Income Inequality and the Distribution of the Costs and Benefits of Agricultural Support

A thesis submitted to the University of Newcastle-Upon-Tyne
for the Degree of Doctor of Philosophy
in the Department of Agricultural Economics and Food Marketing

by

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April 1992

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Abstract

Agricultural production in the UK, as in most industrialised countries, has benefited from support for a considerable period of time. The method of support has changed from the operation of deficiency payments in the period leading up to the UK's accession to the European Community (EC), to the adoption of the Common Agricultural Policy (CAP) since 1973. A policy that supports one sector of the economy must involve costs to other sectors. In the case of agricultural support, it is usually the taxpayers or consumers (or both) who bear the costs. A considerable amount of work has been undertaken to measure the level of support received by farmers and the costs borne by the rest of society. However, this work has stopped short of a systematic analysis of the distribution of the benefits (costs) between farmers (households) at different income levels and the effect that this has on the level of income inequality within society.

Analysis of the dairy sector highlights that support is concentrated on the higher income farms, although the level of inequality associated with the distribution of this support has not been altered by the UK's adoption of the CAP or by the subsequent introduction of milk quotas. A policy alternative, which restricts the quantity of production available for support, is analysed and is shown to reduce income inequality within the dairy sector. As for costs, the adoption of the CAP led to a dramatic equalisation in their distribution, thus increasing the burden of the lower income households. However, more recently the distribution of costs has remained fairly stable. More importantly, it is shown that agricultural policy increases income inequality for the UK as a whole.

Acknowledgements

There are a number of people without whom I would not have been able to complete this study. First and foremost I am indebted to my supervisor, Lionel Hubbard for his continued support, encouragement and expert guidance throughout the last three and a half years. I would like to extend my gratitude to the whole of the Department of Agricultural Economics and Food Marketing, because a door was always open whenever I needed help.

I would like to acknowledge the support of my family (both moral and financial) which enabled me to concentrate my efforts towards completing this study. I would also like to thank my friends, whose continued disbelief that I was undertaking a Ph.D. drove me to completion.

This study is dedicated to the right of access to further education for all.

Contents

List of Tables

List of Figures

Chapter 1 Introduction and General Considerations

1.1 Aims and Definitions

This study is concerned with the inequality of income distribution and the possible effects of agricultural policy on this distribution. Income distribution is a vast topic and the purpose of this opening chapter is to consider some of the *general* concepts and to discuss which areas are of particular concern to agriculture. *Specific* points will be analysed later in the study. The following quotes, from a number of authors who have studied inequality, highlight the nature of the topic:

> "It is difficult to imagine a more controversial subject. The inequality of incomes has been debated for centuries without passions waning or a clear picture emerging" (Pen, 1971, p1).

> "The relation between inequality and rebellion is indeed a close one" (Sen, 1976, p1).

> " 'Inequality' is in itself an awkward word, as well as one used in connection with a number of awkward social and economic problems. The difficulty is that the word can trigger quite different ideas in the mind of the listener, depending on his training and prejudicies" (Cowell, 1977, p1).

These quotes highlight that the topic of inequality is an emotive one. Cowell reasons that 'equality' can either be judged simply in mathematical terms, as saying two or more values are the same or; "On the other hand, the term 'equality' evidently has compelling social overtones as a standard which it is presumably feasible for society to attain" (p1). This study is primarily concerned with 'equality' in relation to income distribution. In this sense, inequality may produce images of third world countries with shanty towns next to high rise luxury apartments. However, inequality is also of concern in the UK, hence the acceptance of a progressive tax system (that is high income earners paying proportionately more of their income in tax than low income earners). Pen and Cowell both note that the idea of 'equality' is subjective. It is not the purpose of this study to try and define the 'ideal' income distribution. In general, however, a reduction in inequality can be considered 'good', all other things being equal.

The next consideration is: what is 'income' and which income distribution should be examined? Pen considers three types of income distribution; the personal distribution (referred to as the size distribution of income), the functional distribution, and distributive shares. The latter two relate to the distribution of the level of renumeration enjoyed by factors of production and the distribution of national income between factors of production, respectively. Although the effects of agricultural policy on the rewards to factors of production is of interest,[1] it is also outside the scope of this study. Pen's 'personal distribution' relates to the individuals' share of total 'income'. This is the 'economic well-being' of the individual.

Cowell suggests three personal characteristics which can be used to measure a person's well-being:

Wealth. This represents a person's total immediate command over resources, to include money in the bank, value of stocks and bonds, house, car and everything that the person owns. There are, according to Cowell, two problems with such a measure. First, how are the disparate posessions to be valued? For example, what is the real 'market price' of a person's house? Second, the measure makes no allowance for the future potential earnings of the individual, for example, the income generating potential of education.

Lifetime Income. This includes a comprehensive index for the entire set of opportunities enjoyed by a person. The problem with this measure is that *actual*

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[1]For example work on the capitalisation of agricultural support into land prices has been undertaken by Traill (1980) and Harvey (1989).

lifetime income can only be measured once the recipient is dead. Therefore, future incomes need to be anticipated and estimated, which is a difficult task.

Income. This is defined by Cowell as the increase in a person's command over resources during a given time period, and is for all practical purposes the best measure. It is restrictive in relation to the all-embracing ideas of the previous two measures and has the problem that it involves the setting of an arbitrary time unit, thus ignoring past accumulations. However, to the pragmatist, there are two clear advantages. First, data on income are more widely available; second, if the measure includes unearned capital gains and income in-kind, as well as earnings, it may be considered a sufficiently comprehensive measure. In general terms, it is clear that any income definition needs to be both measurable and comparable.

Once income has been defined, another problem arises with definition of the recipient. The term individual has already been used, but it is not clear that this is correct. Pen illustrates the problem (in a slightly sexist fashion) by discussing a wife working part-time. As an individual she may be deemed 'poor'. However, if her income is added to that of her husband a different picture may emerge. This raises the question: should the individual, the family or the household be used as the unit of measurement?

For farmers, the unit of measurement would appear to be pre-determined, because the income generally measured is that generated from the farm as a business rather than the individuals within the farm household. However, definition of the unit is not this straightforward. Hill (1990) in a paper entitled 'In search of the EC's agricultural community' argues that there is no clear definition of what constitutes a 'farmer'. Hill (1982)[2] also argues against using the income from farming as the only income measure and concludes that other sources of income to the farm household should be considered. The definition of the recipient is clearly a crucial factor in the analysis of income distribution.

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[2]Hill's work will be discussed in more detail in Chapter 2.

Much of the work on inequality has concentrated on why it exists. Sociologists and economists have tried to explain variations in incomes. These theories allow for a number of factors such as inheritance, ability and chance. Relating these theories to agriculture, it is clear that evidence of each can be found. An individual who inherits a large farm on fertile land is likely to have more income-generating potential than one who inherits a small farm on infertile soil. Second, the more land owned by an individual, the more chance that some of this land will be in an area required for building, or will have mineral deposits etc. thus raising the value of the land considerably. The richer you are the more *chance* you have to become even richer. However, a farmer's own ability must be considered. For example, a bad farmer on good soil may generate less income than a good farmer on poor soil. Other factors are important; those who suffer form poor health and lack of education are likely to have low incomes, whilst those who have opportunities to be better educated or to meet the 'right' people, are likely to earn greater income. Whilst the subject of why some farmers are richer than others is of interest, it is not the aim of this study to produce the definitive explanation as to the processes causing income inequality. What is of concern is whether the distribution that exists has changed, and whether this change is related to agricultural support policies.

A great deal of the work on inequality has revolved around the problems of quantifying the degree of inequality inherent in a distribution. Any assessment of inequality within agriculture needs to consider this work, so that changes over time and differences between distributions can be compared.

Mention has been made of the concepts of inequality, income definition and distribution. The other concern of this study is agricultural policy. Agriculture in the United Kingdom (UK), as in much of the industrialised world, has been supported for many years. A number of methods of support exist, ranging from those that raise the market price received by producers to those which restrict the quantity supplied. The reasons for support vary, but perhaps the clearest justifications are found in the much quoted Article 39 of the Treaty of Rome, which forms the basis for the Common Agricultural Policy (CAP) of the European Community (EC). B.E. Hill (1984, p19) lists the objectives as stated in Article 39:

The Common Agricultural Policy shall have as its objectives:

(a) to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimal utilisation of the factors of production, in particular, labour;

(b) thus to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture;

(c) to stabilise markets;

(d) to assure the availability of supplies;

(e) to ensure that supplies reach consumers at reasonable prices.

Therefore, in the EC, support was justified on the grounds of concern over food security, farm incomes and fluctuating food prices. However, Hill (1982) argues that the main aim of the CAP is to support the income of farmers.

In welfare terms, agricultural policy *may* be justified if it results in a transfer of income from the wealthy in society to the poor. However, it is not clear that it is the poor who benefit from agricultural policy, or the rich who bear the costs. Different policies have different costs and benefits, and one way of assessing them is to analyse the effect they have on the distribution of income between those whose benefit and those who bear the costs. Agricultural policy is a benefit to the farmers receiving support and a cost to those who have to pay for this support. Depending on the method of support, the cost is principally borne by either the consumer (in the form of higher food prices), the taxpayer (through higher taxes), or both. The transfer occuring through support relates to a branch of economics (grants economics) which came to the fore in the late 1960s and early 1970s.[3] Economists were concerned that the majority of economic theory was based on the two-way transfer. That is, an individual (or firm) gives goods/services to another individual (or firm) in exchange for money/goods. Grants economics concentrates on cases where income or goods are given for no renumeration; the one-way transfer. Agricultural policy can be seen as such a transfer, for example, from either consumers and/or taxpayers to farmers.

The agricultural sector therefore presents an ideal medium in which the distributional effects of one-way transfers of income can be measured. Comparisons between the distribution of costs and that of income will enable the nature of the transfer to be assessed. Whether the cost of support is borne by the taxpayer or the consumer has significant income distribution implications. Two points have to be made clear. First, low income households spend proportionately more of their income on food; second, as already mentioned, the tax system in the UK is progressive. Therefore if support is based on higher food prices it is likely that the low income households will bear a disproportionate amount of the costs, whereas if support is based on taxation it will be the high income households who bear more of the costs. Part of the aim of this study is to assess whether the costs of agricultural support are progressively (that is, the rich bear proportionately more of the costs) or regressively (that is, the poor bear proportionately more of the costs) distributed, by quantifying the level of inequality displayed.

The above discussion has highlighted that before an examination of inequality of any kind can be undertaken a number of definitions and assumptions must be made. For the purpose of this study the following general definitions apply: the measurement of 'well-being' is *income* (as defined by Cowell); the income unit is the *farm business*; and the distribution analysed is the *size distribution of incomes*. Initially, this study deals with a small part of the population, farmers, the size distribution of income and

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[3]See, for example, Boulding and Pfaff (1972).

the effects of a government policy on this distribution. Thereafter, the effect of the costs of agriculutural support on the personal distribution of household income is also analysed.

1.2 Outline of the Study

This chapter has addressed general concepts involved in the study of income inequality. Chapter 2 will assess earlier work which has analysed either the effect of agricultural policies on farm incomes or the distribution of income between farmers. In particular, researchers' approaches to general concepts such as definition of income, quantification of inequality and the measurement of support received by farmers will be analysed. Chapter 3 will attempt a more detailed study of the theoretical aspects of the measurement of inequality. In Chapter 4 farm income data will be used for a practical assessment of income inequality in the North of England. In Chapter 5 the analysis will be extended to a national level, and also a more detailed examination of the relationship between support and income will be undertaken. Chapter 6 contemplates the income distribution effects of a proposed agricultural policy alternative. Chapter 7 concentrates on the distribution of income and costs between households and assesses the sensitivity of the results. Chapter 8 summarises the findings of the study.

Chapter 2 Review of the Literature on Inequality in Agriculture.

2.1 Introduction

The purpose of this review is to identify a valid method for examination of the distribution of income and support within agriculture. By examining the methods and findings of previous work it should be possible to gain some overall view of the various aspects involved in such a task. The distribution of agricultural income and the effects of farm support policies on this distribution has long been a subject of concern on both sides of the Atlantic, with the majority of the work undertaken in America.

The review could take a number of possible forms, including an American/European split. However, due to the nature of the work reviewed, a chronological approach is the most practical. The literature on income distribution and the possible effects of agricultural policies is diverse, reflecting individual authors' particular interests. In general, this review is concerned with assessing how previous research has answered the questions posed in the opening chapter, namely choice of income measure, the estimation of levels of support and how support is apportioned between farms.

2.2 Review of Literature

Early work in the US appeared to be concerned with the political justification and reasoning behind farm support, rather than distributional effects. Fuller (1965) argued that farmers were supported because they were poor, and that there was a public perception of farmers as the underdogs of society. Fuller recognised the underlying problem with this line of reasoning: "What is remarkable is that so much political sympathy for the farmer as an undifferentiated eclectic abstraction has not been matched by an equal concern for the really poor as against the not so poor within agriculture" (p 1245). Fuller realised that although farm incomes, on average, were low, no account of the distribution within the farming community was made. His basic argument was that the farmers organisations tried to maintain an "undifferentiated image of disadvantage" leading to the public perception that as long as support was going to agriculture, in whatever form, it was benefiting the disadvantaged of society. "The failure of political sympathy for 'the farmer' to be specific...has meant that the bulk of program benefits for more than thirty years have been rewarding to the owners of land and unrewarding to the owners of labor" (p 1245).

Fuller illustrated his work with examples of how political lobbying ensured that support programmes were implemented which maintained the obscurity as to who was getting what, and also without limits to the support received per farm, in preference to policies which might limit the amount of support. Fuller's work is useful, as a background on why agricultural support occurred and what type of policies were adopted, although no attempt was made to measure the distributional effects of policy.

Robinson (1965) attempted to analyse the income distribution effects of those policies which Fuller claimed were adopted due to political pressures. One of the first conclusions drawn by Robinson was that "The distribution of income among farmers, regions and factors of production unquestionably has been influenced to some degree by farm and income programmes" (p 1224). He noted the difficulty in separating the effects of policy from those of market forces and technology. He also argued that such items as research, education, credit facilities and general economic policies would affect the distribution. Robinson split agricultural support programmes into three broad types with each examined in terms of the effect on income distribution: Price support programmes; Allotment and Land Retirement; Direct Payment programmes.

Robinson disagreed with Schultz (1964) who argued that price support programmes actually worsened the distribution of income within agriculture. He reasoned that as production is highly skewed, then support, which is based on the level of production, will also be skewed. Therefore, skewed production was not a function of support *per se*. He illustrated his argument by showing that farms which produced non-supported products (eggs, poultry, fruit, vegetables) had increased in size at the same rate as those producing heavily supported products (milk, cereals). The conclusion he drew was that, without support, farmers would have less capital to invest in new technology, but that this did not effect the size distribution of firms.

Robinson reasoned that if support programmes were eliminated the reduction in support would occur in relation to proportion of sales, and unless there were differences in the product mix or revenue-to-cost ratios between large and small farms, the distribution of income would not be effected. To assess whether or not large and small farms have a similar relationship between costs and revenue, Robinson developed a 'net income multiplier' (simply the ratio of gross farm receipts to net income). The results for different sales classes can be seen in Table 2.1. Farms with sales of greater than $20,000 a year had a multiplier of 5.2, inferring that a 10% reduction in farm prices would lead to a 52% fall in net income. The ratio was much lower for smaller farms (in terms of sales class), and Robinson concluded that the removal of support should reduce the income of larger farmers more than smaller farmers and lead to a moderate reduction in income inequality.

Table 2.1 Net-Income Multiplier for US 1961 to 1964

Farms with Sales of:	Net Income Multiplier[a]
$20,000 or above	5.2
$10,000 TO $19,999	2.6
$5,000 TO $9,999	2.3
$2,500 TO $4,999	2.0
Below $2,500	1.8

a) associated with a 1% change in Producer Prices and assuming no change in production costs
Source: Robinson (1965)

To test the hypothesis that removal of support would reduce inequality, Robinson analysed data for the 10 years prior to 1965. He noted that the terms of trade[4] to agriculture had worsened. Given the above 'net income multipliers', this should have led to a more equal distribution of income. Robinson tested this by analysing over time the ratio of average net income of different sized farms (Table 2.2).

Table 2.2 Ratio of Average Net Farm Income per Farm, by Sales Categories, US 1959 to 1964.

Year	High to Medium[a]	Low to Medium[b]
1959	2.6	0.6
1960	2.6	0.6
1961	2.8	0.6
1962	2.8	0.6
1963	2.7	0.6
1964	2.9	0.6

a)Ratio of net income of farms with sales of $20,000 + to farms with sales of $5,000 to $9,999
b)Ratio of net income of farms with sales of $2,500 to $4,999 to farms with sales of $5,000 to $9,999
Source: Robinson (1965)

Table 2.2 shows that, despite the apparent worsening of the terms of trade, the ratio between high and medium sales class farms had increased. Higher income farms were doing better than the lower income farms, in relative terms. Robinson concluded that a reduction in the terms of trade would not lead to a permanent redistribution of income against those who have a high ratio of costs to revenue (i.e., farmers with large total sales and high net income multiplier). This supported his argument that removal of price support would not result in income redistribution. There is a basic flaw in Robinson's analysis, in that he assumes farmers in the high sales group all have the highest income. Although income is correlated with sales, it is by no means an exact relationship. Therefore, although the ratio between high and low sales class farms had increased, despite a worsening of the terms of trade, this does not imply the same for

[4]Terms of trade in this sense relates to the prices received for farm products and the costs of the inputs used to produce them.

high and low income farms. Robinson makes judgements about income distribution from inadequate data.

Robinson argued that if agricultural support was removed, the price of those factors of production that have a relatively inelastic supply schedule would decline more than those factors that have uses outside of agriculture (and therefore a more elastic supply curve). This should ensure that the price of land would fall more than that of fertiliser, fuel, tyres and industrial goods. Therefore, those farmers owning land would suffer a capital loss (either real or potential depending on when the land was bought), whilst those renting land would be affected less, assuming farm rental values were adjusted accordingly. This conclusion is supported by Gaffney (1965), who argued that the majority of farm supports were capitalised into land values and that the real effect of agricultural support policies was to transfer income to land owners rather than farmers.

The remainder of the analysis undertaken by Robinson was very simplistic. He attempted a regional analysis in which balance sheets for two regions were shown, one of which produced heavily supported products. The effect on the two regions of the removal of support in the short-run was, not surprisingly, very different, with the non-supported region showing a marked improvement in its relative position. From a brief analysis of the income distribution effects of allotment allocations (area quotas), Robinson concluded that they reduced the move towards more concentrated production. He also reasoned that as government payments are concentrated on grain production, then those areas that produce grain receive the most benefits.

The main conclusions Robinson drew from his analysis of the effects of agricultural policy were:

1) Owners of land gained relative to other input owners.

2) Regions that grew heavily supported crops gained in relation to those regions that produced non-supported crops.

3) Those farms that used home grown feeds gained in relation to those who bought-in feed.

4) The allotment allocations meant that high-cost producers gained in relation to low-cost producers.

5) Farmers in the corn belt gained from government payments in relation to those in the North-East and the West of the country.

The work of Robinson highlights potential problems with analysing the effect of support on income distribution. His analysis attempts no quantification of the degree of inequality either with or without support policies. The questions raised are valid but the answers are very subjective.

In contrast to Robinson, Boyne (1965) analysed actual changes in income distribution between farm households and rural households. Using data on family income, he highlighted a consistent trend over the period of a reduction in inequality for farmers and farm manager families. This appears to contradict the findings of Robinson who argued that there had been little difference in the relative distribution of income during a similar period.

Boyne examined the distribution of income but did not relate it to agricultural policy. He began by asking a number of questions (which any analyst of income distribution in agriculture should ask). "First, given the heterogenity in agriculture, what subgroups should be used for measurement purposes? Second, what income concept should be used?" (p 88). His conclusion was pragmatic, in that the answers were dictated by the type of data available! Boyne used national income survey data, which split rural families into three groups: Farmers and Farm Managers, Labourers and Foremen, and Rural Farm Families. The income measure was total family income which comprised of total money income for each member of the household. Total money income included wages and salaries, net self-employment income, income from interest, rents and social security payments. This was a comprehensive income measure, and included off-farm income sources of the farm family.

Boyne presented his results in a number of ways. First, to illustrate the relative position of farmers to that of the rest of society, the percentage of the farm population in each quintile of the national income distribution was calculated (Table 2.3).

Table 2.3 Percentage of Farmers within Each Income Quintile of National Distribution (US 1948,1960)

Year	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Top 5%
1948	47.3	19.2	12.8	9.3	11.4	5
1960	49.9	25.4	10.2	7.7	6.9	1.7

Source: Adapted from Boyne (1965)

By definition each income quintile related to 20% of the population. Therefore, in order to have a similar income distribution to the rest of the US, 20% of farmers should be in each quintile. In 1948, 47.3% of farms had total family incomes that put them in the bottom 20% of the population in income terms. By 1960 this had risen to just under 50%. At the other end of the scale, the percentage of farm families in the top 20% fell from 11.4 to 6.9%. It would appear that the relative position of farm families in the US deteriorated during the period under analysis. Boyne also noted that the median income had risen over the period by just 15% for farm families, whereas the increase for non-farm families was 41%.

The results in Table 2.3 illustrate how work at the time substantiated the feeling that the majority of farm families were 'poor' and that support was necessary. The majority of farms had very low total family incomes. Boyne, however, noted that these figures did not include income in kind, which later studies (for example, Bryant and Zick, 1985) show to be a major part of rural families income. However, he estimated that the likely effect of income in kind would be to shift farms up income bands, without really effecting the relative distribution of income within agriculture.

Boyne proceeded to compare the distribution of income *within* the agricultural sector, using both quintile analysis and Gini coefficients. He analysed the distributions between the three main groups considered earlier. For the purpose of this review, only the results for the category Farmers and Farm Managers will be assessed (Table 2.4).

Table 2.4 Percentage of Total Income received by Farmers and Farm Managers.

Year	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Top 5%
1948	2.4	6.6	12.6	19.9	58.4	32.5
1951	3	7.9	13.6	21.1	54.5	26.2
1963	3.2	8.5	14.7	23.1	50.5	20.8
U.S.[a]	6	13	17	23	41	16

a)average for all US,1948-63
Source: Adapted from Boyne (1965)

Boyne concluded that the distribution of income to Farmers and Farm Managers had changed during the period (illustrated by the decline in the share of the top 5%). In comparison, the figures for the whole of the US had changed very little during the period (the average shown in the last row of Table 2.4 is an accurate representation of the distribution throughout the period)

Examination of the Gini coefficient,[5] as would be expected, reflected the findings of the quintile analysis. The Gini coefficient declined by 16% from 0.55 in 1948 to 0.46 in 1963. The Gini coefficient for the US as a whole was about a third lower than that for

[5]The Gini coefficient will be discussed in more detail in the next chapter. Here it is suffice to state that it is a means by which inequality in distributions can be measured. The coefficient can range from 0 indicating that the distribution is perfectly equal, to 1, indicating the most extreme inequality.

Farm and Farm Managers, indicating that Farm incomes were more unevenly distributed than that of the rest of the population.

Boyne acknowledged two main problems with his analysis. First, as already mentioned, no measurement of income-in-kind was made, which is a major contribution to farm household welfare. Second, no attempt was made to analyse regional patterns in inequality, or to break down farms into specific categories. Both problems relate to availability of data.

A more specific analysis, dealing with the distributive effects of US cotton support programmes was undertaken by Bonnen (1968). This work is of particular interest, because it involves an examination of the *distribution* of support as well as highlighting possible methods for estimating the actual *level* of support. Estimation of the level of support involved two approaches. The first simply calculated the level of support as the difference between the price received in each state and the average price that would have been received on the next best market (in this case the US export price), and then multiplied this figure by the level of production in each state. The figures were weighted to allow for differences in the quality of cotton produced between regions. Bonnen noted that this method did not allow for possible changes in the quantity produced and exported after the removal of support.

The second approach attempted to allow for changes in demand. Using available demand elasticities, Bonnen estimated the fall in world price that would have to occur to remove the surplus production (whilst maintaining a fixed level of stocks). The difference between this world price and the state average price was deemed the margin of support. Again, this method did not allow for changes in the supply of the product, brought about by the removal of the allotment programme and the lower price, and therefore cannot be considered as a long-run estimate. However, it did allow for some quantity changes and in this sense may be regarded as an improvement on the first method. The two margins of support were described by Bonnen as extremes; the first method an under-estimation and the second an over-estimation of the level of support received by farmers. The different estimates of the level of support, and the regional differences are shown in Table 2.5.

Table 2.5 Regional Variations in Level of Benefits to Cotton Producers

Region	Method 1		Method 2	
	Average per Farm	Average per Acre	Average per Farm	Average per Acre
	$	$	$	$
South East	438	33	949	71
Delta	1,107	45	2,400	97
South West	1,043	20	2,263	44
West	5,934	79	12,869	171
US	1,002	35	2,172	75

Source: Adapted from Bonnen (1968)

The different assumptions about the market situation had a considerable effect on the estimated level of support. Bonnen argued that the per farm differences could be explained largely in terms of differing farm sizes. However, the per acre figure suggests variation in yields (even allowing for variations in the quality of cotton produced). Bonnen also analysed the distribution of support, within states and regions, using Gini coefficients to indicate the degree of inequality. The regional findings (Table 2.6) highlighted large differences. Overall the distribution of support was very unequal, with a Gini of 0.65 for the US as a whole.

Table 2.6 Gini Coefficients For Distribution of Cotton Support[a]

Region	Gini
South East	0.57
Delta	0.66
South West	0.54
West	0.68
US	0.65

[a] Results are for Method 2
Source: Adapted from Bonnen (1968)

The study by Bonnen concentrated on regional differences in levels of support, rather than the distribution between farmers at different income levels. The analysis highlighted that if the assumptions about the market situation were altered, large variations in estimated levels of support could occur.

The year after his work on the distribution of cotton supports, Bonnen (1969), reported in Schultze (1972), extended his analysis to most of the major crops grown in the US. This work differed in methodology quite considerably from that of his earlier work. In order to estimate the benefits received by farms, he assumed that they would be proportional to acreage size. From this distribution he estimated Gini coefficients for different crops (Table 2.7). This assumption removed the need to estimate the level of benefits actually going to each farm or for any information on the levels of production, i.e. acreage size was used as a proxy for support.

Table 2.7 Gini Coefficients for Selected Farm Programmes (mid 1960s)

Commodity		Gini	Commodity	Gini
Income		0.47	Peanuts	0.52
Wheat	Price Support	0.57	Tobacco	0.48
	Direct Payments	0.48	Sugar Beet	0.46
	Total	0.57		
Feed Grains	Price Support	0.59	Sugar Cane	0.80
	Direct Payments	0.41	Cotton	0.65
	Total	0.57	Rice	0.63

Source: Adapted from Schultze (1972, after Bonnen, 1969)

Schultze, whilst recognising that the method adopted by Bonnen had the aforementioned advantages, raised a number of points concerning the disadvantages:

1) It failed to provide information on the income level of farmers receiving the benefit. This meant that the welfare effects of the policies could not be assessed. Schultze reasoned that "The income distribution effects of farm programs can be best judged by the distribution of benefits by income size class and by the absolute magnitude of the support provided to each group" (p 97).

2) It is wrong to assume a perfect correlation between acreage size class and economic size class. Not all large farms have high sales and income, and not all farms with high sales and incomes are large acreage farms.

3) The fact that many farms produce more than one product means that distributing benefits by farm size group on a crop by crop basis does not reveal the distributive effects of multiple enterprises.

The method of distributing support by acreage size is not, therefore, a satisfactory way of measuring the distributive effects of agricultural policy. Schultze, after reviewing the work of Bonnen, conducted his own very detailed analysis of the distribution of support and income. Although published much later, Schultze examined the same time period as Robinson and Boyne. However, any similarity ends here. Schultze's work was based on an analytical framework and, in his own words, addressed the question "Who gets the subsidies?" Specifically, to what extent do farm programs represent a transfer of income from a relatively affluent urban population to a relatively depressed and low-income farm community?" (p 95). He noted that in 1969 the average income of farm families was 33% lower than that of non-farm families and therefore any transfer of income may have appeared justified. However, he argued that this was not the case, because the transfers were related not to the income of the farm families, but to the volume of production "Whatever the advantages and disadvantages of the farm subsidy program it is not a welfare program in the sense of transferring income to low-income farm families" (p 96).

Schultze measured the benefits of farm support programs "principally in terms of the income farmers received beyond what they would have received in the absence of the programs" (p 96). The concept and justification of support was addressed by Schultze, but the bulk of his work was concerned with examining the distributional effects of agricultural policy. To this end he noted that, "Determining how the benefits of US farm programs are distributed among farmers of different income levels presents three major problems: measuring the magnitude of the benefits; estimating the distribution of benefits to farms grouped according to economic class; and relating the economic class grouping to a net income grouping" (p 100).

Schultze used published data to estimate the level of support received by farms in the form of direct payments. The level of support per unit of the commodity was calculated as the total level of direct payments divided by the total level of production. Unlike Bonnen (1969), Schultze also attempted to measure the quantity effects of price support policies. Schultze noted certain factors that have to be estimated in order to measure the magnitude of price support policies in the long-run rather than the short-run. These are:
1) The acreages planted and yields of various crops with acreage restrictions removed and loans and intervention purchases removed.

2) The price elasticities of demand, both domestic and export, for the commodities involved.

3) The impact of lower grain purchases on livestock feeding, production and sales.

4) The impact of lower returns from previously supported crops on the production and prices of other commodities. Because of the substitutability, both in production and consumption, among farm commodities, the effect of removing price supports would extend to returns from other commodities as well as from price supported crops.

5) The changes in production costs that would occur under free market conditions. Increased output due to the removal of quotas would tend to raise costs, but several factors would tend to reduce them: prices for purchased feed, seed, and livestock would be lower; removal of acreage restrictions would improve the mix of inputs (land, labour and capital) and thereby lead to lower costs; and, with sharply lower incomes, farmers' ability to purchase machinery and other capital would be curtailed.

The model used by Schultze to estimate the 'free market' situation was the first major attempt measure the distribution of support by estimating the long-run level of support received, i.e. measuring support in terms of the changes in *prices* and *quantities* produced after removal of support. The advantage of this approach is that it gives a more realistic idea of how much support is received by farmers. The disadvantage is that it requires many assumptions, much time and considerable resources.

The model was used to estimate the loss associated with each major farm commodity, following removal of price supports and acreage restrictions over the period 1961 to 1967. This loss was then distributed to each economic class of farms[6] in proportion to the class's share of production of that commodity. The losses for each commodity were summed to give a total loss for each class. Table 2.8 presents Schultze's findings for 1964.

[6]Economic Class in Schultze's study is comparable to Sales Class in other US studies. With class 1 representing the largest farms and class 6 the smallest, in terms of sales.

Schultze's results show clearly the uneven distribution of agricultural support. Class 1 farms (the farms with the highest sales) represented only a small proportion of the total number of farms, but received the most support. Schultze argued that the results supported his view that agricultural support policies were not welfare policies. The work by Schultze was the most comprehensive to date.

Table 2.8 Distribution of Benefits and Income by Economic Class (1964)

			Economic Class			
	1	2	3	4	5	6
Aggregate Benefits			($ Billions)			
Price Supports	1.44	0.66	0.61	0.37	0.18	0.14
Direct Payments	0.34	0.44	0.58	0.38	0.19	0.26
Total	1.78	1.1	1.19	0.75	0.37	0.4
Distribution of Benefits			(Percent of Total)			
Price Supports	42.3	19.3	17.9	11	5.3	4.2
Direct Payments	15.4	20.3	26.4	17.4	8.6	12
Total	31.8	19.7	21.3	13.4	6.6	7.2
Income and Benefits per Farm			($ 000)			
Farmers Net Income	27.3	11.8	8	6.3	5	5.1
Net Income from Farming	23.3	9.5	6	3.5	2	1
Price Supports	9.9	2.5	1.3	0.7	0.4	0.1
Direct Payments	2.3	1.6	1.2	0.7	0.4	0.2
Total	12.2	4.1	2.5	1.4	0.8	0.3
Net Income under 'Free Market'	11.1	5.4	3.5	2.1	1.2	0.7

Source: Adapted from Schultze (1972)

At around the same time of Schultze's study, work in the UK by Josling and Hamway (1972) attempted to assess the effects of agricultural support on income distribution and the possible changes that were likely to ensue after accession to the European Community (EC). In essence it was a comparison between deficiency payments (which operated by paying a fixed sum per unit of production) and price support (which involved higher market prices).

The data source for this study was the Farm Management Survey (FMS, now known as the Farm Business Survey, FBS), which included data on production and income from some 2000 farms in England and Wales. The definition of income used was Net Farm Income (NFI), calculated as the farmers returns from the business of farming. This income concept can be criticised on the grounds that no information on off-farm sources of income, or on the income of other members of the household was acquired. In comparison, the majority of US work involving the use of income includes family income and income from off-farm sources, thus giving a more comprehensive view of the actual welfare position of the farmer. The work of Josling and Hamway therefore does not relate directly to the relative welfare aspects of agricultural policy, but can still be useful in examining the relationship between the distribution of support in relation to that of farming income.

Support for each commodity was estimated simply as the per unit figure (published by the government in the Annual White Paper on Agriculture) multiplied by the individual farm's level of production of that commodity. The research did not account for possible effects of the marketing boards. It was, like the early American work, a static analysis. Estimation of the 'free market' level of income involved simply deducting the estimated level of support from NFI. Possible changes in demand and supply that were likely to occur were not accounted for. The authors acknowledged the problem with the static approach but defended it on the grounds that, "Static comparisons have value, however, in that they indicate the original direct impact of the changes in prices and methods of support to which producers and households will respond" (p 51). The advantage of Josling and Hamway's approach was that it enabled the level of support to be calculated simply and quickly.

In order to examine differences in the distribution of support between farm types, Josling and Hamway grouped farms according to the enterprise(s) that comprised the majority of the total production, or required the most labour. Gini coefficients were used to measure the distribution of support for each farm programme and for NFI. Selected results are shown in Table 2.9.

Table 2.9 Gini Coefficients for Selected Farm Support Programmes (UK 1969)

Programme/Income	Gini
Potatoes	0.60
Cereals	0.52
Fat Pigs	0.51
Total Support	0.34
NFI	0.30
Non Support Income	0.22
Calf Subsidy	0.18

Source: Josling and Hamway (1972)

Josling and Hamway note: "It can be seen from the table that income including support payments is distributed with a higher inequality coefficient than would be the case if no support policy existed" (p 58). They, therefore concluded that agricultural support increased the level of inequality.[7] Another conclusion drawn from the results was that "Programmes which appear to distribute benefits unequally tend to be those price support schemes which operate through the price guarantee system" (p 58).

Josling and Hamway compared the income distributions under a 'free market' situation with that under deficiency payments, and the likely distribution once the UK acceded to the EC (Table 2.10).

[7]It should be noted, however, that the results indicate a low level of inequality within the agricultural sector even with support. A Gini coefficient of 0.30 for NFI is low compared to the national distribution of income which was 0.39.

Table 2.10 Distribution of Farm Incomes under Different Policies

Policy	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	Gini
No Support	13	25	21	41	0.22
Deficiency Payments	13	17	22	48	0.30
Price Support	15	10	25	50	0.32

Source: Josling and Hamway (1972)

They concluded that whichever of the two policies was in force, inequality would be higher than under a 'free market' situation. However, the move from deficiency payments to price support would slightly increase inequality. The findings of the study by Josling and Hamway were similar to those of Schultze, despite the different approach. Schultze concluded that the majority of benefits were going to the high income farms. The results of the analysis by Josling and Hamway showed that support was more unequally distributed than income, so the high income farmers were benefiting more. Thus, work on both sides of the Atlantic reached similar conclusions about the nature of farm support.

The work by Bell (1973) was, to a certain extent, related to that of Josling and Hamway. The study was limited in that only a section of the FBS data set (the Northern region) was used. Two measures of farm income were employed; NFI as used by Josling and Hamway, and an Adjusted Net Farm Income (ANFI). The calculation of ANFI involved replacing the imputed rent for owner-occupiers and the value of family labour on the farm. The author argued that the adjusted figure gave a more accurate representation of the welfare position of the farm. However, ANFI represented only a slight improvement over NFI, because off-farm income was not assessed.

Bell made reference to work by Benson (1970) which developed practical considerations about the application of the Gini coefficient. Benson referred to the work of Bonnen (op. cit) and Boyne (op. cit) as examples of studies using Gini coefficients which failed to specify the actual procedures followed. The purpose of the work by Benson was to highlight possible shortcomings with the application of the Gini coefficient. In research into the distribution of gross income earned by cotton producers, he found that results in some cases were completely different from *a priori* expectations. On closer examination it was found that the results suffered from cell[8] and aggregation bias. Cell bias can be split into two types; inter-cell and intra-cell. Benson argued that as the calculation of the Gini coefficient requires stratification of the data, a problem can arise with the number of cells chosen. By using graphical illustrations, Benson argued that the fewer cells chosen for calculating the Gini, the lower its value (thus indicating a more even distribution). The number of observations in each cell is also important. The process of dividing farms into cells ensures that observations in the same cell are represented by a linear function. Thus, Benson argued that "When a large number of observations fall within one cell much of the information about the distribution is lost" (p 445). In an extreme case, if 100% of observations fell in one cell the Gini would be zero.

The problem of aggregation bias arises when different distributions are combined to form one distribution. Benson considered the effects of combining individual state data on cotton support to form national data. The Gini for Arizona (0.372) was the lowest from any state (the national figure being 0.686). Since the distribution of benefits in Arizona appeared more evenly distributed, it would seem logical that if that state was removed from the analysis, the Gini for the US as a whole would rise. This was not the case; in fact the Gini actually fell. The reason for this apparent anomaly is related to differences in the mean values of support between states. Benson concluded that it was

[8] For the calculation of the Gini coefficient, it is necessay to group the data according to some size variable and each of these groupings is termed a cell.

not possible to infer the effect that the Gini for one state will have on the national figure. "In summary, when state distributions of benefits are heterogeneous, inferences drawn from the ordinal ranking of state Gini ratios may be very misleading" (p 447).

Bell used the findings of Benson to question the methods behind the Josling and Hamway work and to develop his own research. Josling and Hamway's grouping of farms was based on farm size classes,[9] so each cell consisted of unequal numbers of farms. Also, only four cells were used. The research by Benson inferred that these two factors could have seriously biased the findings of Josling and Hamway. Bell, in calculating the Gini coefficients for the Northern region FBS data, split the data into 10 equal groups ranked by NFI, to reduce the likelihood of inter- and intra-cell bias. As the data were for one region only, the question of aggregation bias did not arise.

Bell's work involved an examination of inequality over a period of time (unlike Bonnen, Josling and Hamway, and Schultze). For the majority of the period, the Gini coefficient for support payments was lower than that for NFI (Table 2.11), indicating that support payments were more equally distributed than income.[10] This was, however, not the only significant result. In Table 2.11, the Gini for ANFI is consistently lower than that for NFI, indicating a more equal distribution. According to Bell, this finding indicated that farmers who had low NFI were in fact owner-occupiers, who used unpaid family labour on the farm and therefore their relative wealth was higher than the NFI figure indicated.

[9] Measured in terms of Standard Man Days (SMDs).
[10] These findings were in direct contrast to those of Josling and Hamway.

Table 2.11 Gini Coefficients for Income and Support (1962 to 1971)

Year	NFI	ANFI	Support Payments
1962	0.39	0.35	0.44
1963	0.42	0.38	0.40
1964	0.48	0.42	0.38
1965	0.41	0.38	0.33
1966	0.43	0.39	0.32
1967	0.44	0.42	0.32
1968	0.42	0.39	0.33
1969	0.45	0.42	0.32
1970	0.48	0.46	0.32
1971	0.40	0.38	0.34

Source: Bell (1973)

Bell did not restrict his study to a year-by-year examination, but proceeded to undertake a form of longitudinal analysis. The justification for this type of examination was that farms will move between income groups in different years due to the variable nature of farm incomes, and that the distribution in any one year may not reflect the true position. Bell argued that farmers are motivated by an expected stream of income over several years rather than a one year result.

In order to attempt a longitudinal analysis, Bell chose a base year to allocate farms to a particular income decile. The data on incomes for each farm in the following years were then located in the same decile as the base year income. The income flow was discounted at 9% (argued to be the medium term rate of interest used by the Agricultural Mortgage Corporation). Therefore, the figure calculated ('present value') was the total income to that farm over a ten year period, discounted accordingly. From these figures new Gini coefficients for both support payments and income were calculated (Table 2.12).

Table 2.12 Comparison between Present Value Gini and 10 year average

Income	Present Value	1962-71 Mean
Income with Supports	0.35	0.40
Income without Supports	0.58	

Source: Bell (1973)

Bell concluded that agricultural policy had helped to prevent greater inequality, because income without support was more unevenly distributed than income with support. He argued that for all but the top 15-20% of farmers, government support payments were a major component of farm income. He reasoned that although large farmers benefit more from subsidies in absolute terms than lower income farmers, the lower income farmers were more dependent upon them. Comparison between the present value figure and that for the mean of the 1962 to 1971 year by year analysis led Bell to conclude that, because the former figure is lower than the latter, it can be argued that temporary market fluctuations may mislead when analysing the distribution of income between farmers.

Bell raised a number of points that other authors have not addressed. The long term analysis, although fraught with difficulties, was an attempt to extend the study of farm income distribution beyond the (possibly misleading) one year stage. The difficulties with this analysis relate to the absence of knowledge as to the individual farmer's motivations. As Bell noted, farmers may be at different stages of their "wealth producing potential". For example, some may be foregoing income generation to build up a capital stock. This means that results can not be accepted as a true indication of the medium term income flow. However, the longitudinal approach still had the advantage of removing from the analysis of income distribution the effects of year-to-year fluctuations in farmers incomes.

The final part of Bell's study was concerned with examination of how the tax system redistributes income between farmers, more specifically, how the extra benefits which large farmers receive are removed by the tax system. Bell reasoned, "One may, of course, wish to question the efficiency of a system which provides subsidies only to remove them by taxation"(p 12), but concluded that a possible effect of taxation was to reduce the level of inequality associated with government support policies.

Hill (1982,1984) was concerned with the measurement of farm incomes for welfare purposes. Whilst not strictly within the parameters of a review of the literature on the distribution of agricultural support, the work is important because it raises questions as to the applicability of using certain definitions of income for measurement purposes. The main consideration of the earlier work of Hill, is that the income levels of farmers are of prime concern to agricultural policymakers throughout the world. However, Hill argues, that within the EC there are no available measures to assess the welfare situation of the farmer. For example, in the UK, every year, the Departmental Net Income Calculation (DNIC) is made for agriculture as a whole. Hill argues that this figure is virtually meaningless because it gives no indication of the distribution of income or of how the incomes of farmers producing different products are affected. If, as Hill argues, there is a dearth of income data, then it is difficult to assess the impact of government support programmes on that income. The measures that are available are criticised by Hill on four counts:

1) Annual measurements of the global income of the farming sector of the economy give no indication of the distribution of that income between individual farmers or of the changes of income from year to year.

2) Total income of the farm household may differ widely from income from farming alone.

3) Views may differ as to the items which should be taken into account when calculating the residual sum which forms the farmer's net income, and in particular the treatment of capital gains.
4) Any measurement confined to current income, and ignoring assets owned by farmers is likely to be inadequate in reflecting total economic well-being.

The later work of Hill was concerned with the use of Inland Revenue data (through the Survey of Personal Incomes) to try and gain information about other sources of incomes for farmers.

In contrast to the dearth of income data in the EC, an example of the detailed data on farmers total incomes in the US can be found in Ahearn *et al* (1985). They use survey data consisting of detailed information about the sources of income to the farm operator household. The definition of income is given as income from the farm operation and income to the farm operator household from off-farm sources. This is split into the following groups:
Three sources of farm income:-
a) Business farm income from the production of agricultural commodities, to include all cash income, net of cash expenses, depreciation, and 'in kind' benefits to hired labour.
b) Household farm income the household earns directly from the business, to include imputed rental value for farm dwellings, the value of products produced and consumed on the farm and wages and fringe benefits the business pays the household for its labour.
c) Income from government farm programmes involving only direct payments.

Four sources of off-farm income:-
a) non-farm wages and salary.
b) wages and salaries earned from work on other farms.
c) business and professional income.

d) income from all other sources.

It is clear that the definition of income used is comprehensive and an advancement on earlier work. Ahearn *et al*, like Schultze, recognise the problems involved in equating sales classes with income classes (Table 2.13). The largest farms (by sales class) have a high percentage of farms with negative income. However, they also have the greatest percentage of very high incomes.

Table 2.13 Distribution of Income of Farm Households by Sales Class (US,1984)

	Value of Sales ($000)				
Total Income Class ($000)	<10	10 to 39	40 to 99	100 to 499	≥ 500
			%		
Negative Income	12	18	18	17	17
0 to 9	25	19	11	6	1
10 to 24	32	32	25	10	3
25 to 39	19	19	21	12	5
40 to 59	8	8	15	17	4
≥60	3	4	9	38	69
Gini Coefficient	0.51	0.58	0.51	0.46	0.30

Source: Ahearn *et al* (1985)

Although there is a large proportion of high sales class farms that have negative incomes, there are very few low sales class farms that have very high incomes. Ahearn *et al* conclude that although off-farm income does supplement the farm income of low sales class farms, it does not bring them up to parity with the high sales class farms. The Gini coefficients reported in Table 2.13 relate to the distribution within each sales class. The distribution of income is most equal within the highest sales class, whilst income inequality is greater within the lower sales classes.

Due to the deficiencies of using sales classes as a means of grouping farms, Ahearn *et al* analyse the contribution of different sources of income to farms ranked by income classes. Results for selected income classes (those at the extremes of the distribution) are reproduced in Table 2.14.

Table 2.14 Average Income By Income Class and Source

Income Source	Income Class ($)				Total	
	0 to 9,999		> 60,000			
	Average Income	% of Total	Average Income	% of Total	Average Income	% of Total
Business Farm	-5,039	-96	77,930	53	749	3
Household Farm	4,960	95	16,743	11	7,689	29
Govt. Payments	565	11	7,009	5	1,982	7
Total Farm	486	9	101,683	69	10,420	39
Non-Farm Wages	1,990	38	10,591	7	8,216	31
Business and Professional	722	14	24,163	16	4,065	15
Wages from other Farms	165	3	84,000		159	1
Other Off-Farm	1,859	36	11,502	8	3,772	14
Total Off-farm	4,737	91	46,340	31	16,213	61
Total Household Income	5,223	100	148,023	100	26,633	100

Source: Adapted from Ahearn *et al* (1985)

A number of points about the distribution of government farm payments in relation to household income can be inferred from Table 2.14. First, high income farms include those with large farm business earnings and also those with high levels of off-farm income. Second, the low income farms appear to be those that are making on average a fairly substantial loss from farming.[11] This loss is offset by the off-farm and other income sources. Ahearn *et al* conclude that: "The more even distribution of household farm income and the uneven distribution of off-farm income towards the smaller farms partially offsets the greater concentration of farm business earnings and government payments on the larger farms" (p 1089).

[11] The table does not include the figures for negative income farm households. The loss from the farm business for this group was on average $52,200.

Ahearn *et al* attempt to disaggregate the Gini for total household income into Gini coefficients for each source of income, using a method introduced by Lerman and Yitzhaki (1985). The results are shown in Table 2.15.

Table 2.15 Gini Coefficients by Source of Income

Source of Income	Gini
Business Farm	0.91
Household Farm	0.60
Govt. Payments	0.90
Total Farm	0.66
Non-Farm Wages	0.84
Business and Professional	0.99
Wages from other Farms	0.97
Other Off-Farm	0.90
Total Off-farm	0.76
Total Household Income	0.60

Source Adapted from Ahearn *et al* (1985)

The Gini coefficients indicate a very unequal distribution of income. The high level of inequality for business farm income is purely a result of the large variation in earnings. Whereas for the other sources of income, the Gini by source is higher than the total Gini, because not all households earn any income from a particular source. Ahearn *et al* commit a cardinal sin (according to the work of Benson) in their use of the Gini coefficient. The survey data produces a Gini Coefficient for income of 0.60. (This in itself is perfectly valid, although no mention is made of the number of cells into which farms are grouped or the proportion of the population within each cell). The problem occurs when the results are compared to the earlier work of Carlin and Reinsel (1973) which gave a Gini coefficient for farm operator households of 0.48. Kinsey (1985), in a paper assessing the work of Ahearn *et al*, notes that the definition of income used is different from Carlin and Reinsel's and the authors themselves acknowledge that the stratification of the data is different. The problem arises because a number of farms actually report negative income. Carlin and Reinsel ensured that the first cell in the distribution consisted of enough of the population to make it positive. Ahearn *et al*, recoded negative income figures to zero. The effects of these alterations can be seen in Gregory (1986) and in Kinsey (1985). It is suffice to note that the Gini results of Carlin and Reinsel are incomparable to those of Ahearn *et al.*

The study by Ahearn *et al*, although not considering the possible effects of agricultural policy (other than direct payments) on income distribution, does address a number of problems found in earlier work. The definition of income is comprehensive. The analysis is concerned with farms ranked by income rather than by sales class, and Gini coefficients for the separate income sources are also considered.

Blandford (1985) reasons that although much has been written about the distribution of farm programme benefits, it does not appear to be a major item on the political agenda in the United States. The main purpose of his study is to analyse the effects of direct payments and to shed light as to their future as a means of agricultural support. It is based on the argument that despite deficiencies of the present system, income support measures will continue to be used.

Blandford's analysis is limited to an examination of the total cost of direct payments, and of the distribution of direct payments and farm income by farm type and region. In examining the distribution of direct payments and farm income (Table 2.16), he shows that if farming income alone is considered, then payments in recent years have represented a significant proportion of average net farm income, although if off-farm income is considered then the ratio of payments to income is substantially smaller. (This is indicated in the final rows of the table, showing the ratio of payments to NFI and total income)

Table 2.16 Direct Payments and Farm Income by Sales Class (US 1984-5)

Income/Payments	Sales Class ($'000) <40	40-99	100-499	>500	Total
			%		
Farm Size Distribution	71.9	14.3	12.6	1.2	100
Total Government Payments	10.6	22.2	54.7	12.6	100
			$ 1985 (per farm)		
Average per Farm:					
Government Payments	526	5,515	15,532	37,117	3,564
Net Farm Income	-1,732	4,700	47,708	631,423	13,030
Off-Farm Income	20,336	10,254	11,037	15,432	17,667
Net Farm and Off-Farm	18,603	14,955	58,745	646,854	30,697
Ratio of Gov. Payments to:-			%		
NFI	n/a	117.3	32.6	5.9	27.4
NFI+Off-Farm Income	2.8	36.9	26.4	5.7	11.6

Note: n/a = not applicable
Source: Blandford (1987)

Two points can be made about these findings. First, the figures are averaged between all farms irrespective of whether they receive benefits or not. Therefore, it is likely that for those farms that receive support payments the ratio of payments to income will be higher than the figure shown. Second, these figures show the importance of off-farm income to the agricultural sector.

An examination of the distribution of income across sales classes is undertaken by Blandford, and this reveals that the importance of government payments to net farm income varies across the sample. The uneven distribution of total payments per farm is highlighted, with the largest (in terms of sales) receiving on average $37,000 and the smallest $500. The largest 14% of farms received 67% of the total payments. Blandford argues that these figures are useful, but they do not give a complete picture. Reference is made to a study of the distribution of payments to farms classified by their debt to asset ratio. This showed that those with a high debt to asset ratio (>40%) received a larger proportion of payments than those that were under less financial stress. Blandford argues that this finding indicates that support is going to those farms that are in greater financial need of it, which is an interesting development in the analysis of the effect of support policies.

The analysis of the level of support received by farms, based on their farm type (i.e. cotton, grain, etc.) shows large variations in the payments per farm. For example, cotton farms on average received $43,000 dollars in 1985, whilst the average over all farms was only $3,500.[12] The intra-state comparison also shows great variation in the level of support. However, this largely reflects the concentration of types of farms and farming in different regions. Blandford argues that the intra-state comparison is useful, because it highlights the states in which direct payments are an important part of farmers incomes and therefore those areas that are likely to be significantly affected by policy changes.

The use of both NFI and off-farm income enables a comparison of the relationship between support payments and the total income of the farmer. However, no Gini coefficients are calculated to estimate the level of inequality associated with direct payments. Inequality measures are essential if greater knowledge about the distributional aspects of direct payments is sought. To distribute benefits by farms grouped by sales class has already been shown to be erroneous by Ahearn *et al*, because of the large number of large sales class farms that have negative incomes. Highly aggregated data are used in Blandford, so in many cases estimated support is distributed between all farms in a particular group rather than those who actually receive it.

[12]Again there is a problem with aggregation, because within a group farms that did not partake of support programmes were included in calculating the average supports per farm. This would lead to an understatement of the benefits going to those farms that were operating under a support programme.

Gregory (op.cit.), whilst not assessing the effects of support policies on income distribution, conducts a detailed analysis of the use of inequality measures for assessing farm income distribution. Many of the problems associated with earlier work - those concerning the choice of inequality measure, the definition of income, and the effects of negative incomes - are dealt with in full by Gregory. As an examination of inequality in farm income, between farm types in the late 1970s and early 1980s, the study is comprehensive. Gregory is also concerned with farm income instability and its effect on income inequality and a large section of his work concentrates on this aspect of income distribution.

Brown (1989), in a recent study of the distributional aspects of CAP price support policies, estimates and disaggregates benefits using Farm Accountancy Data Network (FADN) data. The benefits are analysed by farm type, economic size group, income class and region, to build a picture of the distributional effect of price support. Using FADN data from 1984/5, estimates of the benefits for each commodity on a national level are disaggregated among representative farms. Summation over all commodities gives total benefits for each representative farm. A comparative static partial equilibrium model is used to identify the long-run effects of the liberalisation of all CAP commodity prices.

Brown makes a number of key assumptions. First, it is assumed that the distribution of benefits from commodity supports is proportional to commodity output, or at least that proportion of output eligible for support. Second, a similar supply response to price changes was assumed for all groups. Third, adjustments in the commodity composition of farms after liberalisation were not accounted for.

The benefits from price support in EC countries are estimated by Brown as 12,000 ECU per farm per annum. This represents a quarter of the farm value of agricultural production and two thirds of farm net value added. Brown proceeds to illustrate the distributional aspects of farm policies using the categories reproduced in Table 2.17.

Table 2.17 Distribution Categories used by Brown

Farm Type:	Cereals		Dairying
	General Cropping		Drystock
	Horticultural		Pigs/Poultry
	Vineyards		Mixed
	Fruit/Olives		
Farm Size[a]:-	2 to 4	Income Class[b]:	<4
	4 to 6		4 to 8
	6 to 8		8 to 12
	8 to 12		12 to 24
	12 to 16		> 24
	16 to 40		
	40 to 100		
	> 100		

Regions:-

Country	No.of Regions	Country	No.of Regions
Belgium/ Luxembourg	2	France	22
		Ireland	1
Denmark	1	Italy	20
Germany	7	Netherlands	1
Greece	4	U.K	6

a) European Size Units, where 1 ESU equals 1,100 ECU of Standard Gross Margin.
b) Farm Net Value Added divided by Annual Work Units ('000 ECU)
Source: Brown (1989)

Table 2.17 illustrates the comprehensive nature of the analysis. The choice of categories appears to be determined by data availability. For example, the income measure used is Farm Net Value Added (NVA) divided by Annual Work Units (AWU). This classifies farms according to income per labour unit rather than absolute farm income. Brown defends the use of this measure on the grounds that it facilitates a more useful comparison between full and part-time farms and among farms with different labour uses. Brown notes that ideally the distribution should be by total farm household income, thus allowing for off-farm and family income to be considered. However, the only data available are for NVA . The proportion of benefits going to farms ranked by NVA/AWU can be seen in Table 2.18. Brown does not quantify the level of inequality associated with these distributions.

Table 2.18 The Distribution by Country of Farms and Support in the EC (1985)

Country	NVA/AWU <4000 Percentage of Farms	Percentage of Support	NVA/AWU >24,000 Percentage of Farms	Percentage of Support
BLEU	4.0	1.5	23	41.0
Denmark	17.0	4.1	33	55.8
France	18.0	8.3	11	22.9
Germany	21.0	11.1	7.5	14.3
Greece	44.0	25.7	0.4	1.4
Ireland	32.0	10.8	4.5	17.8
Italy	43.0	17.6	2.9	12.6
Netherlands	4.1	1.3	39	58.9
UK	16.0	5.7	15	29.8
EC	31	10	7.6	24

Source: Adapted from Brown (1989)

Table 2.18 indicates that, for the EC as a whole, farms with the largest agricultural incomes (according to the definition of income used by Brown) receive proportionately more in terms of benefits (24%) than their share of total number of farms (7.6%). The reverse is true of the lowest income farms. These results, according to Brown, highlight the bias of price supports towards high income farmers. A clear difference can be seen in the relative distributions between EC countries, although these differences are not quantified. Brown concludes that this variation is due to the structure of farming, the commodities produced throughout the EC and the varying levels of support per commodity.

Brown examines the distribution of support by region, farm type, size and income to produce an overall picture of the effects of CAP supports. The results indicate a wide variation in the level of support to different regions in the EC. These differences, because of the methods used for the research, can be attributed largely to farm size. "Much of the regional variation of the CAP was associated with different farm sizes; the small farms of the southern regions receiving considerably lower benefits than the rest of the EC" (p 50).

His study then progresses to a discussion of the possible factors, other than welfare considerations, that could justify continuation of price supports. Such factors include the aim of increasing self-sufficiency in the EC. On this point he reasons that:

> "Much of the justification for increasing supplies disappeared with the emergence of the EC as a substantial net exporter of many commodities. The continuation of price support, therefore has been based on social premises" (p 49).

Brown argues therefore that, as other possible justifications have disappeared, the continuation for price support must be on the grounds of social need. However, Brown criticises the method of price support as a welfare policy, drawing examples from his analysis which "... raises serious doubts as to the ability of the CAP to effect a socially desirable transfer of income to the agricultural sector" (p 49). It is not clear that Brown's analysis raises "serious doubts" about the transfer effects of price support. The fact that total household income is not available means that welfare judgements are made on the basis of agricultural incomes, which Brown recognises as a weakness. "Agricultural income, ... may be a poor indicator of the welfare of farm households. Off-farm income commonly supplements agricultural income, and it is farm household income that is paramount in determining 'social need' " (pp 13-14). So even though the conclusion reached is that "Benefits from the CAP are concentrated on the higher agricultural income farms" (p 50), this does not necessarily prove the inadequacies of price support as a welfare policy.

The work of Brown is both thorough and comprehensive in its approach to analysing the distribution of CAP price supports. However, the lack of detailed analysis of the quantification of inequality detracts from the study. For example, Gini coefficients would have quantified the degree of inequality present in the distributions analysed and therefore enabled a quick, clear assessment as to the differences between countries. The lack of detail on farm household incomes is a limitation of the available data set, which reinforces the points made by Hill (1982).

Another recent study, Bollman (1989), examines the distributive nature of farm support programmes in Canada. He notes that Canada, like many other countries, has witnessed an escalation in the level of government payments to farmers. The problem, according to Bollman, is that much work has been undertaken to estimate the aggregate costs and benefits, but little on the distribution of these benefits. The author attempts to redress the balance by simulating the removal of selected government support programmes and illustrating the effects on farmers.

Two important questions are raised by Bollman. First, arguments about the need for support are often interlinked with the question of low incomes for small producers and the claim that larger producers are more efficient. Bollman argues that it is the medium size farms that have the lowest income, because their size of operation is too large to allow for off-farm work and too small to generate a large income from farming. He also argues that there is no real evidence to suggest that larger farms are more efficient in terms of returns on equity. These two factors enable Bollman to conclude that even if the majority of support is received by the larger farms, it is not necessarily the efficient and well off that benefit most.

Bollman reviews a number of previous studies which show the rise in importance of support payments in terms of their proportion of NFI, and the effects of land retirement programmes. He attempts to assign estimated benefits of selected farm programmes to individual census farms. Bollman argues that this is necessary because no data are available from census returns as to the actual value of support received by individual farms. Data are obtained from two separate databases, and a simple algorithm used to distribute the total payments for each programme across all census farms. The estimated payments for each programme are summed to give a total payment received by each farm. This figure is then cross-tabulated by size of farm and other variables to provide a profile of who receives the payments. This approach differs to Brown's, because Bollman is examining specific programmes as opposed to different commodities. Therefore, the summation is across the benefits from support programmes and not across all commodities.

Bollman analyses the distribution of farm household income without payments and realises that this is not an exact 'free market' situation, but quotes Rosenfelds (1981) who states that what is actually being examined is:

> "...a reverse 'before-after' scenario. In other words, the 'with' programme situation and the setting right after dropping the programmes are compared. The problem is that the 'right after' environment reflects the structure of the 'with' conditions rather than a free market structure".

In order to assess the 'with' or 'without' situation it is noted that the changes in input and output prices and quantities would have to be considered along with the much more complicated problem of the possible changes in structure (these points were made by Schultze). Therefore, estimates of the rate of exit and entrance and the different farming patterns occurring would be required.

It is often assumed in American studies that NFI increases as size increases but at a declining rate. Thus, NFI as a proportion of sales is smaller for larger farms.[13] Bollman argues that, if the full cost of unpaid labour and capital resources were taken into account, it may lead to a constant ratio of sales to NFI throughout size classes. This issue, according to Bollman, is fundamental to the analysis of the effect of government support on NFI. Many support payments are tied to the level of production. Therefore, government programmes have a greater impact on the NFI of larger farms if the ratio of sales to income declines with farm size; alternatively, the impact is a constant proportion of net farm profits, if the ratio is constant across farm sizes.

Bollman in his analysis of the effects of selected Canadian farm programmes, uses three methods to estimate support, depending on the type of policy analysed. *Direct payments* are measured simply as the total payments associated with the commodity divided by the gross sales of the product. This method differs to that used by other authors (Josling and Hamway, for example), who distributed benefits according to the quantity produced and not the level of sales. The validity of Bollman's approach is open to question for the following reason. If two farms produce the same quantity of a given commodity, but one (through better marketing, etc.) proceeds to sell the product for a higher price, then according to this method of applying the benefits, this producer will be receiving a greater level of support.

Market price support programmes are estimated as the difference between domestic price and the current 'world price' multiplied by the level of domestic consumption. These estimates of support are, like direct payments, distributed by value of sales rather than the quantity produced, so the same criticism can be levelled.

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[13] This is shown by the 'net income multiplier' used by Robinson (op. cit).

Other calculations are made as to the effects of certain *specific programmes*. Of interest is the calculation of the effects of removing supply control programmes. It is envisaged that the government would purchase all the quota. With the money they receive the farmers would pay of their debts (thus interest payments would be reduced) and NFI would rise. At the same time, output prices would fall, thus reducing income. The contribution of the supply management programmes is estimated as the reverse of the impact of removing them. Three possible scenarios are considered, which allow for differences in the levels of price reduction for the commodities under consideration (milk, poultry, eggs and tobacco) in a free market situation.

The author accepts that the results have to be treated with a degree of caution, due to two factors. First, they are sensitive to the methods used to assign the benefits on a per farm basis. Second, the programmes considered are selected ones. The policies considered are largely grain support programmes. In Canada, grain farms tend to be 'medium' sized farms, therefore support payments will appear to be concentrated in this size class.

Bollman presents his results in an imaginative fashion. Initially it is shown that, contrary to other studies, the distribution does not show a concentration of benefits within the highest size classes. The top 1% of farms account for 15% of gross sales but only 3% of net benefits. The distribution of benefits is found to vary with the programme under consideration. For example, the top 1% of farms receive 17% of the benefits from the Agricultural Stabilisation Act but only 2% from the Grain Transportation Act. The latter finding relates to the point made earlier concerning the concentration of grain farms in the medium rather than large size class. The results show that the gross and net incomes are more concentrated on larger farms than are the net benefits, but again this could be a result of the choice of programmes analysed.

Unlike Schultze (op. cit) who concluded that support was more concentrated than NFI, on large farms, Bollman concludes that "Our results are contrary [to Schultze ... and] indicate that gross and net farm income are more concentrated among larger farms than are the net 'benefits' of the selected government programmes included in this study" (pp 355-366). The results indicate that half of the farms have an income of under $27,000. These account for 20% of aggregate income and 45% of the benefits. Bollman argues this occurs, because the level of gross sales does not appear to vary across the farm household income distribution. When the net benefits are subtracted from household income, a new income distribution arises. In this case, the bottom half have only 10% of income but 58% of the benefits.

Like Blandford, Bollman extends the analysis to examine the question of whether the benefits extend to those who are financially stable. This is examined by calculating Farm Financial Stability Classes (FFSC). FFSC is defined in terms of the combination of the Debt to Asset Ratio (DAR) as an indication of vulnerability, and the Debt to Service Ratio (DSR) as a measure of the funds available to service the debt. Four categories of financial stability are used and the distribution of benefits and income to each group is examined. The results indicate that the 3% of farms classified as having a low level of financial stability, accounted for 4% of sales and 4% of benefits. The 80% of farms classified as having a high level of financial stability accounted for 74% of sales and received 74% of the net benefits. Thus, it appears that there is a close correlation between financial stability and benefits.

Bollman also tried to examine whether those farms that are deemed efficient are benefiting the most from agricultural support. To this end, a measure of the rate of return is calculated as NFI as a percentage of Net Farm Worth. Those with a high return (over 10%) accounted for 18% of the farms, 35% of the sales and 31% of the net benefits. Thus, those farms deemed 'efficient' by the measure used, were receiving less in benefits than their share of sales, but more than their proportion of farms.

Bollman, like Josling and Hamway, does not attempt to make value judgements about whether the distribution of benefits is 'good' or 'bad', but to illustrate the distributions by size class, by family income, by different levels of efficiency and stability. Bollman's study suffers from a lack of quantification of the degree of inequality. It also suffers, by its own admission, because the policies chosen are selected ones. Therefore the conclusions about the distributional effects have to be questioned. The majority of grain is grown on medium size farms therefore the concentration of grain payments will also be on these farms. The largest farms will receive less in support from these particular programmes than their total farm sales. Therefore to state that the top 15% of farms receive only 3% of support from these selected policies is fairly meaningless. Of more relevance, is how the grain payments are distributed by grain farms. Given the nature of the paper, the distributional implications are important in relation to the finding that it is the 'middle' sized farms that have the lowest incomes, but that it is the middle size farms that receive the most benefits.

2.3 Summary, Discussion and Conclusions

A number of studies covering a twenty-five year period have been assessed. In the introduction it was stated that the work would be reviewed with specific attention to the income definition used, the support programmes analysed, how the level of support was estimated, and how the support was disaggregated and distributed between farms. Tables 2.19, 2.20 and 2.21, summarise in a simplified manner, the methods used as a prelude to discussion.

Table 2.19 Income Concept

Author(s)	Income Measure
Boyne	Off and On farm
Robinson	n/a
Bonnen (1968)	n/a
Bonnen (1969)	Off and On farm
Schultze	Off and On farm
Josling	NFI
Bell	NFI/ANFI
Ahearn et al	Off and On Farm and in kind
Blandford	Off and On Farm
Brown	NVA/AWU
Gregory	NFI (and adjustments to NFI)
Bollman	Off and on Farm

Note n/a = not applicable

Table 2.20 Policies Analysed

Author(s)	Policies Analysed
Boyne	n/a
Robinson	Price Support, Set aside, Direct Payments
Bonnen (1968)	Cotton Price Supports
Bonnen (1969)	Price Support
Schultze	Price Support, Direct Payments
Josling	Deficiency Payments, Variable Import Levy, Price Support
Bell	Deficiency Payments
Ahearn et al	Direct Payments
Blandford	Direct Payments
Brown	Price Support
Gregory	n/a
Bollman	Quota, Price Support, Direct Payments

Note n/a = not applicable

Table 2.21 Method of Disaggregation of Support/Income

Author(s)	Distribution of Support/Income	Gini[1]
Boyne	Total Income	Yes
Robinson	n/a	No
Bonnen (1968)	Sales Class, Region	Yes
Bonnen (1969)	Farm size, Farm Type	Yes
Schultze	Economic class	No
Josling	Standard Man Days, Farm Type	Yes
Bell	NFI/ANFI	Yes
Blandford	Sales Class, Financial Stability, Region	No
Ahearn et al	Total Income	Yes
Brown	NVA, Region, Size, Farm Type	No
Gregory	NFI, Farm Type	Yes
Bollman	Total Income, Financial Stability, Farm Type	No

Note [1]Or any other summary inequality measure
n/a = not applicable

From Table 2.19, it is clear that a split emerges between the different sides of the Atlantic. The more comprehensive income definitions (those incorporating income other than that from farming) are almost exclusively found in the work undertaken in America. Hill (1982) acknowledged that there were simply no data available on other sources of income received by farmers in the EC for the researcher to analyse. This explains the widespread use of NFI, ANFI and NVA by UK and EC analysts. It is clear that off-farm income has a considerable influence on farmers incomes. The inclusion of off-farm income in those works reviewed has consistently shown two main effects. First, it reduces the ratio between support payments and income for all farms. Second, as would be expected, it is more important to small farmers. These two factors suggest that using NFI underestimates the wealth of farmers, and that the corresponding distribution is more unequal than if off-farm income is considered. The importance of accounting for off-farm income depends upon the goals of the research. If the aim is to analyse the welfare effects of farm support, then it is clear that all sources of income should be examined. However, if the purpose is to assess the distribution of support in relation to farming income, then an income definition restricted to that from farming is sufficient.

A variety of agricultural policies have been analysed by the authors (Table 2.20). The methods of measuring the level of support vary with the policy or commodity under consideration. Brown and Schultze attempt the complicated procedure of modelling the potential changes in agricultural production and incomes in the 'free market' situation. Others, (Josling and Hamway, Bonnen, Bollman) calculate the 'free market' distribution simply as the income of the farmers minus the estimated supports, with no allowance made for possible changes in the level of production. It is evident that there are advantages and disadvantages with both methods. The modelling of changes in supply and demand, as already mentioned, is a time consuming exercise and requires conjecture as to what would happen without support. The static approach is more appealing, because of the ease of estimation, but does not accurately reflect long-run effects.

The methods by which the estimated levels of support and income are disaggregated between farms are as varied as the studies themselves (Table 2.21). Much of the American work uses published data, which involves grouping farms into sales classes. The possible weaknessess of this method have already been discussed in the text. Here, it is suffice to conclude that grouping farms by sales class does not allow for an accurate representation of whether it is the high or low income farmers that receive the benefits. The use of SMD's as a method of grouping farms, or in fact any measure that relates to farm size, is likely to lead to similar problems to those associated with sales classes. Farm size, although shown to be correlated to a certain extent with income, does not necessarily accurately reflect the distribution of income. If some assessment of the effect of support policies on income distribution is required then farms should be analysed in terms of income classes and not farm size.

The presentation of the results, and the use of measures to indicate the level of inequality associated with the distribution of support, raises a number of questions. The inequality measure used has been exclusively the Gini coefficient, with (in most cases) no justification for choosing this measure over any of the other possible inequality measures. Gregory (and to a lesser extent Josling and Hamway) at least discusses the use of the Gini coefficient and concludes that it is the best measure for the purpose of his research. Others, either do not attempt to quantify the degree of inequality (for example Brown, Bollman), or use the Gini with no explanation of the methodology (Bonnen, Boyne). Despite the work by Benson highlighting the possible problems, only Bell and Gregory appear to have taken heed.

One of the most striking aspects of the review is that little appears to have been learnt from previous work on the subject. In a large number of cases the early work is not even referenced. There is no general development and refinement over time. The later work, that of Blandford, Brown, and Bollman, does not progress further than earlier studies. In fact, some of the methods used in the 1970s by Josling and Hamway and Schultze could, arguably, be described as superior, in terms of gaining an overall impression of the distributional aspects of agricultural policy. Of course, it is possible to conclude, like Boyne, that the methods are dictated by data availability. However, even allowing for this limitation, there are other shortcomings with many of the studies.

The work examined relates to different aspects of inequality within agriculture. For this reason no one piece of work can be considered wholly comprehensive. Bell analysed data for just one region. Brown and Bollman ignored inequality measures. Ahearn *et al* used a comprehensive income definition but pushed agricultural support distribution into the background. Blandford (and others) assessed policies by sales class rather than income. Gregory and Boyne measured income distribution, but ignored the distribution of support. Robinson's analysis was subjective and intuitive. Bonnen used acreage classes in one study and a specific commodity in the other. Schultze produced the most comprehensive study, but the work is now twenty years old and relates to agricultural policy in America rather than in the EC. The work of Josling and Hamway was also comprehensive and, despite the criticisms concerning their use of the Gini coefficient, would appear to be a valid basis from which to begin.

The review, particularly of the articles concerning the UK or the EC, clearly suggests that there is a need for quantification of the distribution of support and income over a period of time. It would appear that with the UK in particular, the movement from national to European policies presents an ideal opportunity for an ex-post assessment of this kind.

The review highlights three main areas where the studies diverge; the definition of income, the grouping of farms and the use of inequality measures. The effect on measured inequality of altering any, or all, of the above has not been adequately addressed in previous studies and therefore gives scope for the present study. It is clear that any analysis should begin by addressing the problems of previous work. To this end, the next chapter will concentrate on the measurement of inequality, whilst Chapter 4 will consider other issues arising from this review.

Chapter 3 The Measurement of Inequality

3.1 Introduction

Economic inequality has long been the subject of much debate and a number of methods for measuring the degree of inequality have been proposed. The previous chapter whilst reviewing studies on the subject of income distribution, highlighted that all of those using inequality measures, opted for the Gini coefficient. It was also noted that Gregory (1986) had conducted a review of other possible measures. This chapter adopts the same approach as Gregory and examines a number of possible measures of inequality and looks critically at their relevance to the problem of assessing changes in the distributions under examination in this study.

In order to assess the validity of a measure, it is necessary to have some criteria upon which to judge it. A problem arises because "... there are no universal criteria that a desirable inequality measure should satisfy and therefore no universally acceptable summary measure." (Gregory, op. cit., p 49). If all measures gave similar results inthe ranking of distributions both cardinally and ordinally, then choice of measure would be simple. However, as Atkinson (1975) notes, different measures often yield conflicting results. Using results of Ranadive (1965) he shows that income in India is more unequally distributed than West Germany according to the coefficient of variation, less unequally distributed on the basis of the standard deviation of the logarithms of income, and ranks equally according to the Gini coefficient. This difference inevitably leads to the question as to which of the measures is to be accepted. It becomes clear, early in the study of inequality, that there are no right or wrong measures, only those that appear more relevant or useful to the particular study in question.

Dalton (1920) reasoned that accepting any measure, or citing criteria which it should satisfy, implies a certain form of Social Welfare Function (SWF). Atkinson puts forward a persuasive argument, that the analysis should be primarily concerned with the form of the SWF. If the SWF is defined, then a measure is given which eliminates the need for a given set of criteria that the measure should satisfy. The concept of social welfare and inequality will be discussed in more detail in a subsequent section. At this point it is only necessary to indicate that there is enough controversy surrounding the concept to make further analysis of inequality desirable.[14]

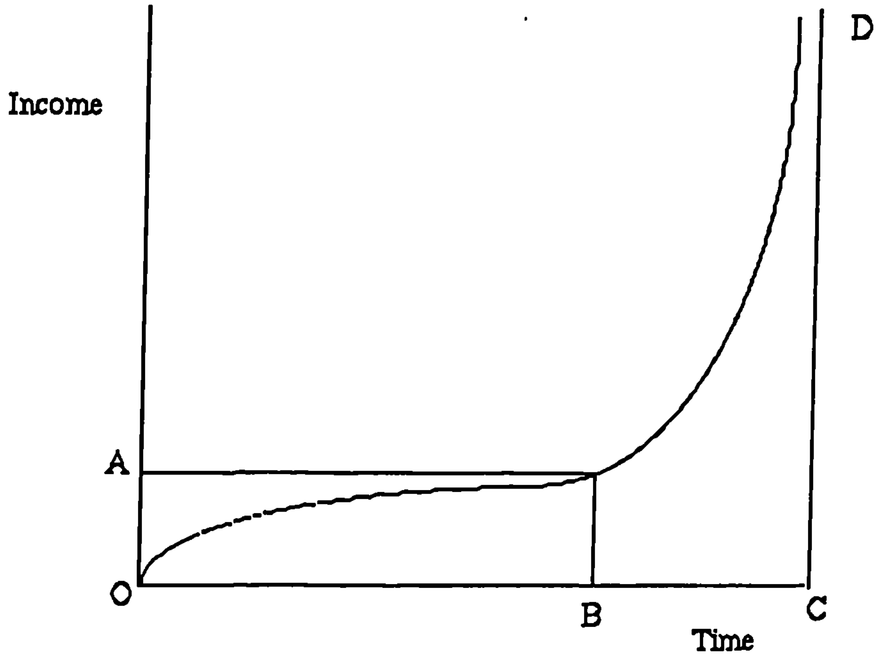
The procedure for this chapter will be to examine both the pictorial representation and summary measurement of inequality. Analysis of the summary measures will involve a brief description of the criteria that relevant measures should satisfy, a description of the measures themselves and finally an analysis of the criticisms levelled against specific measures.

3.2 Pictorial Representation of Income Distribution

A number of possible pictorial representations of the distribution of income have been devised. Four will be studied here, partly for general interest and partly because they introduce ideas which will be referred to later. Pen (1971) introduced a pictorial representation which he entitled 'The Parade of Dwarfs (and a few Giants)' whereby the population are given heights in proportion to their income, and the reader is asked to imagine watching them parade-by during a given time period. Figure 3.1. illustrates the resulting distribution. Line OC represents the length (in time) of the whole parade. The majority of the distribution consists of people with low height, representing low income. OB represents the point when the people of average height (income) go past. OA is therefore the mean level of income for the population. It is evident that average income is not reached until a relatively large proportion of the population have paraded by.

[14]Sen(1976) and Cowell (1977) both have reservations about the SWF approach, and these will be analysed in section 3.4.3.2.

Figure 3.1 The Parade of Dwarfs (and a few Giants)



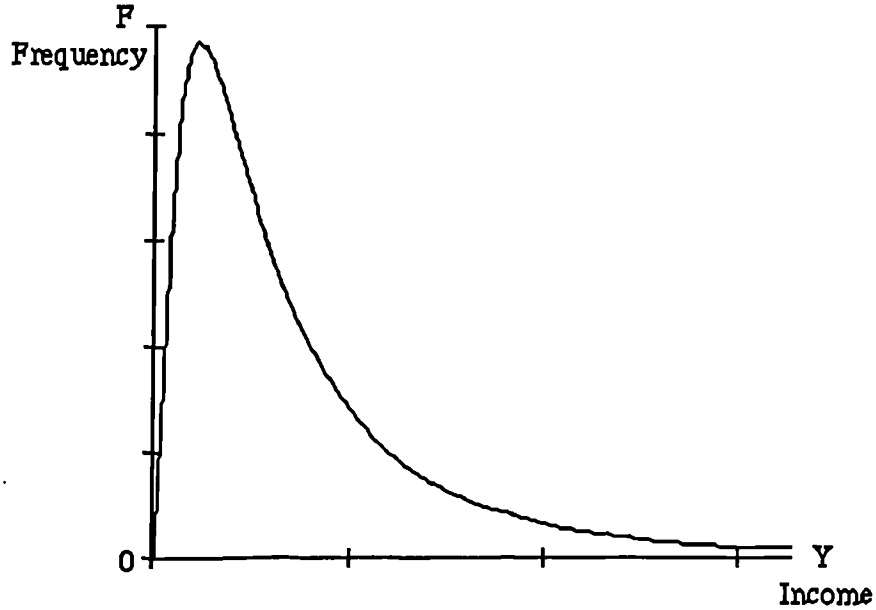
Source: Cowell (1977, after Pen, 1971)

The last few people to pass by are those of giant proportion, representing the wealthiest in society. This method of drawing the distribution illustrates the great differences in the extremes of income. It does not, however, give a clear picture of the middle of the distribution. Pen notes that this method of representing the distribution is not often found in economic or statistical textbooks.

The second pictorial representation, however, is widely used. The frequency distribution is used in many aspects of statistics and can be related to the distribution of income (Figure 3.2). It is obtained by plotting horizontally income classes, and vertically the number of income recipients falling into each class. This approach of charting inequality enables the middle of the distribution to be analysed in some detail (unlike Pen's Parade).

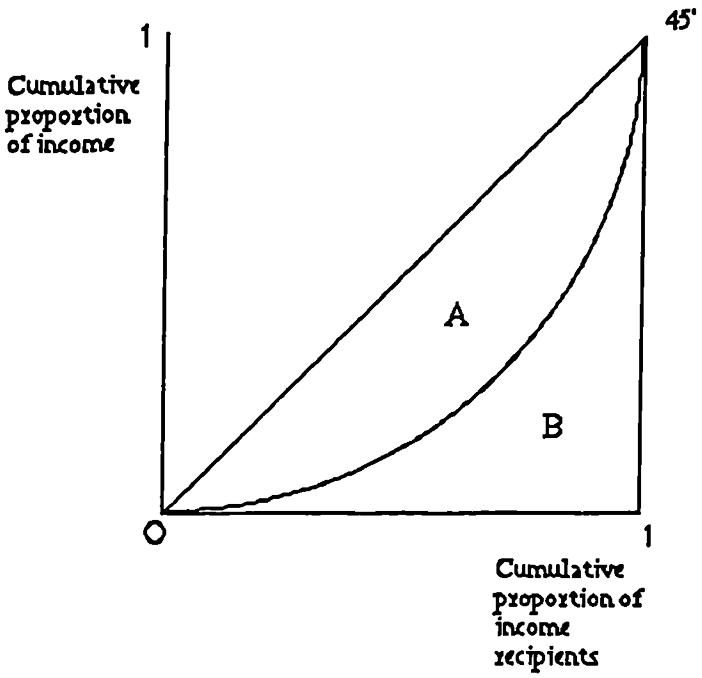
The major problem with the frequency distribution is the scaling along the horizontal axis. Either the right hand tail has to be ignored, or a scale that loses information on the middle incomes must be used. A frequency distribution on a log scale has been proposed as a solution to this problem. In a log form, equal distances along the OY axis represent equal proportionate differences in income. This makes it easier to analyse the right hand tail of the distribution. However, Cowell (1977) feels that this benefit is outweighed by the loss in ease of interpretation of the curve.

Figure 3.2 The Frequency Distribution



Perhaps the best way of pictorially representing the distribution of income was devised by Lorenz (1905) and, not surprisingly, is now known as the Lorenz curve (Figure 3.3). On the horizontal axis the cumulative proportion of income recipients (ranked by their level of income) is plotted. The vertical axis shows the proportion of total income which goes to a given proportion of the population. It is therefore possible to examine the proportion of total income that, for example, the bottom 25% of the population receive. If everyone receives the same income then the Lorenz curve will simply be the leading diagonal, known as the line of complete equality. The further the curve is away from the leading diagonal, the more unequal the distribution. The Lorenz curve gives a good pictorial representation of inequality but, as with the other diagrams mentioned, it does not quantify the level of inequality. However, as will be shown in section 3.4, a measure that does quantify inequality can be derived directly from the Lorenz curve.

Figure 3.3 The Lorenz Curve



The need for more information about the degree of inequality takes the analysis past the simple diagrammatic approach and onto procedures for measuring the degree of inequality.

3.3 Criteria for Identifying Suitable Inequality Measures

In the introduction to this chapter it was suggested that there were no universal criteria upon which to base the choice of inequality measure. However, a way around this problem is to set out the criteria which appear to have a wide range of support and use these to judge the suitability of different measures. This section therefore brings together the analysis of Champernowne (1974), who put forward seven criteria that a measure should satisfy, with Cowell (op cit.) and Atkinson (op cit.) who put forward their own criteria. Each have slightly varying ideas as to what properties are really important for a measure to possess. However, they basically agree on four major criteria which will now be outlined.

1) *Income Scale Independence* (invariance with respect to proportional additions to income)

Measured inequality should not depend on the size of the cake. If everyone's income changes by the same proportion then it can be argued that there has been no essential alteration in the income distribution, thus inequality is the same. This criteria is not universally accepted. For example, Atkinson proposes that it may be desirable for a measure to indicate Increasing Relative Inequality Aversion (IRIA). This is based on the following line of reasoning. As incomes rise, society can afford to be more concerned with inequality and therefore the measure chosen should show an increase in inequality. Gregory (op. cit.,p 70) argues "...that unless one is concerned with making value judgements there is no reason to take other than a neutral view, i.e. that proportionate changes in all incomes does not alter inequality". He also argues that if a measure does not satisfy this criterion then it is likely to be dependent upon the units of measurement used (for example, if income was measured in pounds, then a different level of inequality may be obtained than if it was measured in pence) which would in turn lead to other problems when comparing the distribution between countries.

2) *Principles of Population* (invariance with respect to the number of individuals receiving income).

An inequality measure should not be affected when the total number of persons is increased, if the proportional distribution of persons along the income scale remains unaffected. If two identical distributions are merged into one, measured inequality should not be altered. This is also known as 'Dalton's Principle of Proportional Additions of Persons'.

3) *Principle of Transfers.*

The principle of transfers refers to the argument that, within a specified distribution, if a transfer of income is made from a richer person to a poorer one, such that the richer one is still better off, then the level of measured inequality should be reduced. Cowell splits this up into two parts the weak and the strong principle of transfers. A measure satisfies the weak principle of transfers if a transfer of the above nature reduces inequality. The strong principle argues the change should vary with the distance between the incomes concerned (Atkinson showed that any measure that satisfies this principle will rank in the same order any two distributions whose Lorenz curves do not intersect).

4) *Impartiality between persons.*

This assumption allows the measure of inequality to be calculated simply from the frequency distributions of income (one such distribution is illustrated in Figure 3.2) without requiring information about other characteristics by which individuals are ranked within a distribution. Champernowne (op.cit) feels that this could be disadvantageous because the relationships between income, wealth, race, health etc. (factors which Sen defines as those which influence a person's social state) are ignored. However, as it is the level of income with which we are primarily concerned, then equal weighting between persons would appear valid.

In addition to the above four criteria, Champernowne argues that a measure should be defined between 0 and 1 to simplify the interpretation of results. Cowell disagrees for three reasons. First, a finite maximum value of inequality is not necessarily desirable. Second, many of the ways of transforming a measure, so that it ranges from 0 to 1, lead to an alteration of its cardinal properties. Third, it is possible for virtually all measures to be normalised because they have a finite level. Therefore, division through by the maximum value will result in a normalised measure without loss of cardinal powers.

Having examined a number of criteria that a measure of inequality should satisfy it is now possible to describe various measures and assess their validity.

3.4 Possible Measures of Inequality

In this section a number of measures will be described briefly and their fulfilment of the criteria mentioned above will be evaluated. Those that do not satisfy the criteria will be rejected. However, even those measures that fulfil the basic criteria may be rejected on other grounds. Sen (op.cit.) splits the available measures up into two distinct groups, which he describes as "positive measures which make no explicit use of any concept of social welfare, and normative measures which are based on an explicit formulation of social welfare and the loss incurred from unequal distribution" (p 24). This section will follow the same reasoning with the positive measures analysed first. The approach will be initially to describe the measures, and then analyse the criticisms of them.

3.4.1 Positive Measures of Inequality

The following notation is used throughout this section.

μ = mean level of income.

y_i = the level of income of the ith person.

n = number of individuals in the population.

1) Range (R)

$R=y_i^{max} - y_i^{min}$ where y_i^{max} is the highest income in the distribution and y_i^{min} is the lowest.

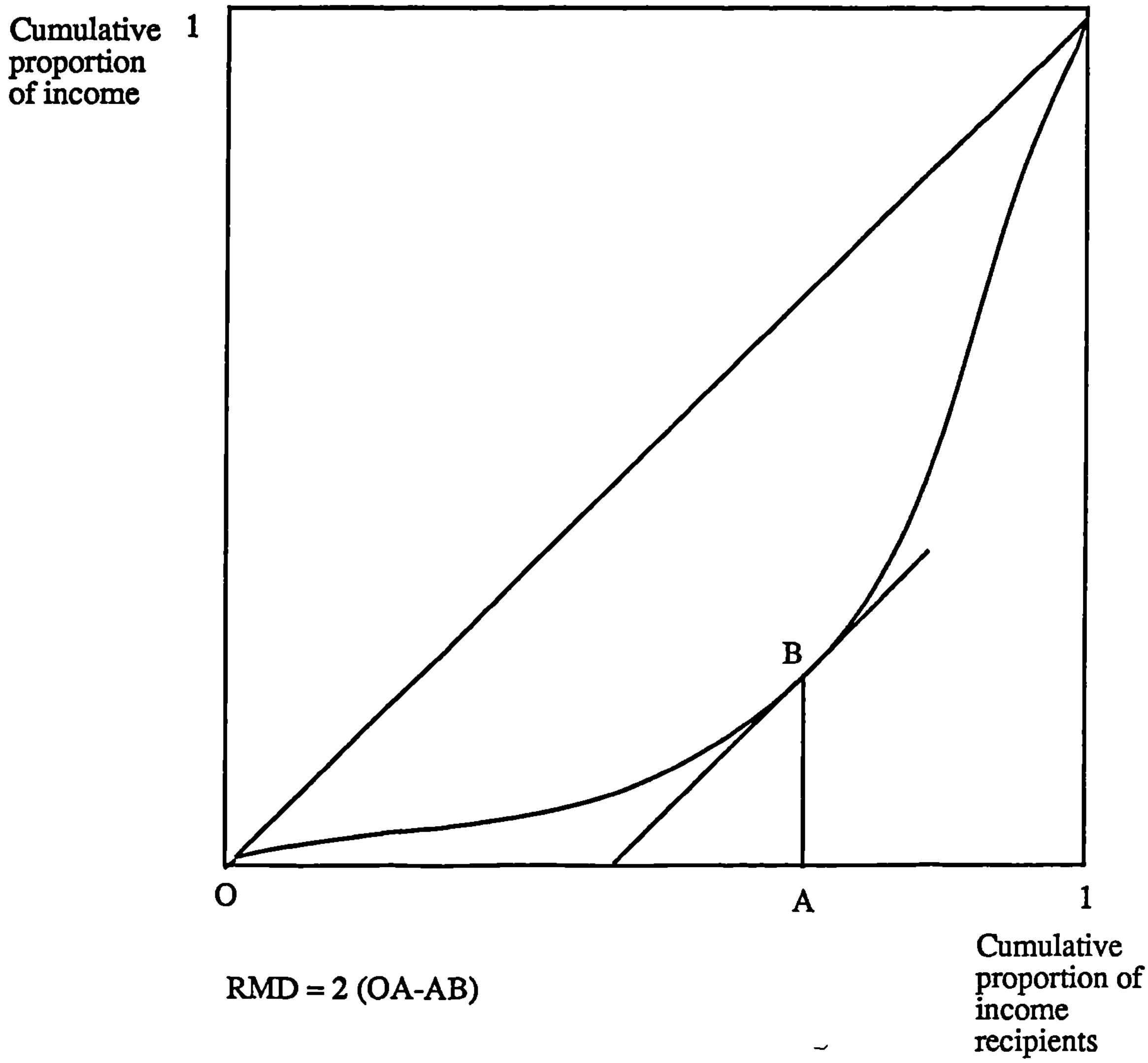
This is probably the simplest measure of inequality and is the distance between the lowest and highest incomes in a distribution. This distance between extremes of the population is the only information given by the range.

2) Relative Mean Deviation (RMD)

$$RMD=\sum_{i=1}^{n} |y_i-\mu| /n\mu$$

The RMD is obtained by measuring differences between each person's income and the mean; these differences are then summed and this sum is expressed as a proportion of total income. In relation to the Lorenz curve, this is equal to the maximum discrepancy between a population's Lorenz curve and the line of equality. A graphical illustration of the RMD is given in Figure 3.4, where B is the point of maximum discrepancy between the Lorenz curve and the line of total equality (the point where a line parallel to the line of equality is tangential to the Lorenz curve). Point A represents the cumulative proportion of the population at this point. The RMD can be defined as 2(0A-AB). The RMD is clearly an improvement over R, because it examines the whole distribution and not just the extremes.

Figure 3.4 Graphical Illustration of the Relative Mean Deviation



RMD = 2 (OA-AB)

Source: Gregory (1986, adapted from Atkinson, 1975, p56)

3) The Variance (V) and the Coefficient of Variation (CV)

$$V=\sum_{i=1}^{n} (y_i-\mu)^2 /n$$

The use of the Variance and the Coefficient of Variation highlight the relationship between statistical measures of dispersion and the measurement of inequality. V is obtained by measuring the distance between the individuals income and the mean, squaring this, and then finding the average for the population. As V is not defined relative to the mean then, if all incomes were to double, the measure of inequality given would quadruple. It is possible to overcome this problem by calculating the CV, which is simply the square root of V divided by the mean income level.

$$CV=\sqrt{V}/\mu$$

The CV is thus independent of the mean income level.

4) The Variance of Logarithms (VL) and the Standard Deviation of Logarithms (SDL)

$$VL=\sum_{i=1}^{n}(\log y_i-\log \mu)^2/n$$

$$SDL=\sqrt{VL}$$

These measures exhibit similar properties and are therefore dealt with together. They are considered useful as inequality measures, because taking the logarithm of the income value removes the arbitrariness of the units used and therefore of absolute levels (unlike V). Sen (op.cit.) points out that the SDL has frequently been used as a measure of inequality. However, there is a difference between the standard statistical literature and the income distribution literature. In the former the deviation is taken from the geometric mean whilst in the latter it is taken from the arithmetic mean. Taking logarithms tends to reduce the level of inequality because it reduces the deviation around the mean.

5) The Gini Coefficient (G)

The Gini coefficient is attributed to Gini (1912) and has been widely used and developed since (for example, see Yitzhaki, 1983). G can be viewed in terms of the

Lorenz curve. If Figure 3.4 is examined, G is simply the ratio of the area between the line of complete equality and the Lorenz curve, to the total area under the line of equality (A/[A+B]). If income was perfectly equally distributed then G would equal zero. If income was perfectly unequally distributed, i.e. one individual had all the income, then G would equal 1. Sen shows that G is equal to half the relative mean *difference* (not to be confused with the RMD), which is the arithmetic average of differences between all pairs of incomes (y_i and y_j).

$$G = \left(\frac{1}{2n^2\mu}\right)\sum_{i=1}^{n}\sum_{j=1}^{n} |y_i - y_j|$$

$$= 1 - \left(\frac{1}{n^2\mu}\right)\sum_{i=1}^{n}\sum_{j=1}^{n} \mathrm{Min}\ (y_i, y_j)$$

$$= 1 + \left(\frac{1}{n}\right) - \left(\frac{2}{n^2\mu}\right)\ [\,y_1 + 2y_2 + \ldots + ny_n]$$

for $y_1 \geq y_2 \geq \ldots y_n$

The G has the advantage that it avoids relying on differences between the level of income of the individual and the mean level of income. Unlike the CV or the SDL, it does not rely on the arbitrary squaring of the figures, nor does it rely on the units of measurement.

6) Theils Entropy (T).

This measure has its roots in information theory. The Entropy of Income Share [H(y)] is defined as the weighted average (by income shares) of the logarithms of the reciprocals of each income share and can be defined in the following way:

$$H(y) = \sum_{i=1}^{n} p_i \log\left(\frac{1}{p_i}\right)$$

where p_i=fraction of total income earned by the 'i'th individual in population size n.

It can be shown the H(y) ranges from zero, when income is perfectly unequally distributed, to log (n) when income is perfectly equally distributed. Theil's index is thus defined as:

$$T = \log n - H(y)$$

$$= \sum_{i=1}^{n} p_i \log np_i$$

The index ranges from 0, when income is equally distributed, to log (n), when income is perfectly unequally distributed. Theil's Entropy satisfies two of the four criteria examined earlier, it is impartial between persons and invariant to equal proportional increases in income.

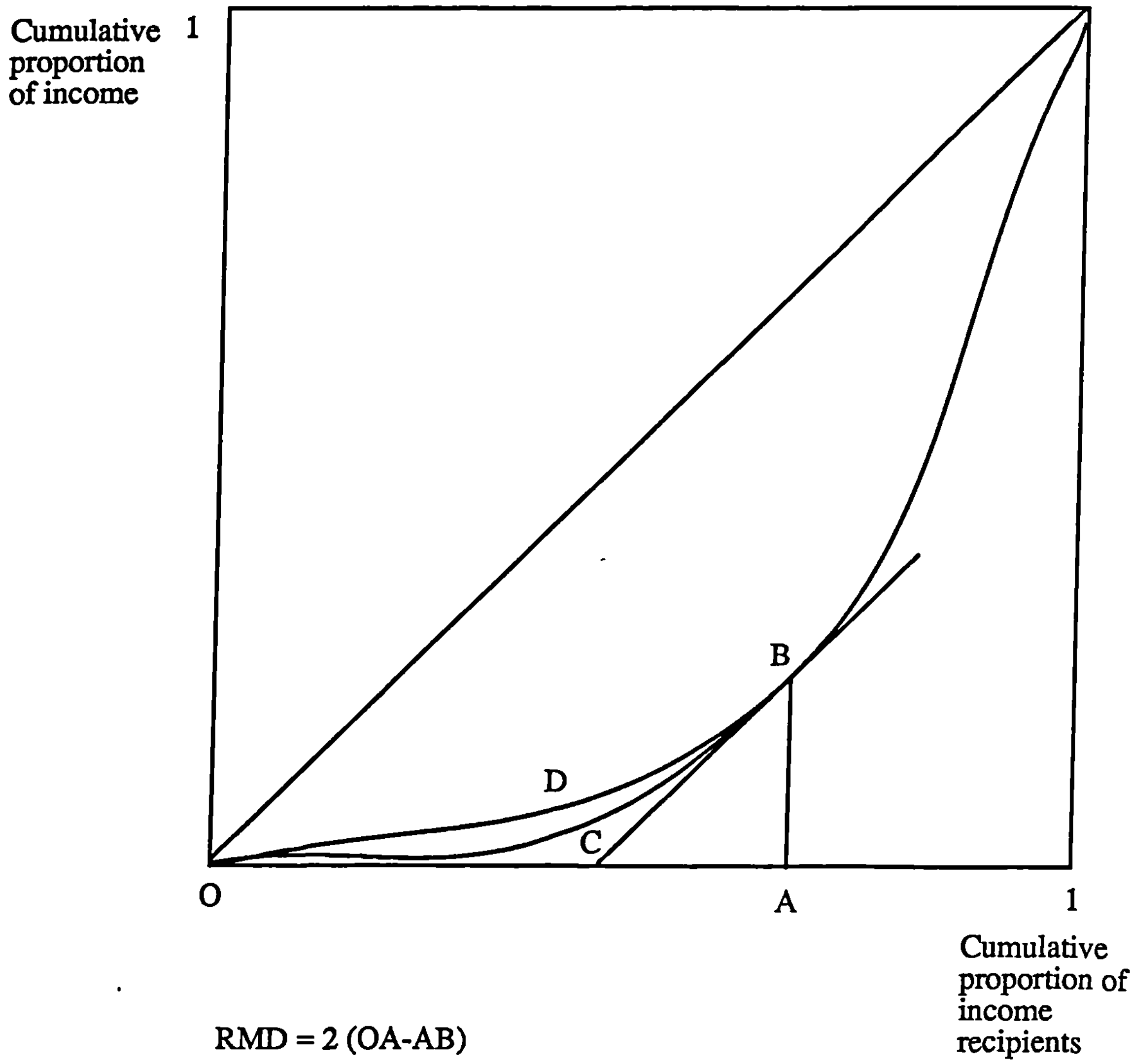
3.4.2 Criticisms of the Positive Measures

This section outlines the criticisms that have been made against the measures already mentioned and highlights why some economists prefer the use of normative measures.

The Range takes no account of the distribution between the two extremes. Therefore, it is possible for two distributions to have the same value for R, where one has the rest of the population distributed evenly between the two points and the other has them all at the bottom end of the distribution. Obviously these distributions are very different and to call them 'equal' would be illogical.

The RMD, although examining the whole population, does not satisfy criterion 3 (the principle of transfers). A redistribution between two individuals on the same side of the mean has no effect on the RMD. Figure 3.5 illustrates this point. A redistribution which shifts the bottom part of the Lorenz curve inwards from C to D should indicate a reduction in the level of inequality. However, the value of the RMD has not changed, and thus it is difficult to accept the RMD as a valid measure of inequality.

Figure 3.5 The Relative Mean Deviation and the Principle of Transfers



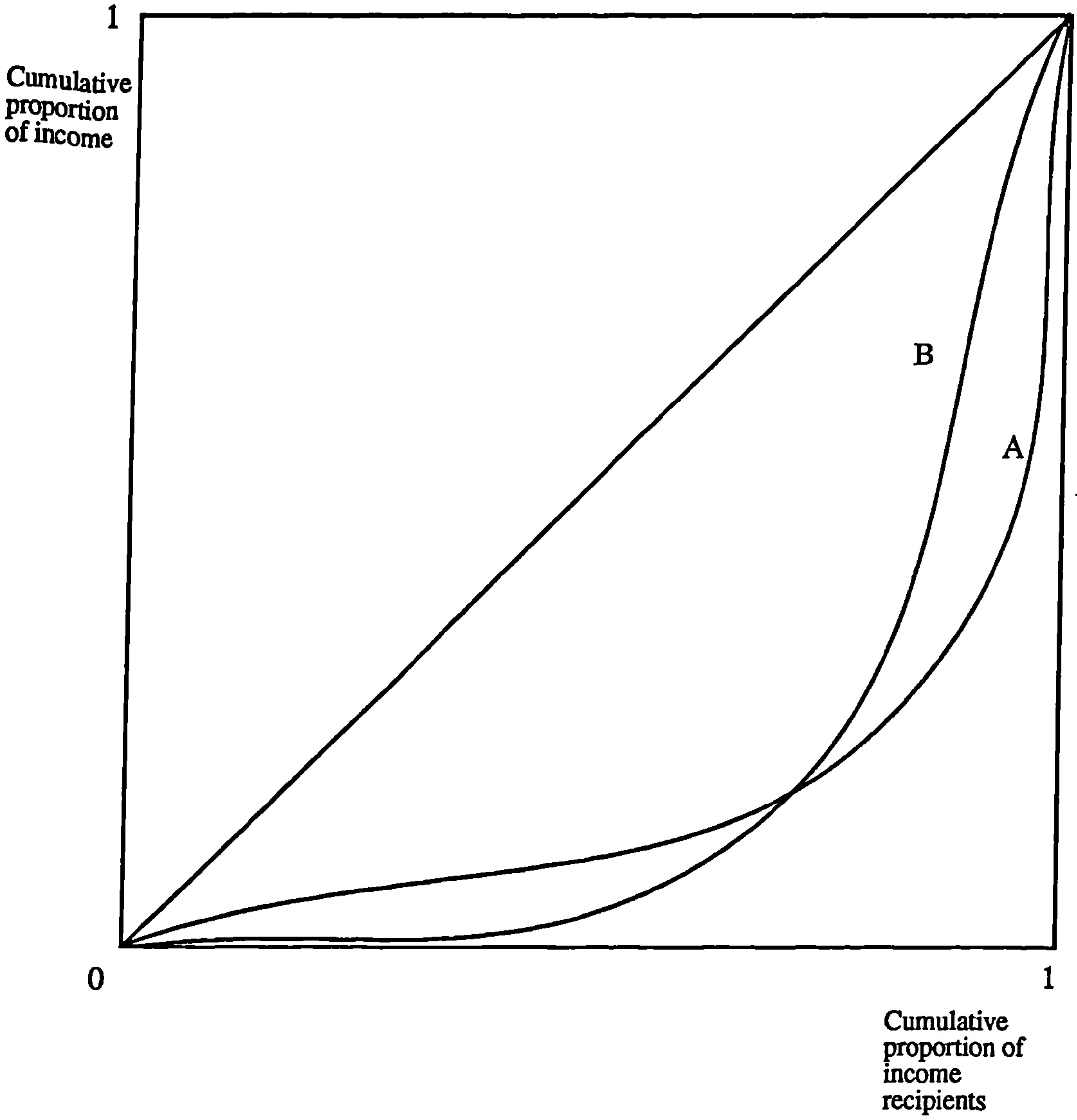
Source: Gregory (1986, adapted from Atkinson, 1975, p56)

The Variance, as already mentioned, has the property that a doubling of the values leads to a quadrupling of the measured level of inequality. This results in V not satisfying criterion 1 (invariance to proportional additions to income). The measure is influenced by the units of measurement and indicates that a scaled-up version of a distribution is more unequal than the original distribution. It can be concluded that V is not likely to be widely accepted as a useful measure.

Theil's Entropy lacks intuitive appeal and some authors criticise the measure because it has no economic rationale, see Sen (op.cit). Champernowne found it to be the least sensitive to transfers at the lowest end of the distribution, which infers that the implicit assumptions about social welfare involved in the measure are not appealing. It also does not satisfy criterion 2 (principles of population). If two identical distributions are combined the resulting distribution illustrates less inequality than did the distributions separately.

The other 3 measures, G, SDL, CV, all satisfy the four criteria, but Atkinson argues against blind acceptance on the grounds of their underlying concept of social welfare. It is true that they are all sensitive to transfers between individuals and that they will all show a reduction in inequality in accordance with criterion (3). However, it is their relative sensitivity to transfers that is questioned. Atkinson illustrates this point by examining two Lorenz curves (A and B) deriving from the same total level of income (see Figure 3.6). The curves intersect once, and it is clear that distribution A is more equal at the lower levels of income and that distribution B is more equal at the higher income levels. It is possible to redistribute income in A so that the distribution is the same as in B. This could be achieved by taking income from the poor and the rich and giving it to the middle income earners. Atkinson shows mathematically the relative sensitivity of the different measures, when the transfers of income become infinitesimal.

Figure 3.6 Intersecting Lorenz Curves



Source: Atkinson (1975)

Atkinson shows that the CV gives equal weight to transfers anywhere in the distribution and is good at measuring changes in the high end of the distribution. The SDL is more sensitive to transfers at the low end of the distribution, and G gives more weight to transfers in the middle of the distribution. A transfer between a person with £10,000 to one with £9,000 will, according to G, reduce inequality more than the same transfer from a person with £600 to one with no money. It would seem reasonable to argue that the latter transfer would do more to reduce inequality. The SDL would show the latter transfer to reduce inequality to a larger extent (and therefore can be considered preferable to G), but would not be sensitive to transfers at high levels of incomes. According to Cowell, if a transfer occurs to an individual with an income of over 2.72 times the mean level from an individual on a higher income, measured inequality will actually rise. This occurs because the log of the higher income falls less than the log of the lower income rises, leading to an increase in the mean. As all the observations are defined relative to the mean, the increase in the difference for those incomes under the mean will be greater than the fall of those above the mean, which will lead to an increase in measured inequality. For this reason, and despite Gregory's decision that it is valid to use the SDL because it is only in extreme cases that it fails the Principle of Transfers, the SDL is discarded here as a valid measure.

The CV would give equal weight to a transfer of a £1 between a person with £60,000 to one with £50,000 as to one between a person with £1,000 and one with £900. Sen, Cowell and Atkinson all question whether this is a desirable quality. On these grounds, and because it involves the arbitrary squaring of the figures and is therefore not really as 'direct' a measure as the Gini, it is not considered acceptable to use this measure of inequality.

It has been shown that all the positive measures have potential weaknesses and can be criticised on these grounds. It may therefore be reasonable to assume that the measure chosen should be normative. However, as will be seen in the next section, normative measures, although overcoming some of the problems of the positive ones, are themselves open to criticism.

3.4.3 Normative Measures of Inequality

In section 3.1 it was noted that some economists felt that the analysis of inequality should be concerned with social welfare and that it was impossible to measure inequality without first specifying the underlying Social Welfare Function (SWF). For this reason, a brief definition and description of SWFs will be given. This will facilitate the understanding of the underlying properties which a SWF incorporates. That is, it is a symmetric, additively separable, strictly concave function of individual's welfare.

3.4.3.1 Social Welfare Functions and Their Applicability to Measuring Inequality

As can be imagined, the study of social welfare is a far from straightforward exercise. It is possible to simplify the analysis, to a certain extent, in that it is inequality with which we are primarily concerned. This makes it necessary only to relate those concepts of social welfare that are useful for the derivation of inequality measures. Cowell (op.cit.) gives a simplified description of the properties of SWFs and it is valid to use his work to aid understanding of the derivation of the normative measures under consideration.

A SWF ranks all possible states of a society in order of that society's preferences. In its simplest form, a SWF orders states unambiguously: If state A is preferable to state B then the SWF will be higher for state A than for B. States could be a function of a number of items, such as personal income, wealth, the number of cars and so on. What is socially desirable can be decided by unions, dictators, academics etc. Of more importance are the characteristics used to define a state. These need to be specified in advance which makes it possible to examine their individual merits.

Cowell suggests five qualities that it is desirable for a SWF to have.

1) The SWF is individualistic and non-decreasing.

For any state A: $WA=(y_1A, y_2A, \ldots y_nA)$

then, if $y_iB \geq y_iA$ it follows that $WB \geq WA$.

where WA and WB are total welfare in State A and B respectively.

This infers that welfare (W) in state B is at least as good as that in A. The assumption of individuality infers that welfare values are related to the income of individuals. If one person's income rises *ceterus paribus* then the total level of welfare cannot fall. It is assumed that every one has the same needs and deserts. This allows the straightforward comparison of individual levels of welfare and the differences between these levels.

2) The SWF is symmetric.

This assumes that the value of W does not depend on the particular assignment of labels to the population, that is:
$W(y_1, y_2, \dots y_n) = W(y_2, y_1, \dots y_n) = W(y_n \dots, y_2, y_1)$. This property follows from (1), because if we assume everyone is equal (in terms of standing) there is no reason for welfare to change if two individuals simply swapped incomes.

3) The SWF is additive

This occurs if

$$W(y_1, y_2, \dots y_n) = \sum_{i=1}^{n}(U_i(y_i)) = U_1(y_1)+U_2(y_2) \dots +U_n(y_n)$$

Where U_i is a function for y_i alone.

From qualities 1, 2 and 3 it is possible to define the welfare index (W) as
$W = U(y_1) + U(y_2) \dots + U(y_n)$

where U is the same function for each individual and $U(y_i)$ is the welfare index for the ith individual. It is also possible to show that the rate of change in the welfare index is $U'(y_i) = \partial U(y_i) / \partial y_i$. This can be defined as the welfare weight for the ith individual. This assumption is quite strong, inferring that if the difference in welfare for state B over state A is examined, where the only change is an increase in one person's income in A from say £1000 to £2000, then the effect of the change is independent of the levels of income in the rest of state A.

4) The SWF is strictly concave.

This is satisfied if the welfare weights always decrease as income increases. The welfare index is not a strict utility function, it represents the valuation given by society to an individual's income. Cowell defines the social utility function (which is the concept corresponding to social marginal utility) as the quantity $U'(y_i)$. This is the welfare weight attached to each person's level of income. Cowell defines it as the welfare weight for the following reason. If a government programme brings about a small change in everyone's income ($\Delta y_1+\Delta y_2...+\Delta y_n$) the change in welfare is $\Delta W = U'(y_1).\Delta y_1 + U'(y_2).\Delta y_2 ... + U'(y_n).\Delta y_n$. The U's, therefore, are a system of weights which measure the effect of a change in income on the whole population. These weights are fixed by strict concavity, so as income rises the social weight will fall. This gives the SWF the 'attractive' property that if income is redistributed from a richer to a poorer person then that society's welfare will increase.

5) Constant elasticity or constant relative inequality aversion.

$$U(y_i) = \frac{1}{1-\varepsilon} y_i^{(1-\varepsilon)}$$

If the U function is restricted in this way then it is possible to tell by how much a redistribution will effect welfare. If a person's income rises by 1% from say £100 to £101 or from £10,000 to £10,100 then their welfare weight will decline by ε%. The higher ε the faster the proportional decline in the welfare weight to the proportional increases in income. For this reason ε is called the inequality aversion parameter. It represents "...the strength of yearning for equality vis-a-vis higher incomes for all"

(Cowell, p 45).[15] It is useful to illustrate numerically how differing values of ε reflect different attitudes to inequality.

Take two people, R and P, with R having 5 times the total income of P. In this case ε measures the desire of society to reduce the inequality between these two individuals. If society is at all averse to inequality, it would appear valid to take £1 from the richer person (R) to give it to the poorer one (P). However society may take 5^{ε} off R to give one pound to P. If $\varepsilon=0$ then it would be willing to take one pound from R to give to P. If however, $\varepsilon=1/2$, then society is willing to take £2.24 off R in order to give £1 to P (the remainder of the £2.24 can be assumed to be the deadweight loss of the transfer). If ε increases to 1, then society will accept £5 being taken from R to give just £1 to P. So as ε increases society is willing to accept a greater reduction in total income in order that inequality is reduced.

In the above analysis, the work of Cowell has been used to give a basic understanding of the concepts underlying SWF and the assumptions made in order to construct them. The next section illustrates how Dalton's (op.cit.) and Atkinson's (op.cit.) work relates to them.

3.4.3.2 The Definition and Derivation of Dalton's and Atkinson's Indicies

According to Atkinson, the traditional approach has been to adopt a summary statistic of inequality with no explicit reason for choosing one over another. His approach is to consider directly the type of SWF to be employed. Dalton (op.cit) suggested that the SWF should be additively separable and a symmetric function of everybody's income. The utility function should be strictly concave, illustrating diminishing marginal utility, and every individual should have the same function. These assumptions (based on the

[15] The ε function will appear later, in the derivation of Atkinson's Index.

qualities outlined above) ensure maximisation of welfare if income is equally divided between everyone. Dalton's Index (DI) can be defined as the ratio of the actual level of social welfare to that which would arise if income was equally distributed.

$$DI=\left[\sum_{i=1}^{n}U(y_i)\right]/nU(\mu)$$

Atkinson criticises Dalton's measure because it is not invariant to linear transformations of the utility function, which means that it is dependent on the units of measurement used. In addition, Cowell shows that in certain cases the addition of a constant to the utility function will lead to a change in the level of inequality as measured by the index. Sen defends Dalton's measure on the grounds that it is only in certain cases that the measure is altered in this way.

Atkinson proposes his own normative measure which he describes as the equally distributed level of income (y_{EDE}), or the level of income per head which, if distributed equally, would give the same level of social welfare as the present distribution. It can be defined as:

$$U(y_{EDE})\int_0^y f(y)\,dy = \int_0^y U(y)\,f(y)\,dy$$

where f(y) is the frequency distribution of what Atkinson terms, for convenience, income, and where U(y) is such that welfare= $\int U(y)\,f(y)\,dy$. Atkinson's Index (AI) is therefore:

$$AI = 1-y_{EDE}/\mu$$

This is, unity minus the ratio of the equally distributed level of income to the mean of the actual distribution of income. The measure has the benefits that it lies between 0 and 1 and that, in Atkinson's words, it is intuitively appealing. If, for example, AI=0.3, then it is possible to infer that if income was equally distributed, only 70% of the present total national income would be needed to achieve the same level of social welfare (according to the function chosen). It is possible to state that a plan to redistribute income would be equivalent to a percentage rise in y_{EDE}. This measure therefore facilitates the comparison of the gains from redistribution with the costs that may be incurred. Gregory (op.cit.) notes that a possible way of deriving the index, if the exact form of f(y) is not known but actual data are available, is as follows:

$$AI=1-\left[\sum_{i=1}^{m}\left(\frac{g_i}{\mu}\right)^{1-\varepsilon} f(g_i)\right]^{1/(1-\varepsilon)}$$

where g_i denotes the total number of those in the ith income range

m denotes the number of income ranges.

f denotes the proportion of the population with incomes in the 'i' th range.

μ denotes the mean income.

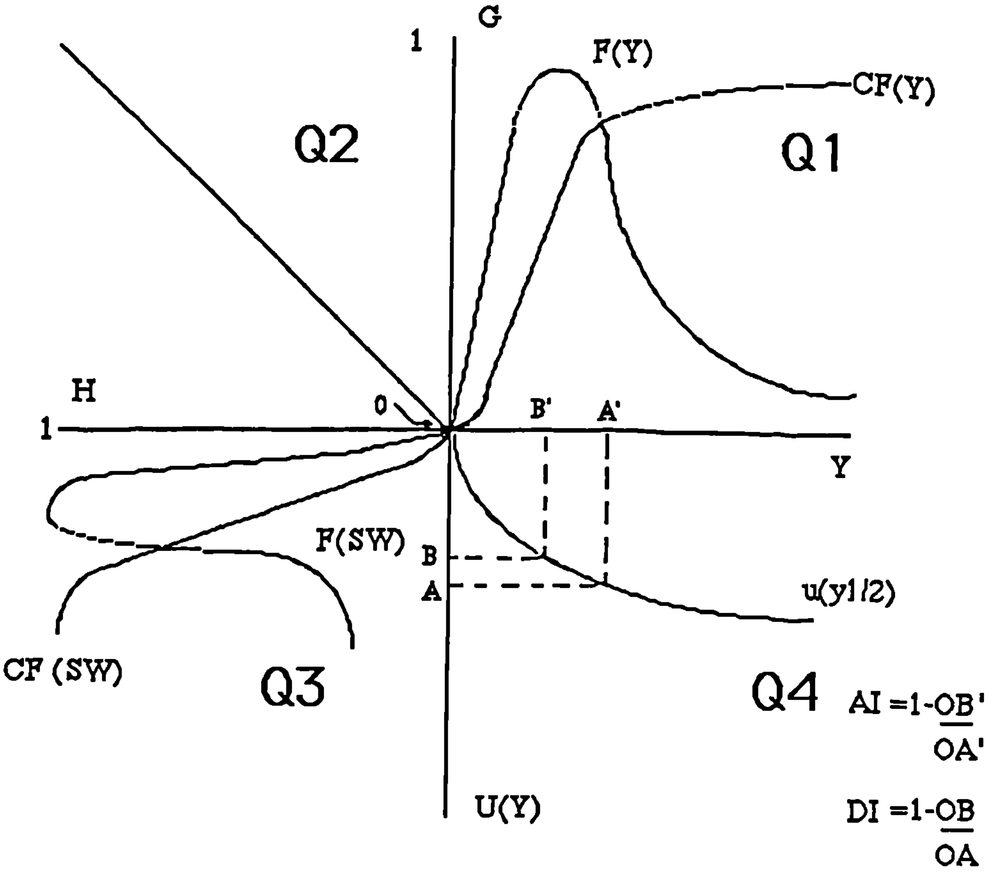
ε is the inequality aversion parameter

The measure depends heavily on the value of ε and it is this that leads to discussion as to the validity of this approach. The problem is in assessing a value for ε for a particular society. If that society is inequality averse then a high value of ε would be required. If it was not worried about equality then a low value of ε would be more appropiate. To what extent a society is inequality averse is not easy to measure.

The concepts behind both Dalton's and Atkinson's measures are harder to grasp than those associated with the positive measures. However, Cowell presents these measures in a diagrammatic form which facilitates understanding. Figure 3.7 illustrates a method by which the measures can be derived.

Quadrant 1 (Q1) shows a frequency distribution for income F(Y), of the type illustrated in Figure 3.2. The cumulative frequency CF(Y) is also plotted, showing the proportion of total income which the population up to that income class commands. A SWF with an ε value of 1/2 (this is the arbitrary part of the analysis) is plotted in quadrant 4 (Q4) with the utility of income U(Y) measured on the vertical axis. Cowell chooses this value of ε, because it ensures that the function is bounded within the quadrant. Quadrant 2 (Q2) is used simply to reflect quadrant 1 into quadrant 3 (Q3). Quadrant 3 is thus the frequency distribution of welfare associated with the distribution of income and the SWF under analysis. It is derived in the following way. Take any level of income along the OY axis, read off from CF(Y) in Q1 the proportion of the population that receives this income. Also read off from Q4 the level of social welfare associated with this income. Reflect both these values into Q3 to produce a cumulative frequency curve for social welfare CF(SW). If this is repeated for all values of income then it is possible to plot the total cumulative frequency curve for social welfare, enabling a frequency distribution for social welfare F(SW) to be derived.

Figure 3.7 The SWF approach to measuring inequality.



Source: Cowell (1977)

On the diagram it is possible to derive both Dalton's and Atkinson's indicies. Point B on the OU(Y) axis represents the mean level of social utility associated with the distribution in Q3 and point A' on the OY axis indicates the mean level of income for the distribution in Q1. To derive Dalton's measure it is necessary to use Q4 to reflect A' onto the OU axis (shown as point A). Point A can be defined as the level of social utility corresponding to the mean level of income. The distance OA is therefore the social utility of the distribution were income to be distributed equally (according to the chosen SWF). Dalton's measure can be described as the amount actual social utility (OB) falls below potential social utility (OA) (if all incomes were distributed equally).

$$DI = 1 - \frac{OB}{OA}$$

Atkinson's index can be illustrated on the axis of the original distribution (OY). Using Q4 again, but this time to reflect point B onto the OY axis (as point B'). B' is the level of income corresponding to average social utility. The distance OB' represents the level of income, which if received by each member of the community would result in the same level of social welfare as the existing distribution yields. Necessarily OB' ≤ OA' because, as mentioned earlier, we can throw away some of the national income, redistribute the remaining equally (according to the SWF chosen) and still have the same level of social welfare. Atkinson's Index can therefore be defined as unity, minus the ratio of the level of income which if distributed equally would generate the same level of social welfare (OB'), to that of the average income of the distribution (OA').

$$AI = 1 - \frac{OB'}{OA'}$$

A brief description of both Atkinson's and Dalton's Indicies has been given. What is clear from the above analysis is that the degree of inequality measured depends heavily on the SWF used. Sen criticises Atkinson's index on the following grounds. He notes that Atkinson requires that the SWF be concave but not necessarily strictly concave. If a U(y) function is chosen that is proportional to income, and a given level of income (10) is distributed between two individuals either as (0,10) or (5,5), then according to the index they will indicate the same level of inequality. This illustrates two points about the weakness of the index. First, because it is based entirely on a normative formulation, the measure of inequality has ceased to have the descriptive content that is associated with its normal usage, and the idea of inequality has become dependent on the form of welfare function. In the normal understanding of the concept of inequality, it would appear nonsense to say that the distributions mentioned exhibit the same level of inequality. Second, Sen criticises the assumption of individuality, because he claims that changing one person's income will have an effect on others.

Gregory (op.cit.,p 50) argues against the normative approach on the grounds that "... once an explicit value judgement has been made then a measure will be of more limited use and may not be acceptable to those that do not subscribe to the given SWF". This is a weak argument, because if the SWF is formulated correctly then it is likely to generate more support than many of the positive measures with implicit SWFs. Despite the criticisms, Atkinson's approach is a valid way to overcome the problem that implicit in the conventional measures is some form of assumption about inequality aversion which might not necessarily be desirable. A possible way of viewing this index is "You tell me how strong society's aversion to inequality is and I will tell you the value of the inequality statistic" Cowell (p 54).

3.4.4 Conclusions on Measures of Inequality

A number of possible inequality measures have been defined and analysed. It has been shown that no one measure can be unambiguously defined as being the right measure. Each measure has some faults, some of which are serious enough to warrant the exclusion of the measure from further analysis. Of the positive measures the Range and the Variance are shown to have major shortcomings and therefore can be discarded. The Relatve Mean Deviation fails only one of the criteria laid down, but it is a sufficient weakness to justify excluding it from further analysis. It is possible to discard the RMD because there are a number of other measures which, as well as being easily understood, satisfy all the criteria. The choice between these other measures becomes more subjective. They all satisfy the major criteria the majority of the time. The Standard Deviation of the Logarithms of income can however be rejected on the grounds of failing to satisfy the principle of transfers for redistributions that occur at high income levels. It may be valid in some cases to use the SDL, as it has been shown to be particularly sensitive to transfers at the lower end of the distribution, enabling analysis of inequality resulting from large numbers of low income recipients. However, other measures are available that always satisfy the principle of transfers, so use of the SDL becomes unnecessary. The choice between the Coefficient of Variation and the Gini comes down to choosing between two measures that satisfy all criteria all of the time. However, it is still possible to choose between them on other grounds. G is a very direct measure and, unlike CV, does not rely on an arbitrary squaring of the numbers, is easy to calculate and is not defined relative to the mean. On these grounds G is preferable to CV and will be used in this study to measure inequality in preference to the other measures considered.

There still remains the underlying concept of social welfare involved in accepting G. It is reasonable therefore to advocate use of a normative measure for the analysis of income distribution. The normative measures are shown to be conceptually more difficult, but have the advantage of allowing the specification of the level of inequality aversion in the particular society under examination. The choice is between Atkinson's and Dalton's indicies. The fact that Dalton's measure is not invariant with respect to some transformations of the utility function lessens its general acceptability. For this reason Atkinson's measure will be used. It may have some valid criticisms levelled against its use due to the arbitrary choice of ε, but this can be overcome, to a certain extent, by sensitivity analysis.

It is felt that in order to obtain a balanced view of the level of inequality within distributions, both a normative and a positive measure should be used. For this reason and because of their attractive properties, the Gini coefficient and Atkinson's Index are considered suitable.

3.5 Functional Forms and Inequality

The preceding analysis has concentrated on the selection of suitable inequality measures for the distribution of income. Cowell (op. cit.) notes that there are important special cases where it is convenient or reasonable to make use of a mathematical formula which approximates the *distribution* of interest. He suggests that the use of a specific formulation may simplify the problem of comparing distributions in different populations, or of examining the evolution of a distribution over time. By making assumptions about the actual form of the distribution under analysis the problems with the choice of inequality measures are simplified. This part of the chapter will analyse the theory behind, and the practical application of, functional forms to assess their validity in the analysis of inequality.

The size distribution of income and wealth , and the distribution of size of firms (as well as many items in the natural world) have been shown consistently to indicate a skewed distribution. This has prompted social scientists to find a functional form that encapsulates this skewness. There are numerous examples of different functional forms that have been applied to actual data. In this analysis one is chosen for detailed examination, the lognormal. The reason for the detailed examination of the lognormal relates to the fact that it has been more widely used in the study of income distributions than most other functional forms. Before examination of the lognormal is undertaken, these other functional forms used for the analysis of income distribution will be briefly examined.

Other than the lognormal, the most widely used functional form is that developed by Pareto (1965). Pareto initiated the statistical study of income using data from a number of countries, including England. He found a regularity which has become known as Pareto's Law.[16] If M is the number of incomes exceeding a given income level, K, the relationship is given as:

$M=AK^{-\alpha}$ Where A and α are constants

Pareto's Law has many of the advantages that can be found in the lognormal (theoretical background, ease of interpretation, relationship with inequality measures).

[16] Cowell argues against the use of the term Law because it infers that the theory will fit all the data all the time, whereas this can be refuted.

However, it is not chosen for consideration in this study, for the simple reason that it can only represent distributions above the modal level of income, whereas it is the total distribution that is of interest. Pareto's Law also has the disadvantage that the corresponding density function is monotonically declining, which does not collate with the findings of income data. A major set-back is the fact that the variance only exists for a α figure of greater than two. Nevertheless Cowell (op. cit.) argues that it is a useful tool for the approximate description of the distribution of incomes among the rich and the moderately rich, and in such a situation may be a better tool for analysis than the lognormal.

Other functional forms that have been used to analyse income distribution include the Sech-squared, the Gamma and the Beta which were promoted by Fisk (1961), Salem and Mount (1974) and McDonald and Ransom (1979), respectively. Lawrence (1988) argues against these forms on the basis that although they appear to fit certain data sets well, they have no sound theoretical basis, unlike the lognormal.

3.6 The Lognormal Distribution

3.6.1 Definition

The lognormal is a skewed distribution which becomes normal when the variable is transformed into logarithms. More formally, a positive random variable (X) is said to be lognormally distributed with two parameters, μ and σ^2, if Y=(ln X) is normally distributed with mean μ and variance σ^2. The two-parameter lognormal distribution of (X) is denoted by $\Lambda(\mu,\sigma^2)$; the corresponding normal distribution of (Y) is denoted by $N(\mu,\sigma^2)$. The probability density function of X having $\Lambda(\mu,\sigma^2)$ is given by:

$$f(x) = \begin{cases} \dfrac{1}{x\sigma\sqrt{(2\pi)}} \exp\{ \dfrac{-1}{2\sigma^2} (\ln\{x\} - \mu)^2 \} & ; \quad 0 < x < \infty \\ 0 & ; \quad -\infty < x \le 0 \end{cases}$$

In addition, a random variable X which can take any value exceeding a fixed value r is said to be lognormally distributed with three parameters r, μ, σ^2, if Y = (lnX - r) is N(μ, σ^2). The distribution is denoted by Λ(r, μ, σ^2) and r is referred to as the threshold parameter. It can be seen that the two parameter lognormal is a special case of the three parameter case where r=0. However, different estimation procedures are required.

The formal definition given above does not really enlighten us as to the possible usefulness of the lognormal to study the distribution of income. The reasons for examining the lognormal in relation to this study are threefold. It has a number of convenient properties that facilitate analysis of inequality; it has a sound theoretical base; and it appears to be applicable to empirical data sets. Each of these points will now be examined.

3.6.2 Convenient Properties of the Lognormal

Cowell (1977) lists five features of the lognormal which he refers to as attractions and reasons for choosing it to analyse the distribution of income. These are as follows:

1) a simple relationship with the normal curve;

2) symmetrical Lorenz curves;

3) non-intersecting Lorenz curves;

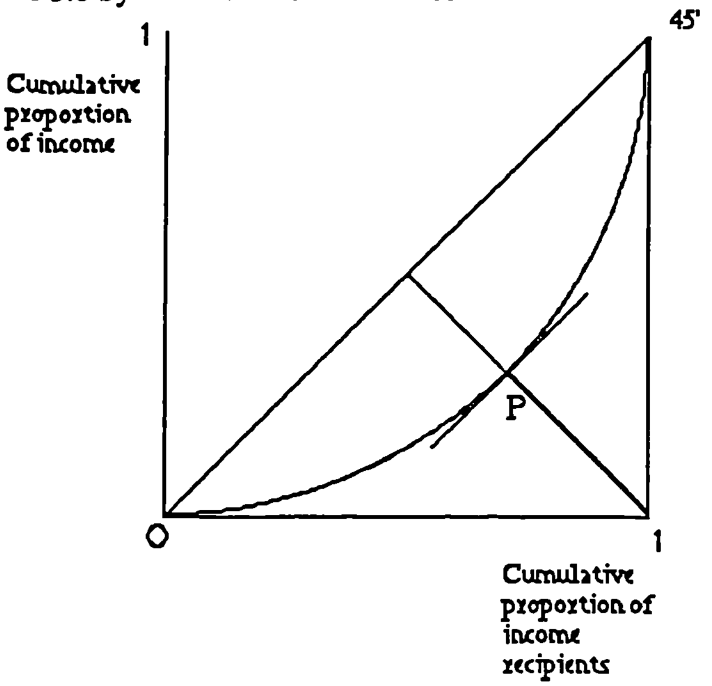
4) easy interpretation of parameters;

5) preservation under log-linear transformations.

The first point relates to the fact that as the lognormal is related to the normal distribution, a number of statistical tests that rely on the assumption of normality can be applied to the logarithm of income, given the lognormal assumption. Aitchison and Brown (1957) mention specifically z and F tests on σ^2 and also t-tests on μ. It also enables tests for normality, such as the chi-squared test, to be carried out on the transformed variable. This, in effect is a test for the lognormality of the untransformed variable.

The second point relates the lognormal distribution to the Lorenz curves. Aitchison and Brown show that, if a distribution is lognormal, the corresponding Lorenz curve will be symmetrical around a point equivalent to the mean of the distribution (this is equivalent to point P in Figure 3.8). Cowell concludes that if the plotted Lorenz curve does not appear to be symmetrical around this point then it is unlikely that the distribution under analysis is in fact lognormal.

Figure 3.8 Symmetrical Lorenz Curves



The third point is of major importance to the study of inequality. Earlier in the chapter it was mentioned that if the Lorenz curves do *not* intersect then the ranking of any two distributions will be the same whichever mean-independent inequality measure is used. The assumption of lognormality, by its very nature, ensures that the resulting Lorenz curves will not intersect. As Cowell explains "... given any two members of the lognormal family, one will unambiguously exhibit greater inequality than the other " (p 83).

The fourth point refers to the economic significance of the parameters of the lognormal. It is possible to see that both μ and σ^2 can be interpreted in a meaningful way. By definition μ is the mean of the logarithm of the variable under consideration. Equivalently μ is the logarithm of the geometric mean of X, and is also the median of the distribution. The mode and arithmetic mean depend upon the dispersion parameter (σ^2) as well as the mean, and are given as $\exp(\mu - \sigma^2)$ and $\exp(\mu + \sigma^2/2)$ respectively. σ^2 is the variance of the logarithm of income (this is equivalent to the inequality measure VL considered in Section 3.4.1). Cowell argues that "...since any Lorenz curve is defined independently of the mean, it can be shown that the family of Lorenz curves corresponding to the family of lognormal distributions is independent of the parameter μ. Thus each lognormal Lorenz curve is uniquely labelled by the parameter σ^2" (pp 84-85). He therefore concludes that σ^2 or even σ will be useful inequality measures.

The above leads on to the other advantage of the interpretation of the parameters. It is possible to estimate a number of inequality measures as functions of the variance. In relation to the Gini coefficient (G) and Atkinson's index (AI) the transformations are as follows:

$G = 2\,N(\sigma/\sqrt{2})-1$ where N is the standard normal distribution (1)

$AI = 1\text{-}\exp^{-1/2\varepsilon\sigma^2}$ where ε=inequality aversion measure (2)

The preceding discussion illustrates the point that, under the assumption of lognormality, it is possible to obtain measures of inequality simply and unambiguously (that is one measure will not contradict another in terms of ranking distributions) and for the purpose of this study this property is of great use.

The final point made by Cowell again stems from the relationship of the lognormal with the normal distribution. The lognormal distribution is preserved under log-linear transformations (this follows from a property of the normal distribution). For example, with pre and post tax distributions of income, if pre tax income is lognormal and taxation takes a specific form, then post tax income will also be lognormally distributed.

Aitchison and Brown put forward ease of estimation as another major reason for choosing the lognormal. There are in fact a number of methods of estimating the parameters of the lognormal depending on the form of data and the need for accuracy.

3.6.3 The Theoretical Basis to the Lognormal

The first point that must be made about the theory behind the lognormal is that there is no *single* theory. A number of possible explanations have been put forward as to the existence of lognormal distributions in the real world. The purpose of this section is to analyse the most relevant ones.

Aitchison and Brown (op. cit.) suggest it has been argued that if any frequency curve represents actual data well, then this is justification for its use. They, however, argue that a more fundamental basis is required for two reasons. First, by providing a basis it may be possible to obtain a clearer insight of the underlying natural or sociological processes, which in turn could lead to a wider application of the system. Second, a knowledge of the elementary assumptions from which the law of frequency may be derived, will enable easier modification of the law if new circumstances arise.

Kapteyn (1903) was one of the first to develop the theory of the lognormal. He built an analogue machine, which showed that by a random process it was possible for a lognormal distribution to occur. One of the most frequently quoted theories behind the occurrence of lognormal distributions in economic variables is Gibrat's law of proportionate effect (Gibrat, 1931). He generated lognormal distributions working with empirical data on income distribution and size distribution of firms.

Gibrat's law of proportionate effect is defined by Aitchison and Brown (1957) but is perhaps best described in laymen's terms by Cowell (1977). Aitchison and Brown, (p 22) state, "A variate subject to a process of change is said to obey the law of proportionate effect if the change in the variate at any step of the process is a random proportion of the previous value of the variate". Cowell (p 81) explains it as "... changes in peoples incomes can be likened to a systematic process whereby, in each moment of time, a person's income increases or decreases by a certain proportion, the exact proportionate increase being determined by chance. If the distribution of these proportionate increments or decrements follows the normal law, then in many cases the overall distribution of income approaches lognormality". Pen (op.cit.) describes Gibrats law of proportionate effect in the following way:

> " In economic terms the growth of a person's income is proportionate to that income itself. This stretches the [frequency] curve to the right; the number of people in the higher income brackets is stretched out over a wider distance on the horizontal axis. To him that has shall be given, in accordance with a fixed percentage ... However, the growth of income may not take place for every individual in exact accordance with this pattern; if everyone's income increases proportionately, a given curve reproduces itself on a bigger scale. There must be a chance that a person's income grows proportionately, and these chances are spread symmetrically. The exact condition is that individual incomes grow in accordance with a factor (1+v), whereby v has been normally distributed. The Gibrat distribution is thus the result of a stochastic process" (p 248).

Kalecki (1945) modified Gibrat's law, because the process by which the lognormal was assumed to develop ensured that the variance would increase over time. This did not tally with actual data sets where the variance appeared to remain fairly constant. His solution was to assume that the chance variable from Gibrat's law was subject to limits. This ensures that the distribution is kept within certain bounds.

Another theory has been developed relating to the distribution of crushed stones, which is known as the theory of breakage. The aim of the theory is to explain the occurrence of two-parameter lognormal distributions in ores which have been crushed by natural or artificial processes. Kolmogoroff (1941), quoted by Crow and Shimizu (op. cit.) showed that by assuming a certain pattern for the crushing of stones it is theoretically possible to derive a distribution that is asymptotically lognormal. His theory can be shown to be the inverse of the law of proportionate effect.

Other theories have been put forward as to the reasons for the existence of lognormal distributions by Roy (1950) and Tinbergen (1956). The point is made by Pen that whilst it is good to have a number of theories for the phenomenon of the lognormal distribution, so that the researcher can choose the one that best fits the line of investigation, it is unsatisfactory that there is no single explanation.

Pen proceeds to argue that the majority of theories about the development of the lognormal in income distribution suffer from the problem that they all assume just one explanatory variable, chance and some other factor (such as the proportionate effect). He argues that no allowance is made for systematic factors that could effect the laws of probability. He offers the concentration of wealth, the power structure, and the whole social system as such factors. He proceeds to argue that this is why in many cases the lognormal fails to estimate satisfactorily the tails of the distribution.

It can be concluded that whilst no single explanation for lognormal distributions exists, there is a sound theoretical basis (although lacking in some aspects) which explains the processes by which the lognormal is generated. This ensures that if, in practice, a distribution is found to be lognormal, it can be regarded as a result of a natural process and not just a one-off phenomenon.

3.6.4 The Application of the Lognormal Distribution

The previous sections presented the theoretical background to the lognormal as well as explaining its usefulness in the examination of inequality. This section analyses applications of the lognormal and tries to assess its usefulness in a practical rather than a theoretical evaluation. As far as this study is concerned, it is the application of the lognormal to the distribution of income that is of paramount importance. However, this study also attempts to measure the distribution of support to farmers. It is likely that support will be proportional to the size of the farms,[17] therefore it becomes important that the lognormal can also be applied to the size distribution of firms. If it is shown from previous studies that the lognormal does not regularly represent a good approximation for actual data sets, it would give rise to doubt as to the applicability of the lognormal to the current study.

In the introduction to a section on the practical application of the lognormal, Aitchison and Brown (1957) argue that it is unlikely that the theoretical processes that lead to a lognormal distribution (such as the breakage of stones or the theory of proportionate effect) will be allowed to run their course. As an example they cite the effect of taxation and the desire to avoid it as an interference in the natural progression of income distribution. They also argue that even if the original distribution is lognormal, published data may be smoothed or even partially estimated already, thus precluding statistical testing. They conclude that "... it is unlikely that actual income distributions will be as well described by any formulation which can be traced back to a simple random process, as is the size distribution of small particles found in sedimentary petrology" (p 116).

[17] This is likely because the basic agricultural policies in the EC operate by price support, and therefore the distribution of support will be similar to the distribution of output.

In the next section a number of examples are drawn from Lawrence (1988) who conducted a fairly comprehensive review of the literature. He begins, "There are tantalising indications that the lognormal represents numerous aspects of economic life" (p 229). The application of the lognormal to the size distribution of firms will be reviewed initially, followed by the application to the size distribution of income.

3.6.4.1 The Size Distribution of Firms

It has already been noted that Gibrat (op. cit.) developed the theory of proportionate effect using empirical data. He examined the size distribution of firms, which were classified by the number of employees. Lawrence (1988) notes that the actual and expected number of firms in each class indicates that, in a large number of cases, the distributions appeared to be lognormal. Hart and Prais (1956) undertook a time series examination of the size distribution of firms. In this analysis they chose the market value of the firm to be the size variable. The results indicated that the two-parameter lognormal gave a reasonable approximation for the distribution (Gibrat had used a three parameter lognormal). Simon and Bonnini (1958), according to Lawrence used the lognormal to examine the movement of firms through size classes over time.

Steindl (1965), (referred to by Lawrence, Cowell (op.cit) and Allanson,1990), examined the size distribution of manufacturing industry in both the United States and Austria and concluded that the lognormal gave a good fit. Steindl, like Gibrat, used the number of employees as the size variable. Perhaps the most comprehensive study in terms of comparing different functional forms was conducted by Quandt (1964). His conclusions were based on study of the size of American firms that were worth one million dollars or more in 1958 and 1960, and also on the sales figures of the 500 largest firms in 1955 and 1960. His results indicated that the lognormal and a type of Pareto function appeared to best fit the data.

Prais (1976), in his examination of the concentration of firms in British manufacturing (both in individual industries and as a whole) found that the lognormal was a useful approximation. Allanson (op. cit.) attempted to fit the lognormal to the size distribution of agricultural holdings in the UK from 1939 to 1989. He concluded that the lognormal gives a reasonable approximation to the size distribution, although holding size tends to diverge from lognormality in the lower tail of the distribution.

3.6.4.2 Income Distribution

The literature on the application of the lognormal to the size distribution of income is much more extensive than that relating to the size of firms. Kapteyn (1903), although not an economist, was the first to apply the lognormal. Gibrat in the 1930s extended the work with a study of income data for a number of countries over a period of years. As with his work on the size of firms, the results indicated that there was little deviation from lognormality. Gibrat argued that the work could be extended to cover income related items such as wealth, rents, profits and dividends.

Aitchison and Brown (op. cit) studied data on the earnings of individuals related to specific agricultural employment (stockmen, cowmen, horsemen, etc) for 1950. They concluded that the data were well represented by the lognormal. This raises a point made by Cowell, that the findings indicate that the lognormal is most appropriate for the distribution of earnings in a fairly homogeneous section of society (eg. the wages of stockmen). Cowell refers to the analysis of Weiss (1972) who found that the lognormal was satisfactory for the study of graduate earnings in different sectors of society.

Aitchison and Brown studied the distribution of all earnings in the US for specific years in the 1940s. They found a systematic deviation from the lognormal, and concluded that the upper tail appeared to be fitted better by a Pareto function. Cowell argues that this divergence illustrates the problems associated with heterogenity within the sample and that the aggregation of distributions that are lognormal will not necessarily lead to a composite lognormal distribution. This relates to the fact that a necessary restriction to ensure lognormality of the final distribution is that the variances for all the individual distributions must be the same. Cowell points out it is not necessarily true that the earnings of herdsmen will be distributed the same as those of cowmen. Harrison (1979) found that the distribution of earnings between different types of workers were in fact different. Creedy (1985) also refers to the problem of aggregation and argues that a lognormal distribution in each age group of a population will not necessarily lead to a lognormal total distribution. This problem apart, many other studies have been undertaken using the lognormal assumption.

Lydall (1968), in a study of income data from thirty countries, concluded that the lognormal fitted the main body of the distribution better than other functional forms, but was not a good fit for the bottom ten and the top twenty percent. He argued that the Pareto function gave the best fit to the higher incomes. Thatcher (1968), working from a sample of the earnings of 170,000 manual labourers, found that the lognormal gave a good approximation. However, like Lydall and Aitchison and Brown, he found that the lognormal failed in the upper tail and this was represented more adequately by a Pareto function (in this case involving the top 10% of incomes).

Fase (1971) examined the income distributions of different age groups and concluded that they were lognormally distributed. Lawrence argues that the most comprehensive study is by Airth (1985), who looks at the earnings of manual labourers over a period of 100 years and finds that there was only systematic divergence from the lognormal in the 1st and 2nd and above the 96th percentiles. This again supports an argument, put forward by Cowell, that the lognormal is more likely to be a valid descriptive statistic if it is the distribution of earnings (i.e. income from employment) that is under examination rather than the distribution of income (i.e. income from all sources). The problem is similar to that found when aggregating different types of income earners.

He also argues that in analysis of the distribution of wealth the Pareto function is likely to be a better fit due to the fact that wealth data are usually only reliably collected from those with moderate wealth or higher.

Lawrence concludes from his review that "The most widely accepted result on the distribution of income is paradoxical: the lognormal approximates incomes in the middle range but fails in the upper tail, where the Pareto distribution is more appropriate" (p 233).

At this stage it is necessary to include the work of Ransom and Cramer (1983). They note that in a large number of cases the lognormal distribution fails the chi-squared test for goodness of fit. Hoewever, they argue that the "... test is clearly too strict, because it allows for sample variation only and thus tests the hypothesis that the income distribution function under review holds exactly" (p 364). In their opinion income distribution functions are, like econometric models, put forward as an approximate descriptive device, and therefore are not meant to hold exactly. They conclude, "If this view is accepted then the application of chi-square tests to specific income distributions is a meaningless exercise since the null hypothesis is known to be much too strict and the outcome is therefore not taken seriously" (p 364). Ransom and Cramer try to overcome this problem by adding a normally distributed error term to the standard distribution. It is shown that this improves the fit of the lognormal, although the new distribution still fails the chi-squared test at the 5% level.

The above illustrates that the lognormal has been used fairly widely for the measurement of both size distribution of firms and of income. Lawrence states that when firms are taken in aggregate the lognormal frequently fits their distribution by size measured by the number of employees or asset value. He also argues that income is lognormal at least for the main body of income earners.

The lognormal has been applied to the size distribution of incomes in agriculture, but only for the distribution of earnings of farm labourers and not for the income of the farmers themselves. In the case of the distribution of the size of firms, the only application to agriculture appears to be that of Allanson (op. cit.) and even this relates to the acreage size of agricultural holdings and not to the distribution of output. It can be concluded that although the lognormal has been applied to many income and firm size distributions, it has not yet been demonstrated that it is a useful tool for the analysis of the distribution of support and income between farms.

3.7 Summary and Concluding Comments

This chapter began by reviewing the possible measures of inequality that are available to the researcher. The results of this review suggest that there is no single measure available and that different measures may well give conflicting results. However, the Gini and Atkinson's Index are selected as the most appropiate measures available. The chapter then examined the possible use of a specific functional form as a method for simplifying the problems associated with the inequality measures discussed. The lognormal has been found to have a sound theoretical background, to have a number of convenient properties and to fit actual data sets in a large number of cases.

The approach adopted for this research will be initially to use the two selected inequality measures (G and AI) without specifying the form of the distribution. However, if no firm conclusions about inequality levels can be reached using this method, the assumption of lognormality offers a possible alternative. Of course, before lognormality can be used, the specific data sets must be examined to ascertain whether the assumption of lognormality is valid.

Chapter 4 Income Inequality in Agriculture in North East England

4.1 Introduction

Chapter 3 concentrated on one aspect raised in the review of the literature, namely choice of inequality measure. However, other issues were raised in the review, such as choice of income measure and the most applicable method of grouping the farms into size classes to enable inequality measures to be calculated. This chapter attempts to fulfil a multiple role. The level of inequality associated with the distribution of income between farms will be measured and assessed, using income data from farms in the North East of England. Another aim is to use the data to illustrate how changing the assumptions relating to the choice of inequality measure, income definition and the size grouping of farms may affect these results. The distribution of income within subgroups of the farm population is also of interest. Therefore, farms will be classified according to 'type' (livestock, dairy, mixed, etc.) and the distributions within these types will also be analysed and compared.

4.2 The Data

In order to conduct an examination of the distribution of income within the farming sector it is necessary to have valid farm income data. To this end, the most appropriate data available (despite the reservations of Hill (1982 and 1984) mentioned in the previous chapter) are those collected for the Farm Business Survey (FBS). Some detail of the FBS in general and of the Northern region in particular is given in the following sections. An outline of the FBS is given for general interest. The Northern region FBS is analysed in more detail to justify subsequent changes made to the classification of the data.

4.2.1 The Farm Business Survey

The FBS (originally known as the Farm Management Survey) was set up in 1936 with the object of systematically collecting, for the first time, information on the economic condition of farming in England and Wales. The FBS handbook stated that the original objectives were:

> " To make available, year by year, such information as would provide a statistical basis for the study of the economic problems of the industry. To provide a useful indication of the level of income each year and over a series of years, to indicate the general trend, thereby enabling more reliable judgments on these matters to be formed" (FBS Handbook, 1990, p 2)

The FBS involves a study, each year, of approximately 2,800 farms in England and Wales by nine universities and colleges of agriculture. Each centre is allocated a quota of farm accounts (Table 4.1).

Table 4.1 The Distribution of Accounts between Collecting Centres (1989/90)

Centre	Quota of Farms
Newcastle	190
Askham Bryan	264
Manchester	280
Nottingham	240
Cambridge	374
Wye	200
Reading	359
Exeter	322
Aberystwyth	550
England and Wales	2779

Source: FBS Handbook (1990)

The survey includes only farms specified as full time and of a certain size. The main criterion for selection is that farms should be full time commercial holdings, defined as over 4 British Size Units (BSU's), and provide enough work for at least one person. In the case of specific types of farms (pigs, poultry and horticultural holdings) there is an upper limit of 250 BSU's for inclusion in the survey. Part-time farms are excluded, as are farmers who derive over 50% of their output from associated agricultural activities, such as contracting and wholesaling. The survey farms are chosen from a classified random sample. The number of each type and size of farm in each university sample is designed to minimise the percentage standard error of the year-on-year change in net income. As the sample is intended to be random, it has recently been decided that any one farm may stay in the sample for a maximum of 15 years.

4.2.2 Northern Region FBS

As can be seen from Table 4.1 the Northern region (Newcastle) has the smallest number of farm accounts (190 in 1989/90). The region covers Cumbria, Durham, Northumberland and Tyne and Wear. Northumberland has the greatest average farm size, 163 hectares (ha) and also the highest percentage of rented farms, 58. The census data confirm the essentially pastoral nature of the Northern region, with almost a quarter of the national beef herd and sheep flock raised in this area. There are also areas of arable in the East of the region and dairying in the West.

The farms in the Northern region are classified into 5 main 'types':

Group 1 Lowland Dairy Farms

(a) with less than 70 cows

(b) with 70 or more cows

These farms are classified according to two criteria; first that at least 50% of the total standard labour requirements is attributable to the dairy herd, and second on the basis of the number of cows. In 1989/90 Dairy output averaged 67 and 63 per cent of total output for the two herd size groups.

Group 2 Lowland Grazing/ Arable Farms

(a) Mainly grazing livestock

(b) Mainly arable

Group 2 (a) consists of farms with at least 50 per cent of the total standard labour requirements attributable to grazing livestock. On these farms, grazing livestock and arable contributed, on average, 68 and 29 per cent, respectively, of total output. Group 2 (b) consists of farms with at least 50 per cent of the total standard labour requirements attributable to arable crops. For these farms grazing livestock and arable contributed, on average, 21 and 76 per cent, respectively, of total output.

Group 3 Mixed Farms

The farms in this group must have at least three enterprises, one of which must be dairying and must account for between 15 and 50 per cent of the standard labour requirements. On average, dairying, other cattle and sheep accounted for 42, 25 and 25 per cent, respectively, of total output.

Group 4 Upland Dairy Farms

(a) With fell grazing rights held in common

(b) without fell grazing rights held in common

This group refers mainly to farms in Cumbria, and the exercise of common fell rights forms the basis of the classification. All farms produce milk for sale and rear cattle and sheep. On average, 51 per cent of output is accounted for by dairy in the first group and 67 per cent in the second group.

Group 5 Livestock Rearing Farms

(a) upland farms

(b) hill farms

All these farms depend on rearing cattle and sheep, which account for at least 96 per cent of total output. They are located in the Pennine, Cheviot and Lakeland Hills. The classification into the two groups occurs according to the following criteria:-

(a) The ratio of actual hectares of rough and common grazing to inbye is at least 5:1.

b) Grazing Livestock Units in sheep is at least 50 per cent or more of total grazing livestock units.

(c) Grazing livestock density is 2 or more hectares per grazing livestock unit.

Farms satisfying two or more of the criteria are classified as hill farms, the remaining as upland.

4.2.3 Problems with the FBS classification of Farms

The above classifications, whilst valid for the overall purposes of the FBS, are not especially suited for the analysis of income inequality. This occurs because the FBS make their selection on grounds of size and geography rather than specific farm types. For example, there are separate classifications for Group 1 farms between small and large herds, which is a distinction that is of no use when considering the distribution of income between small and large farms. There is also a distinction between lowland and upland dairy farms, whereas when looking at the distribution of income between dairy farms, all should be included.

When considering the classifications undertaken by the FBS other difficulties are evident. Although there are only five main groups there are nine different sub-groups. This results in small numbers in certain groups, because the total sample is only around 180 farms. For example, in 1988, the group 'mixed farms' consisted of only 6 farms (they were reclassified the following year). This small number increases the risk of biased results. Also, that the mixed farms were reclassified meant that the sample was not consistent throughout the time period under study.

Due to the problems inherent to the classification of farms under the MAFF guidelines, an alternative method of grouping farms was sought. The aim was to obtain 3 or 4 groups of farms which were similar in terms of production but contained enough farms to reduce the risk of bias.

4.3 Cluster Analysis

4.3.1 Definition and Methods

Initially an attempt was made to group the farms by using arbitrary 'cut-off points', in terms of what proportion of their production came from various enterprises. In the North of England, compared to say the South-East, farming would appear to be more limited in terms of the number and range of enterprises per farm. The groups were therefore based on the proportion of total output accounted for by dairy, sheep, cattle and crops. In order to provide statistically valid groupings, cluster analysis was used. This technique is defined by Hair *et al* (1990, p 295):

> "Cluster analysis is the name of a group of multivariate techniques whose primary purpose is to identify similar entities from the characteristics they possess. It identifies and classifies objects or variables so that each object is very similar to others in its cluster with respect to some predetermined selection criteria. The resulting clusters should then exhibit high internal (within-cluster) homogeneity and high external (between-cluster) heterogeneity".

The data set is ideal for this process because the number of cases is reasonably small and the same variables can be used throughout the time period. Cluster analysis groups data according to the variables chosen, and as these are chosen by the operator it is clear that the process is to a large extent subjective. Gebauer (1987, p 23) points out that "there is no right or wrong answer with cluster analysis, only solutions that are useful or useless are obtained" It is up to the user to decide whether the solution obtained is useful and this in itself will depend on *a priori* knowledge. The variables chosen initially are shown in Table 4.2.

Table 4.2 Variables used for Initial Cluster Analysis

Variable Name	Description
Output :	Proportion of total output accounted for by:
PPNCROT	Arable Crops
PPNSHEP	Sheep Production
PPNCAT	Cattle Production
PPNDAIR	Dairy Production
Area :	Proportion of UAA down to:
PPNTEM	Temporary Grass
PPNPER	Permanent Grass
PPNRUF	Rough Grazing
PPNCRP	Arable Crops

The choice of variables requires further explanation. The variables used included those showing the proportion of total output of the farm made up from varying enterprises. However, because farms that grow a high value crop on a small area of land may be classified according to that crop and not the enterprise that occupies the majority of the farm, variables representing the proportion of Utilisable Agricultural Area (UAA) covered by grass, rough grazing and crops were also included.

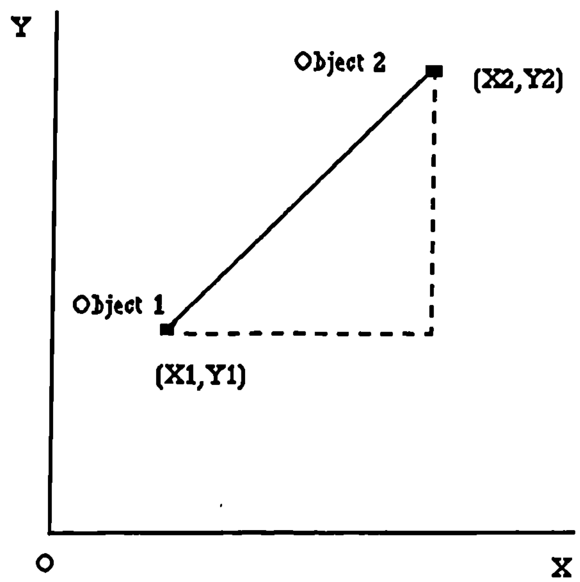
The initial work was based on the 1988 results of the Northern region FBS. The clustering was performed using SPSSX (a mainframe statistical package). Having decided on appropriate variables, the problem becomes one of chosing the most applicable method of clustering. Hair argues that there are three distinct questions that need to be examined. First, how should inter-object similarity be measured? Second, what procedure (algorithm) should be used to place similar objects into groups or clusters? Third, how many clusters should be formed?

The choice of the measurement of inter-object similarity reduces to two main types of measure. These can be classed as measures of similarity and those of distance. Hair notes that the most commonly used measures of similarity between objects are distance measures. Of these measures the most frequently used is the Euclidean distance, which Hair describes in the following manner. Suppose two points in two dimensions have coordinates X1,Y1 and X2,Y2 (see Figure 4.1). The Euclidean distance between the points is the length of the hypotenuse of a right angle triangle, as calculated by:

$$\text{Distance} = \sqrt{[(X2-X1)^2 + (Y2-Y1)^2]} \qquad (3)$$

This formula is applicable to the distance between two variables only, but the concept is easily generalised to additional variables.

Figure 4.1 The Euclidian Distance



Other distance measures are available. On such measure is referred to as the City Block approach, which involves the replacement of the squared differences in (3) by the sum of the absolute differences of the co-ordinates. This approach causes problems if the variables are correlated. As this is likely to be the case with variables such as the proportion of grassland and the proportion of sheep output, this method is not valid for the present analysis. For this reason, the Euclidean method is chosen.

The second question involves the clustering of similar objects. There are a number of methods by which clustering can be undertaken, five of which are analysed in Hair.

The single linkage procedure is based on minimum distance. It finds the two individuals with the shortest distance and places them in the first cluster. Then the next shortest distance is found, and either a third individual joins the first two to form a cluster or a new two individual cluster is formed. The process continues until all individuals are in one cluster. This procedure is also referred to as the nearest-neighbour approach.

The distance between any two clusters is the shortest distance between any point in one cluster and any point in another cluster. Two clusters are merged at any stage by the single shortest or strongest link between them.

The complete linkage procedure is similar to single linkage except that the cluster criterion is based on maximum distance. For this reason it is sometimes referred to as the furthest-neighbour approach. The maximum distance between any two individuals in a cluster represents the smallest (minimum diameter) sphere that can enclose the cluster. This method is called complete linkage because all objects in a cluster are linked to each other at some maximum distance or minimum similarity.

The average linkage begins as with the single linkage or complete linkage, but the cluster criterion is the average distance from individuals in one cluster to individuals in another. Such techniques do not use extreme values, as do single linkage or complete linkage, and partitioning is based on all members of the clusters rather than on a single pair of extreme members.

In Ward's method the distance between two clusters is the sum of squares between the two clusters summed over all variables. At each stage of the clustering procedure, the within-cluster sum of squares is minimised over all partitions (the complete set of disjoint or separate clusters) obtainable by joining two clusters from the previous stage.

In the centroid method the distance between two clusters is the distance (typically Euclidean) between their centroids (means). With this method, every time individuals are grouped a new centroid is computed. Cluster centroids migrate as cluster mergers take place. In other words, there is a change in a cluster centroid every time a new individual or group of individuals is added to an existing cluster.

Each method has certain disadvantages. The single linkage method, because it joins only on the basis of the nearest neighbour, takes no account of the relationship between other individuals in the group. This means that it is likely that the clusters will form snake like chains with individuals at either end of the group being potentially very dissimilar. A similar criticism can be made of the complete linkage method. If two clusters on the whole are fairly similar but the distance between the furthest points is large then this process will not join them. Ward's method tends to combine clusters with a small number of observations and is also biased to the production of clusters with approximately the same number of observations. The centroid method can produce confusing results when the distance between the centroids of one pair may be less than the distance between the centroids of another pair merged at an earlier time. The centroid methods also requires the use of metric data and therefore may be severely limited in terms of application to the social sciences.

For the present analysis the method chosen was average linkage between groups. This approach is arguably preferable to the others reviewed, because it enables the clusters found to be placed into tighter groups.

The final question involves the number of clusters to be formed. Hair (op. cit.), Johnson and Wichern (1988) and Everitt (1980) all note that no standard selection criteria exist. An examination of the distance between clusters at successive steps may serve as a useful guideline. They also accept that some intuitive feel for the data, or *a priori* expectations, will enable the selection procedure to be more valid.

The decision made was to use Euclidean distance to measure interobject similarity, then group these similar objects by the average linkage method. The data seem to suggest four types of farming within the region, so initially four clusters were required.

4.3.2 Results of Cluster Analysis

Using the terminology of Gebauer (op.cit), the initial results appeared useful, with the 4 clusters containing farm groups of dairy, mixed, livestock with a large area of rough grazing, and livestock with a small area of rough grazing. On comparison with the FBS groupings it was clear that, the resulting groups were not that different (in production terms). The 1988 results therefore seemed to justify the use of cluster analysis as a means of grouping the farms. This was emphasised by use of earlier data from 1987 and 1986. However, a major problem arose with the 1985 data. The number of farms classified as 'mixed' fell to just two, corresponding with a rise in the number of farms classified as livestock. If the farms taking part in the survey had changed radically between these years, then the change in grouping may have appeared more likely. However, at this time the turnover of farms in the survey was fairly low, and therefore many of the farms classified as mixed in 1986 were present in 1985. Because the aim of the exercise was to gain reasonably sized groups of similar farm types, the results for 1985 appeared to be of little use. The literature, when assessing the subjective aspects of cluster analysis, suggests a number of alterations that can be undertaken. These involve alteration of the number of clusters required, variation in the chosen variables and manipulation of the units of measurement of the variables. In order to overcome the problems with the 1985 data, variations were made to the subjective parts of the analysis.

The numbers of clusters required was altered, but one of the new clusters formed still comprised of only two farms. A more fundamental change was then used. Analysis of the results for 1988, 1987 and 1986 showed that the distinction between the two types of livestock farms was not based on whether they raised sheep or cows, but on the amount of rough grazing. As there appeared no need for two separate variables for livestock, they were combined to produce one variable representing the proportion of total output accounted for by sheep and cows. It also became clear that the distinction between livestock farms on the basis of the amount of rough grazing was unsupportable. For this reason the different types of grassland and rough grazing were combined into one variable representing the proportion of total UAA accounted for by grassland. Combining the livestock variables meant that three distinct farm types were likely to arise, and indeed the number of required clusters was reduced from four to three. Table 4.3 lists the variables used for re-clustering.

Table 4.3 Variables used for Final Cluster Analysis

Variable Name	Description
Output :	Proportion of total output accounted for by:
PPNCROT	Arable Crops
SHECAT	Sheep + Cattle
PPNDAIR	Dairy
Area :	Proportion of UAA down to:
PPNGRAS	Temporary + Permanent Grass + Rough Grazing
PPNCRP	Arable Crops

At this point a slightly different clustering programme (quick cluster) was used, because it allowed for the solutions from one year to be used as the starting base of the clusters for the next year. This helped overcome the problem that farms were seemingly moving between clusters with only minute changes in their farming pattern. The programme has the disadvantage of being based on the single linkage method, but the results appeared reasonable and more useful.

The alterations produced reasonable results for 1985 and, in fact, for all years under consideration. Therefore, cluster analysis enabled farms to be grouped according to their production, thus allowing income distribution analysis to be undertaken as a comparison between farm types as well as between years. Tables 4.4 and 4.5 illustrate the numbers of farms in the three clusters, and the percentage of production and area accounted for by the various enterprises.

Table 4.4 Number of Farms in Each Cluster Group 1982 to 1988

Year	Livestock	Dairy	Mixed	Total
1982	82	59	31	172
1983	80	57	33	170
1984	89	60	32	181
1985	104	56	30	190
1986	100	49	39	188
1987	114	51	25	190
1988	112	42	35	189

Table 4.5 Composition of Farm Types grouped by Cluster Analysis

Farm Type	Year	% of Total Output from:				% of UAA comprising:	
Livestock		Crops	Dairy	Sheep	Cattle	Crops	Grass
	1982	5	1	55	36	5	94
	1983	4	1	55	38	4	95
	1984	5	1	54	36	5	94
	1985	6	2	51	36	6	93
	1986	5	1	53	35	6	93
	1987	9	0	52	33	10	89
	1988	5	0	53	36	7	92
Average	82-88	5	1	53	36	6	93
Dairy							
	1982	5	60	9	23	11	88
	1983	6	62	10	21	11	88
	1984	5	61	10	21	11	88
	1985	7	57	9	23	11	88
	1986	4	59	10	23	10	89
	1987	5	61	10	20	10	89
	1988	3	62	10	21	7	92
Average	82-88	5	60	9	22	10	89
Mixed							
	1982	60	2	8	20	62	36
	1983	63	2	9	20	62	36
	1984	64	2	8	14	64	34
	1985	71	1	7	13	66	33
	1986	60	2	13	18	60	39
	1987	73	0	7	11	70	29
	1988	56	0	16	21	63	36
Average	82-88	64	1	10	17	64	35

The two tables highlight the success of using cluster analysis to group the farms. Table 4.4 indicates that each classification consists of sufficient observations to enable a statistically valid analysis. Table 4.5 illustrates the consistency, in terms of the output from, and utilisation of, the land, for each of the groups. There is little variation from year to year in the average production levels for each farm type. It therefore seems reasonable to use the clusters as a basis for analysis of the income distribution aspects of farming in the North of England. Before this, data on levels of income by farm type and on average farm size are produced for general information.

4.4 Average Farm Income and Size Data

This section will analyse the classification of farms by average income and by farm size. At this stage Net Farm Income (NFI) is the measure of income used for the analysis and UAA is the measurement for farm size. Table 4.6 gives average NFI and UAA figures for the whole sample during the period under examination.

Table 4.6 Average NFI and UAA of sample

Year	NFI £'000	UAA ha
1982	24.9	232
1983	18.7	241
1984	14.0	237
1985	15.9	227
1986	11.8	226
1987	13.2	217
1988	17.2	208

On examination it can be seen that NFI has varied considerably during the 7 years under review, whilst the average size of farm has declined slightly. Table 4.7 shows the average farm size and NFI for the individual farm types as classified in the previous section. The figures indicate large differences between the three farm types. The livestock farms have by far the largest UAA. However, mixed and dairy farms have on average a higher level of income.

Table 4.7 Average UAA and NFI by Farm Type 1982 to 1988

	Livestock		Mixed		Dairy	
Year	UAA	NFI	UAA	NFI	UAA	NFI
	Ha	£'000	Ha	£'000	Ha	£'000
1982	359	24.3	167	25.0	89	25.5
1983	379	16.0	167	21.1	88	21.1
1984	366	13.6	159	16.4	89	13.3
1985	319	13.5	163	27.1	91	14.4
1986	319	12.4	163	8.9	87	13.0
1987	279	11.0	170	23.2	100	13.3
1988	264	16.0	181	10.3	80	26.2

Table 4.8 represents the average NFI figures in real terms (i.e. allowing for the effects of inflation). The deflator used is the Retail Price Index (RPI). The figures illustrate different patterns for the farm types. Overall, between 1982 and 1988, there is a downward trend in the level of real NFI. This trend is reflected by the largest group (livestock). In contrast, mixed farms highlight a fluctuating pattern with high and low income years, and dairy farmers show relatively high average income during the early part of the period and a lower income during the latter stages.

Table 4.8 Deflated NFI by Farm Type (1977 prices)

Year	Farm Type			
	All Farms	Livestock	Mixed	Dairy
		(£'000)		
1982	14.1	13.9	14.3	14.5
1983	10.2	8.7	11.4	11.5
1984	7.2	7.0	8.5	6.9
1985	7.8	6.6	13.2	7.0
1986	5.6	5.8	4.2	6.1
1987	6.1	5.1	10.8	6.2
1988	7.6	7.1	4.6	11.6

Although the inequality measures used subsequently do not take account of the levels of income received by the groups, it should be borne in mind that a low level of inequality (which may be seen as 'good') may be associated with a low level of average income (which is likely to be considered as 'bad'), and that high levels of inequality (which may be 'bad') may be associated with high average income (which may be 'good').

4.5 Dealing With Negative NFI

This section analyses the aspect of negative farm incomes within the FBS sample. The work of Gregory (op.cit) involves one of the few attempts at analysing the effect of negative farm income on the calculation of the level of income inequality. Analysis of the FBS data used in this study indicates a significant number of farms that report negative NFI (Table 4.9).

Table 4.9 The Number and Percentage of Farms with Negative NFI by Farm Type

	Farm Type							
	All Farms		Dairy		Livestock		Mixed	
Year	No.	%	No.	%	No.	%	No.	%
1982	3	2	0	0	0	0	3	10
1983	7	4	1	2	3	4	3	9
1984	16	9	5	8	3	3	8	25
1985	7	4	2	4	4	4	1	3
1986	26	14	3	6	13	13	10	26
1987	18	9	3	6	13	11	2	8
1988	16	8	1	2	8	7	7	20

Whilst it is possible to calculate Gini coefficients from distributions with negative incomes, there is a major drawback. With positive incomes the range of the Gini, as already mentioned, is between 0 and 1. However, if there are a large number of negative incomes it is theoretically possible to obtain a Gini of greater than 1. This results in difficulties in interpretation of results. In the absence of negative incomes, it is possible to state that a figure of 0.5 is halfway between complete equality and complete inequality. With negative incomes this is no longer the case and it becomes difficult to assess the absolute level of inequality associated with the distribution.

At this point it is necessary to reflect on previous work to ascertain possible methods for dealing with this problem. In Chapter 2, whilst reviewing the work of Ahearn *et al* (op. cit.), it was noted that the method used to deal with negative farm incomes was to truncate their value to zero. This is criticised by Kinsey (op. cit.) who illustrates that this will lead to a reduction in observed inequality. Gregory (op. cit.) noted a number of methods of dealing with negative incomes, of which the method adopted by Ahearn was only one. The question is a difficult one. If two distributions are compared, one of which has a large number of negative results, the other none, then the raising of the negative values to zero will ensure that the difference in the level of inequality between the two distributions is understated. This may lead to false conclusions about the relative levels of inequality.

Another possible solution is to ensure that the first cell[18] has enough observations for the total income for farms in that cell to be positive. This method has problems which relate to Benson's (1970) work on the effects of inter- and intra-cell bias. If there are a large number of negative observations then the first cell is likely to contain a large proportion of the total observations, thus leading to the possibility of intra-cell bias. On the other hand, the advantages of this approach are first, it reduces the under-estimation of the level of inequality compared to the truncation approach, and second, from the second cell onwards the curve reflects the true distribution.

The decision taken with the FBS data when there were negative incomes was to ensure the first cell consisted of enough observations to become positive, after this point nine other cells were constructed with equal number of farms in each. Whilst acknowledging that this may cause problems with cell bias, previous work appears to justify use of this method. The consequences of this decision will be analysed further in the results section. Where there were few or no negative incomes in the sample the approach was similar to that of Bell (op. cit.). Farms were grouped into deciles (cells) based on level of income and the proportion of income accruing to each decile was recorded to enable calculation of Gini coefficients.

4.6 Income Inequality the North East England

In Chapter 3, after analysis of the various inequality measures available, the Gini coefficient and Atkinson's index were chosen as appropriate measures of the distribution of income and support within agriculture. The chapter also highlighted that the two measures may give conflicting results in terms of the ordinal ranking of

[18] It will be remembered that in conventional Gini analysis farms (either in total or by type),are ranked according to income and grouped into cells. The size and number of cell varies between studies. The Gini coefficients are calculated on the basis of differences between these cells.

distributions. The purpose of this section is to analyse the distribution of farm income in North East England using both measures, compare the findings and then draw conclusions about the two measures. Previous sections have explained how the data were organised for the calculation of the Gini coefficient and this is the same for Atkinson's Indicies.

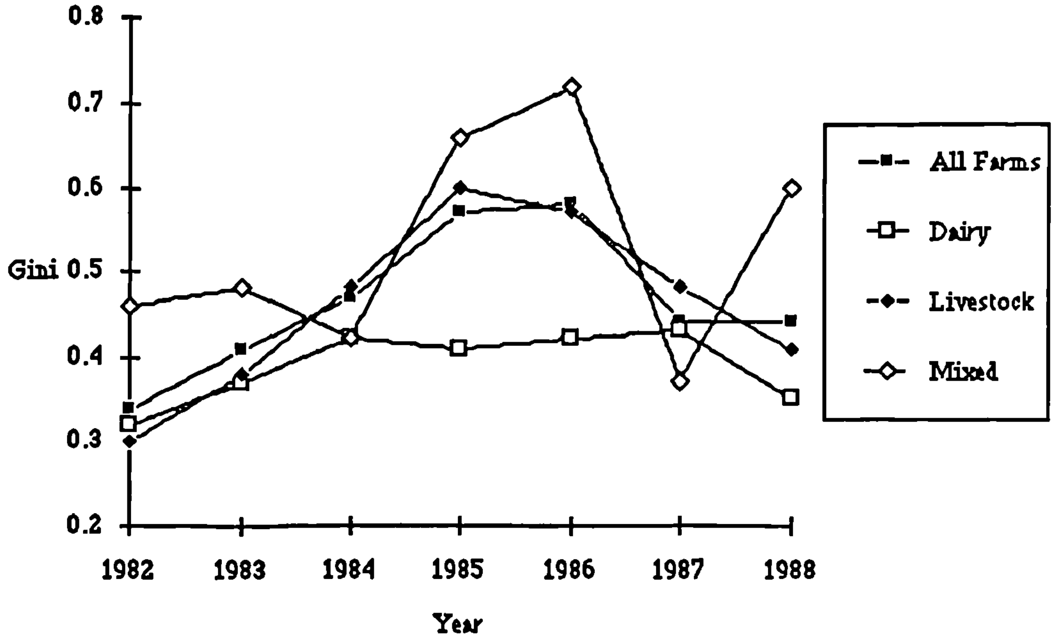
4.6.1 Gini Coefficients

Gini coefficients were calculated for each of the seven years and for each of the farm type groupings. It will be recalled that the Gini can range from zero to one, with zero showing that the distribution is perfectly equal and one that it is perfectly unequal. Thus the higher the value of the Gini, the more unequal is the distribution of income. Table 4.10 and Figure 4.2 show the Gini coefficients for NFI.

Table 4.10 Gini Coefficients for NFI for all Farms and by Farm Type

Year	All Farms	Dairy	Livestock	Mixed
1982	0.34	0.32	0.30	0.46
1983	0.41	0.37	0.38	0.48
1984	0.47	0.42	0.48	0.42
1985	0.57	0.41	0.60	0.66
1986	0.58	0.42	0.57	0.72
1987	0.44	0.43	0.48	0.37
1988	0.44	0.35	0.41	0.60
Average 82-88	0.46	0.39	0.46	0.53

Figure 4.2 Gini Coefficients for NFI for all Farms and by Farm Type, 1982 to 1988



The results for the whole sample during the period show that the Gini varies between 0.34 and 0.58, indicating considerable variation in the level of inequality from year to year, but with no consistent trend. The values for the Gini indicate that inequality within the farming sector is generally greater than that for the population as a whole (the Gini for the UK was 0.40 in 1984/5[19]).

Of the three farm types, dairy shows the most consistency from year to year. The average of 0.39 is low in relation to the other farm types, indicating a more even distribution of income. The variability from year to year and the range of the Gini (from 0.32 to 0.43) are both lower than the other groups.

Livestock farms exhibit greater variability between years and also a greater range in the level (0.30 to 0.60). The level of inequality rises steadily between 1982 and 1985 and thereafter falls. Mixed farms generally indicate the highest level of inequality with a minimum level of 0.37, a maximum of 0.72 and an average of 0.53. Figure 4.2 illustrates that the movement between years is more dramatic for mixed farms than for

[19]This Gini coefficient relates to the pre-tax income distribution and is obtained from Economic Trends (1988).

dairy farms. However, this could be related to the greater variability from one year to the next in the number of mixed farms with negative incomes.

Following the above methods for dealing with negative incomes, and using the Gini coefficient, the results appear to present a fairly clear picture of the levels of inequality associated with farm incomes in the North of England.

4.6.2 Atkinson's Indicies

This section takes the second of the chosen measures (Atkinson's Index) and calculates inequality coefficients for the same distributions as above. The most important question is, 'Can the same conclusions be drawn about the relative levels of inequality from the results of Atkinson's Index as were drawn from the Gini coefficients?'

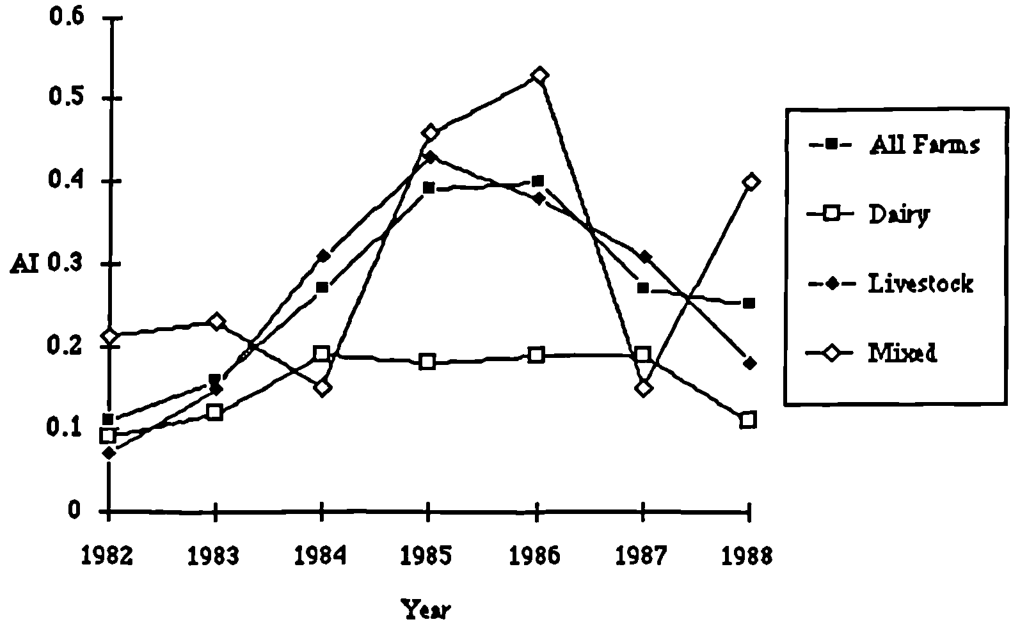
As already mentioned, use of Atkinson's index involves a choice, by the user, of a value (ε) which reflects society's aversion to inequality. This, of course, is problematical. Initially, a low value for ε of 0.5 is chosen (recall that ε can vary from zero to infinity), reflecting little aversion to inequality. The results are shown in Table 4.11 and Figure 4.3.

Table 4.11 Atkinson's Index for NFI for all Farms and by Farm Type with ε=0.5

Year	All Farms	Dairy	Livestock	Mixed
1982	0.11	0.09	0.07	0.21
1983	0.16	0.12	0.15	0.23
1984	0.27	0.19	0.31	0.15
1985	0.39	0.18	0.43	0.46
1986	0.40	0.19	0.38	0.53
1987	0.27	0.19	0.31	0.15
1988	0.25	0.11	0.18	0.40
Average 82-88	0.26	0.15	0.26	0.30

The results indicate a much lower level of inequality than that found with the Gini (recall that Atkinson's Index, like the Gini, can range from zero to one). However, the pattern of inequality appears to be remarkably similar (see Figure 4.3 and Figure 4.2), with dairy farms consistently having a more equal distribution of NFI and mixed farms showing the greatest variability.

Figure 4.3 Atkinson's Index for NFI for all Farms and by Farm Type with ε=0.5



The results of an analysis of the ordinal qualities of the Gini coefficient and the Atkinson's index with ε=0.5 (Table 4.12) show that despite the differences in the absolute level of inequality, the ranking of farm types within each year are remarkably similar.[20] In only one case do the different measures rank the distributions differently. It is reasonable to conclude that the two measures give a broadly similar picture in terms of the measurement of inequality, and that it is possible to assess the *relative* levels of inequality between distributions using either measure.

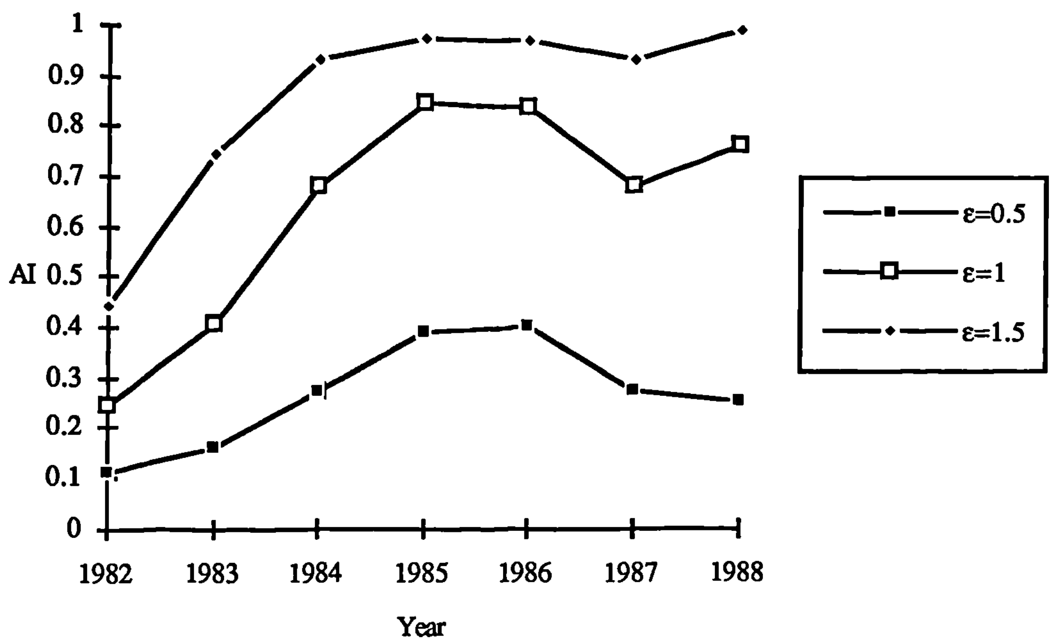
[20] Within each year, the groups were ranked according to the level of inequality, with the most equal group ranked 1 and the most unequal ranked 4. This was undertaken using both the Gini and Atkinson indicies. Comparison can therefore be made between the ordinal qualities of the two indicies.

Table 4.12 The Ranking of Types of Farms by Gini and Atkinson (ε=0.5)

Year	All Farms		Dairy		Livestock		Mixed	
	AI	Gini	AI	Gini	AI	Gini	AI	Gini
1982	3	3	2	2	1	1	4	4
1983	3	3	1	1	2	2	4	4
1984	3	3	2	=1	4	4	1	=1
1985	2	2	1	1	3	3	4	4
1986	3	3	1	1	2	2	4	4
1987	3	3	2	2	4	4	1	1
1988	3	3	1	1	2	2	4	4

The ε value chosen was purely arbitrary and no real justification for using this level rather than any other was given. Figure 4.4 highlights the effect of changing the value of ε. More detailed results are given in Appendix 4.I.

Figure 4.4 Measured Inequality with Different ε values for All Farms



It is clear that as the value of ε increases (reflecting society's higher aversion to inequality) then the level of measured inequality increases. From an examination of

Figure 4.4 it may be reasoned that although the level of inequality is different in absolute terms the relative relationship between years remains the same and therefore distributions will be ranked similarly.

The results in Figure 4.4 are for ε values up to 1.5. A somewhat different picture emerges if an ε value as high as 3 is chosen. If the ranking of the distributions are compared with those for the Gini (as was undertaken for an ε value of 0.5) the measure ranks the distributions differently. In the case of the low ε value (0.5) Atkinson's index and the Gini coefficient coincided on 27 out of 28 possible rankings. For the high ε value of 3, Atkinson's Index and the Gini coefficient only ranked 16 out of the 28 the same (Table 4.13). Therefore, higher ε values lead to differences between the two measures as to the relative levels of inequality exhibited by the distributions.

Table 4.13 The Ranking of Farm Types within Years by Gini and Atkinson (ε=3)

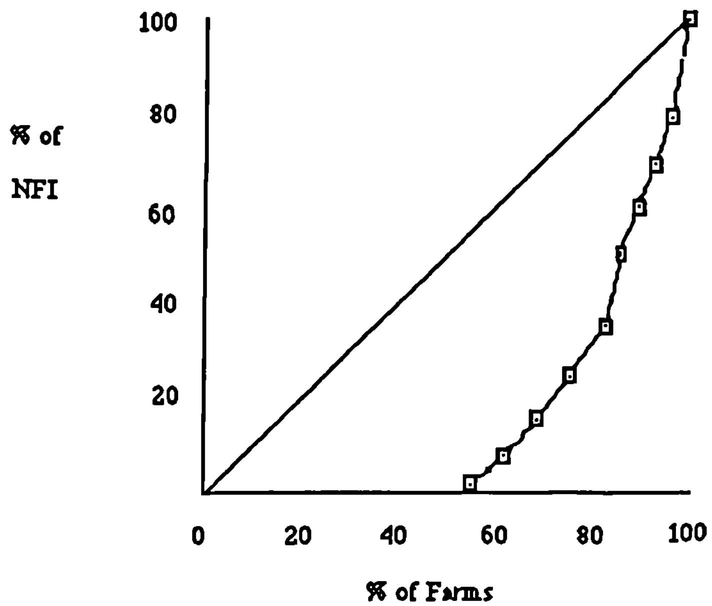
Year	All Farms		Dairy		Livestock		Mixed	
	AI	Gini	AI	Gini	AI	Gini	AI	Gini
1982	3	3	2	2	1	1	4	4
1983	3	3	1	1	4	2	2	4
1984	3	3	2	=1	4	4	1	=1
1985	4	2	2	1	3	3	1	4
1986	2	3	1	1	4	2	3	4
1987	3	3	2	2	4	4	1	1
1988	4	3	1	1	3	2	2	4

What becomes clear is that choice of a value for ε can alter the ordinal as well as the cardinal ranking of distributions. Previous work, by using only the Gini coefficient, has ignored the fact that inequality measures exist which could have produced different results (and thereby possibly altering the conclusions).

4.6.3 Negative Farm Incomes - re-examined

The decision on how best to deal with the problem of negative farm incomes is now re-examined in light of the above results. In theory, it appeared valid to ensure that the first cell was large enough to have a positive total income. However, on closer examination the validity of this approach can be questioned in specific incidences. The best example of the problem relates to the calculation of Gini coefficients for mixed farms in 1986. As Table 4.9 showed, 26% of the farms in the mixed group reported negative incomes. Therefore, to ensure that the first cell of the distribution was positive, over 50% of all observations were needed. Figure 4.5 highlights the effect on the Lorenz curve of this occurrence. Benson (op.cit.) noted that the larger the number of observations in one cell, the greater the likelihood of cell bias occurring. Given this problem, it raises questions as to the validity of the results and thus the conclusions drawn as to relative levels of inequality between distributions.

Figure 4.5 The Lorenz Curve for Mixed Farms 1986



The above example highlights the fact that a given Gini coefficient can hide many problems in the derivation of that figure. Benson claims that a simple Gini often is published without resort to a detailed explanation of the methods used. What appears to be a valid approach (making the first cell large enough to produce a positive total income) can in practice lead to anomalies in the results.

The choice of inequality measure has already been shown to be subjective and therefore conflicts in the results can, to a certain extent, be justified. However, the problems with negative incomes affect the basic analysis and can undermine confidence in the final results. The definition of income was another choice made when calculating the Gini coefficients. Effects of small changes in this definition are now examined.

4.6.4 An Alternative Income Definition

This section attempts to analyse the effects of changing the definition of income. Due to data limitations, the change in definition is small and does not encompass the off-farm income or total family income concepts found in the American studies reviewed in Chapter 2. However, the new definition does have the advantage of enabling the effects of a small change to be assessed.

The adjustment involves adding back to NFI the imputed rent calculated for owner-occupiers and also the value of unpaid labour. This Adjusted Net Farm Income figure (ANFI) is similar to the adjustment made by Bell (op.cit.) and briefly discussed in Chapter 2. Bell justifies this alteration on the grounds that it gives a better reflection of the welfare position of the farms under examination, rather than a strict economic measure (clearly it falls short on a welfare front because other sources of income are not known). The effect of this alteration on average income for each farm type can be seen in Tables 4.14 and 4.15. As the purpose of adjustment is illustrative, it is made only for a selection of the years under examination.

Table 4.14 ANFI by Farm Type 1985 to 88

Year	All Farms	Livestock	Mixed	Dairy
		£'000		
1985	11.6	10.0	17.9	11.4
1986	9.5	9.3	8.5	10.7
1987	10.2	8.8	14.7	11.0
1988	11.3	10.0	9.5	16.2

Table 4.15 Percentage difference between ANFI and NFI

Year	All Farms	Livestock	Mixed	Dairy
		%		
1985	33	34	26	38
1986	41	38	51	42
1987	40	43	27	44
1988	33	29	52	28
Mean Absolute Difference	37	36	39	38

The average percentage change for each farm type over the period is very similar. The alteration in the measure obviously makes a significant difference to average income (the use of ANFI also reduces the number of farms with negative incomes), but in the context of this study it is the effect on the *distribution* of income that is important. A comparison of the levels of inequality obtained using the two different farm income measures follows. The levels of inequality as measured by the Gini coefficient for the distribution of income associated with the ANFI definition are shown in Table 4.16.

Table 4.16 Gini Coefficients for ANFI by Farm Type, 1985 to 1988

Year	All Farms	Livestock	Mixed	Dairy
1985	0.44	0.39	0.41	0.37
1986	0.45	0.44	0.56	0.36
1987	0.38	0.36	0.39	0.38
1988	0.39	0.36	0.45	0.33

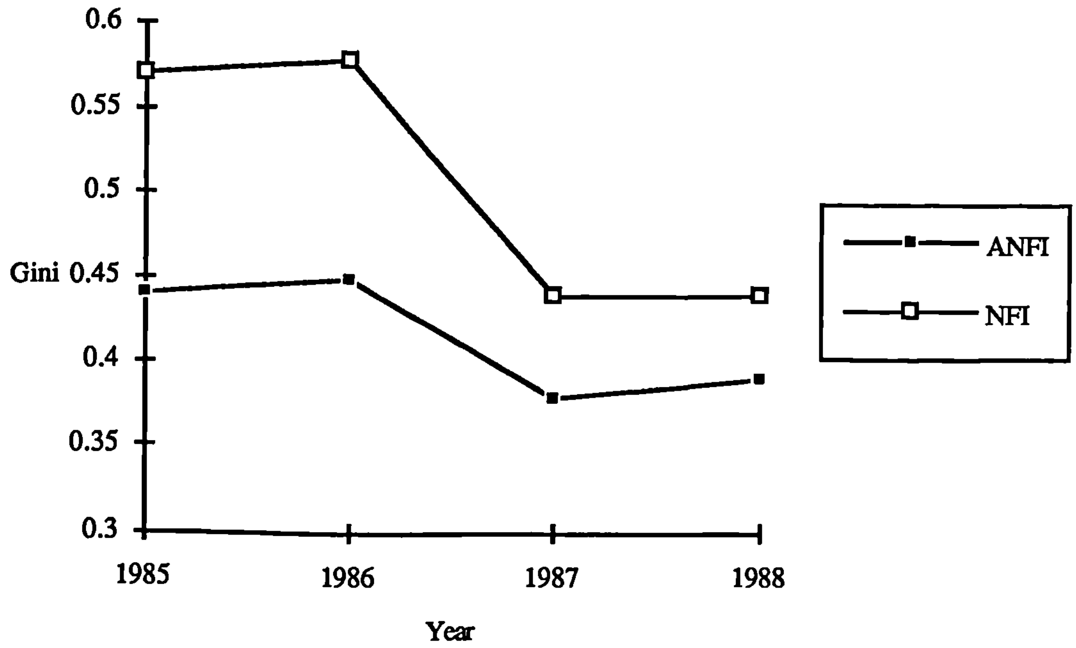
Comparison of Table 4.16 with Table 4.10 indicates that in all but one case the distribution of income is consistently more equal for ANFI than for NFI (i.e. the Gini coefficients are lower). A number of conclusions follow. First, it would appear that the low NFI farms are more likely to be those that are owner-occupied and to use more unpaid labour than the high NFI farms. Second, different measures of income exhibit different levels of inequality, and this leads to problems in assessing the actual effects of support payments on measured inequality.

Table 4.17 indicates that the difference in the level of inequality is not consistent between farm types. Dairy farms have a much lower absolute change in inequality compared to livestock and mixed farms, which indicate significant changes in observed inequality. Figure 4.6 illustrates the Gini coefficients for all farms between 1985 and 1988.

Table 4.17 Difference in Gini Coefficients using ANFI rather than NFI

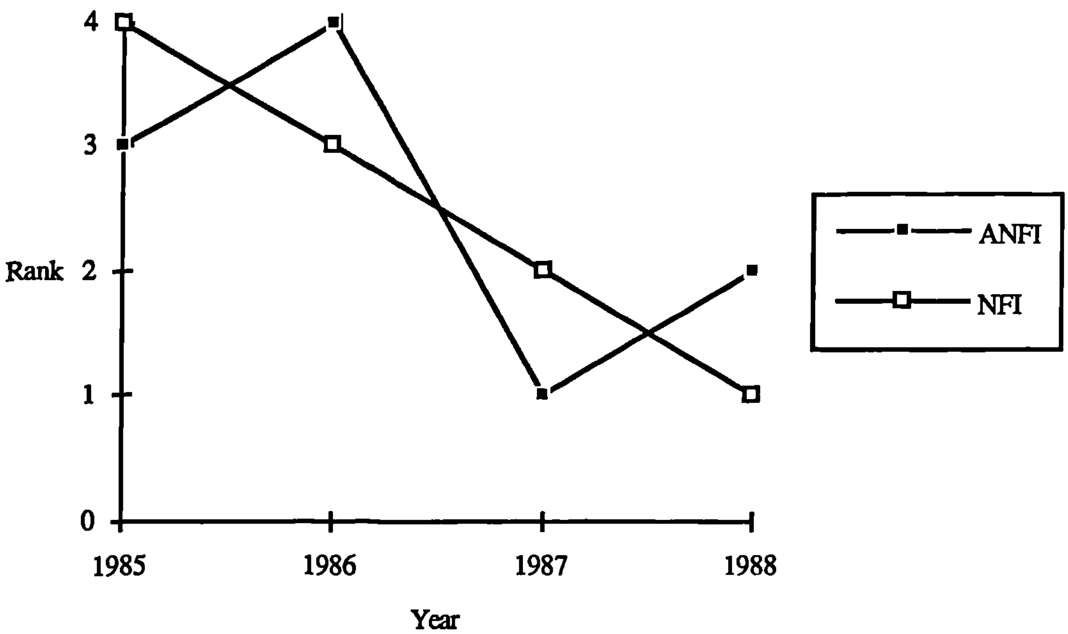
Year	All Farms	Livestock	Mixed	Dairy
1985	-0.13	-0.21	-0.25	-0.04
1986	-0.13	-0.13	-0.16	-0.06
1987	-0.06	-0.12	0.02	-0.05
1988	-0.05	-0.05	-0.15	-0.02
Average Difference	-0.09	-0.13	-0.14	-0.04

Figure 4.6 Gini Coefficients for ANFI and NFI (All Farms)



The measured levels of inequality can be compared with those found for NFI in terms of both the cardinal (as shown above) and ordinal ranking. Figure 4.7, using livestock farms as an example, highlights that changing the definition of income not only changes the absolute value of the Gini coefficient, but also the ordinal qualities. Whereas for NFI, 1988 indicated the most equal distribution, with ANFI it is 1987. This again raises questions about problems caused by the assumptions made by researchers.

Figure 4.7 Ranking of Livestock Farms by ANFI and NFI



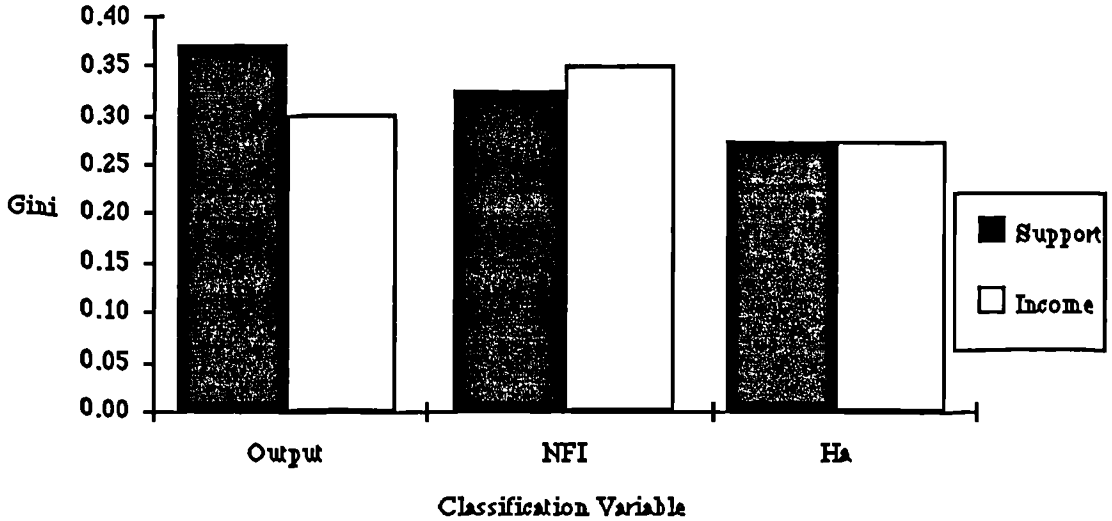
4.6.5 The Size Grouping of Farms

The final consideration is the possible effect of changing the variable by which farms are grouped into the cells from which Gini coefficients are calculated. This relates to the studies reviewed in Chapter 2 that used either sales class (typically the American studies) or income class as the means of grouping farms. This section will concentrate on illustrating the effects of grouping farms by different variables. Three possible groupings of farms - by income, by output and by hectares - are used. The output variable, assuming a similar price for farm products, can be related to that of sales class. The income grouping is that advocated by Schultze (op.cit.) and used by Bell (op.cit.). The hectares class is used to assess the effect on the distribution of grouping by farm area.

So far this chapter has dealt only with the distribution of income. Comparison with support payments clearly requires some measure of the distribution of support to be made. Due to the nature of the EC regime, calculation of the distribution of support is reasonably simple. For most products, support is by maintained prices. Therefore, the price for each unit produced contains a proportion which can be attributed to support payments. This suggests that the distribution of support will follow the distribution of output. Thus to calculate the distribution (rather than the actual level) of support requires only output data. As the examination is illustrative, only one farm type, dairy, is chosen and the distributions are analysed for only one year, 1988.

The possible effects of changing the grouping variable on the level of inequality of income is important in itself. However, of more importance is the effect on the observed relationship between support payments and income distribution. Changes in the grouping variable are made to assess the effects on the relationship between the distribution of agricultural support payments and income. Farms were grouped into size deciles by each of the three variables (income, output and hectares), and the proportion of income and support received by each decile was used to calculate the Gini coefficient. Results are shown in Figure 4.8.

Figure 4.8 Gini Coefficients for Support and Income with different Classification Variables



First, although the inequality associated with income does change (with a range from 0.27 to 0.35) depending on the groupings used, the variation is not substantial. Second, the different methods of ranking farms lead to different conclusions about the relative distributions of support and income. Ranking farms by NFI, shows a higher degree of inequality for income than support. This indicates that large farms (in terms of NFI) receive relatively more income than they do support. On the other hand, if farms are ranked in terms of their output, income is more equally distributed than support, indicating that large farmers receive proportionally more support than income. Finally, if farms are ranked by farm area (hectares) then the distribution of income is similar to that of support. The findings highlight the fact that differences in the methods used to construct the cells for the calculation of the Gini coefficient can lead to conflicting conclusions as to the effect of support on farm incomes. With farms classed by NFI it may be reasoned that as support is more equally distributed than income, then removal of support will lead to a more unequal distribution. The opposite is true under farms grouped by output (or sales class), whilst using farm area leads to the conclusion that support is neutral and removal would lead to no change. Therefore, from the same data set fundamental differences can arise as to the conclusions drawn.

4.7 Conclusions

This chapter has raised a number of points. Initially the FBS data were shown to be inappropriately classified for the analysis of income distribution. Reclassification highlighted the usefulness of cluster analysis for grouping agricultural data. The chapter then proceeded to evaluate the methods used to measure inequality in farm income in the North East of England.

The results from this chapter raise a number of questions about the approach to, and the validity of, measuring the distribution of both income and support. Initially it was shown that the problem of negative NFI could be overcome by ensuring that the first cell of the distributions consisted of enough observations to be positive. The results found by using the Gini coefficient and Atkinson's Index with a low ε value appeared promising. It was possible to conclude that, despite differences in the cardinal level of inequality shown by the income distributions, the ordinal rankings were very similar. At this point it could be argued that the analysis was producing acceptable results. However, on further investigation, this appeared not to be the case.

First the use of differing ε values led to contradictions in the ordinal rankings of distributions. In particular, the ordinal ranking of distributions by the Gini coefficient and Atkinson's index began to diverge as the ε value increased. Second, because of the occurrence of negative incomes, the likelihood of cell bias was high in certain distributions. Third, by altering the definition of income the cardinal and ordinal rankings changed, thus confusing the matter further. Fourth, changing the method by which farms were classified into size groups led to conflicting results as to the relationship between the distribution of farm support and that of income.

The findings are not necessarily unique to this study. Confidence placed by other authors in their findings appears to be ill-founded. The above problems are fundamental when measuring inequality of income or support, and it would appear that in many cases they have not been adequately addressed.

Each of the problems listed can be dealt with, to varying degrees. The use of either the Gini coefficient or Atkinson's Index can be justified depending on subjective judgements. Presenting the results from one measure, of course, will not lead to contradictory findings. However, this does not hide the fact that other measures are available which would give different results.

Negative incomes may arise because the income measure used does not encompass off-farm income and it may be the case that if other definitions of income are used then income would always be positive. A more definitive measure of income would negate the need to decide between such measures as ANFI and NFI, thus simplifying the work of the researcher.

Finally, conflicts arising from different methods of grouping the farms into cells can be overcome by careful consideration of the aim of the study. If the aim is to assess the level of support received by high income compared to low income farmers, then classification by income is valid. If it is considered more important to measure farm support in relation to farm production then output is preferable.

The fact that most of the problems can be resolved does not remove the concern that from one data set it is possible to arrive at a number of conflicting conclusions with only minor alterations in the assumptions made. By altering the measure used, it is possible to present farm incomes as equally distributed or unequally distributed. By changing the grouping of farms is possible to show income to be either more or less equally distributed than support. Therefore, the overall conclusion is that it is possible to manipulate the process of measuring inequality to produce virtually any result that is required, clearly reducing the reliability of such analysis.

One overall solution to the problems found may be the use of functional forms such as those reviewed in the latter part of Chapter 3. The next chapter will assess the validity of using the lognormal distribution in inequality analysis.

Appendix 4.I Tables A4.1 to A4.4

Table A4.1 Measured inequality using Atkinson's Index (with $\varepsilon=1$)

Year	All Farms	Dairy	Livestock	Mixed
1982	0.25	0.18	0.14	0.48
1983	0.41	0.29	0.47	0.55
1984	0.68	0.46	0.77	0.37
1985	0.85	0.47	0.83	0.82
1986	0.84	0.54	0.85	0.85
1987	0.68	0.46	0.77	0.37
1988	0.76	0.25	0.51	0.73

Table A4.2 Measured inequality using Atkinson's Index with ($\varepsilon=1.5$)

Year	All Farms	Dairy	Livestock	Mixed
1982	0.44	0.21	0.21	0.71
1983	0.74	0.51	0.96	0.82
1984	0.93	0.77	0.95	0.63
1985	0.97	0.8	0.96	0.93
1986	0.97	0.93	0.98	0.9
1987	0.93	0.63	0.77	0.96
1988	0.99	0.42	0.87	0.87

Table A4.3 Measured inequality using Atkinson's Index with ($\varepsilon=2$)

Year	All Farms	Dairy	Livestock	Mixed
1982	0.66	0.35	0.27	0.84
1983	0.92	0.74	1	0.92
1984	0.97	0.91	0.98	0.81
1985	0.99	0.94	0.96	0.93
1986	0.98	0.95	0.99	0.97
1987	0.97	0.91	0.98	0.81
1988	1	0.6	0.96	0.91

Table A4.4 Measured inequality using Atkinson's Index with (ε=3)

Year	All Farms	Dairy	Livestock	Mixed
1982	0.87	0.49	0.37	0.91
1983	0.97	0.91	1	0.96
1984	0.99	0.96	0.99	0.91
1985	0.99	0.98	0.98	0.97
1986	0.99	0.96	1	0.99
1987	0.99	0.96	0.99	0.91
1988	1	0.81	0.99	0.93

Chapter 5 The Distribution of Income and Support of Dairy Farmers in England and Wales 1972/3 to 1986/7

5.1 Introduction

Chapter 4 concentrated on an analysis of income distribution between farms within a specific region of the country. It was shown, by various methods, that conflicting results can arise if the definition of income, the inequality measure used, or the grouping of farms is varied, and that confusion can arise from the use of standard inequality measures. In Chapter 3, the possibility was raised of using functional forms to encapsulate a particular distribution. This chapter will attempt to fit a functional form (the lognormal) to national farm data. First, the variables for examination will be selected. Second, the validity of assuming lognormality for the relevant data sets will be assessed. Finally, this method will be used to analyse both national and regional levels of inequality for England and Wales between 1972/3 and 1986/7.

This chapter is concerned with the *level* of income support and support as well as the *distribution,* for two reasons. First, knowledge of the level of income and support enables deeper insight into the situation of farmers, both in relation to society as a whole, and in relation to each other. As was mentioned in Chapter 4, a low degree of inequality may be associated with low levels of income, and therefore may not present the whole story. Second, detail on the regional level of income and support will allow analysis of the distributional effects of policy *between* regions of the country, rather than just within regions.

5.2 Data

A national examination of inequality requires national data. Unfortunately, Farm Business Survey (FBS) data sets for the national sample were not readily available. However, national data were available for dairy farms from the milk costings surveys undertaken by the Milk Marketing Board (MMB). These surveys were initially conducted every 5 years, then every three years from 1977/8, and (as a continuous sample) every year from 1984/5 to 1986/7. The period considered for this analysis runs from 1972/3 to 1986/7. Data for 1977/8 were not available and the selected years examined are 1972/3, 1980/1, 1984/5, 1985/6 and 1986/7. The survey operates on a random sampling method stratified according to herd size (details of the methods used are included in Appendix 5.I).

Since 1980/1 the sample has been stratified on a provincial basis. This will facilitate analysis of regional levels of inequality. The sample is actually split into five regions and nine provinces. Provinces are used for the purpose of this analysis, because there are enough to ensure that a wide range of farming areas are covered. There are also few enough to ensure that the number of farms examined within each is sufficient to minimise the risk of outliers biasing the results. Appendix 5.II lists provinces and the counties which constitute each province (hereafter the terms region and province will be used interchangeably). The sample was stratified by province only after 1980 so the analysis of regional levels of inequality will not include the 1972/3 results.

5.3 Assessing the Lognormality of Income and Support

It is clear that before an analysis of inequality, based on the assumption of lognormality, is undertaken some form of assessment must be made as to the closeness of fit of the actual distributions to the lognormal. The analysis of the applicability of the lognormal to the given data sets is, therefore, twofold. First, the lognormal must be shown as an adequate representation of the distribution of *support*. Second, it must also confer an adequate representation of the distribution of *income* . If it adequately represents the distribution of income this does not necessarily infer that it will represent the distribution of support, and vice versa.

5.3.1 Choice of Variables

In Chapter 4, the distribution of output was used as a proxy for the distribution of support. Output can also represent the size of firm. It is this which produces a link with the size distribution of firms reviewed in Chapter 3. The lognormal has been applied to data sets on the size distribution of firms. As support is assumed to be distributed similarly to output, then if the lognormal represents the size distribution of farms (in terms of output) it will necessarily represent the distribution of support.

In the case of income, the link with the lognormal is more straightforward, in that the functional form has been applied many times. However, problems arise because some farms have negative levels of Management and Investment Income (MII)[21] and it is not possible to take the logarithm of a negative number. (In 1984 nearly a quarter of farms in the survey had a negative MII.)

It may be reasonable to argue that if a data set has negative numbers it cannot be lognormal. However, this relates only to one measure of income, and a farm with negative MII may have a positive income when some other measure is considered. The problem with negative farm income is twofold. First, it makes measurement of inequality more difficult, and second, it is a difficult concept to grasp in terms of distribution. For example, how many times 'better off' is a person with £100 than a person with -£100? For these reasons, and also the desire to overcome the problems associated with the ranking of distributions found in Chapter 4, it was decided that it would be preferable to find some proxy for income that reflects the distribution of MII, but is in all cases positive.

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[21] The unit of income measurement given in the data is MII and this differs from NFI because it does not include the value of the manual labour of the farmer and spouse.

A possible measure is one used by Brown (1989) in his work on the distribution of price support in the EC. The measure he chose (due to data restrictions) for analysing the distribution of income was Net Value Added (NVA).[22] This can be defined as sales revenue minus the costs of inputs involved in the production process. In the dairy sector, this would include the costs of feed, seed, fertiliser, etc.

Using NVA instead of MII results in a positive income figure for virtually the whole sample.[23] The relationship between MII and NVA was analysed by means of simple regressions for the years 1972/3, 1985/6 and 1986/7. The regression took the following form:

$$MII = \alpha + \beta NVA + u$$

The results are reproduced in Table 5.1.

Table 5.1 Regression Analysis of MII on NVA

YEAR	R^2	α	β
1972/3	0.94	-665.36 (-8.68)	0.64 (83.53)
1985/6	0.75	-4953.51 (-5.60)	0.50 (31.89)
1986/7	0.76	-5572.52 (-5.60)	0.50 (31.00)

t-statistics in brackets

The regressions for each year indicate that there is a close relationship between MII and NVA; the R^2 are high and the t-statistics are highly significant. The use of NVA would

[22] The actual measure used by Brown (as reported in Chapter 2) was NVA/Annual Work Units (AWU). His arguments for dividing by AWU relate to differences between farms that are part-time and full-time and also between different types of farming. As this study only relates to Dairy farms the division by AWU is not required.

[23] Two farms in 1972, one in 1980 and four in 1984 still showed a negative income after this transformation. They were excluded from the analysis of inequality.

seem to produce a good proxy for income which has the advantage of being positive, and it was decided to use this proxy when analysing income distribution.[24]

This section has considered the validity of using output and NVA as proxies for levels of support and income, respectively.

5.3.2 Testing For Lognormality

It has been decided to use NVA and output as proxies for income and support, respectively. This section therefore deals with the appropriateness of the assumption of lognormality for these two variables. For output, the analysis examines whether the distribution of herds by output classes is similar to that which would occur under a lognormal distribution. For NVA the analysis examines whether the distribution of herds by 'income' classes is similar.

5.3.2.1 Output

Due to the link between the lognormal and the normal distribution, assessment of the closeness of the actual distribution of output to the lognormal is relatively simple. Predicted distributions can be formed and tests of closeness undertaken with actual distributions. The actual distribution of herds is split into size classes according to the number of litres produced. The predicted number of herds, in each size class, is obtained by using standard normal (z) tables on the assumption of lognormality. Once the predicted and actual herd numbers in each size class are calculated (Table 5.2), a chi-square test is used to formally test the 'goodness of fit' of the two distributions.

[24]A test using Gini coefficients was conducted. Farms were ranked by MII and the Gini calculated for both MII and NVA. The results showed similar levels of inequality for both distributions.

Table 5.2 Actual and Predicted Herd Numbers in Output Size Classes (1980)

Output (000 litres)	Actual Number of Herds	Predicted Number of Herds	Percentage Difference
0-100	7,594	6,608	14.9
100-200	10,252	12,134	-15.5
200-300	8,437	8,571	-1.6
300-400	5,906	5,452	8.3
400-500	3,645	3,398	7.3
500-600	2,628	2,176	20.8
600-700	1,839	1,522	20.8
700-800	1,162	1,008	15.3
>800	2,152	2,748	-21.7
Gini	0.416	0.426	2.40

The predicted distribution fails the chi-square test (that is the null hypothesis of no difference between the distributions is rejected). However, as mentioned earlier, Ransom and Cramer (op. cit.) argue that this is not sufficient grounds for rejecting the assumption of lognormality. As with much of the literature on the subject, it is in the lower-middle to middle size classes that the distribution is closest to the lognormal. The tails indicate greater deviations from lognormality, with the predicted distribution consisting of too few herds in the lowest size class and too many in the highest one. Clearly, the above distribution is not perfectly lognormal. However, it is the effect of the assumption of lognormality on the level of measured inequality that is of most important to this study. Cowell (op.cit.) having noted the problems of goodness of fit tests for large samples, argued that a possible test could be a comparison of the level of inequality obtained assuming lognormality with that from the actual data.

Nine herd size classes have already been used for testing the predicted distribution (Table 5.2). The only additional information needed to calculate Gini coefficients is total output in each size class. Total output figures for the two distributions can be obtained by multiplying the number of herds by the average output in that size class. The average output is assumed the same for both distributions, and is taken from the data set. The difference in the Gini coefficients is therefore a result of differences in the number of herds in each output class. The Gini coefficients (shown in Table 5.2) are similar suggesting that assuming lognormality does not effect the level of measured inequality. The analysis was repeated for 1985, the results of which are shown in Table 5.3. The predicted distribution for 1985 again failed the chi-square test for goodness of fit. However, the Gini coefficients are, like 1980, very similar.

Table 5.3 Actual and Predicted Herd Numbers in Output Size Classes (1985)

Output (000 litres)	Actual Number of Herds	Predicted Number of Herds	Percentage Difference
0-100	5,327	4,424	20
100-200	8,488	9,825	-14
200-300	6,840	7,714	-11
300-400	5,428	5,151	5
400-500	4,012	3,402	18
500-600	2,835	2,187	30
600-700	2,037	1,603	27
700-800	806	1,026	-21
>800	2,666	3,106	-14
Gini	0.418	0.428	2.39

The conclusion arising from the assessment of lognormality of the distribution of output is that although the assumption seems to lead to over- and under-estimation of the number of herds in various size classes, the overall distribution, as measured by the Gini coefficient, seems little altered. The assumption of lognormality does not appear to bias the measure of inequality.

5.3.2.2 NVA

To test whether the assumption of lognormality is valid with respect to the distribution of NVA the above procedure was repeated, but with size classes calculated in terms of income (as measured by NVA). The actual and predicted number of farms in each income group are shown in Table 5.4.

Table 5.4 Actual and Predicted Herd Numbers in Income Size Classes (1972).

Income £('000)	Actual Number of Herds	Predicted Number of Herds	Percentage Difference
0-1	7,350	6,607	-10
1-2	12,975	13,739	6
2-3	10,018	11,603	16
3-4	8,034	8,647	8
4-5	7,141	6,354	-11
5-6	4,623	4,573	-1
6-8	5,310	6,067	14
8-10	5,200	3,576	-31
>10	7,621	7,084	-7
Gini	0.420	0.424	0.95

The results for NVA indicate similar findings to previous work on the lognormality of income, and to the results for output. The lognormal appears to estimate the body of the distribution fairly well, but is not as good a fit in the tails. Overall, the fit for NVA is better than that for output. However, as with output, the more important test is whether the Gini coefficients from the actual and predicted distributions are similar. The Gini coefficients for NVA are calculated in a similar manner to those for output, with the number of herds in each size group multiplied by average income rather than output. It is clear, that like output, differences in actual and predicted distributions do not significantly alter the level of measured inequality (Table 5.4).

The above analysis was repeated using the 1980 survey results. The difference in the Gini coefficients was slightly greater (0.48 compared 0.46) but still suggested that the assumption of lognormality made little difference to the measured level of inequality.

The results for NVA are very similar to those for output. The predicted and actual number of herds in each income class vary, but the overall level of inequality is very similar. The conclusion can be drawn that in both cases the assumption of lognormality will not significantly bias the results. For this reason, analysis of national levels of output (support) and NVA will be conducted assuming that both distributions are lognormal.

Cowell (op. cit.) notes that combining variables that are lognormally distributed does not ensure that the final distribution will be lognormal. If this is the case, then the reverse may also be true. A lognormal total distribution does not ensure that the individual items are lognormally distributed. In the context of this study, this implies that although the variables are regarded lognormally distributed at the national level, the distribution within regions may not be. As regional analysis of inequality is a necessary part of this study, the lognormality of the regional distribution requires assessment.

Table 5.5 presents the Gini coefficients for output for the nine regions as measured under the lognormal assumption and those calculated from actual distributions, for 1984/5 . In general, it would appear that the assumption of lognormality leads to a slight overestimation of inequality at the regional level, although the Mean Absolute percentage Difference (MAD) does not appear to be unduly large.[25] In conclusion, although the distributions appear to vary more on a regional than a national basis, the assumption of lognormality does not significantly alter the level of observed inequality.

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[25] Similar findings were found with an examination for Gini cefficients for actual and predicted NVA at the regional level.

Table 5.5 Gini Coefficients for Actual and Predicted Output by Region 1984/5

Province		Actual Gini	Predicted Gini	Percentage Difference
Wales	(W)	0.40	0.41	3.6
Northern	(N)	0.45	0.47	5.3
North Eastern	(NE)	0.35	0.37	7.1
North Western	(NW)	0.41	0.47	15.9
East Midlands	(EM)	0.37	0.39	5.8
Eastern	(E)	0.40	0.42	4.0
South Eastern	(SE)	0.44	0.48	9.6
Southern	(S)	0.39	0.42	7.5
South Western	(SW)	0.41	0.43	3.9
				MAD=7.0

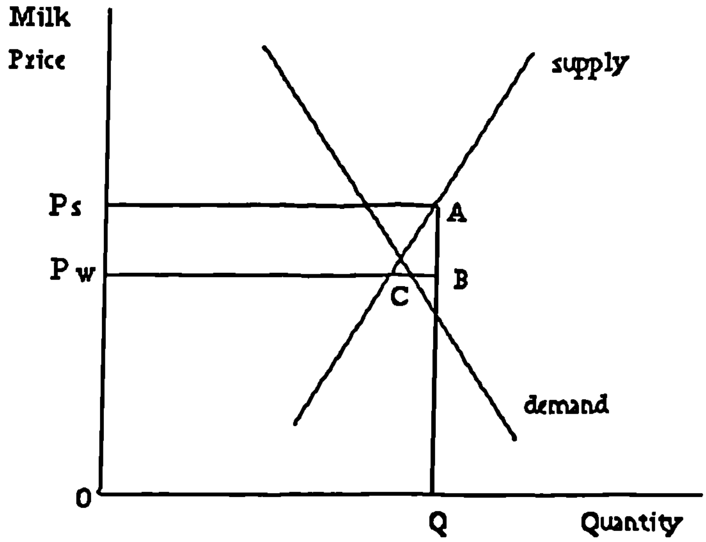
5.4 Estimation of the Level of Support and the Parameters of the Lognormal

The purpose of this section is to analyse the methods by which the total *level* of support received by dairy farmers and the parameters of the lognormal (μ and σ^2) are estimated.

5.4.1 Estimation of the Level of Support

Although it was earlier stated that the *distribution* of output was a valid proxy for the *distribution* of support, it is clear that some direct estimation of the *level* of support received by farmers is useful when analysing distributions. The level of support in this study has been estimated as the difference between the EC support (intervention) price and the world price, multiplied by the level of production. Figure 5.1 illustrates the process by which total support was estimated. P_W is the world price, P_S is the EC support price and Q is the level of production. The total level of support can therefore be approximated by the rectangle P_SABP_W. This is an overestimation of the area of gain in producers surplus (by the triangle ABC) because it does not allow for changes in the level of supply. However, in a static analysis it is a reasonable approximation, because it reflects the immediate loss to the the farmer should support be removed. For the purpose of explaining relative changes over time, and also between regions, it is considered a sufficient approximation.

Figure 5.1 Estimation of Level of Support Received by Dairy Farmers



For all years other than 1972/3, support is estimated using world price levels from the Newcastle CAP model data base.[26] For 1972/3 (prior to UK membership of the EC), a different source is used. It has been assumed that there was some level of support due to the operation of the MMB. This was calculated as the difference between the price received by UK farmers and the comparable New Zealand price of milk.

5.4.2 Estimating the Parameters of the Lognormal

There are a number of methods available for estimating μ and σ^2, including the method of moments and maximum likelihood. As the data were in ungrouped form the latter method was chosen. The sample is stratified and therefore each observation has to be weighted. Thus μ and σ^2 are estimated for both output (or income) as:

[26] The Newcastle CAP model was built at Newcastle University with the aim of estimating the long-run effects of the CAP. To this end, data on actual world prices for agricultural commodities were collected over a number of years. It is these data which are useful to this study. For further information on the Newcastle CAP model, see Buckwell *et al* (1982).

$$\mu = \sum_{i=1}^{n} (\ln X_i . w_i)$$

and

$$\sigma^2 = \sum_{i=1}^{n} [(\ln X_i - \mu)^2 . w_i)]$$

where X = output (or income)

w = weight (based on the MMB's own raising factor)

i = farm

One of the advantages of the lognormal, referenced in Chapter 3, is that it ensures non-intersecting Lorenz curves, which means that both the Gini coefficient and Atkinson's index will rank distributions identically. Use of the lognormal assumption does not ensure the same *cardinal* levels of inequality from different measures, but does ensure that measures give the same *ordinal* ranking. This removes the need for two inequality measures. The Gini coefficient is preferred because, although it has weaknesses, it is conceptually easier to grasp and, more importantly, does not require estimation of society's level of inequality aversion. For each year, μ and σ^2, were estimated and the corresponding Gini coefficients calculated.[27] Estimation of inequality on a regional basis involves similar calculations as for the national data, but with provincial raising factors.

Although it is the Gini coefficients over the period that are of most interest to this study, the *level* of total and average income and support are also reported. The relative 'position' of each region, in terms of level of support, income, size (in terms of output) and number of farms, will be compared. This will facilitate a more thorough analysis of the regional income distribution effects of agricultural policy.

[27] It will be remembered that in Chapter 3 the formula for calculating the Gini coefficient (G) was given as: $G = 2\,N(\sigma/\sqrt{2}) - 1$ where N is the standard normal distribution.

Methods for estimating the level of support and the levels of inequality have been outlined. The next section will report national results for the years under consideration, indicating distributional aspects and levels of support and income. The regional distributions will then be analysed. As milk quotas came into operation in 1984, attention will be given to studying what effect, if any, they have had on the distribution of income and support.

5.5 Results

5.5.1 Introduction

This section presents an analysis of the level and distribution of income and support over the fifteen year period under examination. The analysis, as mentioned earlier, is undertaken at both national and regional level. National results are reported first.

5.5.2 National Results 1972/3 to 1986/7

Table 5.6 presents the total industry level of NVA and estimates of total industry support of dairy farmers in England and Wales for each of the years under consideration.

Table 5.6 Total level of Support and NVA
1972/3 to 1986/7 (1977 prices)

Year	Support	NVA
	£m	£m
1972/3	202	824
1980/1	878	517
1984/5	562	552
1985/6	540	585
1986/7	1,061	639

In real terms the total level of support quadrupled between 1972/3 and 1980/81, but NVA fell. After 1980/1 NVA began to rise, whilst support fell until 1986/7 when it rose dramatically. The estimates of the level of support highlight the importance of changes in world prices. In 1986/7 world price for milk was very low and the estimated support was much higher, despite relatively small changes in production patterns. The use of annual world prices leads to anomalies in particular years. Large changes in world prices lead to large changes in the estimated levels of support. However, it will be remembered that the method by which support is distributed between farms means that the estimated distribution of support will not be altered by these fluctuations. The figures for total support and total NVA make no allowances for changes in the number of producers. In Table 5.7, per farm levels of support and NVA are reported.

Table 5.7 Mean Level of Support and NVA per Farm
1972/3 to 1986/7 (1977 prices)

Year	Support	NVA	Support/NVA
	£	£	%
1972/3	3,009	12,299	24
1980/1	21,490	13,383	161
1984/5	13,153	14,749	89
1985/6	15,380	16,239	95
1986/7	30,411	18,716	162

Immediately clear is that the previously reported fall in total NVA between 1972/3 and 1980/1 is not reflected on a per farm basis, whilst the increase in support is exaggerated. This is because the number of herds declined from over 65,000 to around 46,000 during this period. This decline continued after 1980/1, thus the proportionate increases in NVA are greater on a per farm basis than on a national level. The average level of NVA has shown a steady rise during the period from around £12,000 per farm up to nearly £19,000. Table 5.7 also highlights the importance of support to farms as a percentage of NVA. In 1972/3 support accounted for 24% of NVA, but by 1980/1 it was over one and a half times greater than the level of income. Although the percentage was lower for 1984/5 and 1985/6, it still showed a large increase on 1972/3. In 1986/7 support was again over one and a half times greater than income.

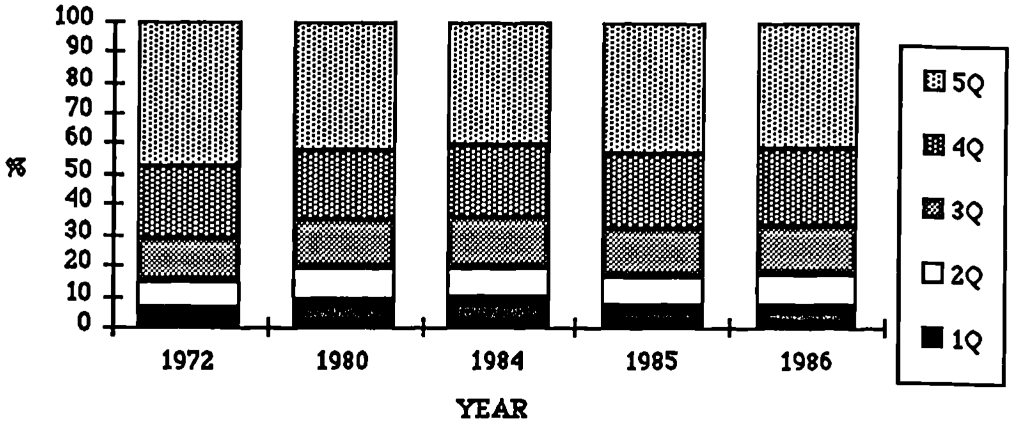
The number of herds, as already mentioned, has declined. At the same time, yields and average herd sizes have increased, resulting in little change in total production. Table 5.8 shows the average herd size and output between 1972/3 and 1986/7. Herd sizes have increased by 75%, output per herd has risen by over 100%, whilst NVA has increased by only 50%. The figures suggest that the dairy sector (like much of agriculture) has been undergoing a cost-price squeeze.

Table 5.8 Average Herd Size and Output 1972/3 to 1986/7

Year	Herd Size	Output
	cows	litres
1972/3	41	206,900
1980/1	62	338,854
1984/5	69	375,666
1985/6	69	388,276
1986/7	72	426,920
% Change 1972/3to 1986/7	75	106

As is evident from Table 5.7, the level of support and NVA vary considerably over time. Of more interest to this study is how these changes are reflected in terms of inequality. This is reported in two ways. First, the percentage of total support and NVA going to farms ranked by income quintiles is calculated. Second, inequality is quantified by the use of Gini coefficients. Figure 5.2 shows the distribution of support between quintiles.

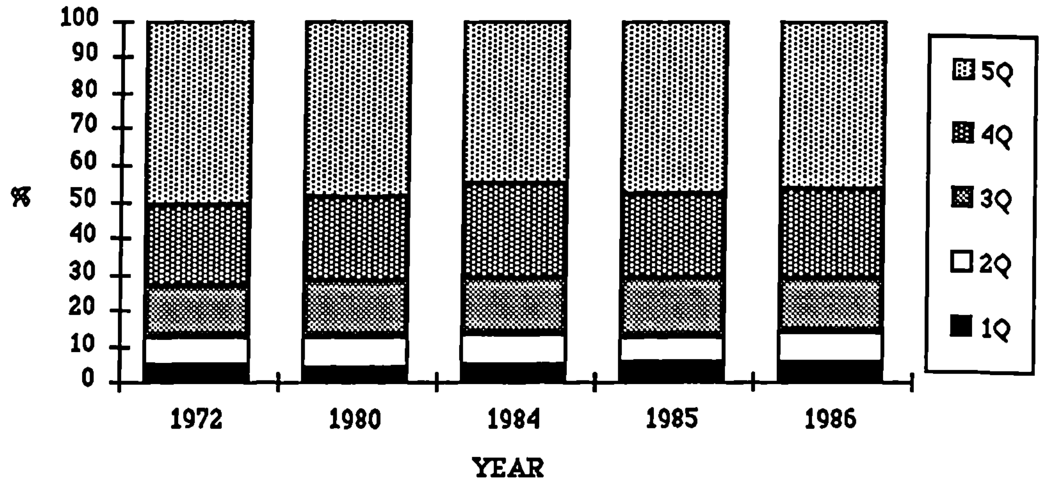
Figure 5.2 Percentage of Support Received by Farms Ranked by Income Quintiles



The distribution of support (in terms of percentage received by quintile) varies little over the time period. For example, the lowest quintile's share of the total ranges from 7 to 10%, and that for the top quintile from 44 and 48%. The implication is that despite changes in policy, total level of support and structure of herds, the distribution of support has remained fairly constant.

A similar pattern is found in Figure 5.3, illustrating the percentage of total NVA accruing to farms grouped by income quintiles. The top quintile continually have around 50%, of the NVA whilst the bottom quintile have around 5%.

Figure 5.3 Percentage of NVA Received by Farms Ranked by Income Quintiles



Quintile analysis gives some idea as to the pattern of the distribution but does not offer a quantification. Gini coefficients for NVA are given in Table 5.9.

Table 5.9 Gini Coefficients for NVA

Year	Gini Coefficient
1972/73	0.48
1980/81	0.52
1984/85	0.55
1985/86	0.54
1986/87	0.52

NVA appears to be fairly unequally distributed (the Gini coefficient for the UK as a whole varied between 0.34 and 0.40 during this period). There is relatively little change over the period in the level of inequality (the Gini ranging from 0.48 to 0.55), indicating a fairly stable distribution of NVA. Since the introduction of quotas in 1984 there has been a slight reduction in the measured level of inequality (0.55 to 0.52).

Table 5.10 reproduces the Gini coefficients for support in the corresponding years. Support appears to be more evenly distributed. There is also less variation over time, with inequality ranging from 0.42 to 0.45. There is no discernible trend in inequality, despite the introduction of quotas.

Table 5.10 Gini Coefficients for Support

Year	Gini Coefficient
1972/73	0.45
1980/81	0.42
1984/85	0.44
1985/86	0.42
1986/87	0.44

Figure 5.4, charting the levels of inequality reported in Tables 5.9 and 5.10, highlights two points. First, the changes in measured inequality for both NVA and support are small. Second, support is consistently more evenly distributed than NVA. Although the changes are small there does appear to be a some evidence of an increasing divergence in the two distributions between 1972/3 and 1985/6.

Figure 5.4 Gini Coefficients for Support and NVA 1972/3 to 1986/7

Since the Gini for support is lower than that of income (indicating that support is more evenly distributed than income), it can be argued that the removal of support would lead to a more unequal distribution of income (if production levels were maintained). These results contrast with the overall findings of Josling and Hamway (op cit., p 58) who argue that, "Programmes which tend to distribute benefits unequally tend to be those price support schemes which operate through the price guarantee system", and who found that total support was more unevenly distributed than farm income. However, it is difficult to compare their findings for dairy farming with those estimated here, both prior to and after EC entry. In their analysis of the distribution of support prior to EC entry, Josling and Hamway made no allowance for the likely price-raising effect of the MMB. When assessing the likely effect of the CAP, they only reported Gini coefficients for total farm support and not for individual farm programmes.

If figures for the distribution of income for the population of the UK as a whole are examined, then the level of inequality is markedly less than that exhibited from dairy farming. Agricultural policy appears to have done little to improve the relative position of the smaller farms. The average real level of NVA may have risen but the farmers on the lowest incomes are still in a relatively poor position.

The stable levels of inequality for both NVA and support (Figure 5.4) are rather surprising, because the time period incorporates three major changes in policy and also significant changes in the structure of the industry. The move from pre-CAP policies through the price support policies of the CAP to quotas have (for the years chosen) had little effect on observed levels of inequality. It may be the case that the actual effect of agricultural support policies has been to keep the distribution of income and support similar. Robinson (op. cit.) argued that, as a result of price support policies, small producers are kept in production, preventing a fall in the level of observed inequality. The decline in the number of herds throughout the period, and the increase in average herd size, have not led to a decrease in levels of inequality. It can be reasoned therefore that both exit from dairying and increases in herd size have been proportionate to the initial distribution of 1972. That is, large herds have not grown proportionately faster than small herds, and also it has not been only the smaller farms that have left the industry.

Fianally, the national results presented highlight a possible omission as a result of using inequality measures. In terms of equity, a policy may be deemed 'fair' if it reaches large numbers of producers. In dairy farming in the UK, support is going to fewer and fewer recipients. In 1972/3 over 65,000 farmers received average support estimated at £3,000 (in real 1977 prices). By 1986/7 fewer than 38,000 producers received, on average, support of around £30,000. More support has been obtained by fewer recipients, but no change in inequality has been noted. To take this argument to its extreme, if support was distributed between two producers, then providing they received similar levels, the distribution would be classed as perfectly equal. But a policy that gave vast sums to only two recipients could hardly be deemed 'fair' within the wider context of society.

5.5.3 Regional Results 1980/1 to 1986/7[28]

The results of the national examination of inequality present a fairly neutral picture in terms of the effects of agricultural policies. The change in methods of support have led to only small changes in observed levels of inequality for both NVA and support. This section will analyse whether these neutral impacts are reproduced at the regional level. The regional analysis involves use of Gini coefficients to estimate the levels of inequality *within* regions. Also, the percentage of income and support going to each region will be compared to enable discussion as to the effects of policy on the distribution *between* regions. First, the levels of support and NVA will be analysed and then the distributional aspects will be considered.

5.5.3.1 Level of NVA and Support by Region

Figure 5.5 charts the estimated level of total NVA received by each of the nine regions for the years 1980/1 to 1986/7. The levels of NVA within each region reflect closely the traditional pattern of dairying in England and Wales, with those provinces in the West and South of England and also Wales having the largest total NVA. Total NVA has, in the majority of cases, shown an upward trend during the period (a noticeable exception is the South East) indicating that the national trend is replicated in most regions.

[28] It will be remembered that 1972/3 data were unavailable at the regional level.

Total levels of support in each region are shown in Figure 5.6. Like the distribution of NVA, it is the traditional dairy regions that receive the majority of support, with the South West receiving the most. There are fluctuations in the level of support going to each region between years, but as with the national results, this is mainly a result of changes in the world price levels from which support is measured. If the two extreme years are examined, the conclusion may be drawn that support is trending upwards, but if all years are examined no discernible trend can be identified.

Figure 5.5 Total NVA by Region 1980/1 to 1986/7

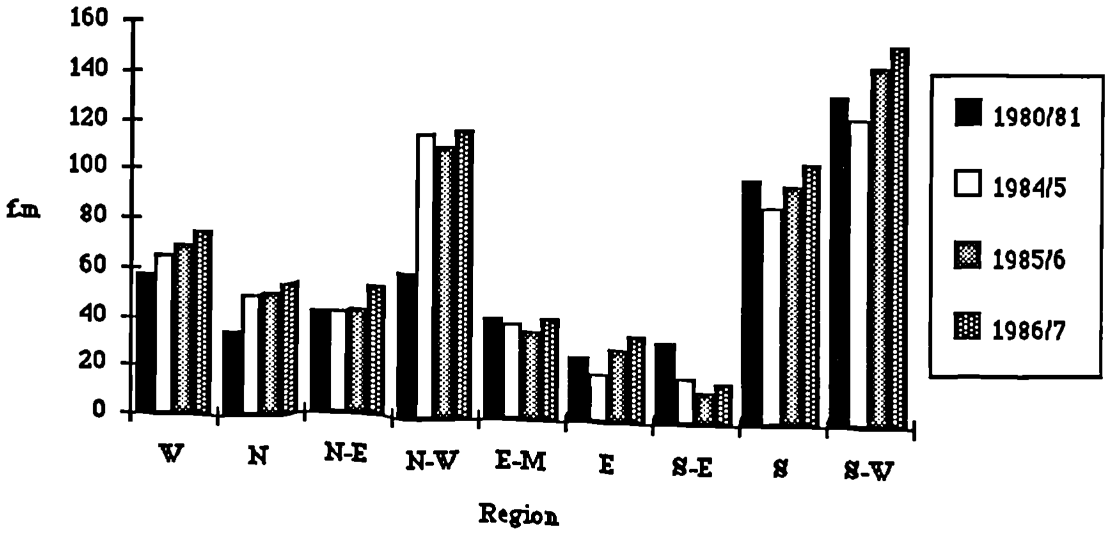
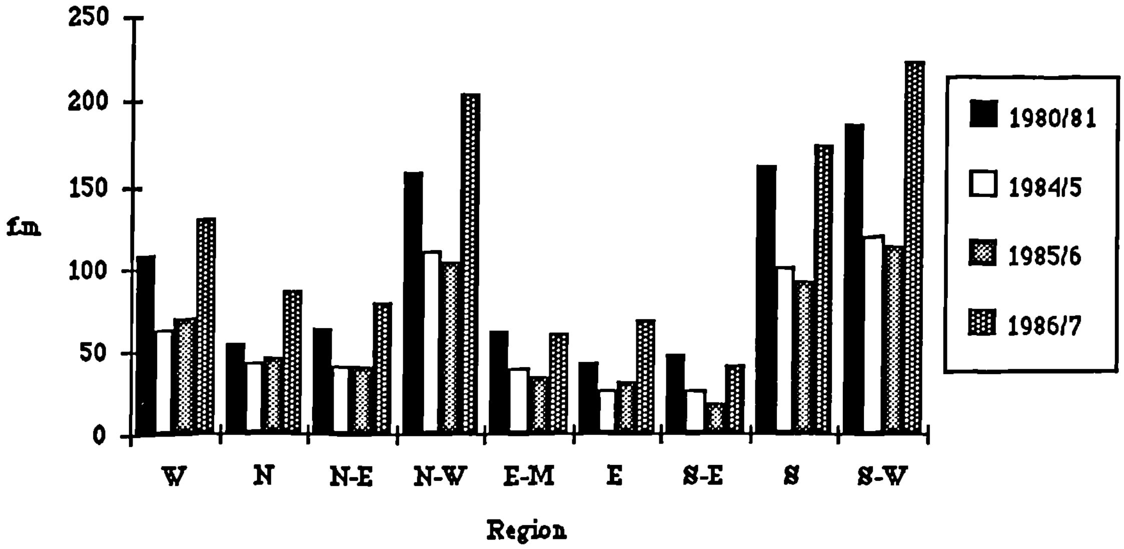
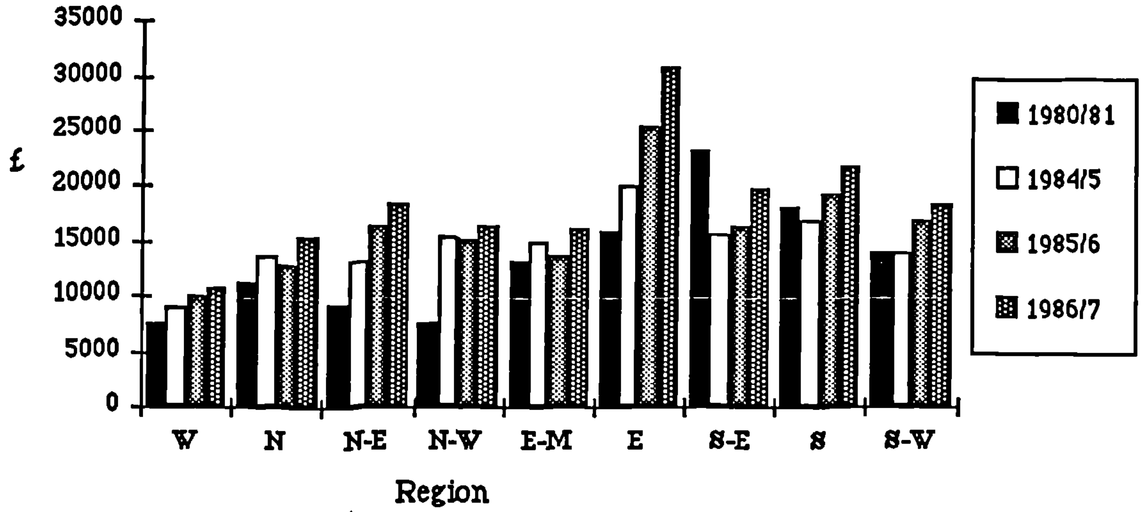


Figure 5.6 Total Support Accruing to Each Region 1980/1 to 1986/7



Examination of total income and support in each region does not take account of the number of producers within these regions. Figures 5.7 and 5.8, present NVA and support, respectively, on a per farm basis.

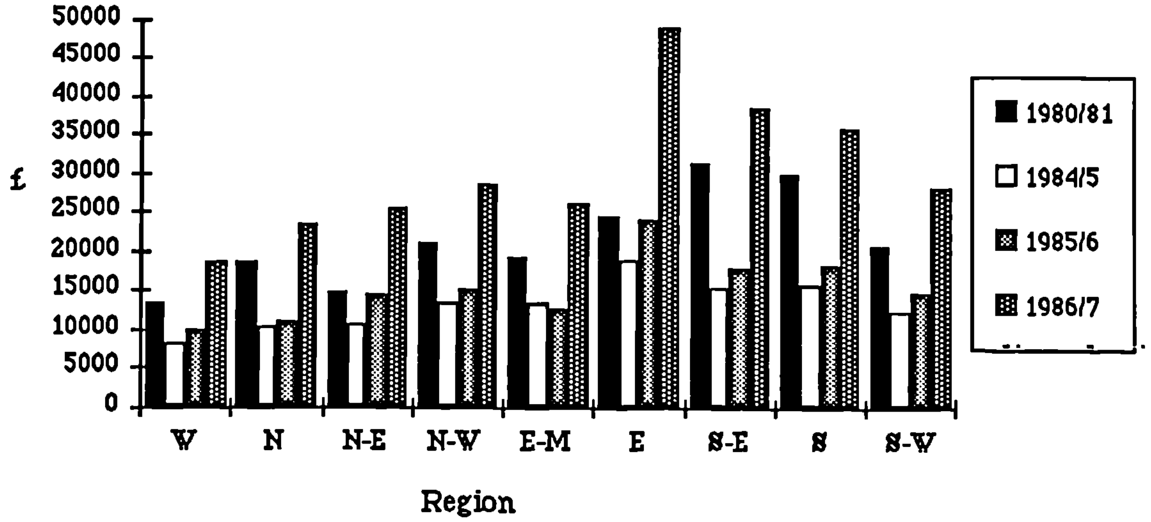
Figure 5.7 Average NVA by Region 1980 to 1987



There are large regional differences in the average level of NVA per farm. In 1980/1 the range was from £7,500 in Wales to £23,400 in the South East. By 1986/7, this range had increased to over £20,000. The Eastern and South Eastern regions, although having low total NVA, have high average incomes, while the Welsh have a very low average income per farm despite a large total income.[29]

The upward trend in levels of total NVA is more noticeable on a *per farm* basis (as it was at the national level), because of the decline in the number of producers throughout the period. The South East and East highlight the differences between total and average NVA. Average NVA in the Eastern region virtually doubles over the 7 years, whilst the decline in average NVA in the South East is proportionately much smaller than the decline in *total* income.

Figure 5.8 Average Support by Region 1980 to 1987



As with NVA, those regions that receive the greatest total levels of support do not necessarily receive the largest amount per farm. In 1980/1, each Welsh farm received an average of £13,500 whilst in the South East farms received an average of £31,500. In 1986/7 the difference between the lowest and highest had increased to over £30,000. Welsh farmers continually received the lowest support per farm, whilst the highest went to the East and South East.

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[29] Figures for Production per Herd, Number of Herds, Average Herd Size, Yield per Cow, and Gross Margin per Cow for all regions can be found in Appendix 5.III, Tables A5.1 to A5.5

A possible method for examining the effects of agricultural policy on the distribution of income and support *between* regions is to examine the relative shares of support and income received by each region. The percentage share of each region in terms of support and NVA are reported for 1980/1). The results are highlighted in Figures 5.9 and 5.10. In 1980/81 the largest share of total income (25%) went to the South West, followed by the South with 19%. The East and South East accounted for only 5 and 6% respectively.

Figure 5.9 Percentage of NVA accruing to Each Region 1980/1

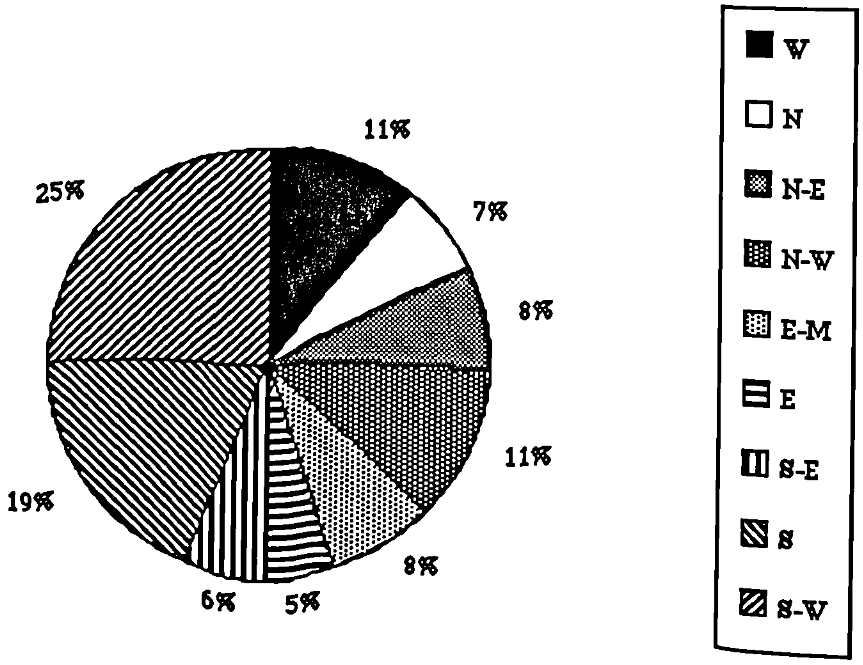
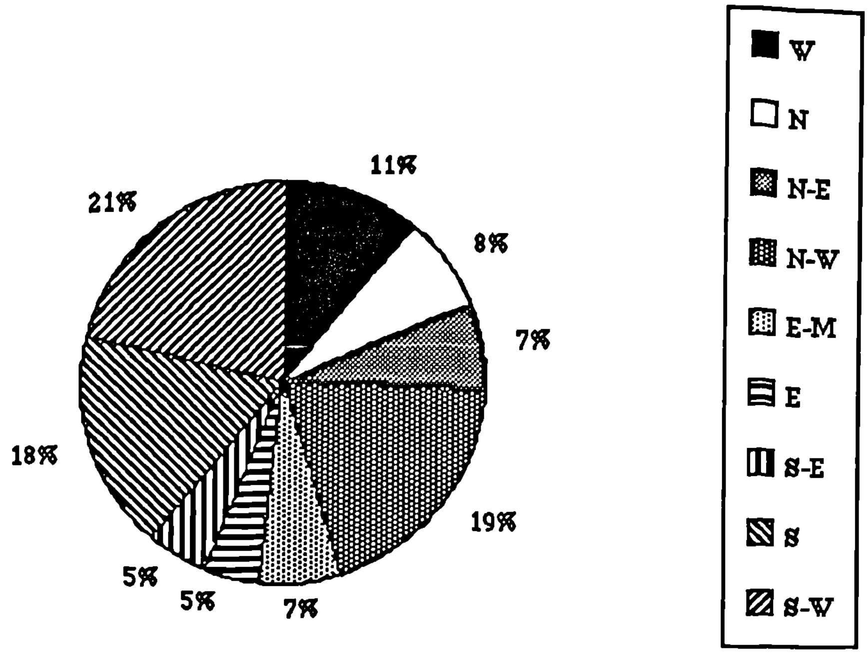


Figure 5.10 Percentage of Support accruing to Each Region 1980/1



A similar pattern emerges for the distribution of support in 1980/1, with total support being distributed unequally between regions. The South and South West together accounting for 39% of support, whilst the East and South East together received only 10%. There are, however, noticeable differences in the two distributions. For example, the North West receives 19% of support but only has 11% of total income. The corresponding distributions for the year 1986/7 indicate that for the majority of regions the percentage share of NVA and support remains virtually unchanged. Notable exceptions include the North West, where NVA increases from 11 to 19%, and the South East, which suffers a decline from 6 to 2%. That the distribution of NVA changes more than that of support could be a result of the effect of good and bad climatic conditions in specific regions and also of managerial ability.

The analysis of the percentage of support and NVA accruing to each region over the seven years, has shown that the shares of the majority of regions have remained essentially unchanged. This finding indicates that agricultural policy has not led to a transfer of support *between* regions.

5.5.3.2 Gini Coefficients

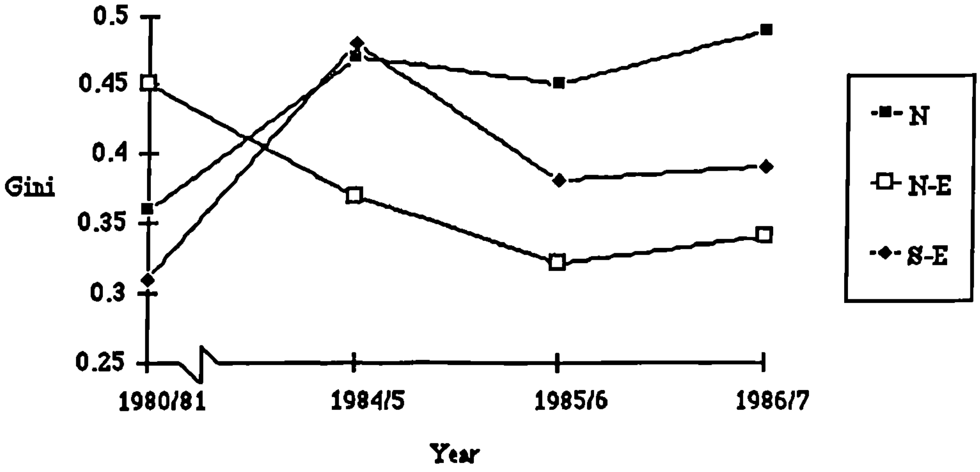
Regional results thus far have highlighted large differences in the level of both support and income between regions. The focus now switches to an analysis of inequality *within* regions. Table 5.11 presents for each region the estimated Gini coefficients for associated with the distribution of support between 1980/1 and 1986/7.

Table 5.11 Gini Coefficients by Region for the Distribution of Support

PROVINCE	1980/1	1984/5	1985/6	1986/7
Wales	0.42	0.41	0.40	0.40
Northern	0.36	0.47	0.45	0.49
North East	0.45	0.37	0.32	0.34
North West	0.37	0.47	0.41	0.44
East Midland	0.39	0.39	0.38	0.34
Eastern	0.42	0.42	0.46	0.47
South East	0.31	0.48	0.38	0.39
Southern	0.42	0.42	0.41	0.41
South West	0.41	0.43	0.43	0.43
Range	0.31-0.45	0.37-0.48	0.32-0.46	0.34-0.49

The results do not indicate excessively high levels of inequality, with the highest Gini coefficient being 0.49. Within years there are large differences in measured inequality. For example, in 1980/81 the Gini ranged from 0.31 in the South East to 0.45 in the North East. The initial impression when examining the regional results on the distribution of support is that there is much more variation in level of inequality over time than there is on the national scale. Figure 5.11 uses selected regions to illustrate this variation.

Figure 5.11 Gini Coefficients for Support for Selected Regions, 1980/1 to 1986/7



Three general conclusions can be drawn. First, as already mentioned, the Gini for support within regions fluctuates over time much more than at the national level. Second, the level of variation is greater in some regions than in others. Third, very few regions show any clear trend in terms of a consistent decrease or increase in the level of inequality (the North East and the North are the only regions to show clear trends).

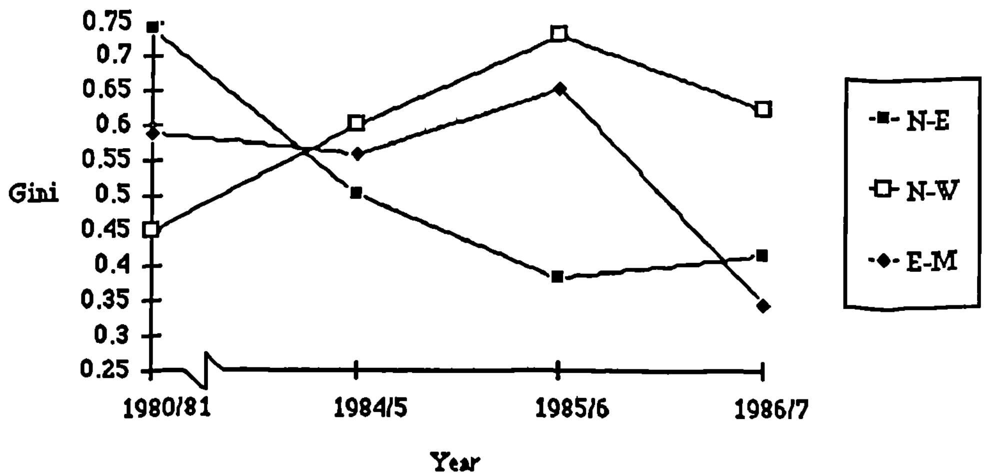
The analysis of inequality within regions can now be extended to that associated with the distribution of NVA (Table 5.12).

Table 5.12 Gini Coefficients by Region for the Distribution of NVA

Province	1980/1	1984/5	1985/6	1986/7
Wales	0.54	0.57	0.46	0.45
Northern	0.41	0.53	0.52	0.57
North East	0.74	0.50	0.38	0.41
North West	0.45	0.60	0.73	0.62
East Midland	0.59	0.56	0.65	0.34
Eastern	0.45	0.55	0.54	0.52
South East	0.34	0.54	0.38	0.36
Southern	0.49	0.49	0.45	0.45
South West	0.46	0.52	0.46	0.47
Range	0.34-0.74	0.49-0.60	0.38-0.73	0.34 -0.62

The largest Gini coefficient associated with NVA is 0.74, indicating a very unequal distribution. The range is much greater than that associated with the distribution of support. For example, in 1980/1, the Gini ranged between 0.34 in the South East and 0.74 in the North East. Figure 5.12 highlights selected regions that show large variations over the period. In the North East, inequality falls from 0.74 in 1980/81 to 0.41 in 1984/5. However, in the North West inequality rises from 0.45 to over 0.60.

Figure 5.12 Gini Coefficients for NVA (Selected Regions 1980 to 1987)



Comparison of the Gini coefficients for NVA and support indicate that, in the majority of cases, the distribution of support is more even than the distribution of income (the only exception is the South East where, in 1985/6, the Gini coefficients are identical and, in 1986/7, the distribution of income is more even than that of support). The results suggest that removal of support would lead to greater inequality of income distribution *within* regions (assuming production patterns remain unchanged).

5.5.3.3 Ranking of Regions by Inequality

In Figure 5.13 regions are ranked according to the level of inequality associated with the distribution of support for each year under consideration (the region ranked 1 is the most equal, that ranked 9 the most unequal). This is undertaken to enable an assessment of the relative levels of inequality within England and Wales. The results indicate that, in general, it is difficult to assess the relative position of each region in the 'league' of inequality. There is much alteration in the relative positions over years. The main variation (understandably) is over the longer time period from 1980 to 1984. However, even after 1984/5 there are significant changes in the rankings. It is possible to conclude that, after 1984, the North East region shows consistently the most equal distribution, followed by the East Midlands, but few other generalisations can be made because of the degree of variability.

Figure 5.13 Ranking of Regions by Level of Inequality of Support

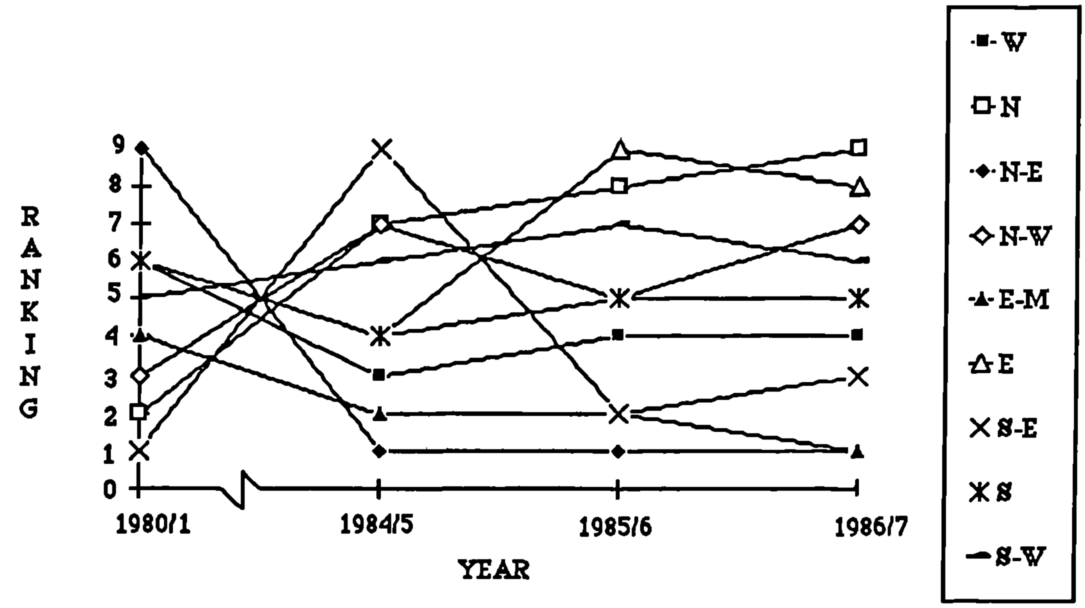
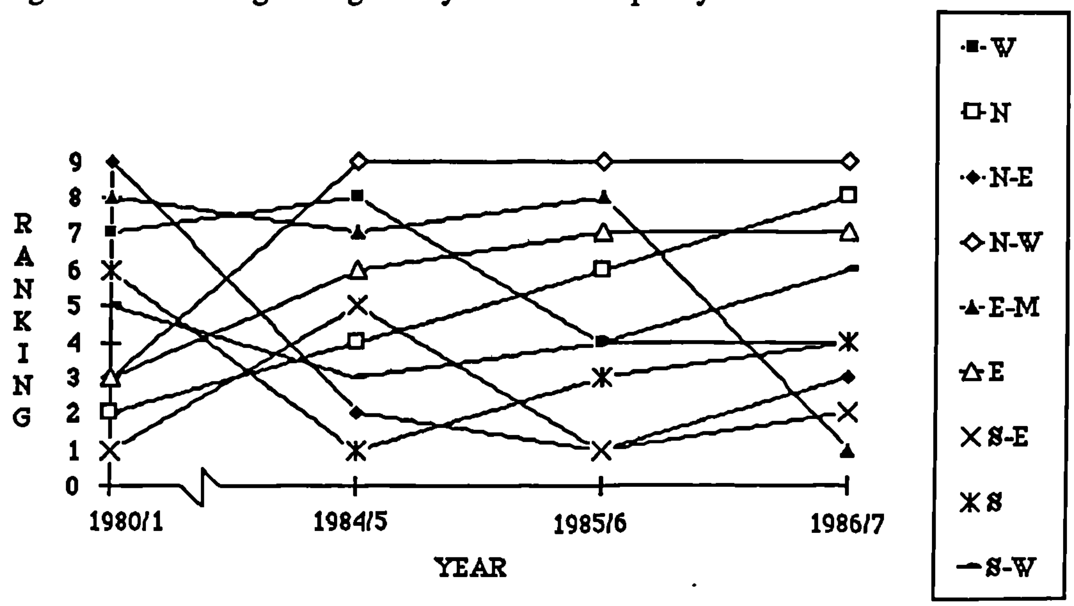


Figure 5.14 shows the regions ranked by the level of inequality arising from the distribution of NVA. The ranking of regions by the level of inequality associated with the distribution of NVA indicates large variation in the relative position between years. Again, the greatest changes occur between 1980/1 and 1984/5. However, even after 1984/5, (with the exception of the North-West and East) no region retains the same ranking between years.

Figure 5.14 Ranking of Regions by Level of Inequality of NVA



Figures 5.13 and 5.14 suggest similarities in the rankings of the regions by support and NVA. This relationship is confirmed by the result of a Spearman's coefficient of rank correlation, which analyses whether there is a relationship between the rank order of two variables. The rank correlation figure can range from 0, indicating no correlation, to 1, confirming perfect correlation. The figures for 1980/1 produce a correlation coefficient of 0.70, and those for 1986/7 one of 0.90. Therefore it can be concluded that, for these two years, there is a positive correlation between the two sets of Gini coefficients. However, if the figures for 1984 are analysed a different picture emerges. There is little relationship (Spearman's correlation coefficient of 0.15) between the two rankings, indicating that the relationship between the Gini for support and for income breaks down. However, a problem with the ranking method is that the Gini coefficients for support in 1984/5 are very similar and therefore a difference of just 0.03 in the Gini can lead to a region being ranked 6th rather than 3rd. This has a significant effect on the level of Spearman's rank coefficient.

5.5.3.4 Discussion on Regional Inequality

The results of the analysis of the levels of inequality of income within regions over the period indicate large variations but with few discernible trends emerging. Regions such as the East Midlands appear to exhibit a decrease in observed inequality whilst others, such as the North West, indicate an upward trend. It may be concluded that, between years, large variations occur, but no significant move to either a more or less equal distribution within all regions can be identified.

It is not suffice to state that there are large variations in the level of inequality from year-to-year and between regions without examining possible causes. Dairy farming, perhaps more than any other type of farming, is heavily dependent on managerial ability. The choice of breeding stock, feeding regimes, etc. are vital to production capabilities. Possible explanations as to the year to year variations can be related to managerial competence. First, in a relatively good year, with the right weather conditions (for grass growth and good forage making), the management requirements are not so demanding and all farms perform relatively well. However, in a bad year it is possible that the more astute managers, those that time forage making better (or who are luckier!) and those who buy in food at the right time, do considerably better than those who are less skilled. This would lead to lower input costs for the more skilled managers and therefore higher income. Coupled with the decline in income of the less skilled, greater inequality will result. Climatic variations may explain why the changes from year to year are dissimilar between regions.

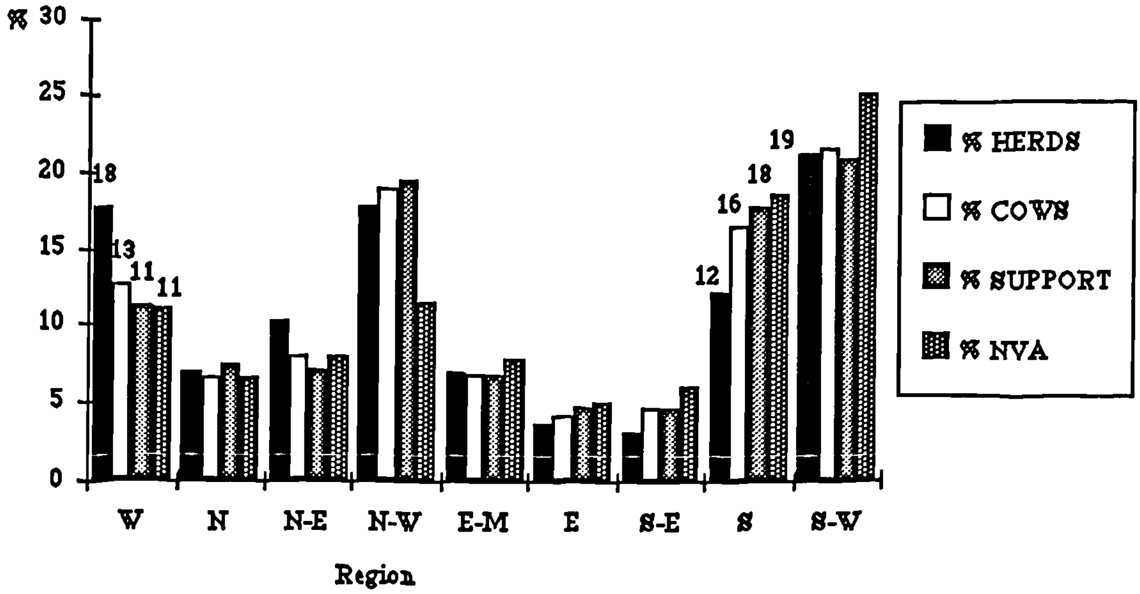
Second, it can be argued that smaller farms are able to cope with, for example, climatic difficulties better than larger farms, due to the fact that they are not so 'stretched' and can pay more attention to detail. This argument suggests that in a bad year the smaller farmers may do better than the larger farmers, the result of which could be a reduction in measured inequality.

The analysis of the regional levels of inequality highlights variations within and over years which examination of the national data obscures. It appears that even though the national Gini remains fairly stable, inequality is constantly changing on a regional basis. In other words regional variations cancel each other out to produce a fairly smooth national picture.

5.5.3.5 A Comparison of Shares

As a prelude to the next chapter, in which an alternative policy will be considered, the final part of the regional analysis concentrates on a comparison of the overall position of each region. Figure 5.15 compares the share of herds, cows, support, and NVA for each region in 1980/1.

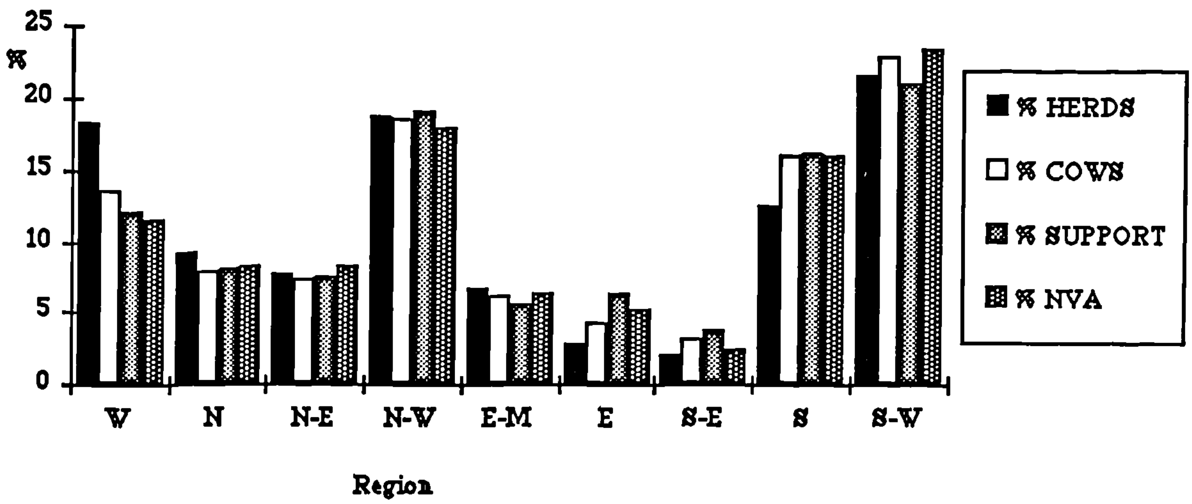
Figure 5.15 Percentage of Herds, Cows, Support and NVA, 1980/1



Examination of the distribution of the share of herds, cows, support and NVA highlights a number of points concerning 'equality'. In all cases support is distributed very closely to the number of cows (indicating similarity in yield per cow). The very nature of price support ensures that the distribution of support will follow that of production. For this reason it can be seen as a 'fair' method of support. Every producer receives a level of support in proportion to production. However 'fairness' can be judged by other criteria. It may be fair that each producer should be valued equally, irrespective of their actual level of production. If support was fairly distributed according to this definition of 'equality', then each region should receive the same proportion as it has dairy farmers. The results show that this is clearly not the case. Wales, for example, has 18% of all dairy herds yet, because these herds are on average small compared to other regions, they have 13% of cows and only 11% of total support. In contrast, the Southern region has only 12% of herds, yet receives 18% of support. Price support ensures that support does not go to the regions necessarily with the most producers, but disproportionately to those with the largest producers. Of course, other policies (such as LFA and SDA payments) that favour areas such as Wales, may partly redress the imbalance occurring under the price support regime.

To assess whether the 1980/1 relationship holds, similar comparisons are made for 1986/7 (Figure 5.16). It is clear that very little change has occurred, suggesting that the findings reported for 1980/1 are consistent with the general picture. How this situation may change under an alternative policy measure is examined in the following chapter.

Figure 5.16 Percentage Shares of Herds, Cows, Support and NVA, 1986/7



5.6 Conclusions

This chapter set out to examine inequality in income and support in dairy farming in England and Wales over a fifteen year period. Due to problems with the traditional approach to measuring inequality (and the apparent advantages, discussed in Chapter 3 of the lognormal), it was decided to use the assumption of lognormality to facilitate the research. The two variables used (output and NVA) were found to be acceptable in terms of lognormality.

The results on a national level showed little change in the distribution of both support and income over the period, considering the changes in policy that had occurred. However, the regional analysis highlighted that the national results obscured variations between regions. The regional analysis also showed that there was little change in the relative positions of the regions over the years, in terms of their share of support and income.

The analysis (both at the national and regional level) highlighted that support was continually more evenly distributed than income, suggesting that removal of support may actually increase income inequality. The national results (and those for the majority of the regions) indicated no general increase or decrease in the level of inequality. It was argued that this 'stability' in inequality might be a result of the effects of agricultural policy. Of course, this premise is difficult to substantiate, because it is not known how the structure would have changed in the absence of agricultural support.

Some regions received a substantially greater share of support than their share of herds, whilst others received notably less. The average support received per farm, in different regions, varied by up to £30,000 in any one year. The next chapter considers an alternative policy measure, which, inter alia, can be used to target support more at producers than level of production.

Appendix 5.I (Extract from MMB Cost Survey)

Sample Selection (1984/5 Survey)[30]

A Random Sample of 1,640 herds with ten or more dairy cows, stratified according to herd size, was selected from the June 1983 census. The sample was designed to reflect the provincial distribution of dairy herds and was subdivided into two samples, a main sample of 410 herds and three reserve samples of 410 herds. The latter samples were to ensure that adequate replacements were available for non-respondents.

If the owner of a herd in the main sample did not co-operate or was ineligible, a replacement from the corresponding cells in the first reserve sample was approached. If the replacement did not co-operate or was ineligible a further replacement was taken from the same cell in the second reserve sample, etc.

The sampling fractions for each herd size were chosen with the intention of minimising the expected sampling error of gross costs per cow.

If it was considered doubtful that a co-operator would continue for the full year, a replacement from the reserve sample was also costed, and the results for the reserve herd were included in the final sample whetehr the original co-operator dropped dropped out or not.

Raising Procedure

Because the sample was disproportionately stratified by herd size, the results have to be raised in order to accurately reflect the population. The raising factors represent the ratio of herds in the population in the June census of the year in question to herds in the sample within each herd size group.

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[30] Similar selection procedures were followed for each of the years under consideration

Appendix 5.II Definition of Provinces

Province	Counties
Northern	Cumbria, Durham, Tyne and Wear, Northumberland
North Eastern	Cleveland, South Yorkshire, North Yorkshire, West Yorkshire, Humberside
North Western	Cheshire, Lancashire, Merseyside, Salop, Staffordshire, Greater Manchester
East Midland	Derbyshire, Leicestershire, Lincolnshire, Northamptonshire, Nottinghamshire
Eastern	Bedfordshire, Cambridgeshire, Essesx, Hertfordshire, Greater London (East) Norfolk, Suffolk
South Eastern	Kent, Surrey, East Sussex, West Sussex
Southern	Berkshire, Buckinghamshire, Gloucestershire, Hampshire, Wiltshire, Hereford and Worcester, West Midlands, Oxfordshire, Avon, Isle of Wight,Warwickshire,
South Western	Cornwall, Devon, Dorset, Somerset, Scilly Isles
Wales	Powys, Gwynedd, Dyfed, Clwyd, South Glamorgan, Mid Glamorgan, West Glamorgan, Gwent

Appendix 5.III Tables A5.1 to A5.5

Table A5.1 Average Production Per Farm by Region

(000 litres)

Province	1980/1	1984/5	1985/6	1986/7
Wales	213	238	253	262
Northern	291	292	279	326
North Eastern	231	304	360	359
North Western	333	379	385	402
East Midland	306	381	321	366
Eastern	383	543	609	687
South Eastern	496	442	451	543
Southern	470	454	460	501
South Western	328	348	375	396

Table A5.2 Number of Herds by Region

(herds)

Province	1980/1	1984/5	1985/6	1986/7
Wales	7,742	7,264	6,990	6,847
Northern	3,019	3,577	3,860	3,426
North Eastern	4,487	3,137	2,579	2,865
North Western	7,769	7,458	7,187	7,021
East Midland	3,057	2,540	2,615	2,507
Eastern	1,601	955	1,153	1,090
South Eastern	1,360	1,167	808	787
Southern	5,337	5,089	4,874	4,731
South Western	9,246	8,711	8,371	8,154

Table A5.3 Average Herd Size by Region

(cows)

Province	1980/1	1984/5	1985/6	1986/7
Wales	44	51	52	54
Northern	59	60	56	61
North Eastern	48	61	70	68
North Western	66	69	69	71
East Midland	61	72	64	66
Eastern	70	96	96	109
South Eastern	95	92	94	108
Southern	83	87	88	92
South Western	63	71	71	76

Table A5.4 Average Yield per Cow by Region

(litres)

Province	1980/1	1984/5	1985/6	1986/7
Wales	4432	4438	4612	4610
Northern	4725	4321	4005	4644
North Eastern	4457	4658	5665	5121
North Western	4823	4804	4985	5068
East Midland	4991	4993	4850	5410
Eastern	5193	5379	4456	5663
South Eastern	5362	4356	6292	4971
Southern	5133	4829	5041	5194
South Western	4810	4607	4794	4930

Table A5.5 Average Gross Margin per Cow by Region

(£/year)

	1980/1	1984/5	1985/6	1986/7
Wales	331	389	405	460
Northern	338	421	390	482
North Eastern	305	429	522	544
North Western	323	420	436	486
East Midland	344	420	408	536
Eastern	374	377	312	490
South Eastern	396	383	553	475
Southern	384	410	428	507
South Western	386	407	423	515

Chapter 6 Inequality and the Producer Entitlement Guarantee (PEG)

6.1 Introduction

Chapter 5 examined the distribution of income and support for years in which different agricultural policies were in operation. Over the period, little change occurred in levels of measured inequality. This chapter considers an alternative scenario and assesses the effects on levels and distribution of support and income. The basic premise revolves around the assumption that reduction of income inequality within agriculture becomes part of the political agenda. On the evidence of the previous chapter, deficiency payments, market price support, and quotas have little effect on inequality levels. Therefore, if income distribution is of concern it would seem that a different policy will need to be instigated. One such policy is the Producer Entitlement Guarantee (PEG), which has been around (in various guises) for a number of years.[31] Advantages of the PEG in other areas of concern, for example, transfer efficiency and trade distortion, have been assessed (Harvey and Hall, 1989). However, it also appears to have significant inequality-reducing potential, and this is the main concern here.

6.2 Definition

The PEG operates to limit the quantity of production eligible for support per farm. Harvey (1990, p 18) describes one possible implementation of this sort of policy:

> " Under PEG farmers get a support payment, paid by the Exchequer..., as the difference between a PEG price and a free market price for a fixed quantity of production. Any quantity over and above this PEGged quantity per farm is sold on the unsupported open market".

[31] For examples, see Hubbard and Harvey (1988), Castle (1988), Harvey (1989,1990)

A ceiling is placed on the amount of support any one farm can receive. All production is sold at the world price, but production up to the PEG level receives the support payment.

Harvey argues that the PEG can be used to support the small 'family' farm rather than large scale 'industrial' agriculture. "The distribution of PEG limits can be used to direct public support towards people rather than products and benefit smaller farmers proportionately more than large farms" (p 18). The validity of this claim can be assessed by examination of the proportion of support and income which the smaller producers receive, with and without the PEG, in relation to the bigger producers. The very nature of the PEG indicates that implementation would lead to reductions in inequality associated with support, by setting an upper limit to the amount of support per farm. The purpose here is to quantify this reduction.

6.3 Methods

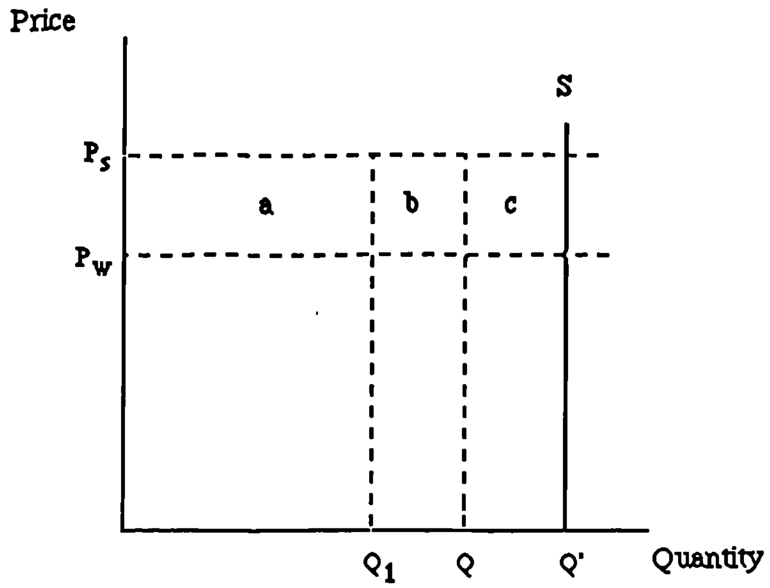
Harvey argues that the quantities eligible for support should relate to the levels demanded under multilateral free trade. It is not in the remit of this study to model EC or world agricultural supply and demand so as to estimate these levels. The analysis is therefore restricted to a particular year (1985/6) and the production patterns that existed in that year. The comparison is between the distribution of support as it was in 1985/6 with what it would have been if a PEG had been applied. No allowance is made for possible production and structural changes, the only alteration is that support is distributed under a PEG policy rather than through price support and quotas.

In the preceding chapter, the total level of support received by dairy farmers in England and Wales during 1985/6 was estimated at £955m, which corresponds to around 8 pence per litre of milk produced. A policy such as the PEG can be implemented in various guises. This study will consider two. One method (PEG1) will examine the implementation of a PEG coupled with a decline in total support to dairy farmers. This is achieved by maintaining the support per litre current in 1985/6, but limiting the number of litres eligible for support. The second method (PEG2) is where total support is maintained at the estimated level of £955m, but eligible production is reduced.

Simplified diagrams (Figures 6.1 and 6.2) illustrate the difference between PEG1 and PEG2 for individual farms. In Figure 6.1, P_W indicates the world price for the product under consideration, P_S is the price the producer receives and Q' is the level of production (at price P_S) of the farm. With no restriction on the level of production eligible for support, total support can be approximated as a+b+c.

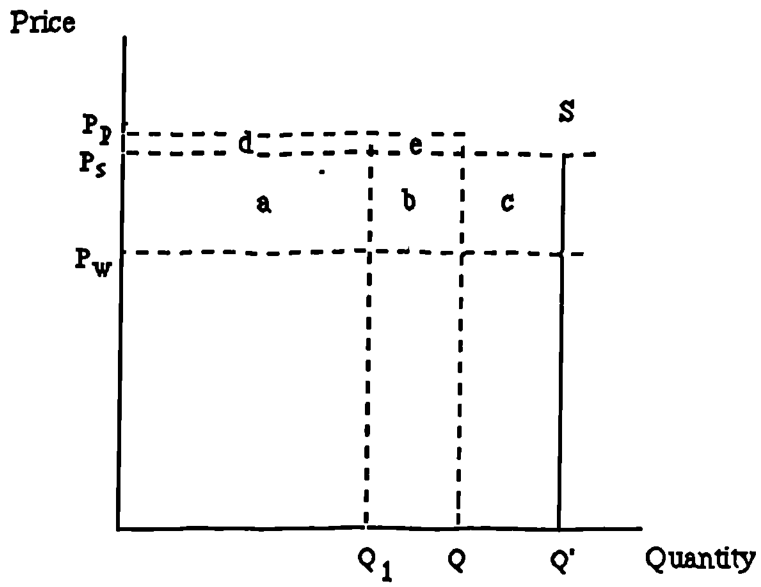
If the PEG is now implementated at the quantity of Q (assuming no change in the level of supply from this farm, that is the supply curve for this farm is Q'S) and the support price per unit is not altered, then the support to the farm will fall to a+b (the amount produced over Q would be sold at P_W, with no support payment attached). Any dairy farm which produced quantity Q or less would have no reduction in the support it received. For example, a producer at Q_1 would not suffer a reduction in support.

Figure 6.1 Effect of PEG1 on an Individual Farm



In Figure 6.2, support is again equal to a+b+c. However, when the PEG is applied at Q, assuming the total support to the industry remains constant, the support price rises to Pp. A farmer producing at Q' loses c, but gains d and e. Any farmer producing quantity Q or less would enjoy a clear increase in support. For example, a farm producing Q_1 would increase support by area d, raising total support from a to a+d.

Figure 6.2 Effect of PEG2 on an Individual Farm



Under PEG1, a farmer whose level of production is greater than the amount eligible for support will suffer a reduction in support. There is no change in the amount of support received by a farmer who produces less than or equal to the eligible quantity. With PEG2, a farmer whose production is greater than the set PEG suffers a less severe reduction in support, and might in fact gain, if production is only a certain amount above the PEG, whilst any producer whose total quantity is below the PEG level enjoys an unambiguous increase in support.

The two different methods allow either total support to vary with support per litre constant (PEG1), or for support per litre to vary with total support held constant (PEG2). Under PEG1 the total cost of support is determined as the eligible quantity multiplied by £0.08 (estimated support per litre). Under PEG2, total cost is fixed with support per litre calculated as £955 million (total support) divided by eligible quantity.

For purposes of illustration the eligible quantity per farm is set at four different levels - 500, 400, 300 and 200 thousand litres - under both PEG1 and PEG2. The analysis therefore involves examination of two different methods at four possible levels. The distribution of support and NVA will be analysed at each level. The percentage of farms whose total production is less than or equal to the eligible quantity, and the percentage of total production covered (including those farms not fully covered), at the four different levels are reported in Table 6.1.

Table 6.1 Quantities of Production covered by a PEG

Eligible production per farm ('000 litres)	200	300	400	500	All
Coverage:					
-Farms (%)	36	54	68	78	100
-Production (%)	48	63	74	82	100

In examining the level of inequality associated with the PEG, a change in the method of calculating the Gini is necessary. A maximum level of output on which support is available will necessarily truncate the distribution of support. In other words, the distribution of support will no longer follow that of output and therefore may no longer be lognormal. The Gini will be calculated on the basis of the share of support received by each decile of the population, ranked by output rather than under the assumption of lognormality.

6.4 Results

As in Chapter 5, the analysis is undertaken at both a national and regional level. The analysis is also concerned with the effect of the PEG on the level of support and income as well as the distributional effects of the PEG.

6.4.1 National Results

6.4.1.1 Level of NVA and Support under PEG

This section will focus on the effects of the different PEG methods on the level of support and NVA. Support in total and per litre, for the two methods, is given in Table 6.2.

Table 6.2 Total Support and Support per litre under the PEG

PEG Level (000 litres)	PEG1		PEG2	
	Total Support	Support per litre	Total Support	Support per litre
	£m	pence	£m	pence
No Restriction	955	8.00	955	8.00
500	783	8.00	955	9.00
400	710	8.00	955	10.00
300	603	8.00	955	11.00
200	457	8.00	955	12.00

Note:Support per litre refers only to that level of production up to PEG level

Under PEG1 total support declines from £955 to £457 million, with the support per litre maintained at 8 pence. With PEG2, total support is maintained at £955 million, and as the PEG becomes more restrictive so the support per litre rises from 8 to 12 pence. The method used under PEG1 results in a fall in NVA corresponding to the fall in support whilst under PEG2 there is no change in the total level of income in the *industry* (Table 6.3).

Table 6.3 Total NVA for the Industry under PEG1 and PEG2

PEG ('000 litres)	PEG1 Total NVA	PEG2 Total NVA
	£m	£m
No Restriction	1,044	1,044
500	872	1,044
400	799	1,044
300	692	1,044
200	546	1,044

Tables 6.2 and 6.3 highlight the changes in absolute levels of support and NVA associated with the PEG. It is evident that the two methods of implementing the PEG have varying effects on the level of support. To analyse the distributional implications of these differences, quintile analysis is a useful first step. Farms are ranked into quintiles according to their level of income. Results under PEG1 for various eligible quantities, are reproduced in Figure 6.3. Each quintile suffers a reduction in the total level of support at any of the four possible eligible quantities. However, the reduction to the lowest quintile is small in comparison to the fall in support to the highest quintile. This can be highlighted by examining the total *change* in support between no restriction and a restriction of 200,000 litres (Figure 6.4).

Figure 6.3 Total Support to Farms Ranked by Quintiles under PEG1

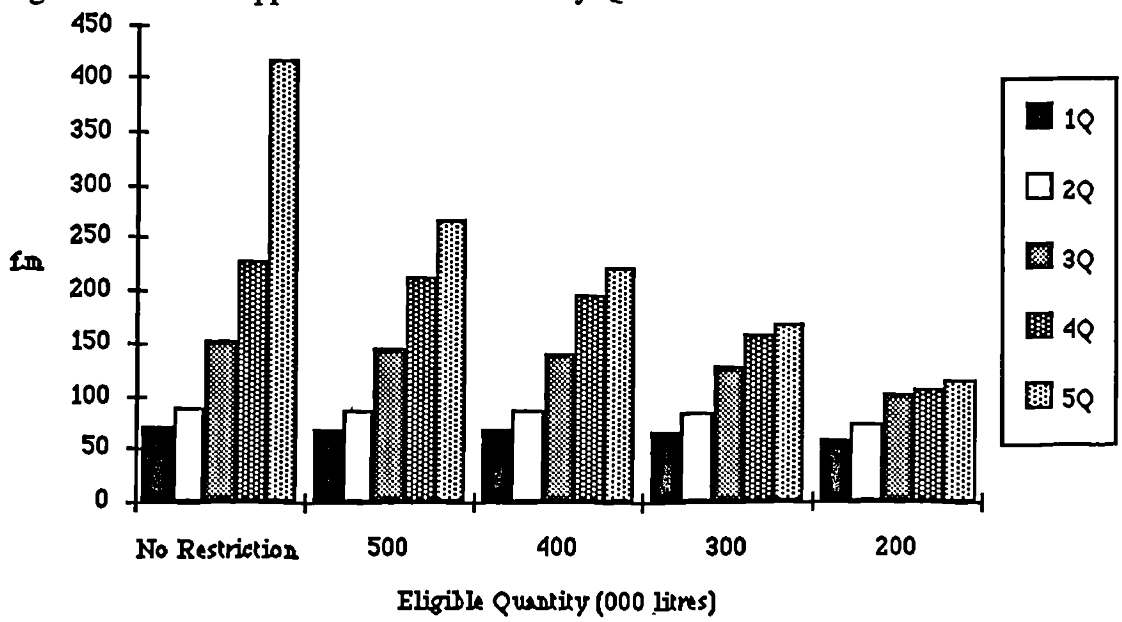
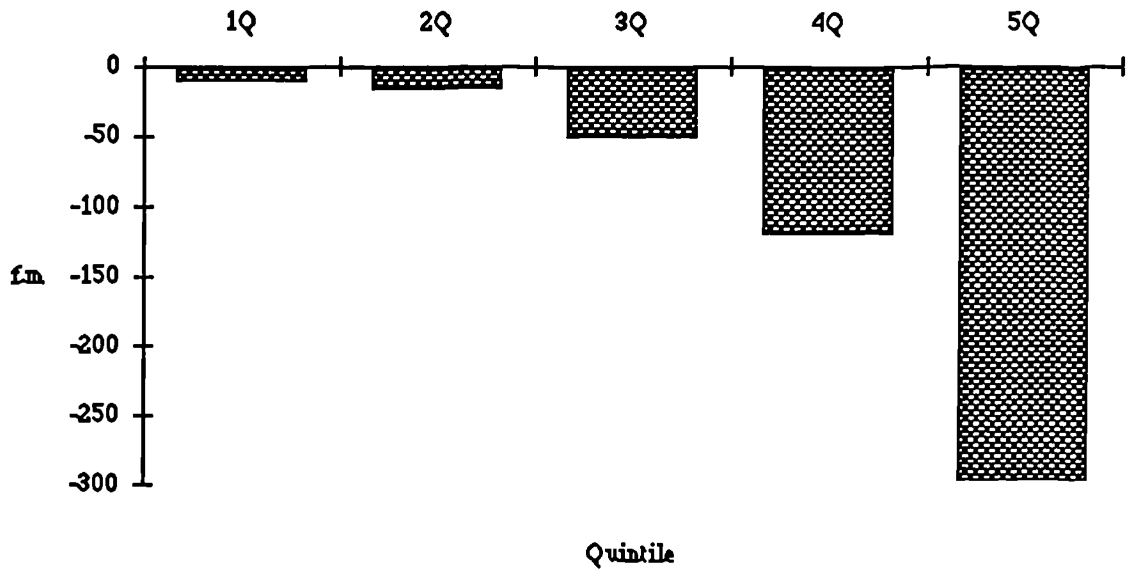


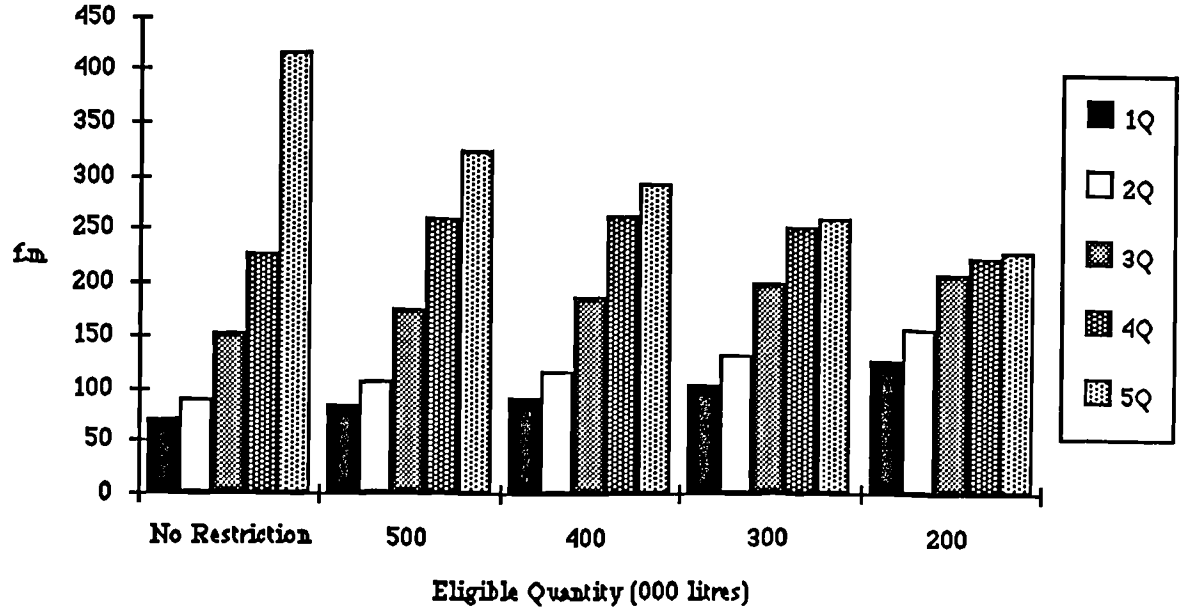
Figure 6.4 Change in Total Support per Quintile, PEG1[a]



a) Between no restriction and a PEG set at 200,000 litres

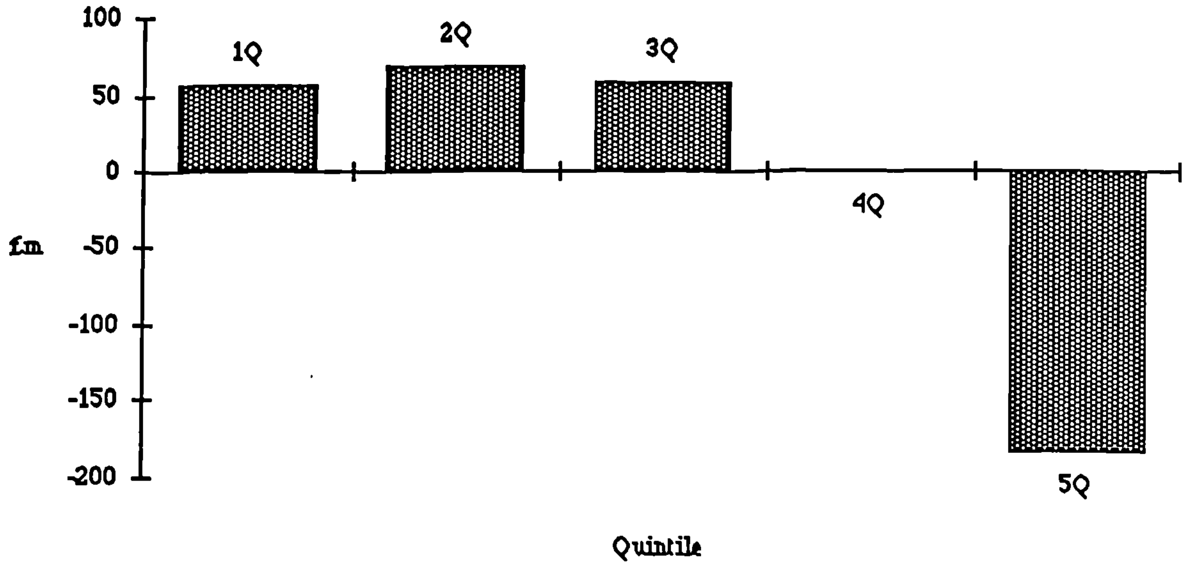
The top 20% of farms would lose over £300m (of a total reduction of around £500m) in support, whilst the bottom 20% would lose only £11m. The results are very different with the PEG2 scenario (Figure 6.5). The lowest three quintiles enjoy an increase in total support at all four levels of the PEG. The more restrictive the PEG the more these quintiles gain. The opposite is true for the highest quintile. The fourth quintile gains most if the PEG is set at 500,000 litres. However, even at 300,000 litres they benefit more than under no PEG.

Figure 6.5 Total Support to Farms Ranked by Quintiles under PEG2



Examination of the change to each quintile from a position of no PEG to one set at the 200,000 litre level (Figure 6.6) is useful. There is an increase of around £50m to each of the bottom three quintiles, with the second quintile benefiting marginally more than the first or third. The fourth quintile suffers a loss of only £1m, while the fifth quintile suffers a reduction of over £150m.

Figure 6.6 Difference in Level of Support to Quintiles PEG2[a]



a) Between no restriction and a PEG set at 200,000 litres

The change in the level of support received by each quintile highlights significant differences between the two methods of implementation. Turning to the effect on levels of income, it is necessary to re-emphasise that the only changes in income will arise from changes in support. Therefore each quintile's total income will fall (rise) by the same amount as support falls (rises). The similarity ensures that under PEG1 every quintile faces a reduction in income as the PEG is implemented. In the case of PEG2, the bottom 60% face an increase in their total levels of income at any PEG level considered. The increase in support received by the lowest income quintile results in a doubling of total income. The highest income farmers show a reduction from just under £500 million, with no restriction, to £314 million with a PEG set at 200,000 litres.

Analysis of the average level of support received by farms in each quintile (Figures 6.7 and 6.8) reiterates the differences in total support. With PEG1, the highest income farmers face reductions in support from over £50,000 to around £15,000 per farm. Under PEG2, support to the highest income earners would still decline, but not as severely (to around £25,000). With PEG1, the low income quintiles face much less severe reductions than the high income quintiles, whilst with PEG2 they have a considerable increase in support (from £9,000 to £15,000). Under both methods, the overall picture indicates an equalisation of the level of support received by farms at different income quintiles.

Figure 6.7 Support per Farm Ranked By Quintiles under PEG1

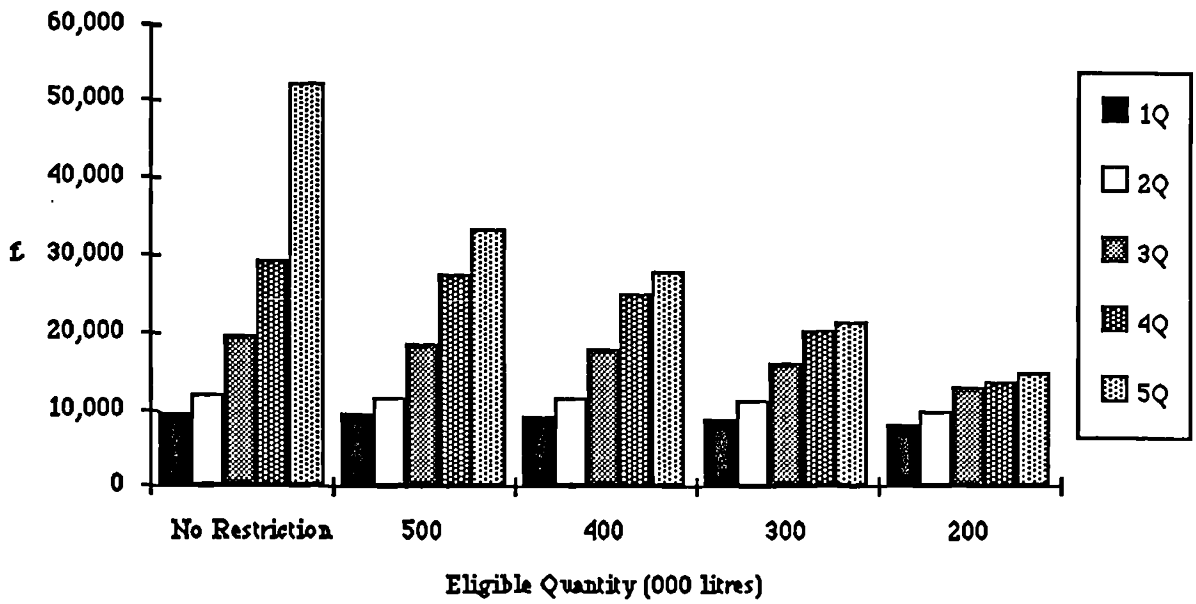
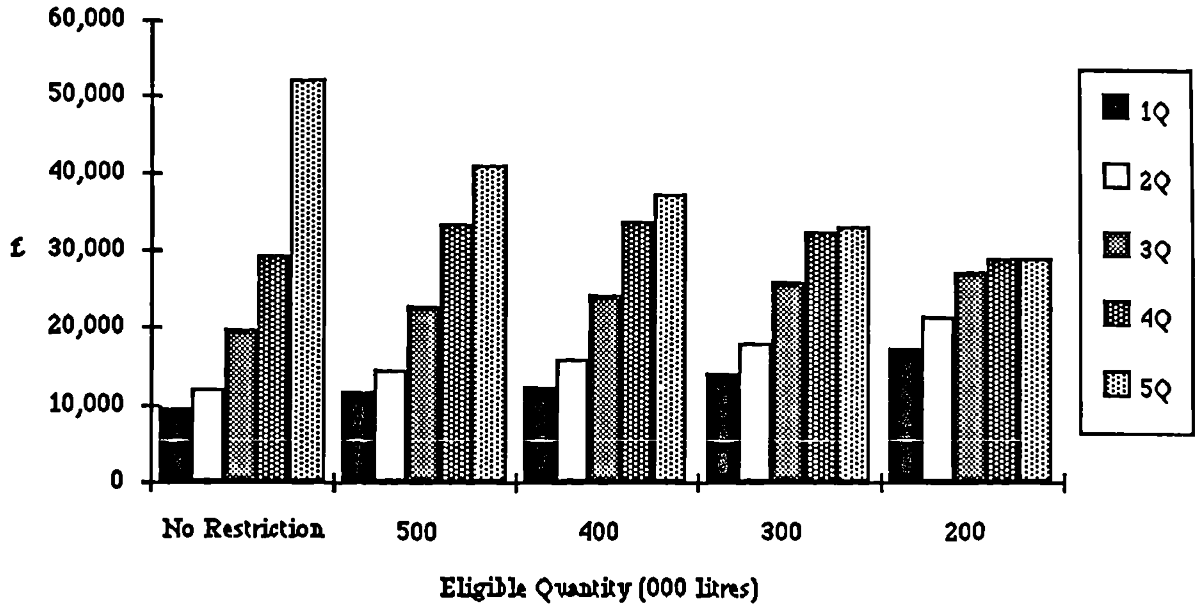


Figure 6.8 Support per Farm Ranked By Quintiles under PEG2



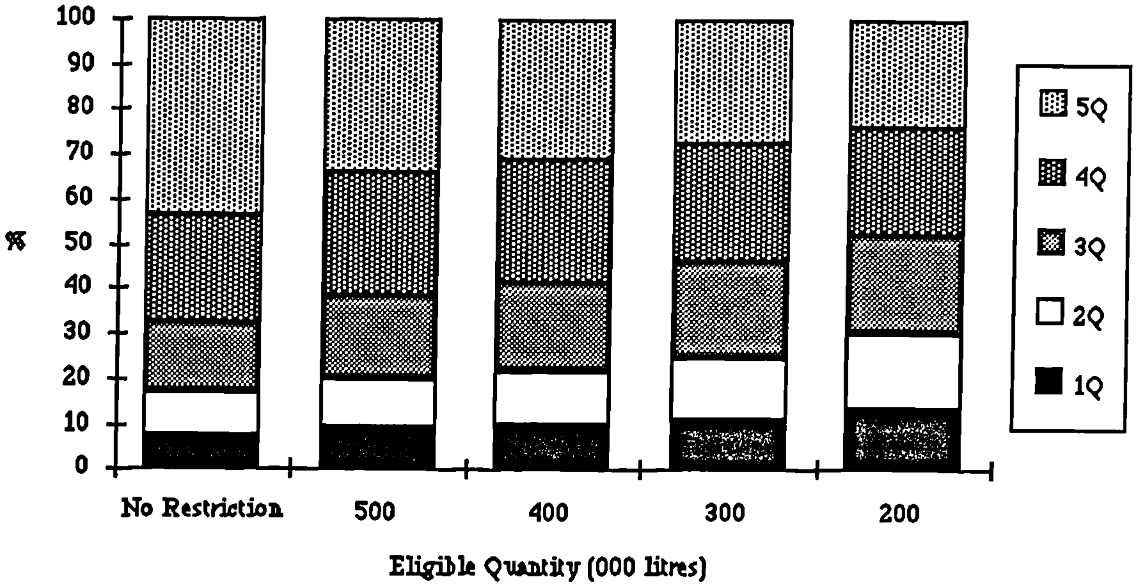
As already mentioned the analysis ensures that the changes in the level of NVA are identical to the changes in support. However, because NVA started at a different level, the PEG does not bring such an equalisation between quintiles as it does with support.[32] For example, under PEG1 at the 200,000 litre level, there is still a difference of £20,000 between the average income of the lowest and highest quintiles. With PEG2, (at the 200,000 litre level) the average level of NVA for a farm in the lowest quintile is £14,000, whilst in the top quintile the average is £40,000, which is a difference of £26,000.

6.4.1.2 Distribution of NVA and Support under PEG

The absolute changes in support and NVA arising from adoption of either of the two proposed methods have been examined. The relative changes in each quintile's position at each PEG level will now be considered. Under PEG1 support to each quintile declines, with the high income earners losing the most. With no PEG, the lowest quintile receives around 8% of support. As the PEG becomes more binding the percentage share of the lowest quintile rises, so although they lose absolutely under PEG1 they gain relative to the high income producers. At the most extreme PEG level considered, the top 20% receive under 30% of support compared to over 40% with no restriction (Figure 6.9). The *share* of support received by each quintile is identical under PEG1 and PEG2 at the same level of restriction. For example, at the 400,000 litre limit the relative share of each quintile will be the same whether support is 8ppl (under PEG1) or 10ppl (under PEG2).

[32] As the change in NVA is identical to the change in support. The results for PEG1 and PEG2 are included as Figures A6.1 and A6.2 in Appendix 6.I.

Figure 6.9 Percentage of Support Received by Quintiles under PEG



The effect of the PEG on the distribution of support is the same whichever of the two methods is implemented. However, the distribution of NVA is different and for this reason the quintile shares are analysed separately. With PEG1 the share of total income received by each quintile changes by smaller amounts than their share of support (Figure 6.10). For example, the fifth quintile would still have 40% of total income even with an eligible quantity of 200,000 litres. The percentage shares of income under PEG2 (Figure 6.11) alter significantly more than under PEG1, but not to the same degree as support.

Figure 6.10 Percentage of NVA by Quintile under PEG1

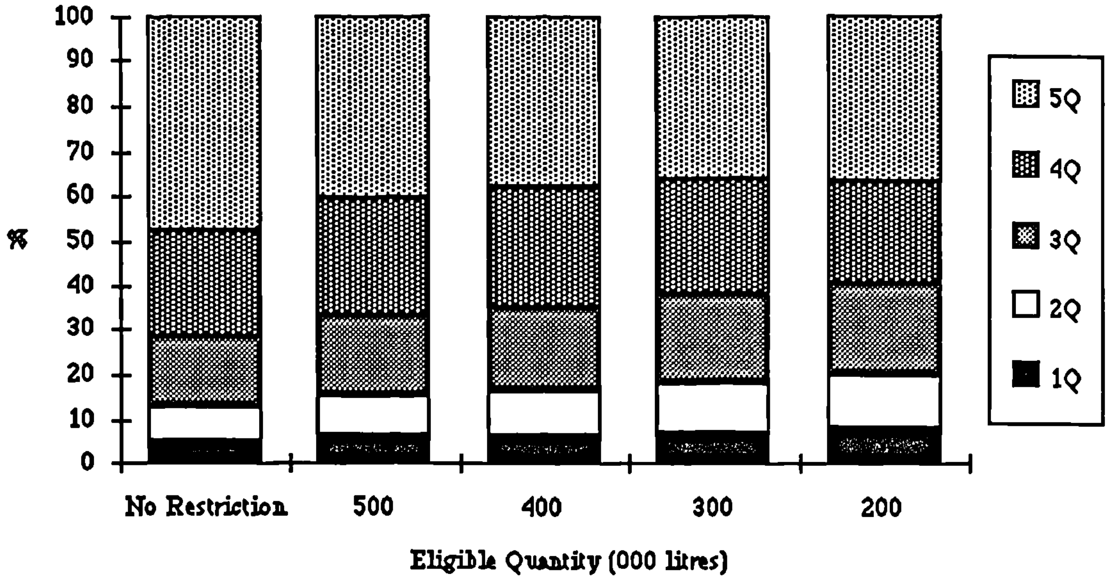
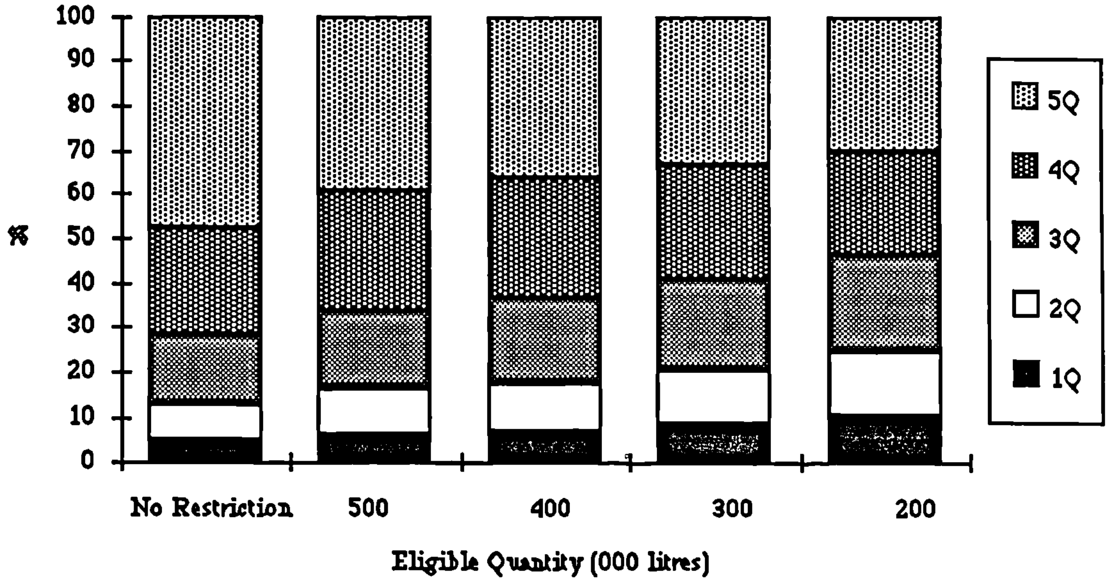


Figure 6.11 Percentage of NVA by Quintile under PEG2



As in other parts of this study, quintile figures are used to illustrate distributions. However, inequality measures are needed to quantify these changes. Gini coefficients for support and NVA, under the two methods are presented in Table 6.4.

Table 6.4 Gini Coefficients for Support and NVA under PEG

PEG (000 litres)	Support	PEG1	PEG2
No Restriction	0.42	0.54	0.54
500	0.30	0.52	0.45
400	0.26	0.50	0.41
300	0.20	0.47	0.35
200	0.12	0.47	0.28

The Gini coefficients for support and NVA quantify the distributional effects of restrictions on the amount of production eligible for support. With no restriction, the Gini for support is 0.42. If a restriction is implemented at 500,000 litres (still above the mean production of 360,000 litres) there is a marked fall in the inequality of support payments to 0.30. As the PEG becomes more binding so the greater the rate in the reduction of inequality. With only the first 200,000 litres of milk eligible for support, the Gini is 0.12, indicating a much more equal distribution.

For NVA, under PEG1, there is a steady decline in levels of inequality as the PEG is made more restrictive, but this fall is relatively small. In contrast, inequality falls by a much larger amount under PEG2. In terms of reducing inequality and maintaining overall industry income levels, PEG2 is a more favourable policy than PEG1 (Figures 6.12 and 6.13).

Figure 6.12 Change in Inequality and Industry NVA under PEG1

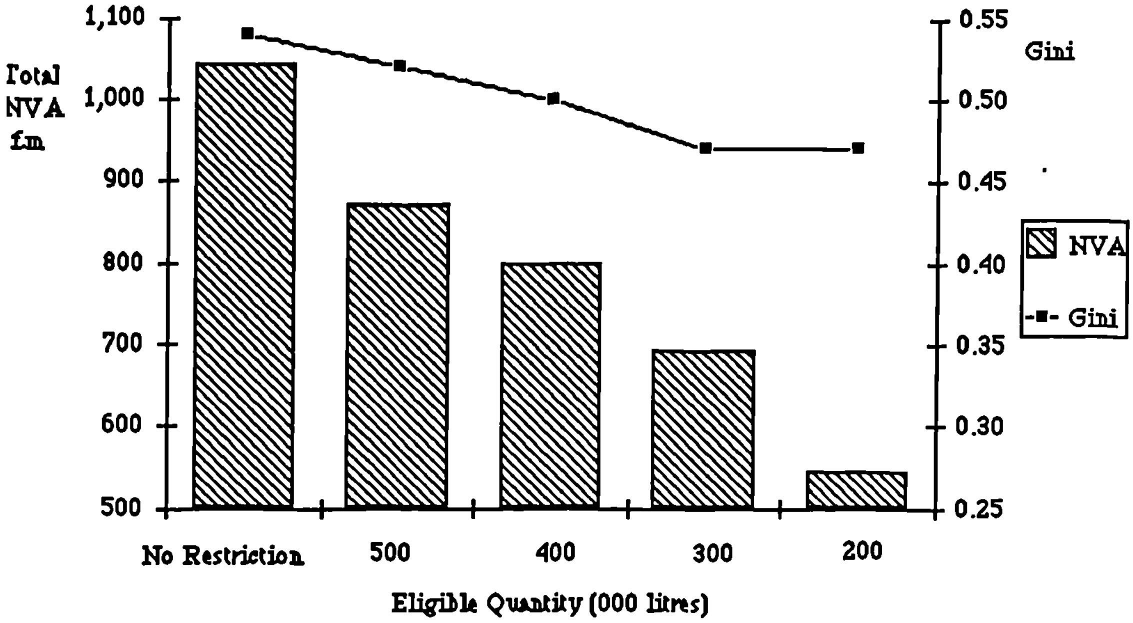
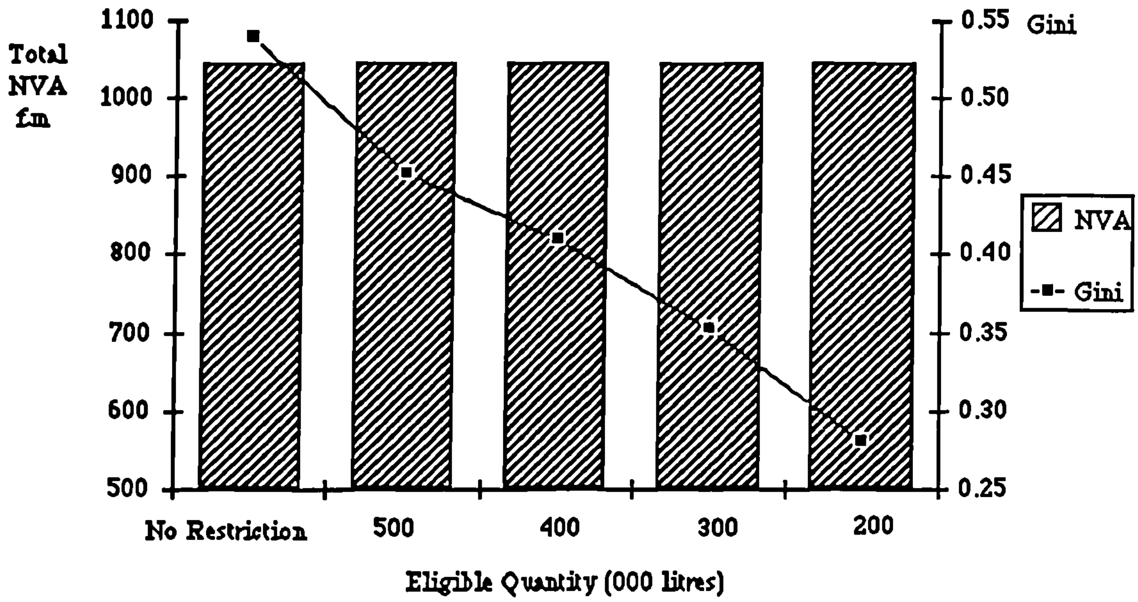
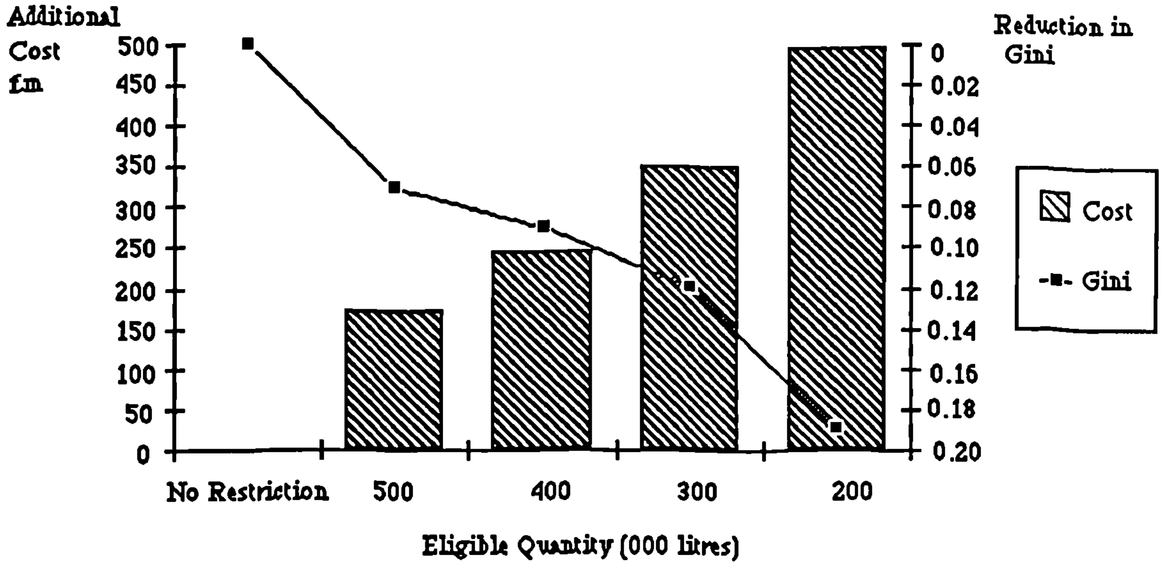


Figure 6.13 Change in Inequality and Industry NVA under PEG2



These two figures highlight that whatever the level of (a binding) PEG, total industry income is higher and inequality lower if the PEG is applied keeping total support at the same level. Therefore, in terms of the distributional impact, PEG2 is unequivocally preferable to PEG1. However, there are costs to be considered. Figure 6.14 presents the extra cost of implementing PEG2 at each level, compared to PEG1, and also highlights the greater reduction in inequality. The extra costs of PEG2 and the reduction in inequality suggests a trade off. By implementing PEG2 rather than PEG1, with a 200,000 litre limit, for example, the Gini coefficient is reduced by 0.19 but costs are greater by over £490m Assuming a linear relationship, each 0.01 extra reduction in inequality therefore costs around £26m.

Figure 6.14 Extra Cost and Reduction in Inequality with PEG2 compared to PEG1



As with the earlier examination of distribution of support and income, the national aspect is only one part of the overall picture. The PEG will also have an effect on the level of inequality within and between regions.

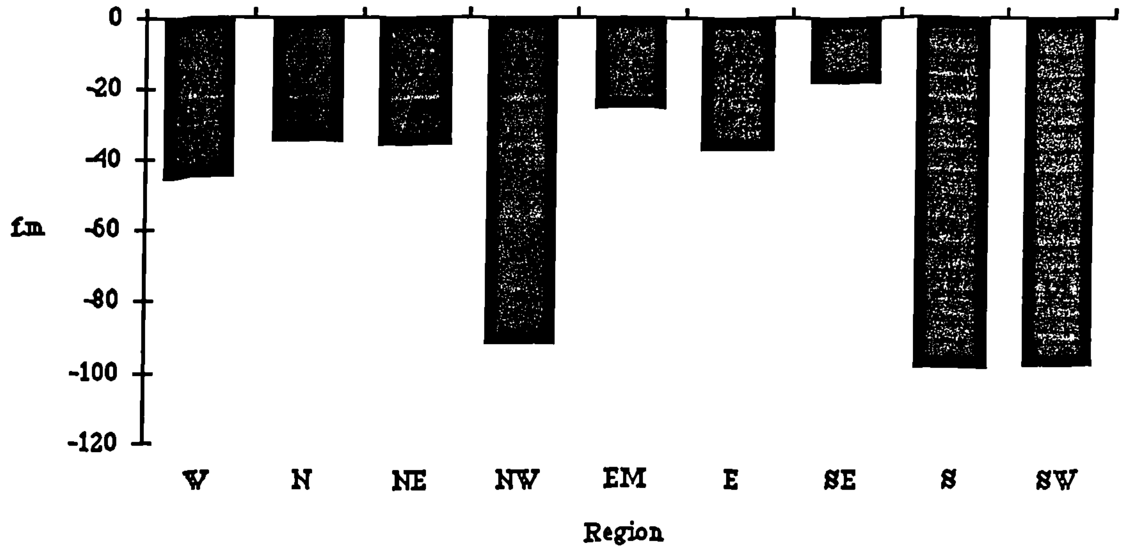
6.4.2 Regional Results

The examination of the PEG on a regional basis will concentrate on those aspects studied at the national level, namely income and support inequality. The two possible methods will be analysed in terms of the distribution of support and income *between* regions as well as their effect on inequality *within* regions. The large number of regions involved, coupled with variation in the methods of implementation of the PEG, lead to a large number of results. For this reason, detailed results will be reproduced in the Appendix, while the text will concentrate on highlighting regional differences.

6.4.2.1 Regional levels of Support and Income under PEG

Initially, the effects of the PEG on the level of support received by each region is reported. First, assuming the PEG1 method, the overall change from a situation of no PEG to one of 200,000 litres is shown Figure 6.15.

Figure 6.15 Change In Level of Support per Region PEG1

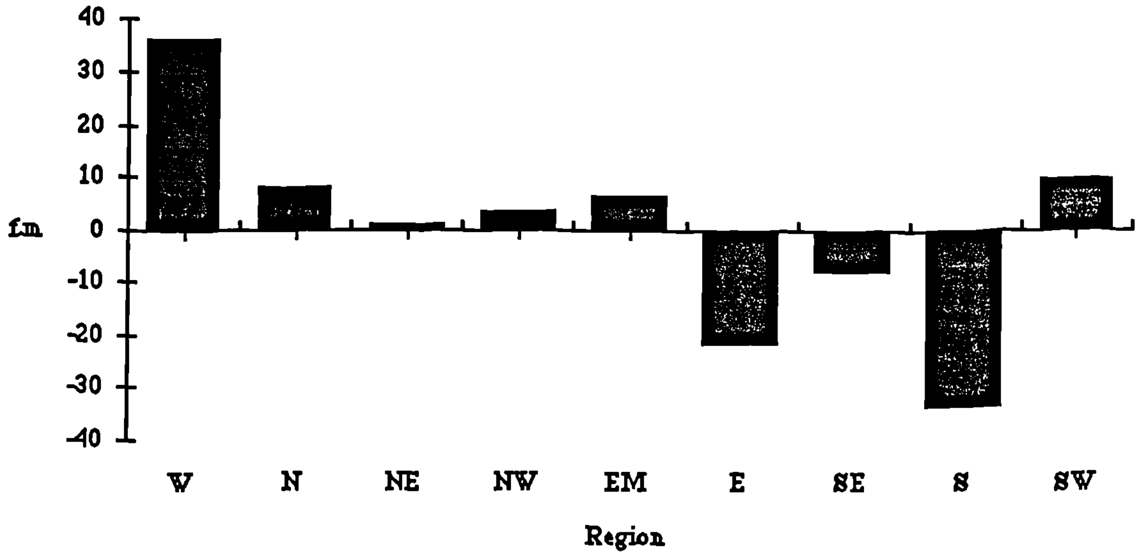


Under PEG1 all regions suffer a decline in *total* support. However, the extent of the decline varies. The regions of greatest production suffer the brunt of the fall in support. For example, the South loses nearly £100m of support, whilst the South East loses only £20m. (Table A6.1 in Appendix 6.II shows the fall in *total* support on a regional basis at various eligible quantities).

There are noticeable differences in the effects of the PEG as it becomes more binding. Taking Wales and the North West as examples, if the PEG was set at 500,000 litres then the decline in support would be £5m for Wales and around £25m for the North West. As the PEG becomes more restrictive the North West suffers large reductions in total support. With no PEG, the difference in the amount of support received by the North West and Wales is around £60m. This would be reduced to under £20m with the PEG set 200,000 litres. Of course, examination of total support does not take account of the number of producers within regions. (Table A6.3 in Appendix 6.II shows the *per farm* changes at the four PEG levels considered). The regions that suffer the greatest loss in total support are not necessarily those that lose the most on a per farm basis. An average farm in the Eastern region would suffer a reduction of £30,000 if the PEG was restricted to 200,000 litres, whilst at the other extreme a farm in Wales would lose around £7,000.

Turning to the effects on the levels of support under PEG2, Figure 6.16 highlights, for each region, the change in *total* support received with no PEG and a PEG set at 200,000 litres.

Figure 6.16 Change in Level of Support per Region PEG2



With PEG2, the large reduction in *total* support received by the North West and South West under PEG1 is not evident. In fact, even with the most restrictive eligible quantity, both regions show an increase in support compared to no restriction. This occurs because, the gains enjoyed by the small producers in these regions outweigh the losses of the large producers. The South would still suffer a drop in support, the East and South East are the only other regions that suffer a reduction in support. In contrast, Wales would receive an increase in support of around £36m. Instigation of PEG2 leads to a redistribution of support from the South, South-East and East to the other 6 regions. At an eligible quantity of 200,000 litres the total redistribution amounts to some £64m, of which £36m goes to Wales . Examining the level of *total* support at varying levels of PEG (Appendix 6.II, Table A6.2) it is clear that the majority of those regions which benefit under PEG2 at 500,000 litres, increase their benefit as the PEG becomes more restrictive.

The *per farm* changes in support which occur as the eligible quantity is reduced under PEG2, are shown in Appendix 6.II, Table A6.4. The South East (even with PEG level as high as 500,000 litres) suffers a large decline in support. Successively stricter PEG levels lead to less support for this region. For Wales, support increases at each stricter PEG level. The North West, as with the total levels of support, would benefit most per farm if the eligible quantity was set at 500,000 litres. With a PEG set at 200,000 litres, farms in the East lose the most (on average £19,500). Farms in the East Midlands, the North and Wales have marked increases in the average level of support, whilst the North East, North West and South West show only marginal increases in average support.

Under PEG2, every region enjoys greater total support than under PEG1, at each level of restriction considered. Even those regions who still lose under PEG2, lose less. The regional results have shown that the effects of the PEG on total support (and thus income received) by region differs greatly between PEG1 and PEG2. As the Welsh have already been shown to have the lowest NVA, it can be interpreted as a redistribution of income from the richer to the poorer regions.[33] With PEG2, the

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[33] As the changes in NVA are similar to those of support the results for NVA are considered repetitive. Tables A6.5 to A6.8 in Appendix 6.III present the regional levels of NVA under the two PEG options.

regions with the lowest average farm income gain relative to the other regions. For example, farms in Wales would enjoy, on average, a 31% increase in the level of NVA, whilst farms in the East would suffer a 32% drop (with an eligible quantity of 200,000 litres).

Another method of examining the distribution between regions involves assessment of the change in each region's percentage share of total support (Appendix 6.IV Figure A6.3). With a PEG set at 200,000 litres, Wales gains nearly 4 percentage points whilst the South loses an almost equal amount. Other regions show less marked changes in their relative positions.

6.4.2.2 Regional Gini Coefficients

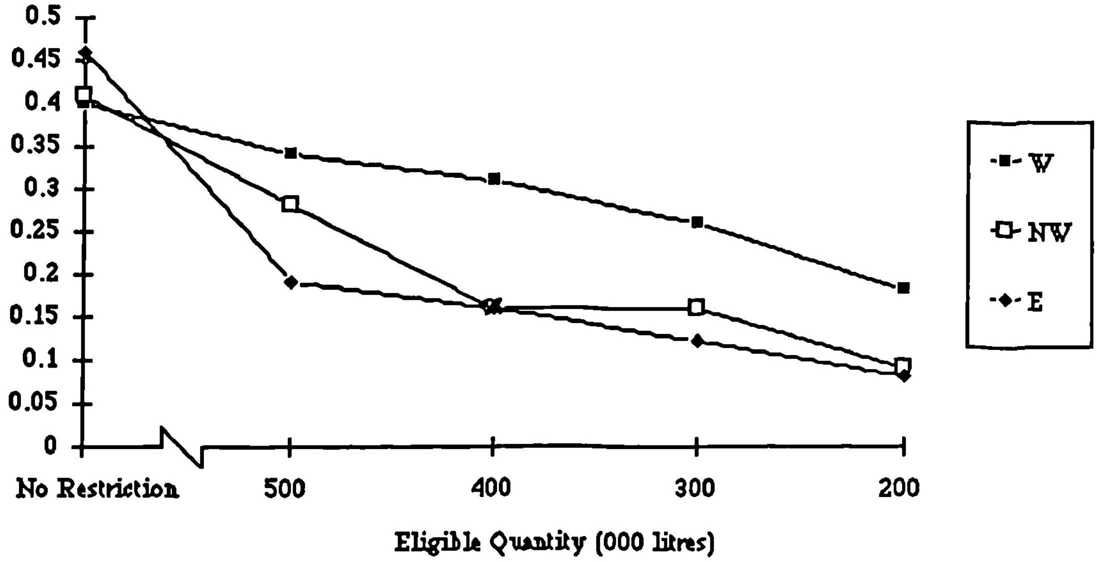
The introduction of a PEG, by whichever method, leads to a redistribution of support and, consequently, income between the regions. Within regions, the PEG will also have a distributive impact. To assess the extent of this impact, Gini coefficients will be reported for support (Table 6.5) and NVA.

Table 6.5 Regional Gini Coefficients for Support under Varying PEG Restrictions

Region	No PEG	PEG 500	PEG 400	PEG 300	PEG 200
Wales	0.40	0.34	0.31	0.26	0.18
Northern	0.45	0.36	0.33	0.27	0.20
North Eastern	0.32	0.32	0.27	0.12	0.03
North Western	0.41	0.28	0.16	0.16	0.09
East Midland	0.38	0.29	0.25	0.19	0.10
Eastern	0.46	0.19	0.16	0.12	0.08
South Eastern	0.38	0.22	0.18	0.13	0.07
Southern	0.41	0.24	0.19	0.14	0.08
South Western	0.43	0.30	0.25	0.19	0.12
Range	0.32-0.46	0.19-0.36	0.16-0.33	0.12-0.27	0.03-0.18

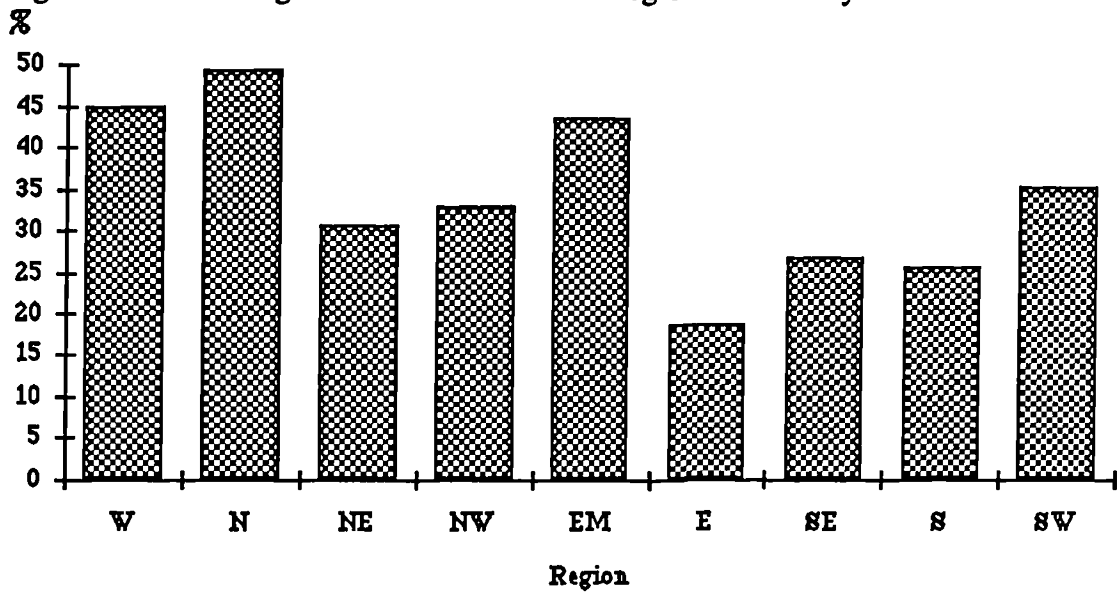
The general pattern, as would be expected, is one of a reduction in the level of inequality as the eligible quantity is reduced. The decline is not consistent between regions. The East loses the most in support through the introduction of the PEG, but at the same time it has the greatest reduction in inequality. This highlights an anomaly with inequality. Farmers in the East have had a great reduction in mean income, but in terms of inequality the distribution is now 'better', the Gini coefficient falling to 0.37. Wales, who gain the most, also have the least reduction in inequality but still considerable in absolute terms. Thus, they appear as one of the most unequal regions. This is shown more clearly in Figure 6.17, where the level of inequality associated with each PEG level is charted for selected regions.

Figure 6.17 Gini Coefficients for Support under PEG for Selected Regions



The structure of farming within regions is responsible, to a large extent, for differences in the impact of the PEG on levels of inequality of support. The percentage of farms whose total production is covered by the PEG at the most restrictive level is shown in Figure 6.18.

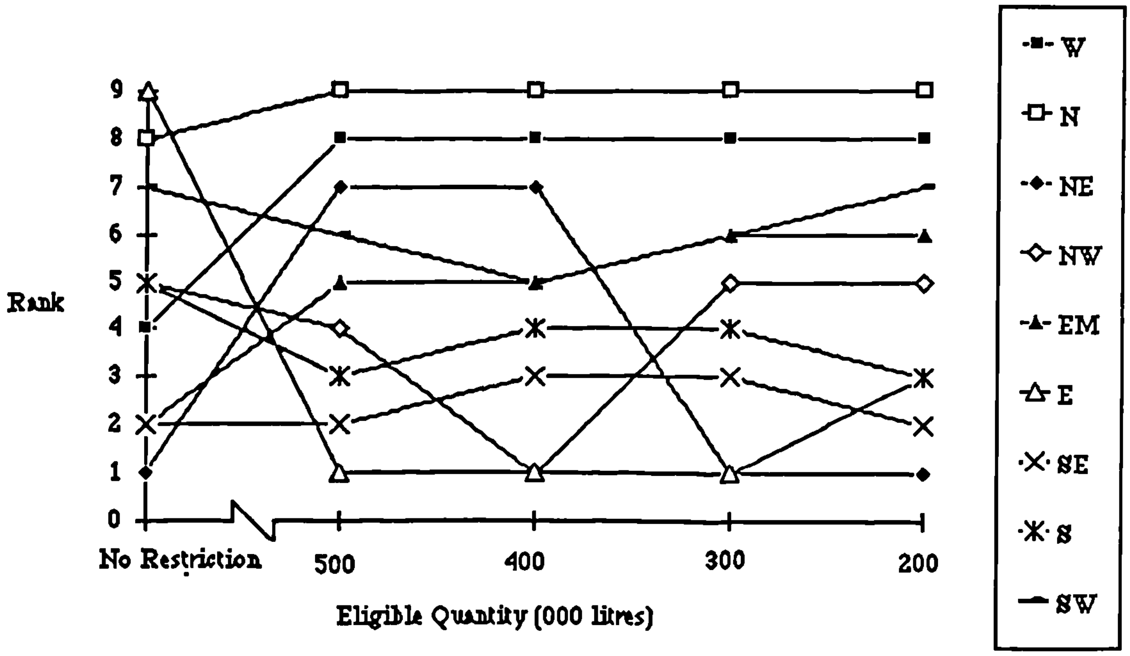
Figure 6.18 Percentage of Farms Within Each Region Covered by PEG



At the extreme restriction, there is a significant difference between the percentage of farmers whose total production is below the eligible quantity. The North and Wales still have between 45 and 50% of producers whose production is completely covered by the PEG. At the other extreme, the Eastern Region has only 19% of producers covered. Therefore, the number of farms facing a reduction in support is greater for the East and consequently inequality is reduced by a greater amount.

Differences in the rate of decline in inequality will obviously effect the relative position of regions. Using an ordinal approach, each region is ranked according to its level of inequality at each PEG quantity (Figure 6.19). As in Chapter 5, the region with the lowest Gini coefficient is ranked 1, whilst that with the highest is ranked 9.

Figure 6.19 Ordinal Ranking of Regional Inequality For Support under PEG



The system of ranking the regions illustrates the effects of the PEG. There are significant changes in the ranking of the regions. Using the East as an example, the dramatic fall in the Gini results in a major change in the ranking of the region (from 9th to 1st) In contrast, Wales becomes ranked more unequal, due to the fact that the PEG has relatively less effect on the distribution of support within the region.

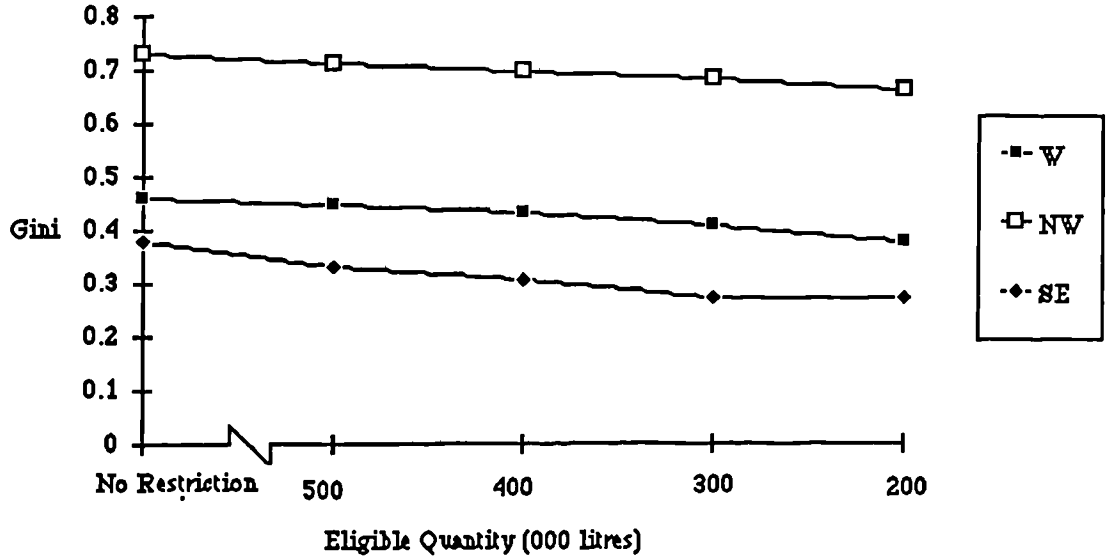
Whilst it has been observed that the level of inequality of support does not vary with the actual method of implementing the PEG, the distribution of NVA does differ. Therefore, the results in terms of income distribution need to be analysed for both possible methods. Table 6.6 presents the Gini coefficients for NVA arising under PEG1.

Table 6.6 Regional Gini Coefficients for NVA under PEG1

Region	No PEG	PEG 500	PEG 400	PEG 300	PEG 200
Wales	0.46	0.45	0.43	0.40	0.38
Northern	0.52	0.50	0.48	0.45	0.41
North Eastern	0.38	0.34	0.31	0.27	0.23
North Western	0.73	0.71	0.70	0.68	0.66
East Midland	0.65	0.63	0.62	0.61	0.61
Eastern	0.54	0.47	0.44	0.41	0.38
South Eastern	0.38	0.33	0.30	0.27	0.27
Southern	0.45	0.39	0.38	0.37	0.36
South Western	0.46	0.41	0.39	0.35	0.32
Range	0.38-0.73	0.33-0.71	0.30-0.70	0.27-0.68	0.27-0.66

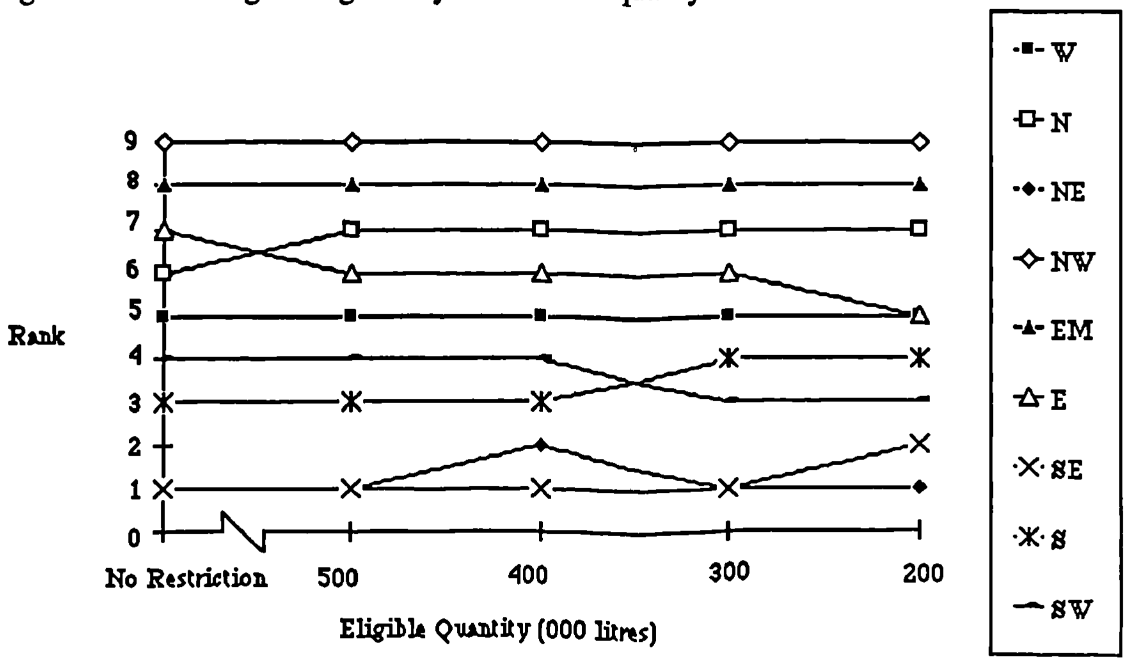
There is a consistent decline in observed inequality in all regions as the eligible quantity is reduced. However, even at the most restrictive PEG, the reduction is not dramatic. The results show that even with a PEG set at 200,000 litres there are still regions (the North West and East Midlands) with high levels of inequality. This indicates that the fall in income associated with PEG1 (declining total support) does not lead to great changes in the levels of inequality. The variation in the level of decline between the regions is less than that of support. Figure 6.20 highlights that separate regions show similar falls in inequality levels as the PEG becomes stricter.

Figure 6.20 Gini Coefficients for NVA under PEG1 for Selected Regions



This pattern is also reflected in the ranking of the regions by level of inequality (Figure 6.21). Unlike the distribution of support, the ranking of the regions does not alter significantly as the eligible quantity is reduced.

Figure 6.21 Ranking of Regions by Level of Inequality under PEG1



The Gini coefficients for income under PEG2 (Table 6.7) contrast markedly with those examined for PEG1.

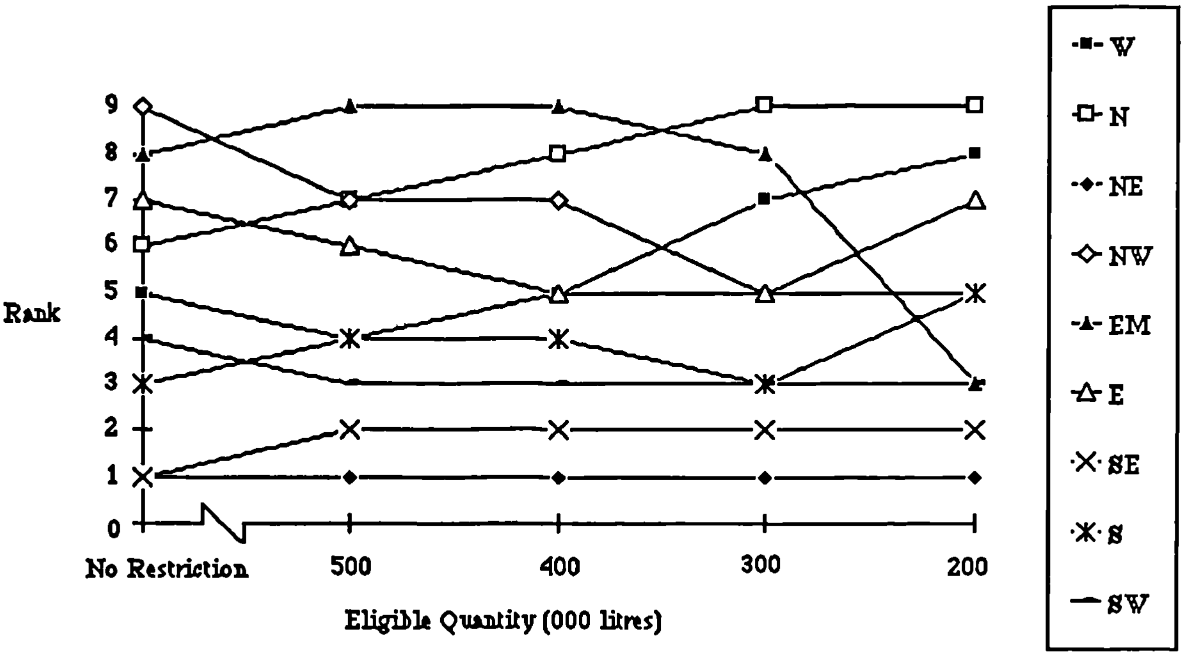
Table 6.7 Regional Gini Coefficients for NVA under PEG2

Region	No PEG	PEG 500	PEG 400	PEG 300	PEG 200
Wales	0.47	0.43	0.40	0.36	0.29
Northern	0.52	0.47	0.45	0.40	0.32
North Eastern	0.38	0.32	0.28	0.22	0.14
North Western	0.73	0.47	0.42	0.35	0.26
East Midland	0.65	0.54	0.47	0.38	0.25
Eastern	0.54	0.44	0.40	0.35	0.27
South Eastern	0.38	0.34	0.30	0.26	0.21
Southern	0.45	0.43	0.38	0.32	0.26
South Western	0.46	0.40	0.37	0.32	0.25
Range	0.38-0.73	0.32-0.54	0.28-0.47	0.22-0.40	0.14-0.32

Under PEG2 all regions would have a noticeable fall in inequality, although differences arise in the level of change. If the PEG was set at 200,000 litres, the Gini coefficient for the North West would fall by nearly 0.5. The reduction in inequality for other regions is not as marked, but is still significantly greater than under PEG1.

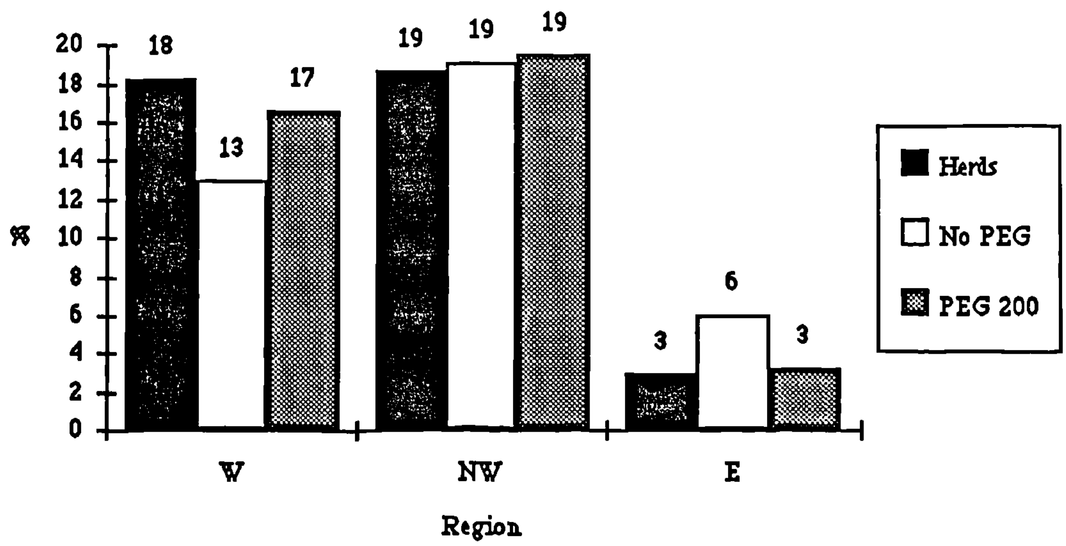
The greater changes in absolute inequality of NVA within regions also effects the relative position of each region. The ordinal ranking in Figure 6.22 highlight the changes. The East Midlands is one of the most unequal regions at PEG levels of 500, 400 and 300,000 litres but at 200,000 it becomes one of the most equitable regions. Wales tends to show greater inequality as the PEG becomes more restrictive.

Figure 6.22 Ranking of Regions by Level of Inequality under PEG2



The examination of the Gini coefficients in both ordinal and cardinal form, shows changes in the level of inequality. Also of interest is the proportion of support received by farms in relation to their share of herds. The regions with the largest shares, the North West and the South West tend to maintain a constant proportion of support under the PEG. In contrast, Wales increases its share by nearly 4% and the East and South East suffer a reduction in their share of total. support (Figure 6.23 highlights the changes for selected regions).

Figure 6.23 Percentage of Herds and Support to Selected Regions



On a regional basis the introduction of a PEG could work in a number of ways, depending on the level of the PEG and the level of support. Any restriction on the level of production eligible for support will lead to a relative reduction in income via a reduction in support for those regions which have the largest dairy herds. The opposite occurs to those regions which have smaller herd sizes. They either benefit in an absolute sense, by an increase in support and therefore in income, or in a relative sense, by having their income reduced less than the other regions. A number of regions, including the two largest production areas, the North West and the South West, retain their relative position (in terms of percentage share of support) whatever the level of PEG. Within these regions there is likely to be a redistribution under the PEG2 method, but as a whole, they do not lose out.

With either method, the redistribution is away from the Southern and Eastern regions to the North and Wales. As mentioned earlier, the tighter the PEG, and the higher the support per litre, the more agricultural support becomes a form of income support measure for the *farm* rather than a reward for increased *production.* If the aim is to divorce support from the level of production, a low PEG limit and a high support payment per litre may be the best method. If the aim is to not significantly effect the level of production, then a high PEG would be a method of putting a ceiling on the cost of the dairy sector. A high PEG would reduce the total support to the largest of farmers but leave the majority of others uneffected. This can be related to the Canadian system of fixing a ceiling of $50,000 on the level of support a farm can receive (Bollman, 1989).

6.5 Implications and Conclusions

This chapter has focused on a possible policy alternative (PEG) and analysed it in respect to levels and distribution of support and NVA. Two methods of implementation were considered. PEG1 considered a reduction in the total cost of support, whilst PEG2 maintained the total level of support. It is clear that the distribution of support becomes markedly more equitable as the restriction on the amount of production eligible for support is tightened. Whichever way the policy is implemented, the distribution of income also becomes more equal. However, under the scenario of maintaining total support, the fall in inequality is substantially higher than the alternative. As the cost of this policy is markedly greater than the other, it becomes clear that there is a trade-off between the costs of the policy and the reduction in inequality. Assuming a linear relationship, at a PEG level of 200,000 litres, each 0.01 reduction in the Gini coefficient under PEG2 costs £26m more than under PEG1.

On a national basis PEG reduces the inequality associated with income distribution in dairy farming. However, at the regional level, large differences become evident. Those regions with smaller average herd sizes either do not suffer such a large reduction in support (under PEG1) or receive an increase in the amount of support accruing to them (under PEG2). The regions with the most production and largest herds suffered the greatest fall in support. Under PEG2, at the 200,000 litre entitlement level, 6 of the 9 regions would gain in terms of support, with a redistribution of income from the East, South East and South to the other regions (Wales in particular).

The impact of the PEG on the level of inequality within regions was assessed using Gini coefficients. The PEG led to large reductions for all regions in the level of inequality associated with support, but with inequality in some regions reduced more than in others. Analysis of the number of farms covered at each PEG level highlighted that those regions which showed smaller changes were those that had the fewest farms affected by the reduction in eligible support (Wales, North, etc). In regions with the largest herds, inequality declined markedly (the East, for example).

Coupled with declining total support, the instigation of the PEG leads to a dramatic fall in the distribution of support and the level of NVA, but only small effects on the distribution of NVA. PEG2 involves no change in total support levels and total NVA but a large reduction in inequality of both support and income. The conclusion is that with the same total cost as present policies, inequality in dairy farming could be significantly reduced within a similar level of total income in the industry. With PEG1, at reduced cost, inequality will be reduced marginally, but with large falls in income.

The level of production eligible for support has significant distributional implications. The results indicate that the PEG can be set to fulfil specific goals. If the sole intention is to reduce inequality then the most restrictive PEG is more appropriate. However, this does have a significant effect on the incomes of larger farmers. If the aim is to raise the incomes of the lowest quintiles then the results indicate the level of PEG and the method of implementation necessary. If it was decided, as Harvey (1990) suggests, to support people rather than products, the PEG set at 200,000 litres is preferable. At this level each region receives virtually the same share of support as it has producers.

If the existing cost is acceptable, PEG2 results in a greater reduction of inequality and redistribution of income, because low income producers benefit both absolutely as well as relatively. The more restrictive the PEG the more they benefit. However, perhaps of more interest is the large percentage of producers who benefit. The three (four) lowest quintiles all increase their share of support at a PEG of 200,000 litres (300,000 litres). Therefore, the PEG involves a significant transfer of support from farms in the highest quintiles. It is questionable whether such a large transfer is possible without significant long-term effects. It must be remembered, that NVA is considered, rather than Net Farm Income, or even Management and Investment Income. Therefore, although the PEG brings the quintiles to similar levels of NVA, because the larger farms have greater wage bills and also more rent to pay, the top quintile will be considerably worse off, if either of the two other income definitions are considered.

The static analysis has a weakness, because it cannot predict the structural and therefore the production effects of the PEG.

Opponents of the PEG could argue that instigation of such a policy would lead to increased costs and lower incomes for the industry as a whole. It is claimed[34] that an advantage of the PEG is that those who are most efficient can expand beyond the PEG level (due to their lower unit costs). However, if even the most efficient make a loss at the unsupported market price this will not be the case. If the larger farms are making a loss on any litre produced over the PEG threshold, the logical step to maximise profit would be to reduce production to the level of the PEG. If the PEG is so restrictive that the larger producers make a loss and reduce production accordingly, and if this production 'transfers' to small farms then average costs in the industry may rise. Dawson and Hubbard (1987) indicated that the larger producers have lower unit costs, therefore any reduction in their production will lead to higher average costs for the industry as a whole. However, it may be the case that reduction in average costs to the smaller producers (arising from increased production) will negate the increase in average costs to those producers who reduce production. The exact effects would depend on the position of individual farms on their cost curve.

The national results hide significant regional trends. The PEG affects regions very differently, both in levels of income and the inequality associated with this income. Results indicate a significant movement in each region's level of income. With a region such as Wales, under PEG2, the lower the eligible quantity (the higher the payment per litre) the more the region benefits. Therefore, as a lobby group it would be in the interest of Welsh farmers, as a whole, to have the most restrictive PEG available. The South East, as a whole, suffers more as the PEG becomes more restrictive, therefore it might be expected to argue for as high a PEG as possible (and preferably PEG at all).

[34] Again reference is made to Harvey (1990)

With regions such as the North West, the overall position varies little whatever the PEG level. However, within the region (and in fact any region), smaller producers will push for a restrictive PEG and larger ones for no PEG.

With PEG1 a different picture emerges. It will not be much comfort to a low income producer to know that he/she is relatively better-off in that his/her income has fallen less than that of a high income producer. A PEG coupled with declining total support benefits no farmer absolutely, but some relatively. Even with the PEG set as high as 500,000 litres, the fall in income to the sector is £150m (or 14% of the total income). One could expect strong opposition to such a policy. However, if the reduction in support was unavoidable then the smaller producers would do well to push for PEG1 rather than a reduction in price support.

Appendix 6.I Figures A6.1 and A6.2.

Figure A6.1 NVA per Farm under PEG1

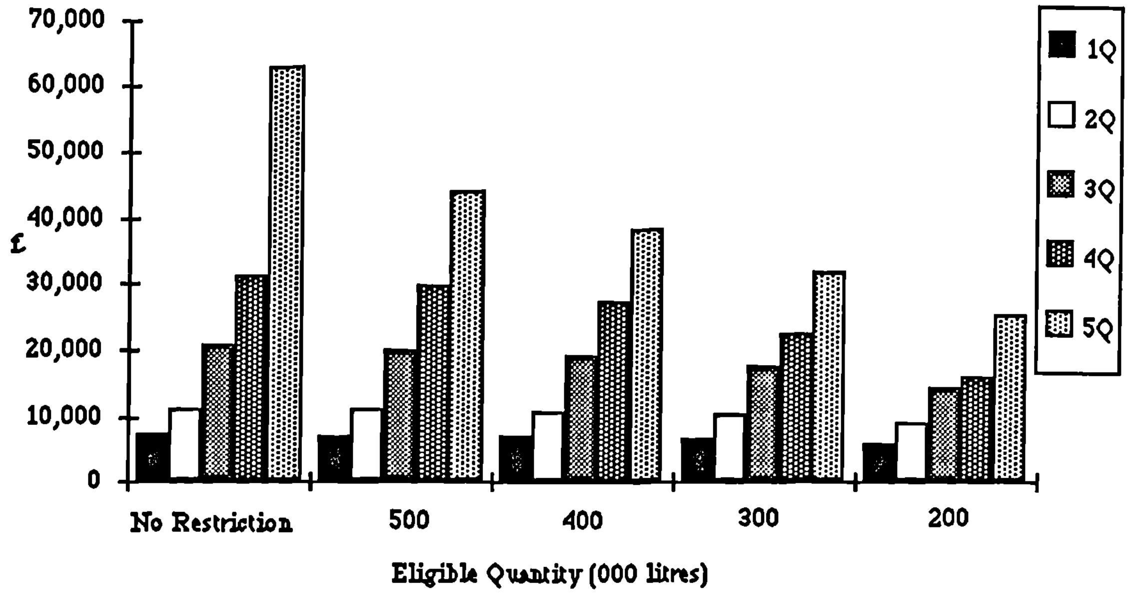
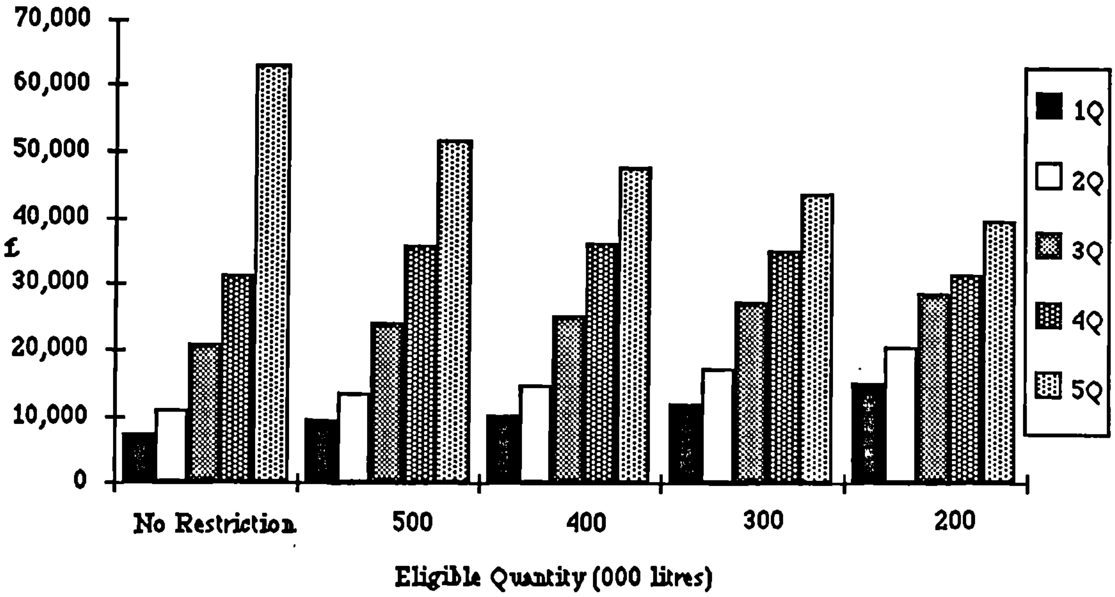


Figure A6.2 NVA per Farm under PEG2



Appendix 6.II Tables A6.1 to A6.4

Table A6.1 Total Support by Region assuming PEG1

(£m)

	Eligible Quantity (000 litres)				
Region	All	500	400	300	200
Wales	122	112	106	94	76
Northern	77	66	61	53	41
North Eastern	71	56	51	44	34
North Western	182	154	138	118	89
East Midland	57	51	47	41	31
Eastern	53	32	27	21	15
South Eastern	30	19	17	14	10
Southern	162	118	105	85	61
South Western	200	176	158	132	100

Table A6.2 Total Support by Region assuming PEG2

(£m)

	Eligible Quantity (000 litres)				
Region	All	500	400	300	200
Wales	122	137	142	149	158
Northern	77	80	83	83	85
North Eastern	71	68	68	70	71
North Western	182	188	185	186	186
East Midland	57	62	63	64	64
Eastern	53	38	36	33	31
South Eastern	30	24	23	23	22
Southern	162	144	141	135	128
South Western	200	214	212	209	210

Table A6.3 Support per farm by Region assuming PEG1

(£)

	Eligible Quantity (000 litres)				
Region	All	500	400	300	200
Wales	17,690	16,066	15,146	13,504	10,834
Northern	19,550	16,993	15,917	13,661	10,528
North Eastern	25,229	21,648	19,717	17,167	13,252
North Western	26,923	21,387	19,136	16,363	12,372
East Midland	22,488	19,509	17,948	15,577	11,681
Eastern	42,648	27,347	23,048	18,136	12,708
South Eastern	31,595	23,947	21,566	17,838	12,759
Southern	32,233	24,165	21,527	17,503	12,600
South Western	26,258	20,967	18,876	15,810	11,974

Table A6.4 Support per farm assuming PEG2

(£)

Region	Eligible Quantity (000 litres)				
	All	500	400	300	200
Wales	17,690	19,835	20,592	21,582	22,874
Northern	19,550	20,341	21,007	21,207	21,608
North Eastern	25,229	24,223	24,314	24,952	25,504
North Western	26,923	27,646	27,274	27,421	27,405
East Midland	22,488	24,325	24,647	25,150	24,931
Eastern	42,648	30,001	27,614	25,306	23,187
South Eastern	31,595	23,659	23,428	22,642	21,102
Southern	32,233	28,464	27,915	26,651	25,308
South Western	26,258	27,981	27,770	27,394	27,420

Appendix 6.III Tables A6.5 to A6.8

Table A6.5 NVA by Region assuming PEG1

(£m)

Region	Eligible Quantity (000 litres)				
	All	500	400	300	200
Wales	124	112	106	94	76
Northern	88	78	74	65	53
North Eastern	75	66	61	54	44
North Western	193	153	137	117	88
East Midland	63	55	51	45	35
Eastern	52	34	29	23	17
South Eastern	23	17	15	12	8
Southern	166	127	114	94	70
South Western	250	205	188	162	130

Table A6.6 Total NVA by Region assuming PEG2

(£m)

Region	Eligible Quantity (000 litres)				
	All	500	400	300	200
Wales	124	139	144	151	160
Northern	88	91	94	95	96
North Eastern	75	73	73	74	76
North Western	193	198	195	197	196
East Midland	63	68	69	70	69
Eastern	52	37	34	32	29
South Eastern	23	17	17	16	15
Southern	166	148	145	139	132
South Western	250	264	262	259	259

Table A6.7 NVA per Farm by Region assuming PEG1

(£)

Region	Eligible Quantity (000 litres)				
	All	500	400	300	200
Wales	17,704	16,081	15,161	13,518	10,849
Northern	22,843	20,285	19,209	16,954	13,820
North Eastern	29,150	25,569	23,639	21,089	17,174
North Western	26,850	21,314	19,063	16,290	12,299
East Midland	24,119	21,139	19,579	17,208	13,311
Eastern	44,882	29,581	25,282	20,370	14,941
South Eastern	28,812	21,164	18,783	15,055	9,976
Southern	34,069	26,001	23,363	19,339	14,436
South Western	29,838	24,546	22,455	19,390	15,553

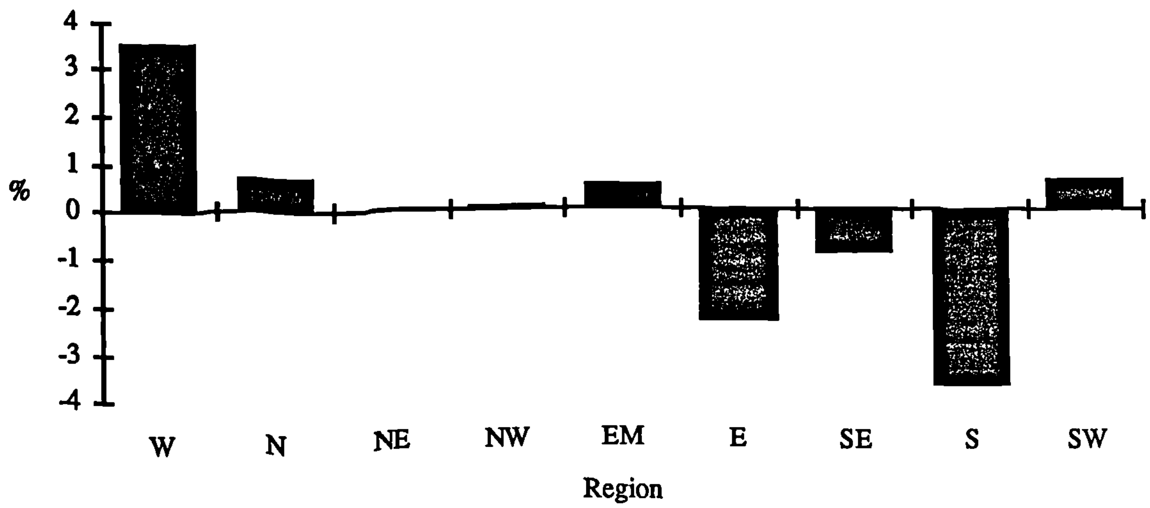
Table A6.8 NVA per Farm by Region assuming PEG2

(£)

Region	Eligible Quantity (000 litres) All	500	400	300	200
Wales	17,704	19,850	20,607	21,597	22,888
Northern	22,843	23,634	24,299	24,500	24,901
North Eastern	29,150	28,145	28,236	28,874	29,426
North Western	26,850	27,573	27,200	27,348	27,331
East Midland	24,119	25,956	26,278	26,781	26,561
Eastern	44,882	32,235	29,848	27,540	25,420
South Eastern	28,812	20,876	20,645	19,859	18,319
Southern	34,069	30,300	29,751	28,487	27,145
South Western	29,838	31,560	31,350	30,973	30,999

Appendix 6.IV Figure A6.3

Figure A6.3 Change in Region's Share of Total Support with PEG of 200,000 Litres (percentage points)



Chapter 7 The Estimation of the Consumer and Taxpayer Costs of Agricultural Support 1972 to 1986

7.1 Introduction

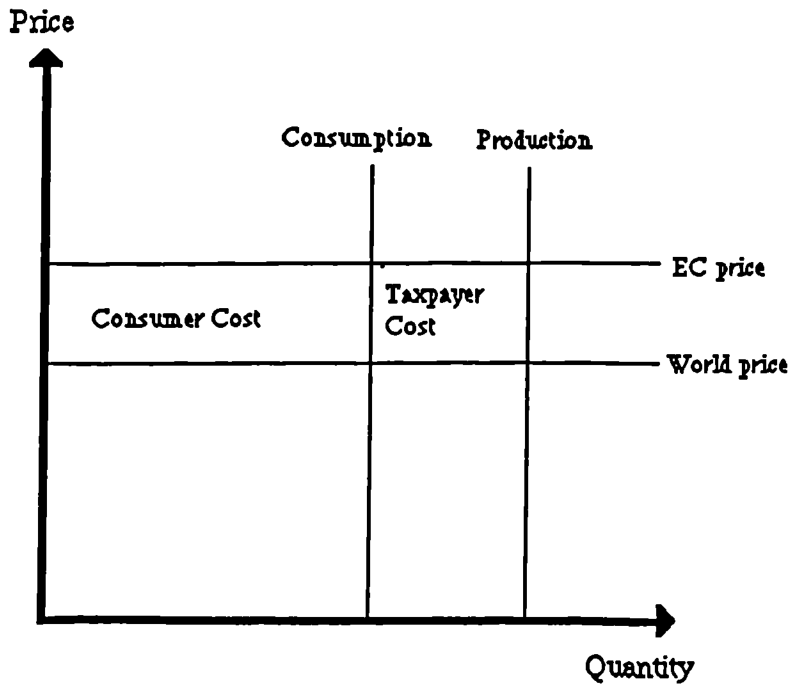
Previous chapters have been concerned with the level and distribution of agricultural support. This chapter examines the effects of agricultural support on those that bear the costs incurred by operation of supports - the taxpayers and the consumers of agricultural products, namely households. Consumer cost arises if the prices of agricultural products are set at a higher than world market levels. The taxpayer cost arises if support is paid for out of Exchequer funds. Therefore it is clear that the method by which support is paid for will determine which of the two groups bears the major burden. In the case of the CAP both groups bear the costs; the consumer, because the prices for many agricultural products under the CAP are set at higher than world market levels; the taxpayer, because production of agricultural products in the EC, in many cases, exceeds demand. Surpluses have to be removed from the domestic market, and in order to dispose of them on the world market export restitutions have to be paid. Figure 7.1, derived from Ritson (1991), indicates the costs described above.

The period under examination is similar to that analysed for the distribution of support. In general, it is concerned with the switch from national to EC policies and the effect on the *level* and *distribution* of the costs of support. Unlike Chapter 5 where, because of data availability, the analysis was restricted to one agricultural commodity, the costs for all major commodities will be considered. The taxpayer cost is estimated both pre and post CAP, whilst consumer costs relate solely to the operation of the CAP.

This chapter will comprise a brief review of some of the previous work undertaken on the distribution of the costs of agricultural support, followed by an examination of methodology and some results for the distribution of the costs of agricultural support.

In examining the distributions, the assumption of lognormality is not made for a number of reasons. First, as mentioned in Chapter 3, the hetereogenity of the population as a whole would mean that the lognormal is unlikely to represent the actual distribution. Second, many of the problems arising with the data for farms are not evident with household data (the definition of income is more comprehensive and the households are ranked by income level). The Gini is again chosen in preference to Atkinson's Index, because their are problems in interpretating the parameter (ε) when costs are considered rather than income.

Figure 7.1 Simplified Model for Estimating Consumer and Taxpayer Costs of the CAP



Source: Ritson (1991)

7.2 A Review

The most striking feature of a review about the consumer costs of the CAP is that the literature is much scarcer than that associated with the distribution of the benefits of support. A distinction can be made between those studies that attempt to estimate the total cost of the CAP to the consumer and taxpayer, of which there are many,[35] and those that try to assess the distributional impacts of the costs. It is the latter type with which this review is concerned.

Josling and Hamway (op. cit.), as well as examining the distribution of benefits of agricultural policy, analysed the distribution of the costs. They concentrated on the policy in existence at the time (Deficiency Payments, DP) and two possible alternatives, Variable Import Levies (VIL) and the regime under the CAP[36]. In essence it was a comparison between policies that operated through funding from the Exchequer (as was the case with Deficiency Payments) and those that operated through higher food prices. The first type are paid for exclusively by taxpayers, while the second should, in theory, be paid for by consumers.

Josling and Hamway examined total costs to households in receipt of different levels of income and also the proportion of final income used for agricultural support. Tables 7.1, 7.2 and 7.3 highlight some of the main findings of the work by Josling and Hamway. Table 7.1 shows the distribution of the total costs between households ranked into income quartiles. The results indicate that DP results in a more progressive method of paying for agricultural support than those policies that operate through higher food prices. The percentage of total costs borne by the lowest 25% of income earners is approximately one half of the VIL and the CAP alternatives (the figures for the CAP and VIL were only *estimates* because neither policy was in operation at the time). The figures also show that, under the DP policy, low income households are paying proportionately less than their share of final income whilst the highest income households are paying slightly more. This is not the case with the VIL and CAP

[35]For example, see Buckwell et al (1982), A.B.A.R.E (1984) and Brown (1989).
[36] The difference between adoption of VIL and the CAP, in Josling and Hamway's work was that the VIL maintained support at the same level as under DP, but transferred the cost from the Exchequer to higher food prices. Adoption of the CAP was considered likely to increase the level of support and transfer the costs from the Exchequer to higher food prices.

alternatives. Under both these scenarios, low income households' share of the costs of agricultural support are greater than their share of total income. The reverse is true for high income households.

Table 7.1 Distribution of Total Support Costs Under Different Policies and of Household Incomes

Income Quartile	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Policy:		percentages		
Deficiency Payments	6.9	18.5	27.7	46.9
Variable Import levy	12.2	25.0	30.7	32.1
Common Agricultural Policy	12.9	25.5	29.6	32.0
Income:				
Original Income[1]	5.7	20.8	25.8	47.7
Final Income[2]	11.0	19.0	27.4	42.6

1) Original Income is income before Taxes are paid and before State Benefits are received
2)Final Income is Original Income - Tax Payments + State Benefits

Source: Adapted from Josling and Hamway (1972)

Table 7.2 Gini Coefficients for Commodity Programmes and for Household Income

Programme	VIL	CAP
Pork	0.14	0.14
Beef and Veal	0.19	0.19
Cereal Programmes	0.21	0.22
Total Costs	0.17	0.16
Original Income	0.39	
Final Income	0.28	

Source: Adapted from Josling and Hamway (1972)

Table 7.3 Cost of Various Policies as Percentage of Final Income

	Household Income (£ per year)						
	At least-	559	816	1,196	1,752	2,566	3,770
Policy	Less than-	816	1,196	1,752	2,566	3,770	5,502
DP		0.52	0.67	0.81	0.92	0.85	0.81
VIL		0.87	0.96	0.98	0.91	0.83	0.69
CAP		4.60	4.30	3.60	3.15	2.40	1.70

Note: Figures given are for households comprising of 2 adults and 2 children
Source: Adapted from Josling and Hamway (1972)

Table 7.2 examines the effects of individual commodity programmes on income distribution. These results are calculated using expenditure on commodities by households of different income levels included in the Family Expenditure Survey (FES). Josling and Hamway describe the significance of the results in the following way:

> "It can be seen from the table [7.2] that under both support systems, costs are, for all programmes, distributed with lower coefficients than is either final or original income. In other words... switching to a support scheme which is financed...by higher food prices exaggerates income inequality" (p 73).

Table 7.3 compares the percentage of final income spent on agricultural support under the different policies for households at different income levels. The household composition shown is that of 2 adults and 2 children (this is only one of a number of different household compositions analysed in the work). The table clearly shows the effects of the various policies on households with different income levels, with the CAP accounting for proportionately more of the income of lower income households.

Josling and Hamway conclude that the switch from the DP method of support to either the VIL or the CAP leads to a more regressive distribution of the costs of supporting agriculture. It must be remembered that this work was undertaken before the UK acceded to the EC. Therefore, the figures for the CAP were only estimates of the *likely* costs. For example, Josling and Hamway could not have envisaged the large taxpayer bill that has also become part of the CAP, due to the surpluses of many of the commodities produced. This is likely to have effected both the overall cost and its distribution.

A more recent piece of work (Hubbard, 1988) made allowance for the taxpayer costs that had arisen under the CAP. Hubbard adopted a different approach to that of Josling and Hamway. The initial consumer costs were calculated as the difference between the EC price and that which would exist with no agricultural policies, multiplied by the level of consumption. Allowance is made for likely increases in world prices of many agricultural commodities if the CAP was discontinued. Hubbard estimated the consumer cost for 1983 at £3,890 million (Table 7.4). This related to total food expenditure in 1983 of £32,600 million. He, therefore, concluded that the CAP effectively represents an implicit tax on food of around 14%. In order to examine the distribution of this tax, Hubbard used data from the FES. Table 7.5 highlights some of the results and illustrates the difference in the level of costs borne by low and high income earners. The high income households pay more in *absolute* terms of the implicit food tax, but when this figure is shown as a percentage of gross income, it is the lowest income households that bear proportionately more of the costs (3.2% as opposed to 1.3%). Hubbard (pp 34-35) notes that:

> "... the consumer cost of farm support has been apportioned to each income group on the assumption that food consumption patterns between income groups are identical. Clearly in practice consumption patterns are likely to vary with income level of income, and since the price of some agricultural

commodities are supported to a greater extent than others, apportioning the total consumer cost as undertaken here is an oversimplification. However the general picture is likely to be little affected." (pp 34-35)

It is not immediately obvious that the likely effects of differing consumption patterns will ensure that "the general picture is likely to be little affected" as Hubbard reasons. If large differences exist, this could lead to discrepancies between his estimated cost for each income level and that which actually occurs. Another problem with Hubbard's work is that whilst figures for the total taxpayer costs involved in supporting UK agriculture are calculated (Table 7.4), these costs are not apportioned between households of different income levels. Finally, lack of use of inequality measures makes it difficult to quantify the degree of inequality associated with farm support.

Table 7.4 The Costs of Agricultural Support in the UK, 1983

Item			Cost (£m)
Consumer Cost			3,890
Taxpayer Cost			2,558
of which	CAP (FEOGA)	1,132	
	CAP (UK Exchequer)	488	
	Potatoes and Wool	5	
	Research and Development	147	
	Capital Grants	182	
	Administration	201	
	Rates Exemption	400	
	Excise Duty on Fuel	3	
Tax Allowances			1,253
Total			7,701

Source: Hubbard (1988)

Table 7.5 Income and Food Expenditure by Level of Household Income UK, 1983

(per adult per year)

	Lowest £	Quintile %	Highest £	Quintile %
Gross Income	2,090		7,400	
Income Tax and National Insurance	7	0.3	1,740	23.5
Expenditure on Food	565	27	794	10.7
Of which implicit food tax	67	3.2	95	1.3

Note: % figures are given as % of gross income

Source: Adapted from Hubbard (1988)

Ritson (1991), whilst not actually estimating costs to the consumer and taxpayer directly, produces a framework from which the process could be undertaken. He notes that it is not just by raising the price of foods that policies such as the CAP affect the consumer; he lists food availability, food security and food quality as others. However, for the purpose of this study it is the effect of higher food prices that is of main interest. Ritson quotes other work that suggests the CAP costs £59 to every taxpayer and £110 to every consumer in the EC per year. This is the usual way of expressing the cost, but does not take account of the distributional effects of the CAP.

Ritson examines the question of reliability of the measurement of costs. First, he notes that the price consumers pay is at the retail level, whereas most calculations of consumer cost are undertaken further up the marketing chain. He argues that it is not certain that the marketing margin will be independent of the wholesale price, so that the whole cost of higher food prices will be passed on to the consumer. In the work by

Josling and Hamway, and by Hubbard, it is assumed that all the costs are passed on to the consumer.

Ritson suggests that the above problem is overshadowed by that of estimating levels of world prices. He does not feel it is valid to take the prevailing gap between EC price and the world price, multiply this by consumption and call it the consumer cost, because this is likely to exaggerate the actual level of consumer costs.

It is evident that estimation of consumer and taxpayer costs is not a straightforward task. Problems arise partly in the estimation of the total costs and partly in the distribution of these costs between households of differing incomes. To overcome these problems careful attention has to be given to the relationship between world and EC prices. Also some method of examining food consumption patterns at differing income levels would be beneficial. Finally, the relationship between wholesale and retail prices needs to be better understood.

7.3 Estimation of Consumer Costs

7.3.1 Introduction

Estimation of consumer costs is necessary before the distribution of these costs between households can be ascertained. In this section, two methods of estimation of the *level* of consumer costs are made. One (the micro method) involves examination of food consumption at the household level. The other (the macro method) examines the total costs to the UK as a whole, and then reduces these to the household level. The method of the micro approach will be described first.

7.3.2 The Micro Approach

7.3.2.1 Data Sources

The micro approach involves the use of two government run surveys-the National Food Survey (NFS) and the Family Expenditure Survey (FES). The NFS has been monitoring food consumption in the UK for 50 years. It was initiated during the Second World War to examine the food intakes of the lower socio-economic classes. Later, the survey was expanded to cover a whole cross-section of society and now examines between 7 and 8 thousand households per year. The survey operates continuously and is conducted using a three tier stratified random sampling scheme:

1) A number of Parliamentary constituencies are chosen, the number from each region of the UK is calculated on the basis of the region's share of the percentage electorate;

2) Polling stations are chosen from each constituency;

3) Addresses from the electoral register of polling stations are chosen for interviewers to call at.

The FES[37] seeks to represent the entire household population and collects information on all sources of income and levels of expenditure. The number of households sampled is similar to that of the NFS. The NFS is a useful source of information because it gives information on the consumption of foods in terms of grammes per person, whilst the FES gives details of food expenditure in relation to levels of income and expenditure on other items.

[37]For more information on the FES see Kemsley *et al* (1980).

7.3.2.2 Methodology of the Micro Method

The micro approach involves a number of steps. First those foods considered as major expenditure items in the FES (Table 7.6) are chosen.

Table 7.6 Food Types Considered as Major Expenditure Items in FES.

Bread Rolls	Beef/Veal	Butter
Flour	Mutton/Lamb	Margarine
Cake	Pork	Lard/Fat
Biscuits	Bacon/Ham	Fresh Milk
Cereals	Other Meats	Milk Products
Sugar	Poultry	Cheese
Syrup/Jam	Sweets/chocolate	Eggs

Second, the quantities of these foods consumed by individuals at different income levels are obtained from the NFS. The next stage involves multiplying the units consumed by the estimated per unit cost of support, to find the total costs of support for each food type. Summing these costs over all the food types gives the total cost of support to an individual at each income level. This figure, multiplied by the average number in a household, gives a total cost of support to each household.

The estimated cost of agricultural support per unit, for each commodity, is simply the difference between the EC price and the estimated world price. Estimated world prices are again obtained from the databases used for the Newcastle CAP model. The world prices are not adjusted for the possible effects of a price rise in the absence of any EC price support policy. As Ritson (op. cit.) notes, this is likely to lead to an exaggeration of the actual consumer costs of support. However, given that the analysis is over a long time period, estimation of the effect of the CAP on the world price levels at different stages in its development would be extremely difficult and highly unlikely to produce reasonable results. The method followed here, although subject to the weakness of being an exaggeration, allows for consistent estimates.

7.3.2.3 Problems with the Micro Approach

In theory, the micro approach is an ideal way to measure the consumer costs of the CAP, because it is based on information about consumption at the individual household level. However, there is a basic drawback with this approach, in that the NFS survey does not include information about quantities of food bought and consumed outside the home. In recent years, food consumption out of the home has risen significantly. This omission may lead to an underestimation of the absolute costs. As it is the high income households that consume larger quantities outside of the home, the distribution of these costs may also be altered.

If Table 7.6 is examined, it is clear that a number of the food types are not simply raw products, but are processed to varying degrees. Josling and Hamway, when making their estimations of the likely impact of accession to the EC, considered only the effects on the basic raw food stuffs (milk, pork, flour etc.). They did not consider costs for products like biscuits and cakes, which comprise of a mixture of basic supported commodities (as well as other products). Without very detailed analysis of the composition of each specific type of food and analysis of the price structure, an exact cost cannot be obtained for these types of processed foods. However, some nominal calculations have been made to estimate these costs. With cakes, for example, the ingredients of butter, sugar, flour and eggs are accounted for. This may be an oversimplification of the constituents, but does allow for some costs to be allocated. The cost attributable to these products on an individual basis is relatively small and therefore slight errors in the allocation of costs will not bias the results to any significant extent.

A problem with compatibility between income classes arises with data for the FES and the NFS. FES data are available for income quintiles. However, the only information available from the NFS of consumption at different levels of income, is divided into classes which are not always quintiles. As these are the only data available for actual consumption, a compromise was necessary. Each income quintile, as given in the FES, is allocated consumption patterns in accordance with those at similar (but not identical) income levels from the NFS. This assumes that the lowest quintile of the population as measured by the FES has consumption patterns which are similar to the low income earners surveyed in the NFS, and so on for each of the five groups. This method has the possible disadvantage of not exactly representing the 'correct' food consumption at each quintile. However, as the NFS data is the only data available on consumption of foods by households at different levels of income, it was decided that the advantages outweighed the possible disadvantages.

A further weakness of the micro method is that it does not measure the consumption of alcoholic beverages. This is a problem because the raw materials for alcoholic drinks are often agricultural products which receive a level of support under the CAP regime. Therefore, there will be costs which the micro method will fail to account for.

Frank *et al* (1984) raise questions as to the reliability of the methodology of the survey, and claim that the low response rates, sampling errors and problems with participation could possibly bias the results. However, they make no attempt to quantify the level of bias.

Due to the problems listed above, the micro approach appears a less than perfect method for measuring consumer costs. It was decided to attempt another approach which is more directly related to that undertaken by Hubbard (op. cit.).

7.3.3 The Macro Approach

7.3.3.1 Methodology of the Macro Approach

The macro approach involves a different line of reasoning to that of the micro approach. Estimation of the total consumer cost of agricultural support is undertaken and this figure is then expressed as a proportion of total food expenditure

The macro approach, like the calculation of the consumer cost with the micro method, involves a number of stages. First, information on the levels of production and utilisation of major farm products in the UK (available from published sources[38]) is obtained. Second, for each commodity, the level of utilisation is multiplied by the difference between the EC and world prices (the levels of world prices are the same as those assumed for the micro approach). These figures are then summed over all the commodities to obtain an overall cost. This can be expressed as a proportion of total food expenditure in the UK. Thus, for every pound spent on food in the UK, x pence can be attributed to the effects of the CAP. To express this cost at the household level involves simply multiplying the total food expenditure of households in each income quintile (given in FES) by the proportion that is assumed as a result of the CAP. A worked example of the calculation for 1977 is given in Appendix 7.I.

The macro approach has the advantage that it includes agricultural products that form the basis of alcoholic drinks, e.g. barley, and therefore implicitly accounts for the cost of these products . Foodstuffs eaten outside of the home are also accounted for, as the figures comprise the total utilisation of agricultural products.

7.3.3.2 Problems with the Macro Approach

As the macro approach is similar to that undertaken by Hubbard (op. cit.), the problems are likely to be similar. First, no allowance is made for differing food consumption patterns at different income levels. Apportioning cost simply on the overall expenditure on food, and not allowing for these differences, may bias the results. Differences in the level of consumption of selected foods between high and low income individuals, for 1977 are shown in Table 7.7.

[38]In Output and Utilisation of U.K Agricultural Produce (various years).

Table 7.7 Consumption of Selected Foods at High and Low Income Households (1977)

Food Type	Income (£ per week) >250	<67
	(grammes per week)	
Bread/Rolls	665	1069
Flour	165	249
Beef and Veal	459	199
Poultry/Other Meat	264	130
Butter	120	129
Margarine	77	115
Lard/Other Fat	28	71
Sugar	246	418

Source: NFS (1977)

The low income earner consumes substantially more cereal based products and sugar, whilst the high income earner consumes more meat products. Therefore differences in the levels of support for these products will effect the actual distribution of costs.

Another problem with the macro method is that the FES data are based on expenditure and not consumption. A high income earner is likely to consume food at more expensive restaurants, so although he/she may be consuming the same quantity of food, the cost is greater. Distributing the costs by expenditure and not quantity consumed suggest that costs to the high income are biased upwards.

7.3.4 Conclusions about the Micro and Macro Methods

Both the micro and macro approach have advantages and disadvantages. The micro method allows for differing quantities of foods eaten at different income levels, but has the disadvantage that it does not account for the consumption of food outside the home. The methodology of the macro approach ensures that it accounts for all food utilised in the UK (within the boundaries of main crops), whether it is destined for catering or for home consumption. However, it does not allow for differences in consumption patterns.

The main conclusion drawn is that the micro approach, because it does not include consumption outside the home, will put a downward bias on the costs to the high income households. In contrast the macro approach will bias the costs towards the high income households, because it takes account of expenditure, and not the quantities eaten outside the home. Since neither method is ideal, it would appear useful to employ both to measure the costs to the consumer, and then compare the results in terms of absolute value and distribution between income groups.

7.4 Estimation of Taxpayer Costs

Previous sections have dealt with methods of estimating the consumer cost of the CAP, that is the costs associated with higher food prices. There is, in addition, a budgetary cost involved with the CAP and this section deals with its estimation. The budgetary cost arises, as mentioned earlier, mainly from the storage and disposal of surplus agricultural production. The costs are met from the funds of the EC through the EAGGF.[39] Originally (prior to UK membership) the EC budget was funded by direct contributions from the member states. However, since 1970 it has been funded by a combination of three parts:

1) Customs revenue collected by member states under the common customs tariff.

2) Levies collected on agricultural imports and sugar production

3) Payments from member states assessed on a common Value Added Tax base in each country (originally set at 1% but subsequently increased).

In theory, estimation of the taxpayer cost of agricultural support to UK households should be easier than that of consumer cost as all UK transactions with the EC are recorded and published (CSO 'Pink Book'). Also all budgetary costs of the CAP are published annually by commodity (Agricultural Situation in the Community, ASIC). Morris (1980) calculated the budgetary cost of the CAP by applying the proportion of

[39]European Agricultural Guidance and Guarantee Fund.

total EC expenditure on agriculture to the UK's payments of customs duties and VAT. The Cambridge Economic Policy Group (CEPG, 1977) used a similar method, although they took the taxpayer cost as the total contribution to the EC and not the proportion spent on agriculture. However, since these works were published changes have been made to the UK's contributions. Towards the end of the 1970s, the UK Government became concerned that it was bearing a disproportionate amount of the cost of funding the EC. From 1980 *ad hoc* refunds were negotiated. These refunds were formalised as VAT abatements in the Fontainebleu agreement of 1984. Therefore, in order to calculate the taxpayer costs as Morris did, these refunds/abatements would have to be taken into account.

There are however a number of problems involved with this approach. First, the overall payments to the EC reflect political commitments. The UK is a net contributor to the EC budget (payments to the budget are greater than receipts from it). Therefore, part of the UK's contribution funds agriculture in countries who are net beneficiaries from the EAGGF. It can therefore be argued that the cost of supporting UK agriculture is not as high as payments to the EC budget would suggest.

In the 'Pink Book' the refunds are recorded when received and not for the year they were applicable. In particular, in 1986 the UK received a large refund relating to overpayment in previous years. The effect of this is twofold: first, it makes the taxpayer costs recorded in those earlier year higher than they should be; and second, the refund significantly reduces the cost for 1986. This problem can be overcome by using figures which relate to transactions in the budget year of the EC rather than the UK.[40]

This study will attempt to distinguish the element of the UK's contribution to the EC which reflects the cost of UK farm support from that which can be considered as farm

[40] These figures are published in The Government's Expenditure Plans (annual).

support in other European countries. A possible method is one based on the UK share of EC production for each commodity. Each commodity has a budgetary cost and this cost can be apportioned to each country according to production share. For example, in 1977, the UK produced 29% of EC barley and therefore it is reasonable to argue that 29% of the budgetary cost for barley in that year should be assigned to the UK taxpayer. If similar calculations are undertaken for each commodity these figures can be summed to obtain an estimate of the total UK taxpayer cost.

Once the total taxpayer cost has been estimated it will be distributed between households depending on their overall burden of direct and indirect taxation. This method ensures that the taxpayer cost, whatever the actual level, will be distributed between households in the same proportion as the total tax paid. Josling and Hamway (op. cit.) argue that this method of distribution should be undertaken because it is not reasonable to relate agricultural support to any specific form of taxation, eg. income tax, VAT etc.

The estimation of the taxpayer cost, therefore, is undertaken as follows:

1) Total EAGGF expenditure on agricultural support is obtained for the year in question.
2) For each commodity, this is distributed between countries on the basis of their contribution to total production. Therefore, the UK's taxpayer cost as estimated here, is related directly to the proportion of the EC's total production in each commodity accounted for by the UK.
3) This cost is then measured as a proportion of the total tax receipts of the UK government for the year in question.
4) This proportion, multiplied by the actual tax payments of households at different income levels, gives the costs in terms of tax payments per household.

The method adopted in this analysis is a direct attempt at assessing the cost to the UK taxpayer of supporting UK agriculture. However, results using a similar method to that of Morris and others (but allowing for the refunds/abatements to the UK Exchequer) will be produced for comparative purposes.

7.5 Results

The results are analysed in two ways: first, there are the findings in relation to the level of costs of agricultural support to the consumer and taxpayer; second, the distribution of these costs are analysed. Using two methods of estimating the consumer cost and five specific years produces a large volume of results. Therefore a number of years are examined but detailed discussion is restricted to a single year (1977). However, significant results from other years are reported.

The results of the analysis of consumer costs are restricted to the period 1977 to 1986 as it is assumed that before accession to the EC these costs were negligible. The taxpayer costs include estimation for an additional year, 1972, as does the calculation of total costs and examination of the distribution of these costs.

7.5.1 Consumer Costs (Micro Approach)

The costs for the main food products estimated by the micro approach are illustrated in Table 7.8.

Table 7.8 Estimated Consumer Cost of the CAP using the Micro Method (1977)

(£)

Food Type	Income Quintile 1st	2nd	3rd	4th	5th
Beef and Veal	3.95	4.35	4.58	4.82	9.1
Mutton and Lamb	9.37	6.25	7.2	8.04	13.22
Other Meat1	13.46	12.77	11.6	10.82	9.26
Total Meat	26.78	23.37	23.38	23.68	31.58
Butter	8.57	8.6	8.47	9.19	7.98
Fresh Milk	10.25	10.46	10.63	11.41	11.1
Cheese	9.69	10.27	10.49	11.21	14.59
Total Main Milk Products	28.51	29.33	29.59	31.81	33.67
Other foods2	13.74	12.7	12.25	12.15	12.22
Total Cost to Individual	69.02	65.41	65.22	67.64	77.47
Average Number in Household	1.51	2.47	3.03	3.25	3.73
Total Household Cost	104.32	161.56	197.62	219.82	289.13

1) Other meat includes sausage,pies,etc, not poultry,ham, pigmeat.

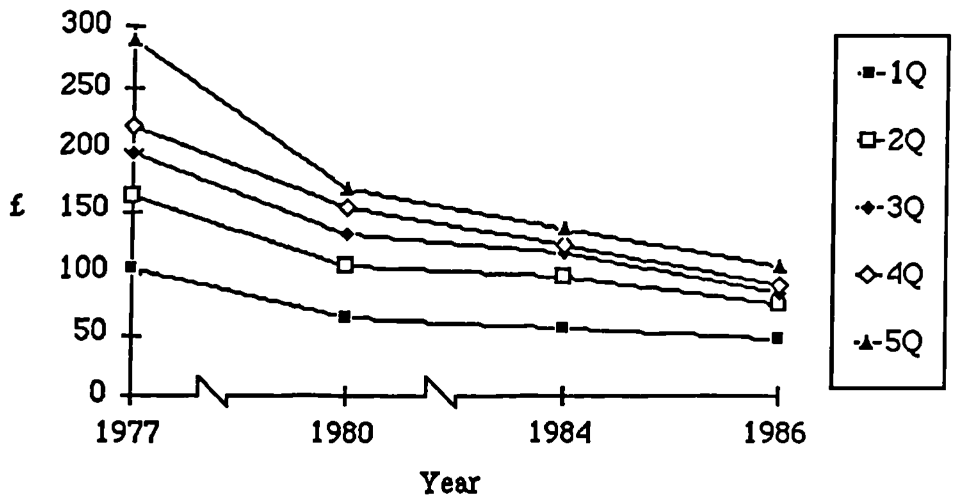
2) Other foods comprise all those listed in Table 7.6 not shown here.

Table 7.8 indicates that the main consumer costs are derived from meat and milk products. This is not surprising, because the level of support for these products is substantial and they also make up a large part of the diet in the UK (even for those on low incomes). The highest income households incur a much larger cost for beef and lamb. This is due entirely to the quantities consumed, as the methods used make no distinction between the quality of meat consumed. Average cost to the individual does not vary substantially between income groups. The lowest income households have a higher cost (per individual) than all other groups, except the top 20%. It is only when the figures are brought up to the household level (by multiplying by the average number of persons in a household) that the difference in costs become noticeable. This result implies that the costs, when considered on an individual basis, are equally spread. The household cost for each group as shown in Table 7.8 is re-presented in Table 7.9 and Figure 7.2 with similar information from the other years examined.

Table 7.9 The Household Costs of the CAP estimated using the Micro Method 1977 to 1986 (1977 prices)

Year	Income Quintile 1st	2nd	3rd	4th	5th	Average Cost
			(£ per year)			
1977	104.32	161.56	197.62	219.82	289.13	194.49
1980	63.9	105.36	131.79	152.79	169.16	124.6
1984	56.16	97.46	116.05	123.21	135.95	105.76
1986	46.81	75.79	84.96	90.32	104.96	80.57

Figure 7.2 Real Consumer Cost To Households Estimated by Micro Method (1977 to 1986)



The most striking feature of Table 7.9 and Figure 7.2, is the decline over the period in the cost to the consumer (in real terms) of supporting agricultural production. This decline is considerable at each level of income. A possible explanation for such a decline can be related to changes in the consumption patterns of consumers. Table 7.10 lists the consumption (in grammes per week) of foodstuffs by a middle income individual for the years under examination.

Table 7.10 Consumption of Food by an Individual in Middle Income Bracket

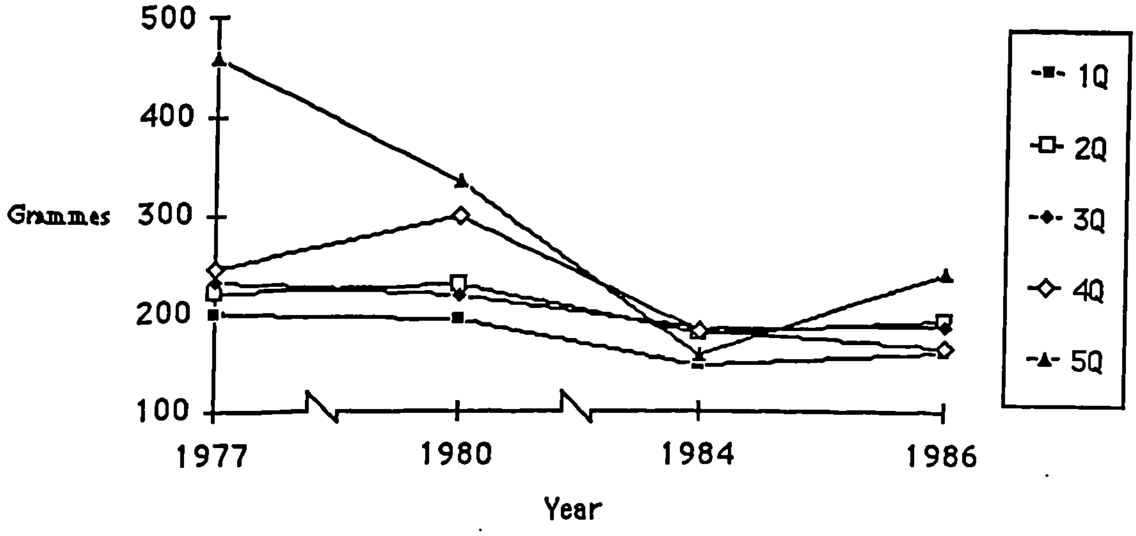
(grammes per week)

Food Type	Year			
	1977	1980	1984	1986
Bread Rolls	900	854	808	797
Flour	168	130	112	93
Cake	105	99	100	103
Biscuits	157	155	155	155
Cereals	240	258	284	308
Beef and Veal	231	217	185	189
Mutton and Lamb	107	126	79	78
Pork	95	124	91	106
Bacon/Ham	116	111	96	90
Other Meat	350	355	362	348
Poultry/Other Meats	175	180	198	202
Butter	128	109	75	58
Margarine	93	97	103	103
Lard/Other Fat	48	48	35	31
Fresh Milk	2	2	2	2
Milk Products	0.19	0.22	0.43	0.70
Cheese	107	115	113	123
Eggs	206	185	158	141
Sugar	305	266	219	188
Syrup/Honey/Jam	61	51	49	51

Source: NFS (1977, 80, 84, 86)

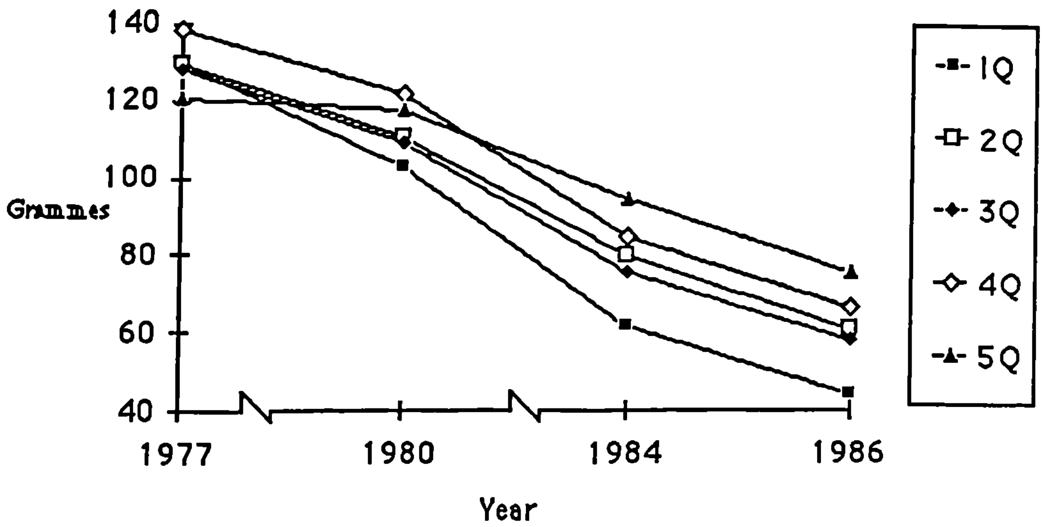
The table illustrates the fact that in most cases consumption of food in the home is declining (although only figures for the middle income bracket are shown, the other groups indicate a similar pattern). This decline is particularly noticeable for specific food types. Figures 7.3 and 7.4 illustrate changes in consumption of beef and butter throughout the period.

Figure 7.3 Trends in Beef Consumption 1977 to 1986



Source:NFS (Annual)

Figure 7.4 Trends in Butter Consumption 1977 to 1986



Source: NFS (Annual)

The decline in consumption of beef and butter was not matched by an equivalent increase in the consumption of other protected foods. This has led, in part, to the decline in the level of costs to households of agricultural support.

The decline in consumer cost is surprising given that the difference between EC and world prices, if anything increased during the period (thus putting an upward pressure on consumer cost), and it would appear that the weakness mentioned in the methodology of the micro approach, that is not accounting for food eaten outside the home, is responsible. The next section, analysing the results of the macro method, will shed light on whether this downward trend is reproduced.

7.5.2 Consumer Costs (Macro Approach)

The macro results, because of the methods involved, are reproduced in a slightly different manner than those of the micro approach. The total consumer cost is given first, followed by results for households at different income levels. Table 7.11 details the composition of total consumer cost for 1977. As with the micro method, it is meat and milk products that constitute the majority of the costs. Similar calculations were made for the other years under consideration and are presented, along with information about the level of total food expenditure in the UK, in Table 7.12.

Table 7.11 Composition of Consumer Cost, 1977 (Macro Approach)

Product	Units	Consumption	Consumer Cost (£m)
Wheat	000 tonnes	5260	34.72
Barley	000 tonnes	1900	0.00[1]
Oats	000 tonnes	145	1.91
Beef	000 live animals	4587	1241.24
Sheep and Lambs	000 tonnes	233	148.17
Pigs	000 tonnes	918	276.80
Poultry	000 tonnes	606.4	5.06
Eggs	million	1127.8	43.66
Sugar	000 tonnes	1054	84.11
Milk Products	million ltrs	14406	997.13
Total Cost			2832.80

1)No cost for barley as EC price was equal to world price in this year

Table 7.12 Total Consumer Cost of the CAP 1977 to 1986 (Macro Approach)

Year	Total UK Food Expenditure	Estimated Consumer Cost	Food Tax[1]
	£m	£m	%
1977	16,057	2,832.8	17.6
1980	23,655	3,951.8	16.7
1984	29,304	5,334.1	18.0
1986	33,059	5,575.8	16.8

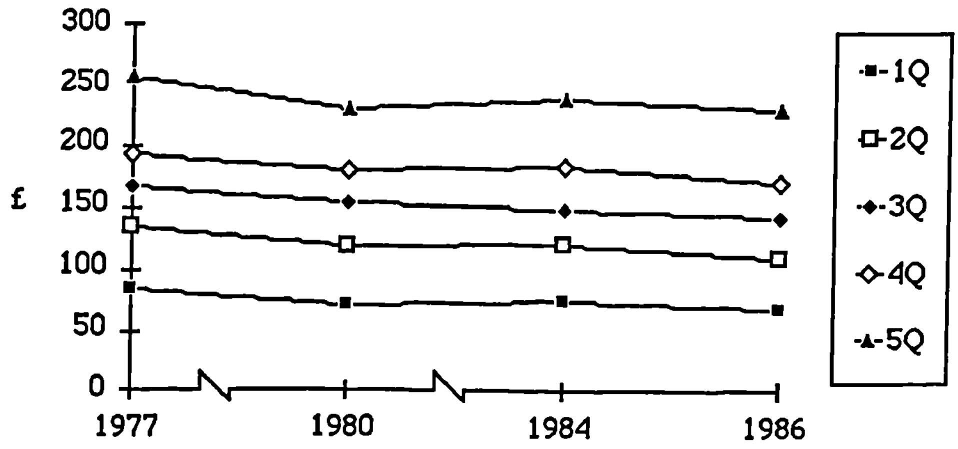
Notes 1) Food Tax is Consumer Cost as a percentage of total food expenditure

Table 7.12 relates the estimated consumer cost to the total level of food expenditure in the relevant years. The percentage food tax shows how much of total food expenditure is accounted for by the higher EC prices. Alternatively, using 1977 as an example, it is possible to say that food expenditure would be reduced by nearly 18% if there was no agricultural support. The results show very little variation in the percentage food tax between years. The range for the whole period is only one and a half percentage points. There is a steady rise in the consumer costs, but this is matched by a similar rise in total food expenditure. In Table 7.13 and Figure 7.5 the costs are reduced to the household level and are also deflated to base year prices.

Table 7.13 The Consumer Costs of the CAP estimated using the Macro Method (1977 prices)

Year	Income Quintiles					Average Cost
	1st	2nd	3rd	4th	5th	
			(£ per year)			
1977	83.84	133.39	167.24	193.48	256.89	162.75
1980	69.99	119.58	154.17	179.17	230.28	150.64
1984	75.13	120.59	150.07	185.43	238.48	153.94
1986	68.79	109.97	142.75	171.27	230.91	144.74

Figure 7.5 Real Consumer Costs To Households Estimated by Macro Method



The results of the macro approach do not indicate a large downturn in the real costs to consumers, although, on average, a slight reduction has occurred. Given that the same level of world prices are assumed for both methods the explanation for the different results must come from levels of estimated consumption. Table 7.14 highlights that the utilisation of many agricultural products has increased.

Table 7.14 Utilisation of Major Farm Products in the U.K (1977 to 1986)

Commodity	Units	Year			
		1977	1980	1984	1986
Wheat	000 tonnes	5260	5030	4903	5272
Barley	000 tonnes	1900	2050	1871	1609
Oats	000 tonnes	145	140	143	158
Beef	000 live animals	4587	4511	4457	4073
Sheep	000 tonnes	233	293	302	307
Pigs	000 tonnes	918	949	965	1010
Poultry	000 tonnes	606.4	615.2	689.7	751.3
Eggs	million	1127.8	1068.1	1027.7	1018.7
Sugar	000 tonnes	1054	1207	1347	1506
Milk	million ltrs	14406	15182	15466	15462

Source: Output and utilisation of agricultural products in the UK (1982, 1987)

The micro approach indicated a large downturn in the level of consumption whilst the macro approach shows no such trend. The difference between the two figures may be explained in part by the consumption of food outside of the home and in part by the consumption of alcoholic beverages. Both of these items, as already mentioned, are accounted for in the macro approach but not in the micro approach. Whichever method is used, the minimum conclusion to be drawn is that there has been no discernible *rise* in the consumer costs during the period.

7.5.3 Taxpayer Costs

Having examined the costs of support to the household as a consumer of food it is now necessary to examine tax costs. As mentioned earlier, this section will include figures for 1972. Table 7.15 relates the estimated taxpayer costs to total tax revenue and shows real levels of tax costs to allow for comparison between years. It highlights a number of points concerning the taxpayer costs of supporting agriculture. Between 1972 and 1977 the real cost fell substantially in absolute terms and as a percentage of total tax. This was due to two main factors. First, the EC minimum price method of support initially meant a switch in the burden of farm support for the UK from the taxpayer to the consumer. Second, the figure for 1972 was obtained from the White Paper on Agriculture and includes all the costs of agriculture, such as the cost of the Potato Marketing Boardt and capital development projects. The figure for 1977 includes only those cost attributable to the expenditure of the EAGGF and does not include national policy costs.

Table 7.15 Taxpayer Costs Of Agricultural Support Policies in the UK 1972 to 1986

Year	Tax Revenue £m	Taxpayer Costs £m	Taxpayer Costs as a % of Tax Revenue	Real Taxpayer Costs £m (1977 Base)
1972	18,325	290.28	1.58	616.96
1977	44,750	236.48	0.53	236.48
1980	73,154	834.8	1.14	576.30
1984	108,912	1,514.68	1.39	783.80
1986	125,647	1,507.76	1.20	711.55

Between 1977 and 1980 the cost to the taxpayer rises substantially. This is due to removal of the increasingly large surpluses from the market, through intervention buying and subsidised exporting, which is a cost to the EC budget and therefore to the UK taxpayer. The cost of support appears to have peaked in 1984, both in relative and absolute terms. A reason for this could be that the UK's share of production and therefore of total cost in 1986 was lower than in 1984. Table 7.16 compares the taxpayer cost as measured in this study with that using an alternative approach to calculating the cost.

Table 7.16 A Comparison of Two Methods of Estimating Taxpayer Costs

Year	Morris Method[a]	Share of Production[b]	Difference
	£m	£m	£m
1977	441.64	236.48	205.16
1980	679.10	834.80	-155.70
1984	1597.22	1514.68	82.53
1986	1962.77	1507.76	455.01

a) Gross Contribution - Agricultural and Sugar Levies - Refunds/Abatements. b) Method adopted for this study

It is clear that estimated taxpayer costs are different from the two methods. From the earlier discussion the higher cost arising from the Morris method can be accounted for by the cost to UK taxpayers of subsidising other EC producers. However, in 1980 there is an anomaly, with the taxpayer costs actually lower than those estimated here. The reason for this appears to be the large refund (£645m) negotiated in this year. Although abatements occur in subsequent years they are not as large a proportion of the gross contribution.

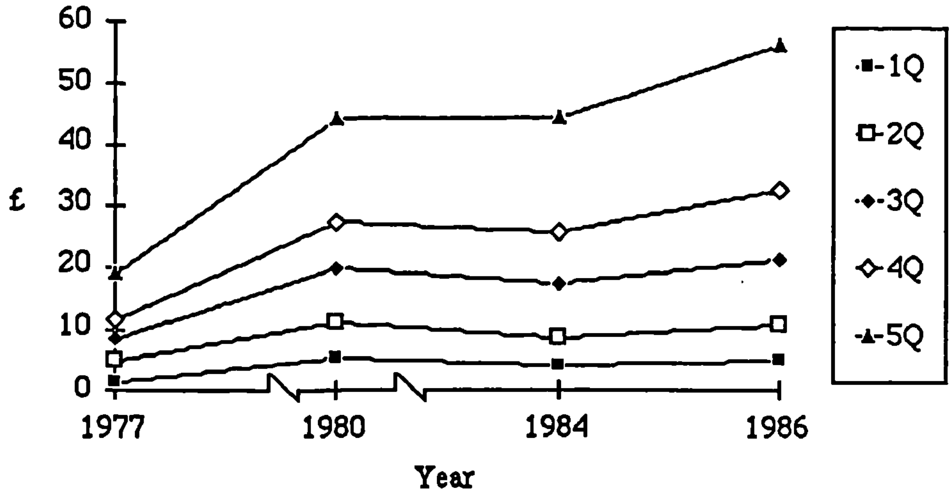
Table 7.17 and Figure 7.6 indicate the taxpayer costs at the household level for the selected years between 1977 and 1986 using the shares of production method.

Table 7.17 Taxpayer Costs to Households at Different Income Levels 1977 to 1986

1977 prices

YEAR	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Average
				£		
1977	1.66	4.78	8.38	11.68	19.00	9.04
1980	5.32	10.93	19.67	27.11	44.12	21.2
1984	3.92	8.52	17.09	25.66	44.11	19.86
1986	4.93	10.59	21.35	32.73	56.07	21.52

Figure 7.6 Real Taxpayer Costs To Households 1977 to 1986



The taxpayer costs to households, unlike the consumer costs, have risen on average during the period. The costs between 1977 and 1980 more than doubled (in real terms) for all income classes. It can be seen from Table 7.17 and Figure 7.6 that the costs in absolute terms have risen faster for the higher income groups. The top 20% of income earners have had an increase from £19 per year to £56, whilst the bottom 20% have had an increase of only £5 during the corresponding period. However, in relative terms the increases have been similar. The difference highlighted in Table 7.16 between the different methods of estimating total taxpayer costs are reflected at the household level in Table 7.18.

Table 7.18 Taxpayer Costs to Households at Different Income Levels 1977 to 1986 (using similar method to that of Morris)

1977 prices

YEAR	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Average
				£		
1977	3.09	8.87	15.53	21.66	35.23	16.76
1980	3.49	9.15	16.45	22.67	36.90	17.73
1984	5.69	12.37	24.81	37.25	64.03	28.23
1986	6.41	13.78	27.79	42.61	72.98	32.71

For all years other than 1980, the taxpayer costs to each quintile are higher under this method of calculation. The difference between these figures and those calculated using shares of production (Table 7.17) can be crudely interpreted as the subsidy from an average household in each income quintile to other (ie. non-UK) European farmers. For example, in 1986 the highest income earners contributed around £17 (ie.£73 - £56) per household to support other EC farmers. On the same basis, in 1980 actual taxpayer costs were less than those based on production, and effectively other European taxpayers were subsidising UK agriculture.

7.5.4 Total Costs

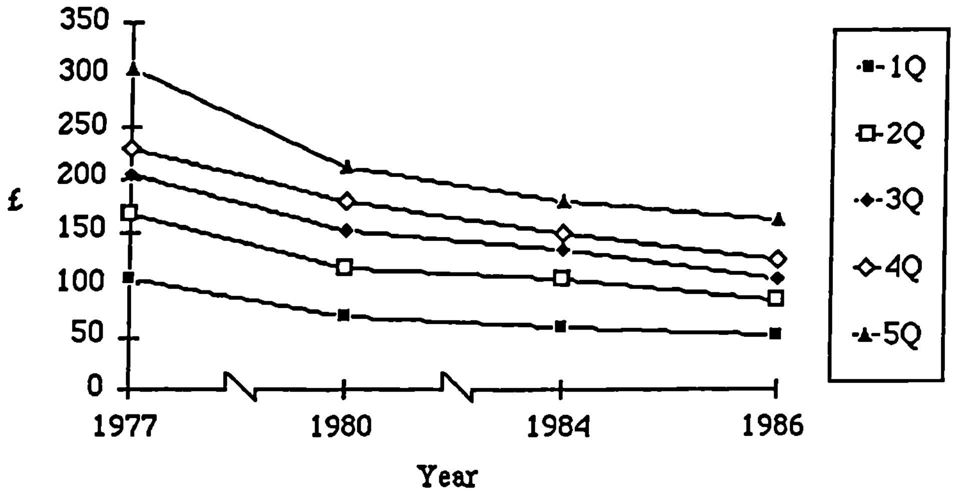
The previous sections have examined the overall levels and distribution of consumer and taxpayer costs. This section will concentrate on the combined costs and analyse whether the contrasting patterns found for the taxpayer and consumer costs are reflected in the trends for total costs. Total costs using the micro approach to estimate consumer costs will be analysed first.

Table 7.19 and Figure 7.7 indicate the total costs for the micro approach between 1977 and 1986. (Again figures for 1972 are not reflected at the household level because of incompatibility of the data).

Table 7.19 Total Costs per household Estimated by Micro Method 1977 to 1986 (1977 Prices)

Year	Income Quintile	1st	2nd	3rd	4th	5th	Average
				£ per year			
1977		105.98	166.33	206.00	231.50	308.12	203.52
1980		69.21	116.30	151.45	179.90	213.28	145.80
1984		60.08	105.97	133.14	148.87	180.06	125.62
1986		51.74	86.38	106.31	123.06	161.03	102.09

Figure 7.7 Real Total Costs per Household 1977 to 1986



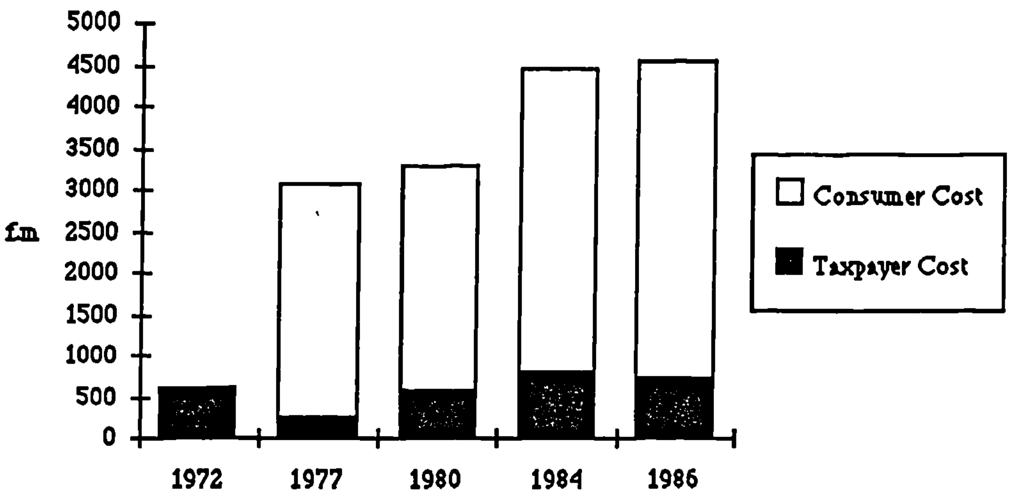
The results show that the decline in consumer costs outstrips the rise in taxpayer costs, and a noticeable downward trend in the real cost of support can be seen for all income classes. The decline is much greater, in absolute terms, for the high income households, nearly £150 per year. The effect that this fall has on the distribution of costs will be analysed in Section 7.7.

The estimated costs using the macro approach are shown in Table 7.20 and Figure 7.8. It is possible to include the results for 1972 here.

Table 7.20 Composition of Total Costs Macro Approach 1977 to 1986
(1977 Prices)

Year	Taxpayer Costs	Consumer Costs	Total Costs
		£m	
1972	616.96	0	616.96
1977	236.48	2832.8	3069.28
1980	576.3	2728.09	3304.38
1984	783.8	3682.31	4466.12
1986	711.55	3849.17	4560.72

Figure 7.8 Level and Composition of Total Cost 1972 to 1986



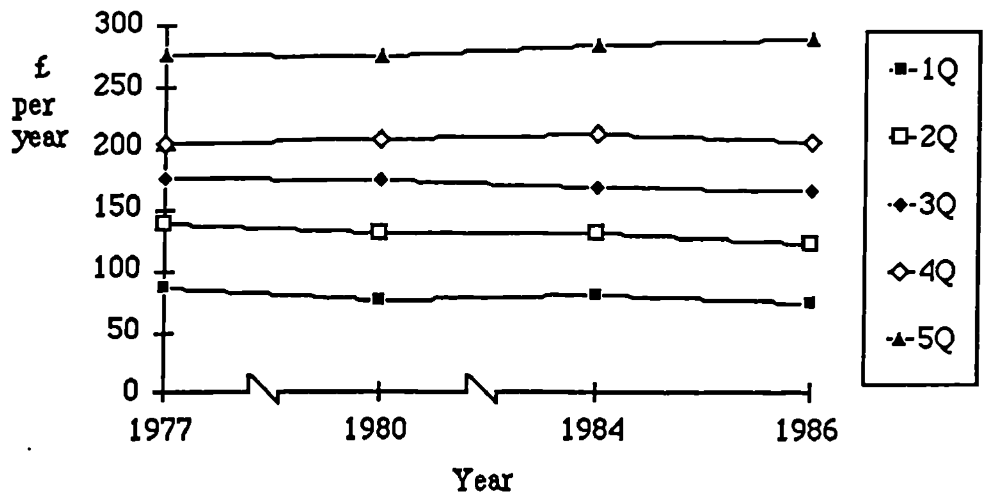
The large rise in the level of total costs between 1972 and 1977 is due to the introduction of consumer costs. The overall costs continued to rise in real terms from 1977 to 1986, due, in part, to an increase in the absolute level of consumer costs and also, up to 1984, a rise in the taxpayer cost. It is evident that after accession to the EC and the corresponding change in policy, taxpayer costs are small in relation to the estimated consumer costs.

The total costs at the household level for the macro approach are reproduced in Table 7.21 and also in Figure 7.9. The strong downward trend found with the micro approach is not evident. Although real costs to the lowest 80% of households decline, this is only small compared to that found using the micro approach. The costs to the highest 20% have risen.

Table 7.21 Total Costs Estimated by Macro Method 1977 to 1986 (1977 Prices)

Year	Income Quintile	1st	2nd	3rd	4th	5th	Average
				£			
1977		85.51	138.17	175.62	205.16	275.89	176.07
1980		75.31	130.51	173.84	206.28	274.40	172.06
1984		79.05	129.11	167.16	211.10	282.59	173.80
1986		73.72	120.56	164.10	204.00	286.98	166.26

Figure 7.9 Estimated Real Total Costs to Households by Macro Method 1977 to 1986



The results from the macro approach, at the household level, show a remarkable consistency in the level of costs, in real terms, over the 10 year period; The changes between the years are slight. The consumer and taxpayer costs, in absolute terms, have increased during most of the period (Table 7.20), but this rise has been matched by increases in the tax revenue of the Government and expenditure on food. Thus, as a proportion of both the consumers food expenditure and their tax payments, the costs have not changed dramatically. From these results, the cost of agricultural support, in real terms, has remained virtually unchanged to households in different income quintiles (Table 7.21).

The preceding analysis has used two methods to estimate essentially the same item, namely the consumer costs of agricultural price support. The results vary considerably, both in absolute levels and general trends, and therefore examination of the possible causes of these differences needs to be undertaken.

A number of weaknesses (which were considered possible sources of bias) with both methods were outlined. It is possible that these problems have an effect on the results. The inability of the micro method to estimate costs for food eaten outside the home has been mentioned. However, some idea as to the seriousness of this omission can be seen in recent figures which estimate that more than a quarter of all meat is now consumed outside of the home. [41] These figures indicate a serious deficiency in the data used for the micro method. On the other hand the macro method, because it is based on FES data includes the cost of food eaten outside the home. Although possibly biasing the results in terms of the costs to the high income earners, this at least allows the macro approach to include some estimation of this consumption.

7.6 Distribution of the Costs

As estimates of total costs of support have been made, it is now possible to consider the distribution of these costs between households. Knowledge of the distribution of costs is not, in itself, particularly useful unless it can be measured against the distribution of other factors, such as income and tax payments. In this section, Gini coefficients are used to show the distribution of income, taxes and costs from both the micro and macro approaches. Although it has already been shown that the latter two methods produce different results in terms of total costs, it will be of interest to see what effect, if any, this has on the distribution of costs.

[41] The Guardian, Monday 14th October, 1991

Before examining the Gini coefficients for income, some idea as to the distributional effects of the CAP can be found by relating the percentage of costs borne by households, at different income levels, to their share of income[42] (Table 7.22).

Table 7.22 Share of Total Costs and Total Income by Households at Different Income Levels (1977 Micro Approach)

	Income Quintile	1st	2nd	3rd	4th	5th	Total
Percentage of-							
Taxpayer Costs		3.66	10.51	18.41	25.67	41.75	100
Consumer Costs		10.73	16.61	20.32	22.61	29.73	100
Total Costs		10.41	16.34	20.24	22.74	30.27	100
Total Income		6.3	12.12	16.33	25.03	40.22	100

Table 7.22 illustrates the regressive nature of the CAP in a number of ways. The lowest quintile has 6.3% of total income, whereas the share of the top 20% of households is 40.2%. If the distribution of the tax costs are examined, the lowest two income quintiles pay proportionately less than they receive in income, while the top three quintiles all pay more than their share of income, highlighting the progressive nature of taxation. However, if the 'food tax' figures are examined a very different picture arises. The lowest three quintiles all pay proportionately more of the costs of consumer support than they receive in income, whereas the top 40% of households pay proportionately less. This infers the consumer costs of support are disproportionately borne by the low income households. The same pattern emerges when total cost (consumer plus taxpayer cost) is considered. However the distribution of total costs is not quite as unequal, because the progressively distributed taxpayer costs have been added to the regressive consumer costs. Similar results are found for the other years under consideration (shown in Appendix 7.II). The discussion so far has been based on the results using the micro examination, but the results in Table 7.23 show that the overall picture is similar for the macro approach.

42 The Income considered is that after government payments but before tax.

Table 7.23 Share of Total Costs and Total Income by Households at Different Income Levels (1977 Macro Approach)

Income Quintile	1st	2nd	3rd	4th	5th	Total
Percentage of-						
Consumer Costs	10.04	15.98	20.03	23.18	30.77	100
Total Costs	9.71	15.70	19.95	23.30	31.34	100
Total Income	6.05	9.55	16.05	24.31	44.04	100

The percentage of total costs borne by the lowest income quintile households under the macro approach is slightly lower than that of the micro approach (9.71 compared to 10.41). However, it is still considerably more than their share of income. The results from both the micro and macro approaches show that the cost of agricultural support is more heavily borne by low income households.

Another way of examining the distributional effects of the costs of support is to calculate, for each income quintile, the proportion of income accounted for by agricultural support (this method was undertaken by both Josling and Hamway (op. cit.) and Hubbard, op. cit.). Tables 7.24 and 7.25, highlight these percentages for the micro and macro methods, respectively. A number of points can be made about these results. First, the differences in the estimated level of costs between the micro and the macro methods are reflected in the generally lower proportion of final income spent on agricultural support under the micro method. Second, despite this difference, both methods show similar trends over the period. Throughout the period there has been a downward trend in the proportion of final income that is accounted for by support. In the case of the macro method this fall is a result of a decline in the proportion of final income spent on food, whilst for the micro method the fall is in part due to the major decline in the estimated consumer costs. Within years, the costs of agricultural support are a significantly higher proportion of final income for the low income households. This highlights the regressive nature of the CAP.

Table 7.24 Percentage of Final Income Spent on Agricultural Support 1977 to 1986 (Micro Approach)

Year	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Average
1977	6.3	5.4	4.9	3.6	3.3	3.6
1980	4.0	3.6	2.9	2.5	1.8	2.5
1984	3.2	3.8	2.8	2.2	1.5	2.2
1986	2.5	2.7	2.0	1.6	1.2	1.8

Table 7.25 Percentage of Final Income Spent on Agricultural Support 1977 to 1986 (Macro Approach)

Year	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Average
1977	5.8	4.9	4.6	3.5	2.9	4.3
1980	5.1	4.7	3.9	3.3	2.7	3.9
1984	4.7	5.1	3.9	3.4	2.7	4.0
1986	4.5	4.6	3.8	3.1	2.4	3.7

The distributional impact of support for agriculture can be best quantified by the use of Gini coefficients. It should be noted that when looking at the distribution of costs, that a change in interpretation of the Gini must be undertaken. When analysing the distribution of support, if the Gini coefficient was larger than that found for the distribution of income then it could be stated that the support was increasing income inequality. If the Gini coefficient for support was lower, then the policy was reducing inequality. In the case of the distribution of costs, if the Gini is higher than that for the distribution of income, then the costs are more unequally distributed and this has the effect of reducing income inequality. If the Gini is lower, the costs are borne more equally than income is distributed, indicating an increase in the level of inequality. These situations are summarised in Table 7.26.

Table 7.26 Interpretation of Gini Coefficients

Income	Support	Effect
0.5	0.7	Increase in the level of inequality
0.5	0.5	No change in the level of inequality
0.5	0.3	Reduction in the level of inequality

Income	Costs	Effect
0.5	0.7	Reduction in the level of inequality
0.5	0.5	No change in the level of inequality
0.5	0.3	Increase in the level of inequality

Table 7.27 and Figures 7.10 and 7.11 reproduce the calculated Gini coefficients for income, taxes and costs for the selected years 1972 to 1986,[43] under both the micro and macro approaches.

Table 7.27 Gini Coefficients for the Distribution of Income, Taxes and the Consumer Costs of Agricultural Policy 1972 to 1986

	Year				
Distribution	1972	1977	1980	1984	1986
Income[1]	0.36	0.32	0.33	0.34	0.36
Taxes[2]	0.41	0.36	0.35	0.39	0.40
Food Tax (Micro)	N/A[3]	0.18	0.16	0.14	0.13
Food Tax (Macro)	N/A[3]	0.19	0.20	0.20	0.21
Total Costs (Micro)	0.41	0.18	0.19	0.18	0.19
Total Costs (Macro)	0.41	0.20	0.22	0.23	0.24

1)Income is after Government payments but before tax.
2)Taxes includes both direct and indirect taxes
3) N/A = not applicable
Source of Income and Tax Data: Social Trends (annual)

43 The figures for 1972 are slightly different than those for the other years. The 1972 figures are calculated on the basis of 12 income classes rather five. This is due to changes made to the Social Trends publication. Unlike 1977,where it was possible to combine the deciles into quintiles, the incomes were grouped according to actual income and not by percentages. The numbers in each group were not given so it was not possible to group them. The effect this would have on the measurement of the Gini is shown in Benson (1970), namely that an increase in the number of cells is likely to reduce the level of inequality. However, it is likely that the change will be marginal and for the purpose of comparison, it is advantageous to include the figures for 1972.

Figure 7.10 Gini Coefficients for the Distribution of Total Costs and of Income, 1972 to 1986

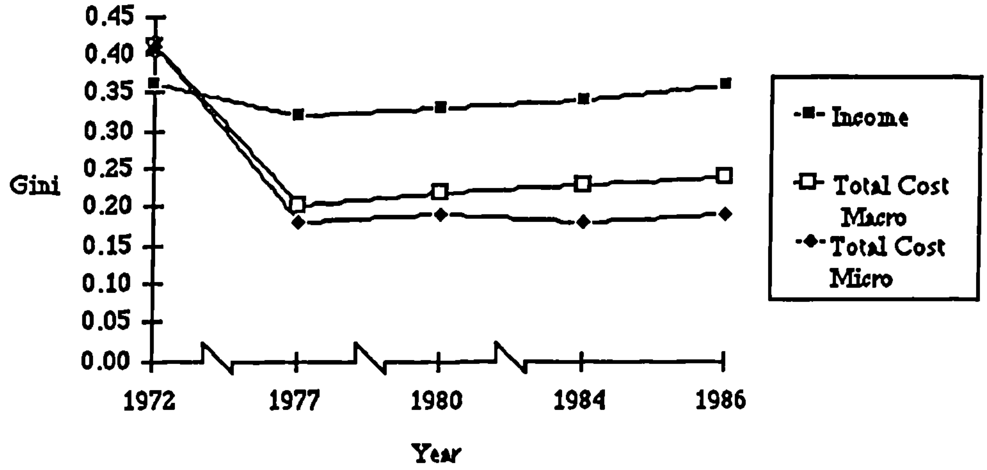


Figure 7.11 Gini Coefficients for Food Tax and Tax Costs 1977 to 1986

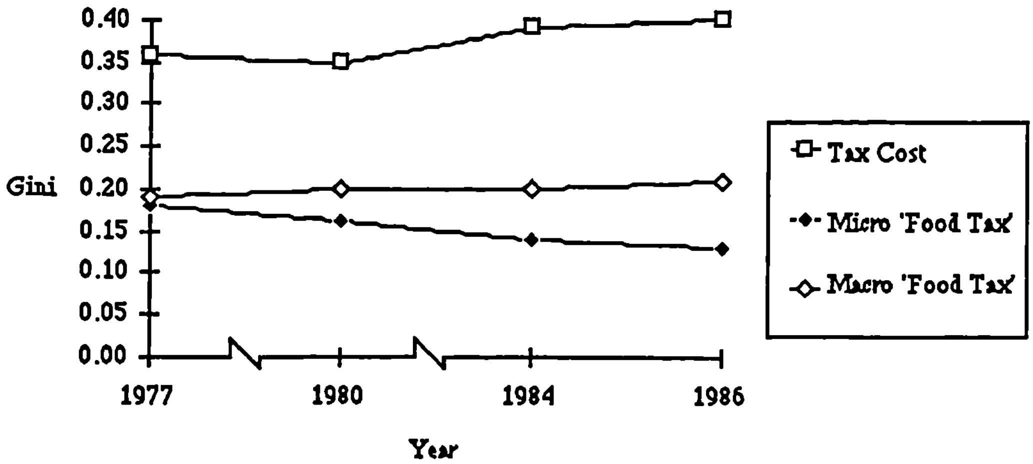


Table 7.27 illustrates a number of points about the distributional aspects of the CAP and also about the distribution of income and taxes. The distribution of income has remained fairly constant throughout the period (the Gini varies between 0.36 and 0.32). The level of Gini is fairly low indicating a relatively even distribution of income. The Gini coefficient for taxes is consistently higher than that for gross income, indicating that tax payments are more unequally distributed than income, highlighting the progressive nature of the UK's tax system.

For comparison, the Gini coefficients for the micro method were calculated using the taxpayer costs shown in Table 7.18. The method by which these costs are allocated ensures that the distribution of taxpayer costs will be the same as those shown in Table 7.27. However, the distribution of total costs alters slightly in some years because of the difference in the weighting of the unequally distributed taxpayer cost to the equally distributed consumer cost. In 1977, 1980 and 1984 the Gini coefficient is 0.19 rising to 0.21 in 1986. Although the absolute level of costs vary considerably using the two methods, the change in the distribution of costs is minimal.

Differences in the absolute level of consumer costs as measured by the micro and macro methods lead to differences in the Gini coefficients for the distribution of these costs (Table 7.27). The distribution of consumer costs estimated using the micro method has become more equal over the period. The fall in the Gini coefficient, from 0.18 to 0.13, can, in part, be attributed to changes in the level of consumer costs borne by low and high income earners as shown in Table 7.28. The level of costs to the lowest income households has fluctuated, but has shown no obvious downward trend. However, this is not the case for the highest income earners whose average consumer costs have declined steadily. Thus, the absolute difference between the lowest and highest income earners has narrowed from £185 to £123. As a consequence, the distribution of costs as measured by the Gini has become more equal.

Table 7.28 The Consumer 'Food Tax' of the Lowest and Highest Income Earners 1977 to 1986 (Micro Approach, nominal prices)

Year	Income		Difference
	1st Quintile	5th Quintile	
	£	£	£
1977	104.32	289.13	184.81
1980	92.56	245.04	152.48
1984	108.53	262.71	154.18
1986	99.20	222.42	123.22

The same is not true for consumer costs as measured by the macro approach. The Gini coefficient has shown a slight increase from 0.19 to 0.21. This has occurred because the costs to the highest income earners have been rising faster than those on low incomes (Table 7.29).

Table 7.29 The Consumer 'Food Tax' of the Lowest and Highest Income Earners, 1977 to 1986 (Macro Approach, nominal prices)

Year	1st Quintile	Income 5th Quintile	Difference
		Cost (£)	
1977	83.84	256.89	173.05
1980	101.39	333.57	232.18
1984	145.19	460.85	315.66
1986	145.76	489.3	343.54

The above table indicates that even though the cost to an average low income household has been rising, the difference between the two groups has risen (accounting for the increase in the Gini coefficient).

In 1972 (before the UK's membership of the EC) the cost of agricultural support was borne entirely by the taxpayer. This meant that the cost of agricultural support was more unevenly distributed than income. The low income household's share of total income was greater than their share of the costs of agricultural support (reflected in a Gini for the distribution of total costs of 0.41 compared to a figure of 0.36 for income). However, as the figures for 1977 show, after joining the EC, the distribution of total costs, whether measured by the micro or macro method, became more evenly spread (the Gini coefficient being approximately halved). Costs are now more evenly distributed than income, which will have led, *ceterus paribus*, to a greater inequality of income.distribution in society. The Gini coefficient for total costs, as measured by the micro method, fluctuates little during the period (aside from the drop in the Gini coefficient from the pre EC year to the post EC years), and is consistently below that derived from the macro approach. The macro approach shows a rising Gini coefficient, indicating a more unequal distribution of total costs and therefore a more even distribution of income.

If the differences in the level of costs associated with using the micro and macro approaches had not been reflected in different distributions, then it could be reasoned that the differences in methodology would not seriously alter the conclusions drawn about the distributional effects of the CAP. However, the two methods do indicate contrasting patterns. The suggestion that the micro approach may lead to an under-estimation of the costs borne by high income earners (due to it not accounting for food eaten outside the home) and the fact that the macro approach may upwardly bias the amount high income earners pay (because it takes no account of quantity eaten) suggests that the actual costs and their distribution lies somewhere between the two sets of figures. If this is the case, then the conclusion may be drawn that the results found in this section indicate upper and lower bounds of the likely distribution of costs. As both sets of figures indicate a more even distribution of costs than of income, the regressive nature of the CAP is confirmed.

The question remains as to whether the system of payment has become more regressive through the period or not. The micro results indicate little change, whilst the macro findings indicate a slightly progressive trend. However, whichever method is used, the costs are more evenly distributed than income, indicating that the CAP still leads to a worsening of the relative position of the low income households.

7.7 Sensitivity Analysis

This chapter has been based on a number of assumptions. First, the assumption was made that any increase in the price paid to producers would lead to an equivalent increase in consumer prices. Second, assumptions have been made as to the level of world prices for agricultural products. Analysis of the effect of changing these assumptions was undertaken and is reported fully in Appendix 7.III. The conclusions from this analysis are:

1) Changing the relationship between producer and consumer price significantly alters the estimated *level* of costs, but has little effect on their *distribution*.
2) Changing the assumed level of world prices significantly alters the estimated *level* of costs, but not the *distribution*.
3) The above findings suggest that the results in this chapter are insensitive to changes in the basic assumptions and therefore can be accepted with a degree of confidence.

7.8 Conclusions

This chapter set out to build a framework by which the overall consumer and taxpayer costs of agricultural support could be measured so that analysis could be undertaken of the distribution of these costs (both within years and over the period as a whole). Estimation of the consumer costs was undertaken using two methods. The micro approach involved the use of data that only accounted for food eaten inside the home, leading to an under-estimation of the level of costs and also a probable bias in their distribution. The macro approach was based on the level of expenditure rather than consumption, therefore the cost of support was likely to have been exaggerated for those who ate better quality (more expensive) foods. In turn this would have led to a probable bias in the distribution of the costs. Use of the micro and macro methods led to wide variations in the results and it can be concluded that problems with the available data was partly the cause.

It is felt, that despite its weaknesses, more weight should be placed on the findings from the macro approach. This is because it does account for all food consumed within the UK and the data sources are more reliable than the NFS.[44] The macro method has

[44] It will be remembered that the question of the reliability of the data was raised by Frank *et al* (op. cit.).

shown that the real level of costs has not varied significantly over the period, and that if anything, the total costs have become distributed slightly more progressively.

Appendix 7.I The Macro Approach to estimating Consumer costs at each Income Quintile

The total expenditure on food in the UK in 1977 was £16,057 million. Using the methods described in Chapter 7 consumer cost for this year was estimated at £2,832.8 million. Therefore it can be argued that without support, total food expenditure would have been £16,057m - £2,832.8m = £13,224.2m, or put another way, the cost of agricultural support represents 17.6% of total food expenditure.

The average expenditure per household on food at each income quintile is given in the first row of Table A7.1. From the earlier calculations it is assumed that 17.6% of this expenditure is due to the operation of the CAP. The cost of the CAP is therefore 17.6%e of the average food expenditure of each quintile.

Table A7.1 Calculation of Cost of CAP by Quintile (1977)

	Income Quintile				
	1st	2nd	3rd	4th	5th
Expenditure on Food (£)	475.23	756.08	947.96	1096.68	1456.14
Cost of Cap (%)	17.6	17.6	17.6	17.6	17.6
Cost of CAP (£)	83.84	133.39	167.24	193.48	256.89

Source FES and Authors Estimates

Appendix 7.II Tables A7.2 to A7.4

Table A7.2 The Percentage Of Total Costs Borne by Households at Different Income Levels (1980 Micro Approach)

	Income	Quintile				Total
Percentage of-	1st	2nd	3rd	4th	5th	
Taxpayer Costs	3.94	10.32	18.55	25.57	41.62	100
Consumer Costs	10.26	16.91	21.15	24.53	27.15	100
Total Costs	9.48	15.93	20.74	24.64	29.21	100
Total Income	5.86	11.04	17.81	24.63	40.66	100

Table A7.3 The Percentage Of Total Costs Borne by Households at Different Income Levels (1984 Micro Approach)

	Income	Quintile				Total
Percentage of-	1st	2nd	3rd	4th	5th	
Taxpayer Costs	3.95	8.58	17.21	25.84	44.42	100
Consumer Costs	10.62	18.43	21.94	23.30	25.71	100
Total Costs	9.57	16.87	21.20	23.70	28.67	100
Total Income	6.65	10.01	16.95	24.64	41.75	100

Table A7.4 The Percentage Of Total Costs Borne by Households at Different Income Levels (1986 Micro Approach)

	Income	Quintile				Total
Percentage of-	1st	2nd	3rd	4th	5th	
Taxpayer Costs	3.92	8.43	16.99	26.05	44.61	100
Consumer Costs	11.62	18.81	21.09	22.42	26.06	100
Total Costs	9.79	16.34	20.12	23.28	30.47	100
Total Income	6.05	9.55	16.05	24.31	44.04	100

Appendix 7.III Sensitivity Analysis

A7.1 Introduction

This appendix reports some sensitivity analysis on the results found in Chapter 7. In addition, the relationship between producer and consumer prices is examined to assess the validity of the commonly made assumption that higher farm-gate prices are passed on to the consumer on a one-for-one basis. It is clear that the assumption of such a relationship is fundamental to the calculation of the cost to consumers of agricultural policies that increase farm-gate prices. The analysis will also take in to account the debate as to the levels of world prices that should be used.

A7.2 Relationship between Producer and Consumer Prices

This section attempts to examine the relationship between producer and consumer prices for a number of agricultural commodities. In so doing it aims to ascertain whether the assumption of a one-for-one relationship between changes in farm-gate and retail prices is valid (i.e. where an x pence rise in producer price is passed on as an x pence rise in consumer price). Of major concern is whether alterations to the assumed relationship change the levels of inequality associated with costs of support, as estimated in Chapter 7.

It is reasonable to postulate the existence of three possible scenarios. The one-for-one increase, as assumed in Chapter 7 and by other authors, has already been considered. An alternative scenario is promoted by Ritson (op. cit, p 124) who reasons that :

> " It is also not certain that the marketing margin (the gap between retail and wholesale prices) will not be independent of the wholesale price so that the whole cost of higher wholesale prices will be borne by consumers."

His argument, therefore, is that part of the increase in farm gate prices will be absorbed in the marketing chain and will not be passed on to consumers. This argument is unconvincing, because the marketing of farm products, to a large extent, takes place within a competitive industry. Therefore, it is reasonable to assume that each link in the marketing chain will be operating at minimum margins. Any increase in the farm price, if not passed on to the consumers, will make the business (transport, processing, butchery...etc.) unviable. It is unlikely that operators in a competitive industry can withstand sustained reductions in their margins. This argument, suggests that any price change will be passed through the marketing chain to the consumer on at least a one-for-one basis.

Another possible alternative is that an increase in producer prices will lead to a greater than one-for-one increase in the retail price. This scenario is possible if firms within the sector work, for example, on a percentage mark up, rather than on a fixed margin.

The next section by using data on the level of producer and consumer prices over a period of time, will attempt to identify a relationship between the two. This will help establish which of the scenarios best fits the data.

A7.2.1 Regression Analysis of Consumer Prices on Producer Prices.

In order to examine the relationship between consumer and producer prices an analysis was undertaken using price data on a selected number of food items. The food types were selected to represent varying degrees of processing, from carcase meat to biscuits. Annual data for 1972 to 1986 on prices paid by the consumer were obtained from the NFS. Prices paid to producers are reported in the Annual White Paper on Agriculture.[45] Where possible, the prices paid by consumers and those received by producers were expressed in the same units, e.g. pence per kilogram (although this was

[45]The only exception is for liquid milk, where prices to the producer and the consumer are obtained from the MMB's Dairy Facts and Figures (various years).

not possible for some products, such as bread). The price levels were deflated to a common base year (1977) to eliminate the effect of inflationary trends. Table A7.5 lists the chosen products.

Table A7.5 Food Items chosen for Regression Analysis

Producer Product	Consumer Product
Beef	Beef
Pigmeat	Cooked Ham
Sugar Beet	Sugar
Milk	Liquid Milk
	Cheese
Milling Wheat	Bread
	Biscuits

Simple regressions were undertaken between the retail and farm-gate prices to establish whether any easily identifiable relationship emerged. The price of bread was regressed on the price of wheat, the price of sugar on sugar beet, the price of cooked ham on pigmeat etc. Estimation took the form of:

$$P_c = \alpha + \beta P_p + \mu$$

Where P_c and P_p are prices paid by consumers and received by producers, respectively and μ is an error term with the normal classical properties.

The results for these regressions are reproduced in Table A7.6

Table A7.6: Estimation of Relationship between Producer and Consumer Prices

Regression	R^2	α	β
Cooked Ham on Pigmeat	0.39	70.72 (1.13)	2.64 (2.87)
Sugar on Sugar Beet	0.04	9.65 (2.2)	0.16 (0.7)
Beef Carcase on Beef	0.24	85.29 (1.4)	2.07 (2.1)
Cheese on Milk	0.07	3.28 (2.69)	0.53 (0.99)
Biscuits on Wheat	0.04	95.52 (9.58)	0.08 (0.71)
Bread on Wheat	0.003	111.12 (8.56)	-0.08 (-0.19)
Liquid Milk on Milk	0.92	7.25 (6.12)	1.16 (9.57)

t-statistics in brackets
sample size=15

The overall results are poor, with low R^2 and very few of the coefficients are significant.[46] There are only three cases where the β coefficient is significant; these are liquid milk with milk, cooked ham with pigmeat and beef with beef carcase. These results will be analysed in more detail. The regression for cooked ham on pigmeat, has a fairly low R^2 of 0.39 but a significant β coefficient. The results suggest that the relationship between producer and consumer price is such that a 10 pence per unit increase in the former will lead to a 26.4 pence rise in the latter. Clearly, this is considerably larger than the one-for-one relationship assumed before. Similarly, the results for beef indicate that the relationship is very different from the one-for-one

[46]On examination of the data it was decided that a log regression may be more suitable. The equations, therefore, were re-estimated in both single and double-log forms. The fits were not noticeably improved and the results are not presented here.

assumption. A 10 pence rise in the producer price for carcase beef will lead to a 20.7 pence increase in the consumer price of beef. The R^2 of 0.24 is lower than that for that for pigmeat and the β coefficient is only just significant. Milk has a much better fit than either ham or beef. The R^2 is 0.92 and the β coefficient is highly significant. This result indicates a much closer one-for-one relationship, with a 10 pence per unit rise in the producer price leading to an 11.6 pence increase in consumer price.

The results from the analysis are not strong enough to support any of the three possible alternatives and consequently cannot be used to argue categorically the effect of price changes. There are a number of possible explanations as to why the results are not strong. First, the data used was highly aggregated (one figure was taken for consumer price and one for producer price for each year). Second, the analysis makes no allowance for possible changes in the marketing margin over time.

An indication of the problems of measuring the relationship between producer and consumer prices is given by Digby (1989). Using Meat and Livestock Commission (MLC) data he calculates the price spreads for a number of meats. His results for beef are reproduced in Table A7.7.

Table A7.7 Beef Price Spreads 1978 to 1987

Year	Producer Price (p/lb)	Consumer Price (p/lb)	Margin (p/lb)	Margin (%)
1978	56.7	74.8	18.1	24.1
1979	65.2	85.2	20.0	23.5
1980	65.9	95.5	29.6	31.1
1981	76.3	108.2	31.9	29.6
1982	83.9	122.9	39.0	31.9
1983	81.6	123.6	42.0	34.1
1984	81.6	125.7	44.1	35.3
1985	80.7	126.1	45.4	36.0
1986	80.7	128.5	47.8	37.2
1987	82.0	130.4	48.4	37.1

Source:Digby (1989)

Digby's analysis shows a large steady increase in both the absolute and percentage margin over the ten year period. The absolute margin rises from 18p/lb to 48p/lb, whilst as a percentage of the retail price it increases from 24 to 37. It is this change in marketing margin that is likely to cause difficulty in assessing how changes in producer price effects the consumer price.[47]

It is evident that the relationship between producer and consumer prices and the working of the marketing chain is less than straightforward. The simple analysis of changes in the relative prices has not shown any consistent pattern. However, as the purpose of this section is essentially comparative, it was decided that, despite the poor fits, it would be of interest to analyse the effect on the level and distribution of consumer costs of altering the assumed relationship.

A7.2.2 Altering the Producer-Consumer Price Relationship

In order to assess the sensitivity of the results to changes in the assumed relationship, a number of changes were made. The significant relationships between producer and consumer prices identified in the regression analysis were used to re-estimate the costs to consumers. This meant that for beef, cooked ham and milk, the rise in producer prices was reflected in a rise of consumer prices in ratios of 1:2.64, 1:2.07 and 1:1.1, respectively. Furthermore, the assumption was made that the beef relationship holds for all carcase meat.[48] For the food products for which the regressions failed to indicate a significant relationship the one-for-one assumption was retained. These changed assumptions mean that the cost to the consumer will be higher than that previously calculated. The estimation was undertaken for 1977, using the micro approach with the new price levels.

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47 In the regression analysis of the relationship between producer and consumer beef prices, a time trend was added to allow for the increase in margin. However, it did not significantly improve the fit.
48 This is a reasonable assumption as all carcase meat undergoes similar processes, in terms of slaughter and marketing.

Table A7.8 reports results concentrate on the level and distribution of costs using the different assumptions.

Table A7.8 Consumer Costs (micro approach) 1977

(£)

Estimate	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Average
Original	104	161.5	197	219	289	194
New	154.9	235	288	321	446	289
Difference	50.9	73.5	91	102	157	95
% Difference	48.9	45.5	46.2	46.6	54.3	49.0

Table A7.8 confirms that the assumption of a greater than equal change in prices for some food has led to a marked increase in estimated costs (i.e. the food tax). This increase is not uniform between income quintiles, because of different consumption patterns (highlighted in the previous chapter). The second quintile has a rise of 45% in estimated costs, but for the highest income earners the increase is over 54%. The change in estimated costs can also be represented as a percentage of the total income of households (Table A7.9).

Table A7.9 Percentage of Final Income Spent on Agricultural Support (Micro Approach) 1977

Estimate	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Average
Original	7.16	5.84	5.36	3.93	3.26	4.24
New	10.59	8.44	7.74	5.66	4.92	6.22

From Table A7.9 it can be seen that the effect has been to widen the gap between the low and high income earners. With a one-for-one assumption the total cost of agricultural support accounted for 7% of the final income of the lowest income households, and just over 3% of the highest income households. However, under the alternative assumption there is twice the percentage point rise to low income earners as to the high income households, and thus a widening has occurred in the proportion of final income accounted for by agricultural support, between low and high income earners.

The above results show that the different estimation procedures lead to different levels of costs. However, as it is the *distribution* of costs that is of primary concern, Table A7.10 reports the Gini coefficients for consumer and total costs under the original and new assumptions.

Table A7.10 Gini Coefficients

Estimation	Consumer Costs	Total Costs
Original	0.184	0.170
New	0.180	0.165

The results of the calculation of the Gini coefficient show only small changes in the distribution of costs under the alternative assumptions. The Gini for consumer costs has fallen by 2% indicating a slightly more regressive (even) cost distribution. A similar pattern is reflected for total costs. The results suggest that changes in the assumed relationship between wholesale and retail prices may alter the actual level of costs, but not significantly the distribution of these costs.

Overall, the results suggest that the regressive nature of the CAP is not altered by changing the ratio of producer to consumer price levels. This analysis, although only undertaken for one year, infers that the results found in Chapter 7, concerning the level of inequality associated with the cost of agricultural support, are not particularly sensitive to changes in the basic price assumption. The next sections examine whether the results are significantly affected by differing world prices.

A7.3 Changing the level of World Prices

In Chapter 7 the world price levels used were from a single source (the Newcastle CAP model data base) and were not adjusted to allow for any possible effects from changes in agricultural policy. The second part of this sensitivity analysis assesses the distributional effects of changing the base (that is the level of world prices) from which the costs are estimated. It is evident that different world prices will alter the absolute level of estimated costs. However, of more importance to this study is whether these changes lead to significant alterations in the distribution (as measured by the Gini coefficient) of these costs.

Harvey and Hall (1988) reported a number of different world price levels for 1986, and the ones selected for comparison are reproduced in Table A7.11.

Table A7.11 EC and Selected World Price Estimates for 1986

Commodity	E.C Support Price	Newcastle CAP	Newcastle Free Trade	O.E.C.D
		ECU/Tonne		
Common Wheat	182	89	136	155
Durum Wheat	333	139	224	149
Barley	169	76	138	83
Maize	195	62	160	73
Other Cereal	169	95	139	102
Sugar	325	190	218	210
Pigmeat	1516	1335	1452	1192
Poultry	1364	875	1079	965
Eggs	992	680	890	773
Beef and Veal	3087	2183	2622	1893
Sheep Meat	3949	1692	3396	2001
Liquid Milk	284	77	223	170
Butter	3178	1362	2227	1993
Skimmed Milk	1694	916	1479	1363
Cheese	3742	1683	2799	2860
Olive Oil	2693	1337	1635	1703

Source: Harvey and Hall (1989)

The first column in Table A7.11 presents intervention prices fixed by the EC for the relevant commodities. The other columns give estimates of the level of world prices.

The second column (Newcastle CAP) consists of the prices used in Chapter 7. The third column presents Harvey and Hall's estimates of price levels if agricultural protection was removed (world-wide) and a situation of free trade existed (These prices are directly derived from the United States Department of Agriculture's SWAPSIM model). Ritson (op. cit.) describes this situation: "Under this alternative less would be produced in Europe, more would be consumed and this would have the effect of raising world prices" (p 87). If there was no support in 1986, world prices would have been higher and therefore the cost of support would have been lower. The increase in assumed world prices varies between commodities. The final column reproduces OECD estimates of current prices in 1986. The difference between the prices used in Chapter 7 and those that arise after trade liberalisation are understandable given the fact that they are based on different assumptions. It is clear that the sets of prices vary widely and that these differences will be reflected in the estimated *level* of costs.

The initial comparison was undertaken using the methodology of the macro approach, substituting in the new estimates of world price. The results for all three sets of prices are reproduced in Table A7.12.

Table A7.12 Estimated Costs under Different World Price Assumptions (1986)

Assumption	Consumer Cost	Taxpayer Cost	Total Cost
		£m	
Original	5,576	1,508	7,084
O.E.C.D	5,112	1,508	6,620
Free Trade	2,306	1,508	3,814

Figures rounded to nearest million

As expected, the results indicate differences in the estimated level of both consumer and total costs. With the assumption of free trade there is a large reduction in consumer costs. The OECD prices yield consumer costs that are slightly lower than those originally estimated. These changes lead to slightly lower total costs under OECD price levels and much lower total costs with the free trade estimates. As with the original analysis these new consumer estimates can be expressed as a percentage of total food expenditure (Table A7.13).

Table A7.13 Estimated Food Tax with Different World Prices

Assumption	Consumer Cost	Food Expenditure	Food Tax
		£m	%
Original	5,576	33,059	16.9
O.E.C.D	5,112	33,059	15.5
Free Trade	2,306	33,059	7.0

The differences in consumer costs lead to large differences in the 'Food Tax', from 7% with trade liberalisation to 17% with the original price levels. This highlights the large variation that can occur in the measurement of the level of costs of agricultural policies depending on the choice of world prices.

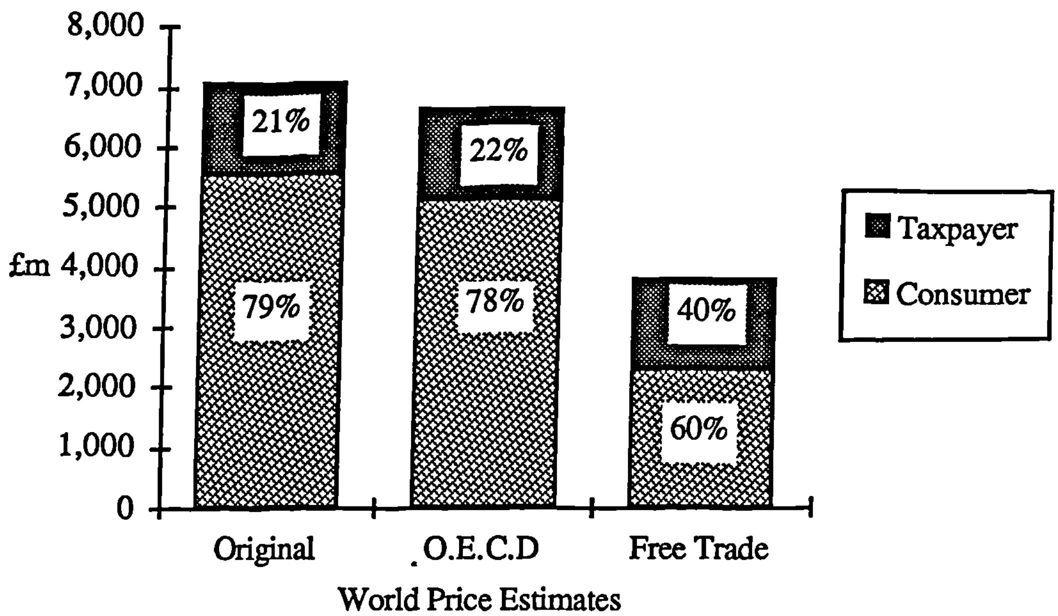
Having examined differences in the level of costs, Table A7.14 shows the distribution of costs under the varying sets of prices. The table highlights the distribution of costs under the micro as well as the macro approaches.

Table A7.14 Gini Coefficients for the Distribution of Costs

Distribution	Original	O.E.C.D	Free Trade
Income	0.36	0.36	0.36
Tax Costs	0.40	0.40	0.40
Consumer Costs (Micro)	0.13	0.13	0.13
Consumer Costs (Macro)	0.21	0.21	0.21
Total Costs (Micro)	0.19	0.19	0.24
Total Costs (Macro)	0.24	0.24	0.27

A number of points can be made about Table A7.14. The change in world prices appears to have no effect on the distribution of consumer costs as measured by the micro and macro methods. Under the macro approach, costs are distributed according to expenditure on food. So a 20% food tax will be distributed in the same way as a 10% tax. The micro approach is not forced to follow the same distribution, yet the Gini does not alter. The results indicate that, although the distributions of consumer and taxpayer costs remain the same, the distribution of total cost varies with the free trade price estimates. This apparent anomaly is a result of changes in the composition of total costs. Taxpayer costs are distributed more unevenly than consumer costs. Therefore if the proportions (weightings) of taxpayer and consumer costs alter, then so will the value of the Gini coefficient for total costs. Using the OECD price levels, the more evenly distributed consumer costs decrease relative to taxpayer costs but only slightly, and there is no change in the Gini coefficient. However, using the free trade price levels, with the more unevenly distributed taxpayer costs becoming a greater proportion of total costs the Gini coefficient alters significantly. Figure A7.1 highlights the differences in both the level and composition of costs.

Figure A7.1 Level and Percentage Composition of Costs under Varying World Price Assumptions



The sensitivity analysis using different world price levels has produced a number of interesting results. With both a small and large decrease in the estimated level of consumer costs the distribution of these costs, using the micro method remained the same. (It has already been noted that the macro method ensures that the distribution will be the same). These findings indicate that the results discussed in Chapter 7 hold with different sets of world price levels. The regressive nature of payment by the consumer for agricultural support is not increased or diminished by higher world price estimates. However the level of world prices does effect the distribution of *total* costs. These changes, as already reported, are a result of the composition of total costs, with a reduction in consumer costs relative to taxpayer costs resulting in a more progressive system of payment and *vice versa.* Nevertheless, the large fall in consumer costs under the relatively high estimates of world prices (free trade), results in a small change in the Gini coefficient for total costs. This infers that the results are insensitive to the actual base from which the costs are measured.

A7.5 Conclusions

The sensitivity of the results from estimation of consumer and taxpayer costs detailed in Chapter 7 has been assessed. Two of the basic assumptions were altered, cost re-estimated and new Gini coefficients calculated. The results indicate that the distributions of cost were not significantly altered. This promotes a degree of optimism as to the validity of the original results.

The use of the macro method for comparative purposes may be criticised to a certain extent because it ensures that a consumer cost of £2,000 million is distributed the same as a cost of £7,000 million. This is due to the fact that the costs are expressed as proportions of total food expenditure. The only effect of altering world price levels is to change the composition of, and the distribution, of total costs. Therefore, if the methodology of the macro method is accepted, it can be reasoned that the distribution obtained relates to any level of prices and adequately represents the inequality associated with the costs of agricultural support. However, it is necessary to note that the analysis using the micro method (for measuring the change in costs associated with altering the assumed producer-consumer price relationship) also showed little change in the distribution of the costs.

Chapter 8 Conclusions

This study set out to assess the effect on income inequality of the distribution of the costs and benefits of agricultural support. Each chapter has analysed separate issues and conclusions have been drawn throughout. The purpose of this final chapter is to draw on the findings that appear most relevant.

Initially, some general concepts involved in such a task were examined. The discussion highlighted that a number of definitions and assumptions must be made before an examination of inequality of any kind can be undertaken. For the purpose of the study of agricultural income distribution the following general definitions were made: the measurement of 'well-being' was *income* (as defined by Cowell, op.cit.); the income unit was the *farm business*; and the distribution analysed was the *size distribution of incomes*. In the case of assessing the income effects of the costs of agricultural policy, the definition used was the *household*, and the income was that generated by the household.

The review of previous work on the subject of income inequality in agriculture assessed how researchers had addressed the general concepts involved. The review highlighted differences in the methods used which seemed to be partly a result of differing aims and also partly a result of subjective judgements. In particular, the studies diverged over the definition of farm income, the measurement of the level of support, the appropriation of this support between farms, and the measurement of inequality.

A clear split between different sides of the Atlantic emerged. The more comprehensive income definitions (those incorporating income other than from farming) were almost exclusively found in the work undertaken in America. Methods by which the estimated levels of support and income were disaggregated between farms varied. Much of the American work used data which grouped farms into sales classes. Evidence suggests that grouping farms by sales class does not allow for an accurate representation of whether it is the high or low income farmers that receive most of the benefits. The use of SMD's as a method of grouping farms, or any measure that relates to farm size, is likely to lead to similar problems to those associated with sales classes. Farm size, although known to be correlated to a certain extent with income, does not necessarily reflect the *distribution* of income. If some assessment of the effect of support policies on income distribution is required then farms should be analysed in terms of income classes and not farm size.

The inequality measure used in the the majority of the literature was the Gini coefficient, with (in most cases) no justification for choosing this over any of the other possible inequality measures. Gregory (op. cit.) (and to a lesser extent Josling and Hamway, op.cit.) discussed the use of the Gini, and concluded that it was the best measure available. Others either made no attempt to quantify the degree of inequality, or used the Gini, with no explanation of the methodology.

A significant part of the study followed the line of research undertaken by Gregory (op. cit.) and critically assessed the possible measures of inequality available to the researcher. The results of the examination suggested that there is no single measure which is universally acceptable. A number of possible inequality measures satisfied given criteria but the choice between them became subjective. Each measure had certain advantages and disadvantages which, depending on individuals' preferences, either justified or precluded its use. However, for this research, the Gini coefficient and Atkinson's Index were selected as the most appropriate measures available. The possible use of a specific functional form as a method for simplifying the problems associated with measuring inequality was discussed. The lognormal was shown to have a sound theoretical background, a number of convenient properties and to fit data sets in a considerable number of cases.

The choice of inequality measure was just one issue arising from the review of literature, others were analysed in Chapter 4. Farm Business Survey data sets were used to measure the levels of income inequality within agriculture in the North of England. Initially, the FBS data were shown to be inappropriately classified for the analysis of income distribution. Their reclassification highlighted the usefulness of cluster analysis for grouping agricultural data. Estimated level of inequality using the Gini and Atkinson's Index were compared. The results using the Gini coefficient and a *low* ε figure appeared promising. Although indicating differences in the cardinal level of inequality, the ordinal rankings of the distributions were very similar. With a low ε value the analysis appeared to be producing complete and non-conflicting results. However, on further investigation a number of problems became evident.

First, the use of differing ε values led to contradictions in the ordinal rankings of distributions. In particular, the ordinal ranking of distributions by the Gini coefficient and Atkinson's index began to diverge as the ε value increased. Second, because of the occurrence of negative incomes, the likelihood of cell bias was high in certain distributions. Third, by altering the definition of income, the cardinal and ordinal rankings changed, thus confusing the issue further. Fourth, changing the method by which farms were classified into size groups, led to conflicting results as to the relationship between the distribution of farm support and that of income.

After these findings, it could have been concluded that the whole process of measuring inequality was flawed, because the researcher could arrive at virtually any result, by altering the methods used. This raised the question of the best method by which to tackle further analysis. The research turned to the use of functional forms and the advantages of specifying the form of the distribution. In particular, one advantage was that specifying the lognormal ensured different inequality measures would no longer conflict.[49] Also, because the distribution was approximated the need for grouping into cells and the subsequent classification problems were removed. Therefore, use of the lognormal became the most practical way around the problems found with conventional analysis.

The only income data available for the length of time required for the study were related to dairy farms. Due to the negative incomes in the sample, a proxy for income (NVA) was used. Support and NVA were found to be lognormally distributed, and this facilitated calculation of the Gini coefficients. However it must be emphasised that the lognormal is only an approximation and is not likely to fit all data sets.

On a national basis quintile analysis was undertaken. The percentage of total support and NVA going to farms ranked by income quintiles was calculated. In one sense the quintile analysis showed the unequal nature of price support, the top 20% of farmers receiving between 40 and 50% of support over the period. However it also showed that, for this quintile, the proportion of total support received was *less* than the proportion of total income.

Gini coefficients were used to quantify the levels of inequality associated with the national distribution. The results on a national level, showed remarkably little change in the distribution of both support and income, considering the changes in policy that had occurred. Support was consistently more evenly distributed than income, suggesting that if support was removed income would become even more unequally distributed.

[49] It was noted in the text that because inequality measures would no longer conflict the need for two different measures was nullified. The Gini was retained because of greater ease of interpretation, whilst Atkinson's index was discarded.

Regional analysis highlighted that the national results obscured variations between regions and temporal changes. The regional analysis also showed that there was little change in the relative positions of the regions over the years, in terms of their share of support and income. Both the regional and national results indicated no significant trends in the level of income inequality. It was argued that this 'stability' in inequality might be a result of the effects of agricultural policy. Of course, this premise is difficult to substantiate, because it is not known how the structure would have changed in the absence of agricultural support. The regional analysis highlighted that as price support gave to producers in accordance with their production, some regions received substantially more than their share of producers whilst others received notably less. The average amount received per farm varied by up to £30,000 in any one year between regions. The relative position of smaller farmers had not deteriorated due to the operation of price support, because over the 15 year period the dairy sector showed little change in inequality.

It was clear little had changed in terms of levels of inequality despite the changes in policy. A policy alternative (the Producer Entitlement Guarantee) which could improve the relative position of the smaller farms was examined purely in terms of its impact on distribution of income and support. Two methods of implementation were considered. PEG1 considered a reduction in the total level of support, whilst PEG2 maintained the total level of support. The distribution of support between farms became markedly more equitable as the restriction on the amount of production eligible for support was tightened. However, under the scenario of maintaining total support, the fall in inequality was substantially higher than under the alternative. On a national basis, instigation of a PEG policy was shown to reduce the inequality associated with income distribution in dairy farming, *ceterus paribus*. At the regional level, large differences became evident as to the effect of the policy. Not surprisingly, the reduction in inequality within regions with small average herd sizes was less than in the regions with large average herd sizes. The use of inequality measures enables a quantification of the differences in the reduction of inequality. Under PEG2, with an entitlement level of 200,000 litres, 6 out of the 9 regions increased their level of total support. The PEG2 option led to a redistribution of income from the East, South East and South to the other regions (Wales in particular).

PEG2 resulted in a greater reduction of inequality and redistribution of income, because low income producers benefited absolutely as well as relatively. The more restrictive the PEG the more they benefited. However, of more interest is the large percentage of producers who benefit. The lowest three (four) quintiles all increased their share of support with a PEG of 200,000 litres (300,000 litres). Of course, as no extra support is injected, the increases to the lower quintiles have to come from the top quintile(s). It is questionable whether such a large transfer is possible without significant long-term effects. It must be remembered that NVA was considered, rather than NFI or MII. Therefore, although the PEG brought the quintiles to similar levels of NVA, when rents and labour are considered the top quintile are likely to be considerably worse off.

Having examined the distribution of the benefits of agricultural support to farmers, the natural progression was to examine the distribution of costs and how this affected income distribution. Initially a review was undertaken, which showed the scarcity of research on this topic. The aim was to build a framework by which the *absolute* consumer and taxpayer costs of agricultural support could be measured, so that analysis could be undertaken of the *distribution* of these costs (both within years and over the period as a whole). Estimation of consumer costs was undertaken using two methods referred to as the micro and macro methods. These methods led to wide variations in the results. The micro approach indicated that the distribution of consumer costs became more equally distributed during the period, with the Gini coefficient falling from 0.18 to 0.13. However, the macro approach showed a marginal increase in the Gini coefficient from 0.19 to 0.21. The contrasting results from the two methods were partly explained by limitations in the data. The micro approach did not account for food eaten outside of the home. As richer households are likely to consume more out of the home, then a larger proportion of their costs were ignored. The macro approach was based on the level of food expenditure. As richer households are likely to eat better quality foods their costs are likely to be exaggerated. Therefore the macro approach was likely to bias the costs towards high income households whilst the micro was likely to bias them towards low income households. The results of the micro and macro methods were stated as the possible extremes of the costs to the consumer.

The UK taxpayer costs were estimated as a proportion of the total EC tax bill. The proportion being based on the UK's share of production of each commodity. The level of taxpayer cost estimated by this method differed from that estimated using published data sources, but these differences had little effect on the distribution of the costs.

The move from national to EC agricultural policies led to a dramatic equalisation of the distribution of total costs, because the major burden of costs switched from just taxpayers to consumers and taxpayers. However, since this switch there has been very little change in the distribution of total costs. The consumer results differ from the producer, because the UK's accession to the EC and the adoption of the CAP appeared to have little effect on the distribution of support to farmers, but did have a great effect on the distribution of the costs. The regressive nature of agricultural support was highlighted, whichever of the two methods of calculating consumer costs was examined. The distribution of total costs was consistently more equal than the distribution of income. This meant that the costs were borne disproportionately by the low income households. Again, this result is not surprising, but inequality was quantified and also examined over a number of years.

The analysis of the distribution of the costs of agricultural policy was based on a number of assumptions. First, any increase in the price paid to producers was assumed to lead to an equivalent increase in consumer prices. Second, assumptions were made as to the level of world prices for agricultural products. A form of sensitivity analysis on the results to changes in these assumptions was undertaken, but results indicated that the distributions of cost were not significantly altered. This promoted a degree of optimism as to the validity of the original results.

At this juncture the logical step would appear to have been a comparison of the distribution of the costs and benefits between farmers and households at different income levels. This should have enabled an answer to the question "Does agricultural support lead to a transfer of income from the rich to the poor, from poor to poor, from poor to rich or even from rich to the rich?" However, the inherent weakness of the data on farm incomes effectively removes the possibility of valid assessment of the transfer effects. It is still possible to use the consumer and taxpayer results to assess the effects on the level and distribution of total household income of different policy options discussed in this study.

Table 8.1 Level of Household Income by Quintile and Change in Income under Various Policies (1986)[a]

Policy	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile	Gini
			£			
Existing Income	3,500	5,520	9,280	14,060	25,470	0.363
			Change			
Support Removed[b]	156	255	348	432	608	0.359
Support Removed[c]	71	119	170	219	321	0.362
PEG Policy[d]	84	111	24	-18	-202	0.358

a) Costs estimated using the macro method.
b) Assuming total costs estimated with no allowance made for possible changes in world prices.
c) Allowances made for possible changes in world prices.
d) Assuming existing level of costs but borne entirely by taxpayers.

The transfer from the existing policy to one of no support (with no change in level of world prices) increases the average income of a household in the lowest quintile by £156. Allowing for possible changes in the world price levels virtually halves the estimated benefit to low income households of the removal of support. If the same level of support was maintained but funded through the tax system the lowest quintile would still benefit. This contrasts with the position of the high income households. With the removal of support they would benefit to the extent of £600 (or £300 depending on method of calculating the costs). However if support was funded through the tax system only they would over £200 a year worse off. There is clearly a marked change in the absolute levels of income under the different policies. However, examination of the Gini coefficients puts the findings of Chapter 7 into perspective. Although the costs of support are not equally spread, removal of support (or transferring the costs from the consumer and taxpayer to just the taxpayer) would lead to an almost negligible change (under 0.01) in the Gini coefficient. It must be stressed that these comparisons are of a static nature. In the longer term, the benefit to the low income households may be negated because of changes in the cost of living. The income of the low income households is made up almost entirely of Government benefits. These payments are often index linked, that is they change with changes in the level of inflation. Inflation is measured by the Retail Price Index (RPI). Food items form a large proportion of the 'basket of goods' used to calculate the RPI. Therefore, changes in food prices will effect the rate of inflation and thus the level of benefits received. If the transmission from food prices to RPI and state benefits was perfect then it could be argued that policies which raised prices would have a neutral impact on the low income households, because their income (from benefits) would rise to offset the cost of higher food. However, the transmission is unlikely to be perfect and therefore it can be argued that the lowest income households would gain some benefit from the removal of price support.

The definition of income of farmers used for the main part of this study was simply NVA; thus other sources of income and family income were not considered. This was enforced by data availability. The main problem with the income definition was not that it prevented an examination of the distribution of income or support to farmers (NVA was found to adequately represent NFI in this case), but that it prevented an objective welfare assessment of the transfer from the consumers and taxpayers to the farmers. However, even if income data from all sources were available, it is not clear that this would be enough to conduct a 'welfare' analysis. It is difficult to judge the quality of life of a farmer just from income. A well-known saying states that "A tenant farmer lives rich and dies poor". How should you value the advantages (and disadvantages) of rural over urban life? Knowledge of all sources of income may not solve all the welfare problems, but in terms of assessing income transfer effects of agricultural policy it would be advantageous.

Another issue raised by this study was the acceptance of the validity of the use of inequality measures in general. In Chapter 5 it was noted that the concentration of support had increased (a similar level of total support was being received by fewer and fewer dairy farmers). This change was not 'picked up' by the inequality measures, because by definition they are invariant to the number of persons receiving support. Therefore, support has become concentrated in fewer and fewer individuals yet inequality has not changed. There is scope for the use of concentration measures to assess the distributional effect of agricultural policy and also changes in the structure of the industry in general.

Another weakness with the study is that the agricultural data did not include all farm types, so it is possible that the results are not representative for the agricultural sector as a whole. In order to conduct a more objective analysis, income data for all farm types and for all sources of income needs to be accumulated. The real transfers between the poor and the rich can then be measured and assessed.

In conclusion, this study has shown that agricultural policy has not increased the level of inequality within the dairy sector. Indeed it may have reduced the level of observed inequality since support has been shown to be more equally distributed than income. The way in which the costs are distributed only marginally increases inequality for society as a whole, and the accusation that agricultural policy is 'unfair', on the findings of this analysis, is difficult to prove.

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