UNIVERSITY OF MANCHESTER

FACULTY OF ECONOMIC AND SOCIAL STUDIES

DEPARTMENT OF AGRICULTURAL ECONOMICS

AN ECONOMIC AND STATISTICAL ANALYSIS OF ADVERTISING IN THE MARKET FOR MILK AND DAIRY PRODUCTS IN THE U.K.

by

John Strak and Len Gill

BULLETIN NO: 189 JULY 1983 *Price:* £5.00

AN ECONOMIC AND STATISTICAL ANALYSIS OF ADVERTISING IN THE MARKET FOR MILK AND DAIRY PRODUCTS IN THE U.K.

A bulletin prepared by John Strak and Len Gill based on work done for the Milk Marketing Board of England and Wales and the National Dairy Council

July 1983

Statistics with a limited validity should not be presented in such a way as to imply that their validity is greater than it really is.

Section 5.3, The British
Code of Advertising Practice
(Fourth Edition, 1970)

Economic analysis of the effectiveness of generic advertising of food products has been relatively neglected in view of the scale of such advertising. In part this neglect may have been due to the inherent difficulties of quantitative assessment of the impact of advertising. In this study of milk advertising John Strak and Len Gill have demonstrated that it is eminently possible to make a rational quantitative estimate of such effects.

The study has entailed devising a theoretical framework for measuring the economic returns to generic and brand advertising, and this in a way which examines such returns from the separate viewpoints of milk producers, and of milk processors. In itself this is a substantial step forward which paves the way for extending analysis to advertising on other products. In addition the study has significantly advanced the econometric arts of measuring the effects of advertising. Together, these two areas of progress in this study indicate the scope which exists for rationalising the management of commodity advertising programmes, and it is to be hoped that this will be built upon.

The Milk Marketing Board and Milk Publicity Council are to be applauded for allowing their advertising programme to be examined in this intense way. They are to be further applauded for allowing the results of the study to be published in full in this Bulletin, and thus for enabling the possibilities which it promises to be more widely disseminated.

David Colman
Professor and Head of Agricultural
Economics Department.

Foreword

In setting out to achieve the objectives of the research proposal on milk advertising[1] originally supported by the Milk Marketing Board of England and Wales and later, by the National Dairy Council, we have, of necessity, coversed with a large number of people. Some of these were our colleagues at Manchester in the Department of Agricultural Economics and Department of Econometrics. Others were relative strangers at the Board, the NDC, and a variety of advertising agencies. To all of them we owe a debt of gratitude for their help and interest.

We are grateful to Professor Wat Thomas and Mr. Roland Williams for their support for the original proposal and as it developed once the work commenced. Special thanks are due to Paul Allsop and Nigel White at the Board who took the burden of answering a multitude of questions about the Board, its involvement with advertising and related matters of interest, and supplied an endless stream of data. Similarly, we are grateful to Ericq Horler for the various modifications and extensions he incorporated in the computer program PRODUCE, requested by ourselves in an attempt to improve the econometric analysis.

This report on the work done has been written assuming a certain amount of background knowledge about the Board's various advertising activities in different produce markets. The text of the bulletin leads directly into a discussion of the work done at Manchester and the conclusions reached. Hopefully, the thoughts expressed within this bulletin will provide a useful stimulus to all those at the Board and the National Dairy Council who have an interest in making optimal decisions about the size of advertising budgets, and to others engaged in similar analysis and decisionmaking about advertising in different product markets.

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1. "An Investigation of the Appropriate Guidelines for Generic Advertising Policy for Milk and Milk Products in the U.K." A research proposal produced by John Strak, April 1979.

Finally, thanks are also due to Jennifer Vaughan and Judy Darnton for their tireless efforts to produce a typed manuscript, and their help in transforming the final report into a departmental bulletin. Of course, they and all the other individuals or organizations mentioned are not accountable for any errors or views that are presented in this bulletin. These remain our sole responsibility.

John Strak Len Gill

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CHAPTER 1

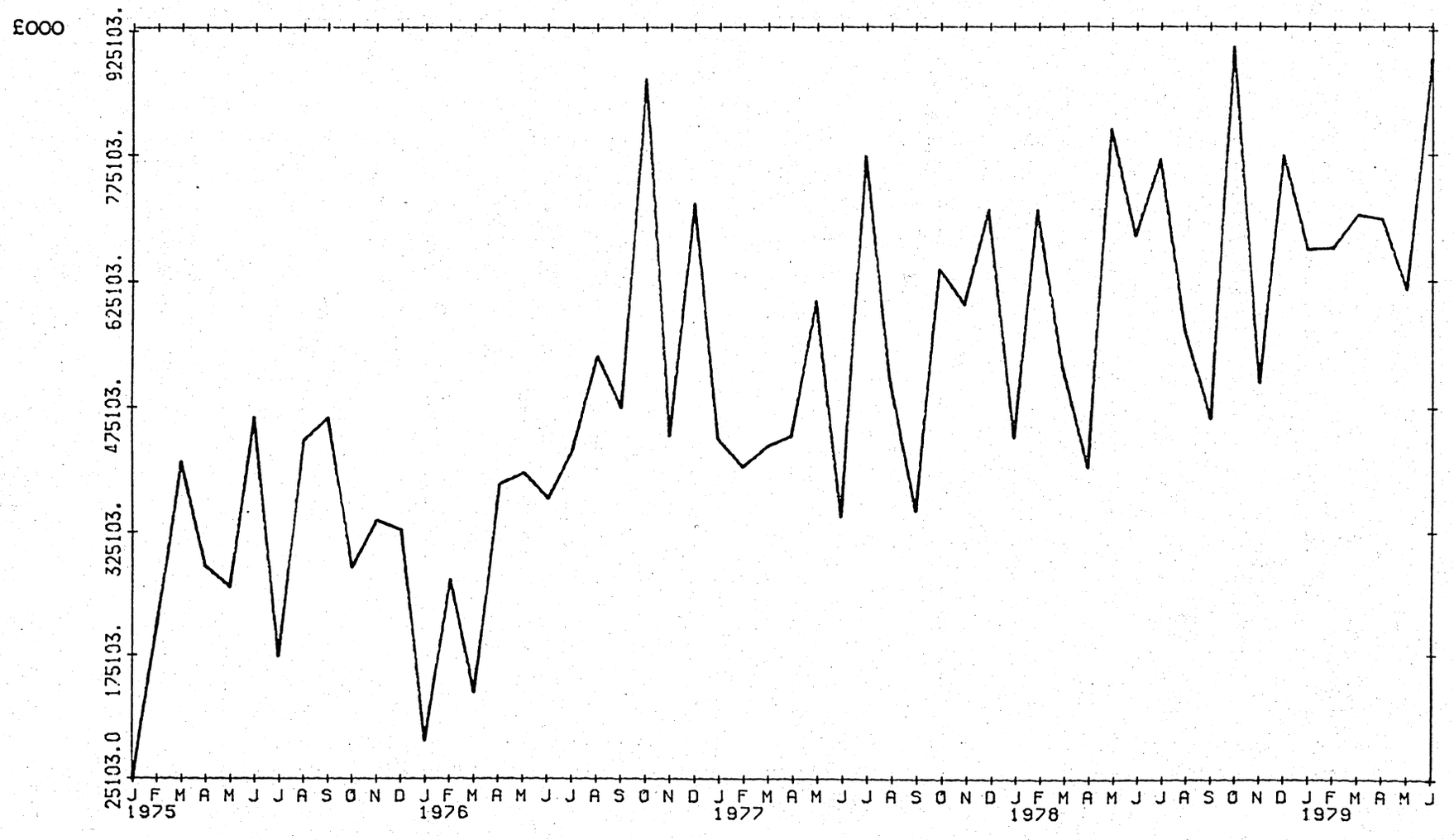
Generic Advertising: the Situation for Milk and Milk Products in England and Wales

The advertising of farm commodities is neither new nor without controversy. Just as other businessmen consider that advertising their product is good for profits farm producers have, over the years and in a number of different countries, supported advertising campaigns for their products. Because of the atomistic structure of the farming industry and the homogeneous nature of farm commodities these advertising efforts have usually been directed at increasing the generic or primary demand for farm output. Typically, the expenditures on generic advertising have been funded and administered by a co-operative organization of producers and occasionally they have operated in conjunction with, or support from, the processing and distributive trades. These observations on the behaviour of a variety of farmers producing various commodities are relevant to the activities of the Milk Marketing Board of England and Wales with regard to advertising milk and dairy products. Indeed, the Board may be described as the leading practitioner of generic advertising amongst the different commodity and producer organizations in the U.K. agricultural sector. The Board's commitment to generic advertising is shown firstly by Graph 1.1, which illustrates the changes in total advertising expenditures paid for by the Board and the National Dairy Council for liquid milk, cream, butter and cheese over the recent time period. Clearly there have been significant

Graph 1.1 TA = Total advertising on milk and dairy products (Board and National Dairy Council 1975.01 to 1979.06)

University of Manchester

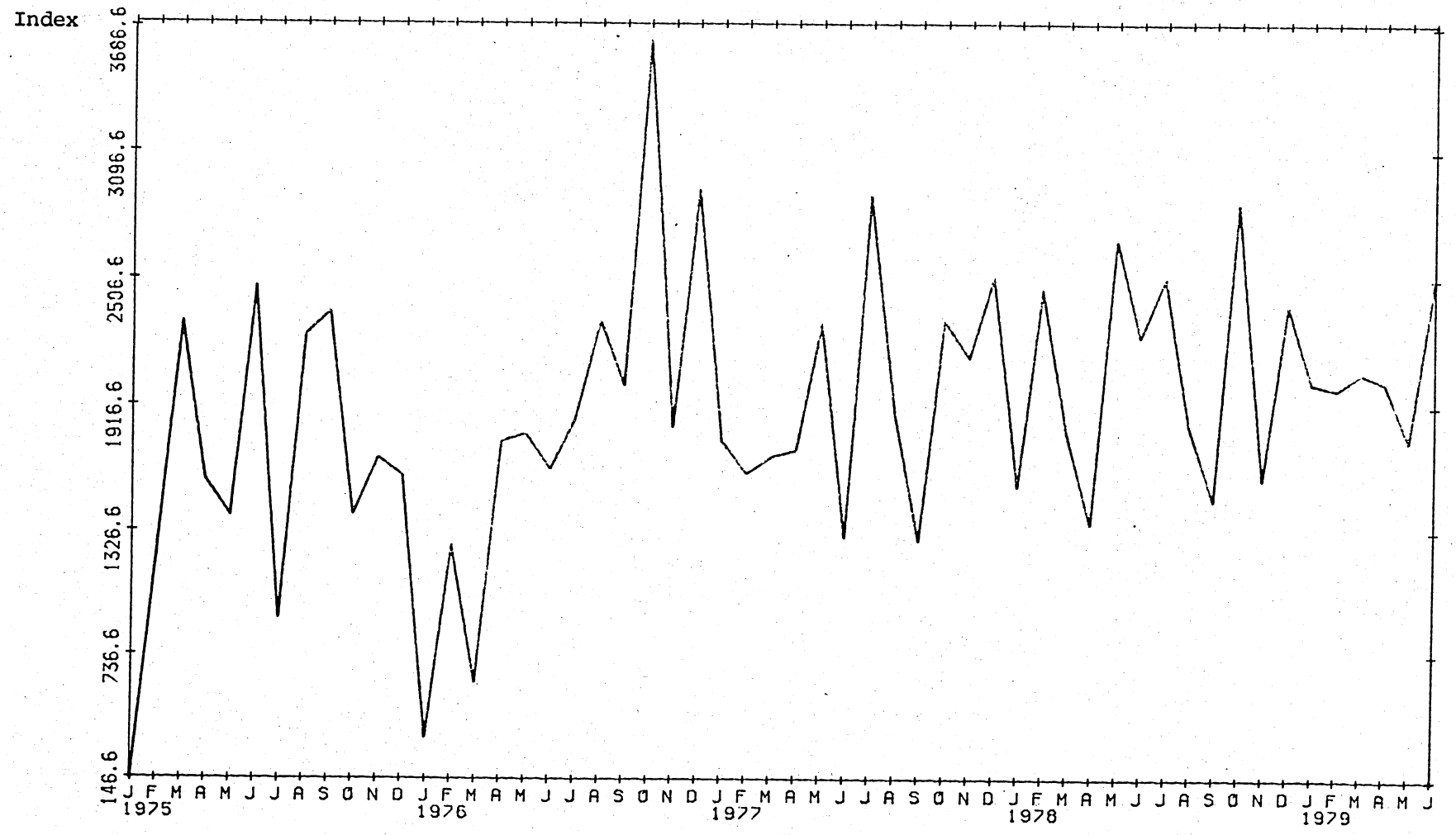
_____ = TA has 57 monthly observations from 1975/1 to 1979/9



Graph 1.2 TRA = Total real advertising on milk and dairy products (Board and National Dairy Council 1975.01 to 1979.06)

University of Manchester

———— = TRA has 57 monthly observations from 1975/1 to 1979/9



changes in expenditure over time and a rise in the absolute level of expenditures. It is less clear whether the advertising budget for milk and dairy products has increased in real terms. As Graph 1.2 shows the upward trend in real expenditures is less marked.

As further evidence of the Board's efforts to promote products in the milk sector, Table 1 compares the Board's expenditures with those of other producer organizations. The relative extent to which the Board is involved in advertising may be further illustrated by the fact that, in 1980, the combined advertising expenditures of the Milk Marketing Board for England

Table 1 : Advertising and Promotional Expenditures by U.K. Agriculture (1980/81)

Commodity	Expenditure (£m)
Eggs	2.116
Red Meat	4.245
Milk and Milk Products (England and Wales)	13.87
Potatoes	0.867

Source: Annual Report and Accounts (1981); Eggs Authority, Meat and Livestock Commission, Milk Marketing Board (England and Wales), and the Potato Marketing Board.

and Wales and the National Dairy Council exceeded those of such major companies as Kellogs, Heinz, and W.D. and H.O. Wills. These expenditures placed the Board and the National Dairy Council in eleventh place in the U.K. league table of advertisers. All this suggests that the resources allocated to the media costs of advertising are relatively large and there can be little argument that it is worthwhile to investigate the critical parameters of the advertising budget decision. This is supported by the apparent lack of a theory of the advertising budget decision relevant to milk producers.

The research results described in the following pages stem from the

Board's support of an investigation to,

> "estimate the effect of generic advertising for milk and milk products over the recent time period and to use these estimates to construct guidelines for the determination of the appropriate generic advertising budget for the milk industry."[1]

The work required to satisfy these objectives may be classified as i) that which describes the appropriate theory of advertising for the Board, and ii) that which estimates the size of any advertising effect on consumption. The combination of these distinct areas then allows a prescriptive comment on the Board's activities.

The results of i) above are given in Chapter Two where the Board's advertising efforts are considered for the Board as a multi-outlet, price discriminating monopolist. The Board is also considered as a processor, in an oligopoly situation. Conclusions are reached about the short run and long run implications of different models of the Board's behaviour with particular reference to the use of a simulation model of the milk market which allows dynamic effects to be described. Chapter Three details the results of an econometric analysis of the data on milk and dairy products' sales and presents estimates of advertising coefficients for the commodities considered. A brief summary of the time series properties of the data used is given in Appendix 2 in order that the reader may understand why particular forms of specification or estimation were used in Chapter Three.

Chapter Four presents an evaluation and interpretation of the empirical work for the Board using realistic values of sales, prices, costs etc. for the various products considered. The construction of a simulation model of the milk market is also explained and various results from running this model are presented. Thus, changes in advertising, prices and rivals' behaviour are hypothesized and their effects on total Board revenue, average producer price, milk utilization etc. are demonstrated. The final

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1. Objectives of a research proposal entitled "An Investigation of the appropriate guidelines for generic advertising policy for milk and milk products in the U.K." John Strak, University of Manchester (April, 1979).

chapter, as ever, considers how far the work done has achieved the original objectives. There is also discussion of where questions remain, or where the answers given are not satisfactory. Finally, a point of clarification; the substance of various conclusions and results is given within the text and summarised at the end of relevant chapters, but detailed mathematical and statistical exposition, and attendant caveats to the analysis are left until the various Appendices at the end of the bulletin.

CHAPTER 2

A Theory of Advertising for Milk Producers and Processors

The economic theory of advertising, that is, the concept of how the optimal advertising budget is set, has occupied the time of a significant number of economic analysts over the years. The influential work of Dorfman and Steiner (1954) provided the foundation for further research into the theory of advertising for the firm, and much of this contributed to more efficient marketing and managerial decisions in the 'real' world. A comprehensive review of the development of the theory of optimal advertising is outside the scope of this report but publications by Schmalensee (1972), Lambin (1976) and Chiplin and Sturgess (1981) contain an abundance of references and explanation of the various theories of the advertising decision for the firm; in monopoly, in oligopoly; under risk and uncertainty; for sales maximization objectives etc. These different concepts of how the advertising budget size is derived all depend on the classic marginal approach and this work does not deviate from that tradition in its treatment of advertising decisions for agricultural commodities.

Whilst the discussion of the theory of optimal advertising for various types of firm and market structure appears to be quite extensive it is important to note that agricultural producers with their unique characteristics of firm size and market organization have been relatively neglected in the theoretical literature. Indeed, there is really only one starting point for discussion of the theory of advertising for farm products. The work by

Nerlove and Waugh (1961) modified the Dorfman and Steiner results to allow the optimal budget to be identified for cooperative advertising where producers have no control over price or output (considered to be the typical agricultural situation).

The Nerlove and Waugh analysis rightly observes that optimal budget decisions for producers with no control over price and output must take account of long-run price and quantity changes as a result of an initial alteration in advertising expenditures. This provision is explicitly formulated and, by substitution, the optimal advertising/sales ratio may be expressed in terms of; the advertising sales elasticity, own price elasticity of demand, the long-run price elasticity of supply for the industry and the rate of return on alternative investments. Hence,

$$\frac{a}{v} = \frac{(\gamma_1 + \gamma_2)}{(\Sigma-\mu)(1-\rho)} \qquad .....(i)$$

where $\frac{a}{v}$ = the optimal ratio of advertising expenditures to sales

$\gamma_1 + \gamma_2$ = the long-run advertising sales elasticity

Σ = the long-run price elasticity of industry supply

μ = own price elasticity of demand

ρ = rate of return on alternative investments.

There appears to have been little theoretical progress beyond this point, or application of other more general theories to the specific problems of agriculture. Even empirical applications of the available theory are relatively scarce. Studies by Ball (1967) and May (1977) on eggs, and on milk by Ball and McGee (1972) were primarily concerned with the estimation of the sales response of advertising with relatively little thought given to the determination of the optimal advertising budget. Thompson and Eiler (1977), and Strak and Ness (1978) attempted to correct this deficiency by applying the theoretical framework identified by Nerlove and Waugh using advertising coefficients estimated for milk and eggs respectively. Neither study

incorporated the promotion of alternative sales outlets into the identification of the optimal budget nor did they consider the indirect effects of advertising on sales revenue for all those involved in the market. For example, government expenditure on farm support policies, and the sales turnover of the processing and distributive trade may be affected by producer advertising. In other words, the distribution of the various costs and benefits of advertising has not been sufficiently considered in the work done so far.

To illustrate the significance of these points it is worthwhile to illustrate, first of all, the possible effects of shifting the primary demand for a farm product on government expenditure using simple diagrams.

The aim of a generic advertising campaign is, presumably, to increase the demand for a product i.e. to influence the tastes and preferences of consumers in a positive manner. This may be represented by a shift in the demand curve for the product. The immediate or short-run effect of this demand 'shifter' will be a rise in the price of the product and in the quantity sold. (The balance between price and quantity change depending on the short-run elasticity of supply). These changes are represented in Figure 1 below.

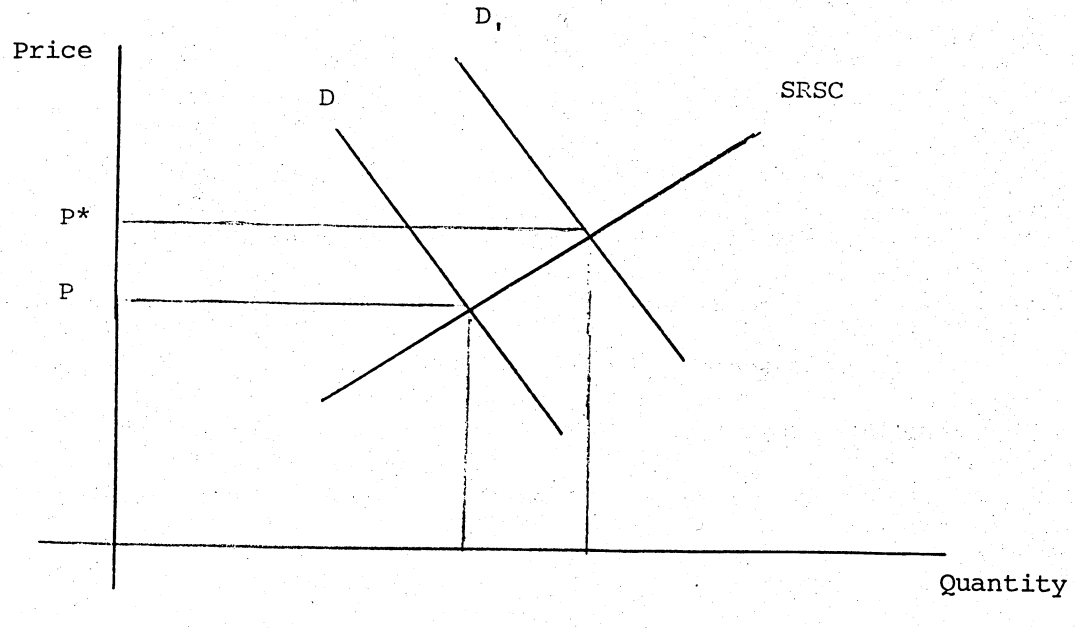


Figure 2.1 : Advertising as a Demand Shifter

Now if government support for farm incomes operates at the market level it may be implemented in various forms. Two alternatives relevant to the U.K. situation are - the Intervention Scheme and the Deficiency Payment Scheme. The former operates by government support-buying, at the market level, at a pre-determined price. Thus supplies are taken off the market and placed in storage. By operating in this manner the market price (to producers and consumers) should not fall below the pre-determined support price. In the U.K., dairy products are given protection by such a support mechanism. In contrast, the Deficiency Payment Scheme allows producer and consumer prices to differ at the market level. Producers are again paid on the basis of a predetermined support price but any deficiency in the market price (from the support price) is made up, not by government support buying, but by a payment from Government directly to producers. (The U.K. Fat Sheep Guarantee Scheme operates in this manner.)

The effects of generic advertising as a demand shifter for farm products need to be considered with respect to the operation of these different methods of farm support. Figures 2 and 3 below attempt to illustrate some of these effects geometrically.

P_s = Predetermined support price

P = 'Equilibrium' price before advertising

P^* = 'Equilibrium' price after advertising

Q_s = Quantity supplied in response to support price P_s

Q'_s = Quantity demanded in response to support price P_s

Q^* = Quantity demanded after advertising

D = Demand for farm product before advertising

D_1 = Demand for farm product after advertising

SRSC = Short-run supply curve of farm product

The marginal revenue product from advertising is dependent upon the sales response coefficient of advertising and the extra net revenue received

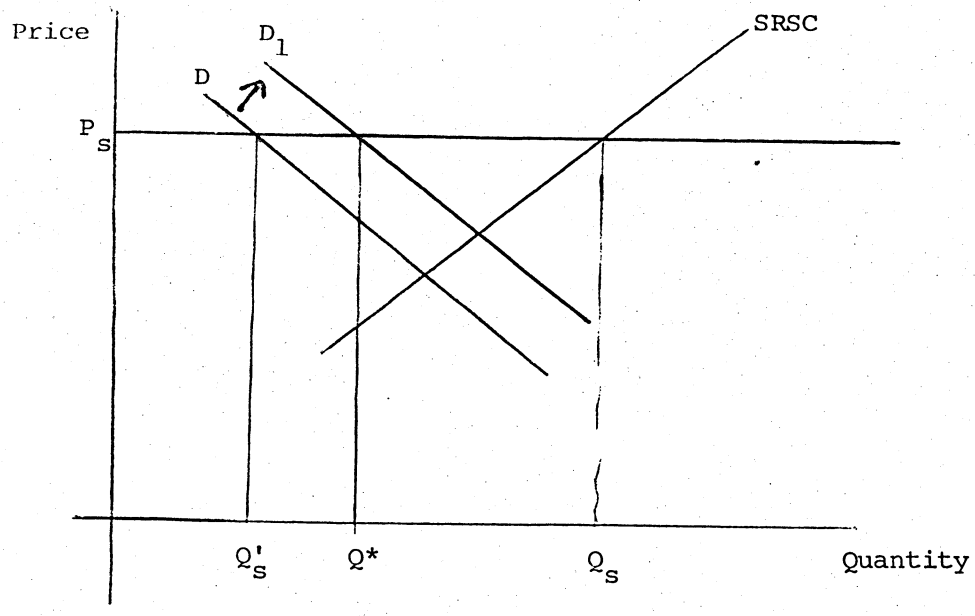


Figure 2.2 : Advertising's Effect when an Intervention Scheme Operates

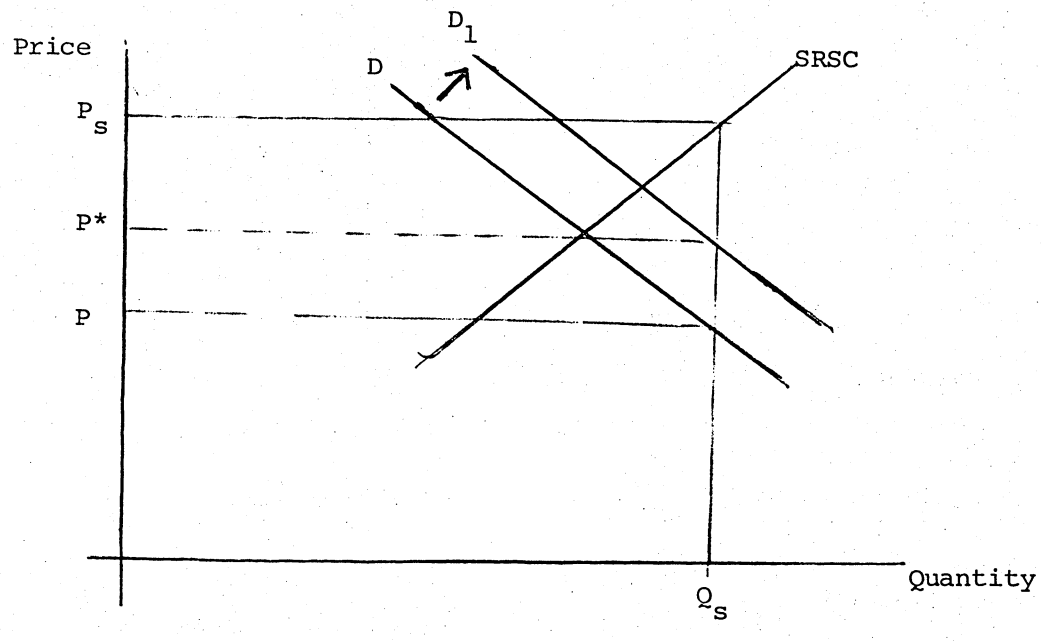


Figure 2.3 : Advertising's Effect when a Deficiency Payment Scheme Operates

by producers from any increase in sales. As Figures 2 and 3 show, whatever the size of any demand shift as a result of advertising, the extra net revenue received by producers may be critically dependent upon the particular level at which the pre-determined support price is set and market conditions before an advertising campaign commences.

In Figure 2 the amount $Q_s'Q_s$ is in storage before advertising. Until the sales response ($Q_s'Q^*$) is greater than this stored amount producers will not gain any immediate increase in revenue from advertising.

Similarly in Figure 3 the increase in price (PP*) resulting from promotional expenditure which shifts the demand function from D to D_1 must be greater than the size of any deficiency payment ($P\ P_s$) before producers receive any direct benefit from advertising.

It is just as important to note that government (through savings in farm support costs) and the processing and distributive trades (through increased sales turnover) may also benefit from increases in generic advertising by producers. As a separate point from this general discussion of the allocation of advertising benefits it is also useful to be mindful of the ways in which dairy producers realise their returns from milk and milk products in the U.K. The sale of milk by the Federation of Milk Marketing Boards, in a variety of different liquid and processed forms is, essentially, a way of maximising returns through multiple sales outlets. Multiple promotion and advertising in these outlets is another feature that has to be taken into account in the optimal advertising decision. Returning to the Nerlove and Waugh theory of the optimal advertising budget as given in equation (i) and repeated here,

$$\frac{a}{V} = \frac{(\gamma_1 + \gamma_2)}{(\Sigma-\mu)(1-\rho)}$$

It is useful to discuss the market assumptions underlying the derivation of this formula. From the preliminary discussion above it will then be possible to consider where the operation of the U.K. milk and dairy products market differs and, therefore, suggest modifications to the Nerlove and Waugh theory.

In particular Nerlove and Waugh assume that:

i) market equilibrium for the farm product may be represented by the intersection of the industry supply and demand curves without specifying at what market level price is measured, or in which sales outlets or product form the product is sold,

ii) the short run supply curve is positively sloped regardless of market level or sales outlet.

iii) product price may change as a result of shifts in the demand curve caused by advertising,

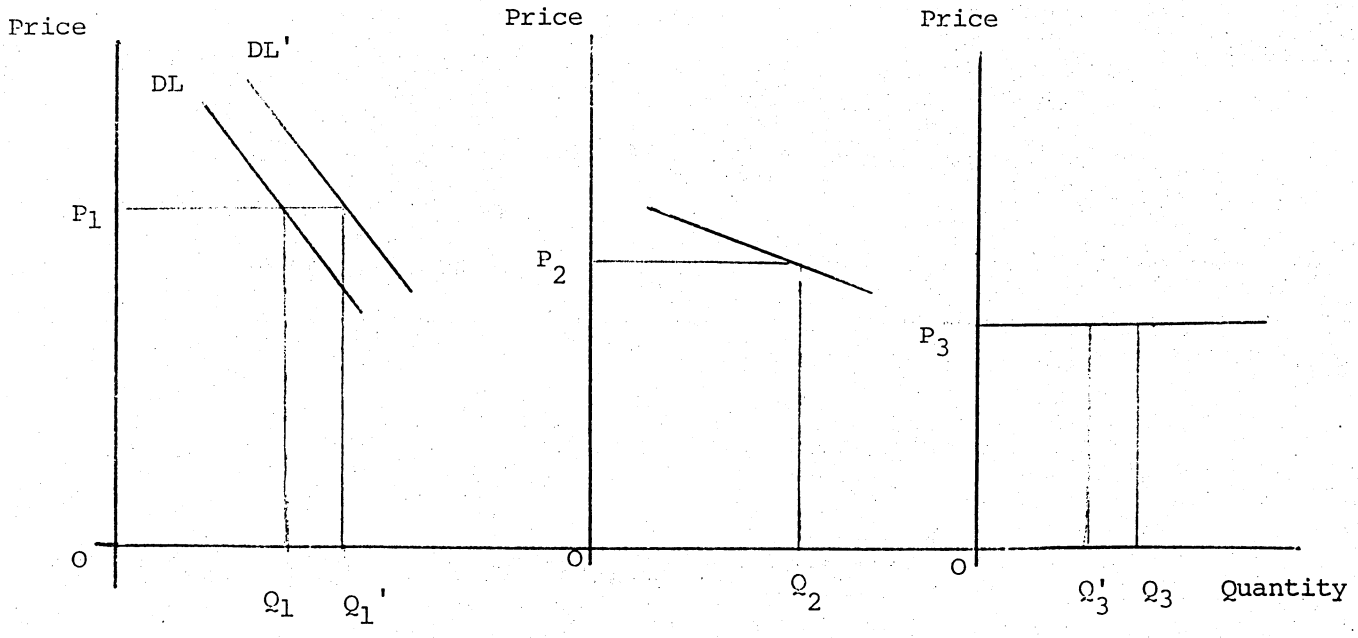
iv) changes in advertising expenditure produces changes in gross sales revenue through the interaction of product price and the change in quantity sold

v) for the market in equilibrium there is no possibility of storage or disposal of any 'residual' to another outlet.

It is not difficult to see how the market for milk and dairy products in the U.K. fails to conform to these assumptions.

Producer returns for milk in the U.K. depend upon the quantities and prices received for milk sold to different outlets. Specifically, the average producer price, P, is calculated from the weighted averages of the prices received for milk sold in the liquid market, the manufacturing milk market and to Intervention. The three markets can be represented by Figure 4 below.

Figure 4 : Simple Models of Sales Outlets in the Milk Market



where the average producer price $P = P_1 \frac{Q_1}{Q} + P_2 \frac{Q_2}{Q} + P_3 \frac{Q_3}{Q}$ .....(2)

and producers' total revenue $V = P_1Q_1 + P_2Q_2 + P_3Q_3$ .....(3)

P_1 = Price received for milk sold in liquid market

P_2 = Price received for milk sold in manufacturing market

P_3 = Price received for milk sold in Intervention

Q = Total quality of milk sold by domestic producers.

Q_1 = Quantity of milk sold in liquid market

Q_2 = Quantity of milk sold in manufacturing market

Q_3 = Quantity of milk sold to Intervention

In Figure 4 the price and quantity relationships are characterised by the inequalities,

$$P_3 < P_2 < P_1 \quad \text{.....(4)}$$

$$Q_3 < Q_2 < Q_1 \quad \text{.....(5)}$$

In order to identify changes in price and quantity that result from a change in advertising expenditure in the milk market it is not necessary for these inqualities to hold true. But assuming that they do represent the price and quantity differentials in the milk market,consider the effect of an increase in advertising expenditures for liquid milk.

Increased liquid milk advertising shifts the demand function for liquid milk (D_L) out to a new locus (D_L') where at all prices greater quantities of liquid milk are consumed than before. The change in quantity being $Q_1Q_1' = Q^*$. The price of liquid milk, P_1, remains the same since the increased quantity required for sale to the liquid market is, in the short run, diverted from sale in the alternative lowest value outlet. Hence milk previously sold to the support agency at a price P_3 is now sold in the liquid market at P_1. The change in quantity of milk sold to Intervention exactly corresponds to the extra quantity sold in the liquid market ($Q_3' Q_3 = Q_1Q_1' = Q^*$).

The change in total producer revenue (ΔV) after an increase in advertising expenditures is, therefore, equal to,

$$\Delta V = (P_1 - P_3)\, Q^* \qquad \text{.....(6)}$$

The change in average producer price (ΔP) that results from an increase in sales to the liquid market caused by advertising is simply,

$$\Delta P = (P_1 - P_3)\ \frac{Q^*}{Q} \qquad \text{.....(7)}$$

Similar results can be obtained for a situation in which advertising is used to increase the demand for manufacturing milk. The change in total producer revenue is,

$$\Delta V' = (P_2 - P_3)\, Q^{**} \qquad \text{.....(8)}$$

and the change in average producer price is

$$\Delta P' = (P_2 - P_3) \frac{Q^{**}}{Q} \qquad \text{.....(9)}$$

A simultaneous change in advertising in both the liquid milk and dairy products market will (providing that $Q^* + Q^{**} < Q_3$) produce the following changes in producer revenue and producer price,

Change in total producer revenue as a result of

simultaneous promotion = $\Delta V'' = P_1Q^* + P_2Q^{**} - P_3(Q^* + Q^{**})$ .....(10)

and the change in average producer price =

$$\Delta P'' = P_1 \frac{Q^*}{Q} + P_2 \frac{Q^{**}}{Q} - P_3 \frac{(Q^* + Q^{**})}{Q} \qquad \text{.....(11)}$$

By this point it should be obvious that the U.K. market for milk and dairy products does not conform to the assumptions (i) to (v) noted earlier. The effect of this is to prevent the Nerlove and Waugh transformation of the effect of a change in advertising expenditure on producers' surplus into the relevant supply, demand and advertising elasticities. Indeed, for the example of simultaneous promotion of liquid milk and dairy products the prospect of multiple differentiation (as advertising changes in several markets simultaneously) without the possibility of substitution yet taking into account the linkage effects of price differentials and quantity on producer price and revenue raises several difficult questions.

For example, at what market level should be prices and quantities involved in the analysis be measured? If a linkage between the change in advertising levels in different markets is identified what relevance has this to the way in which advertising budgets are adjusted. Would decision makers utilize a decision rule which, because of this linkage, was relevant only for simultaneous changes in advertising activity? Furthermore, such a decision rule might disguise the particular effects of advertising in different markets thus preventing a critical assessment of performance in respective markets. Most seriously, the complexities of such a formulation (in which all advertising

expenditures and resultant price and quantity changes are considered together) may create operational and budgetary problems without generating detailed information on price and quantity changes in the long run. The situation is further complicated if there is a probability of different maximization objectives being applied in different sections of the milk market. For example, profit maximization in the liquid milk sector and sales maximization in part or all of the dairy products sector.

These questions and the answers they suggest imply that an *a priori* identification of the optimal budget decision is neither practicable nor appropriate for the total milk market in the U.K. The simple concept of a long-run optimum that may be defined as a fixed advertising sales ratio as in the Nerlove and Waugh analysis is not productive.

If it is reasonable to question the suitability of the Nerlove and Waugh formula for an integrated milk sector, what are the appropriate guidelines for decisions in this area, and how may the decision-maker take account of the complexities of the milk market in the long run? Several alternatives suggest themselves.

The Milk Board as a Monopolist

Firstly, the allocation of advertising expenditures between alternative sales outlets may be handled for the Milk Marketing Board, in the short run, by assuming that the Board acts as a price discriminating monopolist. Whilst prices are fixed advertising expenditure is variable for different sales outlets.

Hence, for liquid milk and manufactured milk the demand functions are,

Demand for liquid milk = $Q_1 = f(P_1, A)$ .....(i)

Demand for manufactured milk = $Q_2 = f(P_2, A)$ .....(ii)

where A = advertising expenditure.

Using (i) to substitute for Q_1 the total revenue for liquid milk sales can then be identified as

$$TR = P_1 . f(P_1, A)$$

The underlying cost function for liquid milk by the monopolist (for sale in any form) is given by,

$$Costs = C(Q_1) + A$$

Again by substitution of Q_1 by (i),

$$Costs = C[f(P_1, A)] + A$$

$$Profits = Revenue - Costs$$

$$\pi = P_1 . f(P_1, A) - C[f(P_1, A)] - A$$

If we then allow advertising to change by differentiating the profit function with respect to A we can obtain a simple relationship between sales revenues from advertising in different outlets.

$$(P_1 - P_3)\ Q^* = (P_2 - P_3)\ Q^{**} = 1$$

That is advertising levels for alternative markets should be chosen such that the changes in producer revenue (profits) for different products resulting from a change in advertising expenditures are equal to one. That is, neglecting alternative rates of return, advertising expenditures should be increased for all sales outlets until £1 of expenditure produces an extra £1 of profits for producers.

This decision rule does no more than support the intuitive notion that profit maximizing price discriminating monopolists should increase advertising levels if the costs of doing so are less than the changes in revenue and, conversely, they should reduce advertising expenditures if the change in revenue is less than the marginal cost of advertising. Thus, the Board considers the direction in which the inequality runs

$$Q^* (P_1 - P_3) < > 1$$

in order to determine the direction in which advertising budgets should move.

Alternatively, the equation $Q^* (P_1 - P_3) = 1$ may be presented as a relationship between the advertising elasticity, advertising and total premium 'sales'. By multiplying through by $\frac{A}{Q_1}$ we obtain

$$Ae = \frac{A}{(P_1 - P_3)\, Q_1}$$

where, Ae = the advertising elasticity of demand

A = total advertising expenditures

$(P_1-P_3)Q_1$ = total 'premium' available by selling commodity in different sales outlet

Hence, the first order condition for optimal advertising is that the advertising elasticity of demand should equal the ratio of advertising to the total value of the 'premium' for a particular sales outlet. For brevity, this ratio may be termed the Advertising Sales Premium ratio (the ASP ratio). The optimum advertising budget, A* , may be obtained by rearranging the terms in the ASP ratio to give,

$$A^* = Ae\ (P_1 - P_3)Q_1$$

Unfortunately, the portrayal of the optimal budget decision for the Board as a profit maximizing, multi-outlet monopolist as shown above is not sufficient for the U.K. milk market. The Milk Board may not be the only supplier in particular markets. In parts of the dairy products market, for example, English butter and cheese compete with imported competitors and various substitutes. Furthermore, the Board may consider decisions on advertising to be linked with decisions on price and the expected reaction of rivals in a particular market. Recognition of this type of market approach to the determination of advertising budgets requires that at least two other alternative approaches for the Board's advertising decision be considered.

The Board as an Oligopolist

Before considering a theory of advertising under oligopoly it is important to establish which parts of the Board's activities are relevant to this discussion. Clearly, as a wholesale seller of milk the Board is a monopolist (and as a single buyer a monopsonist). Whatever outlet or final form wholesale milk goes to it is directed there by the Board. For distributors and

processors there is only one agent supplying milk in the U.K. Thus at the wholesale level the Board may act as a price discriminating monopolist and nothing else. However, the Board also has an involvement in the processing of milk into dairy products, i.e. it is a food manufacturer.[1] In this role supplying and competing in the market for dairy products, the Board is clearly in an oligopoly situation. There are many brands and types of butter and cheese, for example, and the market statistics are usually expressed in terms of; English butter sales, New Zealand butter sales, Danish butter sales etc. Thus it is valid to consider how the Milk Board, as a processor, should set its advertising budget under oligopoly, in particular, where rival firms in the market also advertise their products.

The Dorfman-Steiner rule describes the advertising decision rule for a firm that sets its price and advertising levels assuming no reaction from other firms in the market. Thus, the firm sets its advertising sales ratio equal to the ratio of advertising and price elasticities,

$$\frac{A}{PQ} = \left|\frac{Ae}{\mu}\right| \qquad \text{.....(ix)}$$

where, PQ = total sales revenue

A = advertising expenditure

Ae = the advertising elasticity

$|\mu|$ = the absolute value of the own price elasticity of demand.

In an oligopoly situation a firm will expect competing firms to advertise their products and alter their advertising levels in response to its own advertising expenditure changes. Consequently, the demand function must take account of this relationship.

Hence, the demand function is,

$$Qd = Q(P,A,Ac) \qquad \text{.....(x)}$$

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1. The Board controls a significant proportion of domestic manufacturing capacity for dairy products.

where P = price of product

A = own advertising

Ac = competitor's advertising

Qd = product sales

From this, by allowing own advertising to change in order to arrive at a necessary point for profit maximization we obtain the relationship,

$$\frac{A}{PQ} = \frac{1}{|\mu|}(Ae + Ae' \cdot Ae'') \qquad \text{.....(xxvi)}$$

where,

$|\mu|$ = the absolute value of the own price elasticity of demand

Ae = the elasticity of demand with respect to changes in own advertising

Ae' = the elasticity of own demand with respect to changes in competitors' advertising

Ae'' = the elasticity of competitors' advertising with respect to changes in own advertising.

Clearly, when the response of competitors' advertising to changes in own advertising is zero, equation (xxvi) collapses to the Dorfman-Steiner rule noted earlier.

This result may be expressed in another form. The demand for a product is affected by the amount of own advertising relative to the amount of total advertising in the market for that product (the advertising share). For example, consumers may be influenced by the size of English butter advertising relative to total butter advertising - how much one message is distinct from the overall group of advertising messages. Hence, equation (xxvi) becomes

$$\frac{A}{PQ} = \frac{1}{|\bar{\mu}|} \quad [ASe - (ASe + Ae')\, Ae''] \qquad .....(xxxv)$$

where, ASe = the elasticity of own demand with respect to changes in the advertising share.

Just as before if rivals' response to changes in own advertising are zero the relationship collapses back to the Dorfman-Steiner rule.

The Board's advertising expenditures in the long run

The previous pages have identified the short run profit maximizing conditions for advertising expenditures in the liquid milk and dairy product markets, for the Board acting as a producer, and as a processor. It is important to realise, however, that the re-allocation of quantities of milk between liquid milk, manufacturing milk and milk sold into intervention will as advertising changes, affect the average price for milk received by producers at the farm level. This, in turn, will have long run implications for producer revenues and profits.

The formula for the average product price is restated below,

$$P = P_1 \frac{Q_1}{Q} + P_2 . \frac{Q_2}{Q} + P_3 . \frac{Q_3}{Q} \qquad .....(2)$$

Any change in P, as a result of simultaneous promotion, to $\Delta P''$ is given by equation (11) on page 16. Clearly, $\Delta P'' > P$. Hence, in subsequent periods from the initial change in advertising expenditures, increased supplies of milk are to be expected since the domestic supply of milk, Q_S, is a positive function of producer price

$$Q_S = f(+P) \qquad .....(12)$$

Assuming any initial changes in Q_1 and Q_2 remain constant over time any increase in the total quantity of milk supplied (Q) must increase the amount of milk sold to intervention (Q_3) at a price P_3 (since $Q = Q_1 + Q_2 + Q_3$).

This in turn will reduce the average producer price for milk (through equation (2) shown above). Clearly, whether the new producer price, P*, resulting from producers' supply response is above or below the initial producer price, P, will depend on the rate of change of supply in response to a change in price i.e. $\frac{\partial Q_S}{\partial P}$. Hence the significance of, ε, the price elasticity of industry supply for milk $(\frac{p}{q}\frac{\partial q}{\partial p})$. Obviously, the higher the value of ε then the greater will be the response of quantity supplied to price and the greater will be the dilution of any increase in average producer price (which resulted from the initial change in advertising expenditures).

The feedback effect of supply response into the average product price is unlikely to be a once-and-for-all effect in the period following the change in advertising expenditures. Producers respond to an average price which is calculated from the marginal revenues received from the sale of milk to various sources. Producers' actions, in turn, affect the average producer price and so there can be no guarantee of equilibrium being restored in the milk market within a pre-specified time period. The situation is analogous to the classical cobweb of supply response to an initial price or quantity disequilibrium. At best, changes in advertising expenditures in the milk market may produce a series of damped producer responses bringing forth greater supplies at an ever decreasing rate. The optimal budget, therefore, may only be identified by considering the interactions of the liquid milk and product markets on the average producer price over the relevant time horizon. This suggests that a simulation of the complete set of demand and supply equations that represent the market for milk and milk products may be a third alternative means of determining the appropriate advertising budget. Such a policy simulation[1] of different levels of advertising expenditure would allow identification of the resulting net gain to producers of advertising and the time period over which that gain was

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1. See, for example, Intriligator (pages 548-549, 1978) and Labys (pages 199-239, 1973).

realized (or dissipated). Only then, when the full consequences of any feedback effects have been fully understood will a decision on the optimal budget for advertising be possible.

This simulation approach to the determination of the optimal budget for milk and milk products advertising contrasts with the Nerlove and Waugh type analysis which defines the optimal budget (at any point in time) in terms of advertising sales ratios and various elasticities. The latter approach, however, is not appropriate when, as in the case of milk and milk products, it is not possible to determine changes in the average producer price over succeeding periods as a result of an initial or sustained change in advertising levels. In particular, for a market that is expected to have constantly changing prices and advertising levels it seems inappropriate to utilize simple short-run optimizing formulae that require extensive use of *ceteris paribus*. A simple illustration of what an exercise in policy simulation for the milk market might involve follows.

Econometric analysis of price and sales data generates demand equations for milk and dairy products (cream, cheese and butter) and a domestic supply function for liquid milk. It is also possible to identify the total revenue function for milk producers and the average producer price function which provides the linkage between quantities produced and sold in successive periods for those products and thus the average producer price. A general specification of the equations is given below.

$$Q_1 = f(P_1, A_1)$$

$$Q_{21} = f(P_{21}, A_2)$$

$$Q_{22} = f(P_{22}, A_3)$$

$$Q_{23} = f(P_{23}, A_4)$$

$$Q_3 = f(P_3, Q_1, Q_q, Q)$$

$$Q_2 = Q_{21} + Q_{22} + Q_{23}$$

$$P_2 = P_{21}\frac{Q_{21}}{Q_2} + P_{22}\frac{Q_{22}}{Q_2} + P_{23}\frac{Q_{23}}{Q_2}$$

$$Q = Q_1 + Q_2 + Q_3$$

$$P = P_1\frac{Q_1}{Q} + P_2\frac{Q_2}{Q} + P_3\frac{Q_3}{Q}$$

$$Q = f(P)$$

Q_1 = Quantity of milk sold to the liquid market

Q_2 = Quantity of milk sold to the manufacturing market

Q_3 = Quantity of milk sold to the support agency

Q_{21} = Quantity of milk sold as cream

Q_{22} = Quantity of milk sold as butter (to consumers)

Q_{23} = Quantity of milk sold as cheese

P_1 = Price received for milk sold to the liquid market

P_2 = Price received for milk sold to the manufacturing market

P_3 = Price received for milk sold to the support agency

P_{21} = Price received for milk sold for cream

P_{22} = Price received for milk sold for butter (to consumers)

P_{23} = Price received for milk sold for cheese

A_1, A_2, A_3, A_4 = Advertising expenditures for liquid milk, cream, butter and cheese respectively.

Q = Total quantity of milk produced by domestic producers

P = Average producer price for milk

No attempt has been made to include in the specification above all the endogenous and exogenous variables relevant to particular supply and demand equations. Similarly, the absence of a stock equation does not allow the system to reflect all the precautionary, transactionary or speculative motives of the market. However, it should not be difficult to understand how simulation of such a system of equations can provide useful information on the effects of actual or anticipated changes in the endogenous and exogenous

variables. For example, with regard to changes in advertising policy it is possible to examine the effect of a once-and-for-all and/or a sustained change in advertising expenditures in one or more of the sales outlets for milk. This would produce a range of alternative future values for the endogenous variables. It would also produce a time pattern of the effect on sales of changes in advertising policy. The sensitivity of the milk market to general or specific changes in advertising expenditures could then be easily demonstrated. For example, questions such as "what would be the effect of, say, a movement towards the short run optimal advertising budgets be?" could be answered. The choice between alternative sales strategies would then be dependent upon the implications of each policy option and the weight given to these implications by the policy maker. The optimal budget then would be selected from a range of alternative policies examined within the simulation framework and interpreted directly by those responsible for changes in advertising policy.

In closing, it is worthwhile to note the significance of the price (P_3) and quantity (Q_3) of milk sold to the government support agency in the analysis. Intervention sales of milk affect the advertising expenditure decision in several ways.

Firstly, the inequalities; $Q^{**} < OQ_3$

$$\text{and} \quad Q^{*} + Q^{**} < OQ_3$$

are crucial to the revenue changes identified earlier. If either of these inequalities does not hold then the marginal change in revenue associated with a change in advertising for dairyproducts is likely to increase significantly. This will have obvious effects on the overall revenue function and on average producer price.

Secondly, the proportion of all milk sold into intervention is a determinant of the average producer price. If the response of sales to advertising is relatively low and the proportion of intervention sales is relatively high then

the lower is the consequent effect of that increase in sales on average producer price. In the long-run this 'buffer' effect of intervention milk would (not surprisingly) reduce instability in the milk market. Paradoxically perhaps, a relatively high level of intervention sales of milk will reduce the long-run price changes associated with an initial change in advertising expenditures. Producers would, therefore, be able to identify their long-run change in profits from advertising more easily.

Finally, the price differentials $(P_1 - P_3)$ and $(P_2 - P_3)$ are critical elements in the determination of marginal revenue changes as a result of advertising in the milk market. Since P_1 and P_3 are determined exogenously it may also be worthwhile to examine the effect of changes in these exogenous variables within a simulation framework in order to obtain further information on likely changes in production and consumption over a particular time horizon.

Summary

The principal conclusions of Chapter Two are set out below.

i) It appears that there is no developed theory of optimal advertising for agricultural producers, such as the Milk Board, who combine together to sell their product, in different forms, to a number of alternative sales outlets.

ii) Any such theory must take account of the varying price differentials received from sale of product to different outlets in the calculation of returns from advertising. Also, the distribution of benefits from advertising between producers, processors (and if government support for the product exists) and government. For milk producers in the U.K. this means that the intervention price paid for dairy products is an important part of the evaluation of advertising effects.

iii) A decision rule for milk producers collectively acting as a monopolist was constructed. This sets the optimal advertising budget in the short run in terms of the advertising elasticity and the total sales premium

available in a particular market. Hence,

$$A^* = Ae\ (P_1 - P_3)Q_1$$

where Ae = the advertising elasticity of demand

$(P_1-P_3)Q_1$ = total 'premium' available by selling product in a different sales outlet

A^* = the optimal level of advertising expenditure.

iv) A decision rule for the Board in its role as a milk processor was also developed. This sets the optimal advertising budget in the short run in terms of the advertising sales ratio, the price elasticity of demand for the product, the own advertising elasticity, cross advertising elasticity, and rivals'reactions to changes in own advertising. Hence,

$$\frac{A}{PQ} = \frac{1}{|\mu|}\ (Ae + Ae' \cdot Ae'')$$

where, $\frac{A}{PQ}$ = the advertising sales ratio

$|\mu|$ = the absolute value of the own price elasticity of demand

Ae = the elasticity of demand with respect to changes in own advertising

Ae' = the elasticity of own demand with respect to changes in competitors' advertising

Ae'' = the elasticity of competitors' advertising with respect to changes in own advertising.

v) The decision rule given above for producers is necessary for optimal advertising in the short run. For milk producers, and therefore the Board, who cannot control total supplies this relationship may not be sufficient in the long run. Furthermore, in a market where changes in price and advertising are to be expected it may be that simple

decision rules, for producers and processors, based upon elasticities cannot be a comprehensive guide to appropriate decisions on advertising. Hence, it is likely that advertising budgets (and price changes) will be better determined by the use of a simulation model of the milk market. The construction and use of such a model will allow alternative advertising expenditure changes to be tested over a long period without many of the restricting assumptions inherent in the use of elasticities.

CHAPTER 3

An Econometric Analysis of the Milk and Dairy Products Market

The introduction to this report noted that the estimation of the size of any sales response to advertising in the milk market was a distinct area of analysis. It is not an area, however, that has a plentiful supply of published work on the subject. Indeed, there are comparatively few published examples of econometric demand studies that relate milk products' sales to price and income, let alone advertising. In this respect, therefore, the research entered relatively uncharted territory.

The aim of the econometric analysis was to obtain satisfactory quantitative estimates of the advertising effect in specific commodity markets. These were: liquid milk, household cream, total butter and English butter, total cheese and English cheese. This leaves out milk sold to markets that are, in value terms, relatively small (e.g. yoghurt, flavoured milk) or do not utilize advertising to any great extent (e.g. dried milk powder). The major exception to these categories is cream sold to the catering market which, in volume terms, is larger than the household cream market and (through the 'cream cakes' campaign) spends a significant amount on advertising. The data problems in this market were, however, insurmountable. As some compensation for the neglect of these products some time and attention was given to the margarine market in order to better understand the demand rela-

tionships in the yellow fats market.

This chapter will proceed by setting out, in general terms, the estimation and specification procedures used in the different product markets as many of the problems (and solutions) relevant to particular commodities are also a feature of the overall analysis. The discussion of specific demand equations will concentrate on characteristics of the results that are of direct interest to that commodity. For each product a preferred equation is detailed, sometimes in comparison with other equations for that product, but a more detailed and comprehensive examination of alternative equation specifications is left until Appendix 3. The appropriate elasticities for the explanatory variables involved in the different demand equations are given after each preferred equation and summarized together at the end of the chapter.

General Features of the Econometric Analysis Undertaken

The investigation of the effectiveness of generic advertising of milk and milk products was carried out by estimating various demand equations individually. The general form of the demand function used may be represented by,

$$Q_t = f(\pm Y, -P, \pm P_{SC}, A, \pm A_{SC}) \quad \ldots\ldots\ldots\ldots (1)$$

where,

Q_t = retail sales or purchases of a particular commodity

Y = a measure of real income or consumer purchasing power

P = real price of the commodity

P_{SC} = real price of substitutes and/or complements to the commodity

A = advertising for the commodity

A_{SC} = advertising for substitutes and/or complements to the commodity.

This type of specification has been used by many researchers and economic

theory does, at least[1], support the inclusion of all prices and income in the functional form.

Leaving aside the theoretical treatment of advertising the demand equation, as given, does not include explanatory variables to take account of seasonality, calendar influences, shifts in policy by Government or official bodies, and changes in distribution services of the product. All these factors may influence the consumer's purchasing decision and, indeed, may as Appendix 2 shows for seasonality, explain a significant part of the underlying variation in the dependent variable. The basic model, therefore, was modified, where appropriate, to account for these different factors. For example, a variety of methods were used to eliminate or reflect the seasonal effect. These methods included:

a) respecification of equation (1) as

$$Q_t = f(\pm Y, -P, \pm P_{SC}, +A, \pm A_{SC}, \pm D_2 \rightarrow D_{12})$$

where $D_2 \rightarrow D_{12}$ are monthly dummy variables.

b) Deseasonalize by 12 monthly differences, thus $\Delta Q_t = Q_t - Q_{t-12}$ and use the deseasonalised data in equation (1).

c) Deseasonalize by a moving average procedure e.g. for monthly data calculate Q_{ts} where Q_{ts} is the deseasonalized time series and

$$Q_{ts} = \frac{\frac{1}{2} Q_{t-6} + Q_{t-5} + Q_{t-4} \ldots\ldots + Q_{t+5} + \frac{1}{2} Q_{t+6}}{12}$$

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1. It is not at all clear how advertising fits into conventional demand theory and, as such, what the theoretical basis of equation (1) above is. For example, the comprehensive discussion of the Law of Demand in Chapter 2 of Henderson and Quandt (1980) does not mention advertising. This reflects the emphasis on price as a determinant of consumer behaviour in the theoretical literature. More recently, the suggestion that analysts should consider a marketing mix demand function as exemplified by Kotler (1971) and others has led to the involvement of advertising, distribution and product quality in an explanation of demand along with prices.

d) Use the 12 monthly lag operator, Q_{t-12}, on the dependent variable, in an explanation of current sales, Q_t. Hence,

$$Q_t = f(\pm Y, -P, \circ P_{SC} + A, \pm A_{SC}, \pm Q_{t-12}).$$

It is important to note that methods b) and c) eliminate the seasonal effect without providing information on the size and distribution of the seasonal effect. In contrast, methods a) and d) produce extra information on the magnitude of seasonal fluctuations in the data series examined.

The alternatives outlined above imply that the analysis uses monthly data. This feature of the data requires that calendar variation should also be taken account of in the model. Thus, monthly variation in the number of weekends and bank holidays, for example, was explicitly accounted for by the use of dummy variables in the estimating equations.

A characteristic of regularly purchased commodities is the extent of habit formation that occurs in purchasing patterns. Various writers have drawn attention to consumers' brand loyalty as measured by their retention rate [1], and even without the support of eloquent theories of consumer behaviour it seems reasonable to expect that some part of current sales of a particular good are explained simply by past sales of that good. Whilst some economic researchers have investigated the use of asymmetric price responses to explain changes in demand over time [2] it is also be possible to model habit formation in consumer demand by involving the lag operator, Q_{t-1}, in the explanation of current sales, Q_t. This results, of course, in an estimating equation identical to that of a partial adjustment model. [3]

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1. For further discussion of this term see, for example, the section on Markov analysis of market shares in Chapter 3 of *Qualitative Techniques for Marketing Decisions* by Marvin A. Jolson and Richard T. Hise (Macmillan, 1973).

2. For example, Trevor Young (1980).

3. Such a model will require a different interpretation of estimated coefficients and the consequent calculation of elasticities. Appendix 3 discusses this issue further.

Equation (1) was also modified to allow for estimation of market share models of sales and advertising. Thus (1) becomes,

$$M_t = f(-P, \pm P_{SC}, A/_{AC}) \qquad \ldots\ldots(2)$$

where, P and P_{SC} are as before

and M_t = market share of commodity

$A/_{AC}$ = advertising share (own advertising relative to competitors' advertising).

Again, this type of approach has been suggested and used by other researchers[1] and is not new. However, the general models of demand given by equations (1) and (2) incorporate advertising effects from own, competing and complementary products. It is necessary to make some general points about the features of these advertising responses before considering precisely how the analysis set about estimating the different advertising effects.

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1. As, for example, in the study by Metwally (1975) on firms producing specific commodities in Australia.

The Advertising Sales Response

As various writers[1] have pointed out there is no well developed theory of advertising. At best it is possible to proceed on the basis of reasoned intuition rather than objective analysis. Amongst the many points relevant to accurate identification and estimation of the advertising coefficient in an econometric study are:

i) how should advertising be measured - in expenditure terms or by the number of 'messages' received?

ii) What is the decay rate and duration interval associated with advertising? In other words, what is the range or form of the distribution of effects resulting from an initial advertising message, over time?

iii) Do diminishing marginal returns to advertising exist over the range of observations used?

iv) The advertising budget involves expenditure on various activities such as: informational material, promotions, sponsorship etc. and on different types of media to convey the advertising message. There may also be qualitative differences between different advertising campaigns. Does a breakdown of the budget expenditure aid the estimation process to take account of these different factors?

v) Countervailing advertising for competing products may have a significant negative effect on the sales of the product under study. There may also be an 'anti-advertising' effect as a result of information produced by official agencies e.g. Health Councils.

Apart from point iv) where simplifying assumptions were generally made, all the points above were given extensive investigation for data on sales of liquid milk, cream, butter, cheese and margarine in the U.K. over the period 1975-1981. An important part of this investigation was the way

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1. See, Doyle (1968) and Fitzroy (Chapter 7, 1976).

in which the form and length of the distributed lag of advertising was handled for these different products.

The incorporation of historical advertising expenditures in an explanation of current sales may be represented, in the simplest form, by the equation

$$Q_t = f(A_t, A_{t-1}, A_{t-2} \ldots\ldots A_{t-n})$$

or in linear stochastic form

$$Q_t = a + b_o A_t + b_1 A_{t-1} \ldots\ldots b_n A_{t-n} + u_t$$

described in general as,

$$Q_t = a + \sum_{j=o}^{n} b_j A_{t-j} + u_t$$

where Q_t = current sales in period t

and A_t = advertising in period t

The problem remains, however, of determining the length and form of the lagged advertising expenditures i.e. how to choose values for b_j, j and n in the equation above. In effect, the choice depends on

a) prior knowledge of the market

b) the data periodicity

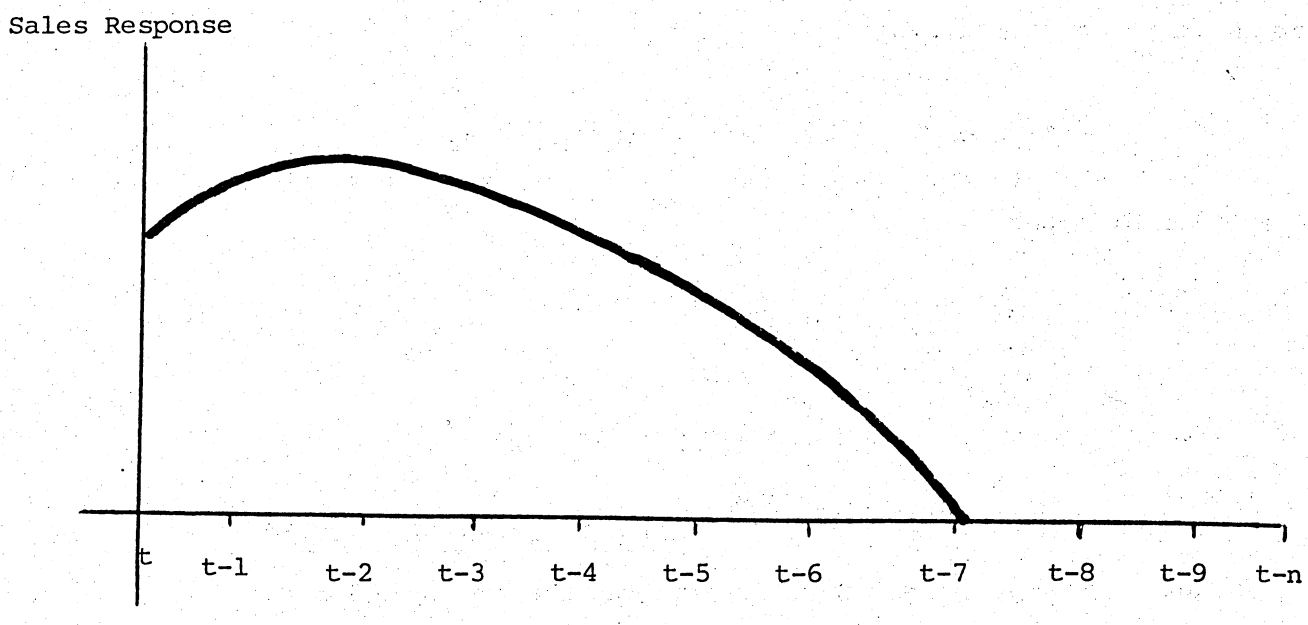
c) the constraints imposed by the econometric techniques available

d) subjective decisions of the researcher.

For any particular demand equation a variety of specifications of the form of the advertising effect was used. Advertising's impact on sales was considered through: linear and diminishing returns, its absolute size, relative to a money or 'messages' index, relative to total commodity advertising and individual competitor's advertising, with long and short lags, etc. Further, the length and form of advertising response was not always assumed continuous over time. Free form lags were often used to determine underlying

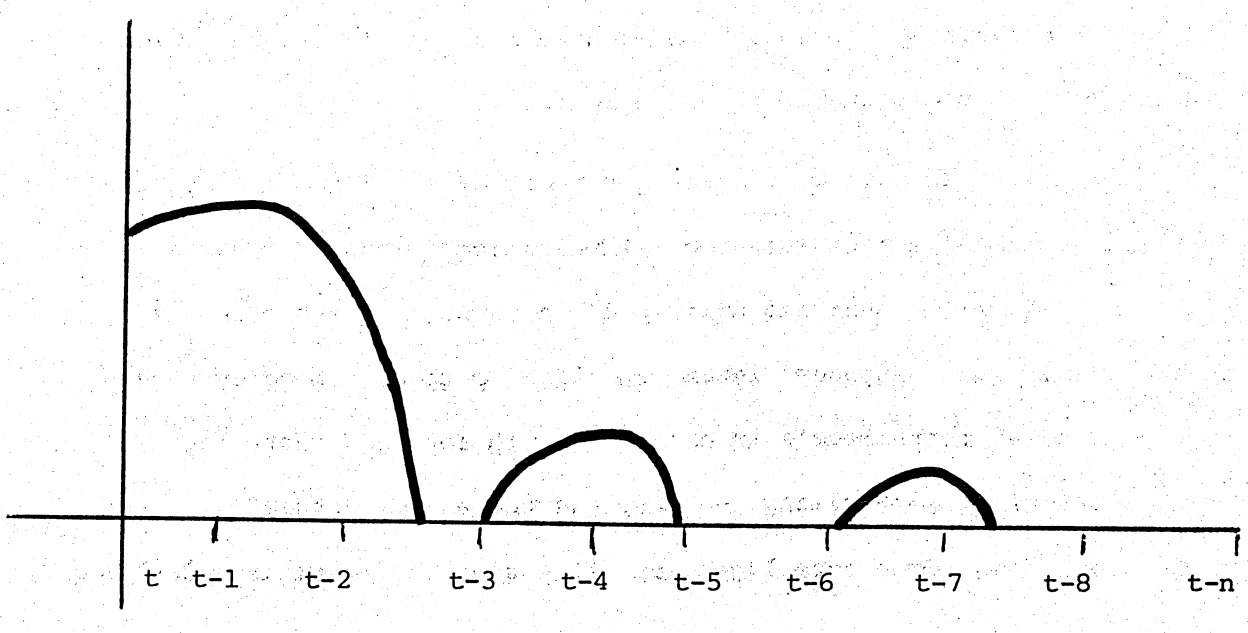
effects and discontinuous, segmented lag structures were used to capture the highly variable and 'pulsing' nature of particular advertising series. This latter point refers to the fact that advertising effects distributed over time are normally considered to be smooth and continuous as, for example, in Figure 3.1

Figure 3A : Continuous Distributed Lag Effect of Advertising



Discontinuous or segmented lag structures would appear as in Figure 3.2.

Figure 3B : A Segmented Lag Structure for Advertising Effects



It may be that where the advertising for a specific commodity is continually being 'switched' on and off to produce a periodic pulse of messages, and competitors to that product behave similarly; it may be unrealistic to expect smooth, continuous distributed lag patterns of advertising response.

Summary of the estimation procedure

For all the different demand equations considered the estimation proceeded by:

i) investigating the extent of seasonality apparent in the monthly data (with reference to time series analysis if necessary) and, consequently, adopting appropriate specification procedures;

ii) utilising the Almon polynomial lag structure to capture advertising effects. This usually required 'overfitting' the length and degree of polynomial to the advertising data and reducing these parameters to obtain results that satisfactorily approximated the historical pattern of advertising response.

iii) Looking at price, income and miscellaneous effects.

For almost all products the problems involved in successful completion of stages i) and ii) far exceeded those encountered in iii). These problems were overcome by using; alternative estimation techniques (ordinary least squares and generalized least squares regression), analysis of residual correlograms, and various statistical tests, further details of which are given in Appendix 3. At this stage it is appropriate to present the preferred equation(s) for each product which satisfactorily involve price, income and advertising effects in the explanation of retail purchases or sales. Note that, all prices, incomes and advertising expenditures used in the estimation of the preferred equations were measured in real terms i.e. they were deflated by the relevant index of inflation. Also, the magnitude of the estimated coefficients on advertising which is often apparently very small is in accordance with results from other econometric work on the sales response to advertising.

The Demand for Liquid Milk

The market for liquid milk accounts for approximately half of all milk sold off farms in England and Wales. As such the household demand for this product deserves serious consideration. Examination of the time series data on liquid milk sales demonstrates significant trends and seasonality of consumption over the period from the beginning of 1970 to the end of 1979. Two different measures of consumption of milk show a declining trend from around 1975 onwards and there is a consistent seasonal pattern of demand over the period considered. One further point that arises from the raw data on advertising expenditure is that the milk advertising data from different sources did not always appear to be in agreement. This latter feature required estimation and specification of particular equations to be repeated with the alternative advertising data series.

The preferred equation Milk 38 is shown in Table 3.1 below. Also given in that table is Milk 37C which uses a different dependent variable. Equations are specified and estimated in double log form and use a 2nd degree Almon polynomial to approximate the lagged advertising effect.

The milk purchases data obtained from the Attwood Panel was deseasonalised using a simple 12 period moving average. This method of accounting for seasonal shifts in the demand for liquid milk seemed, at first, to be satisfactory in that a consistent, positive advertising-sales response was observed in Milk 37C and variants of it. However, satisfactory price and income estimates were not obtained by this specification. At best, the distributed lag structure on the retail price of liquid milk provided a cumulative estimate of the price response which was just plausible (although the shape of the price lag structure was highly implausible as shown in Fig. 3.1). In an effort to improve upon the results of Milk 37C, Milk 38 was specified and estimated.

The dependent variable used in Milk 38 was liquid milk sales data as compiled by the Board. Further important differences with Milk 37C

TABLE 3.1A : Milk Demand Elasticities

Elasticity of demand with respect to:	Milk 37 C	Milk 38
Price of milk (own price)	-0.0913*	-0.2068
Income	0.0254	0.3602
Liquid Milk Advertising	0.0272*	0.0363*

* Indicate long run elasticity computed from cumulative values of lagged coefficients of a variable.

Elasticities are derived from double log form of demand equation and thus are constant throughout the range of observations in the sample.

Figure 3.1 Price Lag Structure (Milk 37C)

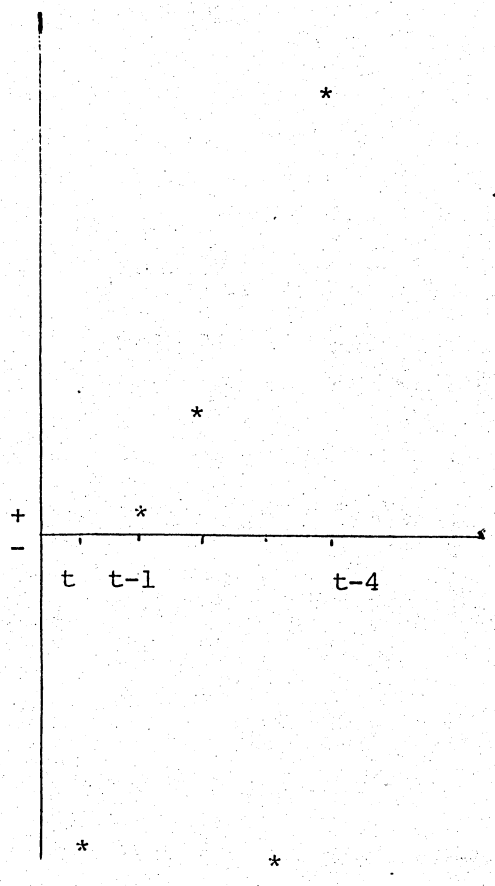


Figure 3.2 Advertising Lag Structure (Milk 37C)

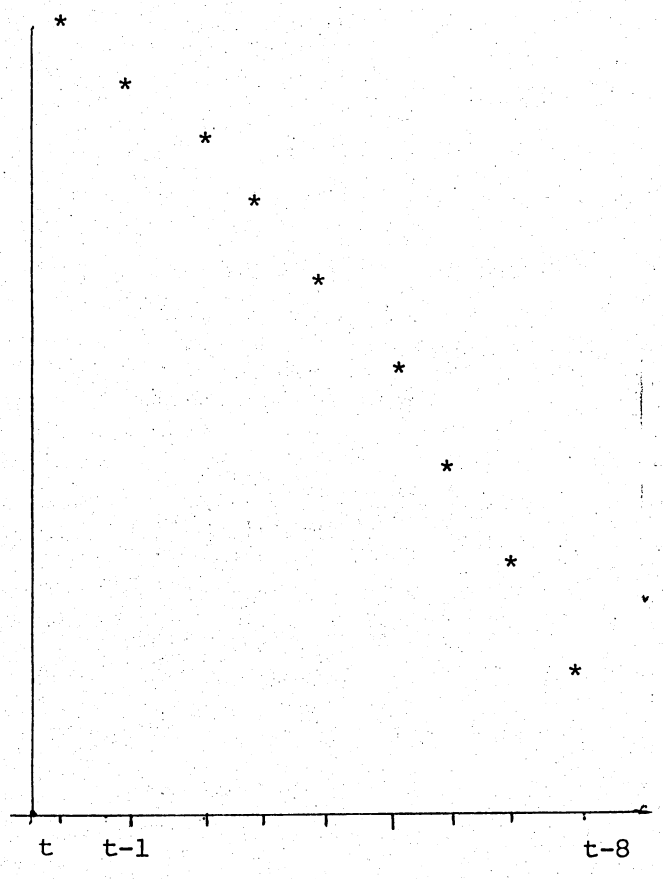
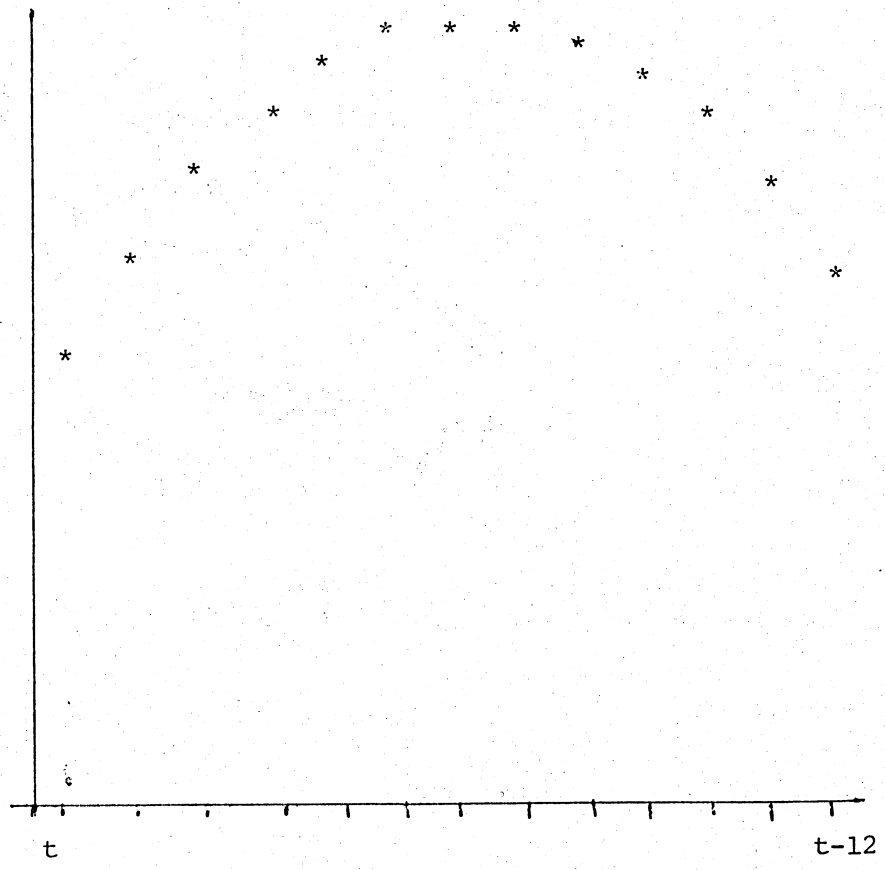


Figure 3.3 Advertising Lag Structure (Milk 38)



included: the use of the 12 monthly lagged dependent variable to account for seasonality, the use of current prices rather than lagged prices, the use of MEAL data on advertising not agency data, and the absence of a time trend. The estimates obtained from regression of Milk 38 are clearly superior to those in Milk 37C . The sign and magnitude of the elasticities given in Table 3.1A indicate that milk demand is relatively inelastic towards small changes in price and income. Interestingly, whilst Milk 38 used advertising data from a different source than Milk 37C, the size of the advertising-sales response and its pattern of effect over time is not really very different. Figures 3.2 and 3.3 above demonstrate the form of the distributed lag effect of the estimated advertising coefficients in the different equations.

TABLE 3.1 : The Milk Demand Equations

Equation	Dependent Variable	Intercept	Price of Milk (t)	Lagged Price of Milk (t-1)	Lagged Price of Milk (t-2)	Lagged Price of Milk (t-3)	Lagged Price of Milk (t-4)	Income	Time Trend	Dummy Weekend	Dummy Bank Holiday
Milk 37C	Deseason-alized Milk Purchases (Pints per head)	3.630	-0.227	0.011	0.079	-0.238	0.283	0.0254	-0.197	0.003	-0.013
		(5.59)	(3.50)	(0.16)	(1.07)	(3.82)	(4.49)	(0.24)	(2.84)	(0.57)	(2.83)
	$\bar{R}^2$ = 0.766										
	D-W = 1.9667										

	Lagged Milk Advertising								
Current Milk Advertising (t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)
0.0048	0.0045	0.0041	0.0037	0.0032	0.0027	0.0021	0.0014	0.0007
(1.55)	(1.97)	(2.08)	(1.90)	(1.70)	(1.56)	(1.41)	(0.91)	(0.31)

Milk 37C estimated in double log form by Generalized Least Squares Regression from 1975.10 to 1979.06.
Advertising data obtained from the advertising agencies and deflated by a media rates index and population
advertising lag structure estimated by Almon polynomial degree 2.
Price lag structure estimated in unrestricted form.

TABLE 3.1 (Continued)

Equation	Dependent Variable	Intercept	Price of Milk	Lagged Milk Sales (t-12)	Income	Dummy Weekend	Dummy Bank Holiday	Current Milk Advertising
	million lires							
Milk 38	Liquid Milk Sales	0.5113 (1.19)	-0.2067 (4.03)	+0.7726 (12.02)	0.3602 (5.37)	0.0058 (1.27)	0.0013 (0.32)	0.0019 (0.86)

$\bar{R}^2$ = 0.896

D.W. = 2.01

ρ = -0.10

Lagged Milk Advertising											
(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)	(t-10)	(t-11)	(t-12)
0.0023	0.0027	0.0029	0.0031	0.0033	0.0033	0.0033	0.0032	0.0030	0.0028	0.0025	0.0021
(1.30)	(1.72)	(2.02)	(2.19)	(2.29)	(2.39)	(2.52)	(2.67)	(2.71)	(2.40)	(1.73)	(1.08)

Milk 38 estimated in double log form by Generalized Least Squares Regression from 1976.01 to 1979.09
Advertising data obtained from M.E.A.L. and deflated by a 'messages' cost index, lag structure
estimated by Almon polynomial degree 2.

The Demand for Cream from Households

The simple time series analysis of the data on household cream purchases given in Appendix 2 supports the intuitive notion that demand for cream is highly seasonal. This seasonality of sales is very marked for cream and accounts for a major part of the explanation of sales in any particular month. The econometric analysis, therefore, has the unenviable task of relating changes in price, income and advertising expenditure to cream purchases against a background of very large seasonal shifts in sales. Furthermore, the sources of data on cream advertising expenditure differed significantly in their portrayal of expenditure changes over the time period considered. The preferred equation, Cream 26B, is shown in Table 3.2 below. Cream 26B is a double log specification using cream purchases data from the Attwood Panel and cream advertising data as supplied by the advertising agency (Ogilvy Benson and Mather) involved. One significant feature of Cream 26B and Cream 26 (also shown in that table) is the explanation of seasonal shifts in cream sales using the lagged dependent variable, that is this month's sales are explained to a large degree by what happened in the same month last year. Also important to note is the segmented lag structure of advertising. Equation Cream 26B utilizes advertising expenditures in the current period and from 4, 5, 6, 7 and 8 months ago to explain changes in current cream sales. In other words, there is an effect of current advertising on current sales and an effect from advertising between 4 and 8 months previously. Advertising 2 and 3 months ago and in periods further back than 8 months has no part in the explanation of current cream purchases.

Tables 3.2A and Figures 3.4 and 3.5 below present the important elasticities of demand derived from the econometric estimates of cream purchases, and the shape of the lag structure on cream advertising.

TABLE 3.2 : The Cream Demand Equations

Equation	Dependent Variable	Intercept	Income	Price	Current Cream Advertising (t)	Lagged Cream Advertising (t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)	Lagged Cream Purchases (t-1)	(t-12)
Cream 26	Cream Purchases	-2.0088	0.9696	-0.7848	0.0100	0.0050	0.0035	0.0046	0.0083		0.0069	0.1400	0.8431
		(4.29)	(2.23)	(4.48)	(3.8)	(2.07)	(1.32)	(1.67)	(3.40)		(2.90)	(3.83)	(24.70)
	$\bar{R}^2$ 0.95												
	D-W 1.83												
						estimated by an Almon polynomial (degree 2)							
Cream 26B	Cream Purchases	-1.890	0.7182	-0.8094	0.0102	0.0047	0.0073	0.0068	0.0032	-0.0037		0.1044	0.8480
		(3.65)	(1.52)	(4.20)	(3.49)	(1.71)	(3.15)	(2.70)	(1.41)	(1.33)		(2.69)	(22.22)
	$\bar{R}^2$ 0.94												
	D-W 1.97												
	ρ = 0.77												

Equations estimated over the period 1976.01 to 1979.07 in double log form by Generalized Least Square regression.

Advertising data obtained from the advertising agency and deflated by a 'messages' cost index.

Cream purchases is measured in fl.ozs/head

TABLE 3.2A : Cream Demand Elasticities

Elasticity of demand with respect to:	Cream 26	Cream 26B
Price of fresh cream (own price)	-0.7848	-0.8094
Income	0.9696	0.7182
Cream Advertising	0.0383*	0.0285*

* Indicates long run elasticity computed from cumulative values of lagged coefficients of a variable.

Elasticities are derived from double log form of demand equation and thus are constant throughout the range of observations used.

Fig 3.4 Advertising Lag Structure (Cream 26B)

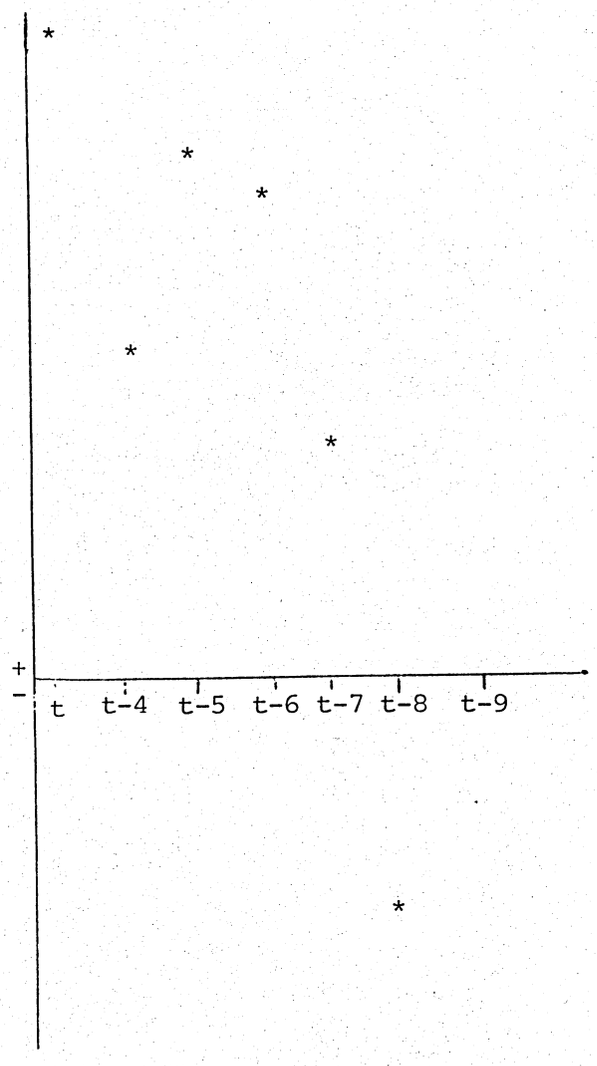
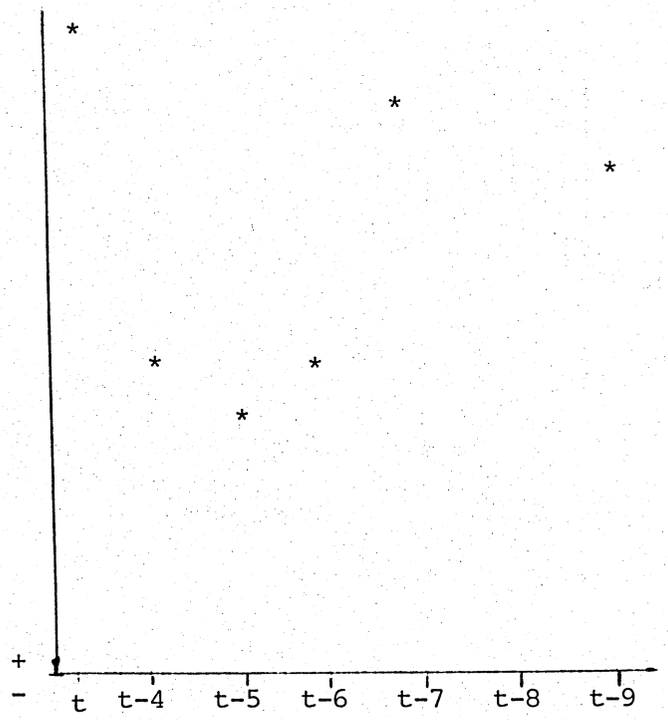


Fig 3.5 Advertising Lag Structure (Cream 26)



In both the cream demand equations shown the responses to price changes for fresh cream are similar. The elasticity values are less than unity suggesting an inelastic response to price. This probably reflects the limited range of substitutes for cream although, with a value of around -0.8, the demand is not markedly inelastic.

For the income and advertising responses, however, there is not complete agreement between the two equations in Table 3.2. The decision to represent the advertising response by a discontinuous lag structure was taken after a continual series of poor results, typified by Cream 25 in Appendix 3, using continuous lag forms which were not satisfactory on either a statistical or economic basis. Cream 26B is the preferred equation since the concept of a separate advertising/sales 'bubble' or 'blip' is best supported by the specification and statistical results in this equation. A positive income elasticity of less than unity is, perhaps, not in full accord with the traditional view that cream is a 'luxury' good but given the overall level in incomes and affluence of the U.K. population it may simply be that, for the majority, cream is a necessary part of the household budget.

The Demand for Butter and Margarine

The production and sale of milk in the form of butter has become an issue of major importance to U.K. milk producers in recent years. As liquid milk sales have declined the pressure to increase returns from the manufactured milk market has increased. At the same time the household market has been subject to various influences working against increased butter sales. Health warnings about cholesterol levels, increased product choice and range in the margarine market, and increases in the real price of butter have created a climate in which butter consumption overall has declined. Advertising may offer a means of countering these negative pressures on demand but in order to make appropriate decisions about advertising it is necessary to have estimates of the demand relationshipsfor; all butter sales, English butter sales, and margarine purchases. The preferred equations Butter 23, Butter 26, Butter 28 and Marg 11A are set out in Table 3.3 below.

The estimated coefficients in Table 3.3 and the elasticities derived from them in Tables 3.3A, 3.3B and 3.3C provide information on price, cross-price, income, and advertising effects in the yellow fats market. Leaving aside discussion of the advertising-sales response for the moment the following observations may be made about price and income effects. For butter, in general, the price elasticity of demand is relatively high and approaches unity. On the other hand, for margarine the response to price changes is seen to be relatively inelastic. The cross price effects of butter and margarine on the demand for margarine and butter are seen to be symmetric. An increase in the price of either commodity produces a similar positive increase in the demand for the other. The elasticity with respect to income is also of similar magnitude for both products but of opposite sign. These latter estimates confirm *a priori* expectations about butter and margarine as 'necessary' and 'inferior' goods.

TABLE 3.3 : The Butter and Margarine Demand Equations

Equation	Dependent Variable	Intercept	Income	Price of Butter	Price of Soft Margarine	Lagged Butter Purchases (t-12)	Dummy Weekend
Butter 23	Butter Purchases (lbs/100 households)	131.1016 (1.09)	149.2282 (1.76)	-905.8226 (6.13)	823.3997 (2.29)	0.5031 (10.13)	3.2888 (1.30)

	Dummy Bank Holiday	Current Margarine Advertising	Lagged Margarine Advertising					
			t-1	t-2	t-3	t-4	t-5	t-6	t-7
	0.2407 (0.10)	-0.00027 (4.47)	-0.00023 (4.21)	-0.00019 (3.80)	-0.00015 (3.19)	-0.00011 (2.41)	-0.00007 (1.54)	-0.00004 (0.68)	0.00000 (0.07)

	Lagged Margarine Advertising		Current Total Butter Advertising	Lagged Total Butter Advertising				
	t-8	t-9		t-1	t-2	t-3	t-4	t-5	t-6
	0.00004 (0.69)	0.00008 (1.18)	0.00002 (0.13)	-0.00012 (1.13)	-0.00016 (1.56)	-0.00013 (1.13)	-0.00004 (0.35)	0.00008 (0.65)	0.00020 (1.61)

	Lagged Total Butter Advertising					
	t-7	t-8	t-9	t-10	t-11	t-12
	0.00029 (2.19)	0.00035 (2.36)	0.00034 (2.21)	0.00023 (1.62)	0.00000 (0.02)	-0.00037 (2.14)

Butter 23 was estimated in linear form by Generalized Least Squares over the period 1976.08 to 1980.03.
Advertising data was obtained from MEAL and deflated by a 'messages' cost index.
Lag structures were fitted using Almon polynomials of degree 1 (margarine) and degree 3 (butter)

TABLE 3.3 continued

Equation	Dependent Variable	Intercept	Income	Price of English Butter	Price of Danish Butter	Price of New Zealand Butter	Price of Soft Margarine	Dummy Weekend
Butter 26	English butter purchases (lbs/100 households)	-79.753 (1.19)	-3.078 (0.07)	-1004.034 (6.78)	726.096 (6.19)	433.386 (3.92)	327.889* (1.74)	-0.043 (0.03)

Dummy Bank Holiday	Lagged English Butter Purchases (t-1)	Current Margarine Advertising	Current Advertising Share	Lagged Advertising Share (t-1)	Lagged Advertising Share (t-2)	Lagged Advertising Share (t-6)
1.196 (0.67)	0.366 (4.92)	-0.00018 (3.80)	6.0239 (2.47)	7.6242 (3.35)	10.6626 (3.48)	5.2519 (2.30)

$\bar{R}^2$ = 0.772

D.W. = 1.910

ρ = 0.14

Lagged Advertising Share (t-7)	Lagged Advertising Share (t-8)	Lagged Other Butter Advertising (t-3)	(t-4)	(t-5)	(t-9)	(t-10)	(t-11)
3.1106 (1.33)	4.0379 (1.78)	0.00009 (0.69)	-0.0003 (2.09)	-0.00005 (0.36)	0.00012 (0.80)	-0.00023 (1.60)	-0.00025 (1.60)

Butter 26 was estimated in linear form by Generalized Least Squares regression over the period 1976.01 to 1980.03. Advertising expenditure data was obtained from M.E.A.L. and deflated by a 'messages' cost index. Advertising share is the ratio of English butter advertising to total butter advertising.

TABLE 3.3 continued

Equation	Dependent Variable	Intercept	Price of English Butter	Price of Danish Butter	Price of New Zealand Butter	Lagged Market Share of English Butter (t-1)	Current Advertising Share (t)
Butter 28	Market Share of English Butter (%)	-11.865 (2.21)	-424.044 (7.03)	241.635 (5.11)	243.424 (4.97)	0.366 (4.32)	1.7908 (2.17)

Lagged Advert. Share					Total Competing Butter Advertising
(t-1)	(t-2)	(t-6)	(t-7)	(t-8)	(t)
2.3361 (2.91)	3.0137 (3.29)	1.1030 (1.32)	1.1146 (1.37)	1.2865 (1.57)	-0.00005 (0.10)

Lagged Competing Butter Advertising				
(t-4)	(t-5)	(t-9)	(t-10)	(t-11)
-0.00005 (1.21)	-0.00001 (0.29)	-0.00004 (0.78)	-0.00014 (2.51)	-0.00003 (0.69)

$\bar{R}^2$ = 0.723

D.W = 1.746

ρ = 0.40

Butter 28 was estimated in linear form by Generalized Least Squares over the period 1976.01 to 1980.03. Advertising expenditure data obtained from M.E.A.L. and deflated by a messages index. Advertising share represents the share of English butter advertising in total butter advertising.

Table 3.3 continued

Equation	Dependent Variable	Intercept	Price Ratio Margarine butter	Income	Lagged Margarine Purchases (t-1)	Lagged Margarine Purchases (t-12)	Dummy Weekend	Dummy Bank Holiday	Current Margarine Advertising (t)
Marg 11	Margarine purchases (lbs/100 households)	246.168	-155.371	-117.319	0.128	0.579	2.321	-8.926	0.00006
		(2.88)	(4.20)	(1.26)	(1.32)	(7.53)	(0.70)	(2.70)	(1.02)

	Lagged Margarine Advertising									
	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)	(t-10)
	0.00011	0.00015	0.00019	0.00021	0.00022	0.00022	0.00021	0.00019	0.00015	0.00011
	(2.57)	(4.24)	(5.18)	(5.37)	(5.27)	(5.12)	(4.95)	(4.72)	(4.209	(3.06)

$\bar{R}^2 = 0.78$

D.W. = 1.93

Lagged Margarine Advertising		Current Total butter advertising	Lagged Total Butter Advertising				
(t-11)	(t-12)	(t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)
0.00004	0.00006	-0.00053	-0.00051	-0.00048	-0.00043	-0.00036	-0.00029
(1.42)	(0.03)	(2.98)	(4.67)	(5.35)	(4.24)	(3.21)	(2.48)

Lagged Total Butter Advertising			
(t-6)	(t-7)	(t-8)	(t-9)
-0.00017	-0.00005	0.00008	0.00023
(1.75)	(0.59)	(0.64)	(1.15)

Marg 11 was estimated in linear form by generalized least squares regression over the period 1976.10 to 1980.03. Advertising data was obtained from M.E.A.L. and an Almon polynomial lag of degree 2 was used to capture the effect of margarine and butter advertising

TABLE 3.3. continued

Equation	Dependent Variable	Intercept	Price of Butter	Price of Soft Margarine	Income	Lagged Margarine Purchases (t-1)	Lagged Margarine Purchases (t-12)	Dummy Weekend
Marg 11A	Margarine purchases (lbs/100 households)	88.388 (0.75)	466.102 (3.42)	-282.478 (0.75)	-147.018 (1.57)	0.203 (2.10)	0.582 (7.76)	3.349 (0.97)

	Dummy Bank Holiday	Current Margarine Advertising	Lagged Margarine Advertising (t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)
	-9.64** (2.85)	0.00008 (1.49)	0.00013 (3.16)	0.00017 (4.79)	0.00020 (5.57)	0.00022 (5.59)	0.00022 (5.33)	0.00021 (5.00)	0.00020 (4.61)

$\bar{R}^2$ = 0.80

D.W. = 1.90

Lagged Margarine Advertising (t-8)	(t-9)	(t-10)	(t-11)	(t-12)	Current total Butter Advertising
0.00017 (4.06)	0.00013 (3.20)	0.00008 (1.89)	0.00002 (0.39)	-0.00005 (0.84)	-0.00052 (2.98)

Lagged Total Butter Advertising

(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)
-0.00049 (4.61)	-0.00046 (5.23)	-0.00041 (4.11)	-0.00034 (3.11)	-0.00024 (2.41)	-0.00018 (1.76)	-0.00008 (0.78)	0.00004 (0.27)	0.00016 (0.79)

Marg 11A was estimated in linear form over the period 1976.10 to 1980.03 by Generalized Least Squares regression Advertising data was obtained from M.E.A.L. and deflated by a 'message' cost index. The lag structures were estimated by an Almon polynomial, degree 2.

TABLE 3.3A : Butter Demand Elasticities

Elasticity of demand with respect to:	Butter 23
Price of butter (own price)	-0.88
Price of soft margarine	0.453
Income	0.468
Margarine advertising	-0.126*
Total butter advertising	0.0343 (0.0734**)

* Indicates long run elasticity computed from cumulative values of lagged coefficients of a variable.

Elasticities are derived from linear form of equations and are calculated at the mean values of the relevant period of estimation.

** Indicates long run elasticity computed from cumulative positive values of lagged coefficients of a variable.

Equations Butter 26 and 28 were concerned with the demand for English butter rather than butter in general. In particular, Butter 28, specified as a market share model, allowed estimation of brand price and advertising effects. The own price elasticity is quite large and indicates a very elastic response to changes in English butter prices. This is to be expected in a market share model where there is likely to be a high degree of substitution between brands. Cross price effects of the two main competitors, Danish and New Zealand butter, are seen to be about equal. This is perhaps a little surprising given the high degree of brand loyalty normally attributed to Danish butter consumers. However, this was a relatively consistent result and, may suggest a reconsideration of established views on substitution possibilities for English and Danish butter (It is worth remembering, however, that the dependent variable here, English butter, is an aggregate of various types of English butter whereas the Danish butter data is made up almost entirely from Lurpak).

TABLE 3.3B : English Butter Demand Elasticities

Elasticity of demand with respect to:	Butter 26	Butter 28
Income	-0.062	
Price of English butter (own price)	-6.081	-7.127
Price of Danish butter	4.690	4.33
Price of New Zealand butter	2.622	4.087
Price of Soft Margarine	1.150	
Margarine advertising	-0.127	
Advertising share (own/ total butter advert)	0.421*	0.339*
'Other' butter advertising	-0.140*	-0.22*

* Indicates long run elasticity computed from cumulative values of lagged coefficients of a variable.

Elasticities are derived from the linear form of a demand equation and are calculated at the mean values of the sample period.

With regard to the effect of advertising on total sales of butter and margarine, and English butter purchases, the equations in Table 3.3 are important in several respects. First of all, the econometric work and the preferred equations resulting from it has not been able to demonstrate a significant positive effect of generic advertising on total butter sales. Such generic campaigns were conducted by the Butter Information Council during part of the sample period. It is felt that the sporadic nature of these generic expenditures and their small size relative to 'brand' expenditures prevented successful estimation of any generic effect. This point is considered again in Appendix 2 along with a brief review of the time series characteristics of generic advertising expenditures. However, the Butter Information Council's advertising is only a small part of total butter advertising (and an even smaller part of advertising in the yellow fats market). Therefore, the successful estimation of brand

TABLE 3.3C : Margarine Demand Elasticities

Elasticity of demand with respect to:	Marg 11	Marg 11A
Income	-0.410	-0.510
Price of margarine relative to price of butter	-0.342	
Price of Soft margarine		-0.173
Price of butter		+0.505
Margarine advertising	+0.233*	+0.221*
Total butter advertising	-0.131*	-0.134*

* Indicates long run elasticity computed from cumulative values of lagged coefficients for that explanatory variable.

Elasticities are derived from equation estimated in linear form and calculated at sample means.

advertising effects and 'brand-generic' effects demonstrated in Table 3.3 is worthy of detailed discussion.

In equations Butter 23 and Marg 11A the effects of total brand advertising for butter and margarine on the primary demand for the product are represented by the Almon lag structures estimated for margarine and total butter advertising. These 'brand-generic' effects reflect the small increases in overall demand for a product that may result from the total amount of advertising messages given for different brands or types of that product. For the yellow fats market it is clearly of interest to know what the effect of margarine advertising is on total butter sales and vice versa (just as it is important to know what the price and cross-price effects are).

The evidence of equations Butter 23 and Marg 11A suggests that brand margarine advertising has a greater generic impact on margarine sales and total butter sales than branded butter advertising. To be precise, margarine advertising is shown, in Table 3.3C, to have an elasticity almost

twice as large as that for total butter advertising. This relationship is seen to persist in equation Butter 23. Here, the size of the brand-generic effect of margarine advertising on butter sales is seen to be considerably greater than the brand-generic effect of butter advertising. In fact it appears that this (negative) margarine effect is about three times greater than the (positive) butter effect. The specification of the butter advertising-sales response in Butter 23 is less than satisfactory, though, relying as it does, on a 3rd degree polynomial to represent the distributed lag shape (Figure 3.7). Other advertising lag structures in Figures 3.6, 3.12 - 3.15 utilize simpler 1st and 2nd degree polynomials. Indeed, the negative coefficients estimated as part of the butter advertising lag structure in Butter 23 are mostly statistically insignificant. Discounting these values produces an alternative long run advertising elasticity (shown in parentheses in Table 3.3A) which is just half the size of the countervailing brand-generic margarine advertising effect.

Whatever the precise relative magnitudes of butter and margarine advertising on overall demand in the yellow fats market, it is significant that margarine advertising seems to have a larger own-, and cross-advertising effect than butter advertising. Further, the price elasticity of soft margarine is actually smaller than the elasticity of demand with respect to margarine advertising. Finally, since the activities of advertisers in the two markets are self-cancelling to some extent it would appear that there is some unnecessary and wasteful duplication of advertising effort in the yellow fats market.

The market share models estimated by equations Butter 26 and 28 presented further problems for the estimation of the advertising sales response. The emphasis here lay on the discovery of the size of brand advertising effects on the English butter market. As the graphical analysis of Appendix 2 shows the characteristic pulsing nature of brand advertising expenditures in this market are an important feature of the data. An advertising share

variable ($\frac{\text{own advertising}}{\text{total advertising}}$) was constructed to allow the own advertising 'message' relative to competitors' 'messages' to be expressed. Also the 'on-off-on' type (pulsing) behaviour of advertising expenditures in the English butter market required that discontinuous lag structures be considered. This produced 'bubble' lag structures, as Figures 3.8 - 3.11 show, with the bubbles appearing at different points in the distributed lag shape for own and competitors' advertising. The relative sizes of the own - and cross-advertising elasticities suggest that within the market for butter, advertising has a smaller effect than price on household purchases. However, the own advertising effect is significantly larger than the cross effect from competitors' advertising, and larger than the brand-generic effect considered in equations Butter 23 and Marg 11A. The relative roles of advertising and price in the market for English butter cannot be determined at this stage until we know the comparative costs and revenues associated with changing these parameters. The estimated coefficients within Butter 28, though, suggest that the interpretation and evaluation of different strategies to increase the market share of English butter will be interesting , to say the least.

Figure 3.6 Margarine Advertising Lag Structure (Butter 23)

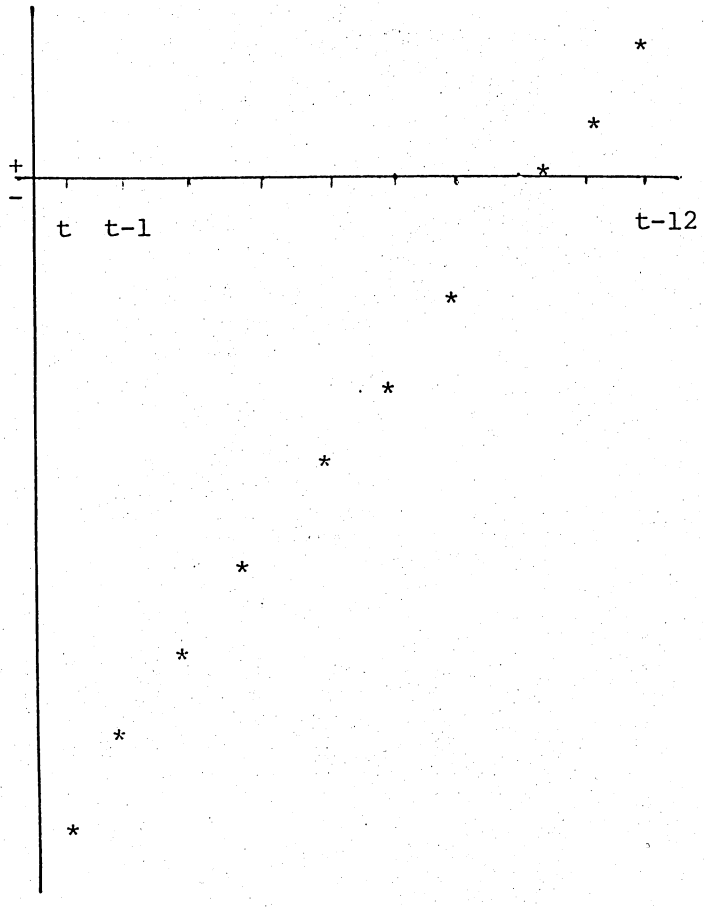


Figure 3.7 Total Butter Advertising Lag Structure (Butter 23)

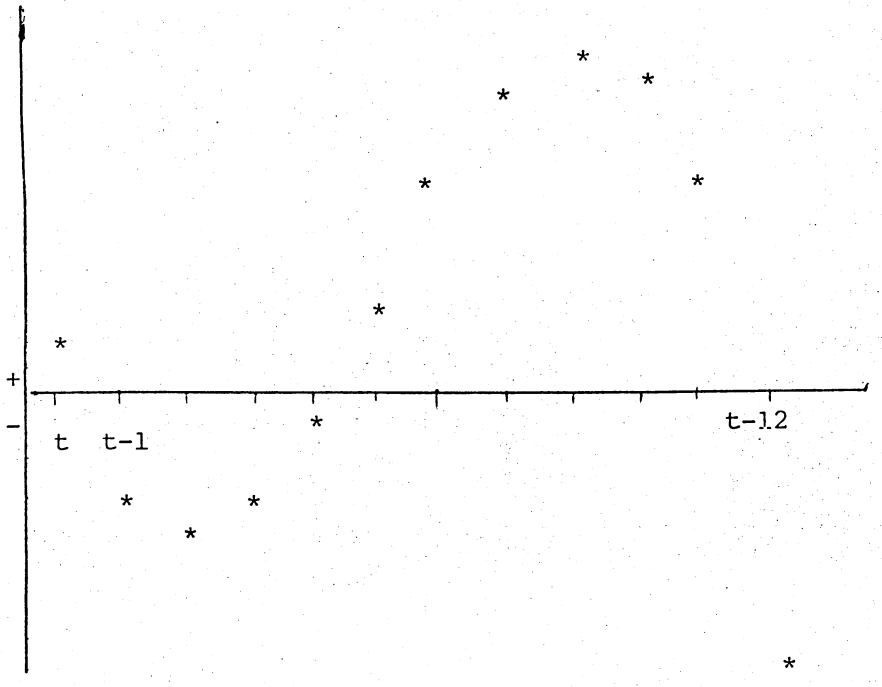


Figure 3.8 Advertising Share Lag Structure (Butter 26)

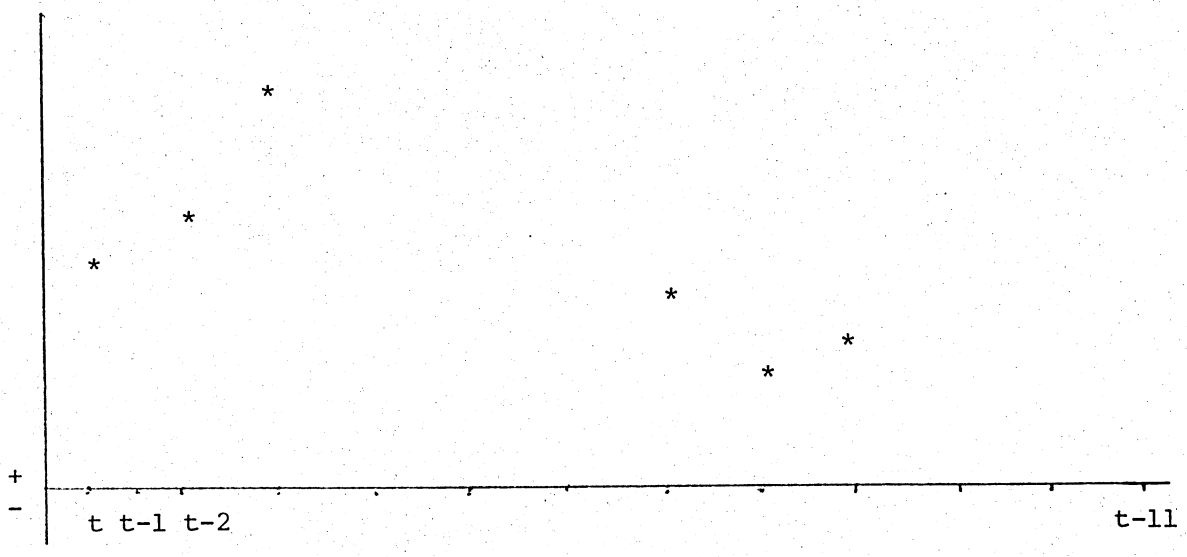


Figure 3.9 'Other' Butter Advertising Lag Structure (Butter 26)

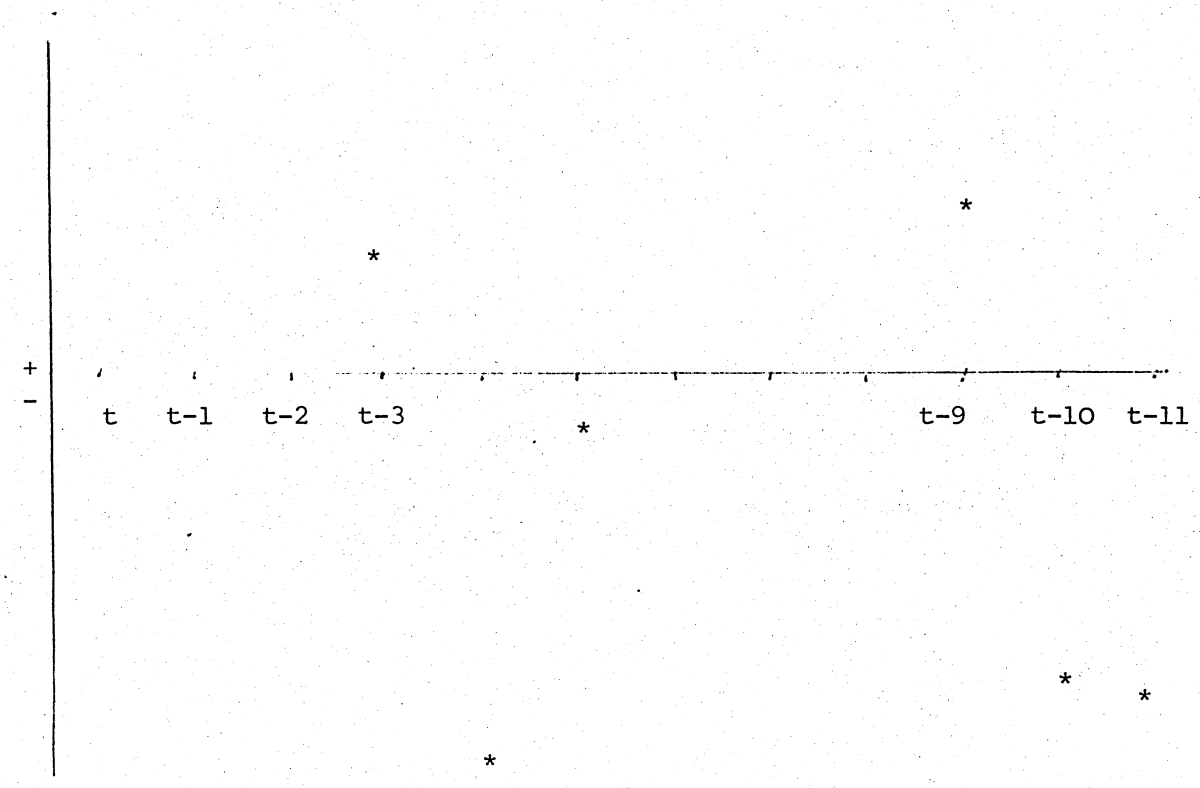


Figure 3.10 Advertising Share Lag Structure (Butter 28)

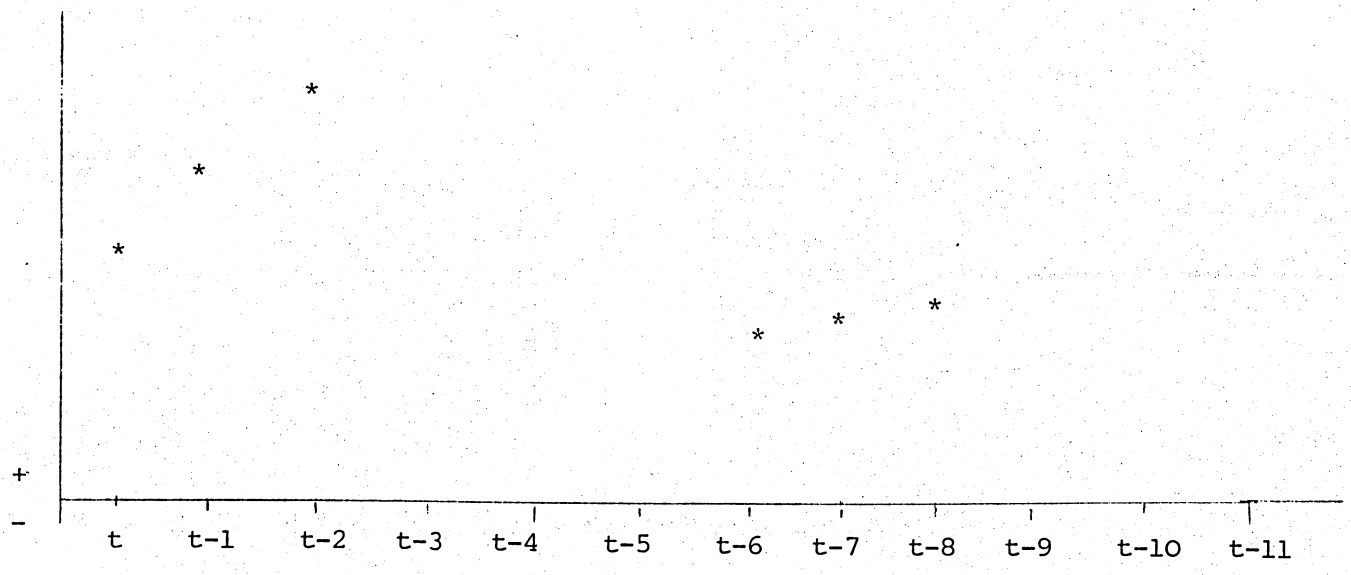


Figure 3.11 'Other' Butter Advertising Lag Structure (Butter 28)

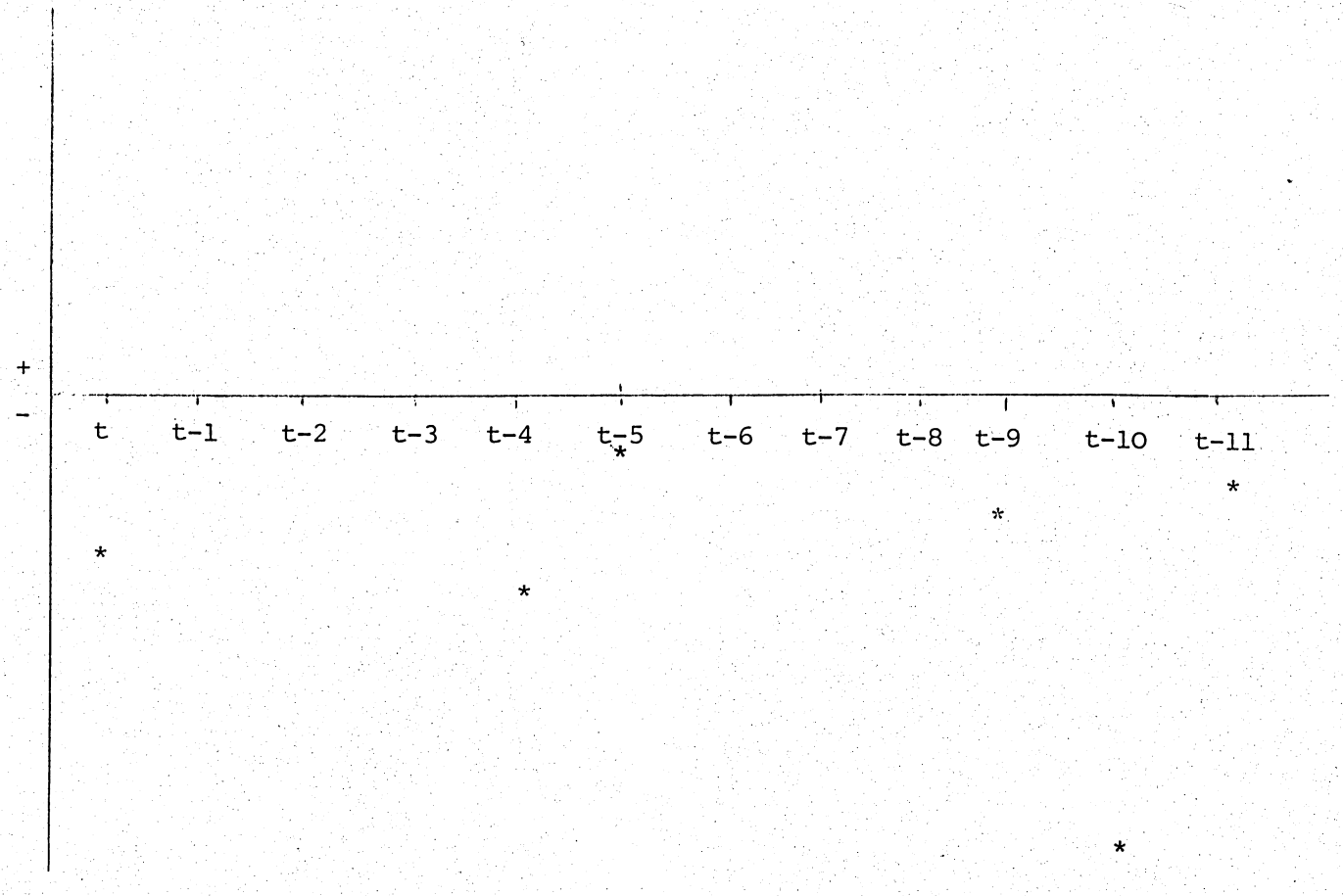


Figure 3.12 Margarine Advertising Lag Structure (Marg 11)

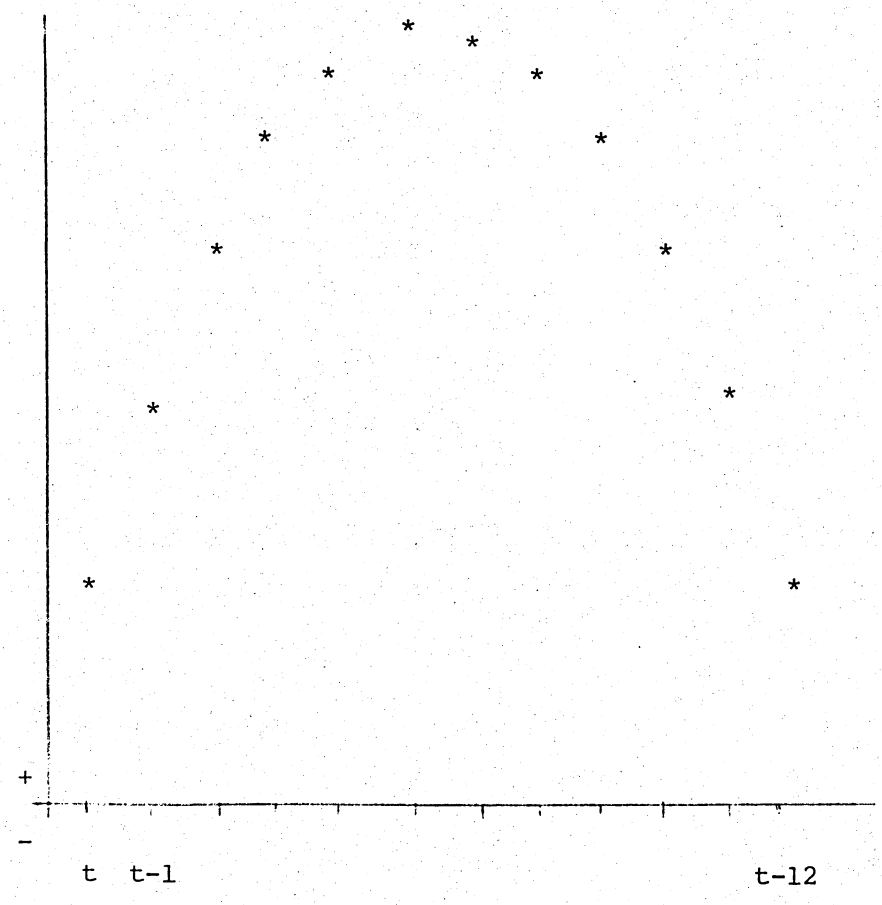


Figure 3.13 Total Butter Advertising Lag Structure (Marg 11)

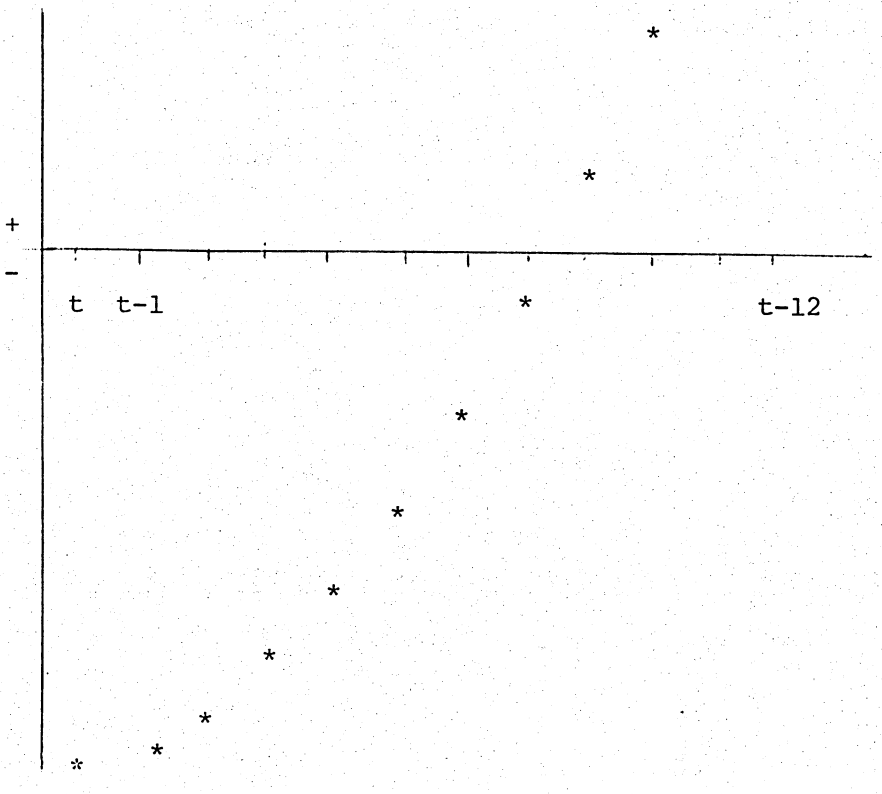


Figure 3.14 Margarine Advertising Lag Structure (Marg 11A)

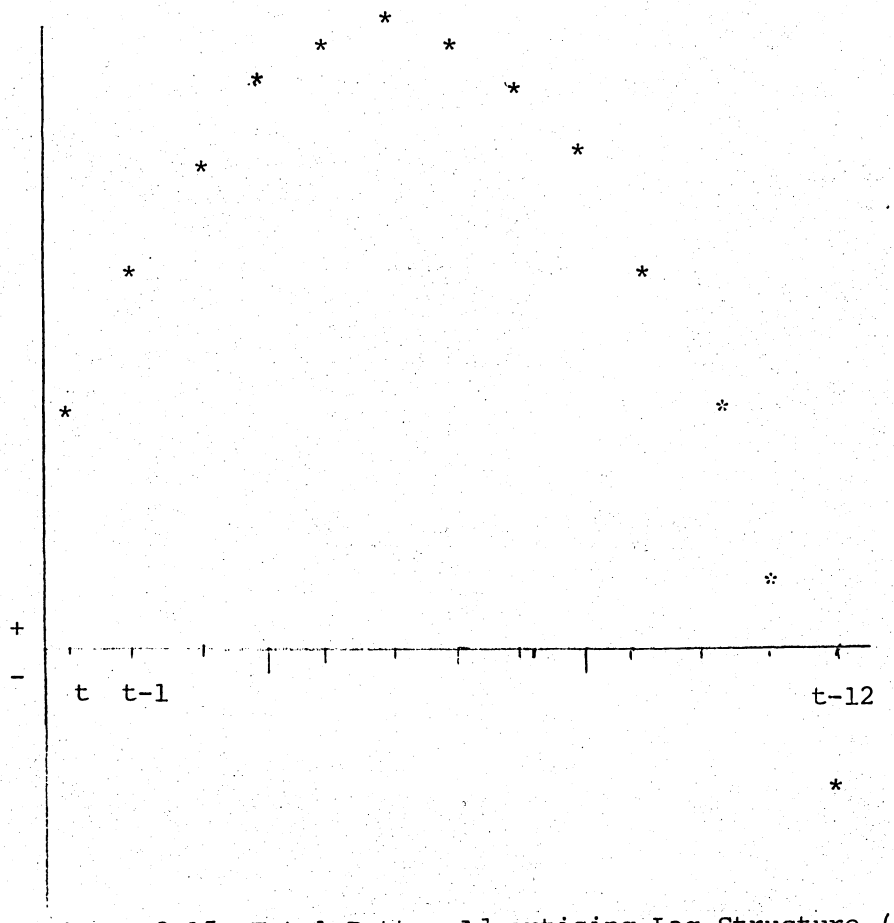
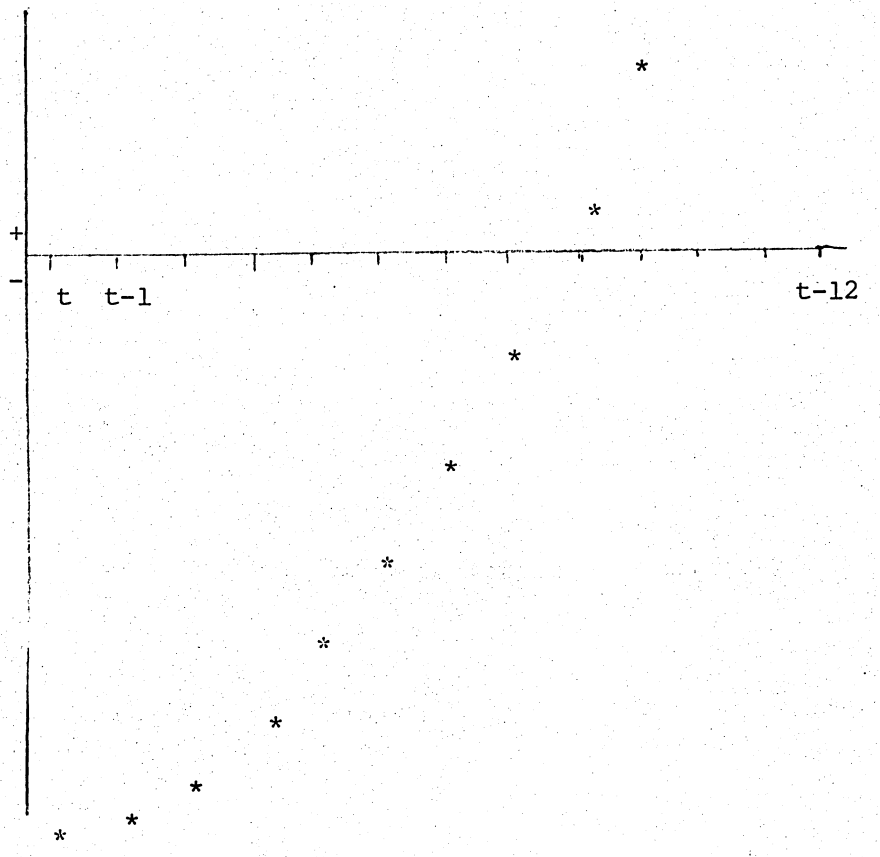


Figure 3.15 Total Butter Advertising Lag Structure (Marg 11A)



The Demand for Cheese

A significant proportion of liquid milk supplies in England and Wales is used in the production of cheese. Furthermore, as the entry of New Zealand cheddar into the Community has been progressively restricted, and consumers have become more aware of 'new' types of soft cheeses, changes in the size and composition of the cheese market are to be expected. Modelling the demand for cheese is particularly difficult, however. Apart from the usual problems of seasonality and advertising response specification it is clear that the product group 'cheese' is not homogeneous with all that that implies for errors in identification and measurement.

Whilst English Cheddar Cheese is a major part of all cheese purchases the residual includes such diverse products as Camembert, Gouda and Wensleydale. Cheese may also appear in many products which have undergone further processing. Thus the consumer is faced with a choice between several types of cheese (for example, cheddar, territorial, or 'Continental') and various processed 'cheese' products (for example, cheese slices, cheese spreads etc.). Also, if cheese is purchased for one of its characteristics, its protein content, then other protein sources may be considered in the demand function. Hence, eggs, meat and fish are all general categories of product that may be relevant to the cheese purchasing decision. Adding to this confusion of product substitutes and complements are the various 'messages' on behalf of all these products individually (brand advertising) and collectively (generic advertising). To separate out these effects on consumption required, perhaps, as much time and effort as that given to all the commodities considered in this analysis put together.

In any event, the preferred demand equations for cheese are given in Table 3.4 in the following pages. An attempt was made to model the overall demand for cheese and this is represented by equation Cheese 20. Not surprisingly for a dependent variable that involves many different types of cheese it was difficult to capture the price effect. One would expect for any particular

product that price effects on overall cheese sales are relatively small (given that there is substitutability between product types in the total cheese demand function). However, the coefficient on the price variable used (English Cheddar) is very low and must be interpreted with care. Cheese 20 was successful, though, in modelling the effect on sales, of generic advertising and the total amount of advertising in the cheese market. Figures 3.16 and 3.17 illustrate the lag structure on advertising and Table 3.4A presents the advertising elasticities. Those elasticity values imply that for the total cheese market generic advertising had a significant positive effect and there was also a small positive effect on overall sales from branded advertising in the cheese market. Since Cheese 20 contributes little to our understanding of what is happening in particular product groups in the cheese market emphasis was given to estimating price and advertising effects in one of those groups - the Cheddar market. This product type forms a major part of all cheese sales and, importantly, of English cheese sales. Thus Cheese 25A describes the cheddar cheese demand relationship.

The price elasticities derived from Cheese 25A are given in Table 3.4A and, perhaps, are rather puzzling. Whilst relatively large own and cross price effects might be expected where consumers move easily from one product type to another e.g. cheddar to territorial, it is difficult to reconcile the large own price effect of cheddar cheese with a much smaller cross price effect on continental (Gouda) cheese. Generic advertising, again is shown to have a small positive effect on sales. As expected, that effect is smaller than that seen in the demand for total cheese. (A generic campaign is, presumably, expected to increase overall sales of cheese not just sales of a particular type).

Further differentiation of the cheese market allowed the analysis to investigate the demand for English cheddar cheese and the results of this are given in equations Cheese 27A, Cheese 30D and Cheese 31 in Table 3.4.

TABLE 3.4A : Cheese Demand Elasticities

	Cheese 20	Cheese 25A
Income	+0.279	+0.039
Price (English cheddar)	-0.052	
Price (cheddar cheese)		-1.022
Price (Territorial cheese)		+0.707
Price (Gouda)		+0.142
Generic Cheese Advertising	+0.1328*	+0.027*
Total Cheese Advertising	+0.0380*	

* Indicates long run elasticity computed from cumulative values of lagged coefficients of a variable

Elasticities are derived from the linear form of a demand equation (Cheese 20) and are calculated at the mean values of the sample period.

Elasticities are derived from the double log form of demand quation (Cheese 25A) and thus are constant throughout the range of observations in the sample.

The corresponding elasticities are presented in Table 3.4B. The data on English cheddar purchases or its share of the total cheese market, as supplied by the Board, did not allow for a satisfactory relationship with prices and advertising. Despite a multitude of alternative specifications and hypotheses about the way in which advertising affected English cheddar cheese purchases no positive, significant correlation was found. Cheese 27A and Cheese 30D then just contain estimates of the price effects for English cheddar. Unfortunately, those effects are not in complete correspondence with each other. Further, the relative size of the price coefficients in Cheese 30D and Cheese 31 are not satisfactory. These estimates suggest that the own price elasticity of English cheddar is quite inelastic and cross price effects with other cheese types (territorial and continental) are also not markedly high. It is difficult to understand why this should be so. Especially for market share models in which subsitution between competing products is expected to be high. Cheese 31 does, by using a simple transformation, provide a means of positively relating advertising

and English cheddar sales.

TABLE 3.4B : English Cheddar Cheese Demand Elasticities

	Cheese 27A	Cheese 30D	Cheese 31
Price (ratio of English cheddar to Gouda Price)	-0.292		
Price (Territorial cheese)	+0.757	+0.406	+0.794
Price (Gouda)		+0.214	+0.252
Price (English cheddar)		-0.117	-0.075
Advertising Share (English Country Cheese to total cheese advertising)			+0.0473*
Other cheese advertising (Dutch)			-0.0098

* Indicates long run elasticity computed from cumulative values of lagged coefficients of a variable.

Elasticities are derived from the linear form of a demand equation (Cheese 27A, Cheese 31) and are calculated at the mean values of the sample period.

Elasticities are derived from the double log form of the demand equation (Cheese 30D) and thus are constant throughout the range of observations in the sample.

The dependent variable in Cheese 31 is the market share of English cheddar sales in the total cheddar market expressed as a percentage. (As opposed to Cheese 30D which uses the share of English Cheddar in the total cheese market.) The resulting estimation demonstrates a significant, positive effect of advertising share on this dependent variable. The share variable is constructed from English Country cheese[1] advertising expenditures divided by total cheese advertising. An elasticity value of +0.0473 was found for this advertising share variable, and whilst no distributed lag effect of 'other' cheese advertising was found, an elasticity value of -0.0098 was estimated for

1. The English Country cheese advertising campaign was considered, by several of those at the Board and the National Dairy Council who were consulted, to have been aimed at increasing English cheddar sales.

current Dutch cheese advertising. This latter estimate may be a satisfactory approximation of the effect of competitive cheese advertising expenditures.

To summarise, the analysis of cheese demand attempted to relate cheese generic and brand advertising expenditure to cheese sales. For a product that is very heterogeneous and for a market that is extremely crowded with advertising messages this was no easy task. The estimates that have been presented satisfy the necessary statistical criteria but it must be accepted that knowledge of the market rather than just economic theory will play an important part in any assessment and evaluation of the quantitative values presented.

TABLE 3.4 : The Cheese Demand Equations

Equation	Dependent Variable	Intercept	Income	Price of English Cheddar Cheese	Lagged Cheese Purchases (t-1)	Lagged Cheese Purchases (t-12)	Dummy Bank Holiday	Dummy Weekend	Current Total Cheese Advertising
Cheese 20	Total Cheese Purchases (lbs/100 households)	-13.6742 (0.21)	74.7083 (1.14)	36.7738 (0.93)	-0.1106 (1.34)	0.7678 (7.37)	2.3884 (1.39)	-0.7971 (0.53)	0.00003 (0.58)

Lagged Total Cheese Advertising

t-1	t-2	t-3	t-4	t-5	t-6	t-7	t-8	t-9
0.00005 (1.07)	0.00006 (1.61)	0.00007 (2.02)	0.00007 (2.16)	0.00007 (2.09)	0.00006 (1.92)	0.00005 (1.66)	0.00004 (1.29)	0.00002 (0.71)

$\bar{R}^2$ = 0.66

D.W. = 1.80

ρ = 0.45

Lagged Total Cheese Advertising

t-10	t-11	t-12
0.00000 (0.02)	-0.00003 (0.66)	-0.00006 (1.05)

Current Generic Cheese Advertising

-0.00002 (0.11)

Lagged Generic Cheese Advertising

t-1	t-2	t-3	t-4	t-5	t-6	t-7	t-8	t-9	t-10
0.00013 (0.65)	0.00026 (1.25)	0.00037 (1.63)	0.00046 (1.85)	0.00053 (2.00)	0.00057 (2.11)	0.00059 (2.22)	0.00059 (2.32)	0.00057 (2.40)	0.00053 (2.43)

Lagged Generic Cheese Advertising

t-11	t-12
0.00046 (2.27)	0.00038 (1.79)

Cheese 20 was estimated by Generalized Least Squares over the period 1976.01 to 1980.03 in linear form. Data on total cheese advertising was obtained from MEAL and on generic cheese advertising from the advertising agency. Advertising lag structures were fitted using an Almon polynomial, degree 2.

TABLE 3.4 continued

Equation	Dependent Variable	Intercept	Income	Price of Cheddar Cheese	Price of Territorial Cheese	Price of Continental Cheese	Lagged Cheddar Cheese Purchases (t-1)
Cheese 25A	Cheddar Cheese Purchases (lbs/100 households)	1.6060 (2.50)	0.0385 (0.23)	-1.0217 (3.80)	0.7069 (2.12)	0.1419 (1.50)	-0.1574 (1.75)

Lagged Cheddar Cheese Purchases (t-12)	Dummy Weekend	Dummy Bank Holiday	Current Generic Cheese Advertising	Lagged Generic Cheese Advertising t-1	t-2	t-3
0.7491 (8.50)	-0.0044 (0.75)	0.0029 (0.0431)	-0.00223 (1.12)	-0.00044	0.00106	0.00227

$\bar{R}^2$ = 0.64

D.W. = 1.82

ρ = 0.50

Lagged Generic Cheese Advertising								
t-4	t-5	t-6	t-7	t-8	t-9	t-10	t-11	t-12
0.00319 (2.25)	0.00381 (2.59)	0.00414 (2.81)	0.00418 (2.96)	0.00393 (3.07)	0.00338 (3.13)	0.00254 (2.96)	0.00141 (1.86)	0.00002 (0.02)

Cheese 25A was estimated in double log form by Generalised Least Squares regression over the period 1976.01 to 1980.03. Advertising data was obtained from the advertising agency and deflated using a 'messages' cost index. The lag structure was fitted using an Almon polynomial, degree 2.

TABLE 3.4 (continued)

Equation	Dependent Variable	Intercept	Price Ratio (English Cheddar/Gouda)	Price of Territorial Cheese	Lagged English Cheddar Cheese Purchases (t-1)
Cheese 27A	English Cheddar Cheese purchases (lbs/100 households)	2.5545 (0.13)	-28.9996 (3.08)	207.8324 (2.73)	0.0966 (0.81)

Lagged English Cheddar Cheese Purchases (t-12)	Dummy Weekend	Dummy Bank Holiday
0.4237 (3.39)	-0.4609 (0.40)	0.2106 (0.18)

$\bar{R}^2$ = 0.47

D.W. = 1.67

ρ = 0.52

Cheese 27A was estimated in linear form by Generalized Least Squares over the period 1976.01 to 1980.03.

TABLE 3.4 (continued)

Equation	Dependent Variable	Intercept	Price of English Cheddar Cheese	Price of Territorial Cheese	Price of Continental Cheese (Gouda)	Lagged Market Share (t-1)	Dummy Weekend
Cheese 30D	Market Share English Cheddar Cheese in total cheese market (%)	2.1885 (2.75)	-0.1174 (2.46)	0.4058 (2.15)	0.2141 (2.07)	0.5560 (3.56)	-0.0059 (0.60)

Dummy Bank Holiday
-0.0339 (4.27)

$\bar{R}^2$ = 0.90

D.W. = 1.99

ρ = 0.32

Cheese 30D was estimated in double log form by Generalized Least Squares over the period 1977.01 to 1980.03

TABLE 3.4 continued

Equation	Dependent Variable	Intercept	Price of English Cheddar Cheese	Price of Territorial Cheese	Price of Continental Cheese (Gouda)	Lagged Cheddar Market Share (t-1)
Cheese 31	Market share of English Cheddar in total cheddar market (%)	-16.5348 (3.14)	-14.3375 (1.44)	143.9098 (4.19)	45.1572 (2.95)	0.2545 (1.77)

Current Advertising Share	Lagged Advertising Share t-1	t-2	t-3	t-4	t-5	t-6	t-7
-1.4458 (2.52)	0.4937 (0.90)	0.3040 (0.52)	0.9471 (1.50)	1.4358 (2.10)	1.7699 (2.43)	1.9495 (2.57)	1.9746 (2.57)

Lagged Advertising Share t-8	t-9	t-10	t-11	t-12	Other Cheese Advertising (Dutch Cheese)
1.8451 (2.41)	1.5612 (2.07)	1.1228 (1.52)	0.5298 (0.72)	-0.2177 (0.29)	-0.0025 (2.97)

$\bar{R}^2$ = 0.90

D.W. = 1.96

ρ = 0.03

Cheese 31 was estimated in linear form by Generalised Least Squares regression over the period 1977.01 to 1980.03. Advertising data was obtained from MEAL and deflated using a 'messages' cost index. Advertising lag structures were fitted using an Almon polynomial degree 2.

Figure 3.16 : Total Cheese Advertising Lag Structure (Cheese 20)

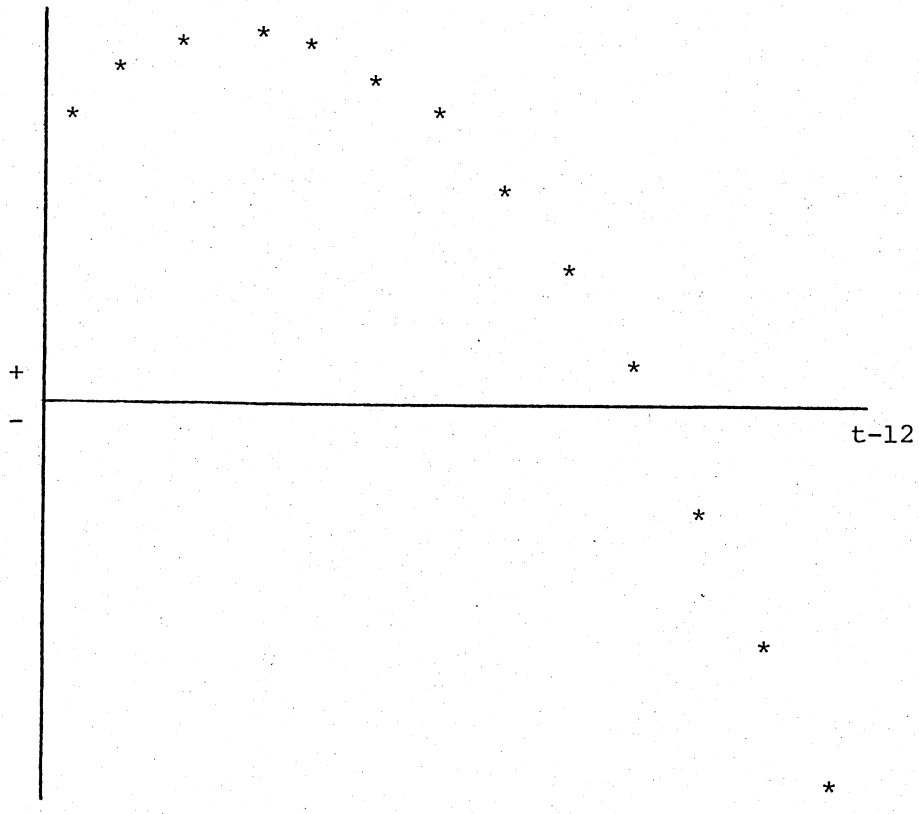


Figure 3.17 : Generic Cheese Advertising Lag Structure (Cheese 20)

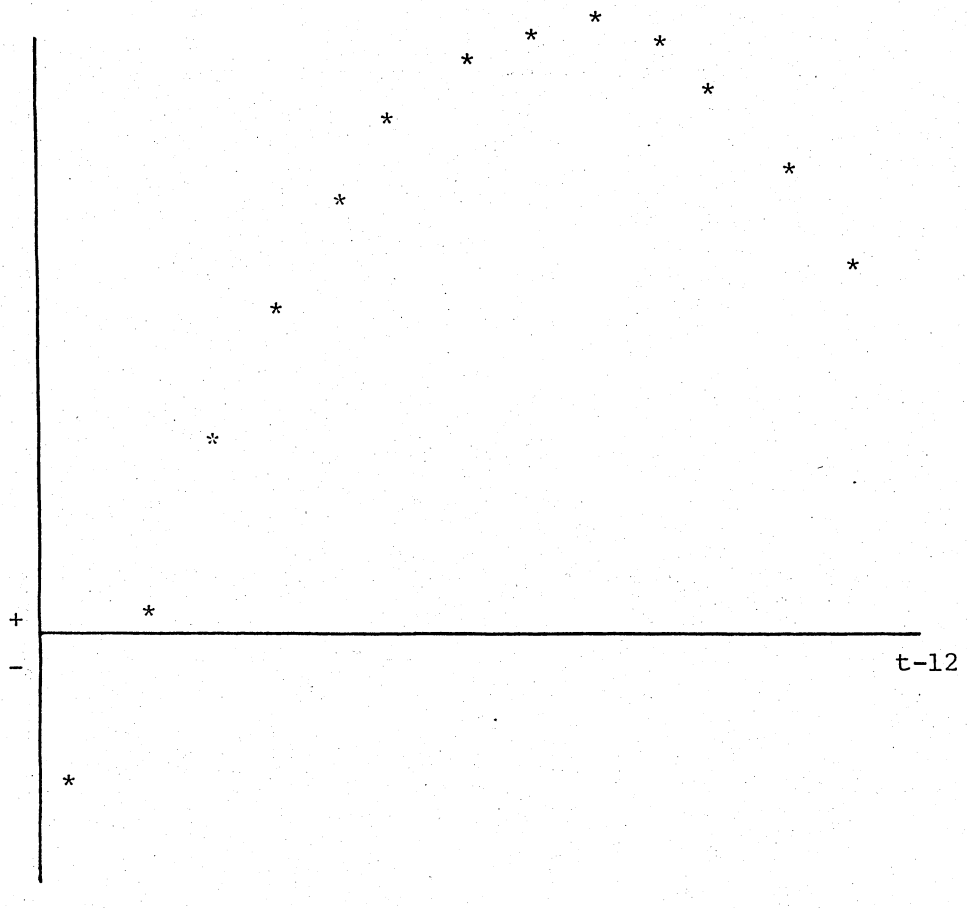


Figure 3.18 : Generic Advertising Lag Structure (Cheese 25A)

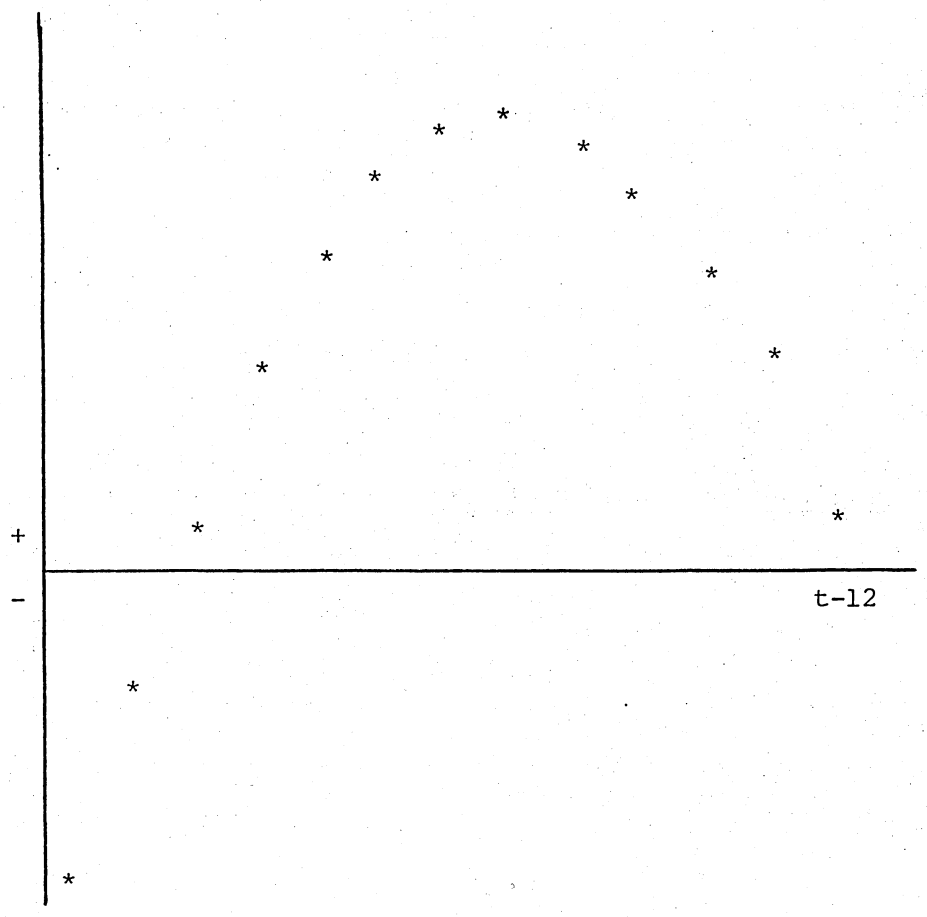
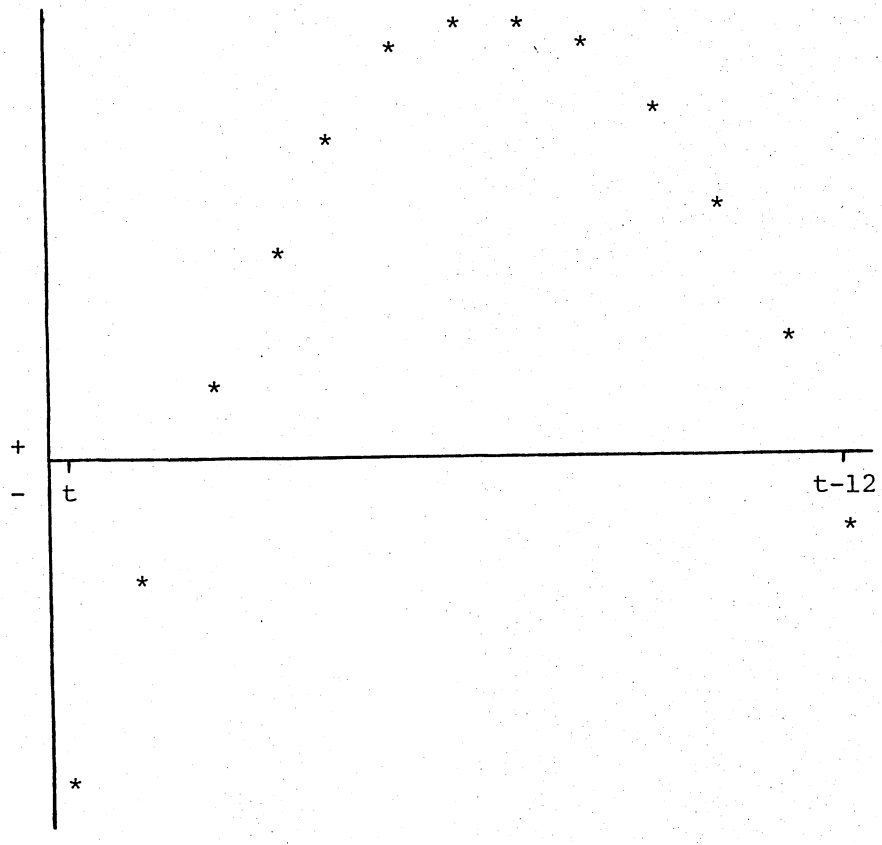


Figure 3.19 : Advertising Share Lag Structure (Cheese 31)



Summary

The introduction to the econometric analysis performed on the dairy products' market noted some of the theoretical and practical difficulties of a quantitative study of demand with special reference to advertising. Notwithstanding these problems the work undertaken produced robust estimates of the effect of advertising on the sales of liquid milk, cream, butter, margarine and English butter. It is not clear whether the results obtained for English Cheddar cheese are completely satisfactory. In brief, the advertising elasticities for the various products considered may be listed as:

i) For liquid milk - an elasticity of + 0.036 for generic advertising

ii) For cream - an elasticity of + 0.029 for generic advertising of cream for households

iii) For butter in total - an elasticity of + 0.07 for the 'brand-generic' effect of total branded butter advertising. An elasticity of -0.13 was estimated for the generic effect of total margarine advertising on butter sales. No satisfactory estimate of the effect of generic (Butter Information Council) butter advertising was found.

iv) For margarine - a 'brand-generic' effect of total branded margarine advertising was found with an elasticity of +0.22. Conversely, a generic effect of total butter advertising on total margarine sales was estimated to have an elasticity of -0.13.

v) For English butter - an elasticity of +0.34 for the brand advertising effect on the market share of English butter. 'Other' butter advertising had an elasticity value of -0.22.

vi) For cheese in total - an elasticity of +0.133 for the effect of generic advertising on all cheese sales. Also, a 'Brand-generic' effect of total cheese advertising was found with an elasticity of +0.04.

vii) For cheddar cheese - the generic advertising effect was estimated to have an elasticity value of +0.03.

viii) For English cheddar cheese - the English country cheese advertising campaign was found to have a positive effect on the market share of English cheddar in the cheddar market. In the form of the share of total cheese advertising, the advertising elasticity had a value of +0.05. 'Other' cheese advertising (represented by Dutch cheese) had an elasticity value of -0.01

The advertising elasticities listed above are presented again in Table 3.5 below along with appropriate price and income elasticities from the preferred equations. Essentially, the values in that table summarise the results of an econometric analysis of the milk and dairy products market.

TABLE 3.5 : Price, Income and Advertising Elasticities in the Milk Market

		Cross Price Effects										
	Income	Own Price	Margarine	Butter	Danish Butter	New Zealand Butter	Territorial Cheese	Continental Cheese	Generic Advertising	Brand Advertising	'Brand Generic' Advertising	Competitor Advertisin
Milk	+0.36	-0.21							+0.04			
Cream	+0.72	-0.81							+0.03			
Butter	+0.47	-0.88	+0.45								+0.07	-0.13
Margarine	-0.51	-0.17		+0.51							+0.22	-0.13
Cheese	+0.28								+0.13		+0.04	
English Butter		-7.13			+4.33	+4.09				+0.34		-0.22
Cheddar Cheese		-1.02					+0.71	+0.14	+0.03			
English Cheddar Cheese		-0.08					+0.79	+0.25		+0.05*		-0.01

* For English cheddar cheese the English Country Cheese advertising campaign is loosely interpreted as 'Branded' advertising expenditures.

CHAPTER 4

Evaluation and Simulation of the Effects of Advertising in the Milk Market

As the introduction to this report noted the determination of the appropriate theory of advertising for a cooperative organization of milk producers, such as the Board, and estimating the size of the advertising-sales response in different parts of the milk market, may be considered as two separate areas of analysis. The preceding chapters, and their associated Appendices, have set out the rationale and results of these areas of the investigation. But whilst the theory and quantitative estimation of advertising are each important in their own right their significance (and comprehension) may be increased by applying the combined results of theory and estimation to the particular numbers and values appropriate for the milk market. The aim of this chapter is to present such an evaluation utilizing the various conclusions of earlier chapters. This should allow an assessment of how close the advertising and promotional expenditures of the Board have been to a theoretical optimum. Given certain assumptions, it may also provide an implicit indication of what the Board's view of any rivals' response to changes in its own advertising is.

Furthermore, the construction of a simulation model using many of the econometric results allows investigation of the effects of simultaneous

changes in own advertising, competitors' advertising and different prices, in the 'long-run'. This can be done without the need to calculate particular elasticities at, perhaps, unreasonable mean levels, and allowing several key parameters in different demand equations to express themselves at the same time. The various 'runs' of the simulation model under different price and advertising conditions are described. Thus decision-makers may consider various levels of advertising budget (and price) as appropriate or otherwise.

Evaluation of the advertising response in the liquid milk market

Evaluating the marginal response to advertising for milk producers or determining the 'optimal' advertising budget for the Milk Board as a monopolist is, as shown in Chapter Two, relatively simple.But also noted in that Chapter (page22) was the fact that the short run response to advertising by producers may only be one part of the total marginal revenue product of advertising. A distribution of benefits from changes in advertising is likely to occur between producers, the trade and government. Examples of these different costs and benefits are given below.

Using the value of + 0.036 to represent the advertising elasticity of demand for liquid milk the change in sales resulting from a small change in advertising for the market in England and Wales in 1980 may be calculated. A 1% change in advertising expenditures in 1980 amounts to £63,150.0 The consequent 0.036% change in sales in 1980 amounts to 2,235,131.9 litres. Evaluating this increase in milk sales requires knowledge of the price differential between milk sold for liquid milk consumption and that for intervention[1] ($P_1 - P_3$, the liquid-intervention premium). For the moment it is illuminating to present the appropriate change in sales revenue from

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1. To obtain this differential an equivalent intervention price for milk has to be constructed. This is done from the published institutional prices for butter and skimmed milk powder, and from information on the cost of processing milk into butter and SMP. This derivation is presented in Appendix 4.

a £1 increase in advertising for a range of liquid premiums.

TABLE 4.1 : Increase in sales value for a £1 increase in advertising for a range of liquid premiums

Liquid premium (pence/litre)	Increase in sales for £1 increase in advertising (£)
1.0	0.35
2.0	0.71
3.0	1.06
4.0	1.42
5.0	1.77

These figures suggest that if a premium of 3.0 pence/litre or above is expected producers will gain when increases in advertising expenditure are made since the increase in sales value is larger than the cost of extra advertising (£1.06 is greater than £1.0 in Table 4.1).

Using the relationship between advertising elasticity and the ratio of advertising expenditures to total market premium described in Chapter Two,

$$Ae = \frac{A}{(P_1 - P_3)\, Q_1}$$

the divergence of observed behaviour of the Milk Board from the profit maximizing position can be judged.

Hence, where $Ae = + 0.036$

$(P_1 - P_3) = 3.0$ pence

$Q = 6208.7$ million litres

$A = 0.036 \times 186.261 = £6.705m$

Since, actual advertising expenditures for the year = £6.315m, and

£6.705m > £6.315m indicating that advertising expenditures could have been increased marginally for profit maximization.

The method of calculating the values presented in Table 4.1 assumes that any increase in advertising expenditure is the sole responsibility of producers. However, both dairy producers, and distributors of liquid milk (the trade) contribute to advertising expenditure in total and so it is relevant to consider the distribution of costs and revenues between them in an analysis of advertising budget changes.

Assume, for the moment, that there is a 75:25 split of advertising costs between producers and the trade.[1] That is, for every £1 of advertising expenditure 75p is borne by producers and 25p by the trade. Hence the producers' share of advertising costs in 1980 is equal to £63,150.0 x 0.75 = £47,362.5.

The liquid-intervention premium is still relevant to the producers' change in total revenue. In fact, the change in sales revenue from a small change in advertising remains the same. However, since that small change is recognized as being financed partly by producers and the trade (the ratio 75:25) the increase in sales as a result of a £1 increase in advertising needs to be recalculated. These new values are given in Table 4.2 below for a range of liquid premiums.

TABLE 4.2 : Increase in sales value for producers of a £1 increase in milk advertising for a range of liquid premiums and taking in account the advertising contributions of the trade

Liquid Premium pence/litre	Increase in producers' returns for a £1 increase in advertising (£)
1.0	0.47
2.0	0.94
3.0	1.41
4.0	1.88
5.0	2.35

1. Communication with the M.M.B. in October 1980 confirmed that, for liquid milk, the distribution of generic advertising expenditures in 1980 was 75.8% for the Board and 24.2% for the trade.

As is to be expected, taking account of the distribution of advertising costs between producers and the trade increases the benefits received by producers from a change in advertising. Again, using the value of 3.0 pence/litre as the appropriate liquid premium in 1980, it would appear that the gains are greater than the extra advertising costs i.e. £1.41 is greater than £1.0 It must be remembered, however, that the calculations in Table 4.1 are performed under the assumption that producers and trade collectively agree to make a marginal change in advertising and continue their contribution ratio as before.

The calculations undertaken above to evaluate changes in producer revenue may also be done for changes in sales value for the trade. Thus Table 4.3 presents the corresponding changes in 'profits' for the trade as a result of a small change in advertising levels. A range of values is presented for a number of different estimates of how profits are related to sales turnover in the trade.[1]

TABLE 4.3 ; Changes in profits for the trade as a result of a £1 change in milk advertising expenditures

% values for profit on return	Increase in profits for the trade after a £1 increase in advertising expenditure (£)
2½%	1.03
5%	2.06
10%	4.11
15%	6.17

The figures used in Table 4.3 are representative of prices and quantities of milk sold in 1980 and, again, it is important to note that the calculations are made on the assumption that a small increase in advertising expenditure is jointly funded by producers and the trade. It would seem that for all the

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1. The identification of 'profits' in the distributive trade is not without difficulty (nor controversy given recent analyses and reports). Hence, a simple measure of profit is used i.e. profit on return, being the percentage share of total sales value being retained by the retailer as profits. This may not be the measure used by trade to indicate profitability but it has the advantage of simplicity and it is possible to show a relationship with this and other measures such as, rate of return on capital.

alternative rates of return considered the trade could increase profits by cooperating with producers to increase advertising levels. The lack of precise information on the appropriate rate of return on gross sales revenue for the trade, however, precludes an unequivocal statement as to the specific gains from advertising for distributors.

As a final illustration of the distribution of the benefits of advertising liquid milk consider the cost savings by government (or in the European situation, the Commission) of reducing intervention purchases as a result of increased advertising expenditures.

The immediate effect of increasing sales of milk to the liquid market is to divert milk from the manufacturing processes typically used to convert surplus milk into products suitable for storage i.e butter and dried skim milk powder (SMP). These commodities are, in fact, joint products. Various conversion ratios and technical coefficients may be used to convert litres of milk into tonnes of butter and SMP depending on the type of milk, butter, time etc. For this evaluation assume that approximately 44.5 tonnes of butter and 88 tonnes of SMP are obtained from 1 million litres of milk. Table 4.4 gives the expected costs of storage and disposal of butter and SMP for one year (1980/81).

TABLE 4.4 : Storage and disposal costs for dairy products in the Community[1]

Costs (ECU/tonne)	Butter	SMP
Storage costs for 1 year	500	200
Export refunds	1600	400
Total	2100	600

Using a Green Rate of £1 = 1.61641 ECU these costs can be valued at £1300/tonne and £372/tonne for butter and SMP respectively. Using these figures, and those for the change in sales as a result of a small change in advertising the comparative cost of disposing of surplus milk by storage or advertising

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1. The evaluation of the different costs of storage and disposal of milk products shown here was obtained by direct personal communication with Nigel White of the Economics and Market Demand Section of the M.M.B., Thames Ditton.

may be calculated. These are presented in Table 4.5 below.

TABLE 4.5 : Comparative cost of disposal of 1 million litres of milk by intervention, and increased advertising (1980/81)

Storage/disposal costs (£)	Advertising Costs (£)
90,000.0	28,252.31

Clearly, the advertising cost is below that of the alternative and would, therefore, suggest that advertising may have a role to play in Community milk policy. The cost of advertising may, in fact, be borne by milk producers from funds collected through the co-responsibility levy thus making this option even more attractive. The example quantity chosen, 1 million litres, is relatively small in relation to the annual level of milk supplies in the Community. It represents around 0.0001% of annual liquid milk sales in England and Wales. Therefore, to increase milk sales sufficiently to make a noticeable impact on the growth in milk supplies would require quite large percentage changes in annual advertising budgets. However, the appropriate comparison, in this context, is with the size of Intervention milk sales. If these amount to around 7% [1] of annual milk production in England and Wales, 1 million litres represents about one tenth of 1% of milk sold to the Intervention Agency. Even a small percentage reduction in these sales is worthwhile but it is important to realise, nevertheless, that the advertising elasticity, 0.036, should not be used to justify major increases in the advertising budget which are far outside the range of observations and experience from which the elasticity was estimated.

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1. This figure was obtained after conversations with several members of the Economics and Market Demand Section of the Board.

Evaluation of the advertising response in the manufacturing milk market

Evaluating the marginal revenues associated with changes in sales of milk as different manufactured products; cream, butter and cheese, is rather more complicated than for liquid milk. In the first place, many processed dairy products are joint products and thus increased production and sale of, say, cream may increase the amounts of skimmed milk powder available. The net effect on revenues of these various changes in quantity produced is not always clear. Very much will depend on the market conditions at any particular time. Secondly, considering the effects of advertising on milk products emphasises the distinction between the interests of producers and processors. The Board, of course, as a producer marketing organisation with an involvement in manufacturing identifies with both groups. Thirdly, many dairy products are increasingly advertised with a view to increasing market share within the dairy product market rather than increasing the overall size of the market. Thus generic and brand-generic effects are less important. The influence of, and reactions of competing 'firms' to, the Board's own advertising is, therefore, of prime interest. Not surprisingly, this latter feature of the dairy products market reduces any incidental benefits to government of any advertising in this market.

The evaluation of changes in advertising in the market for cream, butter and cheese in the following pages will concentrate on the relative benefits to producers and processors of advertising. Marginal revenues will be calculated on the simplifying assumption that, whatever joint products are associated with the product under discussion, their prices and revenues will remain unchanged by advertising the product being considered. Whenever possible, the comparative effect of changes in own and rivals' advertising on sales will be demonstrated and an attempt made to determine appropriate advertising levels given different assumptions about competitors' behaviour.

The Market for Cream

Just as with liquid milk, the estimated advertising elasticity for cream may be used with observed levels of advertising and consumption to evaluate the effects of making a small change in advertising at a particular time. The value of + 0.029 estimated in equation Cream 26B is used to represent the advertising elasticity. A 1% change in advertising expenditures in 1980 amounts to £11,347.50. The resulting 0.029% change in sales to households in the same year is 89,136.7 litres. Again, for a range of different premiums ($P_{2cr} - P_3$, the difference between the cream price and intervention price) the sales revenues resulting from a £1 increase in advertising can be calculated, and are presented in Table 4.6.

TABLE 4.6 : Increases in sales value for a £1 increase in cream advertising for a range of premiums

Premium over intervention (pence/litre)	Increase in sales for a £1 increase in advertising (£)
1.0	0.08
2.0	0.16
3.0	0.24
4.0	0.32
5.0	0.40

These figures suggest that producers will not gain from increases in advertising expenditure and applying the formula, $Ae = \frac{A^*}{(P_{2cr} - P_3)Q}$ the appropriate advertising budget for a premium of 1.0 pence is,

$A^* = 0.029 \times 3.074m$

$= £89,136.70$

Clearly, £89,136.70 is considerably less than £1,134,751.0 which is the total amount spent on advertising in the household cream market in 1980. The implication is that the differential earned by sales to the cream market,

and the size of the advertising response are not great enough to justify current levels of advertising expenditure. Just as with liquid milk, however, the Board and the trade jointly contribute towards cream advertising through the National Dairy Council (NDC). Assuming that, the Board, as a producer, pays for half of this advertising[1] the results in Table 4.6 can be calculated and are shown in Table 4.7.

TABLE 4.7: Increase in sales value for producers of a £1 increase in advertising for a range of premiums and taking into account the advertising contribution of the trade

Premium over intervention (pence/litre)	Increase in sales for a £1 increase in advertising (£)
1.0	0.16
2.0	0.32
3.0	0.48
4.0	0.64
5.0	0.80

The appropriate advertising expenditure for a 1.0 pence premium does not, of course, alter but the discrepancy between the calculated optimum £89,136.7 and the (revised) current cost of advertising (£567,375.0) is considerably reduced.

Once again it is necessary to set out the changes in sales value for the trade as a result of increased advertising separately. Table 4.8 shows the changes in profits for the trade on the same basis as the figures in Table 4.3. A range of percentage values for profit on return are given to allow comparison of different sales increases for different 'profit' situations.

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1. Advertising expenditures of the National Dairy Council are split 50:50 between the Board and the Dairy Trade Federation. But as a processor of milk the Board also pays part of the trades' contribution to the NDC's expenditures.

TABLE 4.8 : Changes in sales for the trade as a result of a £1 change in advertising expenditures

% values for profit on return	Increase in sales for trade after a £1 increase in advertising
2½%	0.17
5%	0.34
10%	0.67
15%	1.0

Just as before the figures used in Table 4.8 are typical of the prices and quantities of cream sold to households in 1980. It appears that, for the household market there is no economic justification for the trade to increase its levels of advertising until relatively high levels of rate of return on sales turnover. However, the identification of the precise gains to the trade (and to a lesser extent, producers) is complicated by the existence of household and catering markets for cream. Further discussion of these different but related outlets for milk sold as cream is necessary before the figures presented in Tables 4.6, 4.7 and 4.8 are used to draw conclusions about the size of cream advertising expenditures. Clearly there may be some effect on the demand for catering cream of advertising in the market for household cream. Indeed, as incomes rise for the population as a whole one might expect increased services and value-added to be purchased along with the consumption of cream i.e. through restaurants, purchased cakes etc. It is also true, however, that advertising of cream intended for the catering market (the cream cakes campaign) will be expected to increase sales of cream. Separating out these similar effects on different parts of the total cream market is obviously not straightforward, and perhaps a more intimate knowledge of how the market operates is required before making judgements on future advertising levels using the results given in Tables 4.6, 4.7 and 4.8.

The Market for Butter and English Butter

As was seen in the previous chapter the econometric analysis failed to determine the extent of any positive effect on sales of generic advertising for butter. This may be explained by the sporadic nature of the generic campaign and its relatively small size in a market characterized by intense advertising activity. On the other hand, it may simply be that the specification and estimation techniques used were inadequate (although the same procedures have captured generic effects in all other markets). Whatever the reason, the econometric results do illustrate the small 'brand-generic' effects of total butter and margarine advertising, and the own- and cross-advertising effects in the branded butter market. It is these latter effects that are of particular interest in the evaluation of advertising changes and on which the following discussion will concentrate.

Just as with liquid milk and cream the value to producers of advertising butter may be determined on the basis of the price differential received for sales in this market and that for sales in the lowest value alternative (intervention). Hence, Table 4.9 presents the extra sales revenue produced by a small change in advertising for the branded product, English butter.

Table 4.9 : Increase in sales value for producers of a £1 increase in English butter advertising for a range of premiums

Premium over Intervention (pence/litre)	Increase in sales for a £1 increase in advertising (£)
0.2	0.60
0.4	1.20
0.6	1.80
0.8	2.40
1.0	3.00

The figures in Table 4.9 are calculated for 1980 where a 1% change in the advertising share amounts to an increase in English butter advertising of

£16,937. The advertising share elasticity used is that derived from equation Butter 28 and is equal to +0.34. Hence, for the levels of English butter consumption observed in 1980 the equivalent increase in milk diverted to this market is 5.076 million litres. The price differentials used in Table 4.9 are thought representative of the range of price differences that might occur between milk sold as English butter or sold as butter to the Intervention Agency. For any premium 0.3 pence/litre or above it would be profitable for the producers to increase advertising. Leaving discussion of what the size of this differential may have been in 1980, for the moment, it is worthwhile to restate the advertising share elasticity. The equation Butter 28 is specified in terms of the market share of English butter. For the advertising elasticity +0.34 the effect of a 1% increase in advertising share is to increase market share by +0.34% or if advertising share increases by around 3%, market share will increase by about 1%, *ceteris paribus*. Clearly though, with a model specified in terms of market share and advertising share there are competing products and advertising effects in the market. Therefore, using the assumption that all other things remain equal is less than satisfactory. It is to be expected that competitors will react in order to maintain or regain their market share and it is preferable that the evaluation makes some attempt to take account of this. It would seem that the model of a monopolist allocating advertising expenditures according to the size of own advertising response, and price differentials between outlets is no longer appropriate. The evaluation must now proceed using the theory of advertising under oligopoly set out in Chapter Two. In other words the remaining part of this section is concerned with the Board, as a processor, setting advertising levels for its own branded product in competition with others.

Restating the formula for profit maximizing levels of advertising for an oligopolist;

$$\frac{A^*}{PQ} = \frac{1}{|\mu|} \quad [AS_e - (AS_e + Ae')\, Ae''] \qquad \text{(xxxv)}$$

it is possible to derive A*, the optimal level of advertising for any specified set of values for μ, AS_e, Ae', Ae" and PQ where

$|\mu|$ = the absolute value of the own price elasticity of demand

AS_e = the elasticity of own demand with respect to changes in the advertising share

Ae' = the elasticity of own demand with respect to changes in competitors' advertising

Ae" = the elasticity of competitors' advertising with respect to changes in own advertising

PQ = total sales value of the product

A* = the profit maximizing level of own advertising

Now the econometric analysis has provided estimates of all the parameters in equation (xxxv) except Ae", the response of rivals to changes in own advertising. Just as with many other parts of oligopoly theory the size of this response is indeterminate. For the purposes of this evaluation, however, it is useful to calculate several 'optimal' advertising budgets for a range of different competitors' reactions. Hence, for example, the optimal budget for a situation where rivals are thought to exactly match any changes in own advertising by changing their advertising, is represented by a value for Ae" of unity. For a less elastic response by rivals i.e. competitors change their advertising less than proportionately with changes in own advertising, a value of Ae" less than unity may be used. Similarly a more elastic response is given by an Ae" value greater than one. Table 4.10 below sets out various advertising budget levels using; sales values for 1980, estimates of μ, AS_e and Ae' from equations Butter 26 and 28, and a range of values for Ae".

Table 4.10 Optimal advertising budgets for English butter for alternative rivals' reactions

Rivals' response to changes in own advertising, (Ae")	A* - the optimal advertising budget (£m)	
	(Butter 26)	(Butter 28)
0.5	5.946	4.115
1.0	4.650	3.248
1.5	3.878	2.351
2.0	2.068	1.470
2.5	0.776	0.588

The actual expenditures on English butter advertising for 1980 amounted to £1.66m; comparing this figure with those given in Table 4.10 two possible interpretations are suggested. Either, the Board has historically held the view that rivals' responses to changes in English butter advertising are quite elastic (just below or just above a value of 2.0 depending on which equation estimates are used). In which case, the current level of advertising expenditures is appropriate. Or, if the Board considers competitors' reactions to be less elastic it would appear that significant increases in English butter advertising could be made. It should be emphasised, though, that it is likely that any advertising (at current or increased levels) should be funded primarily by processors rather than producers. Historical levels of the premium for milk sold as English butter, and the difficulties of involving competitors in a monopoly model of producer behaviour are the basis for this qualification.

The Market for Cheese and English Cheese

The econometric results of Chapter Three included estimates of small positive effects of advertising on sales of cheese and English cheese. The evaluation of these effects uses advertising elasticity values for generic advertising (from equation Cheese 20) and for English Country cheese advertising which may be interpreted as 'branded' advertising (from equation Cheese 31).

Again, the price differential between milk sold as cheese and that sold to intervention is the basis for evaluating the producers' marginal revenue from advertising changes. Table 4.11 sets out the extra revenue obtained when generic cheese advertising is increased marginally.

TABLE 4.11 : Increase in sales value for producers of a £1 increase in generic cheese advertising for a range of premiums.

Premium over Intervention (pence/litre)	Increase in sales for a £1 Increase in advertising (£)
0.2	0.49
0.4	0.98
0.6	1.48
0.8	1.97
1.0	2.46

The values given in Table 4.11 are produced for prices and quantities in 1979/80 using a generic advertising elasticity of +0.133. Just as with other milk products it is expected that the marginal value of advertising by producers would be increased if the evaluation accounts for their contribution to the advertising budget. For the generic cheese campaign the Board's contribution was around 70% of the total advertising costs.[1] However, generic advertising increases sales of all cheese, and U.K. production amounts to just under 70% of U.K. cheese consumption. Hence, the Board's contribution to

1. This figure for the financing of the Cheese Information Service generic campaign by the Board was supplied by Paul Allsop.

advertising costs appears to be proportionate to its share of the cheese market.[1] The values in Table 4.11 are, therefore, also valid for the situation that takes into account the Board's share of advertising expenditures.

Table 4.11 does not demonstrate the gains to manufacturers and processors of milk into cheese. Just as before, this must be done by reference to a set of alternative 'profit' figures. Table 4.12 presents this comparison.

TABLE 4.12 : Changes in profits for the trade as a result of a £1 change in generic cheese advertising expenditures

% values for profit on return	Increase on profits for the trade after a £1 increase in advertising expenditure (£)
2½%	1.13
5%	2.26
10%	4.52
15%	6.78

Values given in Table 4.12 relate to prices and quantities in 1979/80. The calculations also assume that all advertising expenditures are funded by the trade.

The figures in Table 4.12 appear to suggest that, at all the alternative rates of return considered, the trade would benefit from increasing generic advertising expenditures. This is true even when the trade finances all these expenditures itself. Clearly, a joint contribution to advertising costs by producers and the trade would increase the marginal benefits from advertising shown in Tables4.11 and 4.12 significantly. Overall, it would seem that generic advertising of cheese, jointly financed by producers and the trade, is profitable at realistic values of price differentials and

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1. For 1979 the U.K. self sufficiency ratio for cheese was 66.9% (Key Statistics of the U.K. Dairy Product Markets, 1980). But exports are an increasing percentage of home production and as they increase the approximation used here becomes less valid. Also, this assumes Board production is equivalent to U.K. production.

rates of return.

The English cheese market is, perhaps, more easily identified with the Board's interests. The econometric analysis concentrated on the demand for English cheddar cheese given that English cheddar purchases are approximately 40% of the total cheese market. The market share of English cheddar in the cheddar market is even higher - around 63%. On the production side, English cheddar amounted to nearly 70% of U.K. natural cheese production in 1979. Understanding the demand relationships for this type of cheese, therefore, is a major step towards explaining what is happening in the household cheese market and why the Board's revenues from cheese sales are changing.

Determining the appropriate level of advertising expenditures for English (cheddar) cheese is again complicated by the presence of competition in the market. If we consider one type group to be cheddar, then territorial and 'continental' cheeses may be used to represent its competitors. The expected price and advertising changes that these rivals make in response to own price and advertising variations are an important part of an optimal marketing strategy for English cheese. Consequently the appropriate level of advertising expenditures for English cheese is discussed below using the theory of advertising under oligopoly identified in an earlier part of this report. Thus we consider the Board, as a processor[1], determining the level of advertising for a particular type (brand) of cheese, English cheddar, in competition with other manufacturers with their own types (brands).

Using the formula for the optimal level of advertising for an oligopolist given previously:

$$\frac{A^*}{PQ} = \frac{1}{|\mu|} \left[AS_e - (AS_e + Ae')\, Ae''\right] \qquad \text{(xxxv)}$$

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1. In the extreme it is possible to consider the Board, as a group of producers, in competition with producers in another region or country. In which case the theory is still applicable but the responsibility for financing advertising expenditures is with processors and producers.

where A* = the optimal advertising budget and $|\mu|$, AS_e, Ae', Ae'' and PQ are as before.

From equation Cheese 31 values for all the parameters in (xxxv) are known apart from Ae'', the response of rivals' advertising to changes in own advertising. This value is not known *ex ante*. Hence, the procedure of the previous section whereby alternative values of Ae'' are utilized in the evaluation has to be repeated. However, the discussion of the cheese demand equations previously indicated that the own price elasticity computed from the estimated coefficients of equation Cheese 31 was not satisfactory. It was thought to be too inelastic. For the evaluation, therefore, the own price elasticity produced from Cheese 25A was used in equation (xxxv) to calculate a range of optimal advertising budgets. These are given in Table 4.13 below.

TABLE 4.13 : Optimal advertising budgets for English cheese for alternative rivals' reactions

Rivals' response to changes in own advertising, (Ae'')	A* - the optimal advertising budget (£m)
0.5	5.603
1.0	1.868
1.5	*
2.0	*
2.5	*

* indicates that advertising of cheese is not worthwhile due to expected size of rivals' response

In 1979/80 the expenditure on the English Country cheese advertising campaign was £1.083m. It would appear that this expenditure is below the level that is appropriate for the assumption of unitary elasticity of response from rivals. Above this estimate of response, however, the relative magnitudes of own and competitors' advertising effects are such that cheese advertising should not be undertaken.

Simulating the Effects of Advertising and Price Changes in the Milk Market

The construction of the simulation model is discussed in Appendix 4. This section of the report will describe the objectives of a simulation of the milk market and the consequent results for a variety of assumed changes in price and advertising.

First of all, it should be noted that simulation as a technique may be used for a number of reasons. Policy analysis and forecasting are obvious justifications for a simulation exercise and within those general aims the researcher may be interested in absolute and relative changes or simply the time path of change. The difficulty with forecasting where simulation continues beyond the sample period is that forecast values of any exogenous variables in the model must be provided. This in itself is a major problem. Where there are a large number of exogenous variables and/or the forecast period is relatively long this is particularly important. For example, for the (monthly) model of the milk market with a forecast period of 4 years, nearly 30 exogenous variables are present each of which must be provided with a value for 48 periods. To avoid the obvious difficulties arising from supplying such forecast values the simulation exercise performed was not greatly concerned with the absolute changes brought about by an initial change in an exogenous variable.

The primary concern of the simulation was to study the time path of changes or dynamic response of the model. Thus attention is focussed on how long the model takes to reach a stable or new equilibrium situation. Having said this it is recognized that part of a delayed response to an initial shock may occur outside the original sample period. To allow such changes to be illustrated the model was simulated beyond the estimation period by assuming constant values of all exogenous variables required for the model.

The principal endogenous variables of interest are: average producer price total marginal value of sales to households, total milk supplies, and the proportion of milk sold to intervention. The behaviour of these variables over the period 1977.01 to 1983.12 was studied after the model was subjected to a

variety of different shocks in different policy experiments. In most cases, where advertising expenditures were increased the marginal cost of a change is represented by the change in cost of advertising, and the marginal revenue is given by the change in total marginal value of sales to households

Comparing the effects of a + or - 10% change in own advertising

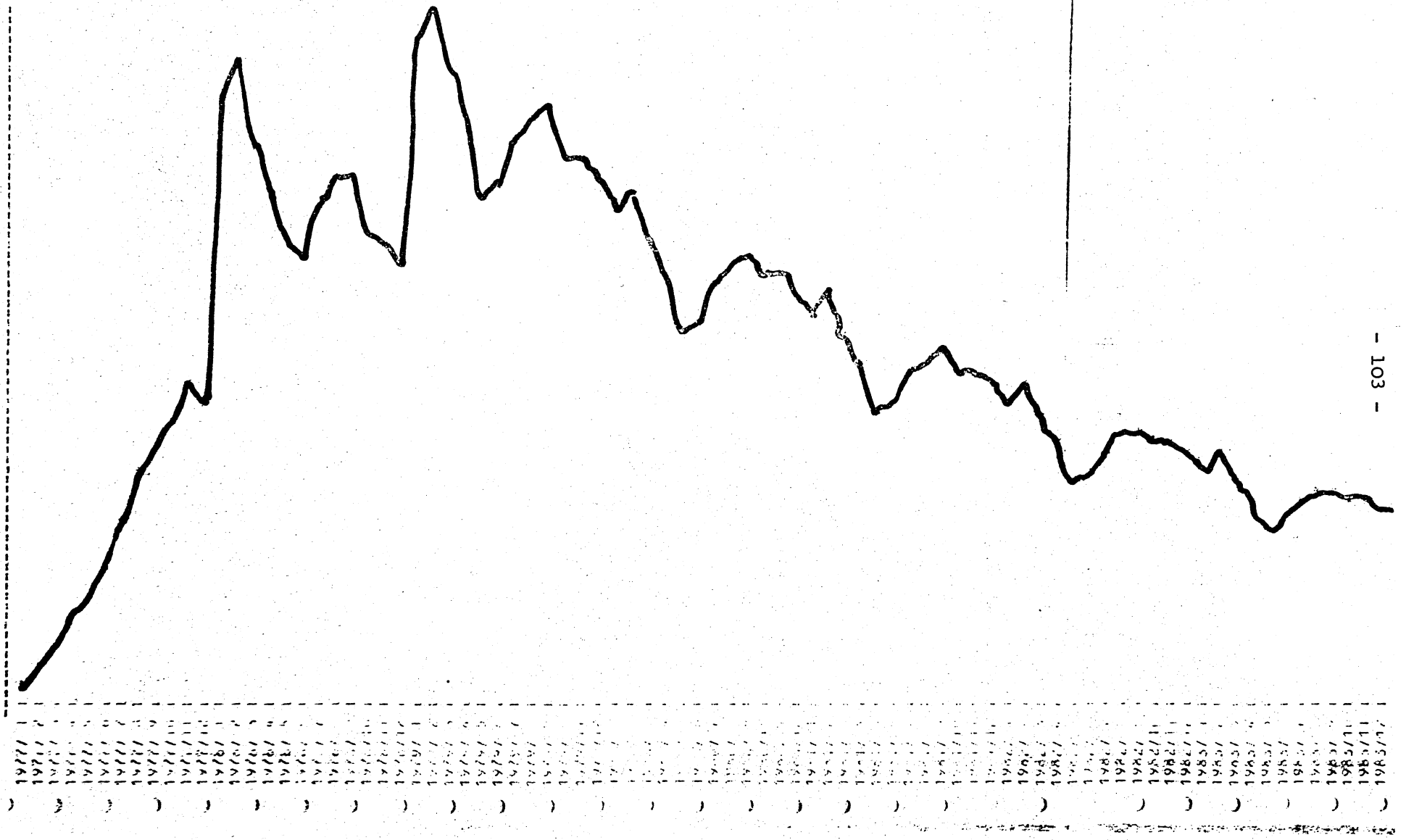
The results of Runs 1 and 2 provide the material for this comparison of positive and negative changes in own advertising. Advertising expenditure on milk, cream, English butter, cheese and English cheese was increased and decreased by 10% in these simulation runs for 12 periods (1977.01 to 1977.12) at the beginning of the simulation period. The total simulation period was 84 periods long (7 years).

For both runsan obvious characteristic of all the endogenous variables of interest is the lengthy dynamic response to the initial change in advertising. The return to base values of these variables is only just accomplished towards the end of the total simulation period. Within that period the lag structure of the various equations that make up the model ensures that the effects of the initial shock continue to rise until some time after their introduction. For example, the peak difference in milk supply changes is not attained until nearly two and a half years after advertising is increased (and one and half years after it returns to normal levels). Similar comments may be made about the effects of decreasing advertising expenditures. Regardless of the direction of change in advertising the time path of effects does not quickly stabilize and move back towards the base level path.

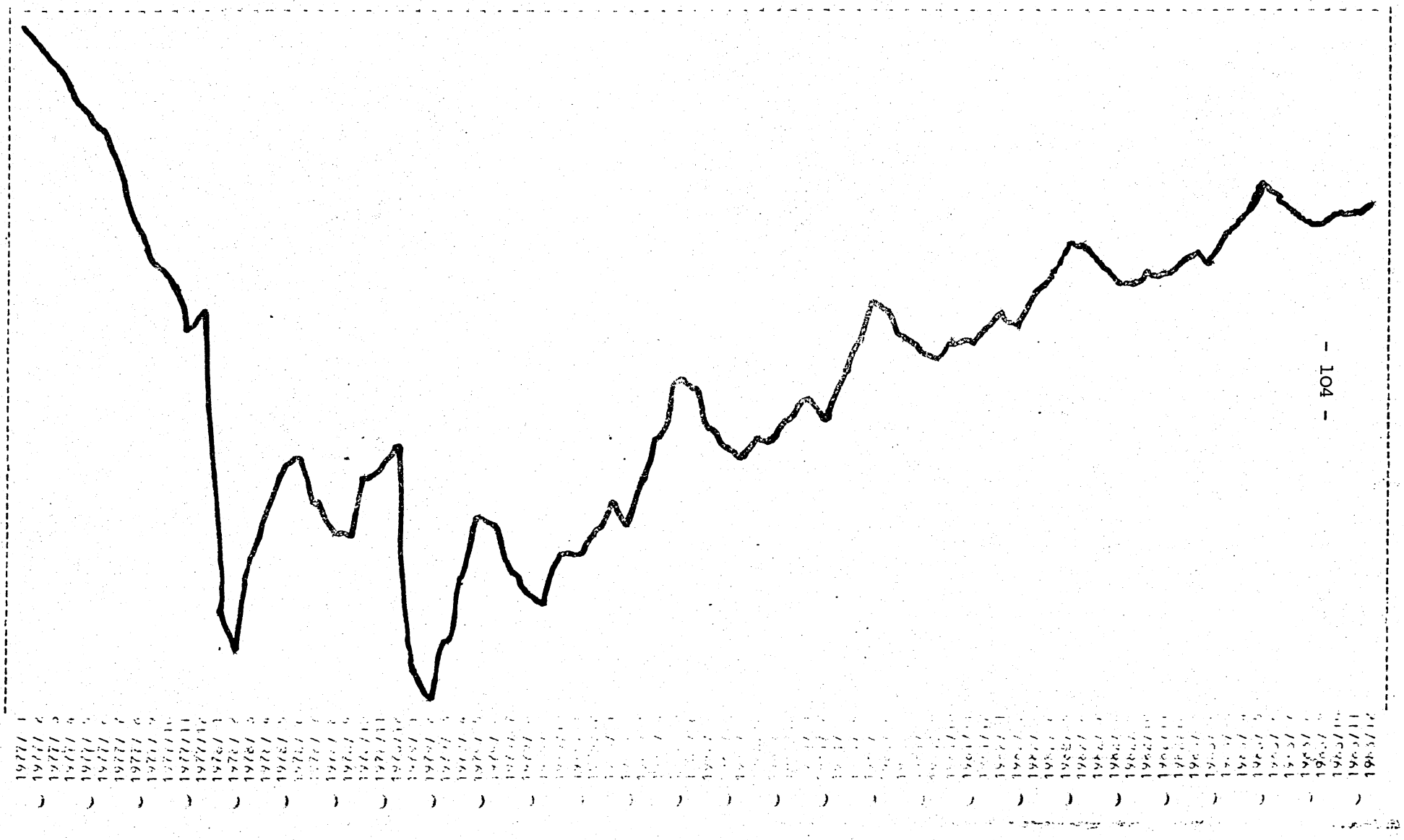
The magnitudes of change are, of course, important in understanding and evaluating the simulation results. The supply changes for an increase in advertising are very small relative to the base monthly production figures. Similarly the proportion of milk sold to intervention changes by only -0.18% in the first year after an increase in advertising (for a decrease in advertising the corresponding change in intervention is + 0.20%). The effect on the total marginal value of sales to households is quite clear, however. A 10% change in total advertising levels for one year amounts to around £652,768. The change in sales revenue as a result of such a change is +£2.601m (for an increase) and - £3.083m (for a decrease in advertising). These sums represent the amounts gained or lost up until the end of 1981 (six years into the simulation) and

are nominal figures. Hence, the appropriate discounted rate of return should be used to evaluate the net gain or loss completely but even so it would appear that marginal increases in advertising levels for milk and dairy products applied simultaneously will increase producer returns over time.

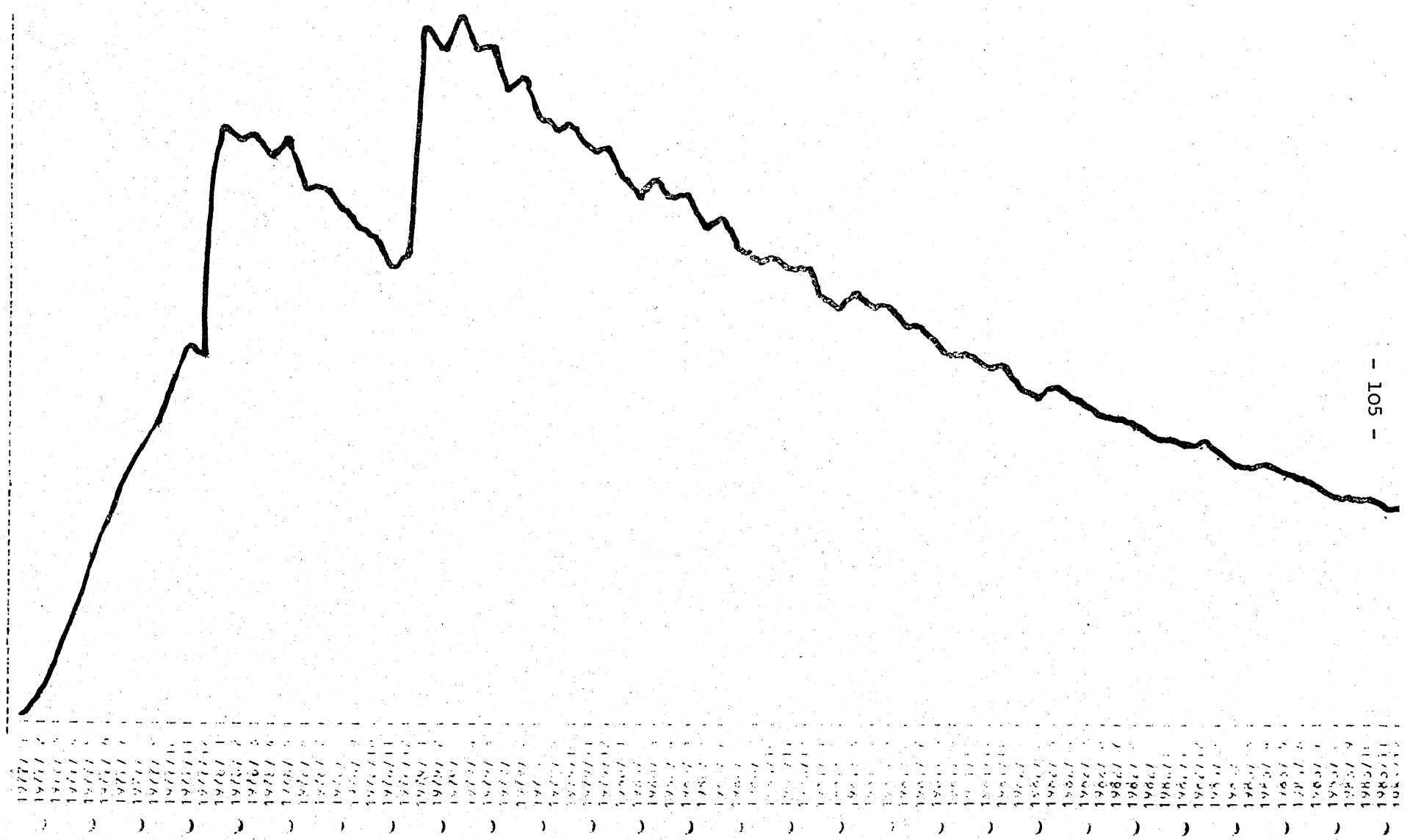
Run 1 : Effect on average producer price



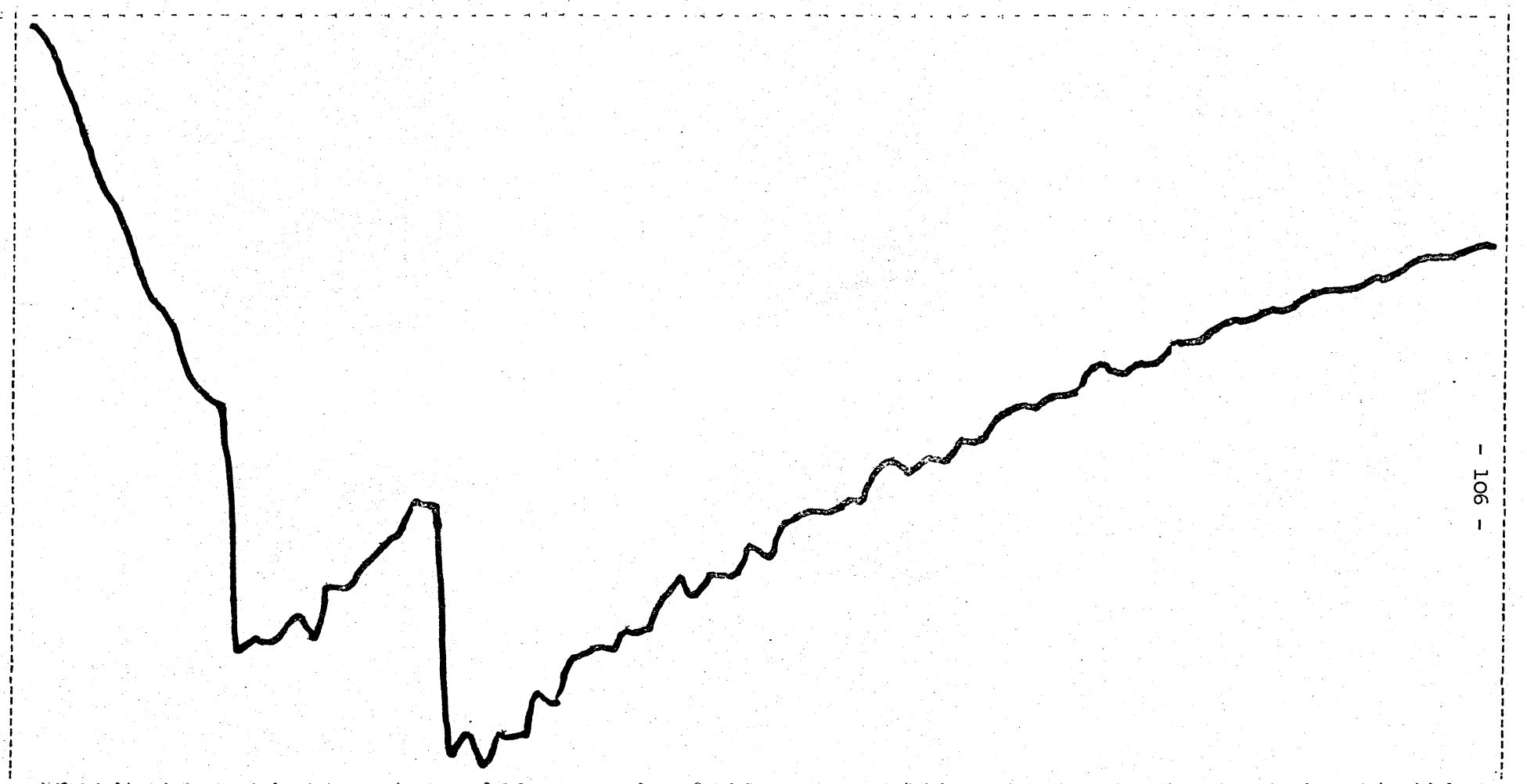
Run 2 : Effect on average producer price



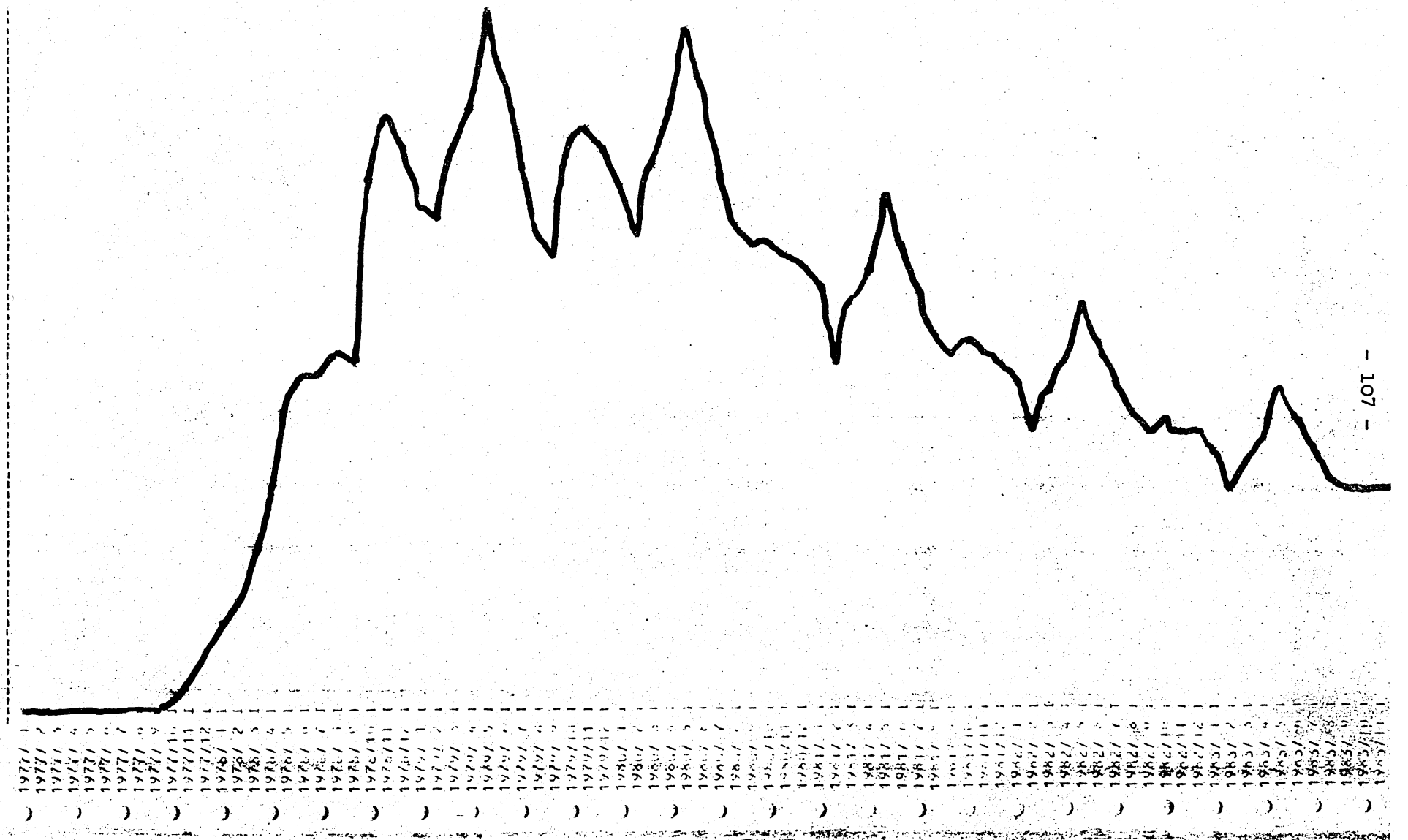
Run 1 : Effect on total marginal value of sales to households



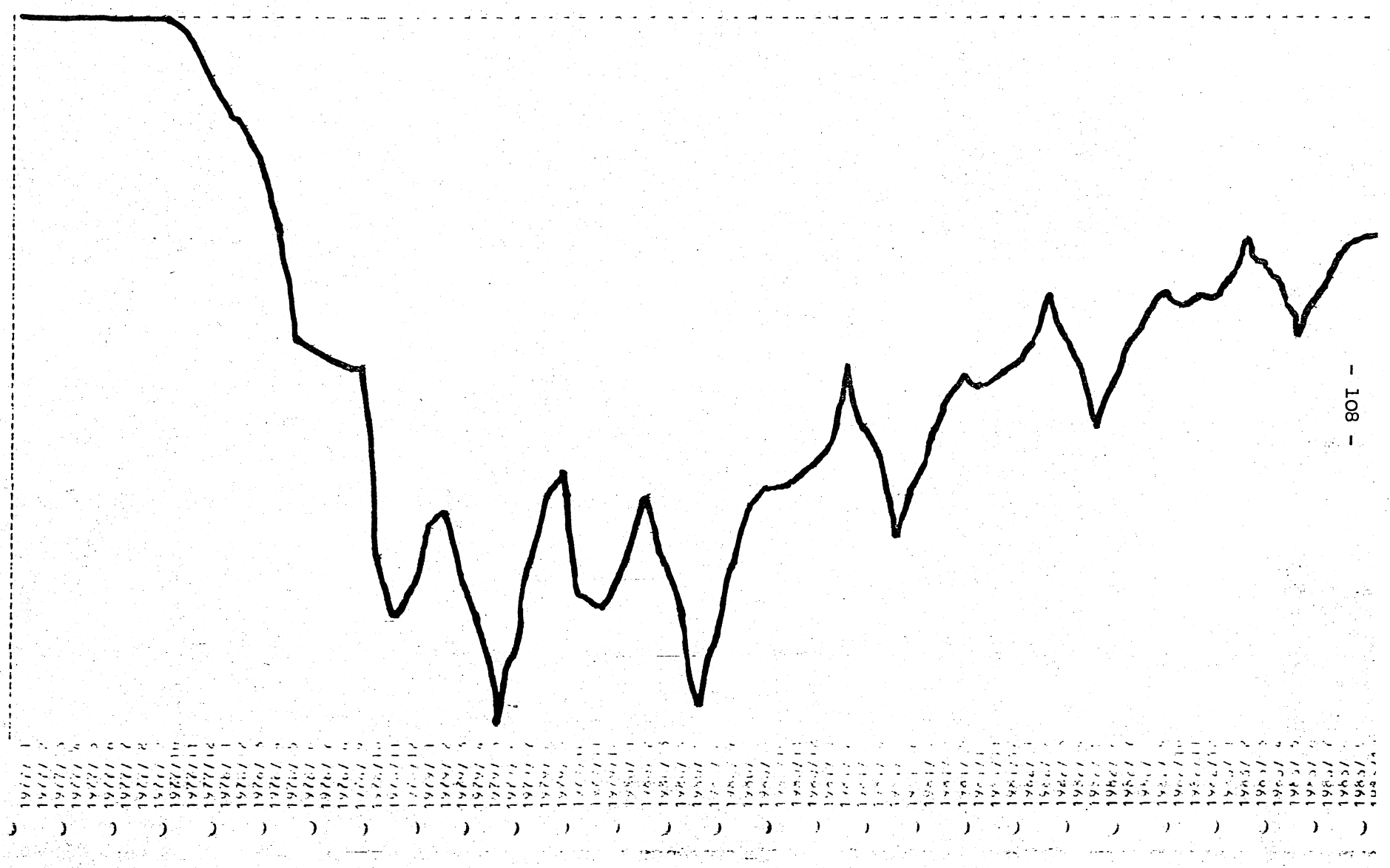
Run 2 : Effect on total marginal value of sales to households



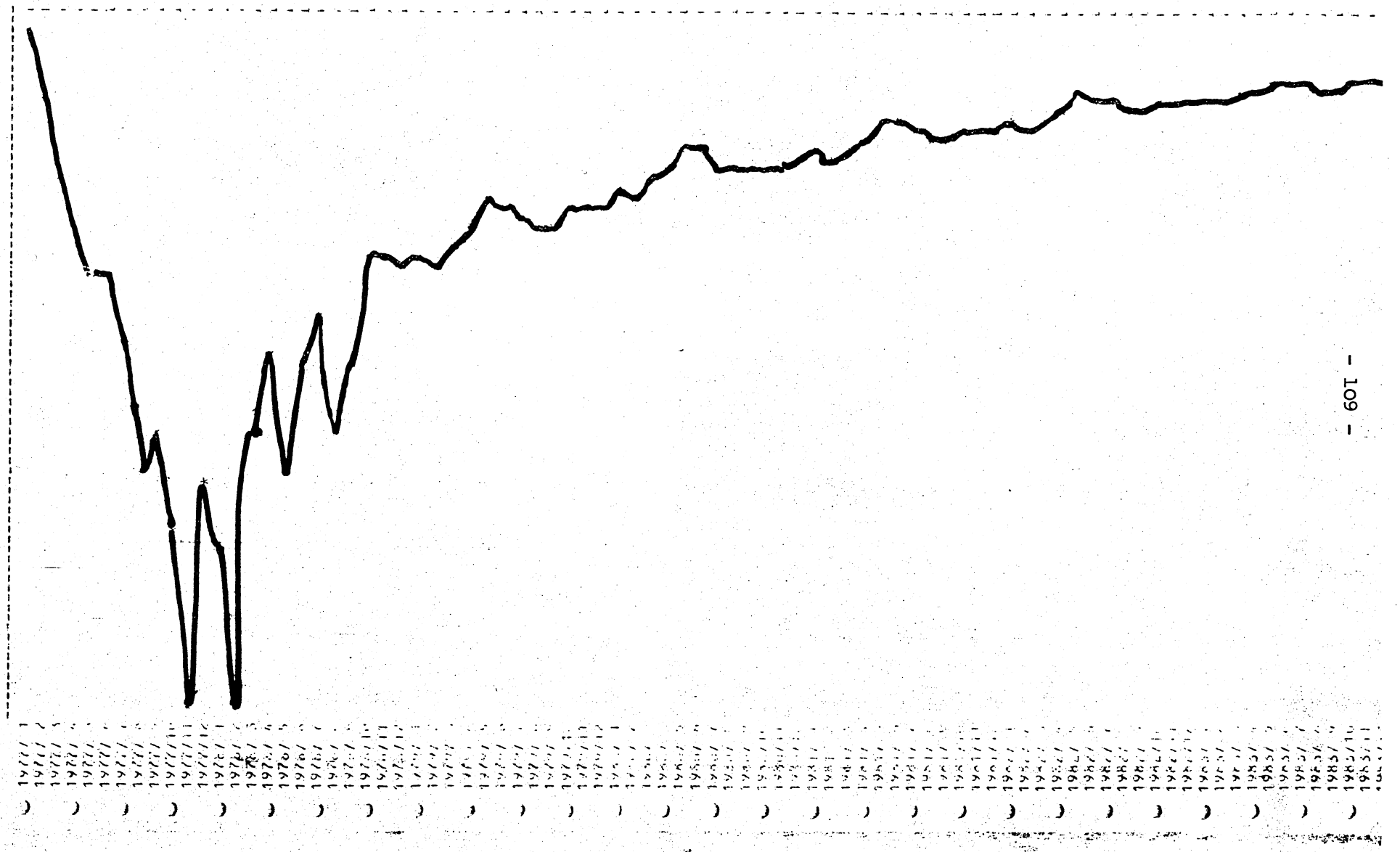
Run 1 : Effect on total milk supplies



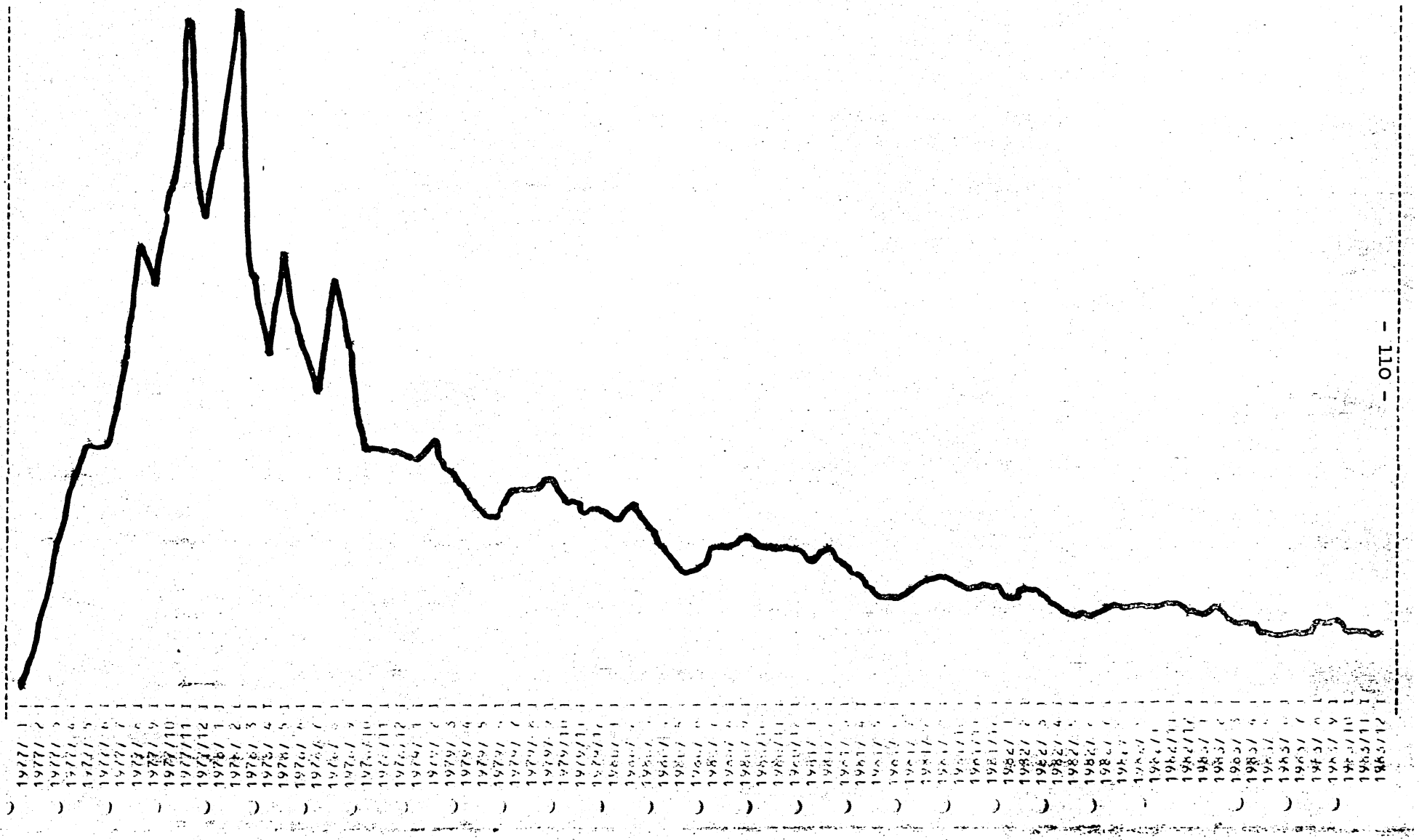
Run 2 : Effect on total milk supplies



Run 1 : Effect on proportion of milk supplies sold to intervention



Run 2 : Effect on proportion of milk supplies sold to intervention



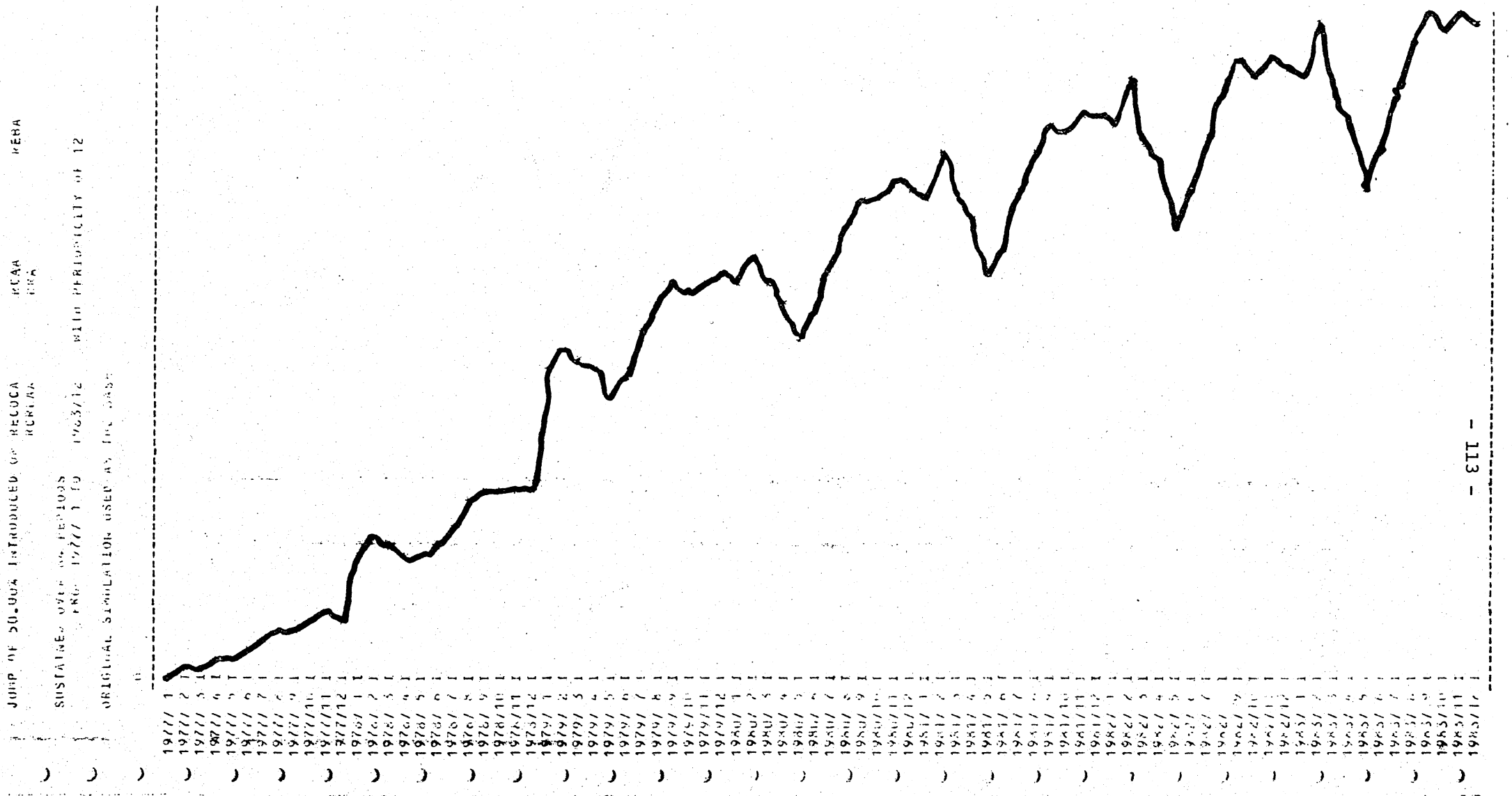
The effects of large changes in own advertising: a 50% increase and a 100% decrease

Runs 3 and 4 of the model attempted to determine the effects of large sustained changes in the advertising budget. Run 3 introduced a 50% increase in advertising levels over the simulation period. In cash terms this approximates an extra £0.5m spent on each of the dairy products, cream, butter and cheese). Run 4 reduced all advertising expenditures to zero for the entire simulation period.

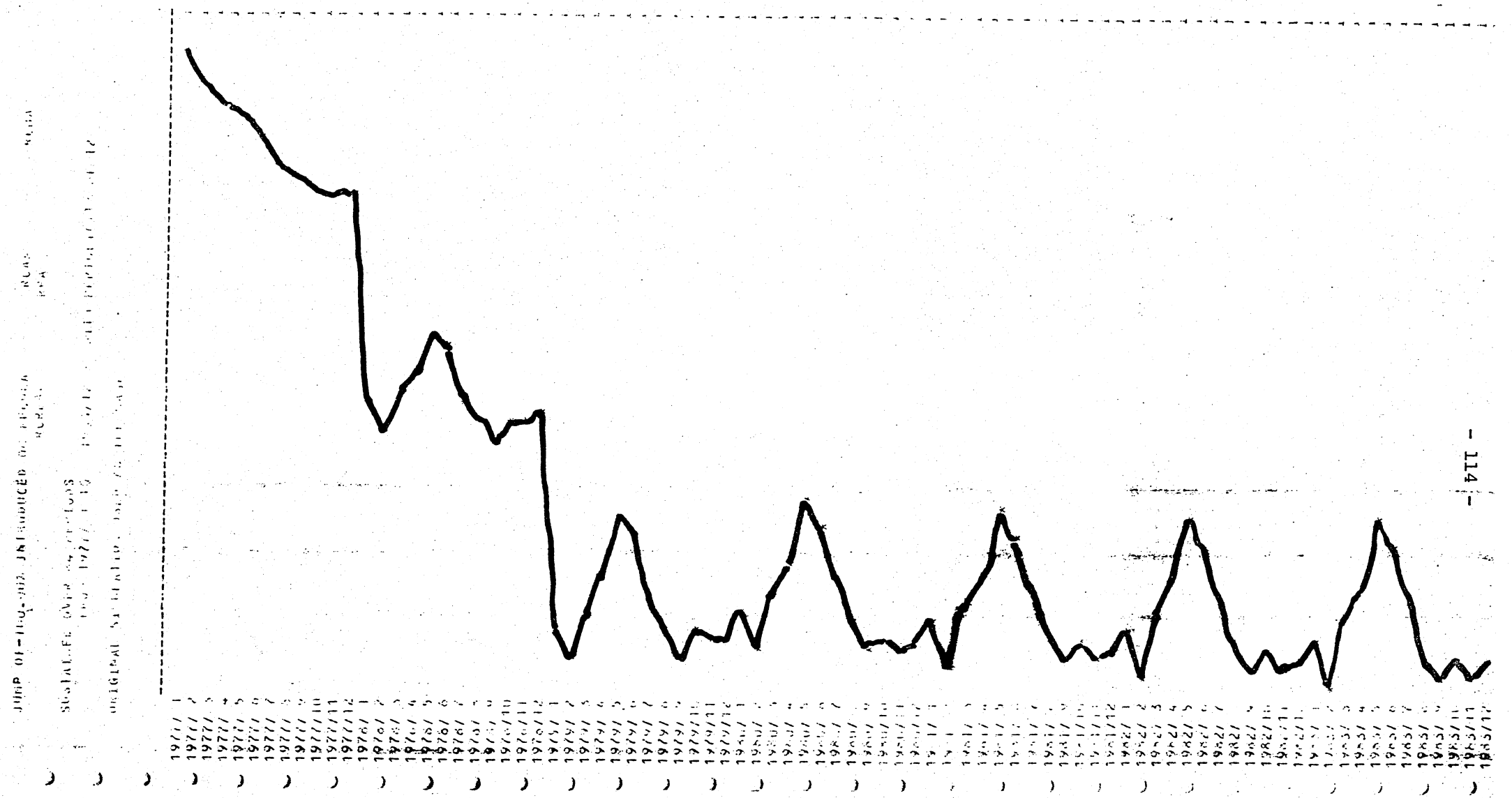
The results of these sustained changes demonstrate the principal weakness of the model. Large changes in any exogeneous variable might be expected to change levels of milk sold to intervention which in turn affected average producer prices, supply and eventually intervention levels again. However, for Run 4 in particular as intervention levels rose and average producer prices fell, the initial decrease in supplies produced was not sufficient to reduce intervention levels and allow producer prices and, consequently, supplies to increase. Instead, the induced paths stabilized at new levels usually at about 2 years after the initial shock was introduced. It may be that with a longer simulation period the anticipated movements would have occurred. More probably, the lack of any expectations hypothesis for prices in the supply side of the model does not allow a complete description of the way in which producers respond to price changes. In Run 3 with a large increase in advertising, a similar weakness occurs. Here, as intervention levels decline towards zero, the model does not take account of the fact that when intervention $<$ zero the average producer price is formed from full prices received from sales in different outlets, not price differentials. Price changes are, therefore, reduced and the model exhibits greater stability than would otherwise be expected. For Run 3 the latest periods in the simulation contain many negative intervention levels indicating that there is an excess of demand over supply. In those months the revised price formation procedure should be used. As a final point, the sustained increase in advertising does produce in the final year of the simulation period (when the cumulative effects of a sustained change are greatest) a reduction

in monthly average intervention levels from 7.6% in the base path to 3.1% in the induced path. It must be remembered, though, that this estimate of change is produced by a movement in advertising expenditures far outside the range of observed experience in the past. As such the results of such action must be interpreted with great caution.

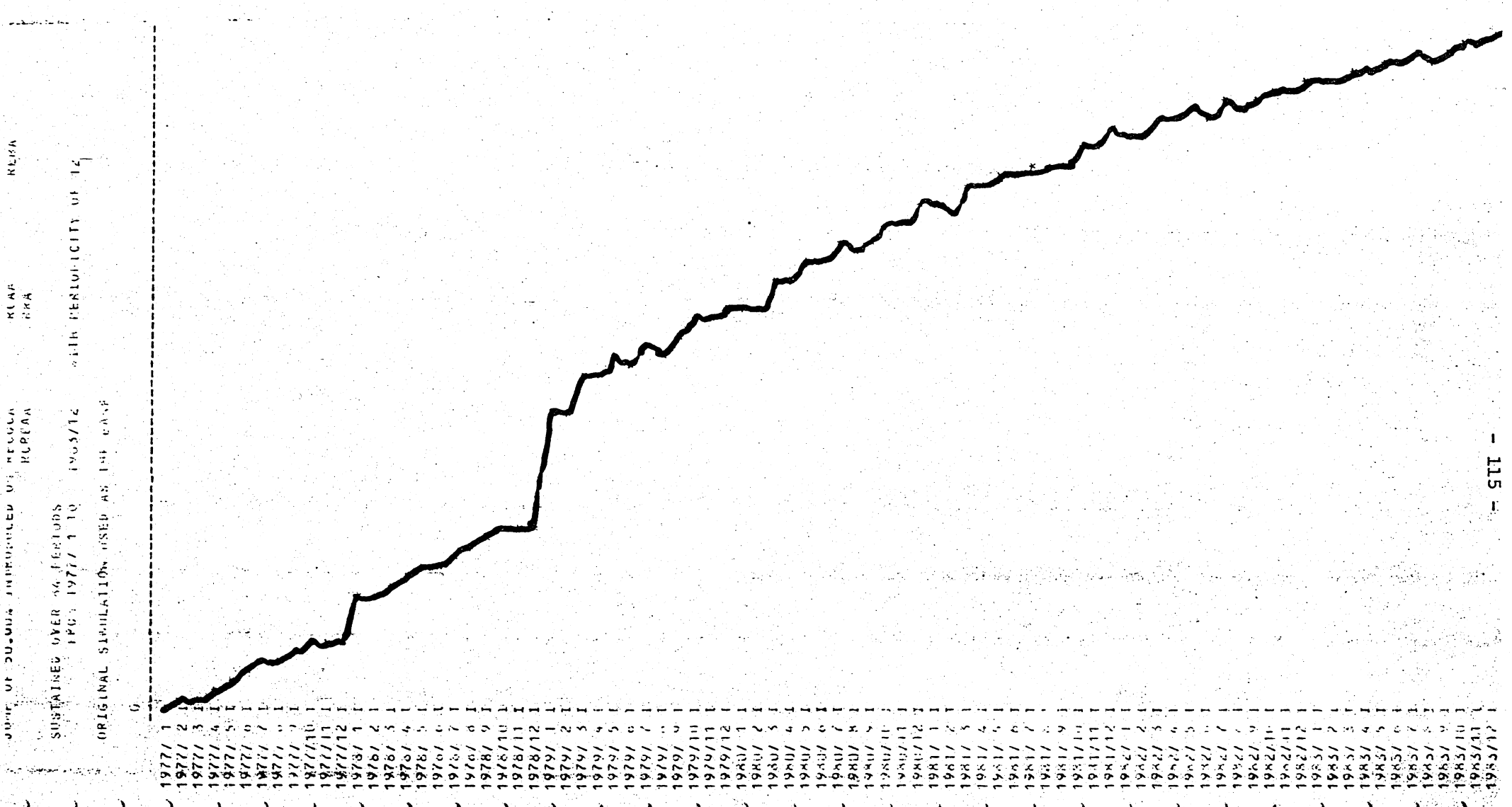
Run 3 : Effect on average producer price



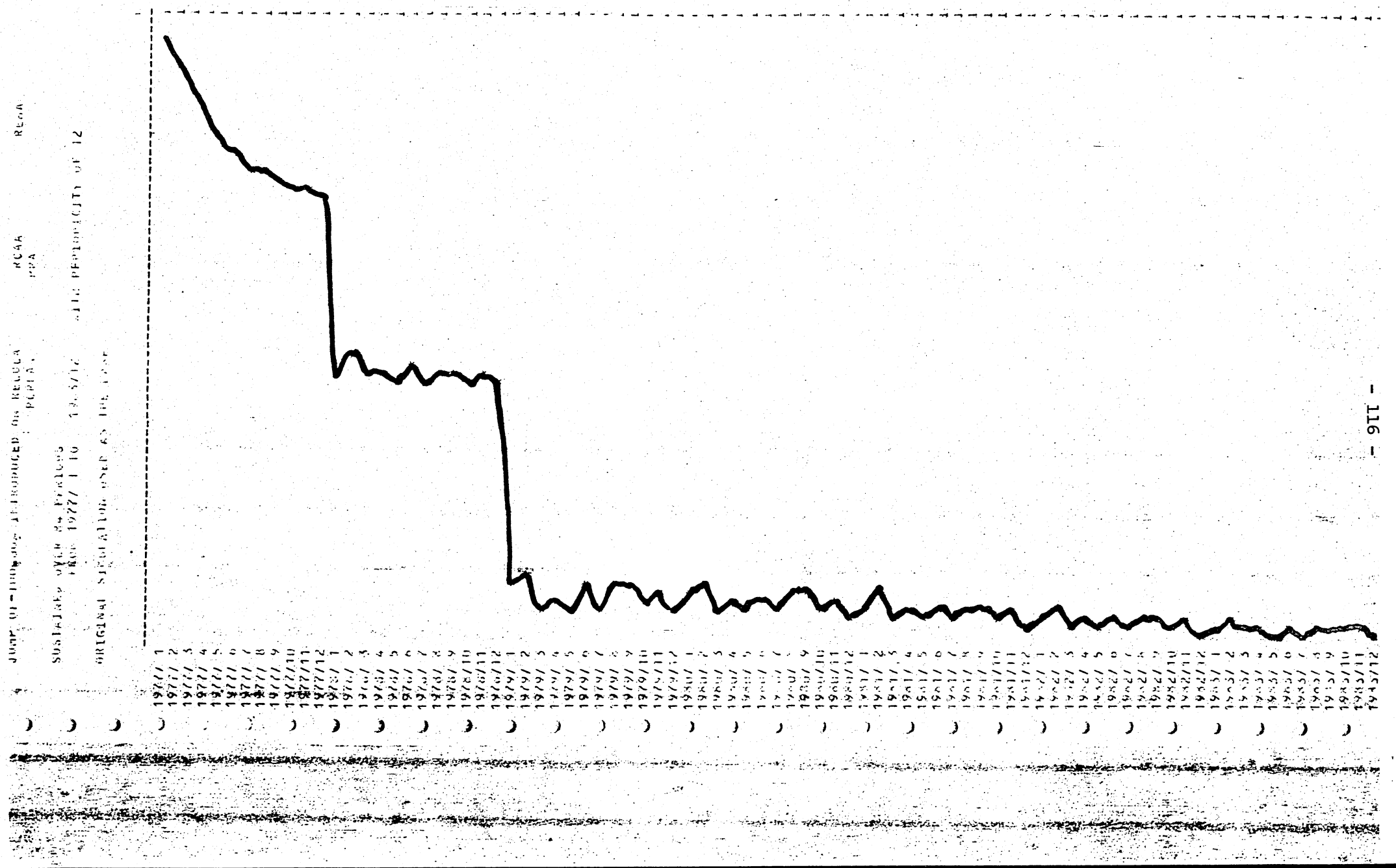
Run 4 : Effect on average producer price



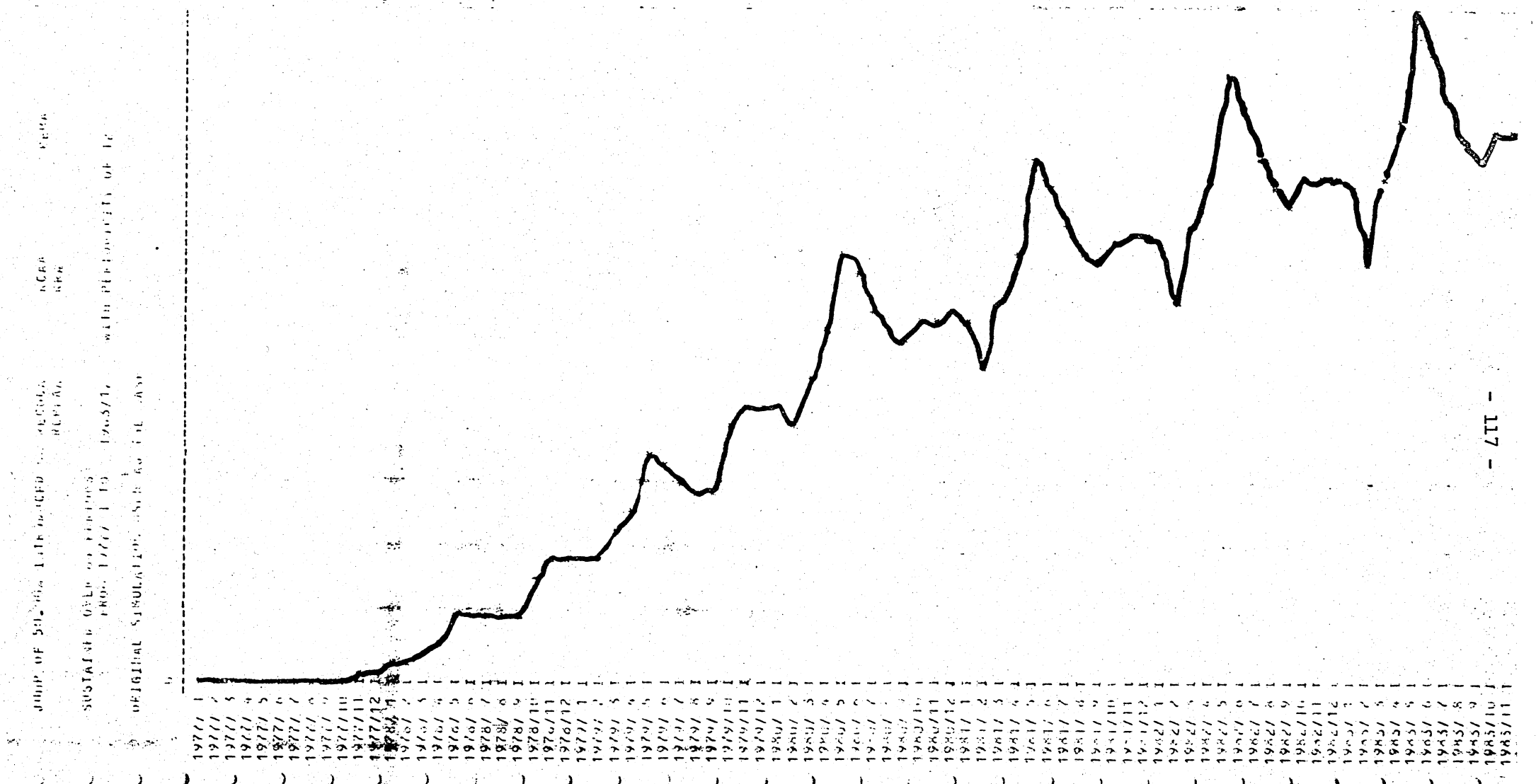
Run 3 : Effect on total marginal value of sales to households



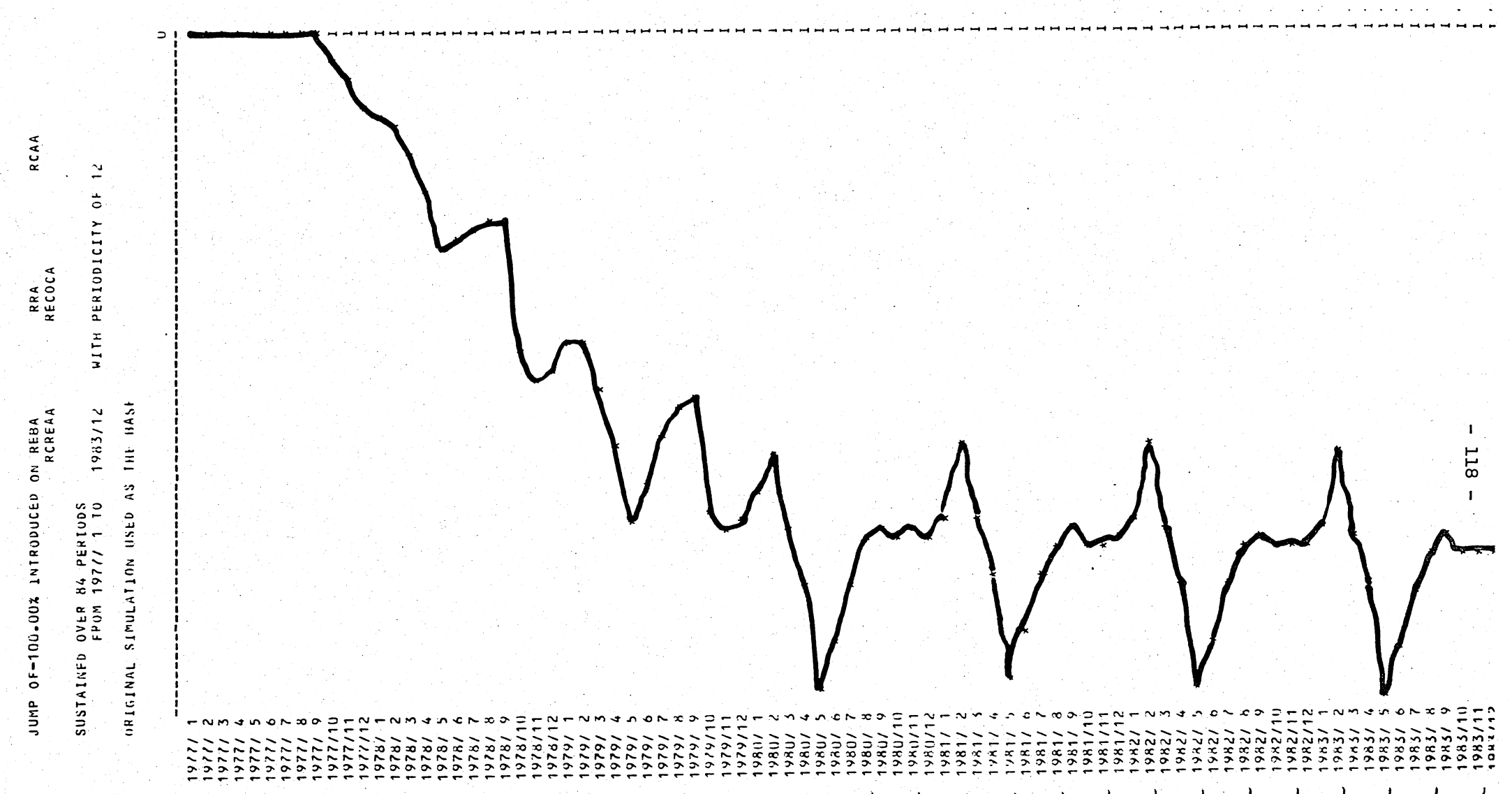
Run 4 : Effect on total marginal value of sales to households



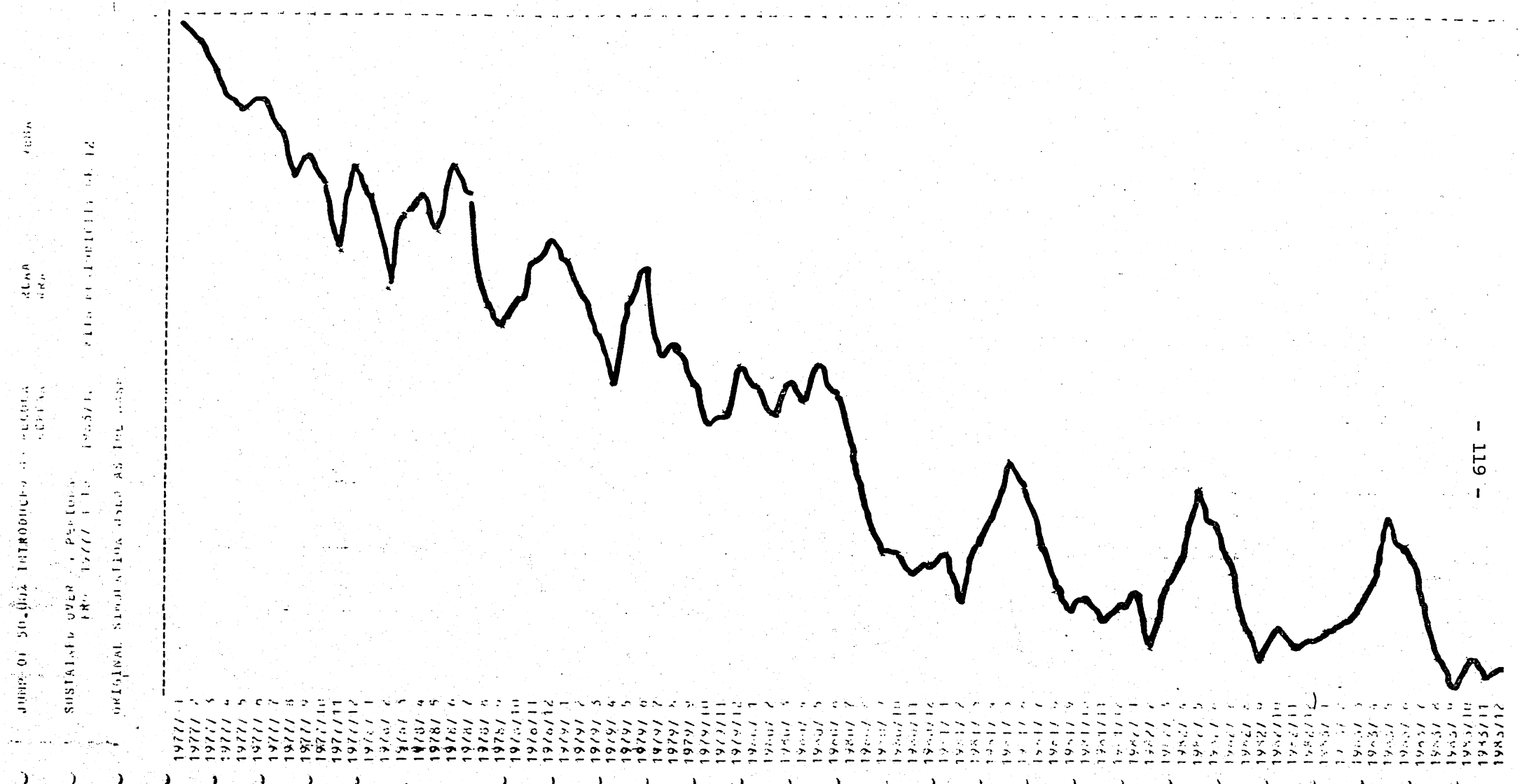
Run 3 : Effect on total milk supplies



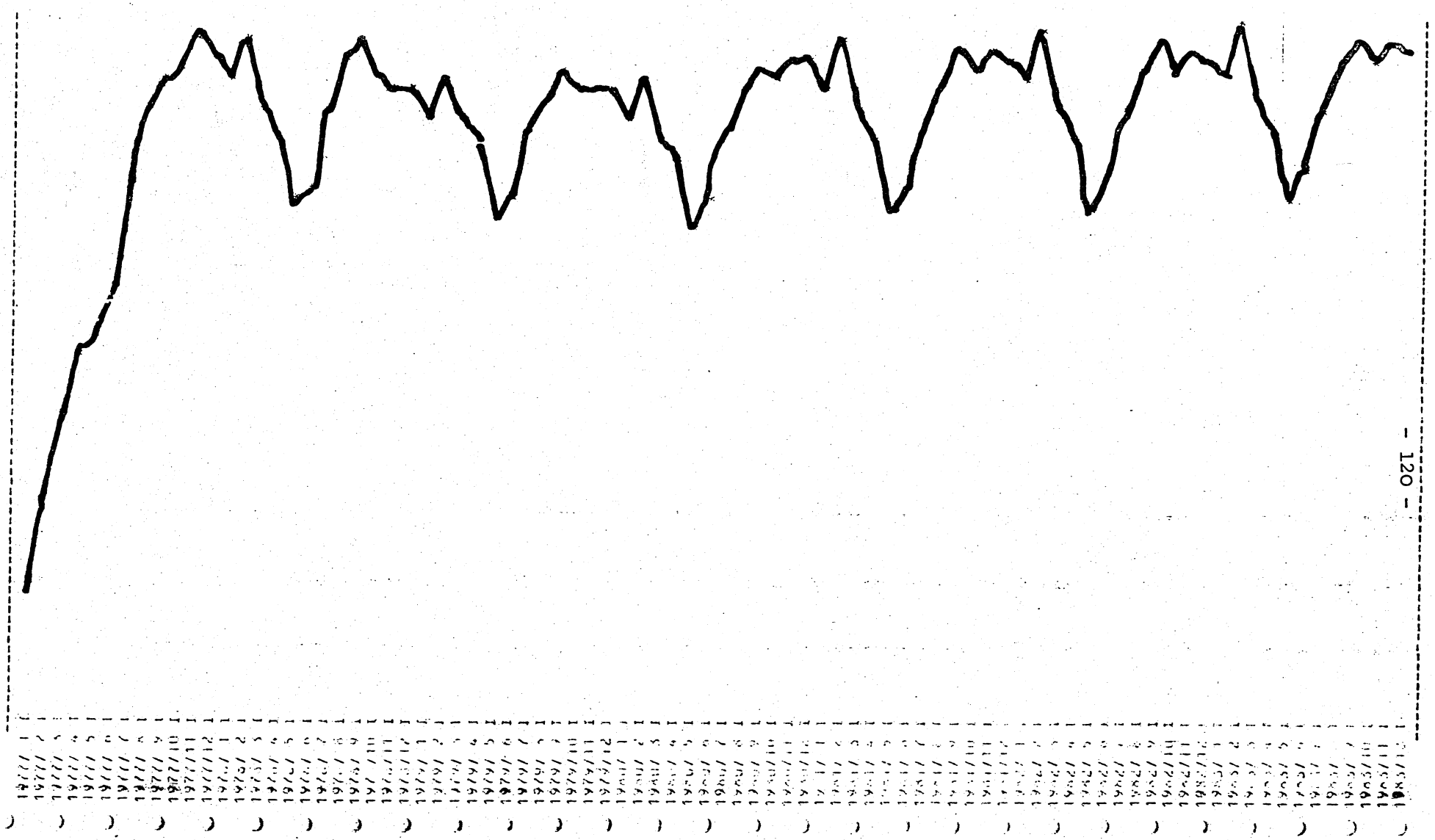
Run 4 : Effect on total milk supplies



Run 3 : Effect on proportion of milk supplies sold to intervention



Run 4 : Effect on proportion of milk supplies sold to intervention

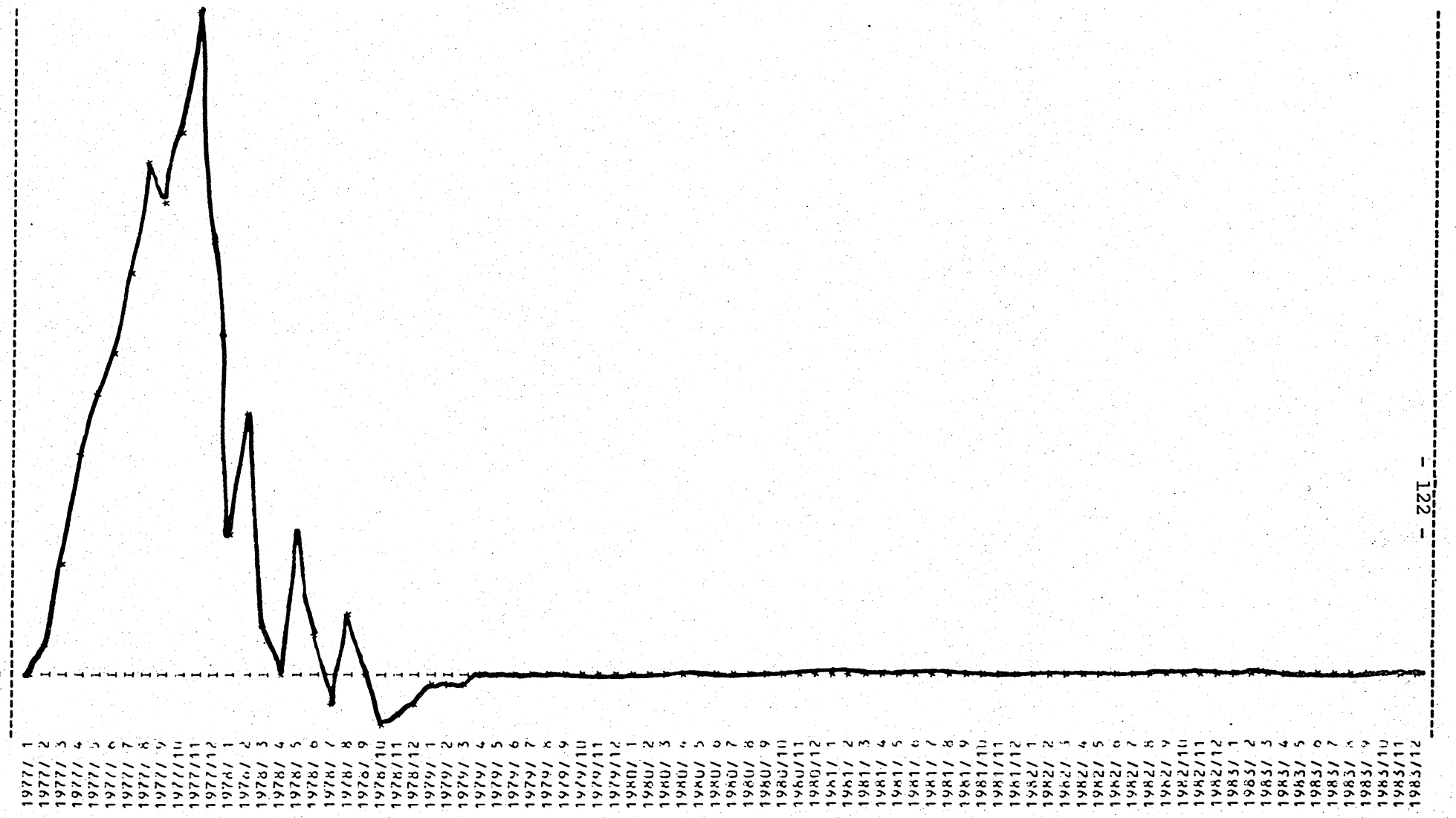


The butter and cheese markets: a comparison of the effects of a change in own advertising and changes in own advertising and competitors' advertising

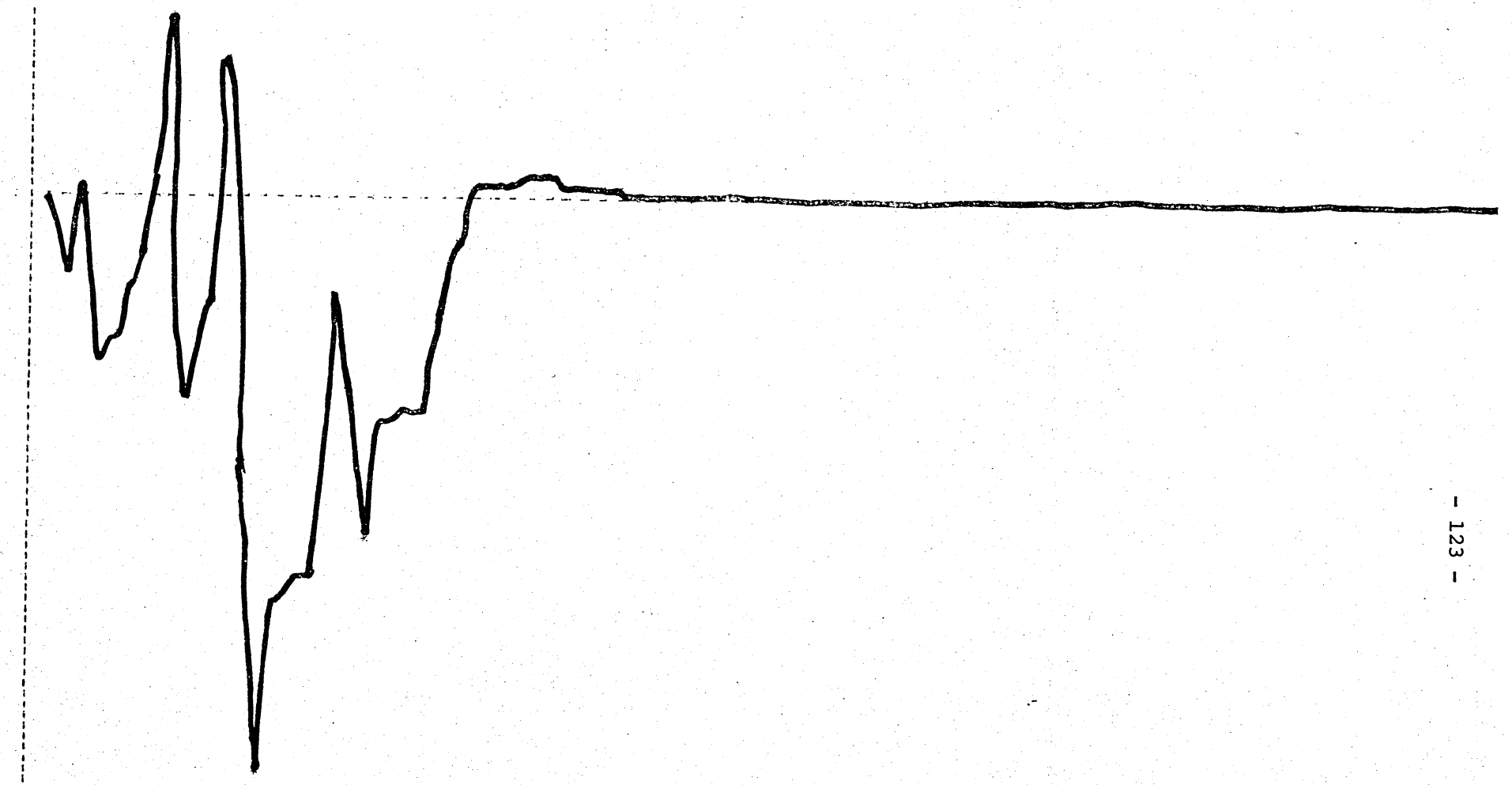
Runs 5 and 6 of the model support a conclusion given earlier in this chapter regarding the financing of English butter advertising by producers, and demonstrate the importance of considering competitors' reactions to changes in own advertising. Run 5 introduced a 10% increase in English butter and cheese advertising for 12 months. Run 6 introduced the same change and a 10% increase in rivals' advertising in those markets on the assumption that rivals would match any changes in own advertising levels.

In both runs the dynamic response for all endogenous variables of interest was shorter than in previous experiments. This was especially so for the induced difference in marginal sales value and average producer price which returned to their base levels one year after the initial change ended. The pattern of change over time for the same variables in different runs is quite different however. The average producer price increases quite markedly in Run 5, whereas in Run 6 average producer price is significantly reduced over most of the simulation period. As is to be expected from this, changes in milk supplies and intervention levels are also different. The most important difference, though, is seen in the effect on the marginal sales value. When only own advertising levels are increased the change in advertising expenditure is around +£155,080. The resulting change in marginal sales value is +£113,035 over the simulation period. This demonstrates the point made previously that, at existing price differentials, producers should not finance English butter and cheese advertising. This conclusion is reinforced by Run 6, when, as own advertising is increased by £155,080 again, the effect of increased rivals' advertising is to reduce marginal sales value by £113,035 over the simulation period. Clearly, producers do not gain from changing advertising levels for dairy products when there are competitors in the market who react to those changes.

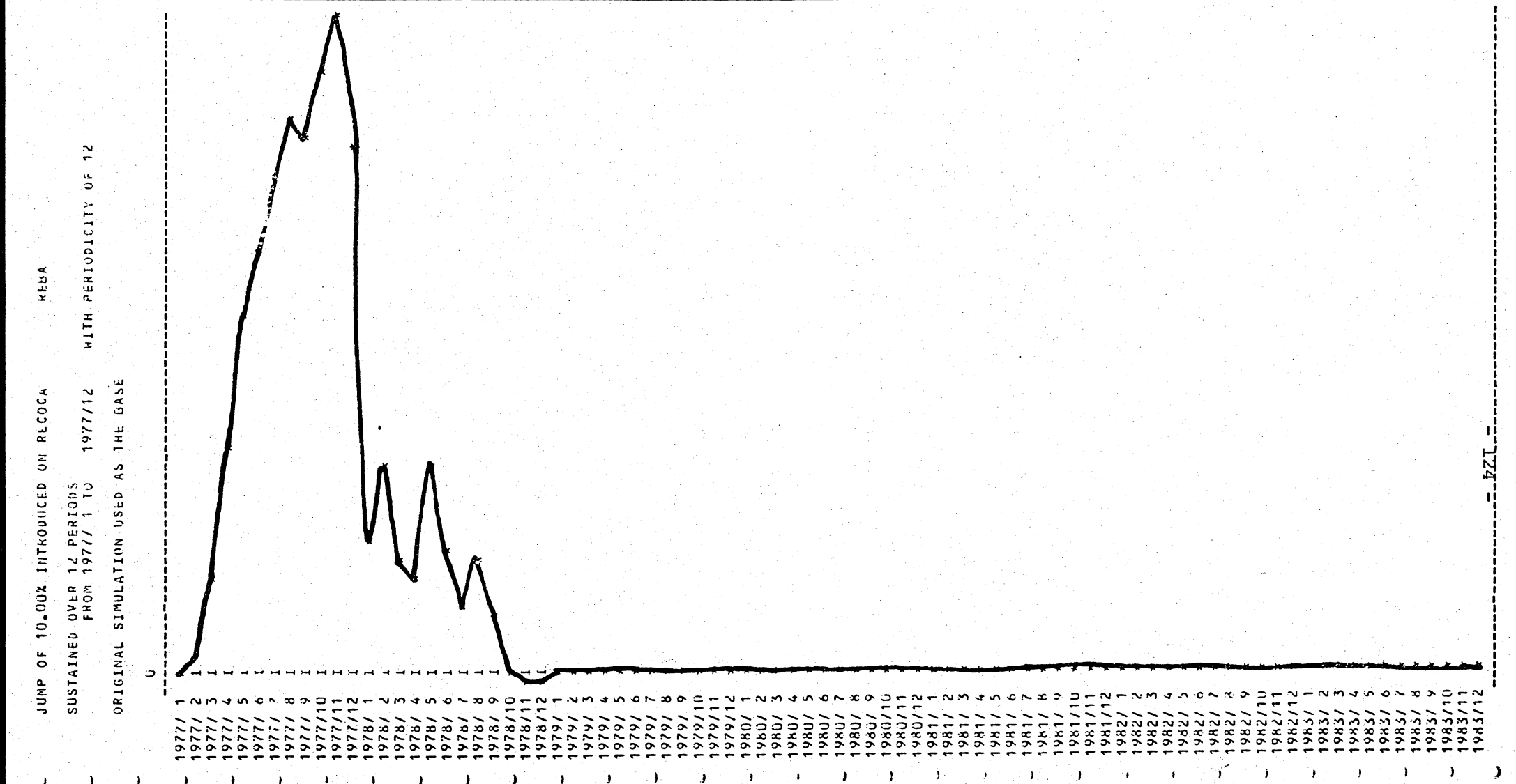
Run 5 : Effect on average producer price



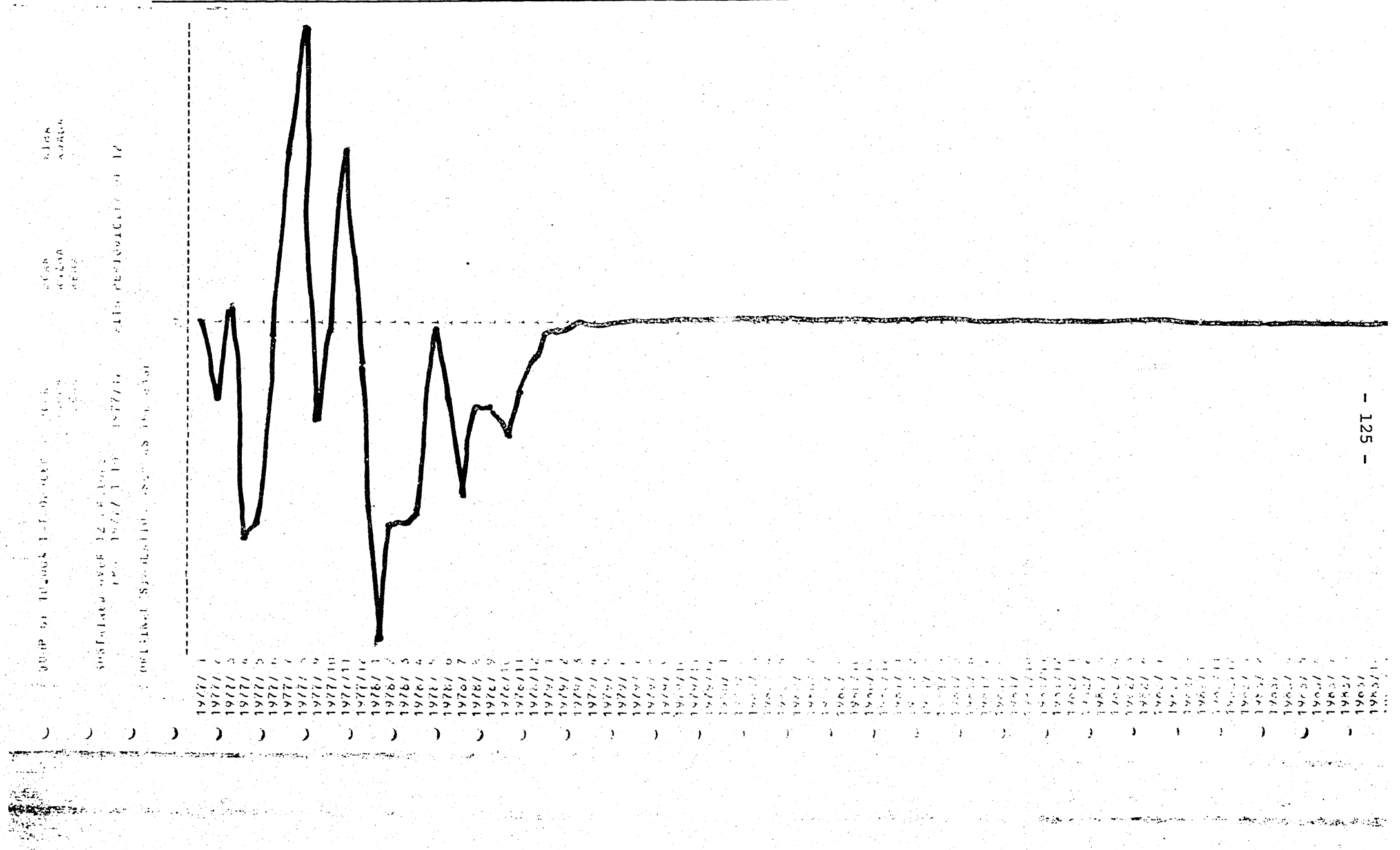
Run 6 : Effect on average producer price



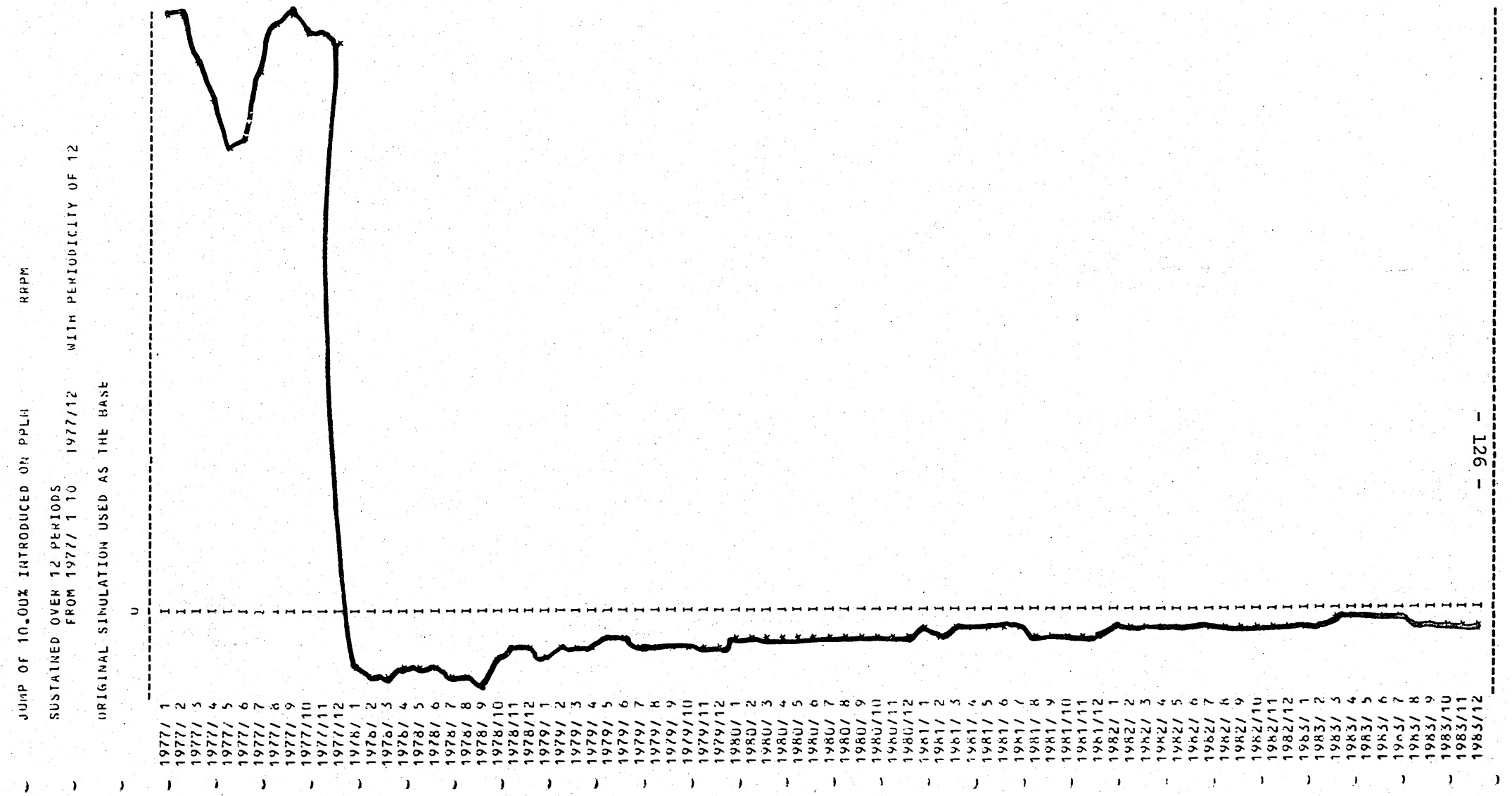
Run 5 : Effect on total marginal value of sales to households



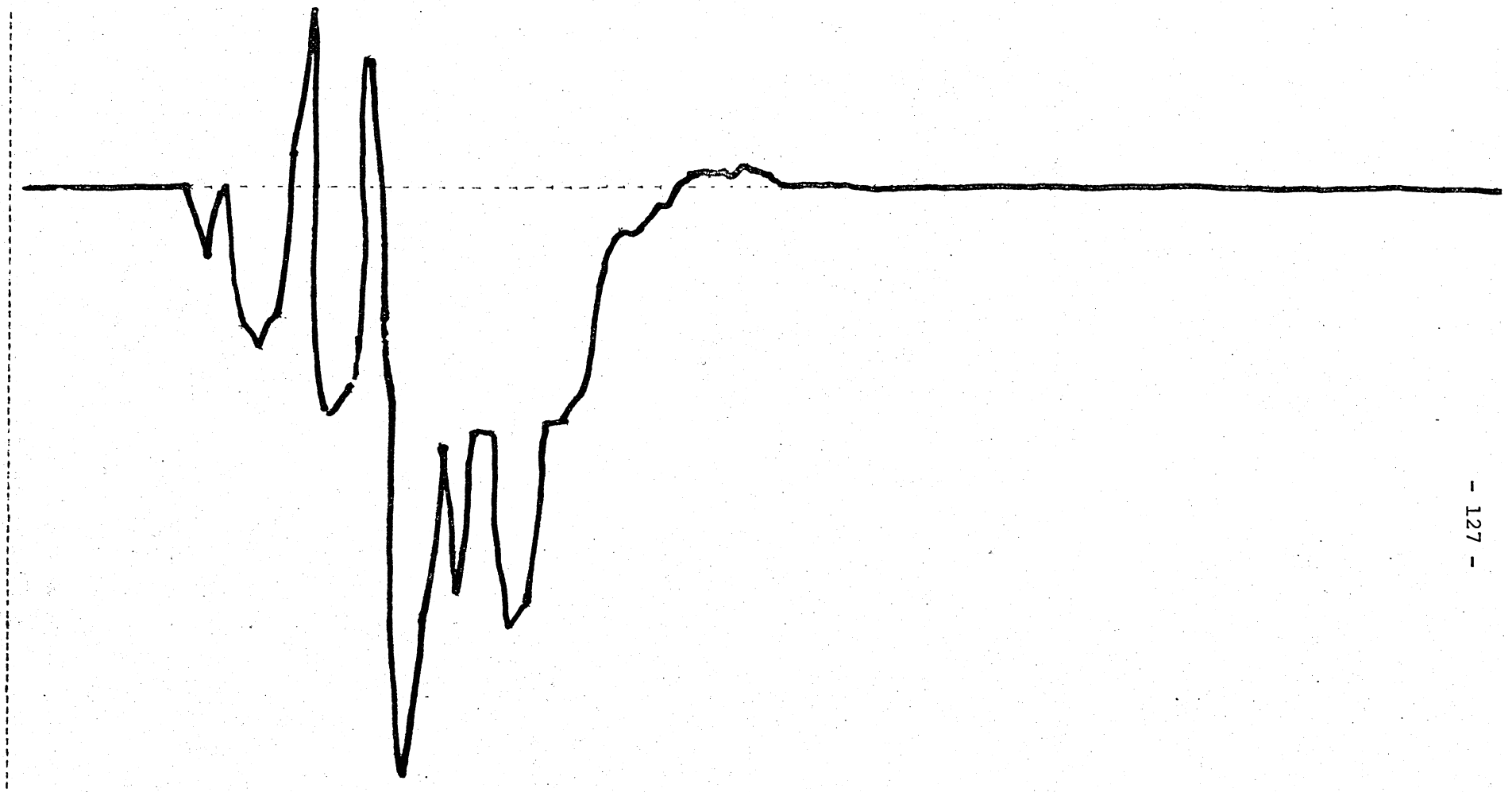
Run 6 : Effect on total marginal value of sales to households



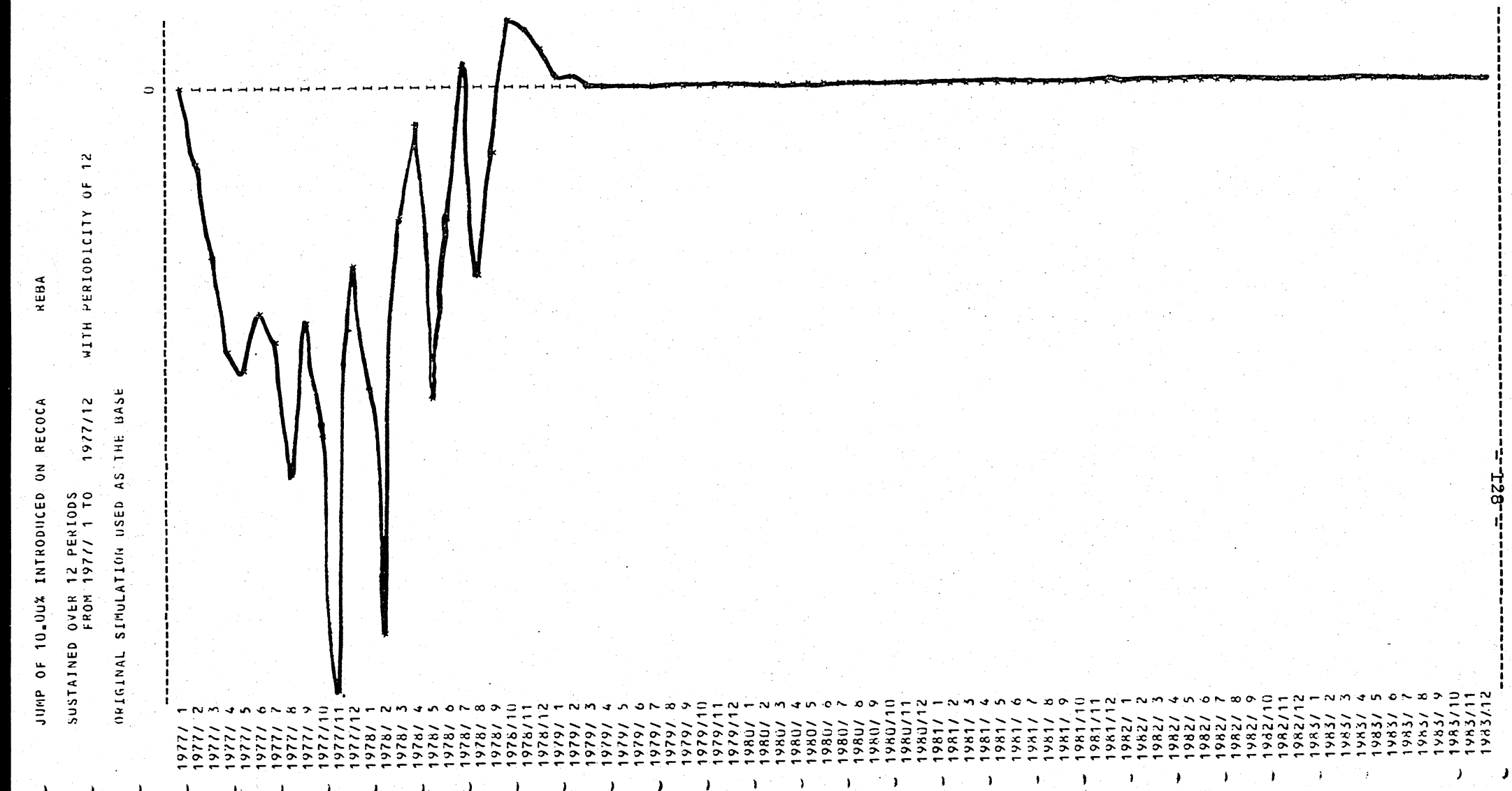
Run 5 : Effect on total milk supplies



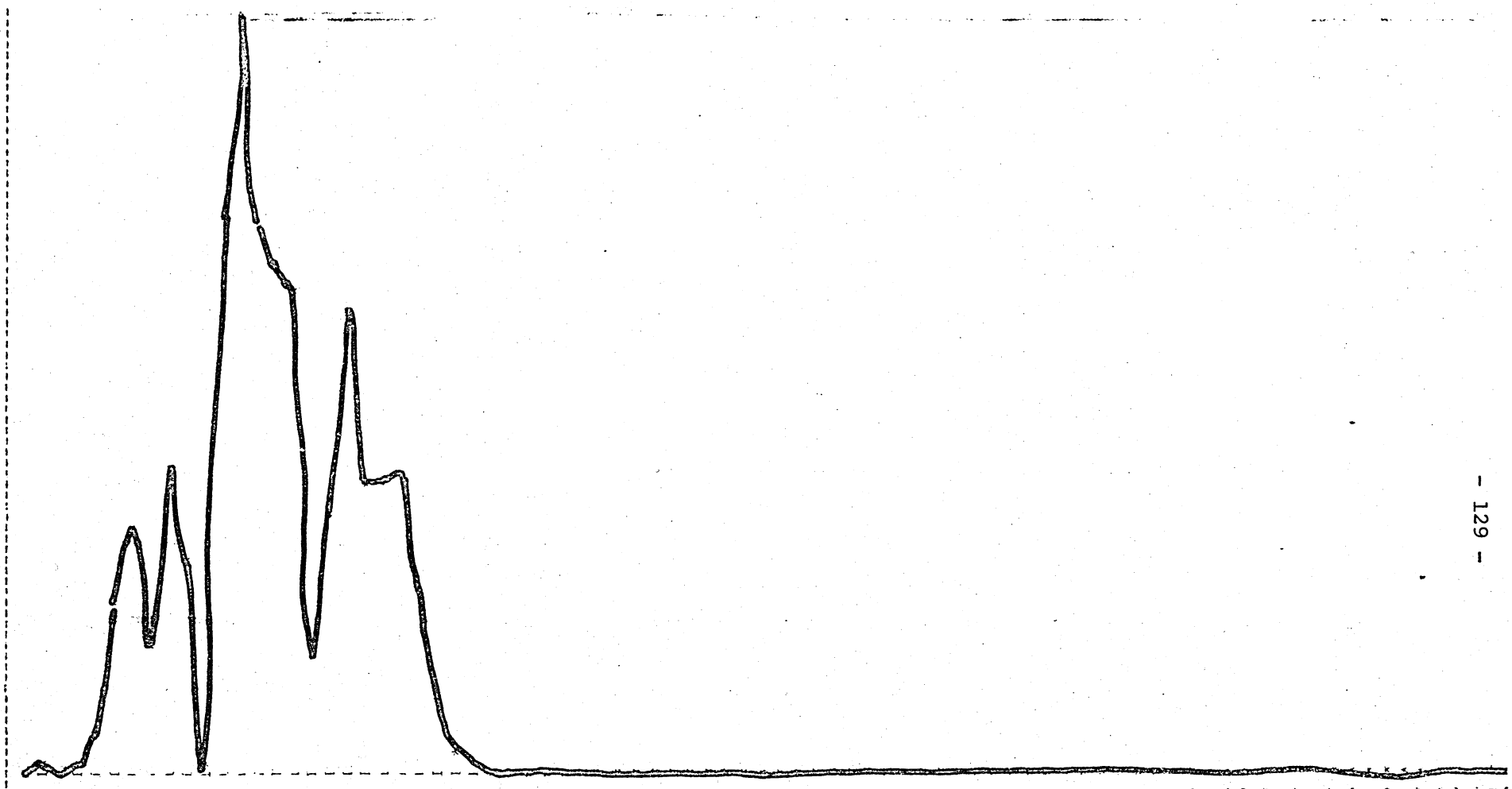
Run 6 : Effect on total milk supplies



Run 5 : Effect on proportion of milk supplies sold to intervention



Run 6 : Effect on proportion of milk supplies sold to intervention

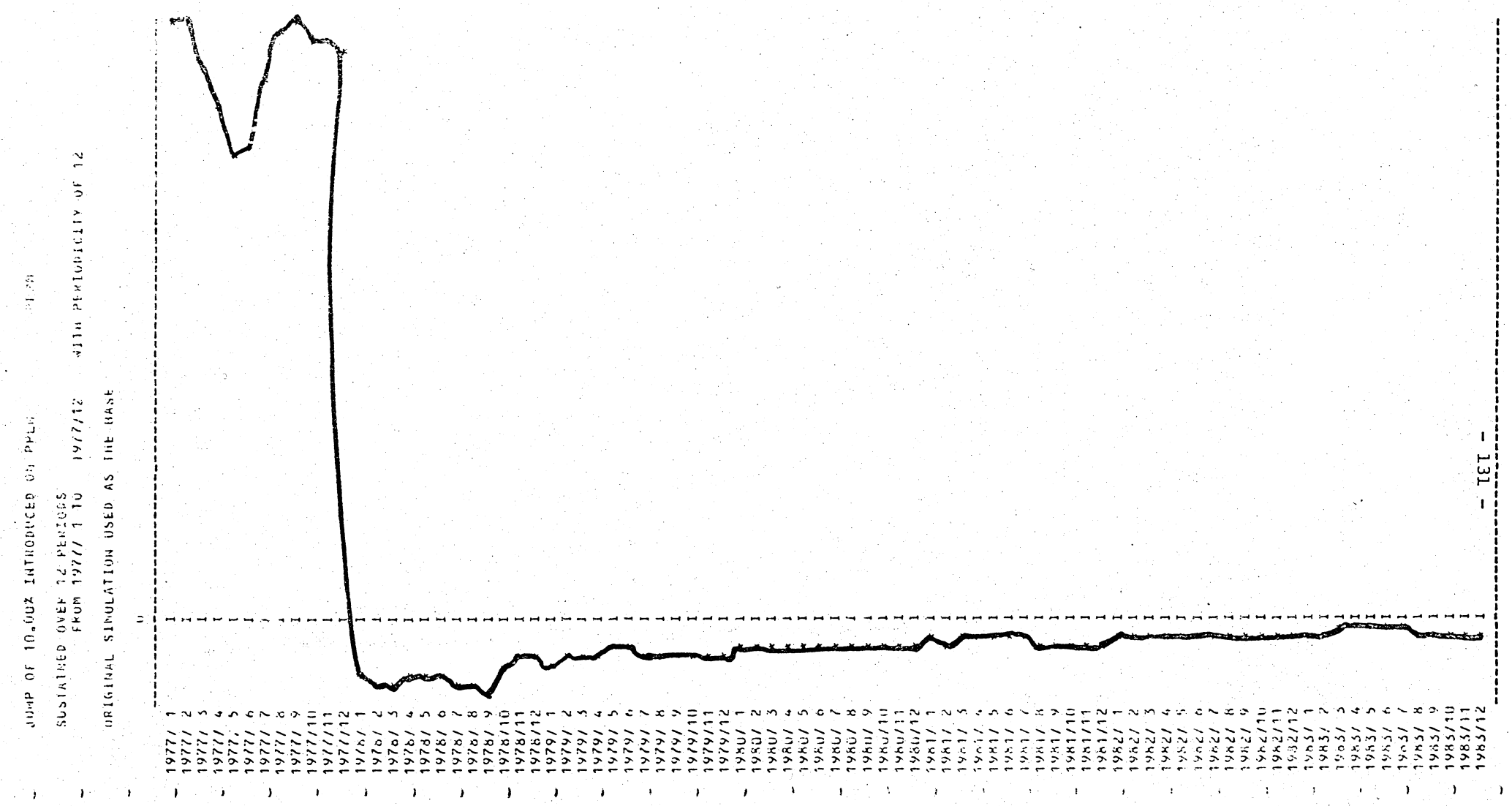


Changing the producer price for liquid milk with and without a simultaneous increase in the retail price of milk

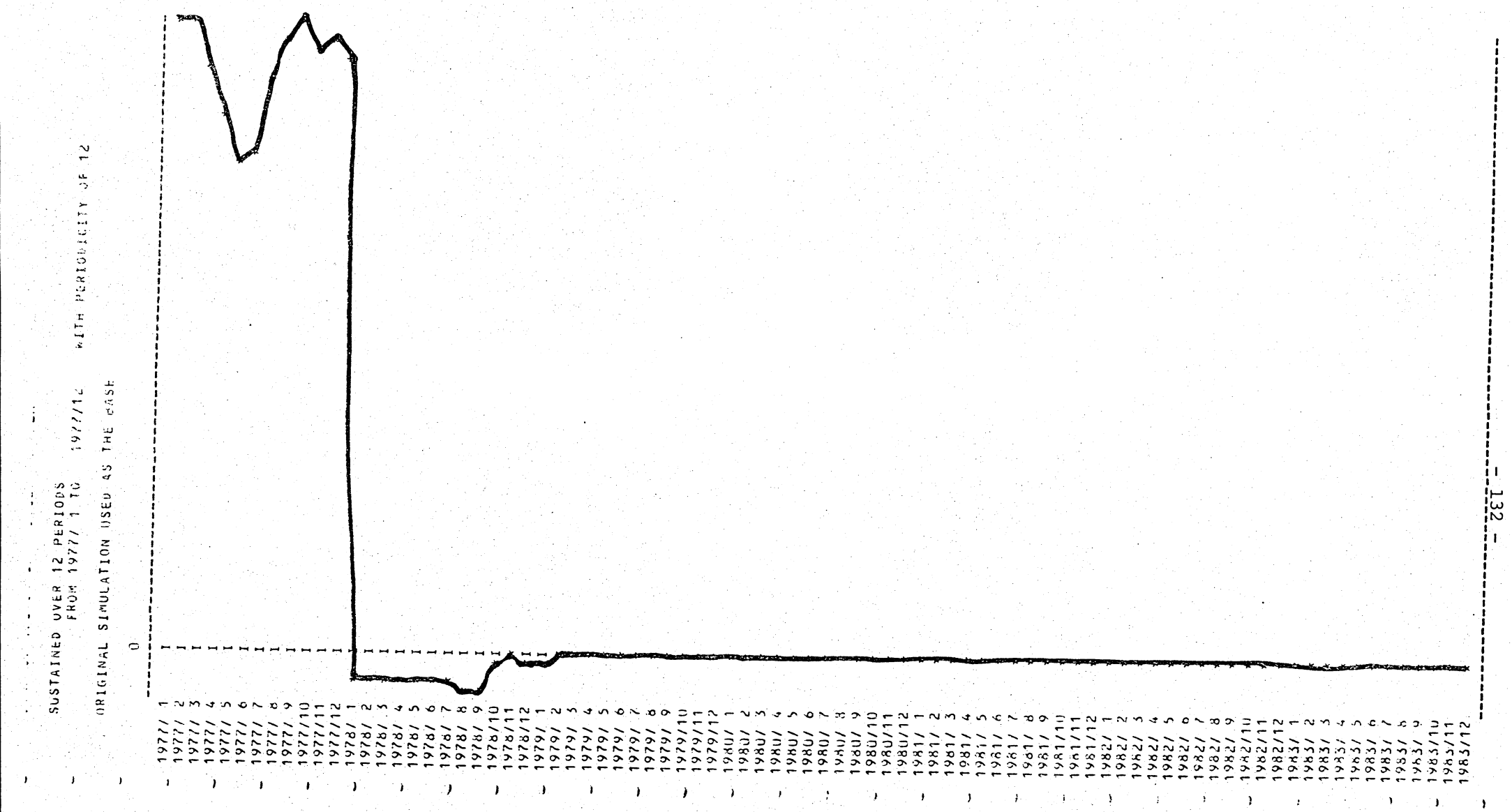
Run 7 and Run 8 of the model attempted to describe the effects of changing producer prices for liquid milk and retail prices of liquid milk simultaneously (Run 7), and of changing the producer price alone (Run 8). The latter change may be thought of as an experiment that investigates the effect of different price increases for producers and consumers. A price increase for producers, whilst retail prices are held constant, will reduce the producer-retail margin. The induced change in prices was introduced for 12 periods at the beginning of the simulation period.

The dynamic response of Runs 7 and 8 are quite similar. Although it is true that the return to the base path takes much longer in Run 7 than Run 8, much of the adjustment of producer price, sales and supplies, takes place within the first twelve periods after the change in prices is removed. The most obvious difference in the time path of effects and in the absolute amount of change is in the proportion of milk sold to intervention. Changing producer price only, induces less of an increase in the percentage of milk sold to intervention than changing producer prices and retail prices simultaneously. Also, the return to the base path is much faster (being accomplished within 12 periods compared with 72 periods). It would seem that reducing the size of the producer-retail margin by producer price increases has a smaller and more immediate impact than a simultaneous increase in prices that leaves the margin constant.

Run 7 : Effect on average producer price



Run 8 : Effect on average producer price



JUMP OF 10.00% INTRODUCED ON PPLM RRPM

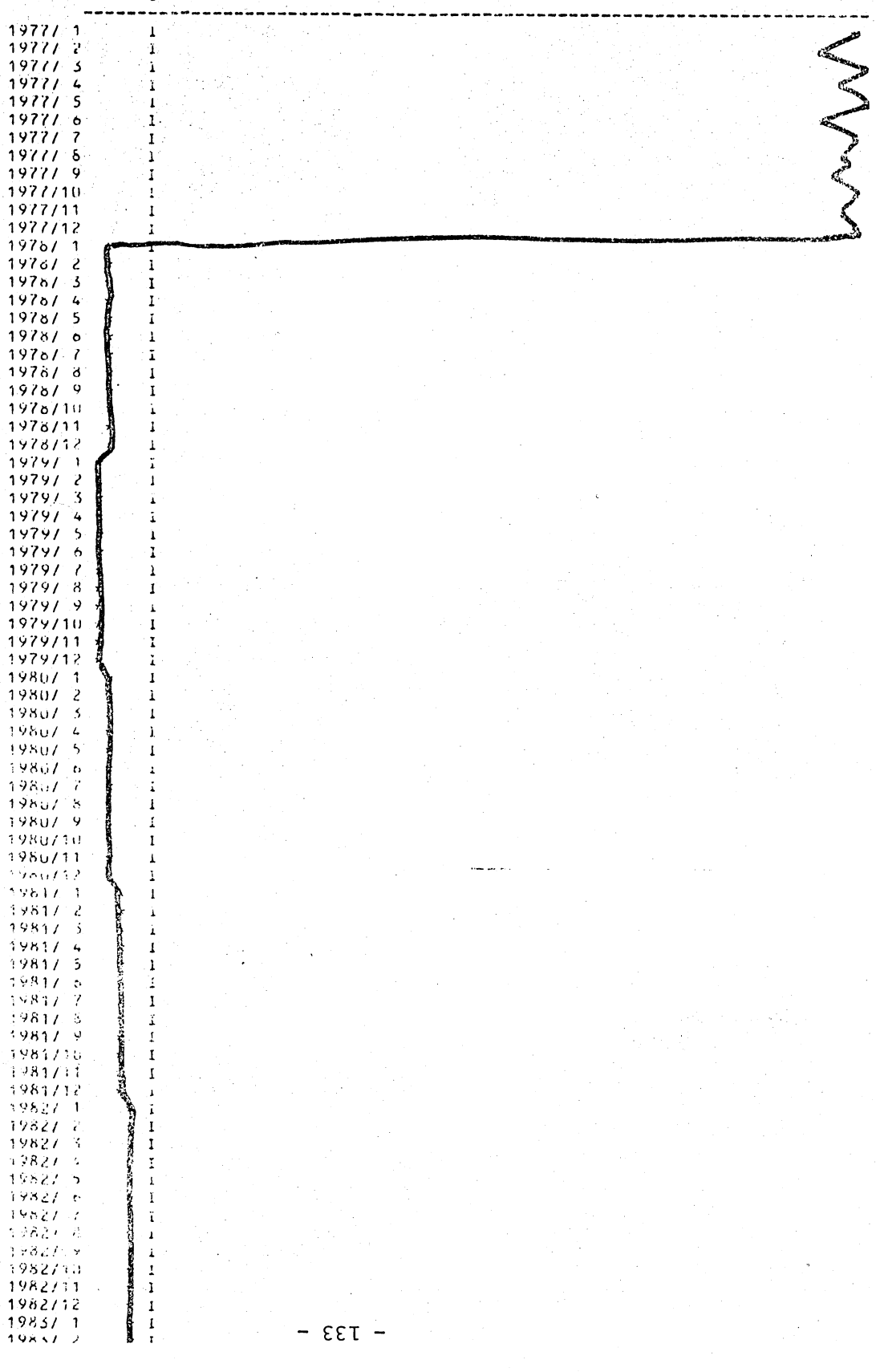
SUSTAINED OVER 12 PERIODS
FROM 1977/ 1 TO 1977/12 WITH PERIODICITY OF 12

ORIGINAL SIMULATION USED AS THE BASE NEGLIGIBLE EFFECT ON ENDOGENOUS VAI
MAXIMUM INDUCED VARIATION IS 0.0000

JUMP OF 10.00% INTRODUCED ON PPLM RRPM

SUSTAINED OVER 12 PERIODS
FROM 1977/ 1 TO 1977/12 WITH PERIODICITY OF 12

ORIGINAL SIMULATION USED AS THE BASE

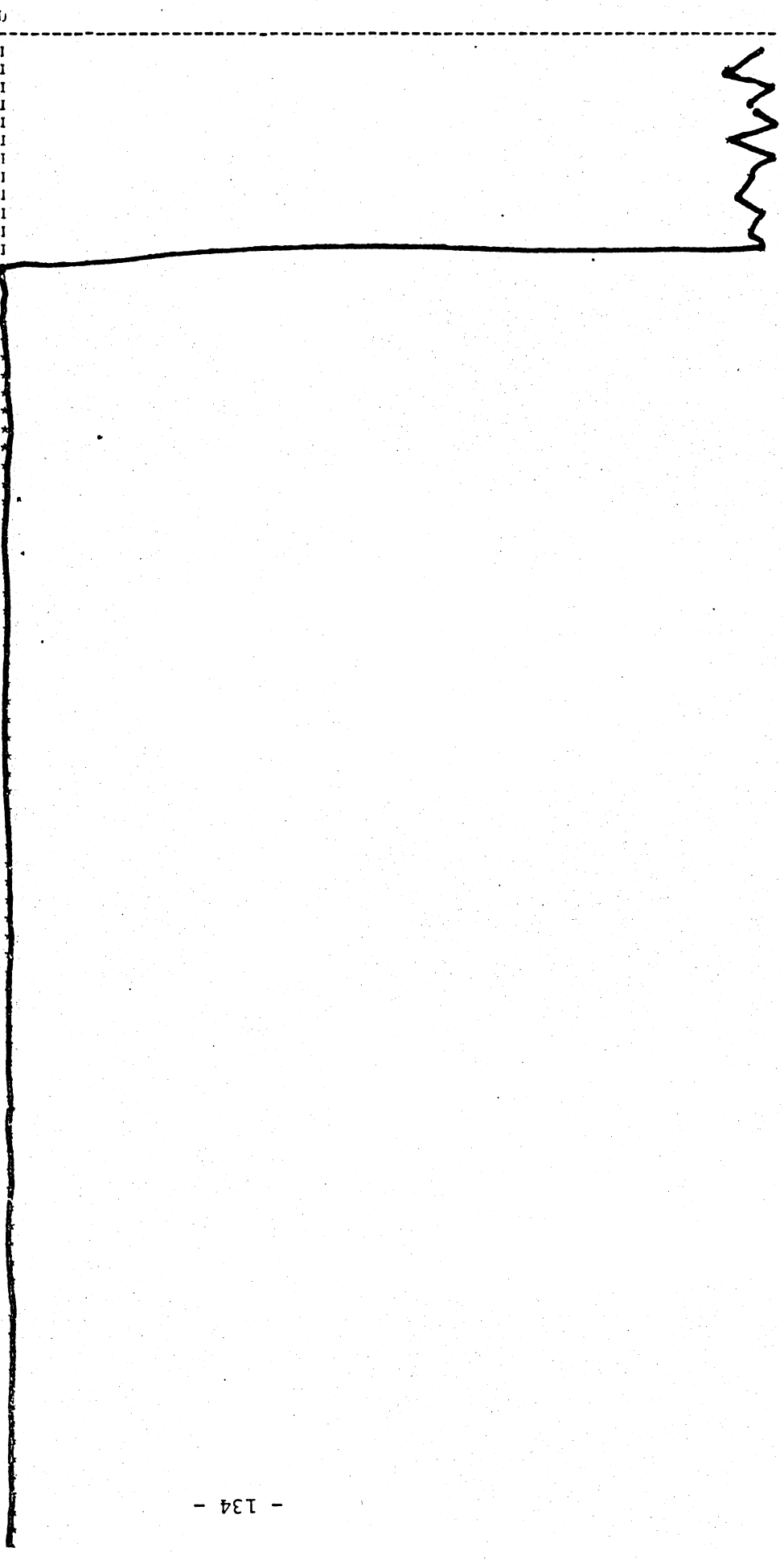


Run 7 : Effect on total marginal value of sales to households

JUMP OF 10.00% INTRODUCED ON PPLM

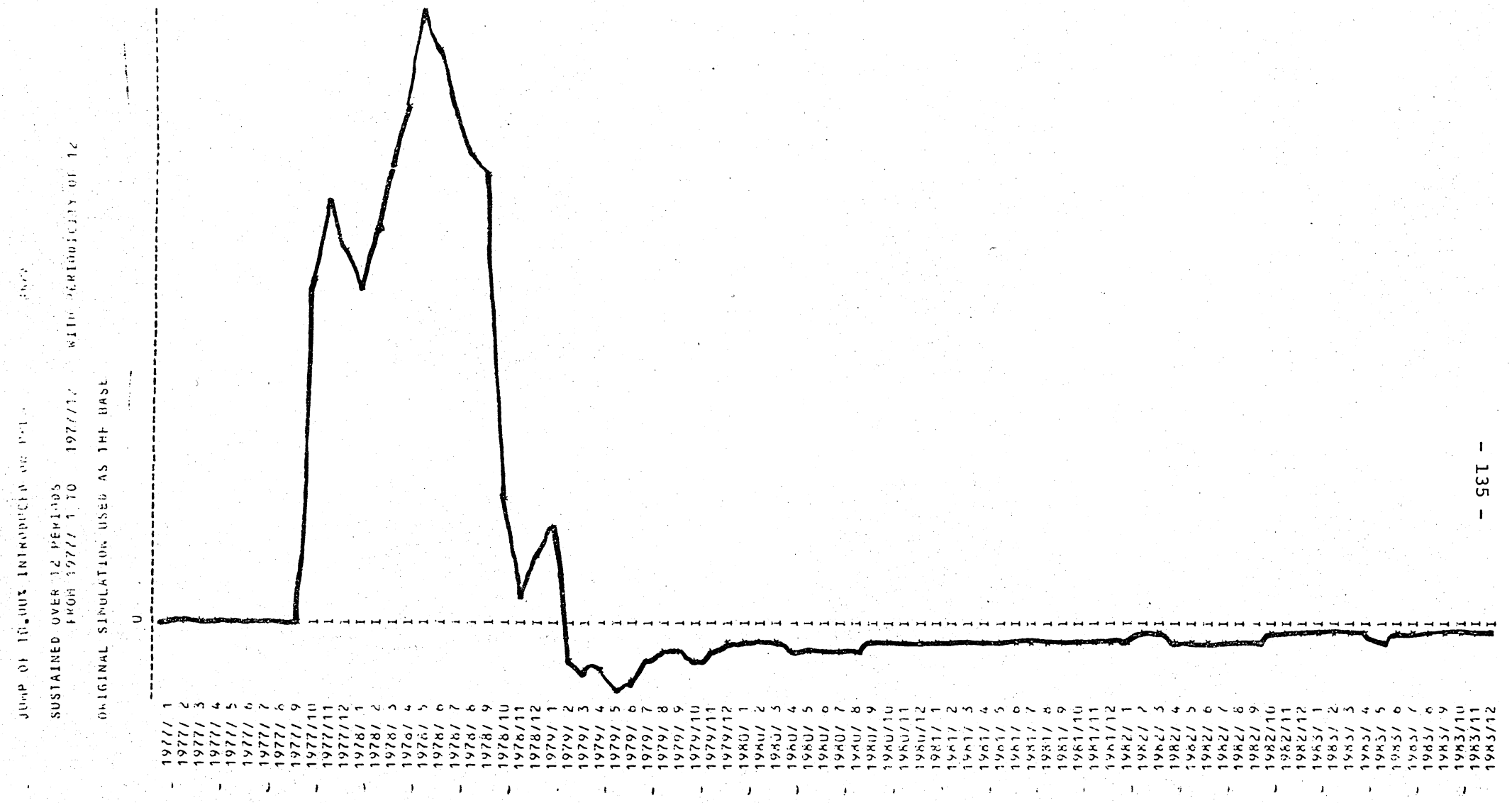
SUSTAINED OVER 12 PERIODS
FROM 1977/ 1 TO 1977/12 WITH PERIODICITY OF 12

ORIGINAL SIMULATION USED AS THE BASE

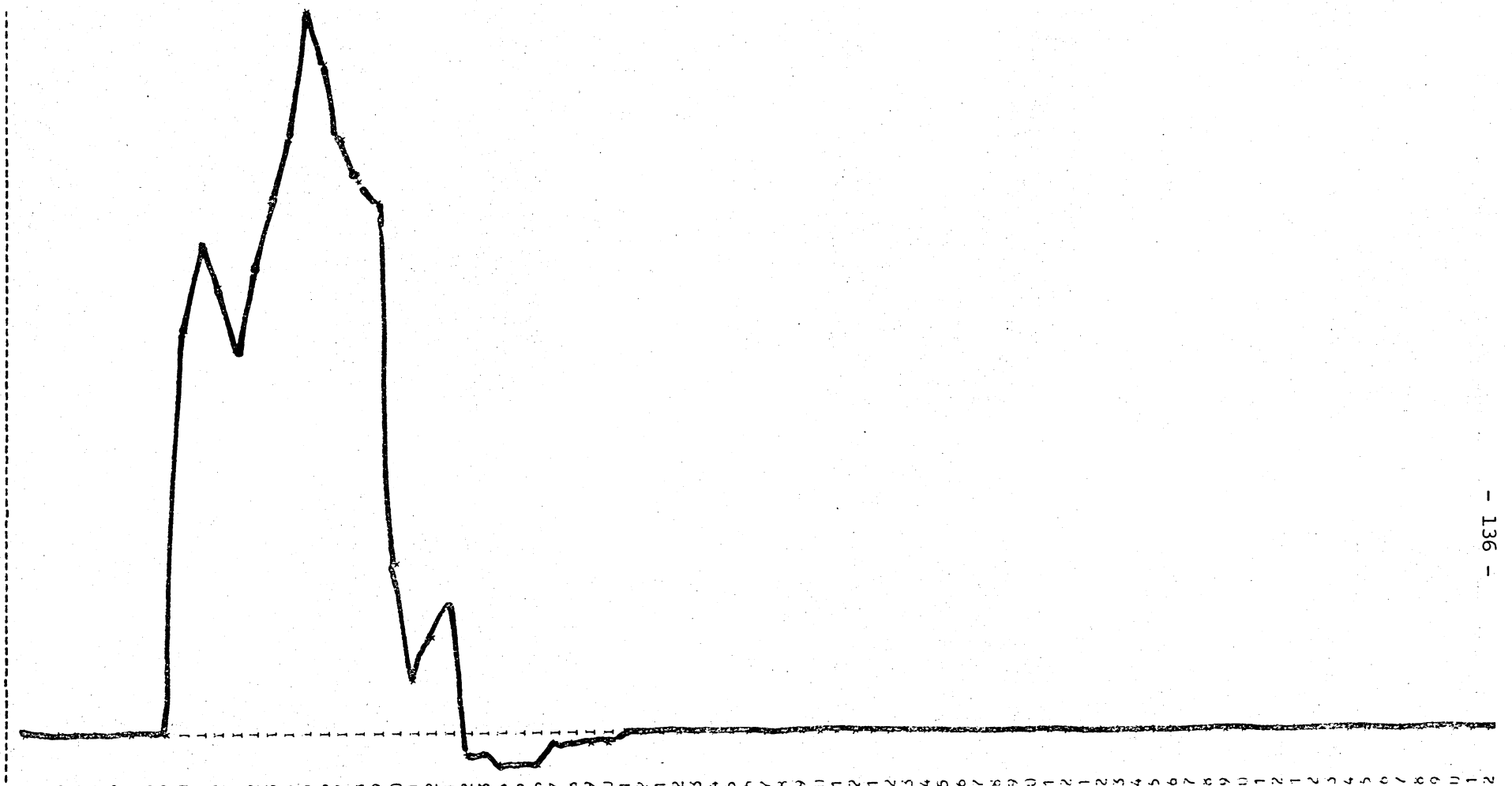


Run 8 : Effect on total marginal value of sales to households

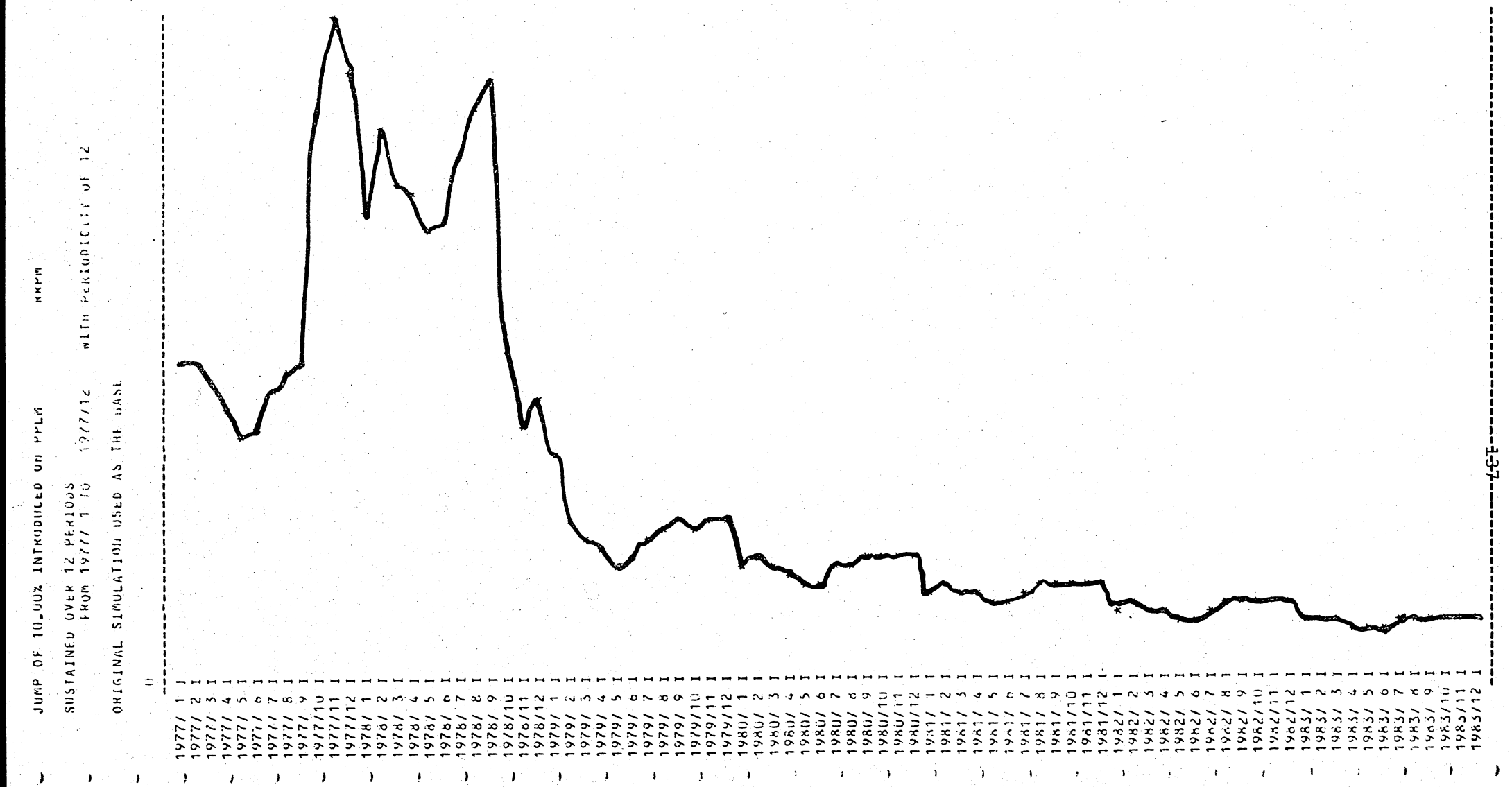
Run 7 : Effect on total milk supplies



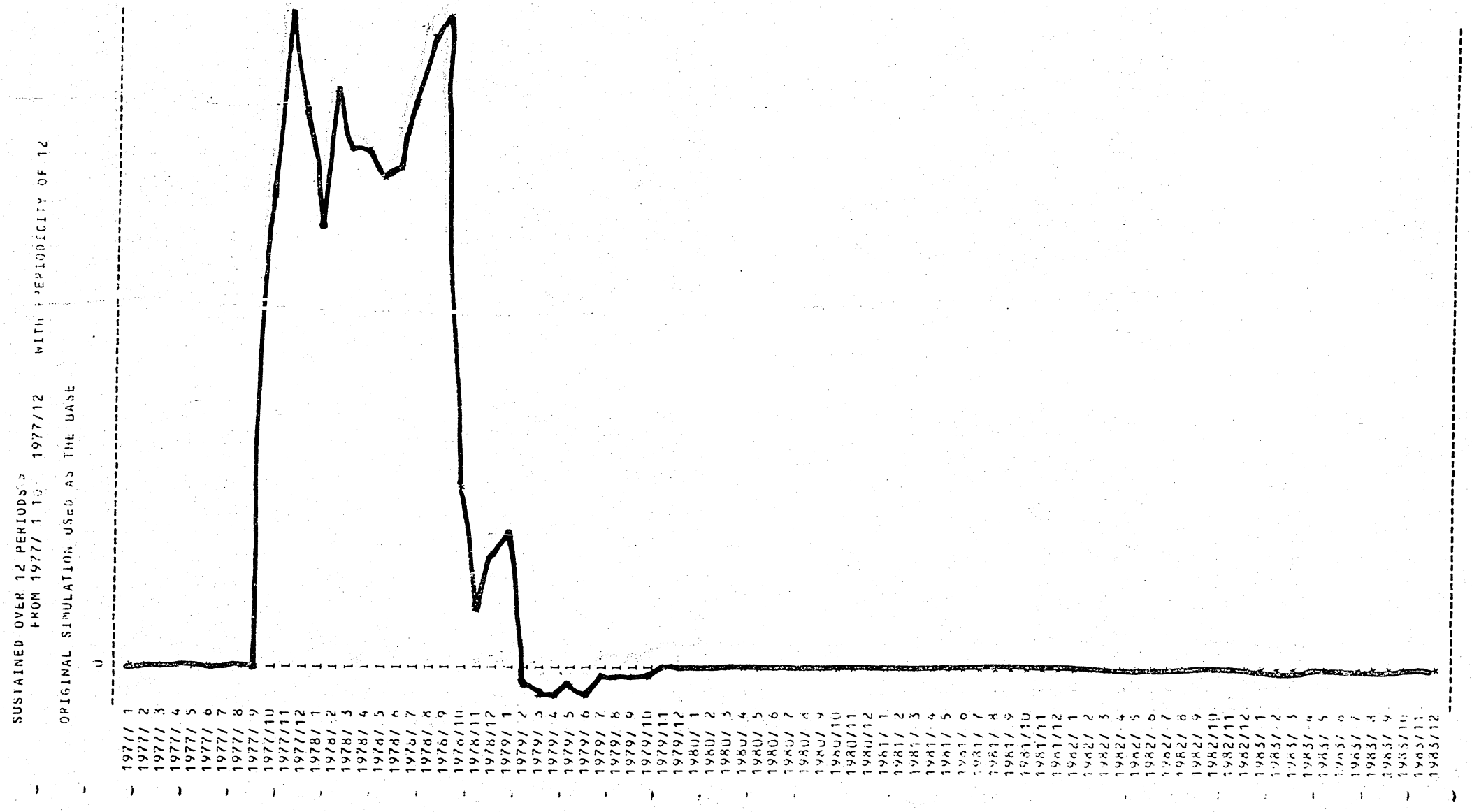
Run 8 : Effect on total milk supplies



Run 7 : Effect on proportion of milk supplies sold to intervention



Run 8 : Effect on proportion of milk supplies sold to intervention



Summary

The evaluation and simulation of the effects of advertising presented in this chapter attempted to demonstrate how quantitative estimates of the sales response to advertising could be combined with a theoretical view of optimal advertising to aid advertising decisions in the milk market. The evaluation used the elasticities calculated in Chapter Three and the simple decision rules presented in Chapter Two, to make a prescriptive comment on how the Board should proceed. The simulation again used the econometric results of Chapter Three in a model of the milk market but the results of several simultaneous changes in price and advertising were examined over several years. For the evaluation, the conclusions are that;

i) Gains from increased advertising in the liquid milk market can be obtained by producers, the trade and government. It is not possible to be precise about the size of these gains for the trade as there is insufficient information on the profit margins for milk processing and distribution. Overall, the liquid market justifies marginal increases in advertising.

ii) For cream, it appears that the optimal advertising budget, evaluated at 1980 prices and quantities, is significantly below contemporary advertising expenditures. For producers there is little direct incentive to increase sales of cream by advertising. The expected increased returns will not cover the cost of advertising. For the trade, it is less clear what their level of commitment to advertising should be. Again, the problem of determining profit margins complicates the evaluation as does the existence of another cream advertising budget (the cream cakes campaign) aimed at the catering market, which was not studied in the econometric analysis. Unless those margins are relatively high it appears unlikely that the generic advertising of cream can be supported on economic grounds by producers or the trade.

iii) English butter - for producers there is no immediate increase in profits from advertising English butter at a price differential, between milk sold as English butter and milk sold as butter to the Intervention Agency, below

0.3 pence/litre. Furthermore, given that the butter market is extremely brand competitive and that rivals' reactions to changes in price and advertising are likely, it may be better to simply consider advertising by the Board as a processor. In this context it appears that the Board should increase its advertising budget for English butter significantly. This conclusion, however, it conditional upon assumptions about the size of competitors' responses to such an increase in own advertising. If that response is quite elastic (an elasticity value greater than 2.0) the Board should reduce its advertising on English butter. If the response is relatively inelastic (an elasticity value less than 2.0) it should increase its advertising on English butter.

iv) For cheese, the evaluation suggests that producers and the trade will gain from increased levels of generic advertising expenditures. Without precise information on the price differential for milk sold as cheese, rather than to intervention, and the profit margins of cheese processors it is not possible to forecast the exact size of the appropriate generic advertising budget. However, the range of marginal returns from advertising used in the calculations implies that expenditures could increase significantly from current levels. This is particularly true for a situation in which producers and the trade jointly contribute to the generic budget.

v) For English cheddar cheese - if it is reasonable to consider cheddar cheese to be in competition with territorial and 'continental' cheeses, then it is necessary to consider these rivals' reactions in response to changes in English cheddar advertising. The analysis suggests that if those reactions are relatively elastic (an elasticity value greater than 1.0) the Board should reduce its advertising on English cheddar cheese. At or below this value of rivals' response the Board should increase its advertising. Just as with English butter it may be more appropriate to consider the financing of advertising of English cheese advertising by the Board as a processor rather than as a producer.

For the simulation, the general conclusion is that:-

Studying the effects of advertising changes on marginal revenues, milk supplies and the proportion of milk sold to intervention is facilitated by a simulation model. The time horizon of these effects produced by a model run, may be very relevant to the advertising budget decision. Different runs of the model also reinforced the view that competitor's reactions must be taken into account when considering advertising levels in the butter and cheese markets. They also illustrated how intervention levels could eventually be reduced by changes in advertising. Overall, econometric estimates of price and advertising response may be more realistically and usefully evaluated using a simulation model rather than by relying upon simple elasticities or their incorporation into decision rules formed under restrictive assumptions.

CHAPTER 5

Some Concluding Observations

This study, just like any other, has produced results which must depend upon various assumptions made by the researchers in the course of the work done. It is at this point, having presented the various decision rules and illustrations of estimation and evaluation, that these assumptions are further examined in order to assess the progress made.

Firstly, the theory —— a feature of Chapter Two was its emphasis on profit maximization as the objective of the firm,and the identification of necessary conditions for optimal advertising decisions. Clearly, neither of these assumptions may be sufficient for an analysis of the firm's behaviour. A firm or entrepeneur may wish to maximize sales rather than profits or maximize sales subject to a minimum profit constraint. Alternatively, firms may have non-pecuniary motives for advertising e.g. milk producers may simply wish to be seen as helping sales of their product (particularly in a surplus situation). These possibilities and their relevance to the advertising decision were not considered in the theoretical analysis. More seriously, perhaps, the derivation of sufficient conditions for the simple profit functions given in Chapter Two was not described. The significance of this will depend upon the precise form of the market demand function and in particular

on the way in which sales respond to advertising. Further, a characteristic of the decision rules for optimal advertising set out in Chapter Two was that they are framed in terms of elasticities. Whilst the concept of elasticities is widespread,their reliance on *ceteris paribus* and other simplifying assumptions may be a serious handicap for decision-makers concerned with markets in which nothing is ever constant.

The specification of the relationship between sales and advertising for the estimation procedure suffered from the inadequate treatment given to advertising in the theory of demand and the lack of a rigorous theory of advertising. Intuitively, diminishing returns to advertising are expected but the only functional form that can reflect this and produce varying advertising elasticities (the semi-log demand equation) continually performed badly in estimation. Rather than suggest that the intuitive feeling is misplaced it may be that this reflects the 'pulsing' characteristics of much of the advertising studied, the (complex) relationship between brand and generic advertising, and the simplifying assumption that all advertising is of equal quality. As a final point, the success or failure of estimating the size of advertising effects was, in almost all cases, directly related to the way in which seasonal effects in the data were handled. This area of the analysis deserves further attention. As a general observation it is doubtful if an econometric study of sales data of less than annual periodicity can be successful unless accompanied by time series analysis. Seasonality may also be an important factor in the evaluation of advertising.

In the evaluation of changes in advertising for different products the implicit assumption was that seasonality of sales does not affect the returns from advertising. Yet it is evident that the same increase in advertising may have a greater or lesser effect on the value of extra sales depending upon when the advertising is conducted during the course of the year. This aspect of the advertising decision, the linkage between timing of advertising and seasonality of consumption, is a neglected area of the evaluation given

in Chapter Four. More encouragingly, the simple examples of simulation given show that the concept of describing the milk market by a set of equations is feasible. Moreover, it will allow investigation of a wide range of effects on various parameters and performance indicators.

Throughout, a feature of the analysis has been the relative novelty of different aspects of theory and estimation. Progress towards any particular matter of interest has, occasionally,been restricted because of the considerable amount of data analysis required for the quantitative estimation of the size of advertising effects. That estimation has been successful though and the results provide much more information on the magnitude of these effects than was available before. The theoretical analysis, too, has clarified the need for milk producers to consider the price differentials between different sales outlets for milk. And for milk processors to consider the size of any reaction of competitors to changes in own advertising. Unfortunately, since both of these factors may be beyond the control of producers and processors, this implies that determining the optimal level of advertising will involve an element of judgement by the decision-maker.

It is difficult to escape the overall conclusion that optimal advertising decisions for producers require recognition of the interests of everyone involved in the market. This will include the trade and may also include government when there is a support programme for producer incomes. Appropriate advertising decisions for milk producers will not be made in isolation. Hopefully, this departmental bulletin will increase the awareness of this and, in its various aspects, will improve quantitative decisions on advertising in the milk market.

APPENDIX 1

The Board as a Monopolist

From the demand function,

$$Qd = f(P_1, A) \qquad \text{(i)}$$

Total Revenue $TR = P_1 f(P_1, A)$

and with Costs $= C(Qs) + A$ (ii)

setting $Qd = Qs$

then for Profits = Revenue - Costs

$$\pi = P_1 f(P_1, A) - C[f(P_1, A)] - A$$

Allow A to change,

$$\frac{d\pi}{\partial A} = P_1 \frac{\partial Q_1}{\partial A} - \frac{\partial C}{\partial Q_1} \cdot \frac{\partial Q_1}{\partial A} - 1$$

at the maximum $\frac{\partial \pi}{\partial A} = 0$

$$\therefore \quad P_1 \cdot \frac{\partial Q_1}{\partial A} - \frac{\partial C}{\partial Q_1} \cdot \frac{\partial Q_1}{\partial A} = 1 \qquad \text{(iii)}$$

Similarly, for milk sold for sale as dairy products

$$P_2 \cdot \frac{\partial Q_2}{\partial A} - \frac{\partial C}{\partial Q_2} \cdot \frac{\partial Q_2}{\partial A} = 1 \qquad \text{(iv)}$$

However, for the price-discriminating monopolist with total supply fixed the prices P_1 and P_2 are not, in themselves, relevant to the change in revenue associated with a reallocation of quantities between different markets.

As equations 6 and 8 given in Chapter Two show, the price differential between alternative sales outlets is the appropriate determinant of change in sales value as a result of an increase in advertising expenditures. Substituting the relevant price differences for P_1 and P_2 in equations (iii) and (iv)

gives,

$$(P_1 - P_3)\frac{\partial Q_1}{\partial A} - \frac{\partial C}{\partial Q_1} \cdot \frac{\partial Q_1}{\partial A} = 1 \qquad \text{.....(v)}$$

$$(P_2 - P_3)\frac{\partial Q_2}{\partial A} - \frac{\partial C}{\partial Q_2} \cdot \frac{\partial Q_2}{\partial A} = 1 \qquad \text{.....(vi)}$$

$\frac{\partial C}{\partial Q_1}$ and $\frac{\partial C}{\partial Q_2}$ represent the marginal cost of supplying milk to alternative sales outlets. Clearly, for the monopolist when the inequality

$Q^* + Q^{**} < OQ_3$ is satisfied the marginal cost of allocating milk to different value outlets is the same and equal to zero. (The extra cost of selling another unit of milk to the liquid market instead of butter is effectively zero). Thus profits will be maximized when,

$$(P_1 - P_3)\frac{\partial Q_1}{\partial A} = (P_2 - P_3)\frac{\partial Q_2}{\partial A} = 1 \qquad \text{.....(vii)}$$

This decision rule does no more than support the intuitive notion that profit maximizing price discriminating monopolists should increase advertising levels if the costs of doing so are less than the changes in revenue and, conversely, they should reduce advertising expenditures if the change in revenue is less than the marginal cost of advertising i.e. the Board considers the direction in which the inequality runs

$$\frac{\partial Q_1}{\partial A}(P_1 - P_3) <> 1$$

to determine the direction in which advertising budgets should move.

Alternatively, the equation

$$(P_1 - P_3)\frac{\partial Q_1}{\partial A} = 1$$

may be presented as a relationship between the advertising elasticity, advertising and total 'premium' sales, thus multiplying through by A/Q_1;

$$Ae = \frac{\partial Q_1}{\partial A} \cdot \frac{A}{Q_1} = \frac{A}{(P_1 - P_3)Q_1} \qquad \text{.....(viii)}$$

Ae = advertising elasticity of demand

A = total advertising expenditures

$(P_1 - P_3)Q_1$ = total 'premium' available by selling commodity in different sales outlet.

Hence, the first order condition for optimal advertising is that the advertising elasticity of demand should equal the ratio of advertising to the total value of the 'premium' in a particular sales outlet. For brevity, this ratio may be termed the Advertising Sales Premium ratio (the ASP ratio).

The Board as an Oligopolist

The Board also has an interest in the processing of milk into dairy products since it controls a major proportion of U.K. manufacturing capacity for milk. Thus, in the product market, the Board is involved in a market where it is possible to consider rivals' reactions to price, advertising and output changes to be relevant. Market share statistics for English butter and cheese are relevant performance indicators with all that that implies about the oligopoly nature of the market. Therefore, it is useful to consider how the Board should set its advertising budget, as a processor, in an oligopoly situation.

The Dorfman-Steiner rule describes the advertising decision rule for a firm that sets its price and advertising levels assuming no reaction from other firms in the market. Thus, the firm sets its advertising sales ratio equal to the ratio of advertising and price elasticities,

$$\frac{A}{PQ} = \frac{Ae}{|\mu|} \qquad \text{.....(ix)}$$

where, PQ = total sales revenue

A = advertising expenditure

Ae = the advertising elasticity

$|\mu|$ = the absolute value of the own price elasticity of demand.

In an oligopoly situation a firm will expect competing firms to advertise their products and alter their advertising levels in response to its own advertising expenditure changes. Consequently, the demand function must take account of this relationship.

Hence, the demand function is,

$$Qd = Q(P, A, Ac) \qquad .....(x)$$

and $$Ac = f(A) \qquad .....(xi)$$

So

$$Qd = Q(P, A, f(A)) \qquad .....(xii)$$

where P = price of product

A = own advertising

Ac = competitor's advertising

Total Revenue for the firm is,

$$TR = P\,Q(P, A, f(A))$$

The total cost function for the firm is,

$$TC = C.Qs + A \qquad .....(xiii)$$

where Qs is the quantity supplied, C is the average total cost per unit of output, and A is the cost of advertising.

Setting Qd = Qs

and recognizing that,

Profits = Revenue - Total Costs

or

$$\Pi = TR - TC$$

$$\Pi = P\,Q(P, A, f(A)) - C[Q(P, A, F(A))] - A \qquad .....(xiv)$$

Allowing advertising to change in order to arrive at a necessary point for profit maximization,

$$\frac{d\Pi}{dA} = P\frac{dQ}{dA} - \frac{dc}{dQ} \cdot \frac{dQ}{dA} - 1 = 0 \qquad \text{.....(xv)}$$

but $$\frac{dQ}{dA} = \frac{\partial Q}{\partial A} + \frac{\partial Q}{\partial Ac} \cdot \frac{\partial Ac}{\partial A}$$

and $$\frac{dc}{dq} = \text{Marginal Cost} = MC$$

therefore,

$$P\left(\frac{\partial Q}{\partial A} + \frac{\partial Q}{\partial Ac} \cdot \frac{\partial Ac}{\partial A}\right) - MC\left(\frac{\partial Q}{\partial A} + \frac{\partial Q}{\partial Ac} \cdot \frac{\partial Ac}{\partial A}\right) - 1 = 0 \qquad \text{.....(xvi)}$$

i.e. $$(P - MC)\left(\frac{\partial Q}{\partial A} + \frac{\partial Q}{\partial Ac} \cdot \frac{\partial Ac}{\partial A}\right) = 1 \qquad \text{.....(xvii)}$$

multiplying by $\frac{A}{PQ}$,

$$\frac{A(P-MC)}{PQ}\left(\frac{\partial Q}{\partial A} + \frac{\partial Q}{\partial Ac} \cdot \frac{\partial Ac}{\partial A}\right) = \frac{A}{PQ} \qquad \text{.....(xviii)}$$

multiplying by $\frac{Ac}{Ac}$ and rearranging

$$\frac{(P - MC)}{P}\left(\frac{\partial Q}{\partial A}\,\frac{A}{Q} + \frac{\partial Q}{\partial Ac}\,\frac{Ac}{Q} \cdot \frac{\partial Ac}{\partial A}\,\frac{A}{Ac}\right) = \frac{A}{PQ} \qquad \text{.....(xix)}$$

Now, $\frac{\partial Q}{\partial A} \cdot \frac{A}{Q} = Ae$ = the elasticity of own demand with respect to changes in own advertising.

$\frac{\partial Q}{\partial Ac} \cdot \frac{Ac}{Q} = Ae'$ = the elasticity of own demand with respect to changes in competitors' advertising.

$\frac{\partial Ac}{\partial A} \cdot \frac{A}{Ac} = Ae''$ = the elasticity of competitors' advertising with respect to changes in own advertising.

Hence,

$$\frac{(P - MC)}{P}(Ae + Ae'.\,Ae'') = \frac{A}{PQ} \qquad \text{.....(xx)}$$

Similarly, allowing a change in price to arrive at a first order condition for profit maximization,

$$\frac{d\Pi}{dp} = Q + P\frac{dQ}{dp} - \frac{dc}{dQ} \cdot \frac{dQ}{dp} = 0 \qquad .....(xxi)$$

$$Q = -(P-MC)\frac{dQ}{dp} \qquad .....(xxii)$$

diving through by p

$$\frac{Q}{p} = \frac{-(P-MC)}{P}\frac{dQ}{dp} \qquad .....(xxiii)$$

or

$$\frac{-dQ}{dQ}\ \frac{Q}{P} = \frac{(P - MC)}{P} \qquad .....(xxiv)$$

the left hand side being the inverse of the absolute value of the own price elasticity of demand this becomes,

$$\frac{1}{|\mu|} = \left(\frac{P-MC}{P}\right) \qquad .....(xxv)$$

substituting (xxv) into (xx) we obtain,

$$\frac{A}{PQ} = \frac{1}{|\mu|}\ (Ae + Ae'\ Ae'') \qquad .....(xxvi)$$

Clearly, when the response of competitors' advertising to changes in own advertising is zero equation (xxvi) collapses to the Dorfman-Steiner rule noted before.

Another way of expressing this result is obtained if the demand function is specified in terms of advertising share.

$$Qd = Q\left(P, \frac{A}{Ac}, Ac\right) \qquad .....(xxvii)$$

where $\frac{A}{Ac}$ = the advertising share and P, A, Ac are as before

$$Ac = f(A) \qquad .....(xxviii)$$

So, $$Qd = Q(P, R(A)\ f(A)) \qquad .....(xxix)$$

Just as before in equation (xv),

$$\frac{dQ}{dA} = P.\ \frac{dQ}{dA} - \frac{dC}{dQ}\ .\ \frac{dQ}{dA} - 1 = 0 \qquad \text{.....(xxx)}$$

$$= (P-MC)\ \frac{dQ}{dA} = 1 \qquad \text{.....(xxxi)}$$

but $$\frac{dQ}{dA} = \frac{dQ}{dR}\ .\ dR + \frac{dQ}{df}\ .\ df \qquad \text{.....(xxxii)}$$

$$. = \frac{\partial Q}{\partial R}\left(\frac{Ac - A\frac{\partial Ac}{\partial A}}{Ac^2}\right) + \frac{\partial Q}{\partial Ac}\ .\ \frac{\partial Ac}{\partial A} \qquad \text{.....(xxxiii)}$$

substituting this back into (xxxi)

$$(P-MC)\left[\frac{\partial Q}{\partial R}\ \frac{1}{Ac} - \frac{\partial Q}{\partial R}\ \frac{A}{Ac^2}\ .\ \frac{\partial Ac}{\partial A} + \frac{\partial Q}{\partial Ac}\ .\ \frac{\partial Ac}{\partial Ac}\right] = 1 \qquad \text{.....(xxxiv)}$$

multiplying through by $\frac{A}{PQ}$ and $\frac{Ac}{Ac}$,

$$\frac{A}{PQ} = \left(\frac{P-MC}{P}\right)\left[\frac{\partial Q}{\partial R}\ \frac{A/Ac}{Q} - \frac{\partial Q}{\partial R}\ \frac{A/Ac}{Q}\ \frac{A}{Ac}\ .\ \frac{\partial Ac}{\partial A}\right.$$

$$\left. + \frac{\partial Q}{\partial AC}\ .\ \frac{Ac}{Q}\ .\ \frac{\partial Ac}{\partial A}\ .\ \frac{A}{Ac}\right] \qquad \text{.....(xxxv)}$$

Using the definitions of Ae' and Ae'' noted previously this reduces to

$$\left(\frac{P-MC}{P}\right)\left[AS_e\ (1 - Ae'')\ +\ Ae'\ .\ Ae''\right] \qquad \text{.....(xxxvi)}$$

Where

$\frac{\partial Q}{\partial R}\ .\ \frac{A/Ac}{Q} = AS_e$ = the elasticity of own demand with respect to changes in the advertising share.

Substituting for $(\frac{P-MC}{P})$ from (xxv) and rearranging gives

$$\frac{A}{PQ} = \frac{1}{(\mu)} \left[AS_e - (As_e + Ae') Ae'' \right] \qquad .....(xxxv)$$

APPENDIX 2

Time Series Properties and Other Difficulties with the Data

The type of products of principal interest to this work are all characterized by important seasonal effects. There is a 'regularity' about the behaviour of some of the series, when graphed over time, that is quite striking. Graphs A.1 to A.13 all contain, to a greater or lesser degree, evidence that the sales of milk and milk products exhibit systematic shifts within any particular year. Indeed, examination of this graphical output suggests that pure time series analysis of milk and dairy products could easily justify a major study in itself. However, in the context of the project's programme of work this was not possible. Instead, simple graphical analysis was combined with examination of simple autoregressive models (estimated by OLS) to help determine the size of seasonal effects. This information was then used in the econometric analysis to help improve the explanation of individual demand equations.

Table A.1 below presents the results of a simple 12th order autoregressive function estimated for each of the major series under investigation. By estimating the equations,

$$Q_t = \gamma + \beta\, Q_{t-12}$$

and

$$\log Q_t = \gamma + \beta \log Q_{t-12}$$

for different products it is possible to judge the extent of seasonality in the sales data for the series. The larger is the size and statistical significance of the 12th order lagged dependent variable, then the greater is its influence on current sales. For some series, for example cream purchases in Graph A.3 this procedure is superfluous. Clearly cream sales are highly seasonal and this is demonstrated by the pattern of peaks and troughs in the plot over time. For others, such as English butter and English cheddar cheese

seasonality is not as vividly demonstrated by the graphs and the simple regression procedure is then, perhaps, more useful.

Table A.1 : Seasonal Explanation of Sales in the Milk Market

Variable		Coefficient Value	T-ratio	$\bar{R}^2$	Durbin-Watson
Liquid Milk Sales	γ	68.001	1.48	0.603	0.435
	β	0.870	10.42		
Log Liquid Milk Sales	γ	0.762	1.46	0.610	0.448
	β	0.878	10.59		
Liquid Milk Purchases	γ	0.559	0.37	0.655	0.871
	β	0.956	11.65		
Log Liquid Milk Purchases	γ	-0.020	0.09	0.700	0.682
	β	1.002	12.91		
Cream Purchases	γ	18.493	2.71	0.821	0.772
	β	0.878	19.44		
Log Cream Purchases	γ	0.588	2.48	0.806	0.661
	β	0.883	18.50		
Butter Purchases	γ	63.91	3.25	0.656	0.369
	β	0.686	10.30		
Log Butter Purchases	γ	0.912	2.17	0.689	0.384
	β	0.822	11.08		
English Butter Purchases	γ	29.705	5.83	0.233	0.649
	β	0.489	4.21		
Log English Butter Purchases	γ	2.321	7.42	0.300	0.663
	β	0.423	4.96		
Margarine Purchases	γ	101.234	5.19	0.547	0.432
	β	0.659	8.05		
Log Margarine Purchases	γ	2.400	6.07	0.540	0.447
	β	0.576	7.95		
Cheese Purchases	γ	69.56	3.54	0.533	0.914
	β	0.706	8.27		
Log Cheese Purchases	γ	1.615	3.49	0.535	0.937
	β	0.704	8.29		
English Cheddar Cheese Purchases	γ	37.248	3.37	0.290	0.373
	β	0.610	5.01		
Log English Cheddar Cheese Purchases	γ	1.871	3.39	0.273	0.351
	β	0.589	4.81		

Table A.1 continued

Variable		Coefficient Value	T-ratio	$\bar{R}^2$	Durbin-Watson
Cheddar Cheese Purchases	γ	71.137	6.20	0.448	0.742
	β	0.538	6.99		
Log Cheddar Cheese Purchases	γ	2.376	6.30	0.448	0.753
	β	0.528	7.00		
Market Share of English Butter	γ	7.090	3.56	0.452	0.565
	β	0.848	6.81		
Log Market Share of English Butter	γ	1.492	7.60	0.487	0.631
	β	0.546	7.30		
Market Share of English Cheddar Cheese	γ	20.409	3.77	0.168	0.257
	β	0.494	3.59		
Log Market Share of English Cheddar Cheese	γ	1.983	3.93	0.149	0.249
	β	0.463	3.36		

Results generated by OLS over varying sample periods in the overall period 1974.04 to 1981.03.

Many of the series considered in Table A.1 demonstrate the relatively high contribution of the 12th order lagged dependent variable towards the explanation of variation in current sales. In all cases the β coefficients are highly significant, and frequently the R^2 values are high enough to suggest that most of the variation in sales is explained almost totally by seasonal shifts in demand. The coefficient values and statistics for cream purchases, for example, reinforce the impression given by graph A.3 that cream sales are highly seasonal. In contrast, the β values and statistics estimated for the English Cheddar cheese market share data suggest that whatever regularity might appear to be within Graph A.13, it is of lesser importance to an explanation of the variation in that data.

Clearly, the various sales series in the milk market deserve full consideration of their time series properties. That implies the development of autoregressive and moving average models of the data, and the use of

autocorrelation functions and differencing procedures to help obtain stationary time series. Unfortunately, with so many important series to consider and the original commitment to make advertising effects the focal point of the project it was not possible to undertake such a comprehensive investigation. The econometric analysis proceeded on the basis of naive graphical and regression analyses of different data series as exemplified by the preceeding discussion. Hopefully, this enhanced the specification of econometric models for the various demand functions by improving the assessment of the relative strengths of economic (structural) and time series (non-structural) variables in the model. Invariably, as the econometric results demonstrate, the final choice of model combined both types of explanatory variables.

In conclusion, it is possible to illustrate some of the other problems of the data using graphical analysis. In particular the difficulties presented by the various advertising series are shown by Graphs A.14 to A.22. For liquid milk, cream, and cheese, for example, the estimates of advertising expenditure from two different sources (MEAL and the advertising agencies) are graphed against each other over a common time period. There are disturbing differences in size and timing of some of these expenditure values and which then required that specification and estimation be duplicated before conclusions could be drawn.

The graphs of advertising data for butter and cheese also demonstrate the fierce concentration of advertising 'messages' in these product markets. For butter, in particular, the relatively small and intermittent size of the generic advertising campaign is illustrated in comparison with the time plot of total butter advertising in Graph A.17. The pulsating nature of English butter advertising (moving from very low to very high advertising expenditures from month to month) is also graphically illustrated in Graph A.18. Most interestingly, butter's main competitor in the market, margarine,is shown in Graph A.19 to spend considerably more on advertising than the total for the

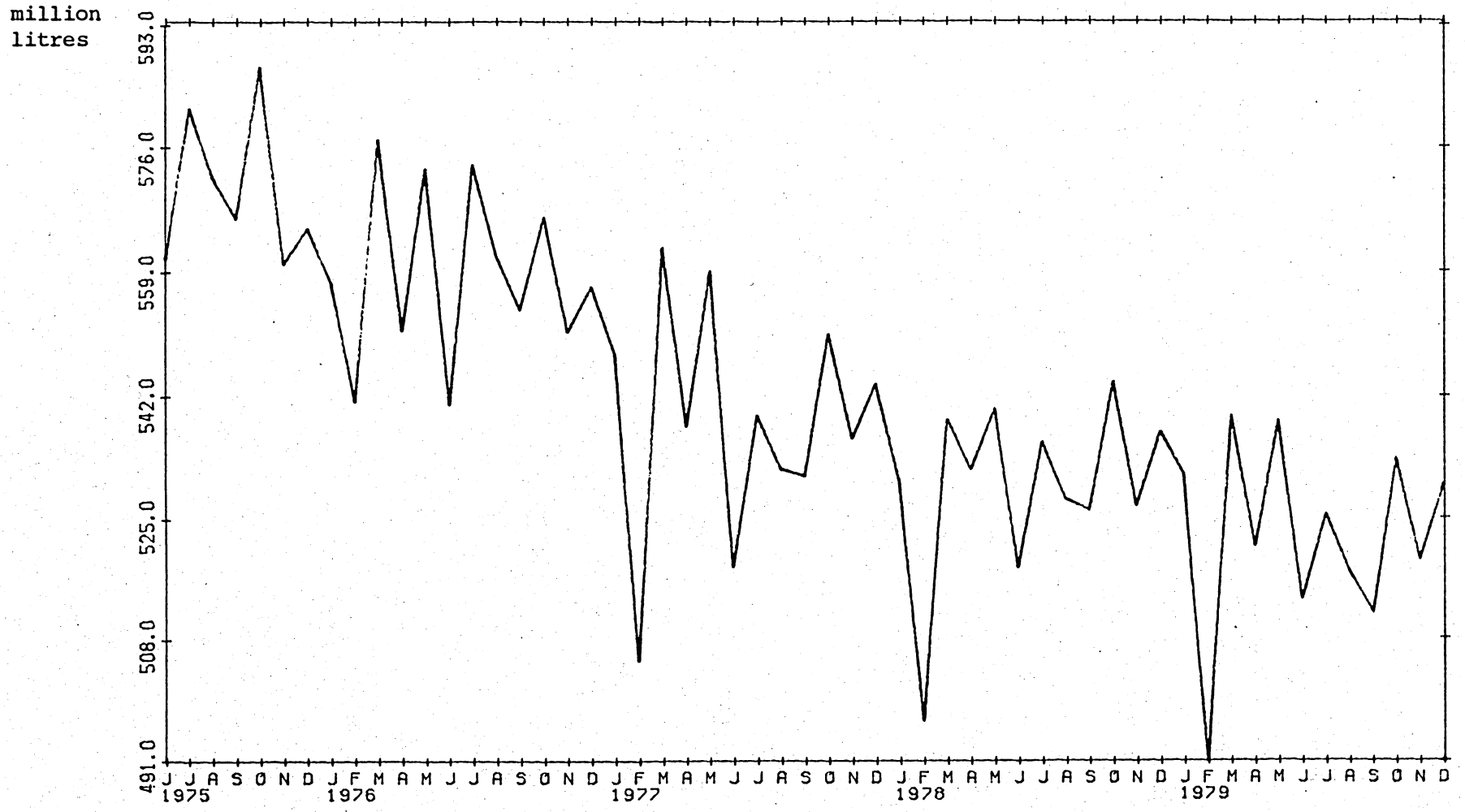
principal butter brands. Finally, as a further area of confusion for the analysis Graph A.22 presents the three alternative indices of media rates available for use as deflators. Whilst the choice between these indices is uncertain the interpolated index looks much less satisfactory than either of the other two.

The overriding impression of the data available for use in the econometric analysis is that a mixture of measurement error, time series effects, and intense own- and cross- advertising responses are present. Combined, as they are in the dairy products' market, they present formidable problems for a quantitative study.

Graph A.1 LMS = Liquid milk sales in England and Wales (excluding school and welfare milk 1975.01 to 1979.12)

University of Manchester

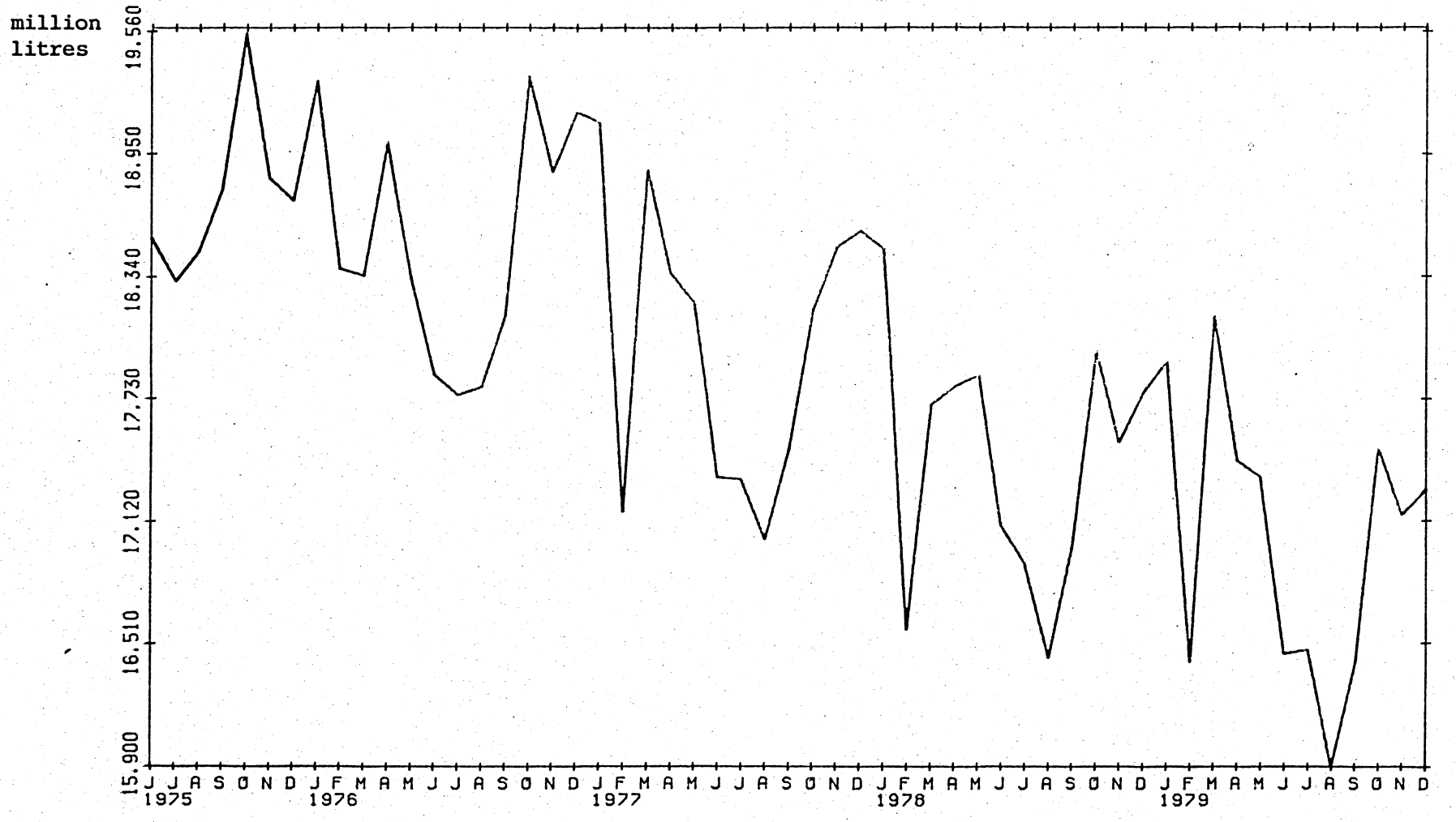
——————— = LMS has 120 monthly observations from 1970/1 to 1979/12



Graph A.2 LMP = Liquid milk purchases by households in England and Wales
(1975.01 to 1979.12)

Univereity of Manchester

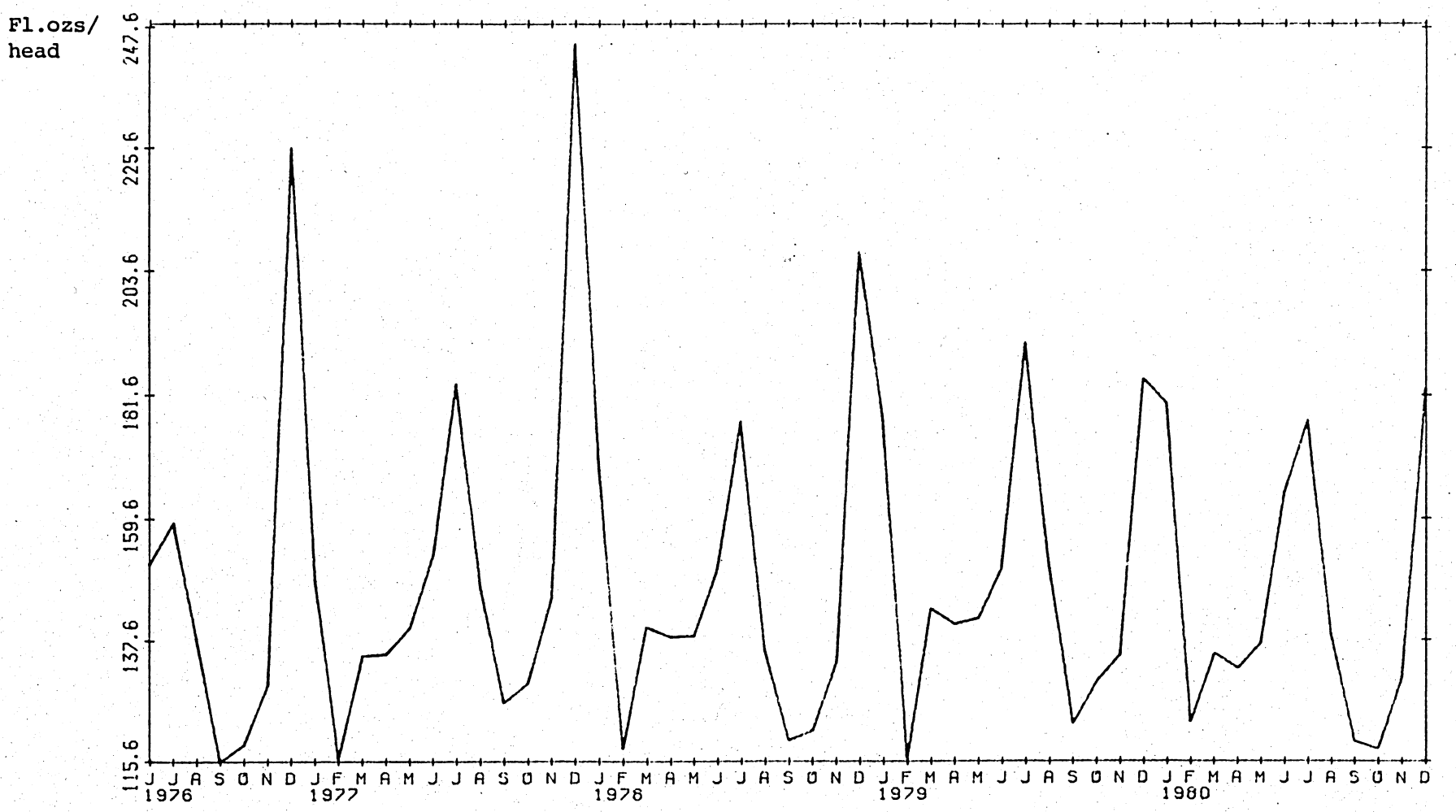
———— = LMP has 120 monthly observations from 1970/1 to 1979/12



Graph A.3 CRE = Fresh cream purchases by individuals in England and Wales
(1976.01 to 1980.12)

University of Manchester

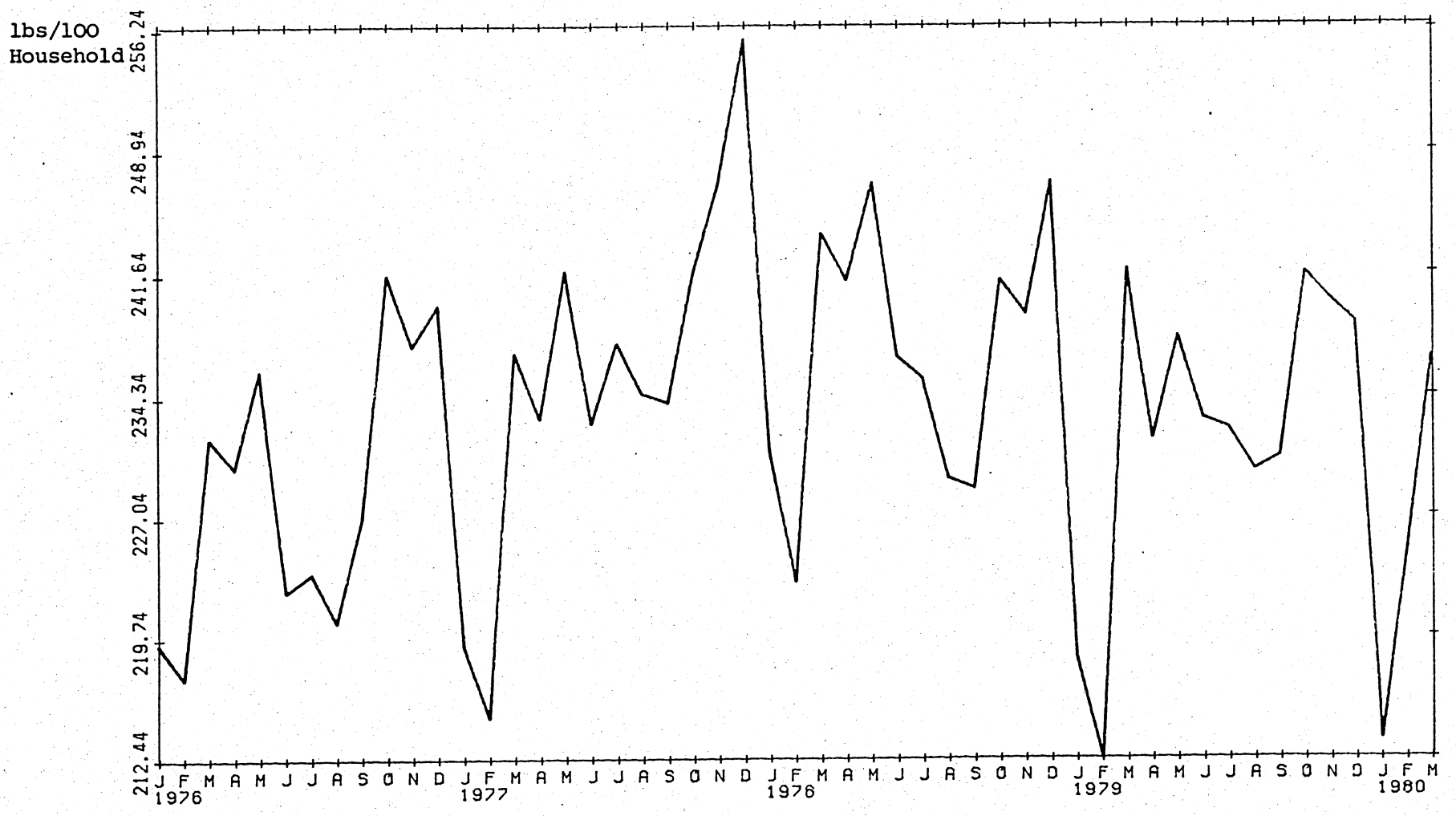
_____ = CRE has 95 monthly observations from 1973/4 to 1981/2



Graph A.4 CP = Cheese purchases by households in Great Britain
(1976.01 to 1980.03)

University of Manchester

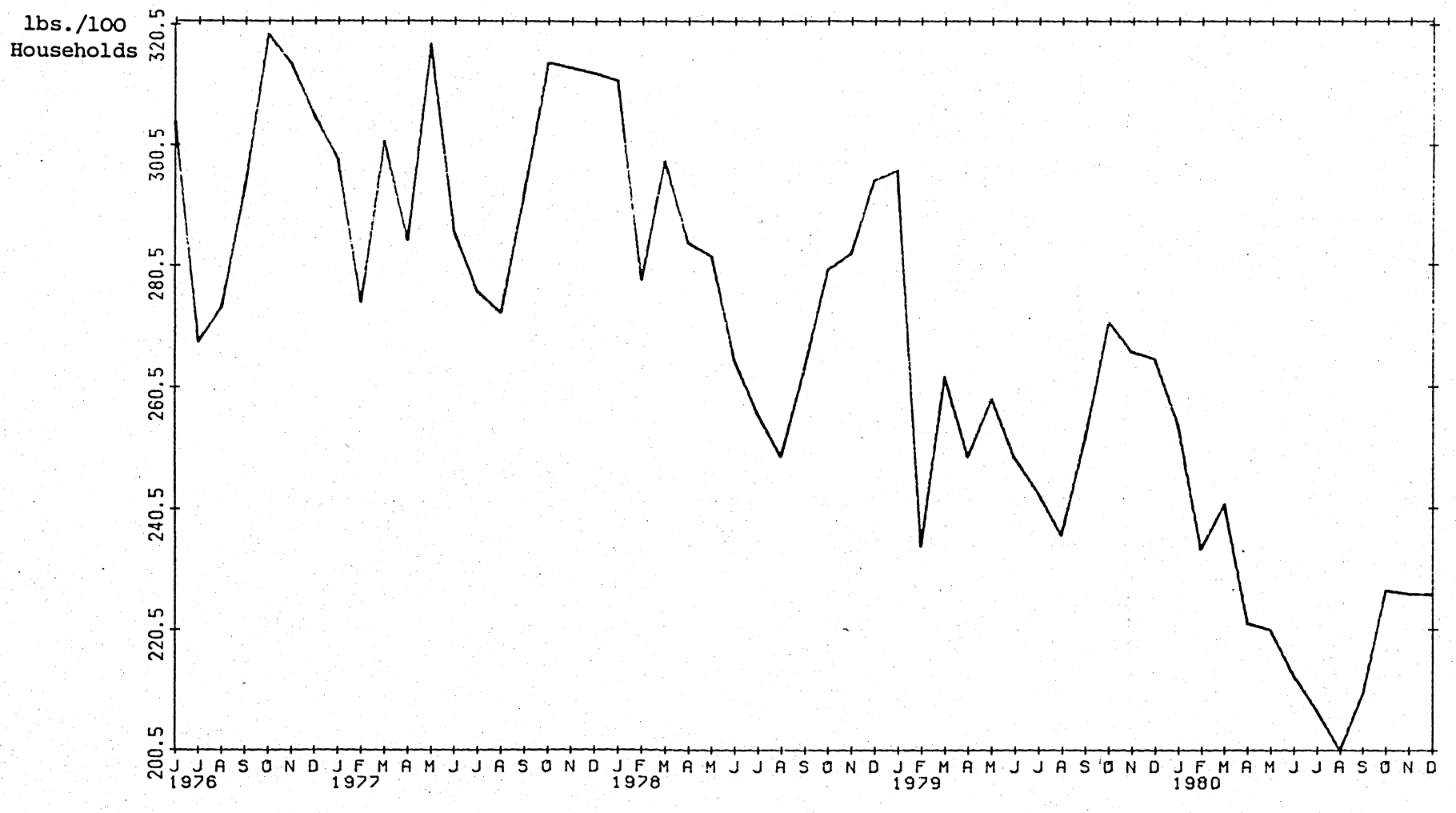
———— = CP has 72 monthly observations from 1974/4 to 1980/3



Graph A.5 BP = Butter purchases by households in Great Britain
(1976.01 to 1980.12)

University of Manchester

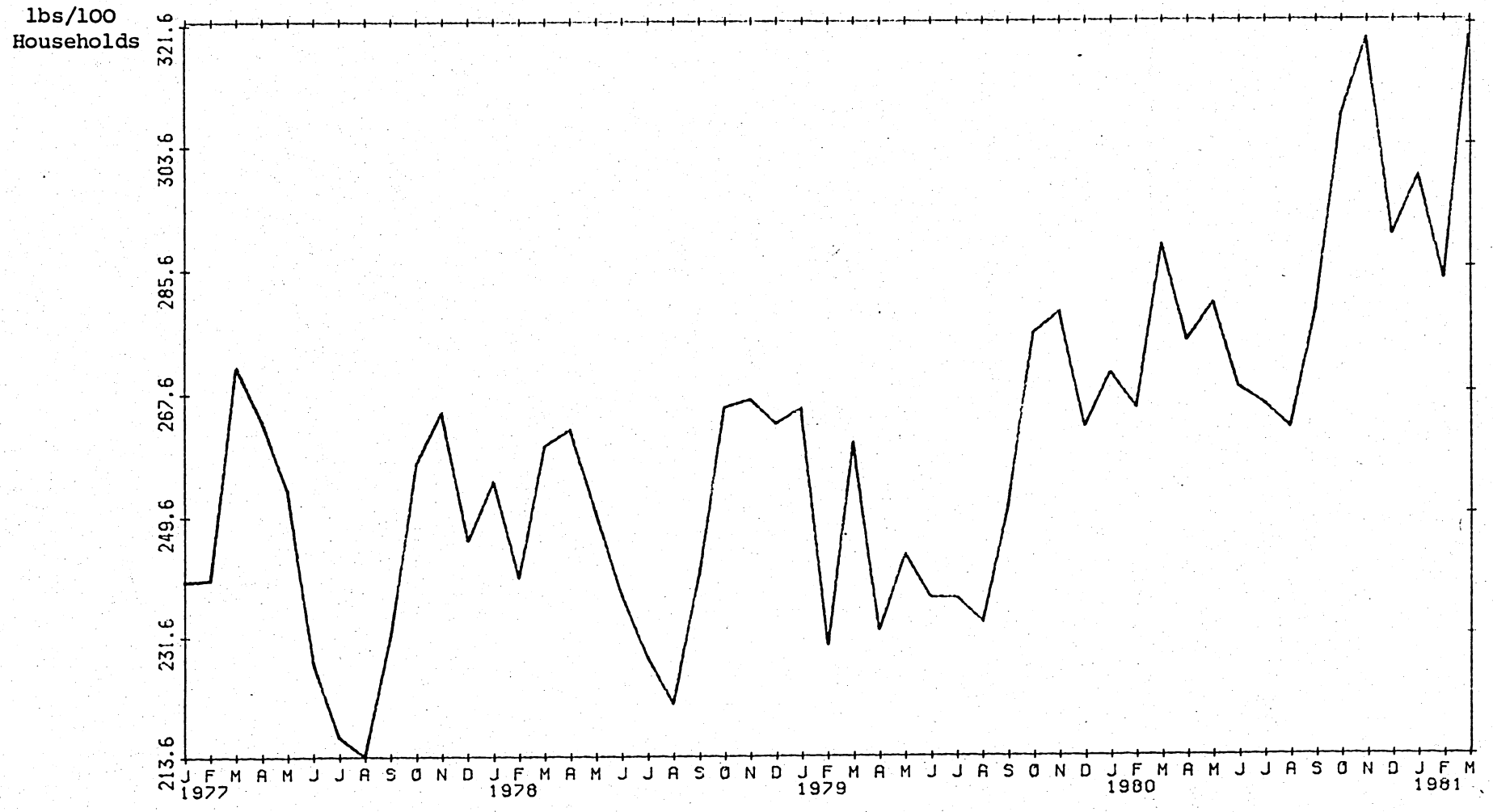
_____ = BP has 68 monthly observations from 1975/8 to 1981/3



Graph A.6 MAP = Margarine purchases by households in Great Britain
(1977.01 to 1981.03)

University of Manchester

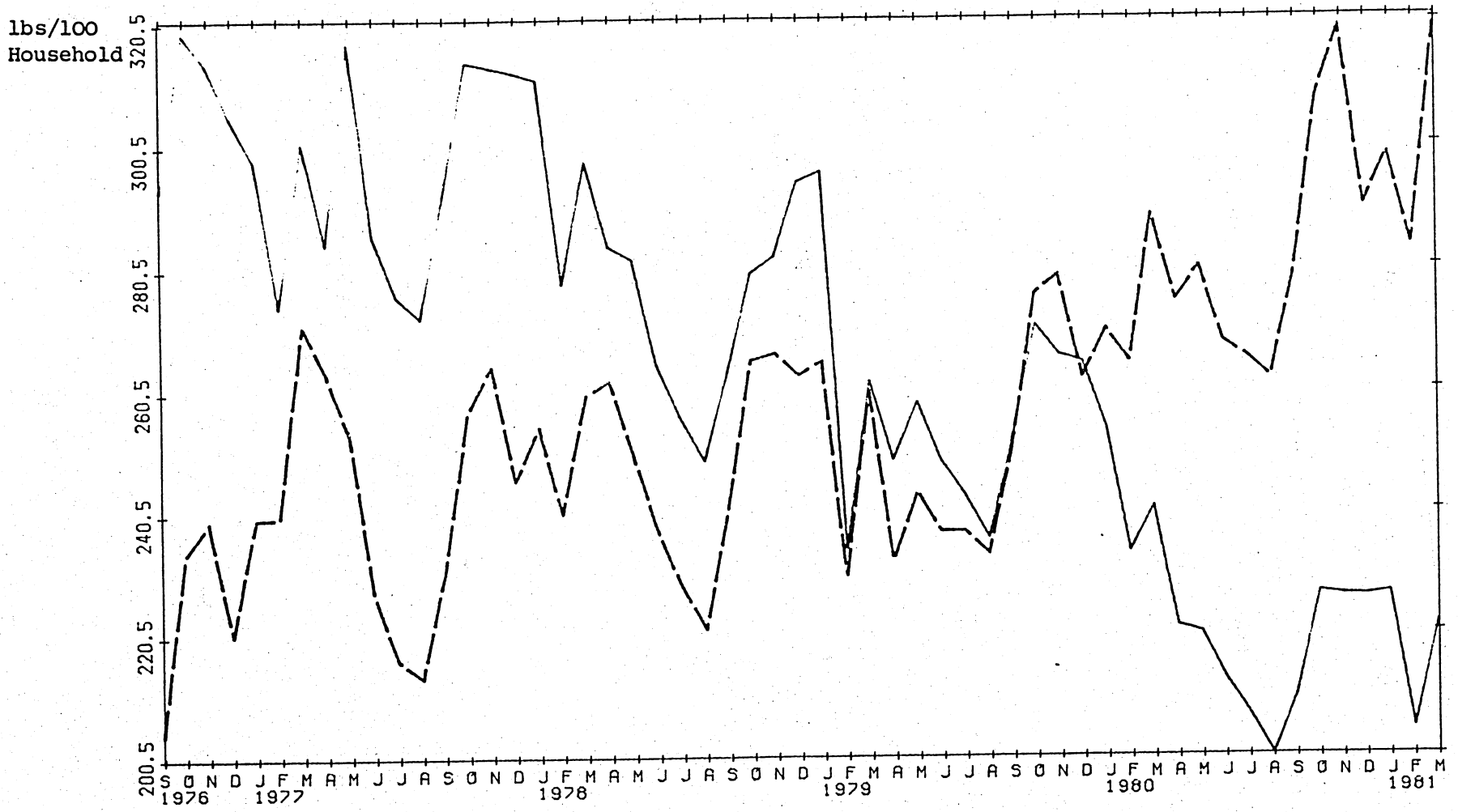
_____ = MAP has 66 monthly observations from 1975/10 to 1981/3



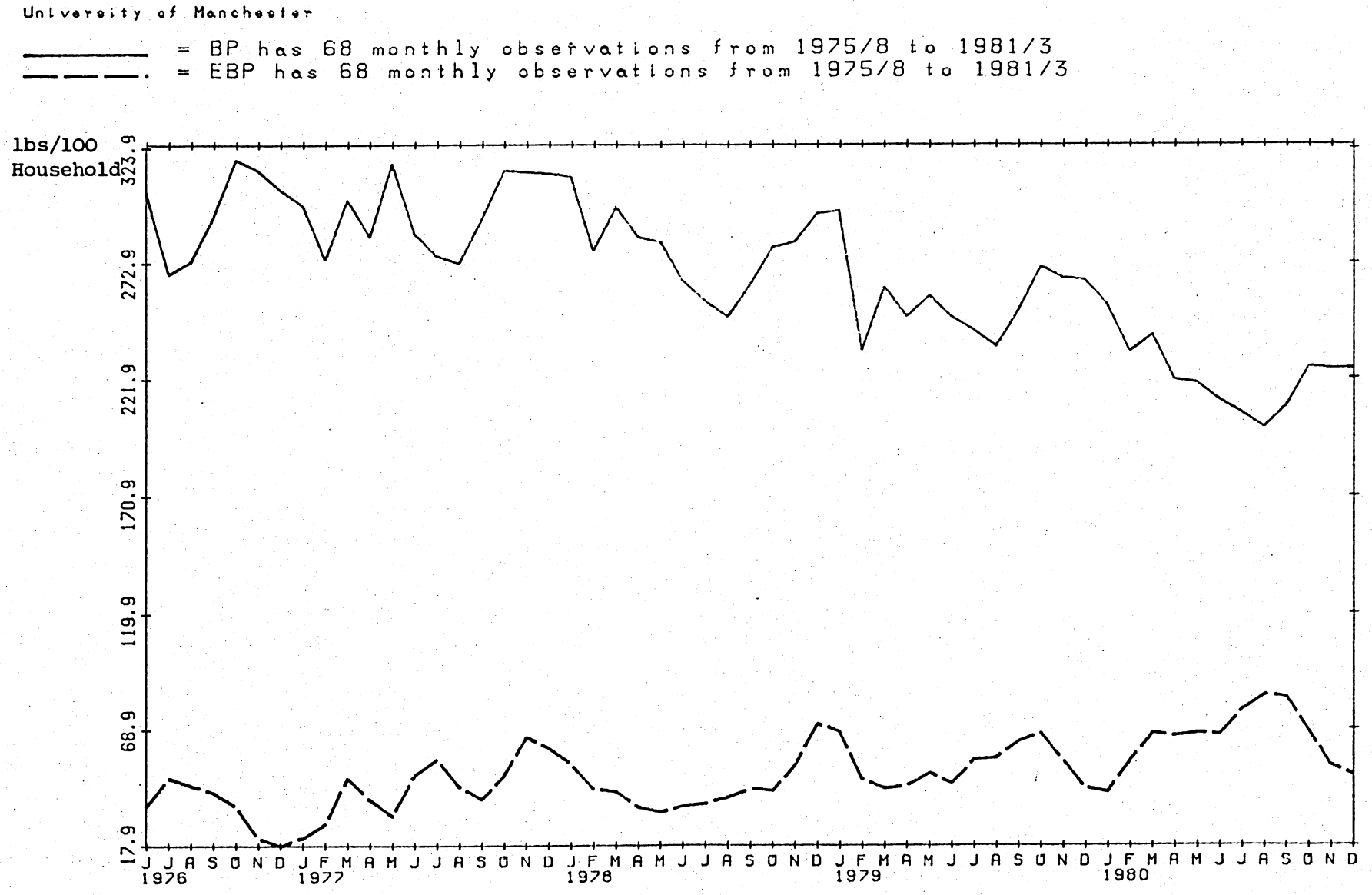
Graph A.7 BP = Butter Purchases MAP = Margarine Purchases

University of Manchester

——— = BP has 68 monthly observations from 1975/8 to 1981/3
— — — = MAP has 66 monthly observations from 1975/10 to 1981/3



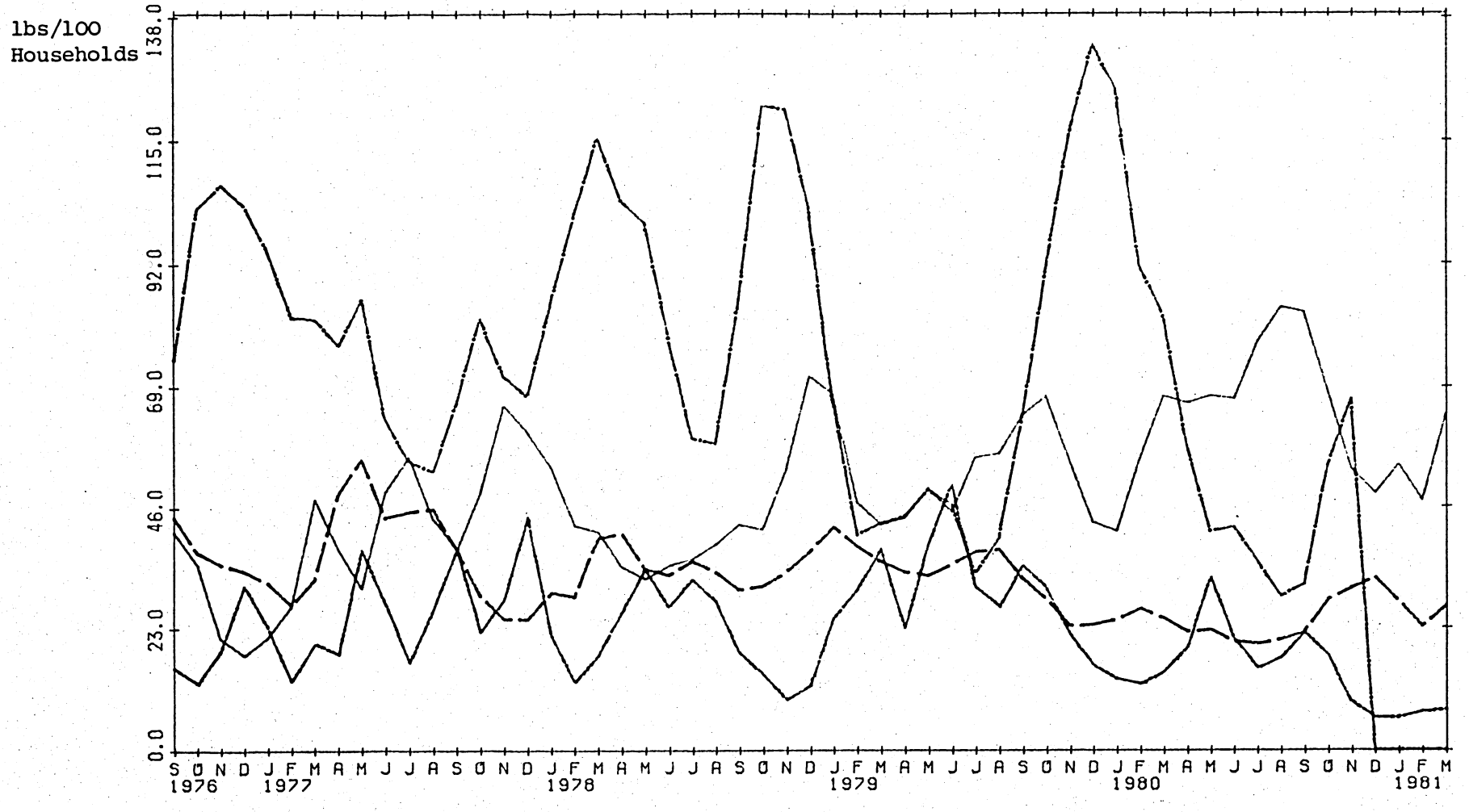
Graph A.8 BP = Butter purchases EBP = English butter purchases



Graph A.9 EBP = English butter purchases DABP = Danish butter purchases
NZBP = New Zealand butter purchases IBP = Irish butter purchases

University of Manchester

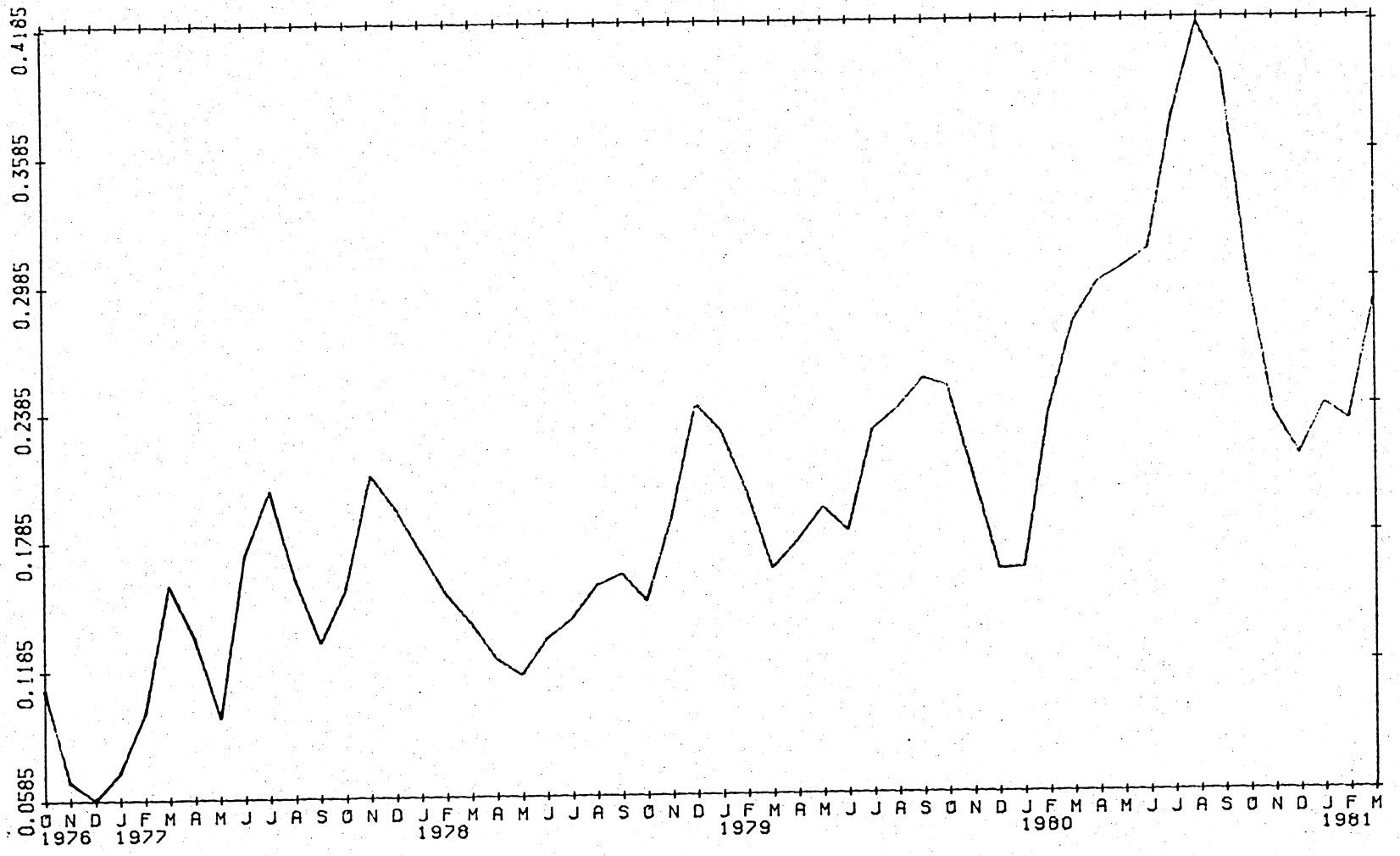
———— = EBP has 68 monthly observations from 1975/8 to 1981/3
– – – – = DABP has 68 monthly observations from 1975/8 to 1981/3
– · – · – = NZBP has 68 monthly observations from 1975/8 to 1981/3
– · · – · · – = IBP has 68 monthly observations from 1975/8 to 1981/3



Graph A.10 TSEB = Market share of English butter (proportion of total sales)
(1976.01 to 1981.03)

University of Manchester

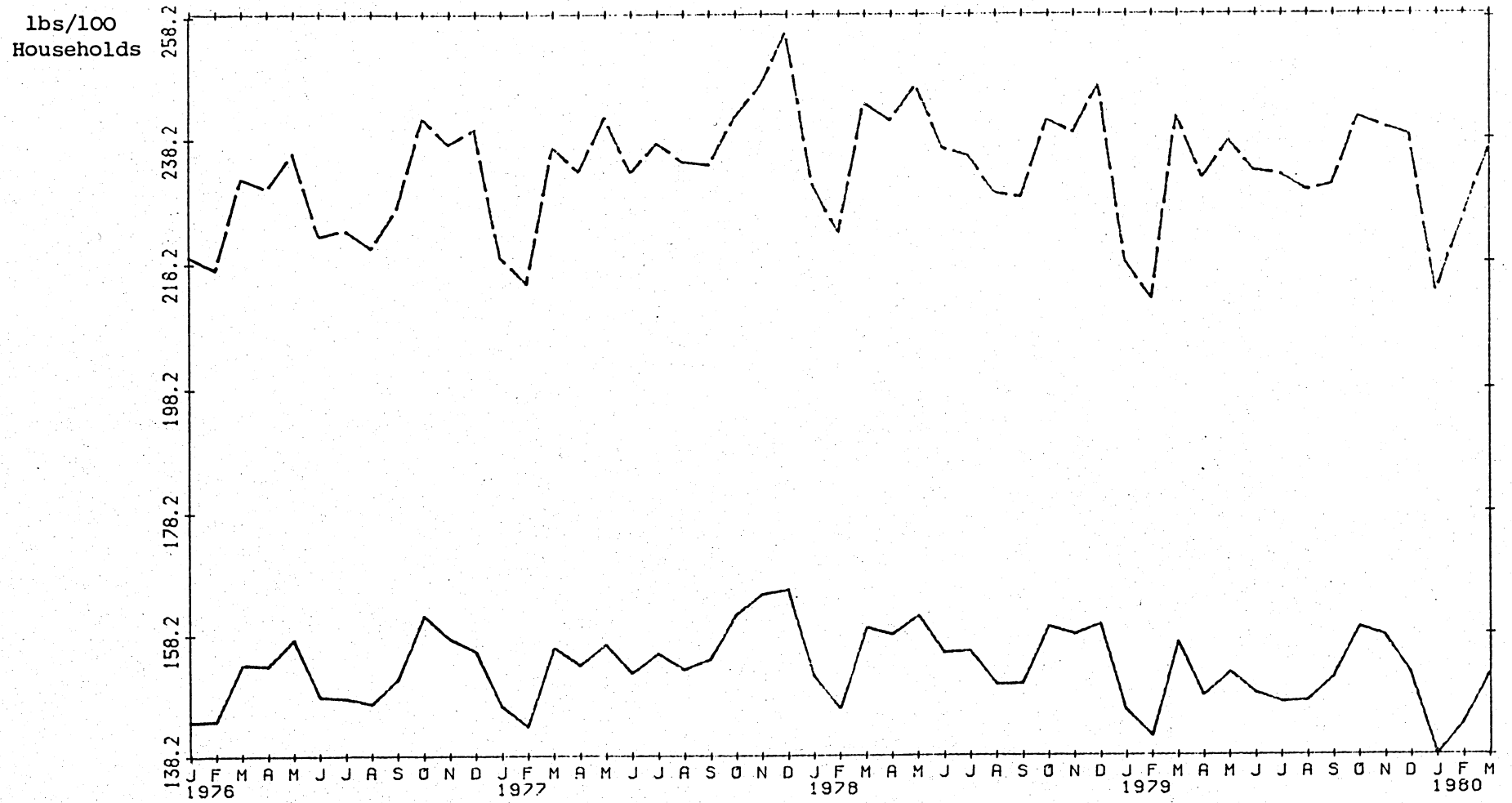
———— = TSEB has 68 monthly observations from 1975/8 to 1981/3



Graph A.11 CCP = Cheddar cheese purchases CP = Cheese purchases

University of Manchester

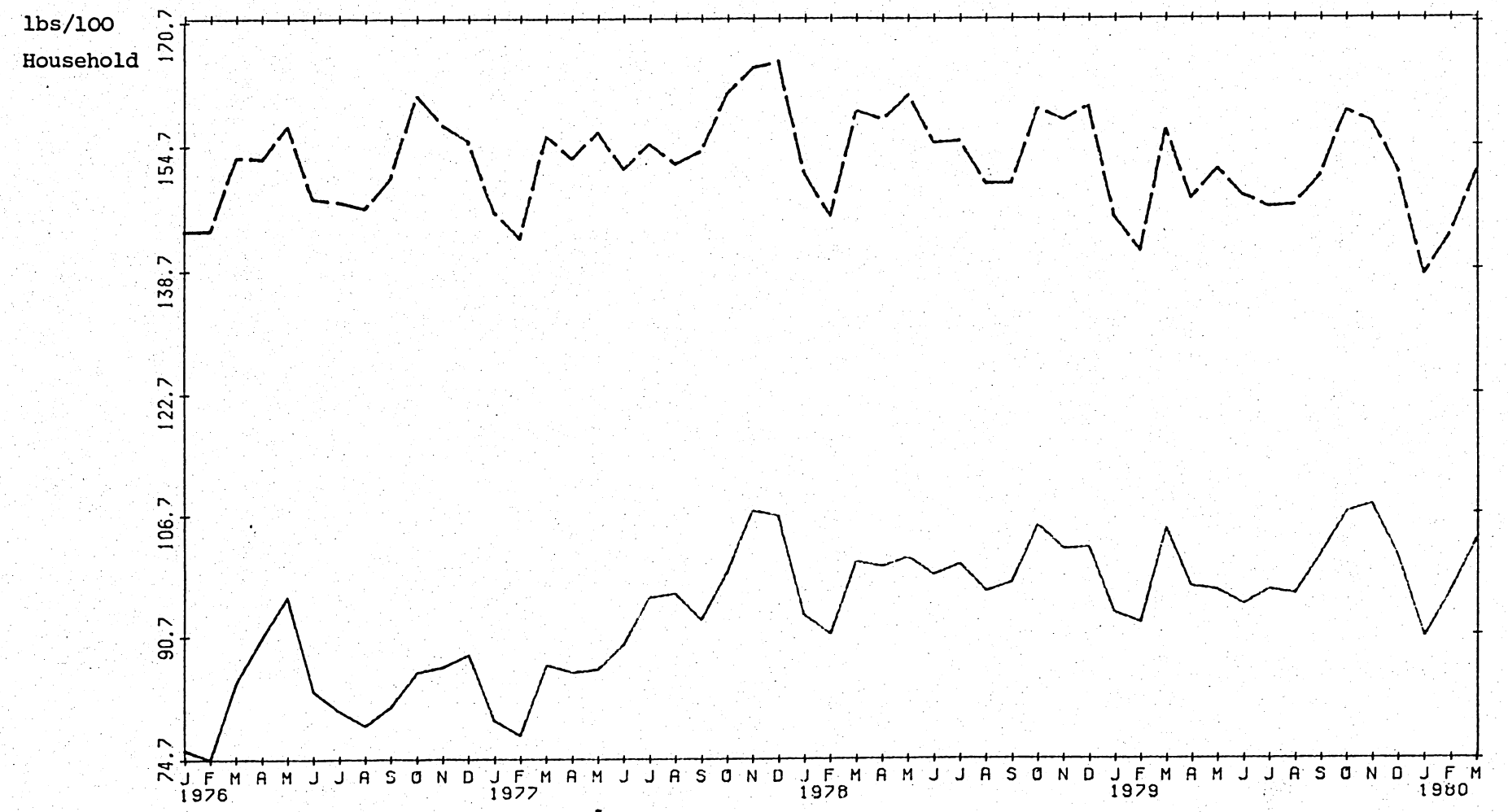
———— = CCP has 72 monthly observations from 1974/4 to 1980/3
— — — — = CP has 72 monthly observations from 1974/4 to 1980/3



Graph A.12 ECCP = English cheddar cheese purchases CCP = Cheddar cheese purchases

University of Manchester

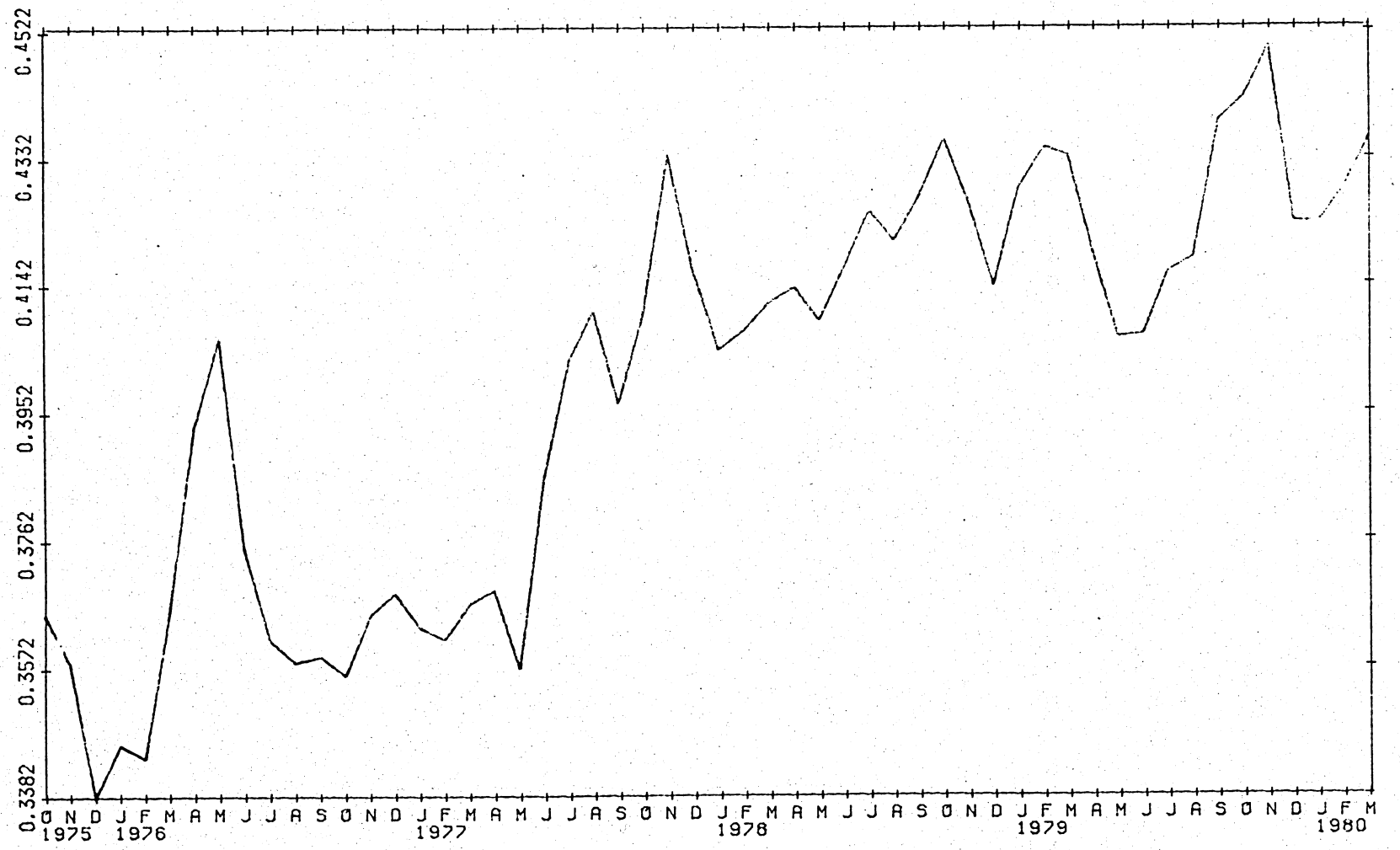
———— = ECCP has 72 monthly observations from 1974/4 to 1980/3
— — — . = CCP has 72 monthly observations from 1974/4 to 1980/3



Graph A.13 TSECC = Market share of English cheddar cheese (Proportion of total sales)
(1975.10 to 1980.03)

University of Manchester

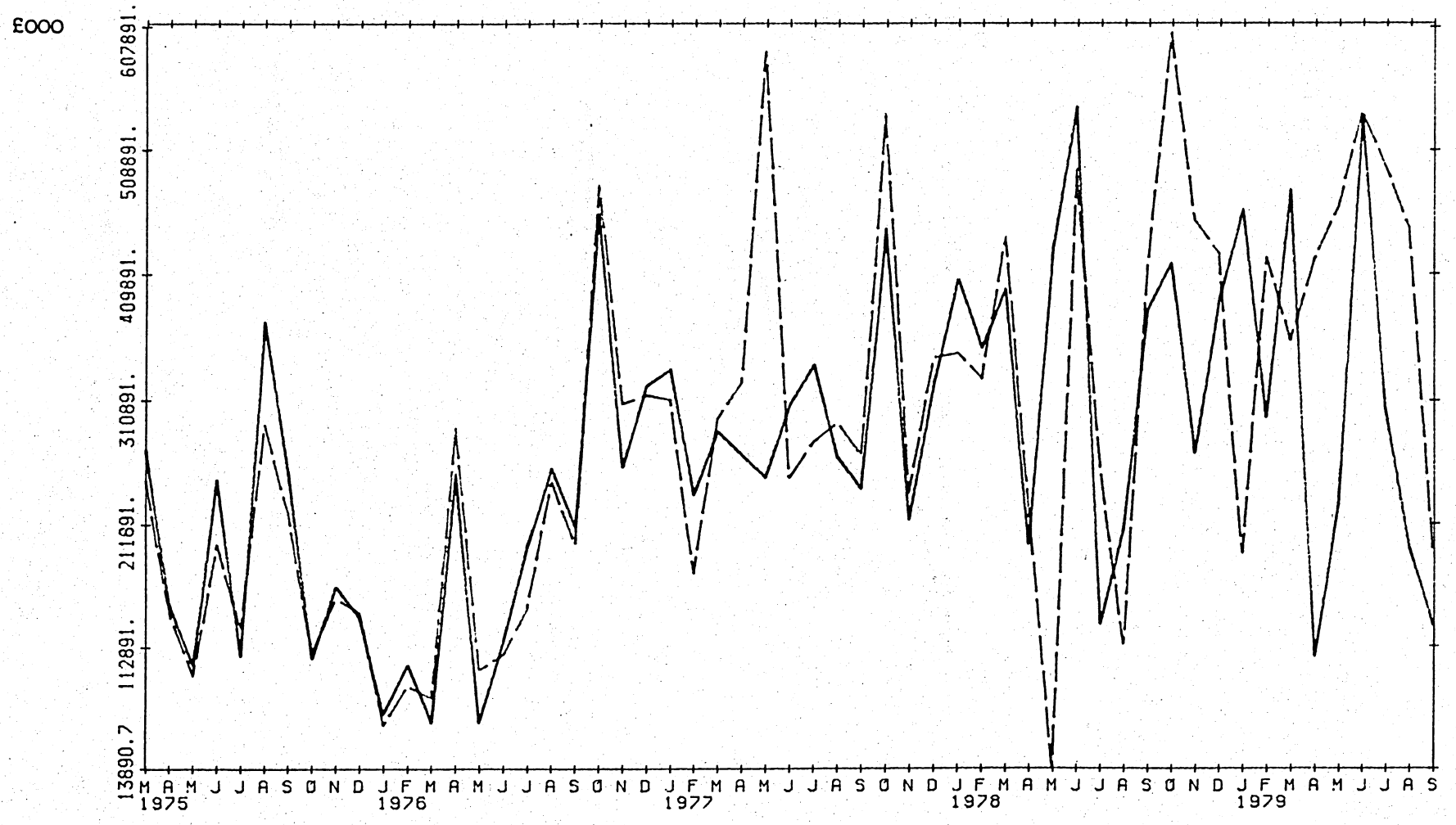
_____ = TSECC has 72 monthly observations from 1974/4 to 1980/3



Graph A.14 A = Liquid milk advertising (MEAL) AA = Liquid milk advertising (Agency)

University of Manchester

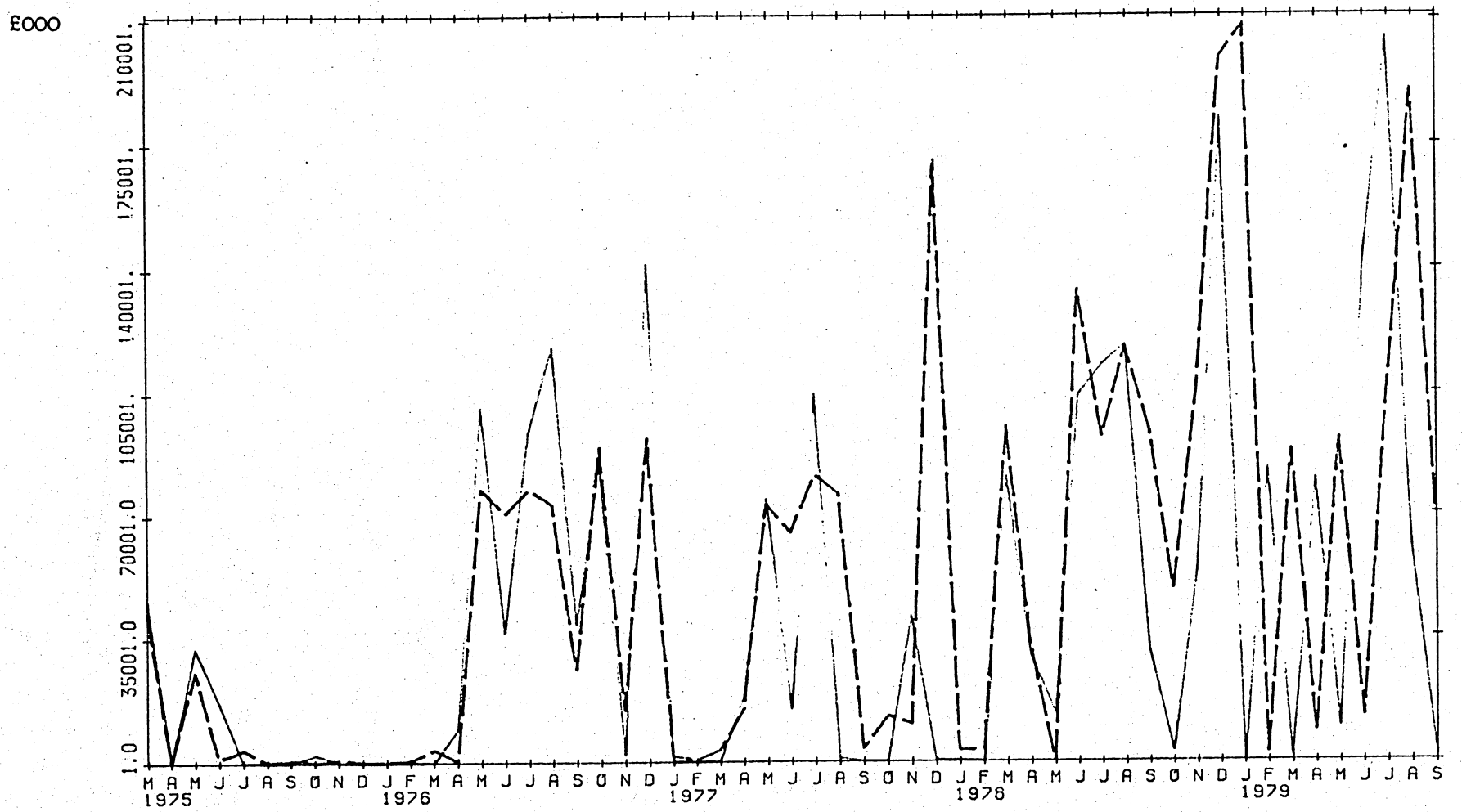
——— = A has 117 monthly observations from 1970/1 to 1979/9
— — — — = AA has 59 monthly observations from 1975/2 to 1979/12



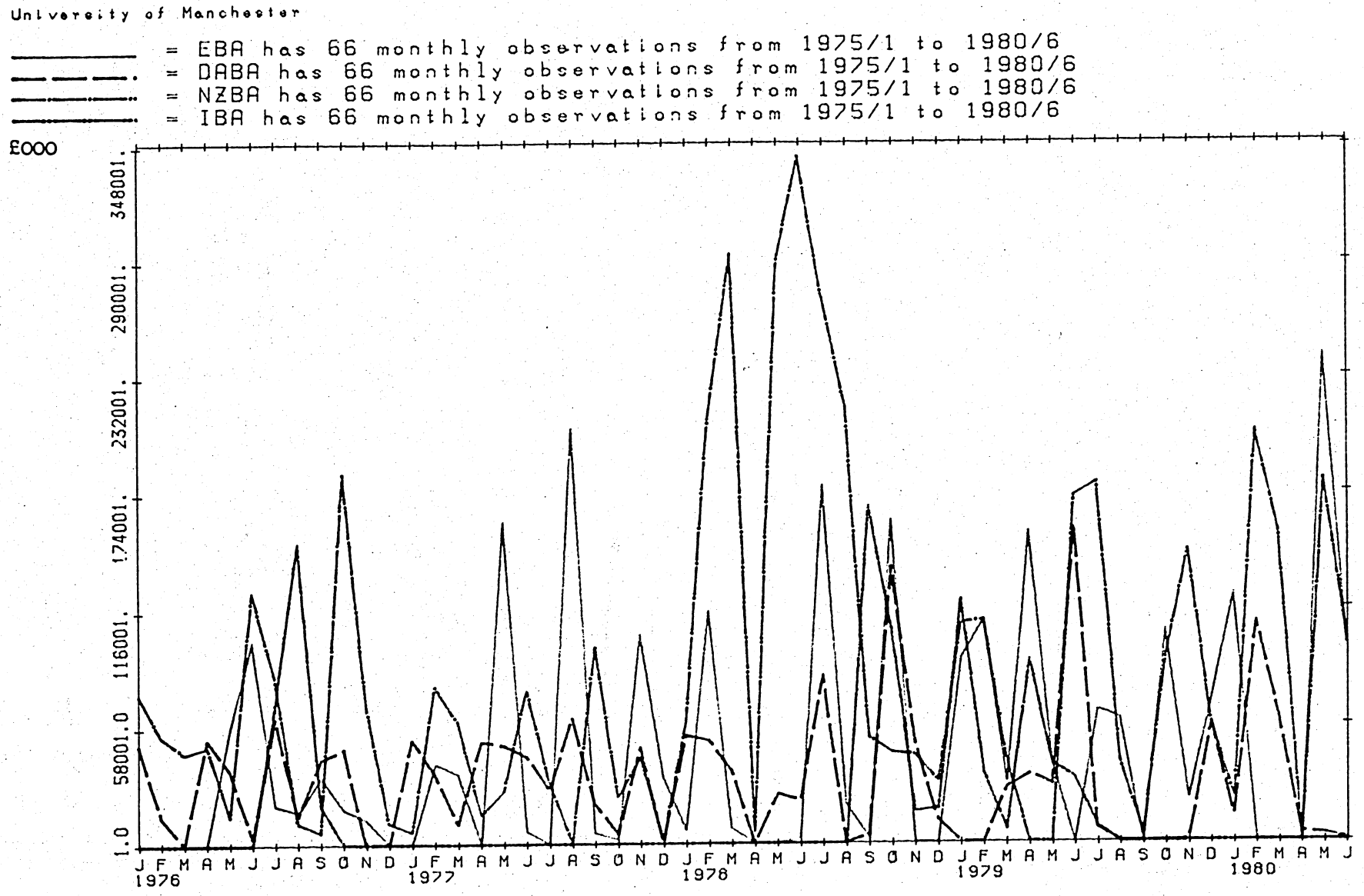
Graph A.15 CRA = Cream advertising (MEAL) CREAA = Cream advertising (Agency)

University of Manchester

———— = CRA has 57 monthly observations from 1975/1 to 1979/9
— — — — = CREAA has 72 monthly observations from 1975/1 to 1980/12



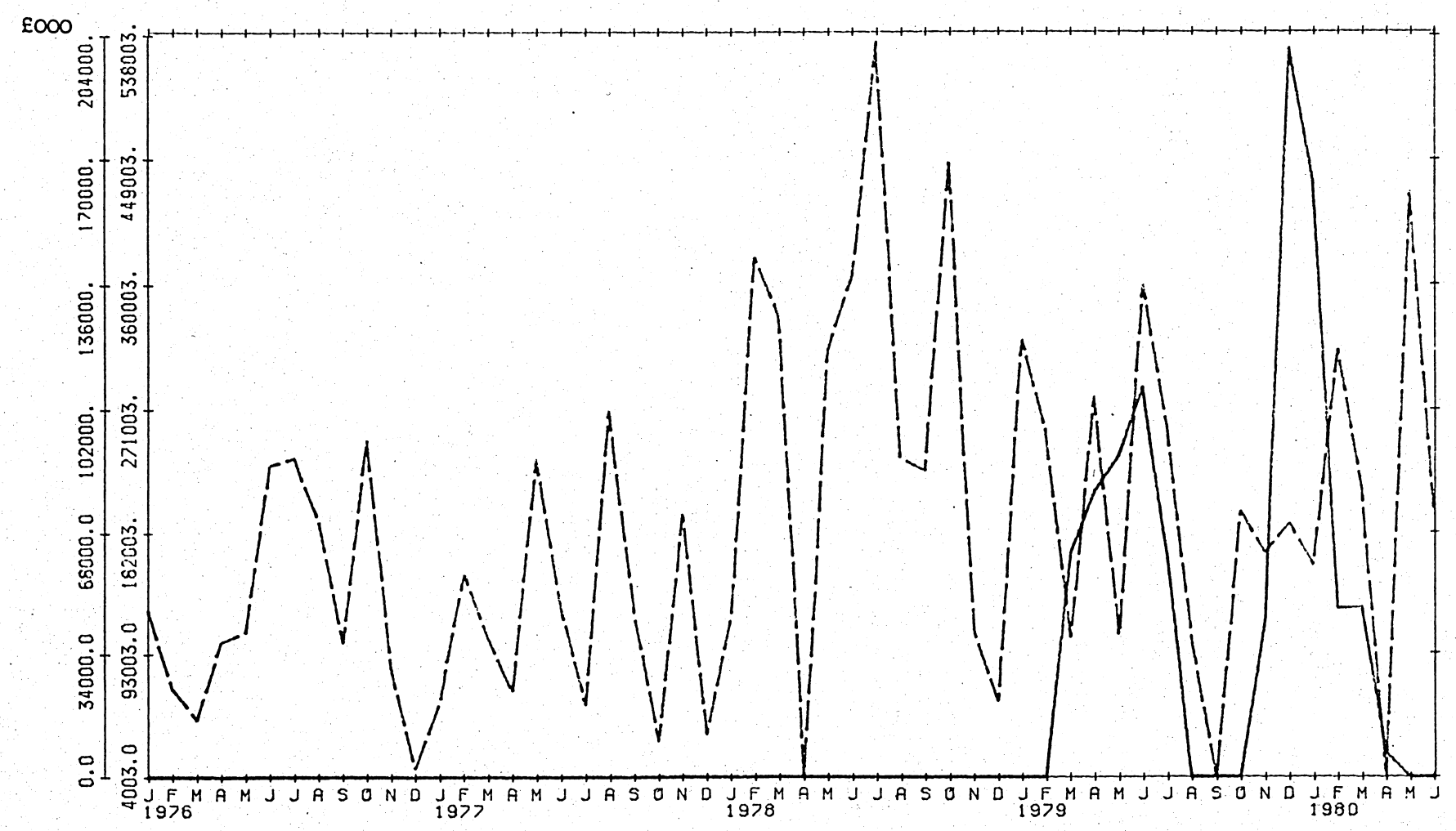
Graph A.16 EBA = English butter advertising DABA = Danish butter advertising
NZBA = New Zealand butter advertising IBA = Irish butter advertising



Graph A.17 BICA = Butter Information Council Advertising (generic)
TBA = Total butter advertising

University of Manchester

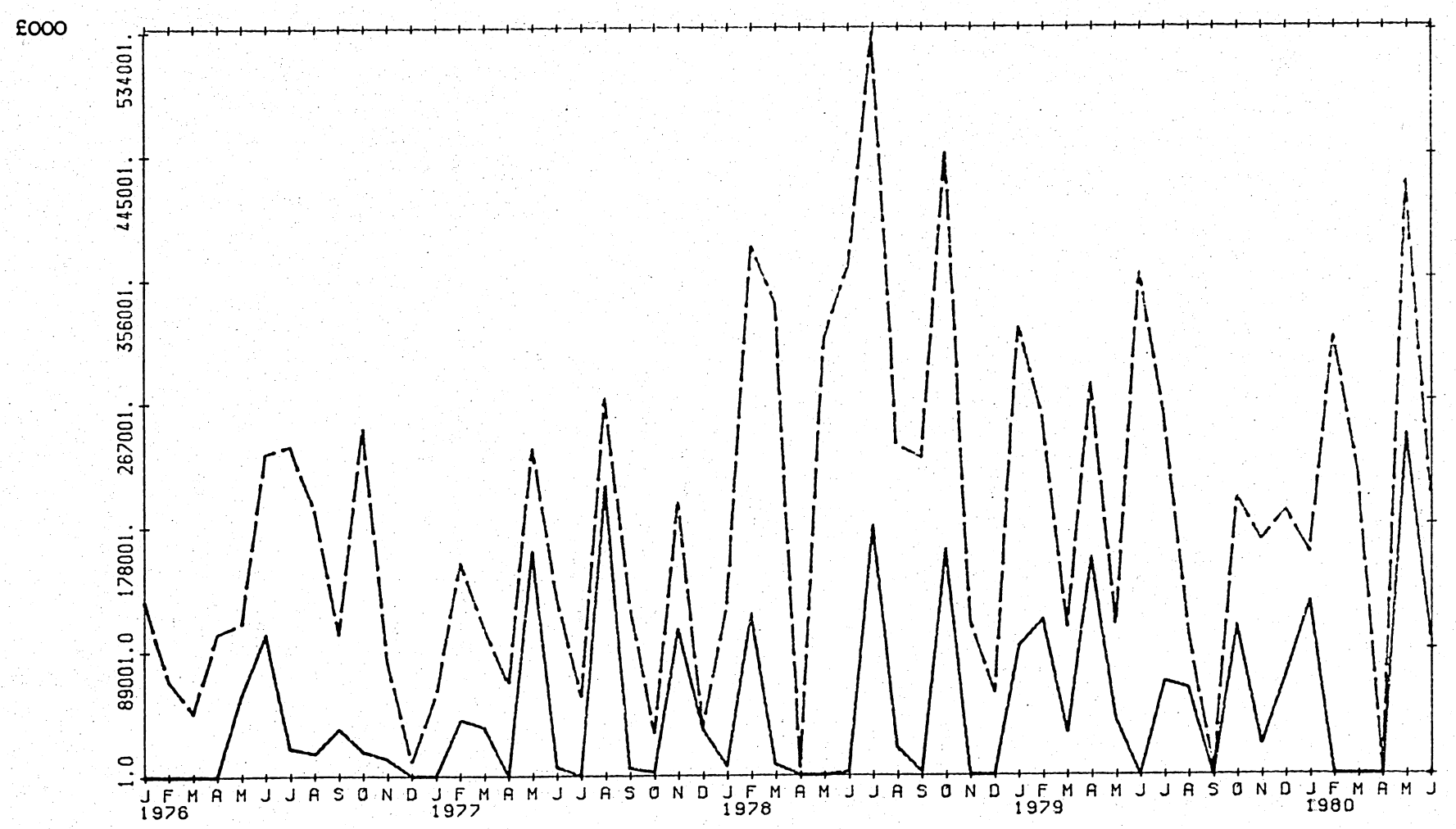
——— = BICA has 66 monthly observations from 1975/1 to 1980/6
— — — — = TBA has 66 monthly observations from 1975/1 to 1980/6



Graph A.18 EBA = English butter advertising TBA = Total butter advertising

University of Manchester

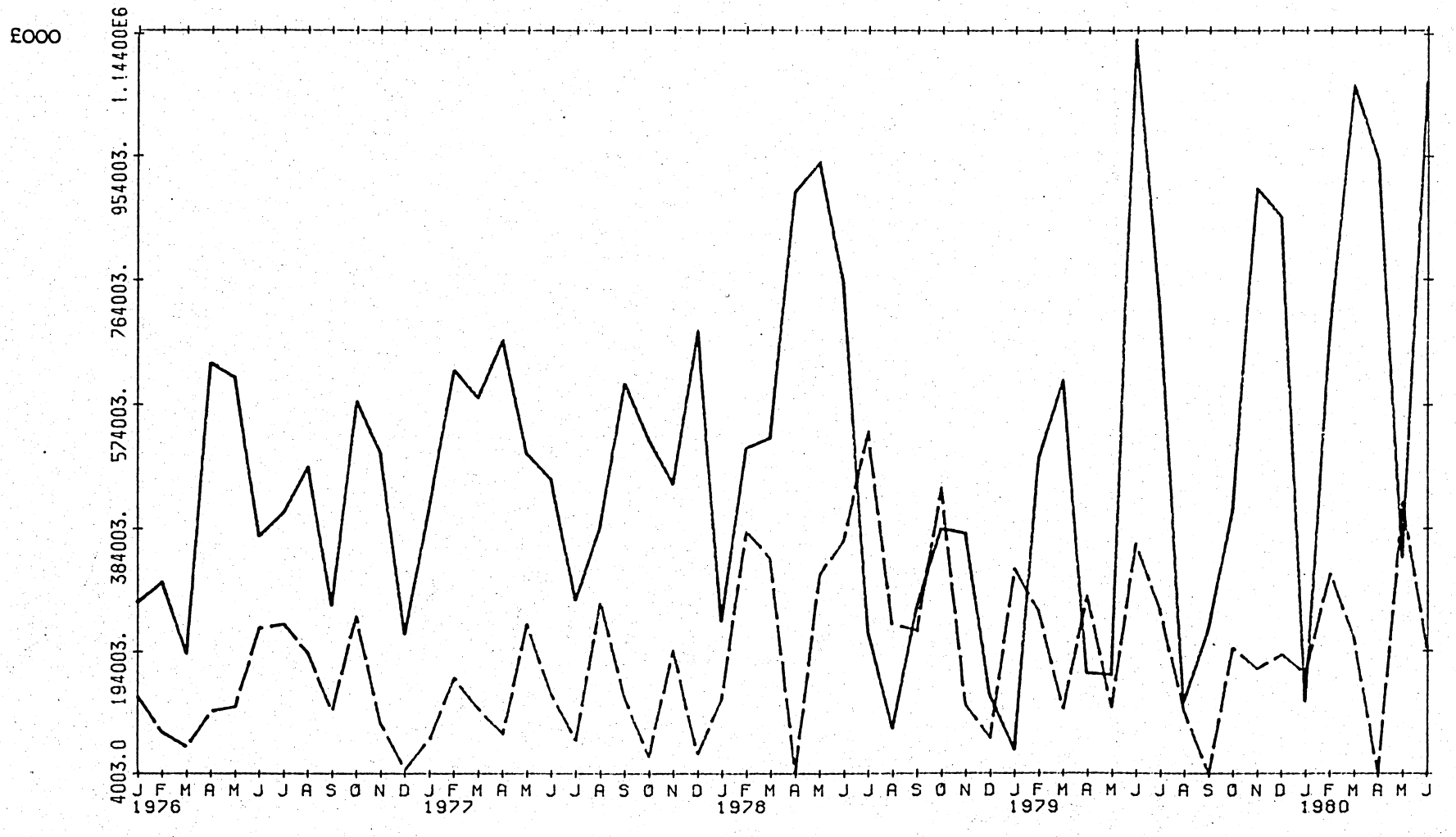
———— = EBA has 66 monthly observations from 1975/1 to 1980/6
— — — — = TBA has 66 monthly observations from 1975/1 to 1980/6



Graph A.19 MA = Margarine advertising TBA = Total butter advertising

University of Manchester

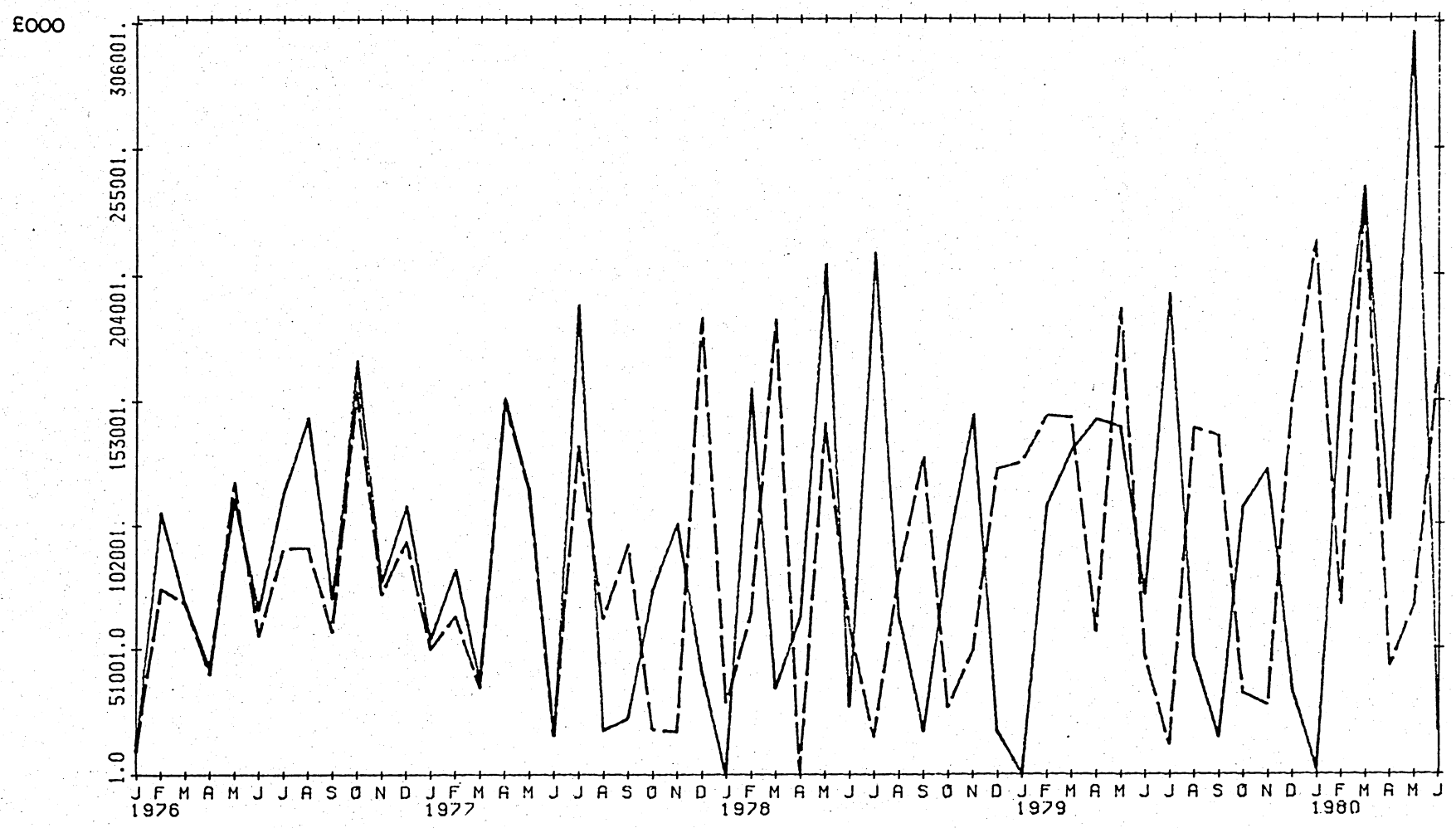
———— = MA has 66 monthly observations from 1975/1 to 1980/6
— — — — = TBA has 66 monthly observations from 1975/1 to 1980/6



Graph A.20 CA = Generic cheese advertising (MEAL)
CAA = Generic cheese advertising (Agency)

University of Manchester

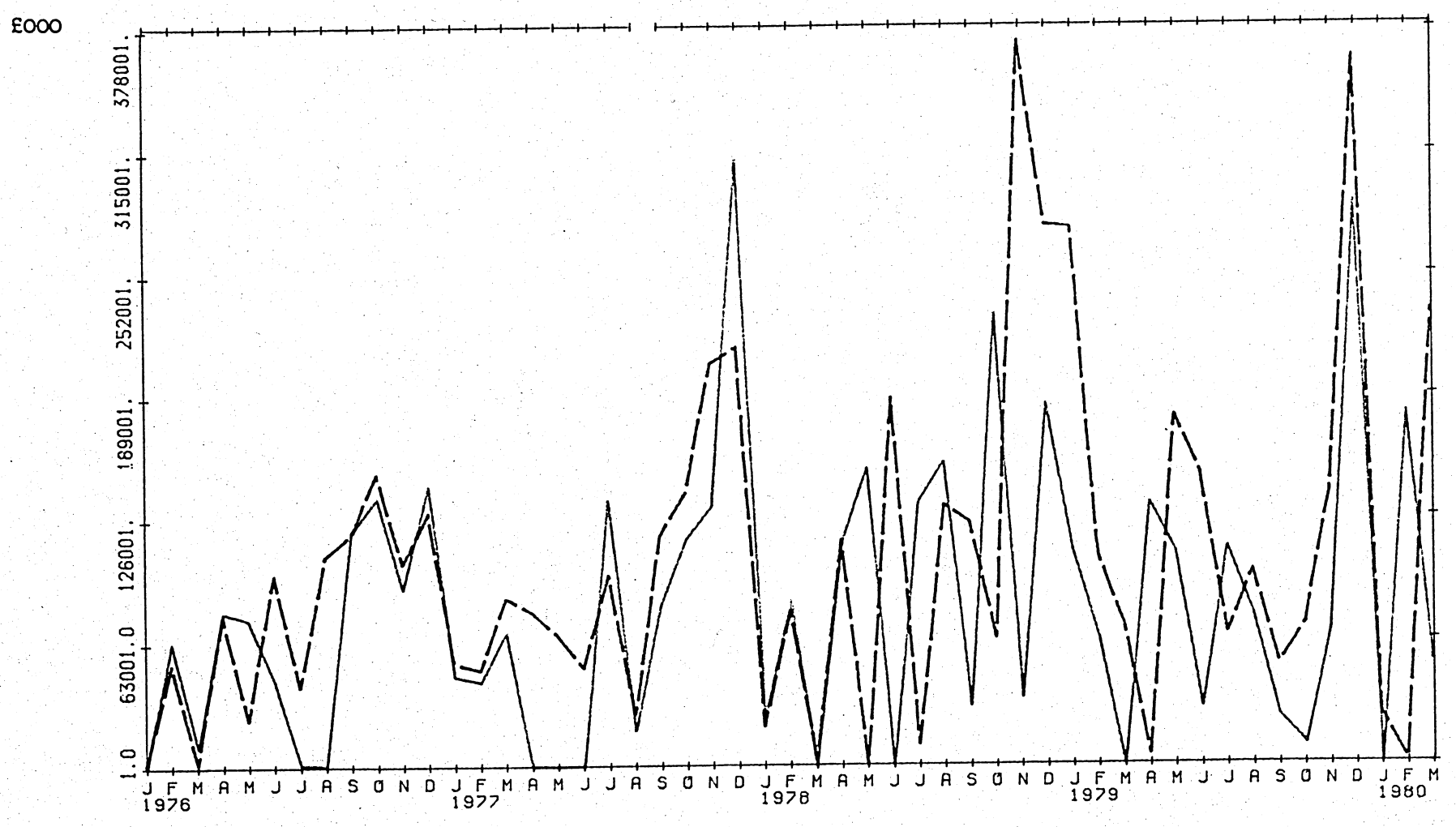
———— = CA has 66 monthly observations from 1975/1 to 1980/6
— — — — . = CAA has 70 monthly observations from 1975/1 to 1980/10



Graph A.21 ECOCA = English countrycheese advertising (MEAL)
ECOCAA = English country cheese advertising (Agency)

University of Manchester

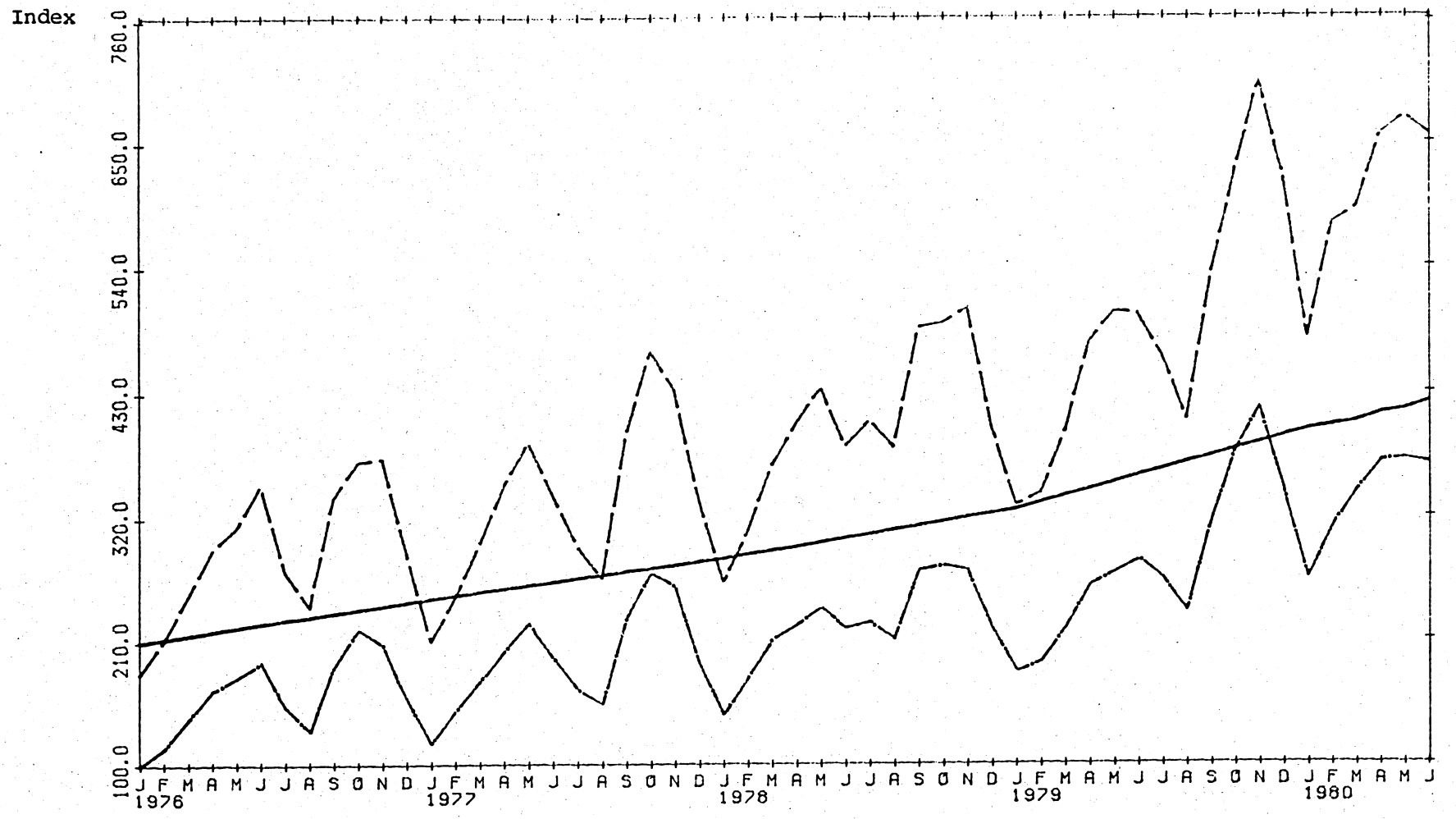
——— = ECOCA has 63 monthly observations from 1975/1 to 1980/3
— — — = ECOCAA has 72 monthly observations from 1975/1 to 1980/12



Graph A.22 MRII = Media Rates Index (interpolated from annual data)
MRIC' = Media Rates Index (cost per 1000 adults)
MRIMS = Media Rates Index (cost per 1000 messages)

University of Manchester

———— = MRII has 126 monthly observations from 1970/1 to 1980/6
— — — . = MRIC' has 132 monthly observations from 1970/1 to 1980/12
———.—.—.. = MRIMS has 60 monthly observations from 1976/1 to 1980/12



APPENDIX 3

Some More Equations

The preferred equations presented in the text of the report represent only a small part of the econometric results. To arrive at those preferred relationships many more alternative specifications of sales, prices and advertising expenditures were considered. It would be a difficult and uninteresting task to comprehensively detail all those alternatives and their consequent regression results. Instead, the following pages contain several more equations for each of the commodities considered (except cheese) in order to give the reader an indication of how the equations presented already earned their preference. The discussion of each equation is brief as, in many cases, it is self evident why the estimation results were considered unsatisfactory.

Equations Milk 35 and Milk 37Cl demonstrate alternative methods of accounting for seasonality in the liquid milk purchases data. Whilst not strictly comparable the different signs and magnitudes obtained for the same explanatory variables in the two equations are an obvious difference. Milk 38F represents an early attempt to test for asymmetric price responses in the liquid milk sales data. The variable, Max. Price, was derived from the number of changes in the maximum price for liquid milk in order to test the hypothesis that at these maximum prices, consumers would switch to competing products and be reluctant to return when prices were reduced.[1] The poor t-ratio on the estimated coefficient suggests rejection of the hypothesis.

Cream 25 again illustrates the effect of using a different method of accounting for seasonality. The 12 monthly differencing procedure produces various changes in the estimates of the effects of price, income and advertising. Cream 26 is simply equation Cream 26B estimated over a shorter time period.

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1. See Trevor Young (op.cit.) page 178 for a fuller description of this derivation and discussion of kinked demand curves.

Equation	Dependent Variable	Intercept	Price	Income	Dummy February	Dummy March	Dummy April	Dummy May	Dummy June	Dummy July
Milk 35	Liquid Milk Purchases	2.809	-0.125	0.079	-0.083	-0.004	-0.016	-0.019	-0.070	-0.06 /
		(21.61)	(2.67)	(0.89)	(7.58)	(0.37)	(1.41)	(1.65)	(6.64)	(6.05)

Dummy August	Dummy September	Dummy October	Dummy November	Dummy December
-0.079	-0.049	0.003	-0.016	-0.011
(7.63)	(4.32)	(0.26)	(1.45)	(1.34)

$\bar{R}^2$ = 0.870

D.W. = 1.973

Dummy Bank Holiday	Instant Milk Purchases	Current Milk Advertising Expenditure	Lagged Milk Advertising Expenditure (t-1)
0.006	-0.093	0.0122	0.0092
(0.74)	(5.66)	(3.09)	(3.39)

Lagged Milk Advertising Expenditure

(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)
0.0066	0.0044	0.0027	0.0014	0.0006	0.0003	0.0004	0.0010
(3.61)	(3.28)	(2.23)	(1.23)	(0.62)	(0.39)	(0.64)	(0.81)

Milk 35 was estimated in double log form by Generalized Least Squares regression over the period 1975.02 to 1979.09 Advertising data was obtained from M.E.A.L. and deflated by a media rates index, advertising lag structure was estimated using an Almon polynomial degree 2.

Equation	Dependent Variable	Intercept	Price of Milk	Income	Trend	Dummy Weekend	Dummy Bank Holiday	Instant Milk Purchases	Current Milk Advertising
MILK 37C1	12 monthly differenced liquid milk purchases	0.023	-46.697	1.946	0.026	0.045	0.035	-0.408	9.119
		(0.01)	(4.17)	(0.93)	(2.12)	(0.33)	(0.29)	(0.78)	(1.78)

Lagged Milk Advertising

(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)
6.5664	4.4706	2.8317	1.6500	0.9252	0.6575	0.8467	1.4930
(2.16)	(2.09)	(1.29)	(0.71)	(0.41)	(0.29)	(0.27)	(0.28)

$\bar{R}^2$ = 0.285

D.W. = 2.373

Milk 37C1 was estimated in linear form by Generalized Least Squares regression over the period 1975.02 to 1979.09. Advertising expenditure figures obtained from M.E.A.L. deflated by media rates index and estimated using Almon Polynomial (degree 2).

Equation	Dependent Variable	Intercept	Income	Price	Max.Price	Lagged liquid Milk Sales (t-12)	Dummy Weekend	Dummy Bank Holiday
Milk 38F	Liquid Milk Sales	12.160	199.884	-1679.065	-135.134	0.773	2.34	0.13
		(0.19)	(5.18)	(3.50)	(0.70)	(12.34)	(1.03)	(0.07)

$\bar{R}^2$ = 0.89

D.W. = 1.98

ρ = 0.10

Current Advertising	Lagged Advertising t-1	t-2	t-3	t-4	t-5	t-6	t-7	t-8	t-9
0.00003	0.00005	0.00006	0.00007	0.00008	0.00009	0.00010	0.00010	0.00010	0.00010
(0.44)	(0.85)	(1.28)	(1.63)	(1.88)	(2.06)	(2.23)	(2.41)	(2.62)	(2.73)

Lagged Advertising t-10	t-11	t-12
0.00010	0.00009	0.00008
(2.53)	(1.97)	(1.35)

Milk 38F was estimated by Generalized Least Squares over the period 1976.01 to 1979.12 in linear form.
Advertising lag structure was fitted using an Almon polynomial, degree 2.

Equation	Dependent Variable	Intercept	Price	Income	Dummy Weekend	Dummy Bank Holiday	Lagged Cream Purchases (t-12)	Current Cream Advertising
Cream 25	12 monthly differenced cream purchases $(Q_t - Q_{t-12})$	-1.910 (3.45)	-0.811 (4.33)	-0.251 (0.58)	-0.009 (0.76)	-0.037 (2.43)	-0.081 (1.66)	+0.007 (2.57)

	Lagged Cream Advertising								
	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)
	0.0043 (1.57)	0.0021 (0.75)	0.0014 (0.47)	0.0028 (1.01)	0.005 (1.79)	0.005 (1.98)	0.0073 (2.53)	0.0003 (0.10)	0.004 (1.78)

$\bar{R}^2 = 0.216$

D.W.= 1.975

Lagged Cream Advertising		
(t-10)	(t-11)	(t-12)
0.0012 (1.40)	-0.0038 (0.07)	0.0002 (0.76)

Cream 26 was estimated in double log form by Generalized Least Squares regression over the period 1976.01 to 1979.07. Advertising expenditure figures were obtained from the advertising agency, deflated by a media rates 'messages' index and estimated using an unrestricted Almon polynomial.

Equation	Dependent Variable	Intercept	Income	Price	Current Cream Advertising (t)	Lagged Cream Advertising (t-4)	(t-5)	(t-6)	(t-7)	(t-9)
Cream 26	Cream Purchases	-1.924	0.761	-0.799	0.0109	0.0059	0.0052	0.0051	0.0091	0.0081
		(3.84)	(2.96)	(4.27)	(3.85)	(2.23)	(1.81)	(1.79)	(3.58)	(2.74)

$\bar{R}^2 = 0.95$

D.W.=1.659

Lagged Cream Purchases	
(t-1)	(t-12)
0.155	0.820
(4.11)	(23.26)

Cream 26 was estimated in double log form by Generalized Least Squares regression over the period 1976.01 to 1979.01. Advertising data was obtained from the advertising agency and deflated by a media rates 'messages' index.

Equation	Dependent Variable	Intercept	Income	Price	Current Cream Advertising (t)	Lagged Cream Advertising (t-4)	(t-5)	(t-6)	(t-7)	(t-9)
Cream 26A	Cream Purchases	-1.570 (2.59)	0.530 (0.95)	-0.650 (2.96)	-0.0002 (1.14)	0.0002 (1.03)	0.0003 (1.84)	-0.00001 (0.08)	0.0002 (1.23)	-0.0002 (0.97)

	Lagged Cream Purchases (t-1)	(t-12)
$\bar{R}^2$ = 0.922	0.072	0.931
D.W.= 2.09	(1.61)	(23.74)

Cream 26A was estimated in double log form by Generalized Least Squares regression over the period 1976.01 to 1979.07. Advertising expenditure data was obtained from M.E.A.L. and deflated using a media rates 'messages' index.

Equation	Dependent Variable	Intercept	Income	Price	Current Cream Advertising	Lagged Cream Advertising (t-4)	(t-5)	(t-6)
Cream 26C	Cream Purchases	-1.877	0.997	-0.789	0.0099	0.0047	0.0051	0.0047
		(3.83)	(2.14)	(4.28)	(3.60)	(1.80)	(1.78)	(1.61)

	Lagged Cream Advertising (t-7)	(t-8)	Lagged Cream Purchases (t-1)	Lagged Cream Purchases (t-12)
$\bar{R}^2$ = 0.947	0.0064	-0.0048	0.121	0.850
	(2.32)	(1.85)	(3.28)	(23.88)

D.W. = 1.860

Cream 26C was estimated in double log form by Generalized Least Squares regression over the period 1976.01 to 1979.07. Advertising expenditure data was obtained from the advertising agency and deflated by a 'messages' cost index. The advertising lag structure was estimated in an unrestricted form.

Cream 26A demonstrates the serious effect of using advertising data from MEAL rather than the advertising agency in the estimation. Cream 26C is again directly related to Cream 26B presented in the text but the advertising lag structure is estimated in unrestricted form.

Butter 20 and 20A are examples of the total butter demand relationship estimated from a deseasonalized data series and involving price, income and competitors' advertising (Margarine). Butter 21, uses the 12 monthly lag operator to account for seasonality. It is estimated over a similar period to Butter 20A and many of the coefficient values are of similar sizes. The estimated effect of generic butter advertising in Butter 21 is typical of the results of including this variable in various specifications of the total butter equation. Butter 22 uses dummy variables to explain the seasonality of sales of butter and whilst satisfactory estimates of the effect of price income, and margarine advertising are obtained, that for generic butter advertising contradicts *a priori* reasoning. Butter 23A is identical to equation Butter 23 given in the text apart from the inclusion of the one period lagged dependent variable. As the results of Butter 23A show there is little statistical support for retaining this variable in the preferred equation. Butter 26T is an example of the type of unrestricted 'overfitted' estimation of advertising's effect on sales. The advertising share data and 'other' butter advertising data is used in the estimation in quite long free-form lag structures. The inconsistent negative and positive signs for advertising's effect in particular periods are then used as indicators of how to specify the lag shape. In this way the 'bubble' lag shapes of Butter 26, in the text, were derived. Butter 26D represents another stage in this derivation, being the unrestricted form of the lags on advertising which appear, from Butter 26T, to have the correct signs. Butter 27 presents a similar unrestricted form of the preferred equation Butter 28.

Marg 11B and 11C are alternatives to Marg 11A given in the body of the report. The dependent variables are soft margarine and packet margarine

purchases (as opposed to total margarine purchases). More interesting, perhaps, are the results given in Butter 23HW and Marg 11HW. These equations investigate the effect of a health warning on heart disease and animal fats published by the Royal College of Physicians in March 1976. This 'anti' advertising effect on the sales of butter and positive sales effect for margarine was tested using a simple distributed lag structure fitted by an Almon polynomial of degree 2. As the equation results and Figures A.5 and A.6 show the effect on sales, of butter and margarine, of the health warning did have a prolonged impact over time. The inclusion of this dummy variable for the health warning had no serious effects on the estimates of other explanatory variables in the demand equations.

Equation	Dependent Variable	Intercept	Income	Own Price	Price of Soft Margarine	Trend	Dummy Weekend	Dummy Bank Holiday	Margarine Advertising
Butter 20	Deseasona-	631.691	-4.079	-636.280	-351.711	-1.135	0.318	-3.250	-0.0003
$\bar{R}^2$ = 0.723	lized butter	(4.62)	(0.04)	(5.48)	(0.74)	(4.10)	(0.14)	(1.31)	(2.68)
D.W.=1.609	purchases (by moving average)								
Butter 20A	Deseasona-	538.060	41.582	-542.505	-23.030	-1.385	0.094	-2.920	-0.0002
$\bar{R}^2$ = 0.743	lized butter	(4.90)	(0.52)	(5.11)	(0.07)	(6.35)	(0.05)	(1.35)	(2.73)
D.W.=1.780	purchases (by moving average)								

Butter 20 and butter 20A were estimated in linear form using Generalized Least Squares regression. They were estimated over the period 1976.02 to 1979.03 (Butter 20) and 1976.02 to 1980.03 (Butter 20A). Advertising data was obtained from M.E.A.L. and deflated using a media rates index.

Equation	Dependent Variable	Intecept	Income	Lagged butter purchases (t-12)	Own Price	Price of Packet Margarine	Price of Soft Margarine	Trend
Butter 21	Butter purchases	-141.165 (1.01)	121.504 (1.16)	0.655 (8.37)	-582.674 (4.17)	302.789 (0.54)	945.589 (1.92)	0.914 (2.51)

	Dummy Weekend	Dummy Bank Holiday	Butter Information Council Advertising	Margarine Advertising
$\bar{R}^2$ = 0.73	4.442 (1.61)	0.517 (0.18)	-0.001 (1.40)	-0.0002 (1.65)
D.W. = 1.890				

Butter 21 was estimated in linear form by Generalized Least Squares regression over the period 1976.08 to 1980.03. Advertising data was obtained from M.E.A.L. and deflated by a media rates index.

Equation	Dependent Variable	Intercept	Income	Own Price	Price of Packet Margarine	Price of Soft Margarine	Trend	Dummy February	Dummy March
Butter 22	Butter Purchases	375.431 (3.69)	233.049 (3.17)	-693.815 (6.17)	-600.721 (1.25)	817.079 (2.18)	-1.286 (8.17)	-27.018 (5.56)	-6.711 (1.32)

Dummy April	Dummy May	Dummy June	Dummy July	Dummy August	Dummy September	Dummy October	Dummy November	Dummy December
-21.239 (3.94)	-23.346 (3.89)	-40.377)6.24)	-54.016 (9.50)	-47.641 (8.85)	-30.376 (5.45)	-6.102 (1.14)	-6.986 (1.33)	-2.744 (0.57)

$\bar{R}^2$ = 0.937

D.W.= 1.852

Dummy Weekend	Dummy Bank Holiday	Butter Information Council Advertising	Margarine Advertising
0.768 (0.31)	-3.854 (1.10)	-0.0004 (0.43)	-0.0003 (3.50)

Butter 22 was estimated in linear form by Generalized Least Squares regression over the period 1975.10 to 1980.03. Advertising data was obtained from M.E.A.L. and deflated by a media rates index.

Equation	Dependent Variable	Intercept	Income	Price of Butter	Price of Soft Margarine	Lagged Butter Purchases (t-1)	Lagged Butter Purchases (t-12)	Dummy Weekend	Dummy Bank Holiday
Butter 23A	Butter Purchases	97.436	161.376	-875.062	880.968	0.064	0.489	3.627	0.225
		(0.79)	(1.93)	(5.85)	(2.55)	(0.82)	(9.97)	(1.33)	(0.09)

	Current Margarine Advertising	Lagged Margarine Advertising								
	(t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)
	-0.0003	-0.0002	-0.0002	-0.0002	-0.0001	-0.0001	-0.0001	-0.00002	+0.00001	+0.000
	(4.64)	(4.44)	(4.07)	(3.50)	(2.74)	(1.90)	(1.09)	(0.38)	(0.21)	(0.68)

	Current Total Butter Advertising	Lagged Total Butter Advertising								
	(t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)
	0.00003	-0.0001	-0.0002	-0.0001	-0.00004	0.00007	0.0002	0.0003	0.0003	0.0003
	(0.16)	(1.05)	(1.54)	(1.11)	(0.35)	(0.62)	(1.49)	(1.97)	(2.09)	(1.90)

	Lagged Total Butter Advertising		
	(t-10)	(t-11)	(t-12)
	0.0002	-0.00005	-0.0004
	(1.26)	(0.41)	(2.41)

$\bar{R}^2$ = 0.845

D.W. = 1.942

Butter 23A was estimated in linear form by Generalized Least Squares over the period 1976.08 to 1980.03. Advertising expenditure data was derived from M.E.A.L. and deflated as a 'messages' index. The lag structure for margarine advertising was estimated using an Almon polynomial of degree 1, and, for total butter advertising using an Almon polynomial of degree 3.

Equation	Dependent Variable	Intercept	Income	Own Price	Price of Danish Butter	Price of New Zealand Butter	Price of Soft Margarine	Dummy Weekend
Butter 26T	English Butter Purchases	-155.160	26.586	-834.715	739.896	293.369	599.781	1.256
		(2.48)	(0.67)	(5.18)	(6.45)	(2.42)	(3.34)	(0.65)

Dummy Bank Holiday	Lagged English Butter Purchases (t-1)	Margarine Advertising	Lagged Margarine Advertising (t-1)	Current Advertising Share
1.496	0.297	-0.0002	-0.0001	4.865
(0.89)	(3.93)	(4.15)	(1.34)	(1.70)

Lagged Advertising Share

(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)	(t-10)
10.731	12.465	-0.943	-3.855	-1.391	4.380	6.483	5.618	-3.316	-0.097
(4.06)	(3.68)	(0.37)	(1.46)	(0.58)	(1.85)	(2.42)	(2.51)	(1.36)	(0.04)

$\bar{R}^2$ = 0.756

D.W. = 1.932

Current Other Butter Advertising

Lagged Other Butter Advertising

	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)	(t-9)
-0.0001	0.0003	0.0002	0.0001	-0.0005	-0.0003	-0.0003	-0.0001	0.0003	0.0002
(0.68)	(1.64)	(1.02)	(0.69)	(3.47)	(2.02)	(1.78)	(0.64)	(1.97)	(1.20)

(t-10)
-0.0001
(0.37)

Butter 26T was estimated in linear form by Generalised Least Squares regression over the period 1975.11 to 1980.03. Advertising expenditure data was obtained from M.E.A.L. Advertising share is the ratio of English butter advertising to total butter advertising.

Equation	Dependent Variable	Intercept	Income	Price of English Butter	Price of Danish Butter	Price of New Zealand Butter	Price of Soft Margarine	Dummy Weekend
Butter 26D	English Butter Purchases	-83.729 (1.26)	18.955 (0.43)	-1072.106 (7.25)	756.139 (6.54)	432.312 (3.91)	315.204 (1.68)	-0.29 (0.19)

Dummy Bank Holiday	Dummy Health Warning	Lagged English Butter Purchases (t-1)	Margarine Advertising	Advertising Share
0.59 (0.35)	-9.822 (1.99)	0.342 (4.64)	-0.0002 (4.28)	5.821 (2.48)

$\bar{R}^2 = 0.76$

D.W = 1.87

Advertising Share

t-1	t-2	t-6	t-7	t-8
7.889 (3.62)	10.062 (3.43)	4.154 (1.85)	2.648 (1.18)	3.870 (1.78)

Other Butter Advertising

t-3	t-4	t-5	t-9	t-10	t-11
0.00005 (0.38)	-0.00030 (2.14)	-0.00004 (0.29)	0.00009 (0.66)	-0.00024 (1.78)	-0.00020 (1.35)

Butter 26D was estimated in linear form by Generalized Least Squares regression over the period 1976.01 to 1980.03. Advertising expenditure data was obtained from M.E.A.L. and deflated using a media 'Messages' index.

Equation	Dependent Variable	Intercept	Lagged Market Share (t-1)	Current Other Butter Advertising	Lagged Other Butter Advertising (t-1)	(t-2)	(t-3)	(t-4)	(t-5)
Butter 27	Market Share of English Butter	5.867 (3.98)	0.288 (3.45)	-0.0323 (1.34)	-0.0313 (1.22)	-0.0643 (2.15)	-0.0087 (0.29)	-0.0299 (1.03)	-0.0181 (0.66)

Lagged Other Butter Advertising (t-6)	(t-7)	(t-8)	(t-9)	(t-10)
-0.0388 (1.41)	-0.0259 (0.75)	-0.0185 (0.48)	-0.0828 (2.31)	-0.0836 (2.68)

Current Advertising Share	Lagged Advertising Share (t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)
-0.0017 (0.31)	0.0040 (0.81)	0.0039 (0.61)	0.0052 (0.80)	(0.0033) (0.51)	0.0099 (1.66)	0.0012 (0.19)	0.0042 (0.71)

Lagged Advertising Share (t-8)	(t-9)	(t-10)	Price Ratio English/ Danish Butter	Price Ratio English/ New Zealand Butter
-0.0025 (0.40)	0.0056 (0.87)	0.0037 (0.65)	-2.511 (2.41)	-7.946 (6.79)

$\bar{R}^2$ = 0.61

D.W. = 1.924

Butter 27 was estimated in double log form by Generalized Least Squares over the period 1975.11 to 1980.03. Advertising data was obtained from M.E.A.L. and deflated by a media rates 'messages' index. Advertising lag structure was unrestricted.

Equation	Dependent Variable	Intercept	Own Price	Price of Butter	Income	Lagged Soft Margarine Purchases (t-1)	Lagged Soft Margarine Purchases (t-12)	Current Margarine Advertising
Marg 11B	Soft Margarine Purchases	95.532 (0.86)	-485.471 (1.32)	358.013 (3.01)	-62.806 (0.76)	-0.040 (0.36)	0.625 (6.33)	0.0001 (2.72)

Lagged Margarine Advertising

(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)
0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001
(3.36)	(3.56)	(3.47)	(3.29)	(3.12)	(2.97)	(2.84)	(2.69)

Lagged Margarine Advertising

(t-9)	(t-10)	(t-11)	(t-12)
0.0001	0.0001	0.0001	0.00001
(2.43)	(1.93)	(1.11)	(0.24)

Current Total Butter Advertising

-0.0005
(3.89)

$\bar{R}^2$ = 0.736

D.W. = 1.953

Lagged Total Butter Advertising

(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)
-0.0004	-0.0003	-0.0002	-0.002	-0.0001	-0.0001	-0.0001	-0.0004
(4.03)	(3.64)	(2.77)	(1.89)	(1.25)	(0.83)	(0.58)	(0.47)

Lagged Total Butter Advertising

(t-9)	(t-10)	(t-11)	(t-12)
-0.00004	-0.0001	-0.0001	-0.0001
(0.50)	(0.61)	(0.74)	(0.84)

Marg 11 B was estimated in linear form by Generalized Least Squares regression over the period 1976.10 to 1980.03. Advertising data was obtained from M.E.A.L. and deflated by a media rates 'messages' cost index. Advertising lag structure for margarine and butter advertising was estimated using an Almon polynomial, degree 2.

Equation	Dependent Variable	Intercept	Price of Packet Margarine	Price of Butter	Income	Lagged packet margarine purchases (t-1)	Lagged packet margarine purchases (t-12)	Current Margarine Advertising
Marg 11 C	Packet Margarine Purchases	-83.942 (1.65)	307.683 (1.61)	71.133 (1.16)	64.838 (1.99)	0.005 (0.05)	0.591 (5.95)	0.00004 (1.22)

Lagged Margarine Advertising

(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)
0.00004 (1.70)	0.00004 (1.88)	0.00005 (1.80)	0.00005 (1.63)	0.00004 (1.46)	0.00004 (1.29)	0.00003 (1.12)	0.00003 (0.90)

Lagged Margarine Advertising

(t-9)	(t-10)	(t-11)	(t-12)
0.00002 (0.60)	0.00000 (0.15)	-0.00001 (0.41)	-0.00003 (0.86)

Current Total Butter Advertising

-0.0001 (2.47)

$\bar{R}^2$ = 0.477

D.W. = 1.427

Lagged Total Butter Advertising

(t-1)	(t-2)	(t-3)	(t-4)	(t-5)	(t-6)	(t-7)	(t-8)
-0.0001 (2.74)	-0.0001 (2.54)	-0.0001 (2.14)	-0.0001 (1.80)	-0.0001 (1.55)	-0.00009 (1.37)	-0.0001 (1.25)	-0.0001 (1.17)

Lagged Total Butter Advertising

(t-9)	(t-10)	(t-11)	(t-12)
-0.0001 (1.10)	-0.0001 (1.00)	-0.0001 (0.82)	-0.00003 (0.56)

Marg 11 C was estimated in linear form by Generalized Least Squares regression over the period 1976.10 to 1980.03. Advertising data was obtained from M.E.A.L., deflated by a 'messages' cost index, and its lag structure estimated using an Almon polynomial, degree 2.

Equation	Dependent Variable	Intercept	Income	Price of butter	Price of soft Margarine	Lagged butter purchase (t-12)
Butter 23HW	Butter purchases	115.070 (0.89)	105.795 (1.18)	-791.470 (5.15)	836.15 (2.05)	0.626 (8.01)

	Dummy Weekend	Dummy Bank Holiday	Current Margarine Advertising	Lagged Margarine Advertising					
				t-1	t-2	t-3	t-4	t-5	t-6
	3.05 (1.20)	-1.44 (0.56)	-0.00023 (3.84)	-0.00020 (3.75)	-0.00018 (3.53)	-0.00015 (3.15)	-0.00012 (2.61)	-0.00010 (1.97)	-0.00007 (1.32)

	Lagged Margarine Advertising			Current Butter Advertising	Lagged Butter Advertising				
	t-7	t-8	t-9		t-1	t-2	t-3	t-4	t-5
	-0.00004 (0.74)	-0.00002 (0.25)	-0.00001 (0.15)	0.00004 (0.21)	-0.00009 (0.80)	-0.00014 (1.16)	-0.00012 (0.95)	-0.00006 (0.47)	0.00003 (0.25)

$\bar{R}^2$ = 0.84

D.W. = 1.95

ρ = 0.18

Lagged Butter Advertising							Dummy for Current Health Warning (March 1976)
t-6	t-7	t-8	t-9	t-10	t-11	t-12	
0.00012 (0.99)	0.00019 (1.41)	0.00023 (1.50)	0.00021 (1.34)	0.00012 (0.83)	-0.00007 (0.56)	-0.00037 (2.29)	-56.038 (1.09)

Butter 23HW was estimated by Generalized Least Squares over the period 1976.08 to 1980.03 in linear form. Lag structures were estimated using Almon polynomials of degree 1 (Margarine) and degree 2 (Butter and Health Warning)

Lagged Effect of Health Warning									
t-1	t-2	t-3	t-4	t-5	t-6	t-7	t-8	t-9	t-10
-45.83 (1.17)	-36.92 (1.28)	-29.30 (1.45)	-22.99 (1.69)	-17.97 (1.89)	-14.25 (1.73)	-11.83 (1.37)	-10.70 (1.16)	-10.87 (1.18)	-12.34 (1.43)

Lagged Effect of Health Warning	
t-11	t-12
-15.11 (1.82)	-19.18 (1.94)

Figure A.1 : Lag Structure - Margarine Advertising (Butter 23HW)

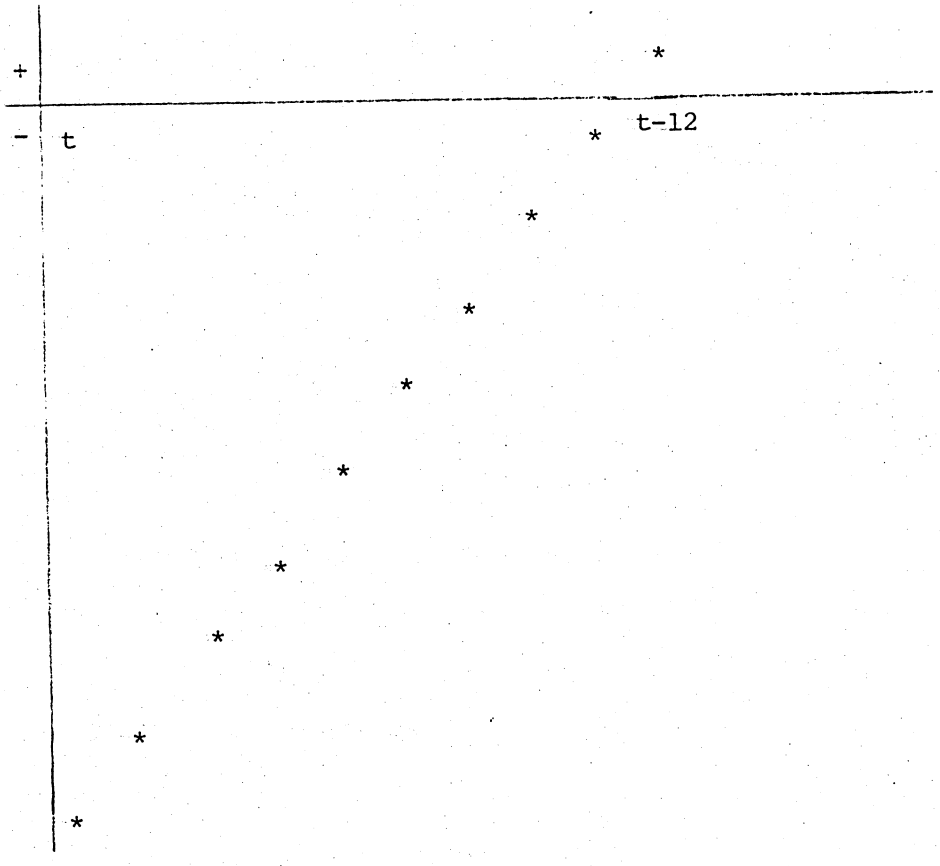


Figure A.2 : Lag Structure - Butter Advertising (Butter 23HW)

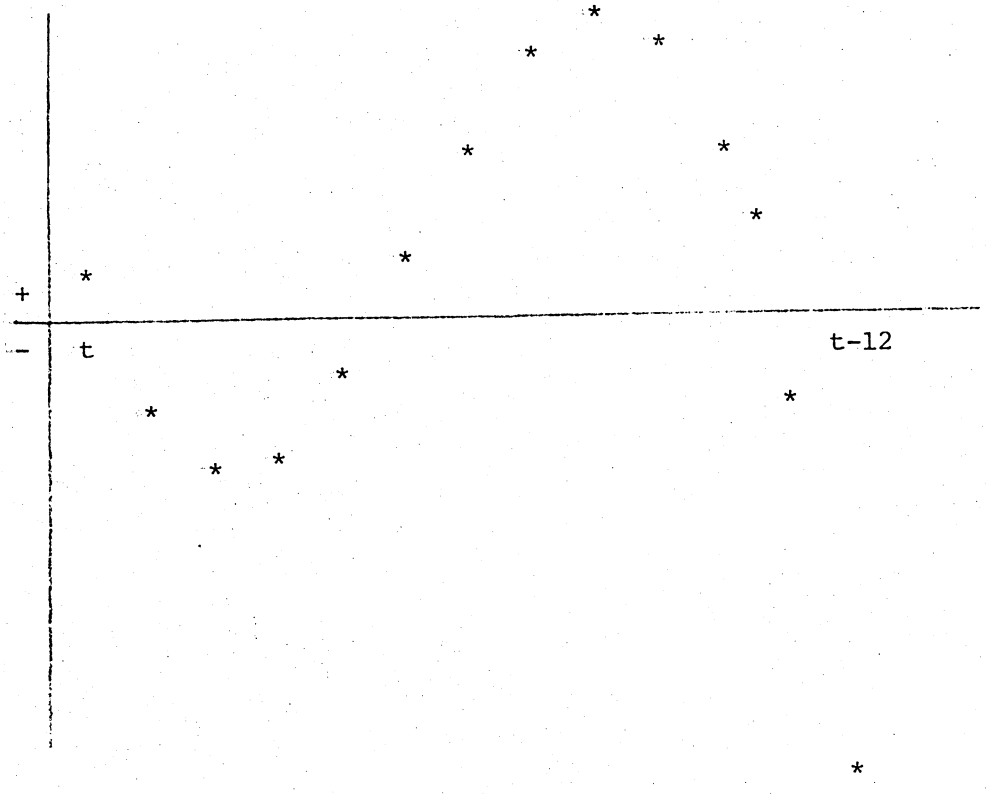
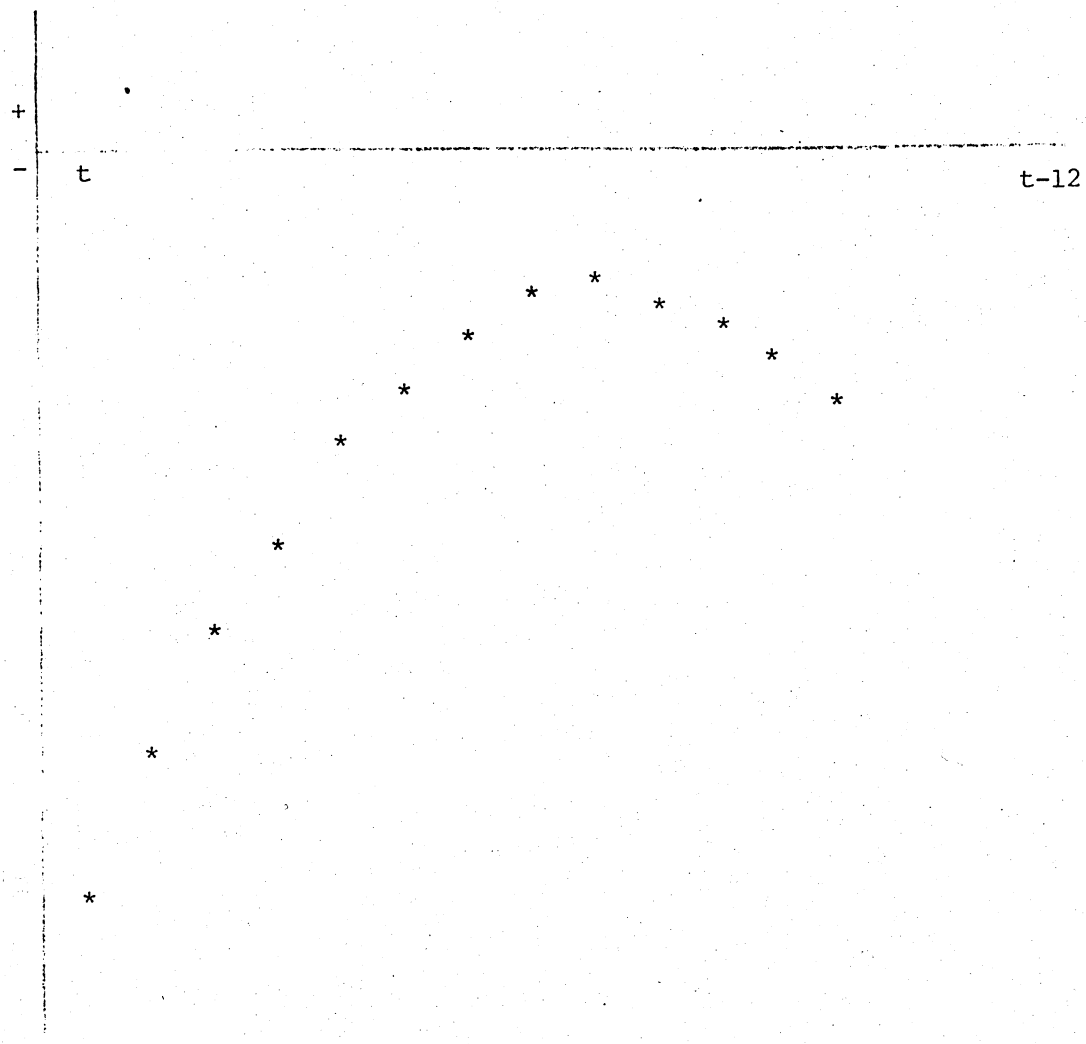


Figure A.3 : Lag Structures - Health Warning (Butter 23HW)



Equation	Dependent Variable	Intercept	Price of Soft Margarine	Price of Butter	Income	Lagged Margarine Purchases (t-1)	Lagged Margarine Purchases (t-12)
Marg 11HW	Margarine Purchases	68.67 (0.57)	-145.507 (0.31)	433.533 (2.83)	-156.769 (1.91)	0.334 (3.24)	0.555 (8.69)

$\bar{R}^2$ = 0.85

D.W. = 1.95

ρ = 0.44

Dummy Weekend	Dummy Bank Holiday	Current Margarine Advertising	Lagged Margarine Advertising t-1	t-2	t-3	t-4	t-5
3.816 (1.05)	-11.315 (3.47)	0.00007 (1.01)	0.00011 (1.84)	0.00014 (2.61)	0.00016 (3.15)	0.00017 (3.42)	0.00017 (3.47)

Lagged Margarine Advertising t-6	t-7	t-8	t-9	t-10	t-11	t-12	Current Butter Advertising
0.00017 (3.37)	0.00016 (3.15)	0.00014 (2.79)	0.00011 (2.22)	0.00007 (1.43)	0.00003 (0.51)	-0.00002 (0.35)	-0.00060 (2.57)

Marg 11HW was estimated over the period 1976.10 to 1980.03 in linear form by Generalized Least Squares. Lag structures were estimated using Almon polynomials of degree 2.

Lagged Butter Advertising t-1	t-2	t-3	t-4	t-5	t-6	t-7	t-8	t-9
-0.00049 (3.60)	-0.00039 (4.53)	-0.00031 (3.39)	-0.00023 (2.18)	-0.00018 (1.55)	-0.00013 (1.23)	-0.00010 (0.99)	-0.00007 (0.61)	-0.00007 (0.33)

Dummy Current Health Warning (March 1976)	Lagged Effects of Health Warning t-1	t-2	t-3	t-4	t-5	t-6	t-7	t-8
299.449 (2.51)	239.722 (2.54)	186.528 (2.58)	139.868 (2.62)	99.741 (2.69)	66.148 (2.81)	39.088 (2.94)	18.563 (2.64)	4.571 (0.72)

Lagged Effects of Health Warning t-9	t-10	t-11	t-12
-2.888 (0.37)	-3.813 (0.47)	1.796 (0.23)	13.938 (1.41)

Figure A.4 : Lag Structure - Margarine Advertising (Marg llHW)

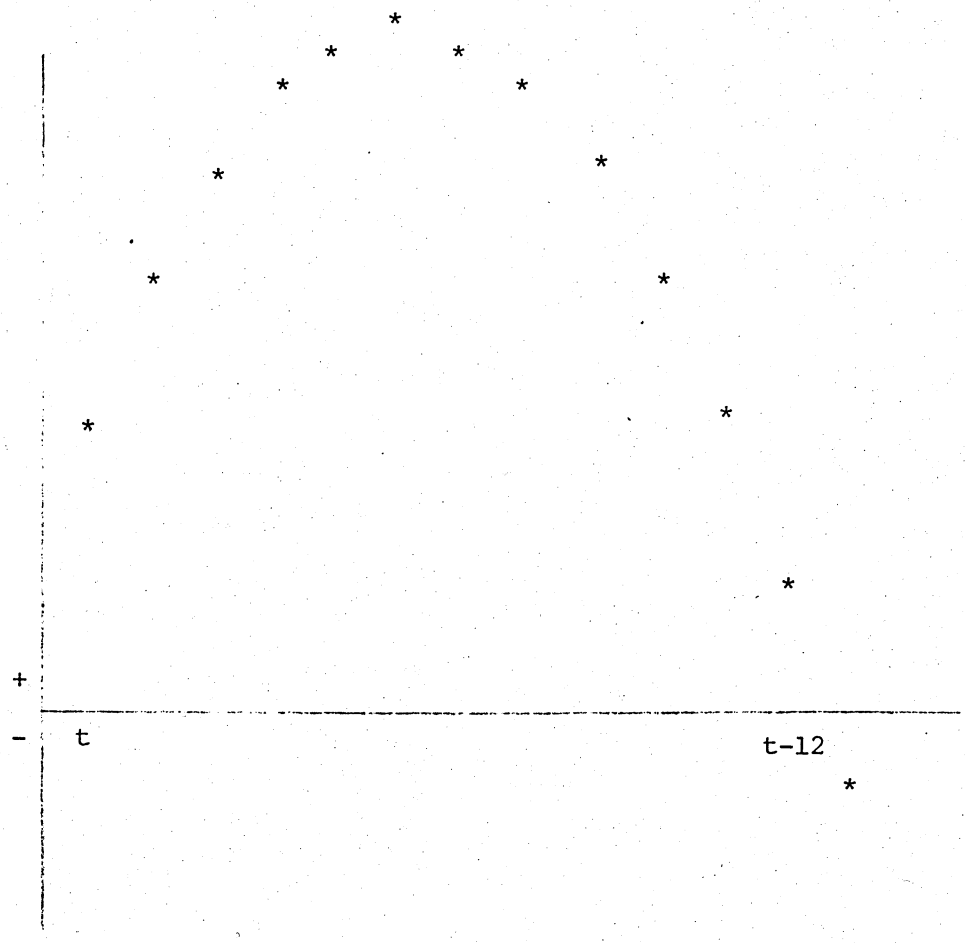


Figure A.5 : Lag Structure - Butter Advertising (Marg llHW)

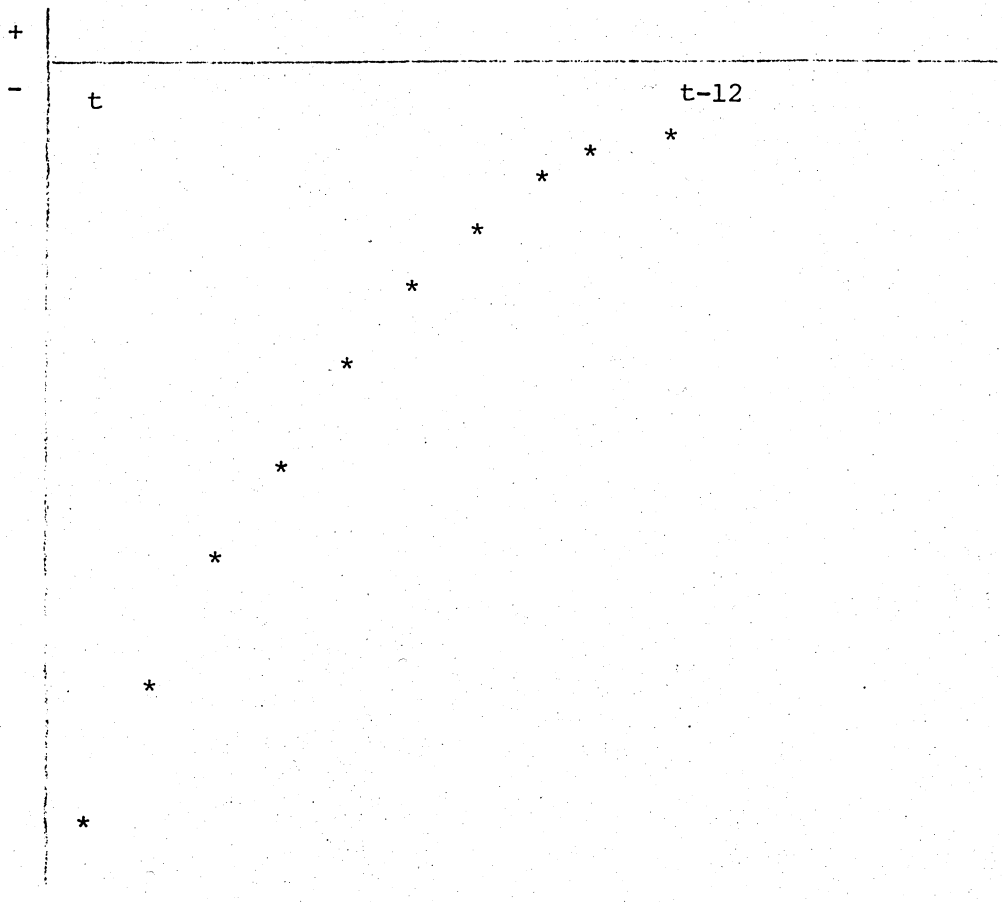
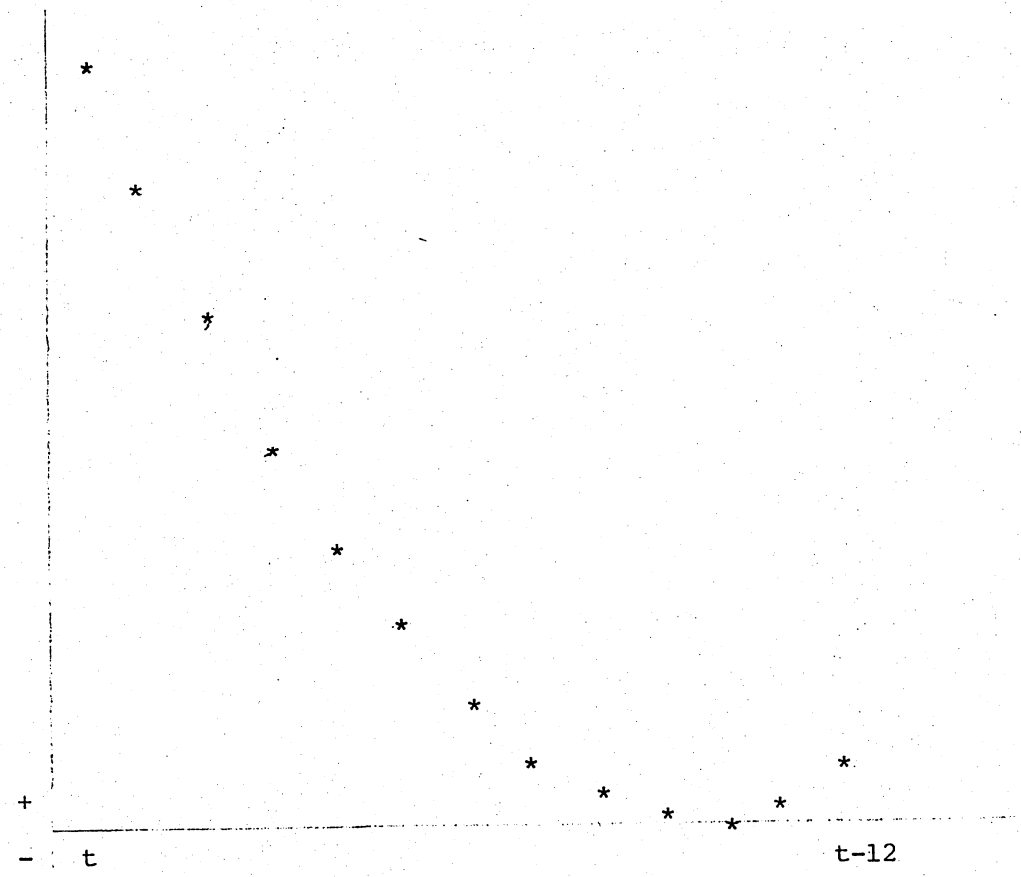


Figure A.6 : Lag Structure - Health Warning (Marg 11HW)



Some More Elasticities

In Chapter Three it was noted that the inclusion of the lagged dependent variable, Q_{t-1}, in the specification of a demand equation resulted in an estimating equation observationally equivalent to that of a Nerlovian partial adjustment model. Put simply,

$$Q_t^* = \alpha + \beta P_t \qquad \ldots\ldots\ldots\ldots(1)$$

where

Q_t^* = optimal current purchases

P_t = current price

If, because of imperfect information, habits, inertia etc. a consumer does not achieve his optimal level of purchases immediately then Q_t^* can be represented by an adjustment function.

$$Q_t - Q_{t-1} = \gamma(Q_t^* - Q_{t-1}) + u_t \qquad \ldots\ldots\ldots\ldots(2)$$

$$0 < \gamma < 1$$

Combining (1) and (2) gives,

$$Q_t = \alpha\gamma + \beta\gamma P_t + (1-\gamma) Q_{t-1} + u_t \qquad \ldots\ldots\ldots\ldots(3)$$

The estimating equation (3) provides a value for γ from the estimated coefficient on the lagged dependent variable. This value for γ may be used to calculate the long run effect of price on quantity demanded i.e. after full adjustment has taken place. In practice, the estimated coefficients on all explanatory variables in the equation are simply divided by the value for γ. Clearly, as γ approaches 1 i.e. adjustment is immediate, short run effects are equivalent to long run effects.

Now, the estimated coefficient values for different explanatory variablesare involved in the computation of elasticities. This implies that short run and long run elasticities may be produced by considering the

effect of partial and full adjustment and many of the estimated equations in Chapter Three and in the preceding section of this Appendix are equivalent to equation (3) above. Does this mean that long run elasticities should be computed and used in the evaluation of advertising effects?

Our response to this question of interpretation depends on the rationale for the inclusion of the lagged dependent variable in the estimating equation. If it is there simply to reflect observed time series characteristics of the data there may be no justification for an economic interpretation of the estimated coefficient on Q_{t-1}. On the other hand, if a partial adjustment model was postulated and the estimating equation included Q_{t-1} then the resulting coefficients can be understood and represented by equation (3). The comparative effects of time series and economic interpretations of the estimated coefficients for the preferred equations in Chapter Three are given below.

For liquid milk, the coefficient on the lagged dependent variable, when used in an estimating equation, was very small, negative and statistically insignificant. Hence, there is no need to debate this issue further for the demand for liquid milk.

For cream, equation Cream 26B contains a small, positive and significant coefficient on Q_{t-1} (value = 0.1044). Using a value for γ of 0.9 the long run elasticities may be calculated and are given in Table A.2 below. For comparison, the short run elasticities are also reproduced in that table.

Table A.2 : Short and long run elasticities for cream

Elasticity of demand with respect to:	Short run	Long run
Price of fresh cream (own price)	-0.8094	-0.8993
Income	0.7182	0.798
Cream Advertising	0.0285	0.0317

For such a large adjustment coefficient it is not surprising to find that the long run elasticities are not greatly different from the elasticities

calculated and presented earlier. In particular, the slight increase in size of the advertising elasticity is not sufficient to warrant any significant changes in the evaluation of advertising effects in the cream market.

For butter, the coefficient on the lagged dependent variable is again very small and positive but statistically insignificant. Whether or not it has an economic interpretation the coefficient value is too small to have an important effect on the calculation of elasticities. However, for English butter the situation is not so straightforward. Equations Butter 26 and Butter 28 both have a value of 0.366 for the coefficient on the lagged dependent variable and which is highly significant. Table A.3 presents a comparison of short and long-run elasticities for Butter 28 using a value for γ = 0.634.

TABLE A.3 Short and long run elasticities for English butter

Elasticity of demand with respect to:	Short run	Long run
Price of English Butter (own price)	-7.127	-11.222
Price of Danish Butter	4.33	6.831
Price of New Zealand Butter	4.087	6.440
Advertising Share (own/total butter advert.)	0.339	0.534
'Other' butter advertising	-0.220	- 0.345

Both short and long run elasticities are calculated from the estimated coefficients in equation Butter 28 and at the mean values of the sample period.

Clearly the adjustment coefficient, when involved in the calculation of elasticities, makes a significant difference to the long run values of those elasticities. It has been shown already that the guidelines for the optimal advertising budget for English butter depends upon various elasticities. The formula

$$\frac{A^*}{PQ} = \frac{1}{|\mu|} [AS_e - (AS_e + Ae') Ae'']$$

may be used with the long run elasticities given in Table A.3 to determine the effect, if any, on the appropriate level of advertising expenditure.

Table A.4 presents a comparison of budgets calculated using short run and long run elasticities.

TABLE A.4 : Optimal advertising budgets for English butter using short and long run elasticities

Rivals' Response to Changes in Own Advertising, (Ae'')	A* - the optimal advertising budget (£m)	
	Short run	Long run
0.5	4.115	3.586
1.0	3.248	2.198
1.5	2.351	0.804
2.0	1.470	*
2.5	0.588	*

* Indicates advertising is not worthwhile due to expected size of rivals' response.

It is important to note that the long run results presented in Table A.4 are derived on the assumption that all elasticities involved in the formula given earlier are given long run values. This includes, Ae'', the competitors' reaction to changes in own advertising. Thus in Table A.4, whilst the values for Ae'' shown are short run values their corresponding full adjustment values are used in the calculation of long run advertising budgets.

The appropriate amount of expenditure on advertising is significantly reduced at all postulated levels of rivals' response. Indeed, if that elasticity exceeds a value of 2.0 in the short run no advertising of own product is worthwhile. If an economic interpretation of the lagged dependent variable in the demand for English butter is correct it would seem that the results given in Table A.4 (using the estimated coefficients of Butter 28) suggest that in the long run the advertising budget for English butter should not be as large as indicated by just using short run elasticities. However, if in fact rivals' responses in the long run are as given by the values shown in Table A.4, then the use of the adjustment coefficient (γ) in the calculation

of elasticities and their use in the formula noted above will not seriously affect the size of the optimal budget. For cheese, both the total cheese and cheddar cheese equations (Cheese 20 and Cheese 25A) had negative coefficients on the dependent variable lagged one period. For a product which is frequently purchased this result has no sensible economic interpretation, and as other writers have noted (Hill, 1971) in a different context, there seems little point in calculating long run elasticities based on these adjustment values. The position for the market share of English cheddar cheese is different. The positive and significant coefficient value of 0.26 on the lagged dependent variable implies that a Nerlovian interpretation is appropriate. Table A.5 below presents the short and long run elasticities calculated from Cheese 31.

TABLE A.5 : Short and long run elasticities for English cheddar cheese

Elasticity of demand with respect to:	Short run	Long run
Own Price	-0.075	-0.101
Price of Territorial cheese	+0.794	+1.055
Price of Gouda cheese	+0.252	+0.336
Advertising share (Own/total cheese advert.)	+0.0473	+0.0660
'Other' cheese advertising	-0.0098	-0.0131

Short and long run elasticities are calculated from the estimated coefficients in Cheese 31 at the mean values of the sample period.

Incorporating the adjustment coefficient in the calculation of elasticities increases the long run elasticity values as expected. The use of these long run estimates in the determination of the appropriate advertising budget produces little extra information though. With any value for Ae'' above the short run value of 1.0 the formula suggests that advertising cheese is not worthwhile. Just as with the example for English butter the crucial question is, are the Ae'' estimates used in Chapter Four really long run values? If they are then recalculating elasticities to take account of the adjustment

coefficient will have no significant effect on the optimal budget figures produced using short or long run elasticities.

APPENDIX 4

The Data and Assumptions used in Estimation and Simulation

Identifier	Description
A	Liquid milk advertising expenditure (6,11)
AA	Liquid milk advertising expenditure (7,11)
APP	Average producer price (0,14)
BC	Butter consumption (2,5)
BICA	Butter Information Council advertising expenditure (6,11)
BP	Butter purchases (5,7)
CA	Cheese advertising expenditure (6,11)
CAA	Cheese advertising expenditure (7,11)
CAAPRESS	Cheese advertising (Press) (7,11)
CAATV	Cheese advertising (TV) (7,11)
CC	Cheese consumption (2,5)
CCP	Cheddar cheese purchases (4,7)
CEF	Consumer expenditure on food (8,12)
COC	Cocoa consumption (1,13)
COF	Coffee consumption (1,13)
CP	Cheese purchases (4,7)
CRA	Cream advertising expenditure (6,11)
CRC	Cream consumption (2,3)
CRE	Cream purchases (3,4)
CREAA	Cream advertising expenditure (7,11)
DABA	Danish butter advertising expenditure (6,11)
DABP	Danish butter purchases (5,7)
DBH	Dummy Bank Holiday
DCA	Dutch Cheese Advertising (6,11)
DCAR	Real Dutch Cheese Advertising
DHW76	Dummy Health Warning on Heart Disease in March 1976
DSLREBANEG	Log negative differences in real English butter advertising expenditure
DSLREBAPOS	Log positive differences in real English butter advertising expenditure
DSREBANEG	Negative differences in real English butter advertising expenditure
DSREBAPOS	Positive differences in real English butter advertising expenditure
DSUM	Dummy Summer
DUBA	Dutch butter advertising expenditure (6,11)
DUBP	Dutch butter purchases (5,7)
DW	Dummy weekend

Identifier	Description
DWBH	Dummy weekend/bank holiday
D10	Dummy October
D11	Dummy November
D12	Dummy December
D2	Dummy February
D3	Dummy March
D4	Dummy April
D5	Dummy May
D6	Dummy June
D7	Dummy July
D79	Dummy 1979
D7901	Dummy January, 1979
D8	Dummy August
D9	Dummy September
EBA	English butter advertising expenditure (8,11)
EBP	English butter purchases (5,7)
ECCP	English cheddar cheese purchases (4,7)
ECOCA	English country cheese advertising expenditure (6,11)
ECOCAA	English country cheese advertising expenditure (7,11)
IBA	Irish butter advertising expenditure (6,11)
IBP	Irish butter purchases (5,7)
IDMC	Instant dried milk consumption (1,15)
IMP	Instant milk purchases (2,15)
LBP	Log butter purchases
LCC	Log cheese consumption
LCCP	Log cheddar cheese purchases
LCOC	Log cocoa consumption
LCOF	Log coffee consumption
LCP	Log cheese purchases
LCRA	Log cream advertising expenditure
LCRE	Log cream purchases
LCREAA	Log cream advertising expenditure
LDABA	Log Danish butter advertising expenditure
LDABP	Log Danish butter purchases
LDSCPCCP	Log non-cheddar purchases
LDUBA	Log Dutch butter advertising expenditure
LDUBP	Log Dutch butter purchases
LEBA	Log English butter advertising expenditure
LEBP	Log English butter purchases

Identifier	Description
LECCP	Log English cheddar cheese purchases
LIBA	Log Irish butter advertising expenditure
LIBP	Log Irish butter purchases
LIDMC	Log instant dried milk consumption
LIMP	Log Irish milk purchases
LLMC	Log liquid milk consumption
LLMP	Log liquid milk purchases
LLMS	Log liquid milk sales
LLMSC	Log liquid milk sales/capita
LMAP	Log margarine purchases
LMC	Log margarine consumption
LMRIC	Log media rates index
LMRII	Log media rates index
LMRIM	Log media rates index
LMS	Liquid milk sales (1,1)
LMSC	Liquid milk sales/capita ((1,9),1)
LNZBA	Log New Zealand butter advertising expenditure
LNZBP	Log New Zealand butter purchases
LOBA	Log other butter advertising expenditure
LPCCR	Log price Cheddar cheese
LPCHESHCR	Log real price Cheshire cheese
LPCR	Log real price cheese
LPDABR	Log real price Danish butter
LPEBR	Log real price English butter
LPECCR	Log real price Cheddar cheese
LPEDAB	Log price ratio English butter to Danish butter
LPEDUB	Log price ratio English butter to Dutch butter
LPEIB	Log price ratio English butter to Irish butter
LPENZB	Log price ratio English butter to New Zealand butter
LPNZBR	Log real price New Zealand butter
LPOP	Log population (GB)
LPSMR	Log real price soft margarine
LRA	Log real liquid milk advertising expenditure
LRAA	Log real liquid milk advertising expenditure
LRAAC	Log real liquid milk advertising expenditure/capita
LRAC	Log real liquid milk advertising expenditure/capita
LRAPP	Log real average producer price
LRCA	Log real cheese advertising expenditure
LRCAA	Log real cheese advertising expenditure

Identifier	Description
LRCAP	Log real cheese advertising expenditure/capita
LRCRA	Log real cream advertising expenditure
LRCREAA	Log real cream advertising expenditure
LREBA	Log real English butter advertising expenditure
LRECOCA	Log real English country cheese advertising expenditure
LRECOCAA	Log real English country cheese advertising expenditure
LRECOCAP	Log real English country cheese advertising expenditure/capita
LRMA	Log real margarine advertising expenditure
LRPCRF	Log price Fresh cream
LRPCRL	Log price long lasting cream
LRPDIC	Log real personal disposal income
LRPI	Log retail price index (all items)
LRPIF	Log retail price index (Food)
LRPM	Log retail price liquid milk
LRRPCRF	Log real retail price fresh cream
LRRPCRL	Log real retail price long lasting cream
LRRPCRS	Log real retail price sterilised cream
LRRPECC	Log real retail price English Cheddar cheese
LRRPM	Log real retail price liquid milk
LRSDATBA	Log ratio Danish/Total butter advertising expenditure
LRSDUTBA	Log ratio Dutch/Total butter advertising expenditure
LRSEDABA	Log ratio English/Danish butter advertising expenditure
LRSEDUBA	Log ratio English/Dutch butter advertising expenditure
LRSEIBA	Log ratio English/Irish butter advertising expenditure
LRSENZBA	Log ratio English/New Zealand butter advertising expenditure
LRSEOBA	Log ratio English/Other butter advertising expenditure
LRSETBA	Log ratio English/total butter advertising expenditure
LRSITBA	Log ratio Irish/total butter advertising expenditure
LRSNZTBA	Log ratio New Zealand/total butter advertising expenditure
LRYAE	Log real average earnings

Identifier	Description
LSMAP	Log soft margarine purchases
LSOF	Log soft drinks consumption
LT	Log time trend
LTBA	Log total butter advertising expenditure
LTEA	Log tea consumption
LTSEB	Log market share English butter purchases
LTSEBA	Log market share English butter advertising expenditure
LTSECC	Log market share English Cheddar cheese purchases
LTSOBA	Log market share other butter advertising expenditure
MSECCP	Market share of English cheddar in total Cheddar market (5,6)
MA	Margarine advertising expenditure (6,11)
MAP	Margarine purchases (5,7)
MC	Margarine consumption (2,5)
MRI	Media rates index (1,0)
MRIC	Media rates index (Cost/1000 adults) (1,0)
MRII	Media rates index (interpolated) (1,0)
MRIM	Media rates index (Cost/1000 messages) (1,0)
NZBA	New Zealand butter advertising expenditure (6,11)
NZBP	New Zealand butter purchases (5,7)
OBA	Other butter advertising expenditure (6,11)
OCA	Other cheese advertising expenditure (6,11)
PB	Price of butter (5,8)
PBR	Real price of butter
PC	Price of cheese (4,8)
PCC	Price of Cheddar cheese (4,8)
PCCR	Real price of Cheddar cheese
PCHESHC	Price of Cheshire cheese (1,8)
PCHESHCR	Real price of Cheshire cheese
PCR	Real price of cheese (4,8)
PDAB	Price of Danish butter (5,8)
PDABR	Real price of Danish butter
PDI	Personal disposable income (9,12)
PDUB	Price of Dutch butter (5,8)
PDUBR	Real price of Dutch butter
PEB	Price of English butter (5,8)
PEBR	Real price of English butter
PECC	Price of English Cheddar cheese (4,8)
PECCR	Real price of English Cheddar cheese
PEDAB	Price ratio English/Danish butter

Identifier	Description
PEDUB	Price ratio English/Dutch butter
PEIB	Price ratio English/Irish butter
PENZB	Price ratio English/New Zealand butter
PGOUDA	Price of Gouda Cheese (4,8)
PGOUDAR	Real Price of Gouda Cheese
PM	Price of Margarine (5,8)
PMAP	Price of packet margarine (5,8)
PMAPR	Real price of packet margarine
PMR	Real price of margarine
PNZB	Price of New Zealand butter (5,8)
PNZBR	Real price of New Zealand butter
POP	Population (G.B.) (9,16)
POPUK	Population (U.K.) (9,16)
PPCRE	Producer price for milk sold as cream (1,14)
PPEB	Producer price for milk sold as butter (1,14)
PEEC	Producer price for milk sold as cheese (1,14)
PPI	Producer price for milk to intervention(1,14)
PPLM	Producer price for milk as liquid milk (1,14)
PPM	Price packet margarine (5,8)
PPMR	Real price packet margarine
PPOO	Producer price for milk sold to other outlets (1,14)
PSB	Price Scottish butter (5,8)
PSM	Price soft margarine (5,8)
PSMR	Real price soft margarine
PTC	Price of territorial cheese (4,8)
PTCR	Real price of territorial cheese
RAAC	Real liquid milk advertising expenditure/capita
RAC	Real liquid milk advertising expenditure/capita
RAPP	Real average producer price
RBICA	Real advertising expenditure Butter Information Council
RCREAA	Real cream advertising expenditure
RDABA	Real Danish butter advertising expenditure
REBA	Real English butter advertising expenditure
RECOCA	Real English County Cheese advertising expenditure
RECOCAA	Real English Country Cheese advertising expenditure
RECOCAP	Real English Country Cheese advertising expenditure/ capita
RMA	Real margarine advertising expenditure
RNZBA	Real New Zealand butter advertising expenditure

Identifier	Description
ROBA	Real other butter advertising expenditure
RPCRF	Retail price Fresh cream (3,17)
RPCRL	Retail price long lasting cream (3,17)
RPCRS	Retail price sterilized cream (3,17)
RPDAB	Retail price Danish butter (1,8)
RPDIC	Real Personal Disposable Income
RPDUB	Retail price Dutch butter (1,8)
REEB	Retail price English butter (1,8)
RPECC	Retail price English Cheddar cheese (1,8)
RPI	Retail price index (all items) (8,0)
RPIB	Retail price Irish butter (1,8)
RPIDC	Price index of dairy feed compounds (1,0)
RPIF	Retail price index (food) (8,0)
RPM	Retail price milk (3,10)
RPMF	Real price milk (food index)
RRPCRF	Real price fresh cream
RRPCRL	Real price long lasting cream
RRPCRS	Real price sterilized cream
RRPEB	Real price English butter
RRPECC	Real price English Cheddar Cheese
RRPM	Real price milk (all items index)
RRA	Real liquid milk advertising expenditure
RRAA	Real liquid milk advertising expenditure
RRSETOTCA	Relative share English County cheese advertising to total cheese advertising
RSDATBA	Ratio Danish/total butter advertising
RSDUTBA	Ratio Dutch/total butter advertising
RSEDUBA	Ratio English/Danish butter advertising
RSEDUBA	Ratio English/Dutch butter advertising
RSEIBA	Ratio English/Irish butter advertising
RSENZBA	Ratio English/New Zealand butter advertising
RSEOBA	Ratio English/Other butter advertising
RSETBA	Ratio English/total butter advertising
RSITBA	Ratio Irish/total butter advertising
RSNZTBA	Ratio New Zealand/total butter advertising
RSOTBA	Ratio other/total butter advertising

Identifier	Description
RYAE	Real average earnings index
SMLRPMF	Exponentially smoothed 'real' retail price of milk
SMLRPMF2	" " " " " "
SMLRPMF3	" " " " " "
SOF	Soft drinks consumption (1,13)
T	Time trend
TA	Total advertising expenditure ((6,7),11)
TBA	Total butter advertising ((6,7),11)
TBAR	Total real butter advertising
TCRE	Total purchases of cream (0,18)
TOTCA	Total cheese advertising (English County cheese and Dutch cheese + other cheese advertising) (6,11)
TEA	Tea consumption
TEB	Total purchases English butter (0,18)
TEC	Total purchases English cheese (0,18)
TI	Total sales to intervention (0,18)
TLMS	Total sales of liquid milk (0,19)
TOM	Total sales to other markets (0,19)
TR	Total revenue for the Board (0,11)
TRA	Total real advertising expenditure
TSM	Total supplies of milk off farms (0,1)
TSC	Type share cheese (4,6)
TSDAB	Type share Danish butter (5,6)
TSDUB	Type share Dutch butter (5,6)
TSEB	Type share English butter (5,6)
TSECC	Type share English Cheddar Cheese (4,6)
TSIB	Type share Irish butter (5,6)
TSM	Type share margarine (5,6)
TSNZB	Type share New Zealand butter (5,6)
TSPM	Type share packet margarine (5,6)
TSSB	Type share Scottish butter (5,6)
TSSM	Type share soft margarine (5,6)
TTS	Total supplies of milk off farm (1,19)
TVCRE	Total producer value of cream market (0,11)
TVEB	Total producer value of English butter market (0,11)
TVEC	Total producer value of English cheese market (0,11)
TVI	Total producer value intervention market (0,11)
TVLM	Total producer value liquid milk market (0,11)

Identifier	Description
TVMM	Total producer value of milk market (0,11)
TVOM	Total producer value other milk outlets (0,11)
TWRRPMF	'Maximum' price of liquid milk
T1	Positive Time Trend → 1977.11
T2	Positive Time Trend 1977.12 →
YAE	Average Earnings Index (8,0)

The figures in parenthesis at the side of each identifier indicate, first of all, the source of data, and secondly, the units of measurement used. The key to these figures in parentheses is given below. Thus, (2,5) indicates that the variable is derived from the National Food Survey Committee's Report on Household Consumption and Expenditure and is measured in ounzes per person. Occasionally, a variable is derived from more than one source and this is indicated by the use of extra parentheses. Transformations of data to produce new variables such as logs, real prices, price ratios etc. are assumed to retain the original units of measurement and sources. Where a variable is constructed or a unit of measurement is not relevant (e.g. price indexes) the not applicable code (0) is used.

Sources of Data

(0) Not applicable

(1) Milk Marketing Board England and Wales

(2) National Food Survey Committee Annual Report.

(3) Attwood Panel Data (England and Wales)

(4) Attwood Panel Data (Great Britain)

(5) Audits Great Britain Panel Data (Great Britain)

(6) Quarterly Digest of Advertising Expenditure (Media Expenditure Analysis Ltd. (M.E.A.L.).

(7) Advertising agency or agencies involved in advertising campaign for that product

(8) Department of Employment Gazette (H.M.S.O.)

(9) C.S.O. Monthly Digest of Statistics (H.M.S.O.)

Units of Measurement

(0) Not applicable

(1) Millions of litres

(2) Pints per individual

(3) Pints per person

(4) Fluid ounces per 100 households

(5) Ounces per person

(6) Percentage share of the market

(7) lb per 100 households

(8) Pence per lb

(9) Pence per fluid ounces

(10) Pence per litre

(11) £

(12) £ million

(13) 'cups' drunk yesterday per person

(14) £ per litre

(15) Equivalent pints

(16) Million

(17) Pence per fluid ounce

(18) Equivalent litres

(19) Litres

The Equivalent Intervention Price for Milk

As Chapter Two and Chapter Four demonstrated milk producers' marginal revenues from advertising depend critically on the price differentials between different sales outlets for milk. For brevity, these differentials were denoted $P_1 - P_3$, $P_{cr} - P_3$ etc. Where P_1 is the producer price received for milk sold in the liquid market, P_{cr} is the producer price received for milk sold as cream, and P_3 is the intervention price of milk. That is, the equivalent price of milk received by producers for dairy products sold to the Intervention Agency. Whilst the producer price for milk sold to various outlets is readily available it is not a straightforward matter to obtain a value for the equivalent intervention price for milk at any point in time.

The Community's market support programme for dairy farmers operates by purchasing dairy products (principally butter and spray milk powder) at predetermined support prices. These intervention prices are set in terms of £ per tonne of product. Whilst it is relatively simple to transform these product prices (£/tonne) into equivalent milk prices (pence/litre) by using the appropriate technical coefficients these prices are then gross offer prices to processors. Unless there is also information on the costs of processing milk into butter and spray milk powder it is not possible to derive the net equivalent intervention price of milk to producers. The problem is best illustrated by the example below. For 1980 the average intervention prices for butter (80%) and spray milk powder are given by Table 137 in Dairy Facts and Figures 1981 (MMB).

	£/tonne
Intervention price butter	1739.97
Intervention price spray milk powder	734.04

If we assume[1] that 1 million litres of milk produces 44.5 tonnes of butter

1. Clearly milk of different fat and protein content will produce varying amounts of butter and milk powder and these figures are approximations The arguments as to the precise technical coefficients to use, however, are not critical to the discussion here.

and 88 tonnes of spray milk powder then,

1 litre of milk produces 0.0000445 tonnes butter

and 0.000088 tonnes spray milk powder

which is equivalent to prices of 7.74 pence/litre for milk sold as butter and 6.46 pence/litre for milk sold as spray milk powder. Thus the equivalent intervention price for one litre of milk, transformed into butter and spray milk powder, is 14.2 pence/litre. This gross figure, of course, includes an allowance for the cost of transforming milk into a form suitable for intervention. An estimate of this cost is necessary to determine P_3, the price received by producers for milk sold to intervention. An estimate of the processor's margin to use for this determination has been difficult to obtain. Communications with the Board suggest that, in any case, producers' and processors' costs and returns may not be separated out in such a way as to facilitate the calculation of equivalent intervention prices. A figure of 13.1 pence/litre has been put foward as an 'appropriate' figure for 1980 but without clear reference as to whether this was a gross or net price.

Perhaps, given the obvious commercial sensitivity of the prices and margins associated with dairy products sold to intervention it is sufficient to present a range of marginal revenues resulting from a change in advertising for alternative price differentials i.e. alternative values of P_3. This procedure, whilst apparently inconclusive, allows the discussion to proceed and of course it is a simple matter to substitute the correct price differential if and when it becomes available.

The Milk Supply Equation

The major preoccupation of the work done was the econometric estimation of demand equations for liquid milk and dairy products. These estimated equations were then used in the simulation model. The model also involved a milk supply equation in its structure and, although a supply equation could have been produced without reference to data, attempts were made to fit a simple model of milk producers' response to price. These attempts were moderately successful and two supply equations (Milk 96 and Milk 97) resulted. The equations are detailed below in Table A.6.

Clearly there was insufficient time available to conduct a comprehensive analysis of milk supply along the lines of George Jones (1982). Notwithstanding this ., Milk 96 and Milk 97 both involve the economic relationships expected in a monthly model of producer response to prices and the magnitude of that response seems about right. For the analysis, an important point and one that was the cause of major differences in the simulation performance of Milk 96 and Milk 97, was the way in which these equations accounted for seasonality.

Milk 96 uses the lag operator (milk supplies$_{t-12}$) to explain seasonal effects on supplies. This may be termed 'endogenous' seasonality. Milk 97 uses a series of Dummy variables for the months of the year to explain seasonal supply shifts. This may be termed 'exogenous' seasonality. Any attempt to use an endogenous explanation of seasonality in the milk supply equation used in the simulation model created serious problems. The other explanatory variables in Milk 96 had relatively small effects on milk supply. Hence, the endogenous seasonal explanation effectively controlled the supply response to any shocks given to the simulation model. Milk supplies then typically exploded away from the base path with no obvious signs of returning. In contrast the exogenous seasonality utilized in Milk 97 allowed milk supplies to move up and down relative to the base path in response to a shock and it was this supply equation that was used in final form of the simulation model.

TABLE A.6 : Alternative Milk Supply Equations

Equation	Dependent Variable	Intercept	Lagged Milk Supplies (t-12)	Time Trend	Lagged average producer Price
Milk 96	Milk Supplies (Million litres)	2.6667 (2.50)	0.9124 (18.95)	-0.0032 (2.20)	0.1414 (2.69)

$\bar{R}^2$ = 0.87

D.W. = 1.71

ρ = 0.80

Milk 96 was estimated in double log form (with linear time trend) Generalized Least Squares over the period 1976.05 to 1980.09

Equation	Dependent Variable	Intercept	Lagged average producer price				
			(t-9)	(t-10)	(t-11)	(t-12)	(t-13)
Milk 97	Milk Supplies (million litres)	21.5581 (123.63)	0.1667 (4.75)	0.0415 (2.14)	-0.0179 (0.75)	-0.0115 (0.61)	0.0605 (1.75)

February	March	April	May	June	July	August	Sept.	October
-0.0812 (7.87)	0.0540 (4.29)	0.0958 (6.88)	0.2278 (15.80)	0.1516 (10.22)	0.0646 (4.29)	-0.0323 (2.12)	-0.0670 (4.66)	-0.0233 (1.54)

November	December
-0.0586 (4.59)	-0.0168 (1.96)

$\bar{R}^2$ = 0.95

D.W. = 2.35

ρ = 0.88

Milk 97 was estimated in double log form by Generalised Least Squares over the period 1976.09 to 1980.09. An Almon polynomial of degree 2 was used to estimate the price lag structure. Dummy variables were used to represent the calendar months.

The Simulation Model

A model of the milk market may be represented by a set of equations each of which aids the description of how prices and quantities are formed and cleared in the market. Many of these equations involve current and lagged values of the same variables thus requiring a simultaneous solution. The simulation process aims to achieve such a solution and usually requires a not inconsiderable amount of research and computer time. Much of this time is used in the construction of the model to achieve the appropriate linkages between equations to allow the model to demonstrate the effect of changes in exogenous variables on endogenous variables of interest. The following pages detail the important parts of the simulation model used to produce the results given in Chapter Four and a brief description of the simulation performance of the principal endogenous variables of interest.

The list of equations below comprise the estimated equations derived from the econometric analysis of Chapter Three.

Milk 38

Cream 26

Cheese 20

Cheese 25A

Cheese 31

Butter 23

Butter 26

Marg 11A

Milk 97

The endogenous variables produced by these equations (apart from the milk supply figures from Milk 97) are then utilized in another block of equations to produce total milk equivalents for the household market.

Milk 17

Milk 9

Milk 56

Milk 57

Milk 58

Milk 59

The technical coefficients used to translate dairy product consumption (lbs/head etc.) into milk equivalents (litres) were obtained from Milk Board publications and are, of necessity, approximations. The total milk equivalent figures are then used to produce total values for each household market and, using coefficients provided by the Board, estimates of the value of various non-household markets. The relevant equations are:

Milk 61

Milk 62

Milk 63

Milk 64

Milk 65

Milk 102

Milk 60D

Milk 67

The schedule of producer prices used to construct the value figures above was obtained from the Board's publications. The equivalent intervention price for milk was assumed to be 0.2 pence/litre below the price received for milk sold as English butter. The average producer price was determined by another block of equations:

Milk 66

Milk 95

Milk 94

Milk 94B

Milk 97

The level of intervention and its value as a proportion of total supplies are defined by equations:

Milk 60

Milk 60B

Various equations are used to describe endogenous variables of interest that may not enter into the explanation of other parts of the model, for example, the total marginal value of sales to each household market and the total market are defined by:

Cheese 27Y

Cheese 27Z

Milk 61C

Milk 62C

Milk 63C

Milk 64C

Milk 64D

Milk 6OE

In total the model amounts to around 70 equations of which the important linkages and identities are given above and all of which are set out completely below.

The endogenous variables chosen to illustrate the effects of price and advertising changes are:

Average producer price (APP)'

Total marginal value of sales to households (TMVHSALES)

Total Milk Supplies (TTS)

Proportion of milk supplies sold to intervention (PROPINT)

The performance of the simulated endogenous variables in tracking actual values during the period 1977.01 to 1979.12 is demonstrated by the copies of the base paths reproduced in the following pages.

SIMULATION STUDY OF MODEL MILK60D

NUMBER	NAME	EQUATION
1	MILK110	TOTCA[T]=(RECOCA[T]+DCA[T]+OCA[T])/MRTC[T]
2	MILK111	DCA[T]=DCAP[T]*MPIC[T]
3	MILK111H	OCA[T]=OCAP[T]*MRIC[T]
4	MILK112	RPSETOTCA[T]=RPCOCA[T]/TOTCA[T]
5	MILK114	LRCAA[T]=LN(RCAA[T])
6	MILK260	TRA[T]=RPA[T]+RECOCA[T]+RCREAA[T]+PERA[T]+RCAA[T]
7	MILK8	LRCREAA[T]=LN(RCREAA[T])
8	MILK4	LPRA[T]=LN(RPA[T])
9	MILK18	RSETDA[T]=PERA[T]/(RERA[T]+RDARA[T]+RNZRA[T]+RDOUBA[T]+RIRA[T])
10	MILK18E	RDRA[T]=RERA[T]+RDARA[T]+RNZRA[T]+RDOUBA[T]+RIRA[T]
11	MILK14	LPCCP[T]=LN(PCCP[T])
12	MILK11	PCCR[T]=PCC[T]/MPI[T]
13	MILK10	PECCP[T]=PEC[T]/MPI[T]
14	MILK6	LRRPCP[T]=LN(PRPCP[T])
15	MILK2	LRRP[T]=LN(RRP[T])

```
16      MILK38      LLMS[T]=Q(0)+Q(1)*LRYAE[T]+Q(2)*LRPPM[T]+Q(6)*LLMS[T-12]+Q(5)*DW[T]+Q(4)*DBH[T]+NNN(0)'LRRADL
                        LORDER(12),DEGREE(2)]

17      MILK1       LMS[T]=EXP(LLMS[T])

18      CREAM26     LCRE[T]=QQQ(0)+QQQ(1)*LRYAE[T]+QQQ(2)*LRRPCRE[T]+QQQ(5)*LRCREAA[T]+QQ(0)'LRCREAA40L[ORDER(4
                        ),DEGREE(2)]+QQQ(9)*LCRE[T-1]+QQQ(10)*LCRE[T-12]

19      CHEESE20    CP[T]=R(11)+R(12)*RYAL[T]+R(13)*PECCR[T]+R(14)*CP[T-1]+R(15)*CP[T-12]+R(16)*DBH[T]+R(17)*DW[T]+
                        VV(0)'TOTCADL[ORDER(12),DEGREE(2)]+U(0)'CAADL[ORDER(12),DEGREE(2)]

20      MILK26B     TA[T]=TRA[T]*MPIC[T]

21      CHEESE25A   LCCP[T]=NN(0)+NN(1)*LRYAE[T]+NN(2)*LPCCR[T]+NNN(19)*LPTCP[T]+NNN(17)*LPGOUDAR[T]+NN(4)*LCCP[T-1]+
                        NN(5)*LCCP[T-12]+NN(6)*DW[T]+NN(7)*DBH[T]+VV(0)'LCAADL[ORDER(12),DEGREE(2)]

22      CHEESE31    HSECCP[T]=R(0)+R(1)*PTCR[T]+R(2)*PECCR[T]+R(3)*PGOUDAR[T]+R(4)*HSECCP[T-1]+VV(0)'RRSETOTCAD
                        [ORDER(12),DEGREE(2)]+R(10)*DCAR[T]

23      BUTTER25    BP[T]=N(0)+N(1)*RYAE[T]+N(2)*PBR[T]+N(3)*PSMR[T]+N(5)*BP[T-12]+N(7)*DW[T]+N(8)*DBH[T]+UUU(0)'
                        RADL[ORDER(9),DEGREE(1)]+SSS(0)'TBARDL[ORDER(12),DEGREE(3)]

24      BUTTER26    EBP[T]=M(0)+M(1)*RYAE[T]+M(2)*PEBR[T]+M(3)*PDABR[T]+M(4)*PNZBR[T]+M(5)*PSMR[T]+M(6)*DW[T]+M(7)*
                        DBH[T]+M(8)*EBP[T-1]+M(9)*RMA[T]+M(11)*RSETBA[T]+M(12)*RSETBA[T-1]+M(13)*RSETBA[T-2]+M(14)*
                        RSETBA[T-6]+M(15)*RSETBA[T-7]+M(16)*RSETBA[T-8]+M(17)*ROBA[T-3]+M(18)*ROBA[T-4]+M(19)*ROBA[T-5]+
                        M(20)*ROBA[T-9]+ZZ(9)*ROBA[T-10]+ZZ(10)*ROBA[T-11]
```

```
25      MILK17      TSEB1[T]=EBP[T]/BP[T]
26      MILK100     CCP[T]=EXP(LCCP[T])
27      CHEESE27X   ECCP[T]=CCP[T]*MSECCP[T]/100
28      MILK9       TSECC1[T]=ECCP[T]/CP[T]
29      MILK101     CRE[T]=EXP(LCRE[T])
30      MILK115     PTCR[T]=PTC[T]/RPIF[T]
31      MILK116     PGOUDAR[T]=PGOUDA[T]/RPIF[T]
32      MILK117     LPTCR[T]=LN(PTCR[T])
33      MILK118     LPGOUDAR[T]=LN(PGOUDAR[T])
34      MILK56      TLMS[T]=LMS[T]*1000000
35      MILK57      TCRE[T]=CRE[T]*(49[illegible]/35.1950)*12.7000
36      MILK58      TEB[T]=EBP[T]*(19[illegible]/2204.62*10181)
37      MILK59      TEC[T]=ECCP[T]*(19[illegible]/2204.62*10181)
38      MILK61      TVLM[T]=TL[illegible]S[T]*PP[illegible][T]
39      MILK60C     TOTSALES[T]=TL[illegible]S[T]+TCRE[T]+TEB[T]+TEC[T]+TOM[T]+TCCRE[T]+TCEB[T]+TCEC[T]+TTEC[T]
40      MILK62      TVCRE[T]=(TCRE[T]+TCCRE[T])*PPCRE[T]
41      MILK238     YELFAT[T]=FP[T]/(FP[T]+MAP[T])
42      MILK63      TVEB[T]=(TEB[T]+TCEB[T])*PPEB[T]
```

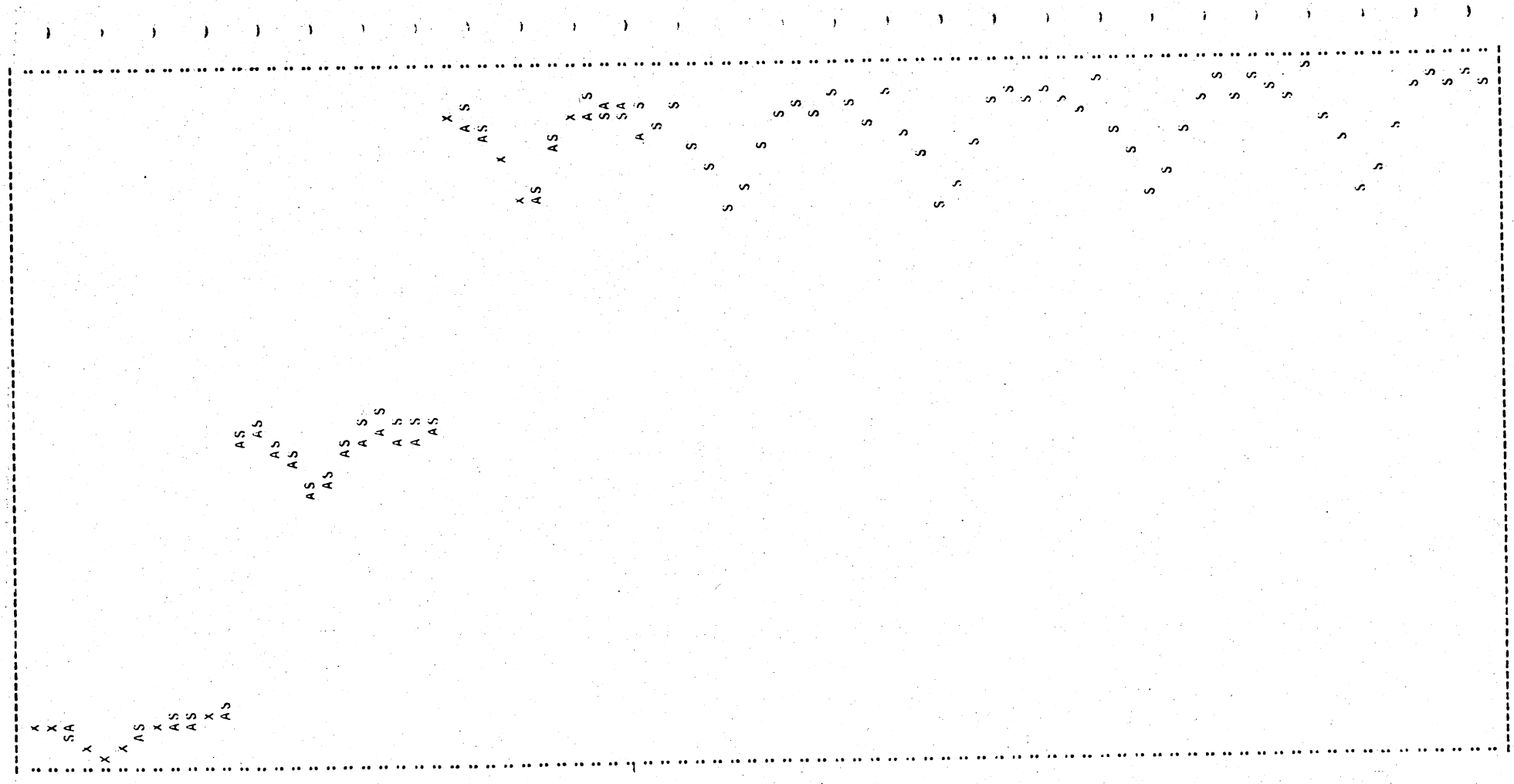
```
43      MILK64      TVEC[T]=(TEC[T]+TCEC[T]+TTEC[T])*PPEC[T]
44      MILK65      TVI[T]=TI[T]*PPI[T]
45      MILK62B     TVHCRE[T]=TCRE[T]*PPCRE[T]
46      MILK63B     TVHEB[T]=TEB[T]*PPEB[T]
47      MILK64B     TVHEC[T]=TEC[T]*PPEC[T]
48      MILK60D     TVHSALES[T]=TVLM[T]+TVHCRE[T]+TVHEB[T]+TVHEC[T]
49      MILK102     TVOM[T]=TOM[T]*PPOO[T]
50      MILK67      TVMM[T]=TVLM[T]+TVCRE[T]+TVEB[T]+TVEC[T]+TVI[T]+TVOM[T]
51      MILK66      APP[T]=TVLM[T]/TTS[T]+TVCRE[T]/TTS[T]+TVEB[T]/TTS[T]+TVEC[T]/TTS[T]+TVI[T]/TTS[T]+TVOM[T]/TTS[T]
52      MILK95      RAPP[T]=APP[T]/RPIDC[T]
53      MILK94      LRAPP[T]=LN(RAPP[T])
54      MILK94B     LRAPPY[T]=LRAPP[T-9]
55      CHEESE20B   TCM[T]=CP[T]*(190000/2204.62*10161)
56      MARG11A     MAP[T]=X(0)+X(2)*RYAE[T]+X(7)*PBP[T]+X(8)*PSMR[T]+X(3)*MAP[T-1]+X(4)*MAP[T-12]+X(5)*DW[T]+X(6)*
                    DBH[T]+XX(0)'MARGDL[ORDER(12),DEGREE(2)]+XXX(0)'IBARYDL[ORDER(9),DEGREE(2)]
```

```
57      CHEESE27Y   ECCPP[T]=TSECC1[T]*CP[T]
58      CHEESE27Z   TECCPP[T]=ECCPP[T]*(190000/2204.62*10181)
59      MILK61C     TMVLM[T]=TLMS[T]*(PPLM[T]-PPI[T])
60      MILK62C     TMVHCRE[T]=TCRE[T]*(PPCRE[T]-PPI[T])
61      MILK63C     TMVHEB[T]=TEB[T]*(PPEB[T]-PPI[T])
62      MILK64C     TMVHEC[T]=TEC[T]*(PPEC[T]-PPI[T])
63      MILK64D     TMVHECTC[T]=TECCPP[T]*(PPEC[T]-PPI[T])
64      MILK64E     TMVEHEC[T]=TMVHEB[T]+TMVHEC[T]
65      MILK60E     TMVHSALES[T]=TMVLM[T]+TMVHCRE[T]+TMVHEB[T]+TMVHEC[T]+TMVHECTC[T]
66      MILK98      DTTS[T]=TTS[T]-TTS[T-12]
67      MILK97      LTTS[T]=RR(0)+BB(0)'LRAPP9DL[ORDER(4),DEGREE(2)]+B(2)*D2[T]+B(3)*D3[T]+B(4)*D4[T]+B(5)*D5[T]+B(6)*
                        D6[T]+B(7)*D7[T]+B(8)*D8[T]+B(9)*D9[T]+B(10)*D10[T]+B(11)*D11[T]+B(12)*D12[T]
68      MILK96      TTS[T]=EXP(LTTS[T])
69      MILK60      TII[T]=TTS[T]-(TLMS[T]+TCRE[T]+TEB[T]+TEC[T]+TOM[T]+TCCRE[T]+TCEB[T]+TCEC[T]+TTEC[T])
70      MILK60B     PROPINT[T]=TII[T]/TTS[T]*100
71      MILK66B     CHANGAPP[T]=(APP[T]-APP[T-1]/APP[T-1])*100
```

Base Run: 1977.01 to 1983.12

Simulated and actual values of average producer price

Theil's inequality statistic ($0 < U_2 < \infty$)
$U_2 = 0.1476$

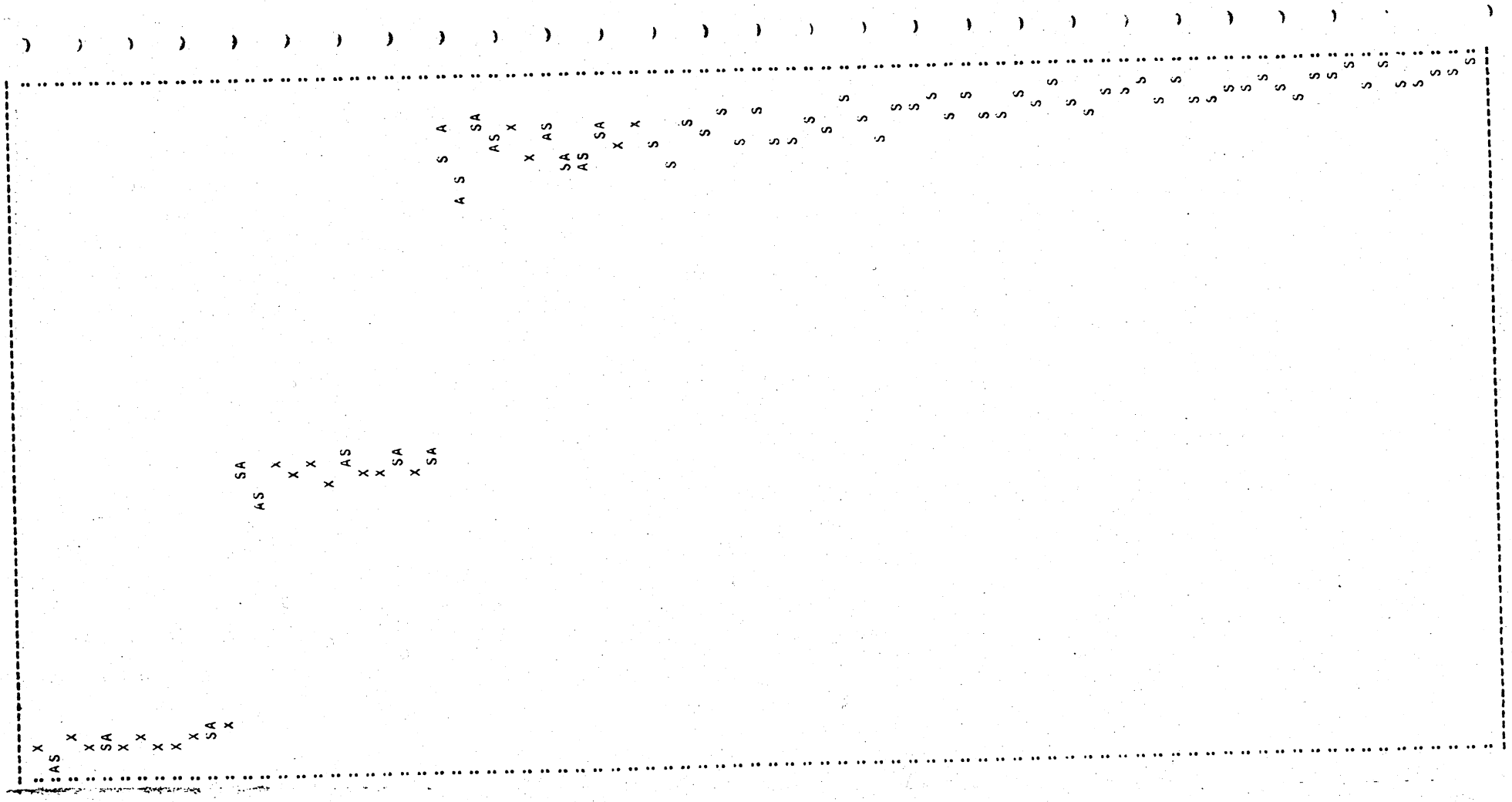


1977.01 1979.12

Base Run: 1977.01 to 1983.12

Simulated and actual values of total marginal value of sales to households

Theil's inequality statistic ($0 < U_2 < \text{infinity}$)
$U_2 = 0.1114$



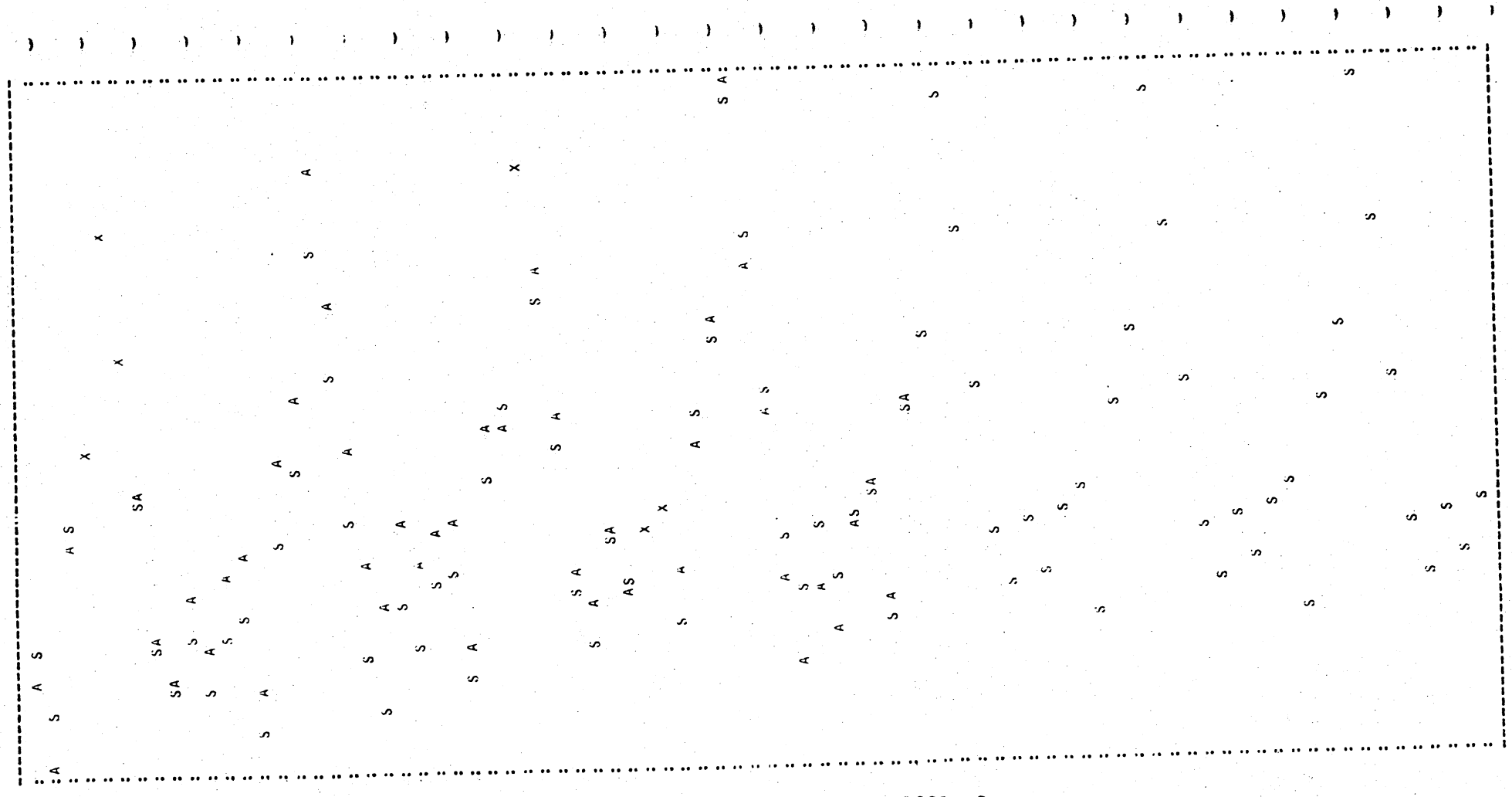
1977.01

1979.12

Base Run: 1977.01 to 1983.12

Simulated and actual values of total milk supplies

Theil's inequality statistic ($0 < U_2 < \text{infinity}$)
$U_2 = 0.3611$



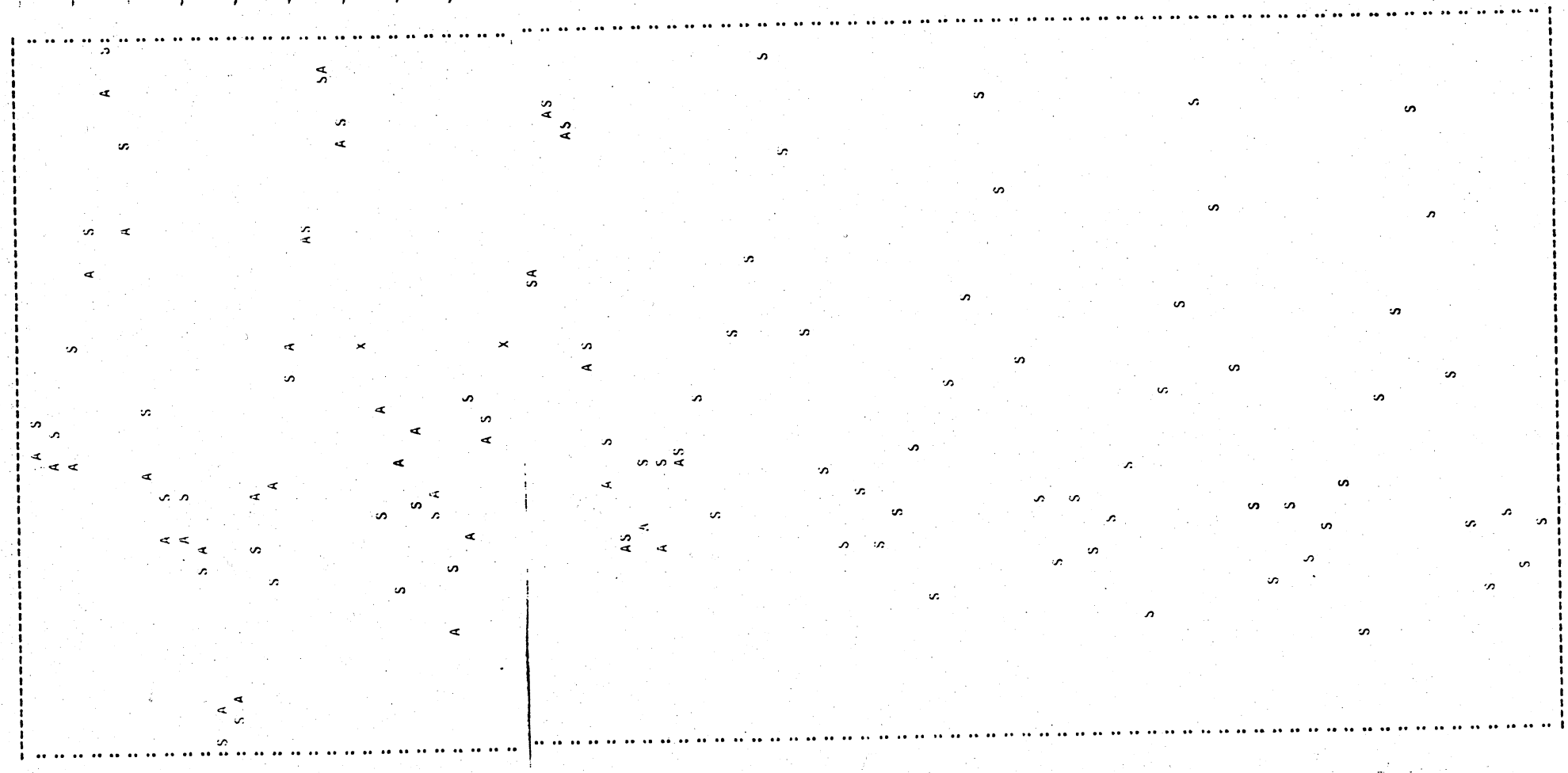
1977.01

1981.03

Base Run: 1977.01 to 1983.12

Simulated and actual values of the proportion of milk supplies sold to intervention

Theil's inequality statistic ($0 < U_2 <$ infinity)
$U_2 = 0.4903$



1977.01 1979.12

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