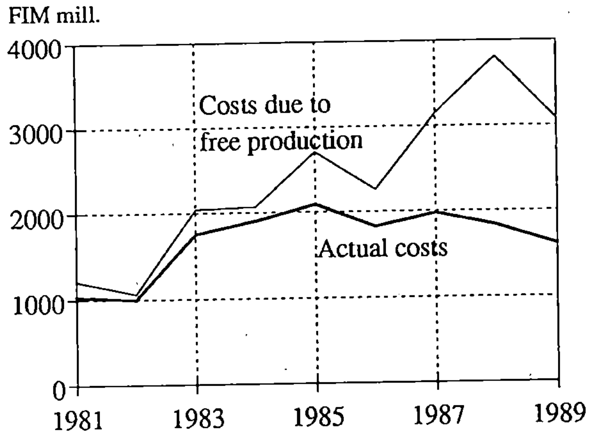

Figure 8.2. Costs incurred due to the actual controlled and predicted free milk production in 1981-89.

savings due to the milk bonuses were FIM 13-152 million. The peak was reached in 1985.

The major determinant of the economic efficiency of the bonus system has been the level at which the compensation payment is administratively set. The profitability of the program is the better, the lower the payment for a reduced milk liter has been set in relation to the unit export cost. Profitability would deteriorate if feed grain costs were assumed higher than was implied by the conservative approximation of the released field area after removal of dairy cows (Chapter 6.2).

The economic efficiency examination has shown in principle the gross effect of restrictions. The profitability is bound to deteriorate if the net effect is strictly considered. To perform this analysis more accurate data on farmers' intentions would have been required. Exact determination of the net effect is among the greatest problems in the estimation of the efficiency of control measures. It remains a potential object for future studies.

The free development would have led to higher export costs due to larger surpluses of dairy products. Production ceilings for milk would have been clearly exceeded. Provided that the Farm Income Act had been followed, however, farmers' responsibility of surplus marketing could only have been raised to the amount corresponding to the maximum limit stipulated in the Act. The threshold was 10 percent of the farm income in 1983-87 and 13 percent in 1988-89. In 1983-86 the export costs of the products exceeding the ceilings were already as high as 8.3-9.8 percent of the farm income (see Table 2.3).

Consequently, farmers' responsibility would have increased markedly only in 1987-89. Farmers would have had to pay FIM 300, 930 and 980 million in 1987, 1988 and 1989, respectively, more for larger milk surpluses.

Accordingly, the marketing responsibility of the state would also have increased in the absence of dairy restrictions. About half of the significantly larger export costs in 1987-89 would have devolved upon the government. A minor relief in cost burden would have been realized through lower feed grain surpluses due to higher feed needs of the uncontrolled larger milk production.

The 1982 Farm Income Act also stated that the appropriation amounting to 20 percent of the appropriations reserved for the export costs of agricultural products has to be reserved for the purposes of production control measures. Thus, larger production would have led to legislative problems along with various other consequences.

8.5. Efficiency of alternative control measures in income redistribution

The prevailing production quota system has been compared with the price regulation program and consumer subsidy program. The emphasis has been on evaluation of the capability of the alternative programs to achieve effectively a better balance between domestic consumption and production of milk.

The surplus transformation analysis has shown that the chosen mandatory quota system has resulted in more efficient income redistribution than the applicable alternative of price reduction program. Quota has caused smaller cuts than price regulation in farmers' welfare in relation to equal improvements in consumer-taxpayer welfare.

These results are in line with the findings of DE GORTER & MEILKE (1989) in the EC wheat market: a production quota (given the current support price) is considered as superior to a price reduction policy. The inelastic demand is the major factor behind the results. However, BULLOCK (1990) has questioned de Gorter's and Meilke's assertion and emphasized the need to account for existing distortions in related markets and the size of the income transfer.

If milk production quota had been set at 100 percent self-sufficiency in 1985, producer surplus would have decreased by FIM 184 million and consumer-taxpayer surplus would have increased by FIM 962 million. To reach an equal increase in consumer-taxpayer surplus in the price reduction program, producer surplus should have decreased by FIM 660 million, i.e. 3.6 times more than in the quota program.

The analysis indicated that consumer subsidy is not a very realistic alternative to reach a considerably better milk market balance. This is because the growing tax burden of remaining surpluses and consumer price subsidies quickly offsets the potential gains in the consumer surplus. The effects of the consumer subsidy program are particularly sensitive to the magnitude of the price elasticity of demand. More price responsive demand implies better applicability of the alternative.

The results of the surplus transformation analysis support the common argument that the producer interest has a strong weight in political decision making. Concerning this study in particular, producers have had enough influence to reach a favorable resolution in selection of control means in Finnish agricultural policy. As producer surplus in general was bound to decrease, the quota program with less adverse effects was preferred to programs resulting in drastic welfare losses to farmers.

The results also support the hypothesis (e.g. GARDNER 1983) of fundamental rationality of decision making. After all, decision makers may end up with efficient choices, given the political influence position of various pressure groups. The program is to be chosen which results in lower reductions in producer surplus but equal increases in consumer-taxpayer surplus than any available program.

8.6. Synthesis of the results and implications for future research

The major accomplishment of this study has been to incorporate a versatile and comprehensive assortment of methods to deal with the very central but little studied problem of production control efficacy. An attempt has been made to reach and utilize a synthesis between methods of different nature. Normative (welfare) and positive (econometrics) approach, qualitative (political economic analysis) and quantitative (efficiency analysis) approach, and volume (quantitative efficiency) and value (economic efficiency) examination have been applied. These approaches have contributed to a comprehensive assessment of the control policy as a whole and, in particular, in Finnish milk production. Hence, this study has provided important additional information to the calculations and approximations of control measures made in other connections.

The analyses performed through the chosen approaches and methods have made it possible to answer the questions set for the study in the following compact form:

1) the background and *principles of the control policy* are bound to the historical development and thereby implied fundamental goals of self-sufficiency, farmers' income level and rural population in Finnish agricultural policy and the wider context of social policy. This result has been achieved through the examination of the derived causal chain and decision making process.
2) the efficiency of the dairy control policy in curbing output and surpluses increased remarkably towards the end of the control period. Both quantitative and economic efficacy were low until 1985, but considerably higher in the last three years in particular. The introduction of the mandatory quota system in 1985 constituted a threshold after which expansion possibilities of future-oriented and efficient producers were eliminated. These results are based on the comparison between the actual milk production and the predicted uncontrolled milk production in 1981-89.

The qualitative political economic analysis has made it possible to conclude that producers have had political influence of sufficient strength to avoid the most unfavorable alternatives in surplus management, e.g. drastic price reduction or strict mandatory controls. The conclusion supports the argument (e.g. BECKER 1983) that governments try to correct market failures with the view that they favor the politically powerful. This means that politicians secure their job continuity by favoring the strongest groups. Strong groups are usually homogenous and well-organized, but not necessarily the most numerous in society. They are relatively the best potential sources of votes in elections.

In Finland agricultural producers as members of the only one and uniform farmers' union have formed this kind of source of votes. Due to these characteristics farmers have been able to obtain favorable political decisions. The historically unique position of agriculture as the supplier of essential consumer goods has helped in this pursuit.

Historical continuity and inertia in decision making evidently strengthen the tendency not to strain farmers more than necessary to prevent other interest groups from opposing the pursued agricultural policy too strongly. However, this procedure may invalidate the means that are intended to restrict production and cut surplus costs.

Although the examination of a single voluntary program (milk bonus in Chapter 6.2) indicated clear profitability, economic efficiency of voluntary control programs as a whole has remained ambiguous. Efficiency has suffered from the very dominant *voluntary nature* combined with relatively *high compensation* payments. The presumably low net effect due to direction of control programs to old small-scale farmers with *insignificant impact on output* has also eroded efficiency. In addition, the increase in *feed grain surpluses* and subsequent export costs have deteriorated efficiency.

Results are always subject to assumptions made and limitations faced in the evolution of research. The results of this study have to be interpreted with caution because of the following characteristics inherent in the analyses. First, there have been problems in variable selection in the estimation phase due to e.g. homogenous price development of agricultural products and declining trend in milk production. Secondly, economic welfare analysis is heavily dependent on the elasticities obtained from econometric supply and demand estimations. Thus, errors may have accumulated. Thirdly, potential changes in agricultural policy and legislation have not been taken into account. E.g. production ceilings and division of surplus marketing responsibility have been assumed unaltered, although milk production has been predicted to reach a remarkably higher level in the absence of control measures. Finally, instead of only qualitative examination of the decision making process in agricultural policy, the aim should be at quantitative empirical analysis.

Consequently, the need for further study is crucial in this very field of *political economic analysis* in terms of endogenizing government behavior, i.e. identifying variables which influence policy makers' decisions and quantifying their effects. It would enhance our understanding of agricultural policy and its very special nature.

Furthermore, the *surplus transformation analysis* applied in this study should be extended to include all market participants in addition to producers, consumers and taxpayers. E.g. manufacturers of inputs and processors of output need to be taken into consideration as well. Taxation required to finance farm programs causes distortions elsewhere in the economy. This aspect should also be included in the analysis of macroeconomic efficiency of income redistribution due to agricultural control programs. Only after these factors are incorporated in the analysis, a comprehensive quantitative analysis of the effects of the practiced control programs and their alternatives can be performed. But the shift from the partial equilibrium analysis to general equilibrium models is a complicated task to accomplish, indeed.

Summary

During the past few decades, agricultural products have been produced in excess of domestic consumption in Finland. As a result, production control programs have dominated in agricultural policy. However, the number of studies concerning control programs and their effects has been quite limited. This is especially true in the case of quantitative examination. One reason for this deficiency is the difficulty in carrying out the research, because the duration and form of control programs have varied greatly. Moreover, the availability of necessary data has often been impeded by the inadequate monitoring of programs.

In order to provide additional information about the effects of control policy the *objective* of this study has been the following:

1) to identify the principles and background of general control policy in agriculture.
2) to assess the quantitative efficiency of control policy in terms of production volume, and
3) to evaluate the economic efficiency of control policy in terms of the policy costs and income redistribution.

The first part is a qualitative general examination of control policy. The latter parts aim at quantifying the effects of control policy in Finland, and are confined to milk production, which is the main line of production in Finnish agriculture.

The pursued agricultural policy is a partial reason for *overproduction*. The central goals of agricultural policy in most countries have been self-sufficiency in food and adequate income for farmers. In order to achieve the goals, prices of agricultural products have been set above the equilibrium price determined by demand and supply. The high price level has been safeguarded through border protection and trade restrictions.

Overproduction has led to *ever-increasing costs* due to expensive surplus disposal. Because there has been no willingness or possibility to abandon price support the inevitable consequence has been extensive control policy. The nature of market competition and price formation has determined the background according to which the overproduction problem can be divided into two broad categories: 1) a price and income problem due to surpluses in free price formation, and 2) a budgetary cost problem due to surpluses in an administered market mechanism.

In Finland the expansion of government expenses due to overproduction has been the most essential reason for the pursued control policy. Numerous and versatile means to restrict production have been applied. Nevertheless, surpluses have persisted.

Control policy has been introduced to *correct the emerging distortions*, i.e. surpluses, caused by the pursued agricultural policy. A causal chain has been formulated to describe the objectives and means of agricultural policy leading to the application of control policy. The decision making process and the factors affecting the process have been evaluated in terms of the decisions made between price and supply management and between voluntary and mandatory control programs.

In the evaluation of the choices made, the historical background of Finnish agricultural policy and the fundamental goals determined through it have to be taken into account. Evolution of overall Finnish agricultural policy has also tied control policy to a context wider in scope than only agriculture. Control policy of predominating voluntary nature has had characteristics of social policy when it has offered a smooth means to withdraw from active agricultural production.

According to the qualitative *political economic analysis*, the conclusion can be drawn that producers have had political influence of sufficient strength to avoid the most unfavorable alternatives in surplus management. The marketing responsibility of surpluses has been divided between producers and the state. Cost increases have been fully compensated to agriculture according to the Farm Income Act and, accordingly, price development has been steady. Voluntary nature has dominated control programs.

The aforementioned characteristics of control policy support the argument that governments try to correct market failures with the view that they favor the politically powerful. Farmers as a homogenous and well-organized group have possessed considerable political influence in relation to other pressure groups, e.g. consumers. An attempt has been made to correct the market failure of over-supply of dairy products by quantitative restrictions of mainly voluntary nature, instead of price reductions.

Uniqueness of agriculture, historical continuity and inertia in decision making evidently strengthen the tendency not to strain farmers more than necessary to prevent other interest groups from opposing the pursued agricultural policy too strongly. The objective of maintaining food security, family farm structure and efficient utilization of forest resources has been accepted widely in the society. However, the decisions made in favor of producers may invalidate the means that are e.g. intended to restrict production and cut surplus disposal costs.

Control policy has had *diverse effects*. Directly, it has affected the volume and structure of production. Farm income, production costs, the number of agricultural population, processing and input manufacturing industries, foreign trade, budget outlays for agriculture and the national economy as a whole have been indirect objects of control policy. In this study, the quantitative examination has concentrated on the effects of dairy restrictions on production volume, surplus disposal costs and income redistribution.

In order to be able to examine the quantitative effect of control programs, the actual controlled development had to be compared with the hypothetical development without control measures. Hence, the *estimation of the supply function* for milk from the uncontrolled period has been the central part of the study. The estimation has formed the basis for the analysis of the efficacy of control programs.

A clear distinction between the free period and the controlled period had to be made for estimation of supply functions. The time period prior to 1981 has been chosen to represent the uncontrolled era in milk production. Accordingly, the time period 1981-89 has been the control period.

The econometric supply functions have been estimated from 1961-80. The best estimated function has included as explanatory variables the producer price of milk, labor cost, technological development and lagged milk production. The inclusion of the lagged dependent variable creates a partial adjustment model. The concept of partial adjustment indicates the inability of producers to reach a desired level of output.

In addition to a causal econometric supply model, a non-causal autoregressive integrated moving average (ARIMA) model has been estimated. In the estimation of the univariate time series model the annual data from 1931 through 1980 has been employed. A parsimonious ARIMA (1,1,0) model has been regarded as an adequate specification. The adopted model has confirmed the specification of the econometric model with lagged dependent variable.

The estimated supply functions have formed the basis for the analysis of the effects of control programs. In the *quantitative efficiency* examination the actual production of the controlled period 1981-89 has been compared with the predicted free production. The *composite prediction* of milk production has been formulated as a simple average of predictions provided by the separate econometric and ARIMA models. The predictions have been obtained when the estimated supply functions have been simulated to the control period 1981-89. The difference between the actual controlled and predicted uncontrolled production has been considered the effect of control measures.

In 1989, the predicted uncontrolled production would have been 600 million liters (23 %) larger than the actual restricted milk production. The difference varied annually from 4 to 24 percent (130-626 million liters). It is worth noting that milk production would have remained quite stable in the 1980s, if there had been no restrictions in force. According to the composite forecast, production would have been 3,203 million liters in 1981 and 3,274 million liters in 1989. The incentive to continuous expansion has obviously disappeared. However, the difference between the actual controlled and predicted free production has enlarged considerably as restrictions have curtailed the actual production.

The free production could have taken advantage of the technological development, whereas utilization of technology in the actual production has been restricted by mandatory control measures, i.e. quotas and establishment regulation.

The effect of the restrictions on production was the most distinct in 1985 and 1988. In 1985, the actual production was curtailed by the introduction of the mandatory quotas in 1985 and the voluntary bonus contracts made in 1984. In 1988, the contracts to reduce milk production contributed to a steep decline in the actual production, which was still affected by the crop failure in 1987.

The results indicate that, in comparison to the free production, the quantitative efficiency of dairy control programs has been especially significant since 1985. The expensive disposal of dairy product surpluses has remained considerably smaller as quotas have eliminated expansion possibilities.

The results of the production quantity examination, in turn, have formed the basis for the evaluation of the *economic efficacy* of overall control policy. In the economic efficiency assessment the costs incurred due to the dairy control policy have been compared with the cost of free development in milk production. The control policy costs have included program compensations, surplus exports and increased feed grain surplus due to dairy control programs. In addition to control policy as a whole, the economic efficacy assessment has also been made for an individual voluntary control measure.

The economic efficiency of the pursued *overall control policy* improved continuously in the control period 1981-89. In 1988 and 1989 the costs of the pursued policy were half of the export costs which would have incurred in the case of the free production. In the entire 1980s, the combined control and export costs created by the pursued policy were, on the average, 70 percent of the costs of the larger free production. The cost savings of surplus disposal were low until 1985 (FIM 63-289 million), moderate in 1985-86 (FIM 437-616 million), and large in the last three years (FIM 1,168-1,970 million).

The contracts to reduce milk production (so called milk bonus contracts) were chosen to represent a *single voluntary measure*.The achieved reduction in milk production has led to expenses in the form of compensation payments and increased *feed grain surplus*. These costs have been compared with the export costs of the amount of milk corresponding to the achieved reduction.

The costs of the bonus contracts and increased feed grain surplus were annually 43-71 percent of the export costs of the milk quantity corresponding to the quantity reduced by the bonuses in 1981-89.

Unlike the overall control policy, the profitability of bonuses was in decline. In absolute terms, the cost savings due to the milk bonuses were FIM 13-152 million. The peak was reached in 1985.

One of the greatest problems in the assessment of the exact efficiency of control measures has been the determination of the *net effect*. The full net effect is realized if the decision to reduce or give up production is solely made due to the contract offered by the state. The exact assessment of the net effect remains a topic for future studies particularly due to insufficient data.

The *surplus transformation analysis* has been applied to compare welfare and income redistribution effects of alternative control measures. The prevailing production quota system has been compared with the price regulation program and consumer subsidy program.

The surplus transformation analysis has shown that the chosen mandatory quota system has resulted in more efficient income redistribution than the applicable alternative of price reduction program. Quota has caused smaller cuts in farmers' welfare in relation to equal improvements in consumer-taxpayer welfare than price regulation. The analysis indicated that consumer subsidy is not a very realistic alternative to reach a significantly better milk market balance due to the price inelastic demand for milk.

The *adjustment process* of milk production to control policy has had two different aspects. On the one hand, producers could have taken advantage of voluntary programs. On the other hand, compulsory restrictions have weakened the possibilities to develop production and its structure.

During the examination period of this study, adjustment problems have not yet been severe. Compulsory restrictions have been applied in an efficient way only since the 1985 quota system. Yet, the longer the quota system is in effect without any flexibility, the more difficult adjustment problems become. As the technological development and the subsequent productivity improvement remain unobtainable, the overall economic efficiency of the pursued control policy deteriorates. It is difficult to quantify this trade-off between export cost savings and inefficacy in production due to the practiced control policy.

In this study some *alternative practices* to contribute towards a more balanced milk market have also been explored. The alternatives are intended to reduce the presented drawbacks of restrictions and excessive costs of surplus exports. The purpose of the examination has not been a comprehensive analysis of all available alternatives. Rather, it has been an indicative suggestion to new possibilities. The following potential solutions have been identified: 1) stronger price differentiation according to seasons and quality, 2) investment in research and development of dairy products, 3) contract production, 4) extensive production, and 5) direct income support.

The analyses performed in this study have made it possible to draw the following conclusions:

1) the background and *principles of the control policy* are bound to the historical development and thereby implied fundamental goals of self-sufficiency, farmers' income level and rural population in Finnish agricultural policy and the wider context of social policy, and
2) the *efficiency of the dairy control policy* in curbing output and surpluses increased remarkably towards the end of the control period. Both quantitative and economic efficacy were low until 1985, but considerably higher in the last three years. The introduction of the quota system in 1985 was an important factor in contributing to better efficiency and represented a decisive change from voluntary programs to a major mandatory control measure.

In this study, an attempt has been made to incorporate several approaches and methods to contribute to a comprehensive assessment of Finnish control policy in milk production. The quantitative assessment has provided further information about the efficacy of dairy control policy. The qualitative political economic analysis has offered a possible explanation of the behavior of the government and decision makers in pursuing agricultural policy.

The need for further study is evident in the political economic analysis and welfare analysis in the framework of surplus transformation. These novel approaches are quite unexplored in the agricultural economics research in Finland and they can be further extended from the application made in this study. The analyses of political economy and surplus transformation enhance general understanding of the conditions under which agricultural policies in practice are formulated and potential changes introduced, and contribute to more comprehensive assessment of the effects of agricultural policies.

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APPENDIX 1. PRODUCTION CONTROL MEASURES APPLIED IN 1969-1990 IN FINLAND.

Voluntary programs are listed in certain year according to their realization, i.e. if new contracts were made in that year. The measures which have affected milk production are printed in **bold** letters. Source: National Board of Agriculture.

Year	Control measure
1969	Soil bank Afforestation premiums
1970	Soil bank Afforestation premiums **Slaughter premiums for dairy cows**
1971	Soil bank Afforestation premiums **Marketing fees**: milk, wheat
1972	Soil bank Afforestation premiums **Marketing fees**: milk, wheat Additional marketing fees for large enterprises in pork and egg production
1973	Soil bank Afforestation premiums **Marketing fees**: milk, wheat Additional marketing fees for large enterprises in pork and egg production
1974	Soil bank Afforestation premiums **Marketing fees**: milk, wheat Pension system for farmers giving up production
1975	Afforestation premiums **Marketing fees**: milk, wheat, pork Pension system for farmers giving up production Establishment permits: pigs, hens
1976	Afforestation premiums **Marketing fees**: not collected Pension system for farmers giving up production Additional marketing fees for large enterprises in pork and egg production Establishment permits: pigs, hens Slaughter premiums for hens

1977 Afforestation premiums
Marketing fees: milk, pork, wheat
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, hens
Fallowing contracts
Contracts to change the production line (4§)
Restrictions on hatching
Licence system for poultry breeding animals

1978 Afforestation premiums
Marketing fees: milk, pork, wheat
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, hens, dairy and beef cattle
Fallowing contracts
Contracts to change the production line (4§)
Restrictions on hatching
Licence system for poultry breeding animals

1979 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, hens, dairy and beef cattle
Fallowing contracts
Contracts to change the production line (4§)
Restrictions on hatching
Licence system for poultry breeding animals
Production premiums for bread grain: wheat, rye

1980 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, hens, dairy and beef cattle
Fallowing contracts
Contracts to change the production line (4§)
Restrictions on hatching
Licence system for poultry breeding animals
Slaughter premiums for dairy cows (suffering from mastitis)
Production contracts for beef
Contracts to change the production line (4a§)

1981 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, hens, dairy and beef cattle
Contracts to change the production line (4§)
Restrictions on hatching
Licence system for poultry breeding animals
Production contracts for beef
Contracts to change the production line (4a§)
Contracts to reduce milk production (milk bonus)
Contracts to reduce egg production

1982 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, dairy and beef cattle
Contracts to change the production line (4§)
Restrictions on hatching
Licence system for poultry breeding animals
Production contracts for beef
Contracts to change the production line (4a§)
Contracts to reduce milk production (milk bonus)
Contracts to reduce egg production
Production premiums for bread grain

1983 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, dairy and beef cattle
Restrictions on hatching
Licence system for poultry breeding animals
Production contracts for beef: two-year terms
Contracts to reduce milk production (milk bonus)
Contracts to reduce egg production
Contracts to reduce pork production
Contracts to reduce agricultural production
Production premiums for rye

1984 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, dairy and beef cattle

Restrictions on hatching
Licence system for poultry breeding animals
Contracts to reduce milk production (milk bonus)
Contracts to reduce egg production: four-year terms
Contracts to reduce agricultural production
Contracts to reduce animal production
Fallowing contracts: three-year terms

1985 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, beef cattle
Restrictions on hatching
Licence system for poultry breeding animals
Production contracts for beef: term extensions only
Production quota system for milk

1986 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production: revised markedly
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, beef cattle
Restrictions on hatching
Licence system for poultry breeding animals
Production quota system for milk
Contracts to reduce agricultural production
Fallowing contracts
Production quota system for eggs

1987 Afforestation premiums: raised markedly
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, beef cattle
Restrictions on hatching
Licence system for poultry breeding animals
Production quota system for milk
Contracts to reduce agricultural production: old and young farmers
Fallowing contracts
Production quota system for eggs
Contracts to reduce egg production: five-year terms
Production contracts for beef
Land clearing charge

1988 Afforestation premiums
Marketing fees: pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, beef cattle
Restrictions on hatching
Licence system for poultry breeding animals
Production quota system for milk
Contracts to reduce agricultural production: old and young farmers
Fallowing contracts
Production quota system for eggs
Land clearing charge
Contracts to reduce milk production: five-year terms

1989 Afforestation premiums
Marketing fees: pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, beef cattle
Restrictions on hatching
Licence system for poultry breeding animals
Production quota system for milk
Contracts to reduce agricultural production: young farmers
Fallowing contracts: considerable expansion
Production quota system for eggs
Land clearing charge
Contracts to reduce egg production

1990 Afforestation premiums
Marketing fees: milk, pork
Pension system for farmers giving up production
Additional marketing fees for large enterprises in pork and egg production
Establishment permits: pigs, poultry, beef cattle
Restrictions on hatching
Licence system for poultry breeding animals
Production quota system for milk: temporary alleviations
Contracts to reduce agricultural production: young farmers
Fallowing contracts
Production quota system for eggs
Land clearing charge
Contracts to reduce egg production

APPENDIX 2. MATHEMATICAL APPENDIX TO COMPLEMENT THE SURPLUS TRANSFORMATION APPROACH.

Appendix 2a.

Derivation of marginal rate of surplus transformation: general functions.

The following presentation complements the framework developed in Chapter 3.2.2. *First*, marginal rate of surplus transformation for quota program, i.e. the slope of STC^Q, is derived. Consumer (CS) and producer (PS) surpluses due to restricted production $Q^r<Q_0$ are:

$$(A.1) \quad CS = \int_0^{Q^r} D(Q)dQ - D(Q^r)Q^r$$

$$(A.2) \quad PS = D(Q^r)Q^r - \int_0^{Q^r} S(Q)dQ$$

To find out the slope of STC^Q, (A.1) and (A.2) are differentiated by the policy variable Q^r:

$$(A.3) \quad \frac{\partial CS}{\partial Q^r} = D(Q^r) - \frac{\partial D(Q^r)}{\partial Q^r} \cdot Q^r - D(Q^r) = -\frac{\partial D(Q^r)}{\partial Q^r} \cdot Q^r$$

$$(A.4) \quad \frac{\partial PS}{\partial Q^r} = D(Q^r) - \frac{\partial D(Q^r)}{\partial Q^r} \cdot Q^r - S(Q^r)$$

The slope of STC is the relation between the change in PS and CS as CS changes due to policy variable. Consequently, (A.4) is divided by (A.3):

$$(A.5) \quad \frac{\partial PS / \partial Q^r}{\partial CS / \partial Q^r} = \frac{D(Q^r) - \left(\partial D(Q^r) / \partial Q^r\right) \cdot Q^r - S(Q^r)}{-\left(\partial D(Q^r) / \partial Q^r\right) \cdot Q^r}$$

To simplify this form, both numerator and denominator are multiplied, first, by $1/D(Q^r)$, and, second, by e_d. First, (A.5a) is obtained:

$$(A.5a) \quad \frac{\partial PS}{\partial CS} = -\frac{\dfrac{\partial D(Q^r)}{\partial Q^r} \cdot \dfrac{Q^r}{D(Q^r)} + \dfrac{D(Q^r) - S(Q^r)}{D(Q^r)}}{\dfrac{\partial D(Q^r)}{\partial Q^r} \cdot \dfrac{Q^r}{D(Q^r)}}$$

The second multiplication results in (A.5b):

$$(A.5b)\quad \frac{\partial PS}{\partial CS} = -\left[1 + \frac{D(Q^r) - S(Q^r)}{D(Q^r)} \cdot e_d\right]$$

The middle term in the brackets provides the price distortion parameter τ. Finally, the *slope of STC^Q* can be written as follows:

$$(A.6)\quad \partial PS / \partial CS = -1 - \tau(Q^r) \cdot e_d$$

According to (A.6), if there is no intervention (τ=0), the slope of STC^Q is -1. This would indicate no deadweight loss, i.e., a markka given up by consumers yields a markka gained by producers. In addition, STC^Q can be positively or negatively sloped depending on the magnitude of price distortion $\tau(Q^r)$ and the price elasticity of demand e_d.

Secondly, to find out the slope of STC^T in the target price program, the surplus equations (3.9, 3.10 and 3.11 presented in Chapter 3.2.2) are differentiated by the choice variable p^T:

$$(A.7)\quad \frac{\partial CS}{\partial p^T} = -D\left(p^d(p^T)\right) \cdot \frac{\partial\left(p^d(p^T)\right)}{\partial p^T}$$

$$(A.8)\quad \frac{\partial PS}{\partial p^T} = S(p^T), \quad where \quad S(p^T) = \frac{\partial}{\partial p^T}\left(\int_0^{p^T} S(p^T)dp^T\right)$$

$$(A.9)\quad \frac{\partial TX}{\partial p^T} = \left(1 - \frac{\partial p^d}{\partial p^T}\right) \cdot S(p^T) + (p^T - p^d) \cdot \frac{\partial S(p^T)}{\partial p^T}$$

The differentiated Equation (3.12), $\partial CTS/\partial p^T = \partial CS/\partial p^T - \partial TX/\partial p^T$, provides the following relationship to show the change in CTS due to the change in p^T:

$$(A.10)\quad \frac{\partial CTS}{\partial p^T} = \left[-D\left(p^d(p^T)\right) + S(p^T)\right] \cdot \frac{\partial p^d}{\partial p^T} - (p^T - p^d) \cdot \frac{\partial S(p^T)}{\partial p^T} - S(p^T)$$

The first term in the brackets yields zero, because $D(p^d(p^T)) = S(p^T)$. So, the slope of the surplus transformation curve (STC^T) for the price policy program is the change in producer surplus due to the change in consumer-taxpayer surplus:

$$(A.11)\quad \frac{\partial PS}{\partial CTS} = \frac{\partial PS / \partial p^T}{\partial CTS / \partial p^T} = \frac{S(p^T)}{-S(p^T) - \left((p^T - p^d) \cdot \partial S(p^T) / \partial p^T\right)}$$

Equation (A.11) can be simplified further as it is multiplied by $1/S(p^T)$, and the latter part of the denominator is multiplied by $p^T/p^T=1$:

$$(A.11a)\quad \frac{\partial PS}{\partial CTS}=\left[-1-\frac{p^T-p^d}{p^T}\cdot\left(\frac{\partial S(p^T)}{\partial p^T}\cdot\frac{p^T}{S(p^T)}\right)\right]^{-1}$$

These modifications produced the so called price distortion parameter, $\tau=(p^T-p^d)/p^T$, and the price elasticity of supply, $e_s=(\partial S(p^T)/\partial p^T)\cdot(p^T/S(p^T))$, which can be used to express the formula for the *slope of* STC^T in its final form:

$$(A.12)\quad \frac{\partial PS}{\partial CTS}=\left[-1-\tau(p^T)\cdot e_s\right]^{-1}$$

STC^T is always negatively sloped ($\partial PS/\partial CTS<0$), because $\tau>0$ and $e_s>0$. This means that producers always gain from higher price p^T, i.e. $\partial PS/\partial p^T=S(p^T)>0$.

Appendix 2b.

Derivation of surplus transformation curves: linear functions

The *slopes* of surplus transformation curves derived above are *generally* applicable, i.e. they hold for any functional form. However, with the *specific* functional form of demand and supply curves, the actual *surplus transformation curves* can be obtained for each program. The conceptual framework of general surplus equations derived in Chapter 3.2 is utilized, but the assumption of *linearity* is employed for demand and supply functions:

$$(B.1)\quad P^d=a_0+a_1Q^d$$

$$(B.2)\quad P^s=b_0+b_1Q^s$$

First, the surplus equations for the *quota* program are derived in the conditions of competitive market. In general, the surpluses resulting from production restriction are obtained by substituting the linear demand and supply equations for the general form Equations (3.5) and (3.6) in Chapter 3.2.2. Hence, the surpluses are:

$$(B.3)\quad CS=\int_0^{Q^r}(a_0+a_1Q^r)dQ-(a_0+a_1Q^r)\cdot Q^r$$

$$=a_0\cdot Q^r+\tfrac{1}{2}a_1\cdot(Q^r)^2-a_0\cdot Q^r-a_1\cdot(Q^r)^2=-\tfrac{1}{2}a_1\cdot(Q^r)^2$$

$$(B.4) \quad PS = (a_0 + a_1 Q^r)\cdot Q^r - \int_0^{Q^r}(b_0 + b_1 Q)dQ$$

$$= a_0 \cdot Q^r + a_0 \cdot (Q^r)^2 - b_0 \cdot Q^r - \tfrac{1}{2} b_1 \cdot (Q^r)^2$$

$$= (a_0 - b_0)\cdot Q^r + (a_1 - \tfrac{1}{2} b_1)\cdot (Q^r)^2$$

STC^Q for the quota program is determined as a function PS=f(CS) by solving (B.3) for Q^r. It produces $Q^r=(-2CS/a_1)^{1/2}$. Now, Q^r is substituted in (B.4) to yield an equation for STC^Q:

$$(B.5) \quad PS = (a_0 - b_0)\cdot \sqrt{-2CS/a_1} + \left[(a_1 - \tfrac{1}{2} b_1)\cdot(-2CS/a_1)\right]$$

Secondly, surplus transformation curve for the *price policy* program can be derived the same way as STC^Q above. STC^T will be expressed as a function CTS=f(PS). The surplus equations in the price policy program are:

$$(B.6) \quad CTS = (a_0 - b_0)\cdot Q^r + (\tfrac{1}{2} a_1 - b_1)\cdot (Q^r)^2$$

$$(B.7) \quad PS = \tfrac{1}{2} b_1 \cdot (Q^r)^2$$

Equation (B.7) is solved for Q^r, which produces $Q^r=(2PS/b_1)^{1/2}$. Now, Q^r is substituted in (B.6) to yield the surplus transformation curve for the price policy program, STC^T:

$$(B.8) \quad CTS = (a_0 - b_0)\cdot \sqrt{2PS/b_1} + \left[(\tfrac{1}{2} a_1 - b_1)\cdot(2PS/b_1)\right]$$

Appendix 2c.

Derivation of empirical surplus equations

In the following, the surplus equations are algebraically derived and they are also shown in a numeric form, given the known parameters estimated in Chapter 7.

First, the producer surplus (PS^Q) and the combined consumer-taxpayer surplus (CTS^Q) for the quota program are presented ($\overline{q}$ is the policy variable):

$$(C.1) \quad CTS^Q = CS^Q - TX^Q = \tfrac{1}{2}(a_0 - p)\cdot Q^d - (p - p^w)\cdot(\overline{q} - Q^d)$$

$$= (\tfrac{1}{2} a_0 + \tfrac{1}{2} p - p^w)\cdot Q^d - (p - p^w)\cdot \overline{q} = 37772.71\cdot 10^6 - 2216\overline{q}$$

$$(C.2)\quad PS^Q = p\cdot\bar{q} - \tfrac{1}{2}S(\bar{q})\cdot(\bar{q}-Q^0) = p\cdot\bar{q} - \tfrac{1}{2}(b_0 + b_1\cdot\bar{q})\cdot(\bar{q}-Q^0)$$

$$= \tfrac{1}{2}b_0\cdot Q^0 + (p + \tfrac{1}{2}b_1\cdot Q^0 - \tfrac{1}{2}b_0)\cdot\bar{q} - \tfrac{1}{2}b_1\cdot\bar{q}^2$$

$$= -1922.78\cdot 10^6 + 5477.96\bar{q} - 9754\cdot 10^{-7}\,\bar{q}^2$$

The surplus transformation curve, STC^Q, for the quota program can be determined as a function PS=f(CTS) by solving equation (C.1) for $\bar{q}$, and substituting it in Equation (C.2). From (C.1) $\bar{q}$ is:

$$(C.3)\quad \bar{q} = \frac{CTS^Q - (\tfrac{1}{2}a_0 + \tfrac{1}{2}p - p^w)\cdot Q^d}{p^w - p} = 17045448.56 - \frac{CTS^Q}{2216}$$

Now, let us substitute it for $\bar{q}$ in PS^Q-equation (C.2) to yield the STC^Q as PS^Q=f(CTS^Q):

$$(C.4)\quad PS^Q = -1919.47\cdot 10^8 + 12.53\cdot CTS^Q - 198.63\cdot 10^{-12}\cdot(CTS^Q)^2$$

Secondly, the surpluses in the *price regulation* program are ($\bar{p}$ is the policy variable):

$$(C.5)\quad CTS^P = CS^P - TX^P = \tfrac{1}{2}(a_0 - \bar{p})\cdot D(\bar{p}) - \left[(\bar{p}-p^w)\cdot(S(\bar{p}) - D(\bar{p}))\right]$$

$$= \tfrac{1}{2}(a_0 - \bar{p})\cdot(\bar{p}-a_0)/a_1 - \left[(\bar{p}-p^w)\cdot((\bar{p}-b_0)/b_1 - (\bar{p}-a_0)/a_1)\right]$$

$$= \tfrac{1}{2}(2a_0\bar{p} - a_0^2 - \bar{p}^2)/a_1$$
$$-\left[(\bar{p}^2 - p^w\bar{p} - \bar{p}b_0 - p^w b_0)/b_1 - (\bar{p}^2 - p^w\bar{p} - \bar{p}a_0 - p^w a_0)/a_1\right]$$

$$= \left(\frac{1}{2a_1} - \frac{1}{b_1}\right)\bar{p}^2 + \left(\frac{b_0 + p^w}{b1} - \frac{p^w}{a_1}\right)\bar{p} + \left(\frac{2p^w a_0 - a_0^2}{2a_1} - \frac{p^w b_0}{b_1}\right)$$

$$= 38707.95\cdot 10^6 - 1090613.78\bar{p} - 555.95\bar{p}^2$$

$$(C.6)\quad PS^P = \bar{p}\cdot Q^0 + \tfrac{1}{2}\bar{p}\cdot\left(S(\bar{p}) - Q^0\right) = \bar{p}\cdot Q^0 + \tfrac{1}{2}\bar{p}\cdot\left(\frac{\bar{p}-b_0}{b_1} - Q^0\right)$$

$$= \bar{p}\cdot Q^0 + \left(\tfrac{1}{2}(\bar{p}^2 - \bar{p}\cdot b_0)/b_1\right) - \tfrac{1}{2}\bar{p}\cdot Q^0$$

$$= \left((\tfrac{1}{2}Q^0 - \tfrac{1}{2}b_0/b_1)\cdot\bar{p}\right) + (1/2b_1)\cdot\bar{p}^2$$

$$= 1404000\bar{p} + 256.31\bar{p}^2$$

To determine STC^P, the surplus transformation curve for the price regulation program, Equation (C.6) is solved for the policy variable $\bar{p}$ to yield:

$$(C.7)\quad \bar{p} = \tfrac{1}{2}\cdot\left[-(b_1\cdot Q^0 - b_0) \pm \sqrt{(b_1\cdot Q^0 - b_0)^2 + 8b_1\cdot PS^P}\right]$$

$$= -2739 \pm \sqrt{7502121 + 0.0039 PS^P}$$

When $\bar{p}$ is replaced in Equation (C.5) by its numeric expression above (assuming $\bar{p}>0$), CTS^P is obtained as a function of PS^P. This is the *STC^P:*

$$(C.8)\quad CTS^P = 33353.58\cdot 10^6 + 1954858.97\cdot\sqrt{7502121 + 0.0039\cdot PS^P} - 2.17\cdot PS^P$$

Finally, the surplus equations for the *third* alternative program, *consumer subsidy* ($\bar{p}$ is the policy variable), are presented:

$$(C.9)\quad CTS^C = CS^C - TX^C = \tfrac{1}{2}(a_0 - \bar{p})\cdot D(\bar{p})$$
$$-\left[(p^s - \bar{p})\cdot D(\bar{p}) + \left((p^s - p^w)\cdot(Q^s - D(\bar{p}))\right)\right]$$

$$= \tfrac{1}{2}(a_0 - \bar{p})\cdot D(\bar{p}) - p^s\cdot D(\bar{p}) + \bar{p}\cdot D(\bar{p}) - p^s\cdot Q^s$$
$$+ p^s\cdot D(\bar{p}) + p^w\cdot Q^s - p^w\cdot D(\bar{p})$$

$$= (\tfrac{1}{2}a_0 + \tfrac{1}{2}\bar{p} - p^w)\cdot D(\bar{p}) - (p^w - p^s)\cdot Q^s$$

$$= (\tfrac{1}{2}a_0 + \tfrac{1}{2}\bar{p} - p^w)\cdot\left[\frac{\bar{p} - a_0}{a_1}\right] - (p^w - p^s)\cdot Q^s$$

$$= \frac{1}{2a_1}(a_0\bar{p} - a_o^2 + \bar{p}^2 - \bar{p}a_0) - \frac{1}{a_1}(p^w\bar{p} - p^w a_0) - (p^w - p^s)\cdot Q^s$$

$$= \frac{1}{2a_1}\cdot\bar{p}^2 - \frac{p^w}{a_1}\cdot\bar{p} + \left[\frac{2p^w a_0 - a_0{}^2}{2a_1} - (p^w - p^s)\cdot Q^s\right]$$

$$= 31750\cdot 10^6 + 45330.44\bar{p} - 43.34\bar{p}^2$$

$$(C.10)\quad PS^C = p^s\cdot Q^0 + \frac{(Q^s - Q^0)\cdot p^s}{2} = \frac{p^s\cdot(Q^s + Q^0)}{2} = 5768.33\cdot 10^6$$

In the consumer subsidy program, PS^C remains constant. Hence, CTS^C as such represents the surplus transformation curve of the consumer subsidy program, *STC^C*.

APPENDIX 3. DATA USED TO ESTIMATE SUPPLY FUNCTIONS

Year	Q^m	P^m	P^b	P^L	Feed	Crop	PPindex
1960	3384.0	33.91	2.54	1.17	12.66	18.95	13.80
1961	3519.9	33.81	2.76	1.22	12.57	17.81	13.70
1962	3537.5	34.15	2.66	1.25	12.96	16.85	13.90
1963	3648.5	36.51	2.63	1.41	13.99	17.68	14.50
1964	3714.6	41.77	2.55	1.60	15.12	16.17	15.70
1965	3655.7	45.35	3.14	1.84	15.98	18.81	17.40
1966	3581.8	45.88	3.81	2.05	16.54	18.38	17.90
1967	3455.7	48.51	3.98	2.24	17.98	19.23	18.70
1968	3491.4	56.78	4.63	2.43	19.43	20.30	21.10
1969	3494.6	57.34	4.89	2.63	19.73	19.34	21.90
1970	3313.7	56.02	5.56	2.94	19.76	22.21	22.30
1971	3197.5	59.08	5.99	3.43	20.26	23.25	23.10
1972	3189.9	66.44	7.04	4.15	20.91	24.16	25.60
1973	3107.3	73.22	8.28	5.27	23.96	22.44	28.90
1974	3055.9	90.17	8.87	6.60	29.43	22.41	33.50
1975	3065.7	114.95	11.15	8.40	35.46	22.90	42.00
1976	3176.0	137.09	11.51	9.90	41.57	25.60	47.60
1977	3130.4	144.79	14.27	11.06	50.64	22.18	51.20
1978	3124.9	155.15	14.66	12.29	49.57	23.36	54.00
1979	3141.1	167.65	15.54	13.83	49.38	24.37	57.30
1980	3173.6	184.23	17.69	15.39	53.72	24.51	64.30
1981	3072.9	203.06	19.59	17.19	65.55	20.47	72.40
1982	3064.4	229.59	22.22	19.27	74.21	24.58	82.60
1983	3135.8	248.21	24.01	20.76	84.76	27.65	88.00
1984	3123.7	261.74	25.84	23.38	95.27	26.85	93.60
1985	2987.5	273.91	27.62	25.29	100.00	26.31	100.00
1986	2975.6	277.48	28.28	26.95	98.00	26.80	101.80
1987	2846.9	284.18	28.77	28.50	102.10	19.92	103.40
1988	2667.5	293.67	30.62	30.64	105.00	23.35	107.20
1989	2667.6	313.58	32.86	34.21	109.40	27.00	111.50

Q^m = milk production, million liters
P^m = producer price of milk, p/l
P^b = producer price of beef, FIM/kg
P^L = average pay of hired labor, FIM/h
Feed = industrial feed price index, 1985=100
PPindex = producer price index, 1985=100
Crop = combined yield of barley, hay and silage, hundred feed units per hectare

Q^m in 1931-1960:

1931	2194	1936	2437	1941	1699	1946	1573	1951	2583	1956	2917
1932	2194	1937	2544	1942	1578	1947	1573	1952	2709	1957	3024
1933	2282	1938	2592	1943	1602	1948	1748	1953	2777	1958	3038
1934	2291	1939	2573	1944	1608	1949	2262	1954	2786	1959	3194
1935	2350	1940	2039	1945	1578	1950	2524	1955	2689	1960	3384

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