

**THE COMMON AGRICULTURAL POLICY AND WHEAT AND BARLEY
ACREAGE RESPONSE IN THE UK UNDER THE CAP**

by

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TABLE OF CONTENTS

	Page
APPROVAL	ii
STATEMENT OF PERMISSION TO USE	iii
ACKNOWLEDGMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	x
ABSTRACT	xi
1. INTRODUCTION	1
PART ONE---HISTORY OF THE COMMON AGRICULTURAL POLICY OF THE EUROPEAN UNION	5
2. DEVELOPMENT OF THE COMMON AGRICULTURAL POLICY	6
History of Unification in Europe	6
EEC-Objectives and Institution	8
Agriculture and Common Agricultural Policy (CAP)	10
Cereal Policies: 1964-1995	13
European Community Common Denominator	16
Net Importer versus net Exporter	21
Financing the CAP	23
Reforming the CAP	25
1992 CAP Reform	31

TABLE OF CONTENTS (Continued)

	Page
3. THE UNITED KINGDOM AND THE EUROPEAN UNION	37
The UK Accession	37
The UK and the CAP	39
4. SUMMARY	43
PART TWO---WHEAT AND BARLEY ACREAGE SUPPLY RESPONSE IN THE UK UNDER THE CAP	46
5. LITERATURE REVIEW	47
6. THEORY	57
General Theoretical Concerns	57
Expectations about Future Conditions	60
The Influence of Risk in Decision Making Process	61
Government Programs	63
Wheat and Barley Acreage Response Models for the UK	64
Estimation Model	69
7. DATA	73
8. PRICE AND YIELD FORECAST MODELS	75
Price Expectations Models	75
Time Series Price Expectations Model	75
Structural Price Expectations Model	79
Naive Price Expectations	85
Summary	85
Yield Expectations Model	86
Measure of Uncertainty	88

TABLE OF CONTENTS (Continued)

	Page
9. WHEAT AND BARLEY ACREAGE RESPONSE ESTIMATION MODELS AND EMPIRICAL RESULTS	91
Econometric Method and Variable Definitions	92
The Comparison of Different Expected Price and Yield Variables.	95
The Wheat and Barley Acreage Response Models under Uncertainty	101
Developments in Wheat and Barley Yields and the CAP Prices	105
Summary of Empirical Results	112
10. CONCLUSION	114
REFERENCES CITED	118
APPENDICES	124
APPENDIX A--HISTORY OF THE EU AND THE CAP	125
APPENDIX B--WHEAT AND BARLEY ACREAGE, PRICES AND YIELDS	128
APPENDIX C--ARIMA FORECAST MODELS FOR WHEAT, BARLEY AND OATS	132
APPENDIX D--WHEAT AND BARLEY ACREAGE RESPONSE MODELS WITH SEPARATE PRICE AND YIELD VARIANCES	136

LIST OF TABLES

Table	Page
1. Farmers' Selling Price of Soft Wheat in 1978 (ECU/1 tonne)	18
2. Ec Wheat Production and Consumption: 1968-1994 (Millions of Tons)	22
3. 1992 CAP Reform-the New Cereal Regime (The Transition Period)	33
4. EC Budget Transfers in 1985 (Million ECU)	40
5. Average Area per Farm Holding and % of Farms over 50 Hectares in the EC	41
6. Two-step Forecast Model for the Price of Wheat	83
7. Two-step Forecast Model for the Price of Barley	84
8. Percentage Deviation of the Forecasted Values from the Dependent Mean	88
9. Definition of the Variables Used in the WBAR Models	94
10. Comparison of Price Expectations Variables (Wheat)	96
11. Comparison of Price Expectations Variables (Barley)	97
12. Comparison of Yield Expectations Variables (Wheat)	99
13. Comparison of Yield Expectations Variables (Barley)	100
14. Wheat Acreage Response Model under Uncertainty	102
15. Barley Acreage Response Model under Uncertainty	103
16. Elasticity of Wheat Acreage	104

LIST OF TABLES (Continued)

Table	Page
17. Elasticity of Barley Acreage	105
18. The Average Acreage (000 ha) and Yield (t/ha) Figures for Wheat and Barely	106
19. The Average Production (000 tons) Figures for Wheat and Barely	107
20. Wheat Acreage Response Model (with the Threshold Price)	110
21. Barley Acreage Response Model (with the Threshold Price)	111
22. History of the EU and the Common Agricultural Policy with attention to cereals	126
23. The ARIMA models--forecasts of wheat expected spot prices	133
24. The ARIMA models--forecasts of barley expected spot prices	134
25. The ARIMA models--forecasts of oats expected spot prices	135
26. Wheat Acreage Response Model with separate price and yield variances	137
27. Barley Acreage Response Model with separate price and yield variances	138

LIST OF FIGURES

Figures	Page
1. The CAP Basic Price Support Mechanism	15
2. East Anglia--Wheat and Barley Acreage	129
3. West Midlands--Wheat and Barley Acreage	129
4. Wheat and Barley Policy and Producer Prices	130
5. Wheat and Barley Percentage Increase in Yields	131

ABSTRACT

In the early 1960's the European Union adopted the Common Agriculture Policy (CAP). This study explains the objectives, principles and developments of the CAP. Wheat and barley acreage response under the CAP is examined for eight production regions in the UK using time series-cross section data for period 1975-1995. This is the first study to examine the individual effects of prices and yields on cereals acreage in the UK separately. Attention is focused on alternative models of price and yield expectations. The performance of the resulting alternative price and yield forecast variables in estimation models are then compared. The study also examines the impacts of revenue uncertainty and recent changes in the CAP, including the set aside programs of 1988 and 1992, on wheat and barley planted acreage.

Models in which expected prices were forecasted using ARIMA models and expected yields were forecasted by nonlinear time trend models provided most satisfactory results. The empirical findings indicate that wheat and barley acreage response is mainly explained by changes in the ratio of expected wheat yields to expected barley yields, by changes in relative prices and by variables that account for the set aside programs. The increasing gap between the wheat intervention price and threshold price together with developments in bread-making and wheat-washing industry also have had a significant positive impact on acreage planted to wheat and a significant negative impact on acreage planted to barley. The results further indicate that the CAP set aside programs have had a larger negative impact on barley acreage than on wheat acreage. Barley acreage planting decisions have been also more sensitive to changes in expected prices and revenue uncertainty than wheat acreage planting decisions.

CHAPTER 1

INTRODUCTION

The European Economic Community (EEC) was established on March 25, 1957, during the height of the Cold War, both for political and economic reasons. Common economic policies were formulated and gradually introduced to facilitate the integration of culturally and economically diverse community member states. It was apparent that progress in developing common economic policies would be difficult without agreement on a common agricultural policy, which would level the cost of food in community and eliminate barriers to intro EEC trade in agricultural products. However, since full introduction of the Common Agricultural Policy (CAP) of the European Community (EC) in 1969, the CAP has been the subject of many disputes that have often threatened the integrity of the EC. During the late 1980's and early 1990's, the increasing budgetary cost of CAP operations and pressure from trading partners during the Uruguay Round of GATT negotiations resulted in major reforms in the CAP in 1992. In the case of cereals, these reforms were introduced in the 1993-94 marketing year.

The first part of this thesis describes the history, objectives, shortcomings, and changes in the CAP during the period 1960-1992, and the CAP reform of 1992. The particular focus is on changes in the Common Agricultural Policy with respect to cereals and on the position of the United Kingdom with respect to the CAP.

Cereals production in the UK has altered considerably over the last twenty five years in large part because of the operation of the CAP. Over this period the UK shifted from being a net importer to a net exporter of grains, despite the fact that acreage planted to cereals and cereal consumption remained constant. The substantial increase in cereals production was largely due to increases in cereals yields. These increases in yields, associated with increase in fertilizer use and introductions of new high yielding varieties, especially in the case of wheat, has considerably influenced cereals planting decisions. Further, movements in market prices and developments in the CAP encouraged farmers to shift acreage from barley production to wheat production. The second part of this thesis examines wheat and barley acreage supply response in the UK under the CAP. The objective is to estimate the effects of changes in relative output prices, relative yields, cereal agricultural policy prices, the role of risk and the impact of the CAP set aside programs on planted wheat and barley acreage.

Agricultural supply response has been the subject of extensive numbers of studies in agricultural economics. Approaches to estimating econometric agricultural supply response models have varied across commodities and, for given commodities, across different studies. However a common feature of almost all of these studies is that they have utilized time series data. These data sets have contained relatively few observations but, ideally, the models to be estimated should include a large number of explanatory variables. The relating degrees of freedom problem has forced many investigators to compromise with respect to the set of explanatory variables and shift to estimation models that have small sample properties.

To obtain more efficient parameter estimates and, at the same time, to account for the effect of numerous explanatory variables, in this study a time series-cross section (TS-CS) regional data set is used to estimate wheat and barley acreage supply response in the UK in eight production regions over the period 1975-1995.

The TS-CS regional data set provides sufficiently large numbers of observations to permit the estimation of the separate effects of expected changes in relative output prices and crop yields on planted acreage. Previous studies have, by and large, estimated only models in which output prices and yields have been combined to form revenue per acre variables. Here considerable attention is also devoted to modeling price and yield expectations and to developing measures of uncertainty about future revenue, prices and yields. The performances of five alternative price expectations variables and two alternative yield expectations variables are compared in a representative wheat and barley acreage response (WBAR) model. ARIMA forecasts of harvest period spot prices and yield forecasts based on nonlinear time trend models appear to perform better than other price and yield forecast models. In general, the results indicate that, while shifts in relative output prices have significant effects on planted acreage, changes in expected relative yields are more important. The results also indicate that changes in revenue variability have significant negative impacts on barley acreage planting decisions, but wheat acreage planting decisions are unaffected by revenue uncertainty.

In addition, the role of policy variables in wheat and barley planting decisions are explicitly examined. These policy variables include the ratios of threshold prices to intervention prices and dummy variables for the 1988 and 1992 set aside programs. The

results indicate that as the threshold price for wheat increased relative to intervention price, wheat acreage increased, probably because of incentives created to substitute medium protein wheat produced in the UK for high protein wheat imported from Canada and the U.S. in bread industry. The results for the set aside variables indicate that, in a program in which acreage was required to be removed from all cereals production, set aside requirements were satisfied by reducing barley acreage rather than wheat acreage.

The thesis is arranged as follows. Part one, which discussed the history of the CAP, consist of chapters 2-4. Chapter 2 reviews the history of the CAP with respect to cereal policy developments. Chapter 3 describes the particular history of the UK and UK agriculture in relation to the European Union and the CAP. Chapter 4 provides a summary of the history of cereals policy in the EU.

Part two, which presents the empirical analysis of cereal acreage response in the UK, is organized as follows. Chapter 5 contains a literature review. Chapter 6 presents a discussion of the theory of the firm and its relevance for estimating acreage response models, and also describes the estimation model for wheat and barley acreage response in the UK. Chapter 7 describes the data and data sources. Chapter 8 describes five alternative price and three alternative yield forecast models and examines appropriate measures of price, yield and revenue uncertainty. Empirical results are presented and discussed in Chapter 9. Chapter 10 consists of a conclusion.

PART ONE

**HISTORY OF THE COMMON AGRICULTURAL
POLICY OF THE EUROPEAN UNION**

CHAPTER 2

DEVELOPMENT OF THE COMMON AGRICULTURAL POLICY

History of Unification in Europe

His vision of a united Europe led Pierre Dubois to propose a European confederation as early as in the fourteenth century. In the seventeenth century, after the Thirty years war, Sully proposed that a European army be created to keep the peace in Europe. The need to prevent conflicts and wars in Europe was perhaps even more appealing after the destructing First World War. The League of Nations was formed and a proposal based on the federal model of the USA called for a United States of Europe. However it was not until after 1945, after Europe had experienced another devastating war, that the idea of united Europe was seriously reconsidered.

Several important international institutions were developed after the war. Some of these institutions which had important impact on the post war reconstruction of Europe were the International Monetary Fund (IMF) and the International Bank for Reconstruction and Development (IBRD - the World Bank), both established on December 27 1945 in Washington D.C. In March of 1948, through the Treaty of Brussels, the UK, France, Belgium, Netherlands and Luxembourg agreed to provide military support to one another and to cooperate on economics. This agreement was

hastened mainly by Russia's "help" in overthrowing the democratic government in Czechoslovakia in February 1948. The formation of the Organization for European Economic Cooperation in 1948 (OEEC), which made possible the successful implementation of the Marshall Plan and the Council of Europe in 1949, followed afterwards. The first economic community, formed by a treaty signed in April 1951 by Belgium, France Germany, Italy, Luxembourg and Netherlands (the six), was called the European Coal and Steel Community (ECSC). The development of the ECSC was inspired in 1950 by a proposal by Robert Schumann and Jean Monnet to put French and German coal and steel production under a joint authority.

The development of the "Iron Curtain" and the "Cold War", increased the incentives for Western Europe countries to become more unified. In 1955, a committee under Paul Spaak, the Belgian foreign Minister, was set up in Messina to study further possible integration. At this time, differences in ideas about Western European integration between the six and UK became apparent. The UK favored a free trade area arrangement, while the six preferred the establishment of a customs union. Further negotiations among the six followed in 1956, leading to two treaties which were signed in Rome on March 25, 1957. They were the European Economic Community (EEC) and the European Atomic Community (Euroatom) Treaties. Both came into effect on January 1, 1958. The UK responded with a proposal for a European Free Trade Association (EFTA) which was established on January 4, 1960 in Stockholm.¹

¹ The signatories were Austria, Denmark, Norway, Portugal, Sweden, Switzerland and the UK. The EFTA dealt explicitly with industrial goods, agriculture was excluded.

EEC-Objectives and Institution

The political reasons for creating the EEC were obvious. However, potential economic gains resulting from free trade within the Community were of great importance as well. The Objectives of EEC were clearly stated in articles two and three of Treaty of Rome (European Communities, 1973):

Article 2

The community shall have as its task, by establishing a common market and progressively approximating the economic polities of Member States, to promote throughout the Community a harmonious development of economic activities, a continuous and balanced expansion, an increase in stability an accelerated raising of the standard of living and closer relations between the States belonging to it.

Article 3

- (a) the elimination, as between Member States, of customs duties and of quantitative restriction on the import and export of goods, and of all other measures having equivalent effect;*
- (b) the establishment of common customs tariff and of a common commercial policy toward third countries;*
- (c) the abolition, as between Member States, of Obstacles to freedom of movement for persons, services and capital;*
- (d) the adoption of a common policy in the sphere of agriculture;*

The Treaty has several more clauses, but it is noteworthy that the clause concerning common agricultural policy is incorporated in the article essential to the establishment of the Community.

Between 1958 and 1969 (the transition period) the Six proceeded to construct the Economic Community envisaged in the Treaty of Rome. The Treaty of Rome provided several administrative bodies for the development of economic policy. These include the Commission, the Council, the European Parliament and the Court of Justice (Goodman, 1990).

1. The Commission

The Commission proposes policy and legislation, executes decisions of the Council of Ministers and maintains the daily running of the Community. It also takes legal action against members who do not comply with treaties.

2. The Council

This is the decision making institution for the Community. It consists of ministers (Council of Ministers) and officials from member states (Council working groups). It also includes the Committee of Permanent Representatives of the members (COREPER).

3. The European Parliament

Its opinion is provided on proposals from the Commission before the Council adopts them.

4. The Court of Justice

It looks after the Community law and its judgements are binding on member states.

policy instruments among countries, so that implementing a common policy was inevitable although difficult task. Three stages for developing a common agricultural policy were proposed in the Treaty of Rome. In stage one, which was intended to last for three years (1958-1961), policies were to be formulated and agreed upon. In stage two, which was to end in 1970, these policies were to be introduced. In stage three, a fully operable unified market would be in place (Hill, 1984).

Nine articles of the Treaty of Rome deal explicitly with agriculture. The objectives of the CAP are defined in article 39 of the Treaty of Rome (pp.38-47):

Article 39

1. The objectives of the common agricultural policy shall be:

(a) to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilization of the factors of production, in particular labor;

(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 stabilize markets;

(d) to assure the availability of supplies;

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

2. In working out the common agricultural policy and the special methods for its application, account shall be taken of:

(a) the particular nature of agricultural activity, which results from the social

structure of agriculture and from structural and natural disparities between the various agricultural regions;

(b) the need to effect the appropriate adjustments by degrees;

(c) the fact that in the Member States agriculture constitutes a sector closely linked with the as a whole.

Article 43 stated that the Commission should immediately enter this treaty into force and study the existing situation in members states. The July 1958 conference, held in Stresa and chaired by the first Commissioner for agriculture Dr. Sicco Mansholt, provided a list of agricultural policy objectives. These objectives, which were not entirely identical to these in the Treaty of Rome, were as follow:

- to increase agricultural trade within the Community and with other countries;
- to maintain a balance between structural and market policies;
- to avoid surpluses, and to give scope to the comparative advantages of the regions;
- to eliminate subsidies which would distort competition;
- to improve returns to capital and labor;
- to preserve the family structure of farming;
- to encourage rural industries which, by providing new job opportunities, would assist the removal of surplus labor, and to provide special aid to disadvantage regions.

In 1960, the Council of ministers had accepted the proposal that internal agricultural prices should be raised to target levels by means of variable import levies which would protect community farmers from lower prices prevailing on world markets. Despite the initial reluctance of Member states to accept the common agricultural policy,

on January 14, 1962 the Council announced an agreement which initiated common policies for cereals, pigmeat, poultrymeat, eggs, fruit, vegetables and wine, and outlined the method for financing them. Subsequently, many other policies and instruments concerning different agricultural products were introduced. In this thesis, the commodities of interest are wheat and barley. Thus the remainder of this chapter is concerned with the history of the cereals CAP.

Cereal Policies: 1964 - 1995

In 1964 the Commission proposed common price levels for cereals, pigmeat, poultrymeat and eggs, but cereals were considered to be the most important commodities and therefore became the initial focus in developing a common agricultural policy. The cereals regime was the first common agricultural support program and was subsequently used as a model for other EC wide commodity programs. Target and intervention prices were set annually for common wheat, durum wheat, barley, maize and rye. The *target price* was related to Duisburg (Germany), a city situated in a highly industrial region that is the main deficit area of the community. The *target price* was the one which the Community would like to see in the wholesale market. Target prices elsewhere in the Community were modified from the Duisburg price by subtracting transport costs.

The target price was higher than the world market price. Thus, the CAP established a *threshold price* for imports, below which products could not enter the Community. The threshold price was originally the target price at the Duisburg market less the sum of the transport costs between Rotterdam (port in Netherlands) and Duisburg

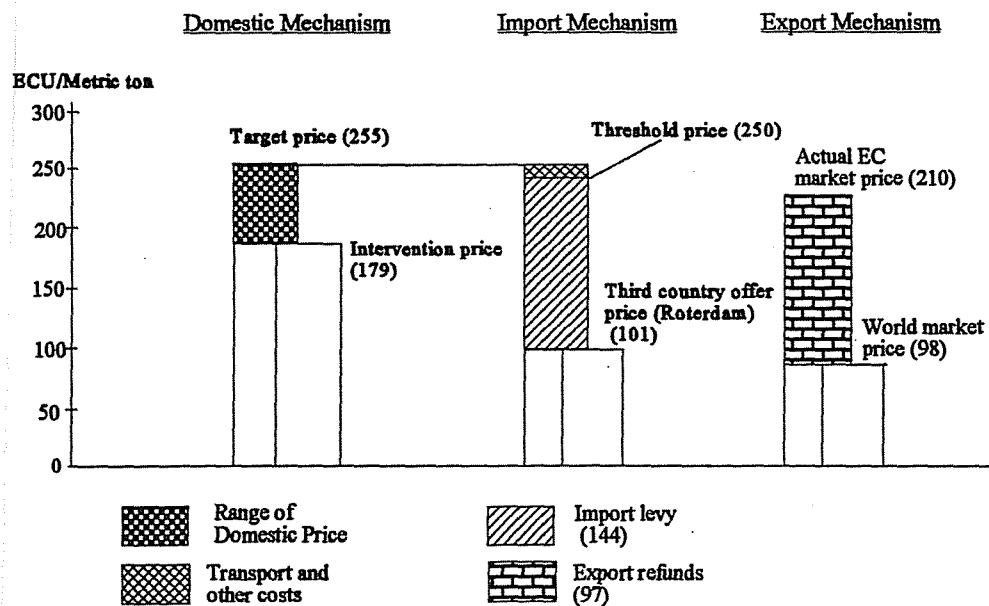
and the discharge costs and commercial margin. The difference between the threshold price and the import price is the variable import levy which is set daily by community authorities. Importers are charged this amount on top of the price of the commodity.

When internal supply exceeds demand, even if foreign supply is zero, price has to be depressed in order to clear the market. To prevent this, or to guarantee a certain price level for producers, community authorities intervene and buy the product for Community storage at an intervention price. Originally the *intervention price* was based on a price at Ormes (France) which is located in the area of maximum cereals surplus in the Community. The idea was that seasonal surpluses would be brought at the intervention price and stored. When reduced supplies cause a price to increase, these stocks could be resold on the market. Such reselling would eventually lower the internal price and so there had to be an "outlet" for surpluses on the world market and an export policy. EC exporters were therefore to be given export refunds or variable export subsidies which were based on the difference in the price on the world and community markets. Such refunds could vary according to destination.

In practice, the EC Commission formulated export policies, but execution of those policies was in the hands of commercial institutions or national governments. The basic policy instruments included export refunds, export subsidies for open market sales, reduced price sales from intervention stocks and food aid. The major portion of EC cereal export was covered by export refund tenders under which exporters submitted applications for refunds for the quantities they wished to export. Exporters could also submit bids for commercial export from intervention stocks. All EC grain export had to

be licensed and had to take place within the certificate's period of validity. In addition individual EC countries were allowed to finance their own grain exports through subsidized credit systems. The basic price support mechanism is illustrated in figure 1.

Figure 1. The CAP basic price support mechanism.



A special intervention price was established for durum wheat and in certain regions a production aid was provided to durum wheat producers. In addition, the price of bread-making quality wheat was set 13 percent above the intervention price for common wheat, to reflect lower yields of wheats of bread making quality and the needs to compensate farmers. This reference price commonly applies for only the first three months of the marketing season (August-October).

Generally, prices were set well above world market levels in order to provide farmers with a "fair" standard of living, and until 1992, agricultural prices were annually pushed upward by ministers of agriculture for political reasons.

European Community Common Denominator

In order to satisfy the Treaty of Rome's objectives concerning free trade there had to be only one price for each commodity in each member state. Thus, there was a need for a common denominator in which to express price levels that was independent of exchange rate movements.

The Community adopted a denominator called the Unit of Account (UA) - whose value was initially set equal to the US dollar under the Bretton Woods fixed exchange rate regime. For agricultural commodities, a special denominator, Agricultural Unit of Account (AUA), was introduced in 1962. When the target price for wheat in the AUA was translated into national currencies, all target prices would be the same. AUA market values were par values with the US dollar but problems began in 1969 when the German mark (DM) was revalued and the French franc (FF) was devalued. These exchange rates movements distorted the market in the sense that in Germany imports became cheaper and German exports became more expensive. In France, imports became more expensive and exports became cheaper. As a result prices paid to German farmers needed to be reduced to maintain common price levels across countries.

Politically, this outcome was unacceptable. Instead prices were calculated at the original exchange rates. The problem, however, was that higher prices in Germany would

draw agricultural produce into Germany. To illustrate the issue a simple hypothetical example can be used. Suppose that initially $1\text{AUA} = 3\text{ Deutsche Marks (DM)} = 5\text{ French Francs (FF)}$. Further, suppose that one tonne of wheat costs $10\text{AUA} = 30\text{DM} = 50\text{FF}$. Now assume that after the revaluations of the DM and the devaluation of FF, the new rates of exchange are such that $1\text{AUA} = 2\text{DM} = 6\text{FF}$. As was noted above, for political reasons, within the EU agricultural prices in home currencies remained unchanged, thus departing from prices calculated using the current real exchange rate. The exchange rates for agricultural commodities, called representative rates, also became known as “green rates.” The green rates were the same as the original rates prior to exchange rate movements. Thus, after the shifts in market exchange rates:

the green rate was $1\text{AUA} = 3\text{DM} = 5\text{FF}$

the market rate was $1\text{AUA} = 2\text{DM} = 6\text{FF}$

Without any system of taxes and subsidies, German importers could buy one tonne of wheat in France for 50FF which, in turn, would cost them 16.7DM ($1\text{DM}=3\text{FF}$). Then they could sell the wheat in Germany for 30DM making an “exchange rate” profit. To prevent this type of arbitrage, Monetary Compensatory Amounts (MCAs) were introduced. In Germany these MCA’s operated as taxes on agricultural imports and subsidies on agricultural exports. In France, agricultural imports had to be subsidized and agricultural exports had to be taxed.

In 1971, several countries broke away from the fixed exchange rate regime and the MCA’s became a regular policy instrument with each country having its own set of farm prices. Under the new exchange rate regime, the weighted average of all currencies was

used to create a new denominator called the European Unit of account (EUA) in 1975 which replaced the UA and which was itself, in 1979, after the introduction of the European Monetary System (EMS), replaced by the European Currency Unit (ECU). The AUA was also replaced by the ECU. At the time of the change to the ECU, the AUA was about 21% stronger than the EUA. The member states agreed that after the introduction of the ECU agricultural prices would be higher, but that MCA's would continue to be in effect. Koester (1978) has pointed out that if MCA's were considered as custom duties, then in 1970's trade restrictions within the EEC were greater than permitted by GATT. This was the exact opposite of the objectives of the Treaty of Rome.

Differences across countries in the farm gate selling price for soft wheat in 1978 are illustrated in Table 1.

Table 1. Farmers' Selling Price of Soft Wheat in 1978 (ECU/1 Tonne)

State	price
Germany	180.00
France	130.00
Netherlands	161.80
Belgium	165.50
Luxembourg	158.80
UK	131.50
Ireland	147.60
Italy	170.90
Denmark	155.40

Source: Hill (1984) & Statistical office of the EC 1981.

The data represent the prices in 1978 which was the end of transitional period for three new members; the UK, Ireland and Denmark, so that there should not have been

major differences. The table shows that a common price for wheat did not exist. The UK had the lowest price due to the fact that one of the UK government's objectives was to keep domestic food prices low. This could be accomplished by keeping its green currency overvalued when sterling was devalued.

In general, EC countries with devalued currencies maintained lower farm prices using green rates at a lower ECU exchange rate than the market exchange rate. EC countries with revalued currencies maintained green rates at the initial domestic currency rates of exchange thus ensured higher farm prices than those implied by the official ECU exchange rate. Within the EC agricultural exports from countries with weak currencies were taxed, imports subsidized and MCAs were called "negative MCAs". Agricultural exports from countries with the strong currencies were subsidies, imports were taxed and MCAs were called "positive MCAs".

Germany, under pressure from other member states, proposed that positive MCA's be abolished. This proposal suggested that a "switchover coefficient" be introduced. The EC accepted the switchover coefficient mechanism proposed by Germany in 1984. The switchover coefficient was to be set equal to the revaluation of the strongest currency against the ECU. This correcting switchover coefficient was applied to the ECU central rate creating a "green" ECU rate for all EC currencies. Due to the introduction of the switchover coefficient, large negative MCAs were created in EC countries with weak currencies. The member country with the highest farm prices thus determined CAP farm prices throughout the Community.

The MCA system was very complicated. It also added the substantial transaction costs of collecting the MCA to the EC budget. The Commission proposed to phase out the MCA and switchover coefficient systems by January 1, 1993. In December 1992, at the Edinburgh Summit, the new agrimonetary system was introduced which eliminated MCAs but retained the switchover coefficient mechanism to ensure that farms in the "strong" currency country would not suffer substantial price decreases.

At the end of 1994, the European Commission proposed a further reform of the agrimonetary system. The changes were put into effect on February 1, 1995. However, because of some disputes, agrimonetary policy reform was amended in June 1995. The main point of the reform was the elimination of the switchover mechanism. The switchover mechanism prevented declines in policy prices and payments in any national currency when the currency was revalued against the ECU by inflating the value of the ECU used for agricultural policy amounts to establish a "green ECU".² Together with the switchover mechanism, the "green ECU" was eliminated as well. Green rates of member states were reduced by the value of the former switchover coefficient, by 20.7509%, but still remain in effect. The result is that support levels are still in national currencies, but are more transparent. Until a single currency is adopted, agricultural policy amounts fixed in ECU must still be converted to national currencies. The agrimonetary policy reform amendment in June 1995 was concerned with compensating farmers' losses when a revaluation of a member state's currency takes place.

² It means support prices, compensatory payments (aids in disadvantaged areas), levies and subsidies.

Net Importer versus net Exporter

By 1980 it was clear that founders of CAP had underestimated technological progress in agriculture and supply response to high support prices (Smith and Alston, 1994). In the early 1960's, the European Community represented the world's largest grain importing bloc. The EC's net imports of about 20 million tons of grain accounted for one fifth of world trade. Technological progress was reflected by rapidly increasing yields. In the case of wheat, yields rose from 2.39 tons per hectare (t/ha) in 1960 to 4.75 t/ha in 1979, and to as much as 8 t/ha in the Netherlands in 1990. However, as in other developed economies, within the EC, per capita and total consumption increased only a little. Despite the fact that planted acreage remained roughly constant, output began to exceed consumption. By 1980 the EC had shifted from being large net importer to become a large net exporter of grain. Since 1980, EC net exports of wheat has accounted for more than 10 per cent of world trade. The Community tried to deal with surpluses by reselling them back to farmers at lower prices for animal feed. Surpluses were also used for food aid to Third World countries which, in some cases, undermined food prices in these countries, damaging the incomes of marginal farmers. The major outlet for surpluses was the world market where more efficient producers such as Australia, the USA, Canada or Argentina had to compete with EC wheat sold below actual costs of production in the EC. EC production and consumption of wheat for selected years is shown in Table 2.

Table 2. EC Wheat Production and Consumption: 1968-1994 (Millions of Tons)

Year a)	Production	Consumption	Year b)	Production	Consumption
1968	36.7	36.3	1985	71.6	59.6
1974	44.9	39.9	1986	72.0	56.7
1975	37.7	37.5	1987	71.4	58.8
1976	38.8	37.7	1988	74.7	60.1
1977	38.0	39.2	1989	78.6	58.0
1978	47.3	40.9	1990	80.5	57.8
1979	46.3	41.8	1991	90.1	64.9
1980	55.0	44.1	1992	84.8	60.6
1981	54.2	44.5	1993	80.2	69.7
1982	59.8	44.7	1994	81.9	67.5

a) For EC-9 until 1980; for EC-10 until 1982

b) For EC-12

Source: years 1968-1982 Agricultural policies in the EC, Canberra 1985
years 1985-1994 Situation and outlook series, Europe, USDA-ERS

Table 2 shows that the production substantially exceeded consumption since 1978. Thereafter the Community became a consistent net exporter of wheat. The gap between production and consumption increased rapidly reaching 25 Mt in 1991. The difference between world and EC's prices, which meant that EC export was heavily subsidized, required substantial financial support from the EC's budget. Since the 1992 CAP Reform (discussed in details below), the EC curbed production incentives and decreased "expensive" wheat exports.

Financing the CAP

From the very beginning of the CAP, it was clear that there had to be a fund which would allow for price support. In 1962, the European Agricultural Guidance and Guarantee Fund (EAGGF) was created.³ The Guarantee section was to deal with the cost of export refunds and support purchases. The Guidance section was to be used to finance structural changes in agriculture. Originally the Guidance section was intended to amount to one third of the expenditures of the Guarantee section. However, in 1966, strict limits were placed on Guidance section expenditures. By 1980, the Guidance section accounted for only 2% of the EC's total budget while the Guarantee section which was thirty five times larger accounted for approximately 70% of that budget.

Until 1971, the EC budget was funded by levies on selected agricultural imports, an internal levy on sugar production in the EC and, mainly, by direct payments from Member States. The introduction of the Common Custom Tariff (CCT) system in 1968 enabled the Community to change the base of financing the EC budget. After the 1969 Hague Summit, member states agreed to finance the budget from "own resources". In addition to agricultural import levies and internal sugar levies, custom duties and value added tax (VAT) receipts were introduced.

Custom duties and agricultural import levies became less important components of the EC budget partly because of GATT negotiations on tariff reductions and partly because of the increasing self sufficiency of EC. The main source of contributions was the

³ The EAGGF is also known as the FEOGA (from the French)

VAT component. The member States agreed that they would contribute up to 1 percent of total domestic VAT receipts to the EC budget. However, because member states failed to meet the 1975 deadline for agreement on the introduction of the VAT budget component, the Community continued to finance the budget from direct payments by the member states related to member states GNPs. In 1977, the sixth VAT Directive was introduced which further developed the system of VAT contribution but not until 1979 was the VAT contribution system fully operable (and then only because of action by the Court of Justice).⁴ Increasing budgetary expenditures resulted in the VAT rate being raised from 0.73% in 1980 to 0.92% in 1982 and in 1984 the VAT rate reached its maximum limit of 1%. This limit was raised to 1.4% in January 1986 but at the same time the member states also agreed to control agriculture spending which accounted for more than two-thirds of the EC budget.

Nevertheless, in the mid 1980's agricultural spending continued to increase and budgetary problems continued to recur. A new plan for financing from "own resources" was put forward under which an own resource ceiling of 1.4% of the Community GNP would be established. In February, 1988, heads of government of the EC-12 agreed to increase their contribution to support the CAP and introduced policy changes to limit its cost. Member state contributions to the budget were altered from 1.4 percent of each state's VAT to 1.2 percent of each member's Gross National product (GNP), which is equivalent to almost 2 percent of VAT. The new system allowed the budget to grow from

⁴ The Court of Justice determined that Ireland, Luxembourg, Italy and Germany had to comply with the sixth VAT Directive.

\$54 billion in 1988 to \$ 65 billion in 1992. Despite all previous attempts to meet increasing agricultural expenditures, major reform of CAP became inevitable.

Reforming the CAP

In 1968, Dr Sicco Mansholt had identified many problems with the Common Agricultural Policy and suggested that the gap between world and community prices must be narrowed. Further, if productivity per person or acre was to increase and farm incomes to rise, farms would have to be larger with fewer people on them. To keep output within the "range," a set-aside program would also have to be introduced. Mansholt suggested that five million people and five million hectares would have to be removed from agriculture. Farmers should be offered retirement pensions, retraining programs, and the remaining farms should be modernized.

The only country which favored the Mansholt plan was the United Kingdom, then in the process of applying for membership. However, on the Continent thousands of angry farmers organized strong opposition. Dr Mansholt was called "the peasant killer" and the plan became politically unacceptable, but the need for reform was recognized. (Swann, 1988). In 1971, the Council of Ministers accepted a reform proposal which was a modification of the Mansholt plan but the proposal was never implemented. In fact, largely because of the strong political influence of the farmers' lobbying groups agricultural prices continued to rise steadily and even the largest net contributor Britain, which had the biggest reason to press for reform, did not make any real effort to force changes in the CAP. Instead, Britain manipulated its green rate so that the CAP would fit

better to Britain's "cheaper food" price policy (George, 1991).

Nevertheless, the Community realized that the structure of EC agricultural sector had to be improved and during the 1970's several measures to encourage structural change were adopted. These measures were financed from the Guidance section of EAGGF. In 1972 three measures were implemented. The first measure was the Modernization of Farms (which was amended in 1981); the second was the Cessation of Farming and the Reallocation of Agricultural Land for Structural Improvement and the third was Provision of Socio-economics Guidance. In 1975, a measure called the Mountain and Hill Farming and Farming in Certain Less favored Areas was adopted. This measure was introduced to compensate farmers in disadvantaged areas. Despite these minor changes in the CAP program, no major reform of the CAP took place.

In 1980, serious difficulties arose when the Community tried to agree on an agricultural price package and on the Community budget.⁵ On May 30, 1980, the Commission was given a so-called Mandate. This Mandate was to be fulfilled by June 1981 and obligated the Commission to examine possible development of Community policies and common financial responsibility for these policies. The Commission issued a report which, in the case of cereals, proposed a measure called a guaranteed threshold.

The guaranteed threshold measure was similar to an unpopular quota system but somewhat more acceptable to farmers than the alternative of direct price reductions. For the 1982-83 marketing year, the guarantee threshold was fixed at 119.5 millions tons for

⁵ i.e. The UK was in favor of lower agricultural prices and CAP's adequate share in the EC total budget. Germany, France were in favor of higher prices and consequently CAP expenditures.

all cereals except durum wheat. The Council decided that if the actual quantity produced exceeded the threshold then the intervention price would be reduced by 1% for every additional million tons, but only up to a maximum reduction of 5%. In addition, if the amount of imported cereal substitutes exceed 15 million tones, any additional import quantity would be subtracted from the threshold.

Actual production exceeded the output limit in 1982-83 by more than one million tons and thus the intervention price for 1983-84 was reduced by 1%. This in fact meant that the Council's proposed price increase of 4% was reduced to 3% in ECU terms. Moreover, because of green currency adjustments, the average increase in national prices was 6.5%. In 1983-84, even though the threshold limit was not exceeded, the intervention price was reduced by 1% in ECU terms (mainly because of budgetary problems). In 1984-85 actual production exceeded the output limit by eight million tons, which meant that for the 1985-86 year the intervention price was reduced by 5%. However, the intervention price fell by only 3.6 because the Council had already adopted a 1.4% increase of price. A guarantee threshold was introduced for durum wheat in 1984-85 but, for the 1985-86 season, durum wheat was included in the guarantee threshold for all cereals (Avery 1985)

Trade within the EC was still restricted by many trade and non trade barriers. Thus, the EC proposed a draft treaty establishing the European Union, which would remove any remaining obstacles to trade. This proposal was adopted by the European Parliament in 1984. The idea was also embodied in what came to be known as the Single European Act which was signed in February 1986. At this time the European Community

consisted by the original six members, the UK, Ireland, Denmark (which all joined in 1973), Greece (which joined 1981) and Spain and Portugal (which joined in 1986).

Budgetary problems in the enlarged EC-12 became an even more serious problem.⁶ Because the CAP was responsible for a major part of these problems, additional policy instruments were adopted. In the case of wheat, the first major innovation was the introduction of the co-responsibility levy in the 1986.⁷ The basic co-responsibility levy accounted for 3% of the common wheat intervention price. The objective was to use revenue from this levy to offset the cost of export subsidies and thus help to solve the budgetary problem.

In 1987, the EC Commission's price proposal included a freeze on support prices for grains and oilseeds in ECU terms. However, because of green currency and exchange rate adjustments, a slight increase in the average farm support price was achieved. The EC tried to harmonize protection levels among grains, oilseeds and non grain feeds and provided incentives for an increase in the use of cereals as animal feeds. However, the share of EC budget for grains and oilseeds grew from 17% in 1985 to 29% in 1988. The Member states then agreed to set up a limited system of automatic price stabilizers for grains. This meant that if production exceeded a maximum guaranteed quantity of 160 million tons, support prices would be reduced in the following season by 3%. The Member states also agreed on a program of paid land set-asides and a new producer co-

⁶ The Treaty of Rome does not allow for Community budget deficits.

⁷ Co-responsibility levy was a tax on production. This levy worked as a price reduction but was more acceptable to farmers as well as politicians.

responsibility levy (tax), in addition to the one already in place. The new co-responsibility levy was to be refunded if production failed to exceed the maximum guaranteed quantity (MGQ). In 1988, a new set aside program enjoyed limited success because of the low payments offered. Only West Germany, the UK and Netherlands met the original goals for the set aside program.

In 1990-91, grain production in the EC slightly decreased, but German reunification and the entry of East Germany into the EC resulted in an actual increase in grain production of 12 million tons while consumption increased by only eight million tons. This generated even larger EC surpluses. Thus, for the 1991-92 crop year a new set aside program, which supplemented the existing five-year set aside program, was introduced to further reduce area planted to grains and other crops for the 1992 harvest. Producers were required to set aside at least 15 % of their eligible area under the program, including at least 15 % of the area planted to grains. In addition, the basic co-responsibility levy increased from 3 to 5 percent of the common wheat intervention price for the 1991-92 marketing year. However, participants in the set-aside programs would be reimbursed for all co-responsibility levies paid on grain (1991-92) and would be eligible for per hectare set-aside payments.

The regulation for the new one-year set-aside program also allowed for additional payments by national governments up to a maximum of the national contribution to the existing five-year program. The application deadline for the new program was December 15, 1991. The UK announced that no national premium would be used to supplement EC payments to its farmers who participated in the one-year program.

The Commission next proposed an 8 % co-responsibility levy (5% basic and 3% additional) however these levies were abolished starting 1992-93. The Commission also cut intervention, target and threshold price for 1992-93 by 3% using the stabilizer mechanism because MGQ was exceeded. Nevertheless, the 1992-93 price package implied an increase in price supports for EC grain farmers of 2-3% in terms of the ECU (relative to 1991-92). A downward trend in grain consumption and a sharp decline in feed use caused EC grain stocks to reach record heights. Budget costs for grains still accounted for the largest share of EC budget but the Community hoped that the implementation of the CAP reform would help to curb production.

In the late 1980's, the EC had faced increasing surplus problems together with budgetary problems, plus pressure from the USA and the Cairns group in the GATT negotiations of the Uruguay round.⁸ The Uruguay round of GATT was initiated in September 1986. For many years, partly because of the unwillingness of the EC to liberalize agricultural trade, agreement about agricultural trade policies under the GATT could not be reached. A deadline for the final Uruguay round GATT agreement had been set for December 1990. On July 1, 1990, Art de Zeeuw, chairman of the Agricultural Negotiating Group, made an attempt to bring the negotiations to agreement. His proposal called for significant reduction in domestic supports, for limitation of import restrictions. Most importantly he proposed sharp reduction in export assistance. This proposal was not accepted by the EC and a new GATT agreement was not reached in 1990. (Avery, 1993)

⁸ Fourteen so-called fair trading countries formed in 1986 Cairns group

Negotiations were resumed in 1991. The final negotiating proposal was presented by EC agricultural Commissioner MacSharry. Even though the MacSharry proposal was initially rejected, EC member countries realized that failure to achieve an agreement on GATT would mean the loss of many benefits from the Uruguay Round in non-agricultural sectors. Eventually, the EC member states therefore agreed on major reform of the CAP. The 1992 CAP Reform, which was implemented for the 1993-94 crop year, represented the most significant reform made to the grains and beef sectors since the inception of the CAP in 1970.

1992 Cap Reform

The major elements of the 1992 CAP reform were (1) reductions in support prices, (2) the creation of corresponding direct compensation payments, and (3) the introduction of new supply control measures. The Council agreed to reduce the cereals intervention price by thirty three percent over the three year period 1993-1996. By the last year of the three-year period, the intervention price for all grains would be 100 ECU (\$159) per ton and the target price would be 110 ECU (\$176) per ton. The difference between the threshold price and the target price was to be set at 45 ECU per ton in 1995-96; thus the 1995-96 threshold price would be 155 EC per ton. Under the MacSharry plan, the threshold price was supposed to be only 110 ECU.

Producers were to be compensated for the cereals price reduction under CAP reform by direct compensatory payments. These payments would be made to farmers on a per hectare basis and determined by historical individual farm planted area and historical

average yields in the region. Durum wheat producers were to receive additional payments to compensate them for a much larger price cut. The 1992 CAP reform established two crop payment mechanisms, base areas and yield regions, for the administration of the new crops regime which, for the most part, was to be carried out by member countries. The base area is the total area eligible to receive compensatory payments. The eligible area equals the annual average area planted to grains, oilseeds, or protein crops in 1989, 1990, and 1991, plus land enrolled in the five-year or one-year set-aside program during those years.

EC member countries could opt for either regional or individual base areas. Most member countries lacked sufficient data on plantings by individual holdings and decided individual bases would be inflexible. In the initial phase of the reform, all states established regional base areas. Belgium, for example, created two regional base areas, while the UK established five. On September 5, 1994, the U.K. Ministry of Agriculture, Fisheries and Food (MAFF) announced that under the arable area payments scheme the UK would be divided actually into seven regions. (Attache Reports, 1994). Base areas limit the acreage on which compensatory payments will be paid, and supply control measures prevent inflation of the regional base area. If producers plantings for which producers apply for compensatory payments exceeds the regional base area, then producers in the area are subject to two penalties. In the same marketing year in which the base area inflation occurred, the eligible acreage of each farmer in the region is reduced by the same proportion as the base area is exceeded. In the following marketing year, producers subject to the set-aside requirement have to implement an additional set-

aside, equal to the percentage by which the base area was exceeded in the previous year.

Farmers will not receive compensation for the additional set-aside. Table 3 shows the new cereal regime scheme.

Table 3. 1992 CAP Reform-the New Cereal Regime (The Transition Period)

Policy mechanism	1992/93	1993/94	1994/95	1995/96
<u>Intervention price</u>				
Common wheat	154 ECU/ton	117 ECU/ton	108 ECU/ton	100 ECU/ton
Corn				
Barley	146 ECU/ton			
<u>Threshold price</u>				
Common wheat	222 ECU/ton			
Corn	201 ECU/ton	175 ECU/ton	165 ECU/ton	155 ECU/ton
Barley	201 ECU/ton			
<u>Cereals payment</u>	NA	25 ECU/ton	35 ECU/ton	45 ECU/ton
<u>Set-aside payment</u>	NA	207 ECU/ha (45 ECU/ton)	207 ECU/ha (45 ECU/ton)	207 ECU/ha (45 ECU/ton)

NA = Not applicable

Source: USDA - ERS; CAP Reform A new Era for EC Agriculture

According to the EC Commission, yield regions should account for characteristics that influence yields, such as soil quality. In each yield region, average yields were to be calculated for 1987-91 for grains and oilseeds. A base area region could contain several yield regions, but yield regions could not cross the boundaries of the base areas.

Compensatory payments for producers within each yield region would be based on historical average grains yields.

Supply control in the crop sector was to be implemented through a paid set-aside program which was established for producers who wished to receive compensation

payments under the general scheme. Farmers who did not want to participate would not be eligible for compensatory payments. There are two options in the set-aside program, a rotational option and a nonrotational option. The rotational set-aside program requires that in each year a different piece of land has to be idled for a minimum of seven months between December 15 and August 15. The rotational set-aside requirement is set at 15% of the area sown to grains, oilseeds, and protein crops. Under the nonrotational set-aside program 20% of land has to be taken out of production but the same land may be set aside each year. This is because producers are likely to remove their least productive land and so that a higher set-aside rate is needed to achieve a given reduction in output. Two exceptions were permitted. For farms utilizing reduced fertilizer farming practices and for producers in member states where more than 13% of the aggregate arable crops area was set aside on 1993-94 (this only apply for UK), the nonrotational area set aside requirement is only 3% higher than the above of rotational set aside requirements.⁹

Producers, with areas planted to grains, oilseeds, or protein crops sufficient to produce no more than 92 tons of grain at average regional yields, are classified as small producers and exempted from set-aside requirements. These producers receive compensatory payments for all their arable area. Producers subject to the set-aside provisions are allowed to grow crops for nonfood, nonfeed uses on the land they set-aside. Land to be set-aside for the 1993-94 marketing year had to be cultivated with the intention of harvesting in 1992. Thus, temporary grassland could not be used to satisfy the set-aside requirement, although such land could be planted to crops and receive compensatory

⁹ The reduced fertilizer farms are located in designated nitrate-sensitive areas.

payments. Land idled under either the five or one-year set-aside programs (adopted in 1988 and 1991, respectively) would, however, be eligible for set-aside under the new regime.

In the 1993-94 marketing year, the first price reduction was implemented. For grains, prices were cut by 22%. However, although this cut was in effect from July 1 for the intervention price, threshold prices (except for oats) were not reduced until September, a policy adjustment which was designed to protect prices in EC markets before intervention opened in August or in November.

An EC-wide Integrated Administration and Control System (IACS) was established to administer the system of direct payments for set-aside and system of compensatory amounts. Producers had to submit official forms detailing their planted and set-aside area. Completed forms had to be submitted to national agriculture ministries by May 15, and many producers missed the deadline. Producers who submitted their forms late faced the loss of 1 percent of this compensatory payments per a day for each day past the deadline. Those whose forms were more than 20 days late lost their entire entitlement to payments. If farmers submitted inaccurate IACS form, their support would be reduced for that year by twice the percentage of the error. An error in excess of 20 % would exclude producers from receiving any aid. Member state national governments are to be responsible for enforcing the new cereals regime.

In grain production, farmers began to replace coarse grains with wheat because coarse grain yields are lower than common variety wheat yields (and there is only one price for grains). A new standard for wheat interventions was introduced in the 1993-94

marketing year. Only wheat meeting the new quality standards (which included standards for moisture, weight and protein content) is now eligible for intervention. Intervention support for feed grain may not be provided because feed wheat generally does not meet these new requirements. Another significant change in 1993-94 the set-aside program was an increase of the set aside payments from 45 ECU to 57 ECU per ton.

On June 22, 1995 the EU Council adopted the 1995-96 farm price package and further modification of the 1992 CAP Reform set aside program. This modification allows farmers to include some set aside land from previously created environmental and reforestation CAP programs into their set aside obligations. The Commission proposed to open intervention for grains two months later, which would increase the importance of the open market.¹⁰ The Council, however, rejected this proposal.

On July 1, 1995, the European Union started the final stage of the three-year CAP reform program, which was designed to curb the spending and agricultural surpluses. Farm support is changing from market price support towards direct payments to producers. The cost to EU taxpayers with this program is increasing, but benefits of CAP reform may include lower surplus stocks, lower market price for EU costumers, lower taxpayer expense for export subsidies, and reduced political pressure from trading partners.

¹⁰ The open intervention for grains runs from August to April in the southern states and from November to May in northern states.

CHAPTER 3

THE UNITED KINGDOM AND THE EUROPEAN UNION

The UK has always had and still enjoys a special position in the EU, especially in relation to agricultural policy, because of its long history as the center of the British Commonwealth and its equally long history of pursuing cheap food policies. This chapter examines the recent history of the relationship between the UK and the EU with a special focus on agricultural and cereals policy.

The UK Accession

In the mid 1950's, the UK was in favor of a free trade area arrangement, while the original six member countries of the EC were in favor of a customs union. The major disagreement between the UK and the six rested in the fact that under the British proposal the agricultural sector would be excluded from an internal free trade area created by a customs union arrangement.

A customs union presented a serious problem for British Commonwealth countries, which exported a large part of their agricultural production to the UK. For example, New Zealand exported almost 85% of its dairy products to the UK, and many developing countries under the Commonwealth Sugar Agreement exported most of their sugar to the UK. In addition, if agriculture was included in the arrangement, consumers in

the UK would have to buy food at prices similar to those paid to farmers in the six (Swann, 1988). Thus, a customs union would be contrary to the UK's historical cheap food policy and the Commonwealth Preference system under which the UK imported food at low prices in exchange for its industrial goods. UK farmers were protected from relatively low import prices by a deficiency payments system which drove a wedge between prices received by farmers and prices paid by consumers. Deficiency payments for each import competing commodity were established annually in the UK Annual Farm Price Review. Under the CAP, these traditional deficiency payments would also have been abandoned.

Even though there were disagreements, particularly on agriculture issues, the UK realized that, for political reasons, it would be desirable to join a large group with the potential to exercise world power. On July 31, 1961, the UK prime minister, Mr. Harold Macmillan, formally submitted an application to join the EEC. On September 21, 1961 the Council of Ministers decided to accept the application. In its proposal, the UK tried to modify the CAP, but the proposal was unacceptable and represented one of the major reasons for the collapse of negotiations in January, 1963. In May, 1967, the UK made a second application to join the EEC. Primarily due to the objection of France (in particular by President General de Gaulle), negotiations did not begin until 1969 when France elected a new president, Georges Pompidou. The major challenges in the negotiations were again agriculture and trade with the Commonwealth countries. After lengthy discussions, a compromise was reached and terms of accession were published in the White Paper in 1971. The date of accession was established for January 1, 1973.

The UK and the CAP

Under an early draft of the White Paper the UK was to adopt the CAP immediately upon accession (Hill, 1985). However the major gap between the CAP prices and food prices in the UK led to a decision that higher agricultural prices would be introduced gradually through a transitional period. The original proposal of the UK included a three year transitional period for industry and a six year transitional period for agriculture. After negotiations between the six EC member states and the UK, the transitional period for both industrial and agricultural goods was set at five years. In the case of agriculture, prices were gradually increased to the Community levels in six steps over the five-year transition period. The CAP became fully operable in the UK on January 1, 1978.

Uncertainty about the advantages of joining the EC and about the effect of the implementation of the CAP created many doubts about EC membership among UK citizens. The situation led to the first ever British national referendum on a political issue. The purpose of this referendum, which took place on July 5, 1975, was to decide whether or not the UK should remain in the EEC. The final result of the referendum was to remain in the EEC. One important concern, the UK balance of payments cost, soon became a major political issue for the EEC. This was the issue of what constituted a "fair" contribution to the EC budget for the UK. Member states importing agricultural products were contributing to the budget because of import levies. Member states exporting agricultural products were receiving export refunds and therefore benefited. The situation was deemed by some to be unfair in the sense that Denmark, which enjoyed the highest

income per head in the EC, was a major beneficiary while the UK, one of the poorer countries in the EC, was the biggest net contributor to the EC budget. In addition, large income transfers occurred from consumers in the UK to producers of the EC exporting countries.

In 1980, the new UK conservative government, under Prime Minister Margaret Thatcher, demanded a major cut in the UK contribution and a "fair" relationship between payments to the budget and receipts from the budget. After several EC budgetary crises the problem was largely resolved after the Fontainebleu Summit in June 1984. The member states agreed to a system of corrections (rebates) for excessive contributions. Table 4 illustrates the situation after the Fontainebleu Summit.

Table 4. EC Budget Transfers in 1985 (Million ECU)

	GDP per head (%of EC(12) average)	Before UK's rebates	After UK's rebates
Denmark	153	+400	+300
Luxembourg	142	+300	+300
W. Germany	138	-3,100	-3,500
France	126	+500	0
Netherlands	112	+500	+400
Belgium	108	+600	+500
UK	91	-3,000	-1,000
Italy	86	+800	+1,200
Ireland	66	+1,200	+1,100
Greece	38	+1,400	+1,400

Source: The Economist, 20 June 1987

Even though the situation for the UK had improved as a result of the Fontainebleau Summit agreement, the UK still remained a substantial net contributor to the EC budget.

The development of the agricultural sector of the UK under the CAP followed the same path and encountered the same problems as in the rest of the EC. UK farms, together with other EC farms, gradually increased in average size in 1970's and 1980's, and became more specialized. Table 5 shows the percentage distribution of farms over 50 hectares in size and average size of farms in different countries in the EC.

Table 5. Average Area per Farm Holding and % of Farms Over 50 Hectares in the EC

Country	Average area(ha)		Farms over 50 ha (%)	
	1967	1977	1967	1980
Germany	10.7	14.7	1	4
France	19	25.5	7	13
Italy	8.5	7.4	2	2
Netherlands	10.7	15	1	3
Belgium	10.5	14.5	2	4
Luxembourg	17.8	25.4	4	17
UK	30	65.6	21	33
Ireland	-----	22.5	-----	9
Denmark	18.8	23.5	15	10

Sources: 1967-A MEL-AGRA, 1980 and Hill (1984)

Table 5 also shows that British farms were much larger than farms in the rest of the EC.

The UK also ceased to be a major importer of food and became self sufficient and even an exporter of many agricultural products. In the grain sector, production substantially increased. The UK became the second largest wheat producer in the EC and also encountered problems with surpluses. In order to control agricultural production and the impacts of intensive farming on the environment, two government programs were adopted in the UK in the 1980's. The first was the program to protect Sites of Special Scientific Interest (SSSI) introduced in 1981, an agreement between farmland owners, leases or occupiers and the Nature Conservancy Council (NCC) not to undertake operations harmful to nature. The second program, introduced in the mid's 1980's, involved payments to farmers for not practicing intensive farming in Environmentally Sensitive Areas (ESAs). However, the impact of these programs on agricultural production has been negligible as the areas covered are very small. (Erwin, 1988)

In September 1986, the UK Ministry of Agriculture, Fishery and Food (MAFF) proposed a large scale set aside program for consideration within the EC. The main reason was to decrease cereals supply, thus decreasing EC expenditures for supporting intervention stocks and funding export restitutions.

In 1988, the EC introduced a five-year voluntary set aside program. Then, the 1992 CAP Reform (discussed earlier) engendered major changes in the EC agricultural support system with the clear intention of curbing agricultural production. These changes appear to have substantial impacts on UK cereals production, as is illustrated by the empirical work presented in part two of this thesis.

CHAPTER 4

SUMMARY

The Common Agricultural Policy of the European Community has been the central policy issue in the EU over the past 25 years. The original objectives of the CAP were to increase supplies of agricultural product with a goal to reach self-sufficiency, to stabilize markets, to increase productivity by promoting technical progress and to ensure a fair standard of living of agricultural community. In the 1960's, common policies were introduced, implemented and the CAP became fully operational by 1969.

However, in the early 1970's, many countries in the EC broke away from the Bretton Woods system of fixed exchange rates. In response, agricultural "green rates" of exchange were introduced to prevent changes on farm gate prices in terms of local currencies occurring when two or more exchange rates changed. Even though the MCA system was introduced, the system of common agricultural prices (valued at par with respect to exchange rates) ceased to exist and the common agricultural policy became less transparent. Also during the 1970's, the Community became more than self sufficient in many agricultural products including cereals.

Grain production stimulated by high support prices for cereals, technological progress, structural and infrastructural development had exceeded consumption of cereals, and as result, cereals surpluses began to accumulate. The disposal of surpluses through

the use of variable export subsidies became very expensive, mainly because of the gap between world prices and EC prices. At the beginning of the 1980's, CAP expenditures accounted for almost three quarters of the total EC budget. Several budgetary crisis followed afterwards. The CAP had become a disruptive element in the Community. Large budgetary transfers took place between countries (in some instances from poorer members to richer members). In addition, there were "trade transfers" resulting from high prices of agricultural commodities produced in one member state and paid by consumers in another member state. Annual disputes and political battles over the CAP price package, EC budget and the UK budget refund became a threat to the integrity of the EC.

It became clear that the policy developed in 1958, which was suitable for a net importer, was unlikely to be relevant for the world's largest net exporter of agricultural products and thus the original objectives of the CAP needed to be modify. Nevertheless for many years no major changes in the structure of the CAP took place although pressure for CAP reform increased.

In the grain sector, the Community tried to control output by introducing the Guarantee Threshold measure in 1982. In 1986 the EC introduced co-responsibility levy and in 1988 adopted the Automatic Price Stabilizer for grains and five-year set-aside program in order to further curb cereal production. Despite these adjustments to the cereal's CAP, the gap between production and consumption expanded. The Community tried to meet the increasing financial burden of the CAP by introducing higher "own resource" contributions to the EC budget. Increasing budgetary pressure and pressure from trading partners in the Uruguay round of the GATT negotiations eventually resulted

in EC agreement on major CAP reform in 1992. The major characteristics of the 1992 CAP Reform were a 33% cut in the cereal intervention price over the period of 1993-1996 and the creation of corresponding direct compensation payments. In addition, the 1992 CAP Reform introduced a new paid set-aside program to reduce supply.

Since the implementation of the 1992 CAP reform, cereals production has decreased. However, CAP budgetary costs have remained very high. In 1995, a reform of the Agrimonetary system was adopted which should make EC national prices more transparent. Whether the 1992 CAP reform was effective in controlling supply should become more apparent in the near future.¹¹

¹¹ See Table 22 in Appendix A for a summary of the history of the EU and CAP in relation to cereals.

PART TWO

**WHEAT AND BARLEY ACREAGE SUPPLY RESPONSE
IN THE UK UNDER THE CAP**

CHAPTER 5

LITERATURE REVIEW

The objective of the second part of the thesis is to estimate wheat and barley acreage response models for the UK in order to investigate the effects of changes in relative prices and yields, the effects of risk and structural changes in the cereals CAP on cereals production in the UK.

This chapter provides a review of empirical studies of cereals and wheat supply response models for the United Kingdom (UK) and other European Union (EU) countries. Previous analyses include studies by Colman (1970), and Bewley, Young and Colman (1987) for the UK, by Oury (1966) and Liapis (1988) for France, and by Meilke and de Gorter (1987), the EU Commission (1983) and Shiff (1985) for the EU.

To the best of my knowledge, the first attempt to model cereal supply response in Europe was by Oury (1966). Oury developed a multi-equation production model for wheat and feedgrains in France for the period 1946-1961 that consisted of a yield equation, an acreage equation, and a production equation. Oury estimated several competing yield and acreage response models for wheat and considered numerous potential explanatory variables. The yield model explained variability in yields as a function of the price of wheat deflated by the wholesale price index, mean winter temperature, a nine months aridity index (October through June), and a time trend or the

three-year moving average of fertilizer consumption.¹²

Wheat acreage was modeled as a function of the mean winter temperature, the deflated wheat price, and the ratios of the price of wheat to barley, corn, oats, feedgrains and fertilizer prices. Each price or price ratio variable was introduced with no lag, with a one-year lag, or as a three-year moving average of past values of the variables. The lagged deflated price of wheat appeared to be the most important explanatory variable. Of the relative price variables, the wheat to barley price ratio appeared to have the largest effect on wheat acreage. The explanatory power of the models and the plausibility of the results improved considerably when the dependent variable was expressed as the share of all grain acreage allocated to wheat. Oury estimated the acreage response elasticity for wheat acreage with respect to the deflated lagged wheat price to be 0.631, while the acreage response elasticity obtained using the ratio of the price of wheat to the price of barley, calculated as a three-year moving average, was 0.321.

Colman (1970) developed supply response models to explain changes in UK cereal acreage for the period 1955/56-1966/67. He estimated a total cereal acreage response model as well as individual acreage responses models for crops such as wheat, barley, oats and oats plus mixed corn. Colman's UK cereal acreage response model was specified as a function of lagged acreage, the de Martonne aridity index for fall months and the weighted average nominal gross return per acre from grains in the previous year.

¹² Aridity indexes combine the effects of precipitation and temperature. For example, the annual de Martonne aridity index can be written as: $I = P / (T + 10)$, where P is average rainfall and T is average temperature.

The return per acre from grains was calculated as price times yield and included subsidy payments.¹³ Weights assigned to individual crops were not reported. The coefficient on the nominal lagged grain returns per acre was positive and significant at the 5% level. When the gross returns variable was deflated using an index of returns per acre from milk production, its coefficient was not statistically different from zero.

During the sample period examined by Colman (the nineteen fifties and nineteen sixties), spring wheat accounted for a substantial percentage of the area sown to cereals in the UK. Thus, separate acreage response models were estimated for winter and spring wheat. Variations in winter wheat plantings were mainly attributed to variations in fall precipitation. Coefficients for variables such as returns to wheat and other cereals returns or prices were not statistically significantly different from zero. Variations in spring wheat were less dependent on weather conditions as measured by the de Martonne aridity index for spring months. In the spring wheat model, the coefficient on the ratio of wheat returns to barley returns variable was positive but not statistically significant. The coefficient for winter wheat acreage, included as an explanatory variable in the spring wheat model, was negative and significant. However, incorporating this variable in the spring wheat model creates a simultaneity problem, a problem which also appeared in several others individual crop acreage response models.

The coefficients for the relative per acre returns variables were not statistically significant in any acreage response models except the oats plus mixed corn acreage

¹³ Before joining the EU, the UK agricultural policy for cereals included direct government subsidies in the form of deficiency payments.

response model where the coefficient for the ratio of per acre returns of barley to returns of oats was significant. In an addendum to the paper, Colman also estimated the total wheat acreage response as a function of the de Martonne aridity index, a time trend and the percentage change in the barley area. The negative sign on the latter variable suggested that an increase of barley area leads to a decrease of wheat area due to a limited total area suitable for cereal planting.

The studies by Oury and Colman both estimated wheat supply response models for the period prior to membership of the country of interest in the EC. As noted above, only a few studies have examined wheat supply response in the EC under the CAP. Some of those studies have developed models of wheat supply response as a part of larger models examining world wheat trade (Schiff, 1985) or international wheat prices (Meilke and de Gorter, 1988). These models were estimated using aggregate EC data. In 1983, the EC Commission developed a model of cereal supply for the EC using more disaggregated data. Bewley, Young and Colman (1987) estimated cereal supply response for the UK using a multinomial logit model and Pete Liapis (1988) examined grain production in France under the CAP.

Schiff (1985) estimated EC planned wheat output response for the period 1963/64-1978/79. The dependent variable, planned output, was constructed as expected yield (yields regressed on a simple time trend variable) multiplied by harvested area, which was used as a proxy for planted acreage. Schiff estimated ten different specifications of the general model, and among the set of explanatory variables, included the current or lagged nominal producer price, the real threshold price for wheat, the current or lagged

real factor cost index, the current threshold price for barley and a time trend.¹⁴ The threshold price of barley was not statistically significant in any of the estimated models. The wheat producer or threshold prices were statistically significant at the 10% level and calculated point own price elasticities ranged from 2.08 to 0.54 under different model specifications. However, it should be noted that the results of the study are subject to some limitations.¹⁵

Meilke and de Gorter (1988) analyzed the impact of the CAP on international wheat prices and estimated a system model of the EC wheat supply, feed wheat demand, government and commercial stock holding for the time period 1964-1981. Meilke and de Gorter also assumed that farmers form price expectations in a naive fashion, and specified wheat acreage to be a function of simple one and two period lagged deflated wheat prices, and barley prices and a time trend.¹⁶ The coefficient on the price of wheat lagged two years was statistically significant, while the coefficient on the price of wheat lagged only one year was not significant. The coefficient on the lagged price of barley was negative and significant. Own price elasticities corresponding to the one-year and two-year lagged prices were calculated to be 0.34 and 0.67 respectively. The cross price elasticity of wheat acreage response with respect to the price of barley was -0.75.

¹⁴ The deflator used in the study was not specified.

¹⁵ When the threshold price of barley was included in the estimated model, the results (including evidence of statistical significance of variables) were considerably weakened.

¹⁶ The prices were deflated by an index of prices paid by farmers for production requisites.

Meilke and de Gorter also estimated the effects of EC policy prices on farm gate prices following Colman (1985), who first brought attention to the issue of the imperfect transmission of policy prices. Meilke and de Gorter found that a £1 increase in the intervention price, which was recalculated from the ECU using the UK green rates, would increase farm price by £ 0.9, a stronger impact than that reported by Colman, who estimated that a £1 increase in the intervention price would increase the farm gate price by £0.2.¹⁷

The EC Commission's cereal supply model consisted of yield and acreage response equations. The yield equation was specified as a function of a simple time trend and weather variables. The dependent variables in the acreage response models for included crops were calculated as the ratio of the acreage allocated to the individual cereal to total cereal acreage. Previous year expected returns, calculated as price times yield, were used as explanatory variables in the models.

Bewley, Young and Colman (1987) also addressed the problem of estimating cereal supply response by assuming that the allocation of total cereals acreage among crops can be represented as a process of assigning shares of the resource to activities, where the sum of the shares equals one. Thus, each dependent variable was defined as the share of the total area allocated to a particular crop. Bewley, Young and Colman specified a system multinomial logit model and estimated the allocation of the UK cereal area in static and dynamic forms although they did not identify the sample period over

¹⁷ Colman also estimated the effect of a £1 increase of the policy price, which was constructed to take account of the intervention plus threshold price. The results showed an impact of 0.62 pound on the farm gate price.

which the model was estimated. The explanatory variables for each crop equation were the ratio of per hectare gross returns for wheat and barley in the previous year, the ratio of per hectare returns for oats and barley in the previous year, September rainfall in the previous year and total cereal hectares in the current year. All explanatory variables were included in logarithmic form. The results showed that an increase in the ratio of wheat to barley returns had a positive impact on wheat acreage, while an increase in the ratio of oats to barley returns had a negative impact on wheat acreage. Short run partial own-returns elasticities for wheat, barley and oats were 0.09, 0.08, and 0.87 respectively. Colman et al. pointed out that low own returns elasticities were probably obtained because total cereals acreage is assumed to be fixed and thus the elasticities only reflect the redistribution of the total cereals acreage among particular crops. The variable total cereal hectares in the current year was introduced into the model as an independent variable. It can be argued that this variable is actually endogenous, thus introducing a problem of simultaneity which was not addressed in the estimation procedures.

Liapis (1988) examined supply response models for the cereal sector in France. In his discussion on trends in cereal production in France, Liapis pointed out that after the 1960's, when barley yields were slightly above wheat yields, wheat yields notably outperformed barley yields. Wheat yields increased annually at a rate of 3.6% while barley yields only increase at a rate of 2.5% which resulted in wheat yields being on average one ton higher than barley yields in the period 1980-1984. Liapis estimated yield expectations and area response functions for different cereals for the period 1963-1984. In the yield expectation equation, cereal yields were specified to be a function of a simple time trend, a

lagged deflated fertilizer price index and estimated crop area. The estimated yield equation performed well which was reflected in high R^2 and significant coefficients with expected signs. The dependent variable in the acreage response model was harvested acreage which was used as a proxy for acreage planted. Liapis did not assume perfect transmission of policy prices (see Colman, 1985) and instead estimated a price expectation equation in which producer prices were regressed on the current intervention prices. Estimates of expected prices were obtained under the assumption that the intervention price was known to farmers in advance of its announcement. Harvested acreage was then specified to be a function of the crop's own expected price, competing crop expected prices or crop own expected revenues (calculated as expected prices times expected yields). In addition, Liapis included into the acreage equation the harvested acreage area for competing crop(s) which, as expected, had adverse impacts on particular crop harvested area. The results for the wheat acreage equation included a significant positive coefficient for the expected wheat price and a significant negative coefficient for the expected barley price with high own and cross price elasticities of 1.17 and -2.24, respectively. The price elasticity with respect to nominal wheat revenue ranged from 0.07 to 0.18 in the several estimated models.

All but one of the studies reviewed here assumed farmers utilized naive expectations processes and estimated cereal acreage response models with explanatory variables such as current or lagged producer or policy prices, or returns per acre in the previous year. Liapis (1988) developed more sophisticated price and yield expectations models which were used to create variables such as expected wheat and barley returns per

acre. However, Liapis did not include measures of relative profitability among crops, instead estimating the effects of expected prices or returns for wheat and barley separately. The studies by Oury (1966), Colman (1970), and Bewley, Young and Colman (1977) considered the importance of relative profitability among crops. Oury reported that only price of wheat relative to price of barley had a significant impact on wheat planted acreage. Colman found that neither relative returns ratios nor separately included returns variables had a significant impact on wheat or barley planted acreage. Bewley, Young and Colman estimated a multinomial logit model and found that an increase in the ratio of wheat to barley returns per acre had a significant positive impact on wheat acreage and an increase in the oats to barley returns had a significant negative impact on wheat acreage. In the barley acreage response equation, while the coefficient on oats to barley returns variable was again significant and negative, the coefficient on wheat to barley returns had the wrong sign, and was not statistically different from zero.

Some of the above studies also assumed acreage allocation decision for competing crops or for all cereals to be exogenous. It can be argued that planting decisions for all cereals are made simultaneously and that, consequently, variables such as the current acreage of competing crops or total cereal acreage are in fact endogenous. If a model is then estimated by OLS the inclusion of endogenous variable among explanatory variables fails to address the problem of joint dependencies and simultaneity and results in inconsistent parameter estimates. Thus, a specification test, such as the Wu-Hausman test, should be performed to check whether a particular variable is exogenous or endogenous.¹⁸

¹⁸ See Greene (1993) for further discussion.

The issue of relative profitability among agricultural enterprises, the development of more sophisticated price and yield expectations, and the importance of risk in the decision making process will be discussed in the following chapter on the development of the theoretical acreage response model for wheat and barley in England.

CHAPTER 6

THEORY

This chapter discusses theoretical concerns associated with estimating supply response models in agriculture. Important issues that arise in modeling crop planting decisions and supply response include modeling expectations about future conditions, accounting for the effects of uncertainty about prices, yields and revenues, and the impact of the government programs. First, general theoretical concerns will be discussed. Then, specific issues associated with estimating the single commodity wheat and barley acreage response models for the UK will be addressed and the estimation model presented.

General Theoretical Concerns

Estimating supply response models in agriculture has been, and remains, a challenging task for researchers. One of the reasons is the special nature of agricultural production. Lags between production decision and production together with difference between actual production and commodity supply market due to the stocks complicate the examination of effects of prices on agricultural production and visa versa. Further, changing government agricultural programs often make precise statistical estimation from time-series data rather difficult. Colman (1983) has divided empirical agricultural supply response models into two broader categories: programming models and econometric

models. He has further divided the latter into three subclasses: 1) two stage procedures, 2) directly estimated systems, and 3) directly estimated single commodity models.

The theory of the firm provides a basis for estimation of supply response in agriculture by imposing restrictions upon the form of systems of equations, the form of equations themselves and upon parameters values. The theory indicates that for any regular production function there is a dual minimum cost function and visa versa.

Similarly, for any profit maximization function there exists a dual relationship between the production function and the profit function. Empirical agricultural supply response models derived from either the production function, the cost function or the profit function involve what Colman classifies as two stage procedures. The theoretical basis for directly estimated systems models of agricultural supply is agricultural production possibility frontier, or isofactor curve. However, as Colman notes, the majority of agricultural supply response models are directly estimated single commodity models (models included in Colman's class three).

Directly estimated single commodity supply models are inherently partial in nature because they do not account explicitly and systematically for joint commodity production decisions. Colman notes that models in class 3 do not attempt to build up various parameters of supply functions from the technical parameters that underlay them. Instead, behavioral parameters are obtained directly from the statistical analysis of historical time series in which supply responses are modeled in terms of explanatory variables chosen on the basis of economic theory and knowledge of the technical conditions of production. Thus, even though profit maximizing conditions as restrictions upon the supply equation

cannot be fully applied, knowledge of economic theory is essential for constructing the directly estimated single commodity supply response models.

Some studies have derived agricultural supply response models using a framework in which the expected profit function is maximized. Planned production is then a function of all the parameters and variables that appear in the definition of the expected profit function and in the associated constraints (Lee and Helmenberg, 1985). In this approach, expectations about future conditions explicitly influence the behavior of the economic decision makers. If we assume that the decision maker-producer is a risk averse producer who maximizes his expected utility, agricultural supply response will be also influenced by uncertainty. Expected utility theory indicates that the assumption that indifference curves are everywhere convex to the origin is equivalent to the assumption that the producer's Von Neumann-Morgenstern expected utility function is concave. Jensen's inequality theorem then implies that any individual with a concave utility function (risk averse) prefers a sure income prospect to an uncertain income prospect with equal expected value. (Silberberg, 1990). Thus, the production decision of risk averse producers are influenced by the dispersion of expected profits.

In many agricultural supply response models, producer decisions are assumed to be constrained by total acreage and, in some cases, by the producer budget constraint. If the producer is assumed to maximize a Von Neumann-Morgenstern expected utility function, the optimal acreage allocation to each crop will depend on expected input prices, output prices, yields and on measures of dispersion of those prices and yields (see Chavas and Holt, 1990, and Massow and Weersink, 1993). In this framework, planting decisions are

based on the farmer's knowledge of production conditions, expectations about relative prices and yields, changes in government programs and measures of price, yield and/or revenue risk.

Expectations about Future Conditions

Expectations about future conditions play important roles in agricultural production decisions. The timing of the investment (planting) decision and the timing of actual production (harvest) differ. The importance of the formation of expectations in agriculture has led the modeling of producer's expectations to become a fundamental part of the supply response studies. Seminal contributions to modeling expectations were made by Koyck (1954), Nerlove (1956) and Almon (1965). The approach to the formulation of expectation variables has varied considerably across different studies of cereal acreage response. Some studies assume naive price expectations formation processes in which the expected price is assumed to equal the lagged producer price (Colman, 1970, Hoffman, 1973, Garst and Miller, 1975) or the higher of the lagged producer price and the policy price (Chembezi and Womack, 1992). In contrast, Gardner (1976) was among the first to assume that the rational forecast of commodity's expected price is its futures price, arguing that "the price of a futures contract for next year's crop reflects the market's estimate of next year's cash price".¹⁹ Lindman and Bawden (1974) developed a model based on the adaptive expectation mechanism, Burt and Worthington (1988) developed a wheat supply model with an underlying distributed lag structure on

¹⁹ See also Mozruch, Weaver and Helmberger (1980) and Choi and Helmberger (1993).

price variable, and Lin (1977) developed a polynomial lag structure in a response model for wheat acreage. Massow and Weersink (1993) specified a weighted lag structure with preassigned declining weights.

Modeling expectations about future yields presents different problems. Yields are in general subject to random effects caused by variability in weather conditions or pest infestation, which cannot be observed at the time of the planting decision. Thus, these effects are usually difficult to incorporate in yield expectations models. Some impacts on yields also derive from biological effects associated with fertilizer use, technological effects, and also the effects of change in output and input prices. In previous studies, the effects of input prices and fertilizer use have been accounted for by real fertilizer prices, lagged real fertilizer prices (Liapis, 1988) or fertilizer consumption (Oury, 1966).

Technological effects on yields are usually accounted for by a simple linear time trend (Schiff, 1985, Masow and Weersink, 1993, Chavas and Holt, 1990) or linear and quadratic terms for the time trend (Miranda, Novak and Lerohl, 1994). This is largely because of lack of data on variables that would satisfactorily capture changes in the underlying technological processes.

The Influence of Risk in Decision Making Process

Farmers form expectations about future conditions, but are also uncertain about those expectations. The incorporation of risk into supply response models assumes that both the change in the mean expected values of prices and the dispersion of these expectations matter in decision making.

Behrman (1968) was among the first to incorporate risk into econometrics models of supply and developed as a measure of subjective risk a fixed length moving average of squared deviation about a simple moving average of the same length. Just (1974) developed a more general method of evaluating acreage response to changing risk. The expectation of the risk was specified as a geometrically weighted past observation on the risk. Risk was calculated as the variance of revenue (price times yield) as follows:

$$E(R_t) = \phi \sum_{k=0}^{\infty} (1-\phi)^k [Z_{t-k-1} - E(Z_{t-k-1})] , \quad (6.1)$$

where $E(R)$ is the expected risk, Z is an explanatory variable, $E(Z)$ is the expectation of Z , ϕ is a scalar geometric parameter, and t is the time operator. The producer's subjective evaluation of the covariance structure as a risk variable was calculated in a similar fashion.

Chavas and Holt (1990) introduced uncertainty under government price support programs. In their study the support price, which (in the U.S.) places a floor under the market price, was used to truncate the subjective probability distribution for market prices. The variance of price was calculated as a weighted sum of the squared deviations of past prices from their expected values with three year declining weights of 0.5, 0.33 and 0.17. Masow and Weersink (1993) also examined effects of uncertainty under government programs but concentrated on the effect of truncated variance of returns per acre. The variance of returns per acre was not calculated as a simple variance of returns but rather as a variance of the product of yield and price. Masow and Weersink assumed price and

yield to be statistically independent and calculated the variance of returns as follows:

$$\sigma_{return}^2 = E(P_t) \sigma_{y_t}^2 + E(Y_t) \sigma_{p_t}^2 + \sigma_{p_t}^2 \sigma_{y_t}^2, \quad (6.2)$$

where $E(P)$ is expected price, $E(Y)$ is expected yield, σ^2 is the variance of price or yield and t is the time operator. The correct specification of equation 6.3, however, should include the squared terms for $E(P)$ and $E(Y)$; that is,

$$\sigma_{return}^2 = E(P_t)^2 \sigma_{y_t}^2 + E(Y_t)^2 \sigma_{p_t}^2 + \sigma_{p_t}^2 \sigma_{y_t}^2. \quad (6.3)$$

Government Programs

Government programs often have a considerable influence on supply. The “tools” used in government programs include marketing quotas, direct payments, deficiency payments, support prices and acreage restrictions programs. Frequent changes in the structure of government programs makes the estimation of their impacts on supply and supply response in general rather difficult. One possibility is to estimate separate models for the periods with and without government programs (Lee and Helmberger, 1985). This, however, creates some estimation difficulties due to the discontinuity of the samples. The usual approach is to incorporate government programs directly into supply response models. An early method adopted in many studies was introduced by Houck and Subotnik (1969), who developed a single variable called the “effective support price”, which accounted for both price support and acreage restrictions. The support “price floor” was introduced into the supply analysis by truncating the market price. The support price was

also used in the formulation of expected price and impact of support price upon producer price was subsequently analyzed. A common presumption was that an increase in the policy price would cause an increase in the market price by the same amount. Colman (1985) has argued that this is not really the case and that policy prices are transmitted imperfectly; that is, a unitary increase in the policy price results in less than a unitary increase in the market price.

One attribute of government programs is that they usually consist of several "tools" whose levels are jointly determined (Gardner, 1983, Alston and Hurd, 1990, Bullock, 1992, and Alston, Carter and Smith, 1993). Therefore the specification of the model and interpretation of the results for the government program variables requires caution. For example, if the support price for a particular year is connected with participation in acreage restriction programs, an increase in the support price might not increase but rather decrease planted acreage.

A common approach to capturing the impact of changing government programs on supply is to introduce dummy variables to account for policy regime changes. The dummy variable representing a particular program takes on a value of one for the years when the program was in place, and zero otherwise.

Wheat and Barley Acreage Response Models for the UK

The wheat and barley acreage response models developed in this study are the first to examine the separate effects of prices and yields on planted acreage. Considerable

attention is also devoted to the form in which the relevant variables should enter the model equations. Some other specific issues about the wheat and barley acreage response (WBAR) models will be discussed in this section and estimation models will be presented.

The majority of agricultural supply response studies have estimated acreage response models in which only price variables are included or price and yield variables are combined into a single variable, called gross returns or gross revenue per acre (hectare) which is simply calculated as price times yield. To the best of my knowledge, no previous study of cereals supply response in the UK has attempted to examine the separate effects of price and yield on planted acreage. One common reason for combining price and yield into a single returns per acre variable has been lack of sufficient observations and, therefore, a need to preserve degrees of freedom in order to obtain more efficient parameter estimates.

However, Just (1974) has noted that "Nothing in the supply model prevents the separate inclusion of prices and yields and their associate variabilities and covariabilities." Separate movements in prices and yields can have different impacts on forming planting decisions. Thus, in this study we examine the separate effects of prices and yields upon planting decisions. Whether separate variances and covariances for prices and yields should be included as explanatory variables is more problematic. It is not clear to what degree a farmer looks at the uncertainty of prices and yields separately and to what degree he considers the uncertainty of prices and yields together. In this study, for the most part, it is assumed that uncertainty about future crop returns (price times yield) is important in decision making. However, the separate impacts of individual variances of prices and

yields will be considered as well.

Colman (1983) has pointed out that in previous studies insufficient attention had been given to the form in which prices or other relevant variables should enter the supply equation. Theory indicates that the profitability of production influences output decisions. Farm production decisions are usually concerned with multiple outputs. Thus, relative profitability across enterprises among competing agricultural activities is important. Examining only the effects of the price of the crop itself on supply in isolation, therefore, can be misleading. In the period of 1974-1995, for example, the real average wheat price received by farmers in the UK fell steadily. On the other hand, the area planted to wheat in the UK exhibited a strong upward trend. Thus, it is essential to account for the effects of changes in the profitability of other crops.

As in other European countries, the amount of agricultural land in the UK available for cereal production is quite limited. Thus changes in planted acreage for a specific crop are mostly accounted for by shifts in acreage among competing crops.²⁰ In the UK, more than 95% of all wheat and about 75% of all barley are produced in England; therefore, this study examines wheat and barley acreage response in England. In the specification of acreage response models for England, crops competing for arable land were considered to be wheat, barley, and oats. Activities competing for land viable for crops were considered to be animal production activities. By far the major competitors for the arable area were wheat and barley. Figures 2 and 3 in Appendix B show the acreage sown to wheat and barley in two regions in England (West Midlands and East Anglia) during the period 1974-

²⁰ See Bewley, Young and Colman (1987).

1995. The plots for the two crops are almost mirror images of each other, suggesting that land shifts from barley to wheat production and vice versa.

The relative profitability of different crops is determined by both gross revenue and input cost. For the above specified competing crops, production costs, such as the cost of machinery, seems to move closely together, due to similar technologies. In addition even the increase of the cost of fertilizer might not influence the shifts in production among similar crops.²¹ However, the increase could lead to a shift to different agricultural activities, which are not dependent on the use of fertilizer.

It is important to note that the relative prices and yields of competing crops together with input costs are not the only variables that influence farmers' planting decisions. Government programs also play an important role. The UK, during the period of the model estimation 1975-1995, had already joined the EC. Thus the CAP applied to UK agriculture. How should the study embody the impact of the CAP on the wheat and barley supply? The core of the cereal policies of the EC lies in its system of support prices. Thus the effect of CAP support prices can be incorporated directly into price expectations models. The EC also applied several measures in order to control cereal supply such as the guarantee threshold, the maximum guarantee quantity, the co-responsibility levy, and five-year and one-year set aside programs.²² These measures, however, may only have had a very small impact on cereal production. The 1992 CAP Reform, in addition to the reducing support prices, introduced more complex set aside

²¹ If we assume the same or similar biological response of crops to the fertilizer.

²² See chapter one for further discussion.

programs in order to curb cereal production. This study will not try to capture the incentives to participate or not to participate in the set aside programs, as did Fraser (1992). One reason is that the UK met the set aside requirements almost entirely during the first year in which the 1992 CAP Reform was implemented; thus the majority of UK farmers participated in the set aside program. The impacts of the set aside programs implemented in the UK on planted acreage both for 1988 and 1991 and since 1992 will be accounted for by dummy variables.

As was noted earlier, previous studies have examined the effects of prices and yields through a gross returns per acre variable, but separate movements in prices and yields can have different impacts on planting decisions. An examination of movements in the wheat and barley prices in the UK over the period of estimation 1974-1975 shows that wheat and barley annual market prices moved very closely together through the period (See Figure 4 in Appendix B). Intervention prices for soft wheat and barley were identical between 1976 and 1992. In 1976 a higher new intervention price was introduced for wheat of bread making quality in order to reflect lower yields for wheat of bread making quality in comparison with other wheat varieties and thus compensate farmers (Fennell, 1979). In 1993, under 1992 CAP Reform the separate intervention price for soft wheat was abolished and again the intervention price for wheat (wheat of bread making quality) and barley remained equal. The examination of wheat and barley threshold prices in Figure 4 reveals that these prices increased at higher rate than producer or intervention prices for both wheat and barley. The evolution of wheat and barley yields in eight regions in England is shown in Figure 5 in the Appendix B. Figure 5 shows that wheat

yields increased from 1975 to 1995 by 70-75% while barley yields increased by only 50-55%, indicating that on average wheat yields increased at about 0.9% higher annual growth rate than did barley yields. The impact of different movements in prices and yields on planted acreage will be revealed by the empirical estimation of the wheat and barley acreage response models.

Estimation Model

The estimation model is developed on the assumption that changes in an area planted to a particular crop are caused by changes in the relative profitability of competing crops or other competing agricultural activities. In addition it is assumed that changes in acreage are also affected by the change in the price of fertilizer relative to the price of the crop. Further it is assumed that uncertainty about gross returns for an individual crop influences the acreage to be sown to that particular crop. The five year and one year set aside programs and the 1992 CAP Reform set aside program are included in the acreage response model to account for the impact of the Common Agricultural Policy.²³ The effect of the CAP prices will be accounted for in competing price expectation models whose performances are subsequently compared. In addition the hypothesis that change in the ratio of the crop threshold price to crop intervention price had impact on crop planted acreage will be examined. Also, the performance of alternative measures of expected yields will be examined. The general form of the acreage response equation is as follows:

²³ The one year set aside program was implemented in addition to the five year set aside program; thus the effect of both programs will be accounted for by a single dummy variable.

$$A_j = \alpha_j + \sum_c \beta_{cj} \frac{E(P_c)}{E(P_j)} + \sum_c \gamma_{cj} \frac{E(Y_c)}{E(Y_j)} + \theta_j \frac{E(F)}{E(P_j)} + \phi_j \frac{E(P_j^{Thr})}{E(P_j^{In})} + \psi_j E(R_j) + \omega_{1j} SETAS88 + \omega_{2j} CAP1992 + \epsilon_j \quad (6.4)$$

Where,

A	=	area harvested (proxy for area planted)
E(.)	=	expectation operator
P	=	producer price
Y	=	yield per hectare
F	=	price of fertilizer
P^{Thr}	=	threshold price
P^{In}	=	intervention price
R	=	measure of uncertainty-variance of gross returns
SETAS88	=	one for years 1988-1992, zero otherwise (accounts for five and one year set aside programs)
CAP1992	=	one for years 1993-1995, zero otherwise (accounts for CAP 1992 reform set aside program)
j	=	crop, which area response is estimated (wheat, barley)
c	=	competing crops or activities (wheat, barley, oats, animal production) where $j \neq c$
ϵ	=	error term

The expected direction of changes in the crop harvested area due to the changes in individual variables or their ratios are as follows. The partial derivatives of A_j with respect to the expected crop price and yield variables are hypothesized to be negative; that is,

$$\beta_j = \frac{\partial A_j}{\partial \left[\frac{E(P_c)}{E(P_j)} \right]} < 0 \quad (6.5) \quad \gamma_j = \frac{\partial A_j}{\partial \left[\frac{E(Y_c)}{E(Y_j)} \right]} < 0 \quad (6.6)$$

In addition, the partial derivative of A_j with respect to the expected fertilizer/crop price ratio is also hypothesized to be negative; that is,

$$\theta_j = \frac{\partial A_j}{\partial \left[\frac{E(F)}{E(P_j)} \right]} < 0 \quad (6.7)$$

The partial derivative of A_j with respect to the expected crop threshold/crop intervention price ratio is hypothesized to be positive; that is,

$$\varphi_j = \frac{\partial A_j}{\partial \left[\frac{E(P_j^{Thr})}{E(P_j^{Im})} \right]} > 0 \quad (6.8)$$

The effect of increased risk on planted acreage for a specific crop are expected to be negative. Thus, the partial derivative of A_j with respect to the expected uncertainty about the future returns is also hypothesized to be negative; that is,

$$\psi_j = \frac{\partial A_j}{\partial E(R_j)} < 0 \quad (6.9)$$

It is evident that the expected effect of the set aside program is to decrease the planted

area because that is the purpose of the set aside program. However, because the set aside programs apply to total cereal acreage and are not crop specific, the farmer can set aside area sown mostly to competing crops and in fact increase the area sown to crop j . Thus, for individual crops the sign of the coefficient on the set aside program dummy variables may be negative or positive. Therefore the expected signs on of A_j with respect to the set aside program variables are uncertain; that is,

$$\omega_{1j} = \frac{\partial A_j}{\partial SETAS88} \begin{matrix} < \\ = \\ > \end{matrix} 0 \quad (6.10)$$

$$\omega_{2j} = \frac{\partial A_j}{\partial CAPI992} \begin{matrix} < \\ = \\ > \end{matrix} 0 \quad (6.11)$$

Nevertheless, it is important to note that the sum of these coefficients must be negative.

CHAPTER 7

DATA

Data for this study were collected from several different sources. These data and data sources are described in this chapter. Data on yields and harvested acreage were obtained for the eight production regions in England. These regions are: the North, Yorkshire and Humberside, East Midlands, East Anglia, South East, South West, West Midlands and North West. Regional data for wheat and barley harvested acreage and yields were obtained from the Statistics Division, Branch F of the Ministry of Agriculture, Fisheries and Food (MAFF) for the period 1981-1995. Regional data for the period 1974-1980 were provided by Dr. Noel Russell of Manchester University who constructed regional estimates from county data for that period published by MAFF. Additional county level data for England were obtained from MAFF for the period 1970-1973. However, because of changes in county boundaries during a local government reorganization in the UK in 1974, it was impossible to construct estimates of regional wheat and barley acreage that would be consistent with the data reported for the period 1974-1995.

Data on monthly spot prices for wheat, barley and oats for the period 1970-1995 were obtained from the Statistics Division, Branch A of MAFF. These data were constructed by the Home Grown Cereal Authority in the UK. In addition, MAFF

provided data on annual average UK producer prices for wheat, barley and oats through 1970-1994. Prices for the period 1986-1991 were gross of the co-responsibility levy. The monthly and annual prices were reported as per hectare "corn return" prices.²⁴

Data on June and September on-farm wheat and barley stocks were obtained from MAFF for the period 1970-1995. June is the end of the marketing year and thus June stocks represent carryover stocks. September is the last month before the planting decision for wheat is made.

Common Agricultural Policy prices for wheat and barley and the green rates for the UK were obtained from the USDA database-Agricultural statistics of the European Community, 1960-85 and from the various issues of the *Situation and Outlook series - Western Europe* published by USDA. Data on fertilizer and machinery expenditures in 1990 pounds for the UK were obtained from the MAFF database-"Statistics on UK farming and food". Data on fertilizer, animal for slaughter and machinery prices were obtained from MAFF in the form of price indices. The price indices with different base year were recalculated to the common base year of 1990.

²⁴The corn return price system has been used with modifications in the UK since 1882 when the Corn Returns Act was introduced in order to decrease the chance for traders to manipulate prices. The act requires all persons buying British corn to report to the Home Grown Cereals Authority, on weekly basis, details of quantities of corn purchased and prices paid.

CHAPTER 8

PRICE AND YIELD FORECAST MODELS

Chapter 6 discussed the theoretical underpinnings of the potential wheat and barley acreage response models and examined the importance of modeling farmers' expectations about yields and prices and uncertainty about these expectations in the planting decision process. This chapter presents and compare five different price forecast models and three different yield forecast models and also develops empirical measures of uncertainty.

Price Expectations Models

Three general approaches to developing price expectations models are considered in this study. Forecasts of expected prices are obtained using (1) pure time series model, (2) structural models with distributed lags on price, and (3) various naive price expectations approaches.

Time Series Price Expectations Model

In simple univariate time series models, predictions of future movements in the variable of interest are based on the past behavior of that variable. In these models the assumption is made that a farmer who sells his produce on the market is closely observing current and past spot market prices. In the UK, spot market prices are readily available and are reported for every month on a weekly basis in the *Weekly Bulletin* issued by the

Home-Grown Cereal Authority. Time series models assume that the farmers form expectations about future prices of the commodities of interest on the basis of the behavior of past prices.

For wheat prices, the first step in estimating time series model was to examine the autocorrelation function for monthly spot prices for wheat for the period 1970-1995. The autocorrelation function declined very moderately indicating the presence of non-stationarity. Therefore, the series could not be assumed to be invariant with respect to time, and parameters of the model could not be estimated. The series was then first differenced as follows:

$$\Delta P_i = (1 - L) P_i \quad (8.1)$$

where L stands for the lag operator and P_i is a monthly spot price. After first differencing, the autocorrelation function declined substantially after the first lag but, not surprisingly, revealed a strong seasonal pattern with peaks once every 12 months. To account for seasonality the series was therefore differenced a second time with a 12 months lag

$$\Delta^2 P_i = (1 - L^{12}) \Delta P_i \quad (8.2)$$

For the twice differenced series, the autocorrelation function showed a smoother seasonal pattern. However, the null hypothesis that the residuals for the series exhibited white noise was rejected using the X^2 test. Thus, even this twice differenced time series could not be assumed to be stationary and a different approach was required.

To smooth seasonal effects the monthly data were aggregated to quarterly data by computing the average monthly price over each quarter. Data aggregation results in some loss of information. However, the monthly price data were aggregated in order to smooth

out seasonal effects and to solve the problem of non-stationarity.²⁵ The quarterly data were again twice differenced to account for drift and seasonal effects as follows:

$$\Delta P_k = (1 - L) P_k \quad (8.3) \quad \text{and} \quad \Delta^2 P_k = (1 - L^4) \Delta P_k \quad (8.4)$$

where P_k denotes the quarterly average price. The autocorrelation function was again examined and again revealed non-stationarity in the series. Thus, instead, to take account of quarterly seasonal effects, quarterly dummy variables were introduced to the time-series model. The series were differenced only once and four dummies were used in the estimation of autoregressive integrated moving average models of the form of an ARIMA(p,d,q), where p represents a number of autoregressive (lagged dependent variable) terms, d represents the number of times the series was difference and q represents the number of lagged moving average terms.²⁶ For example an ARIMA(3,1,2) model without an intercept term is represented by the equation

$$\Delta P_t = \beta_1 \Delta P_{t-1} + \beta_2 \Delta P_{t-2} + \beta_3 \Delta P_{t-3} + \varepsilon_t + \gamma_{t-1} \varepsilon_{t-1} + \gamma_{t-2} \varepsilon_{t-2} \quad (8.5)$$

Determining the appropriate number of lags, p and q, generally involves ad hoc procedures, although examining the partial autocorrelation function for the model is sometimes helpful. Several ARIMA models were specified and estimated using the ARIMA procedure in SAS (1989) by maximum likelihood methods. These models were

²⁵ If data on crops quantity sold per month were available, each month could be assigned a weight according to quantity sold in that particular month and several months weighted average of forecasted prices could be calculated.

²⁶ Four, instead of three, dummy variables were used because the model was estimated without the intercept term.

than compared using Akaike's information criterion (AIC), X^2 statistic, and the root mean square error (RMSE).²⁷

In this case, the RMSE is sufficient for comparison because the dependent variable is identical in each model and thus no scaling problem exists. Table 23 in Appendix C presents summary statistics for the three most satisfactory models estimated for quarterly wheat prices, where AR_i represent the i 'th autoregressive term, MA_i represent the i 'th moving average term and the variables represent four quarters of the year beginning January. In all three models, the null hypothesis that residuals exhibit white noise was not rejected using the X^2 test. The ARIMA(6,1,3) model displays the best fit according to the AIC, RMSE, and X^2 statistics. Thus, this model was chosen used in a step-wise forecast of quarterly wheat prices. The autocorrelation function for the simulated series generated by the ARIMA(6,1,3) model was compared with the sample autocorrelation function of the original series. The two autocorrelation functions showed the same pattern which indicated that model was not misspecified. The percentage forecast error was 5.6 percent.²⁸

Similar procedures were used to develop price forecast models for malting barley and milling oats. After aggregating monthly price data for malting barley to obtain a quarterly series and differencing once, several ARIMA models were estimated, again using dummy variables to account for seasonality. The results of the most satisfactory models

²⁷ AIC is computed as $-2\ln(L) + 2k$ where L is the likelihood function and k is the number of free parameters. The X^2 statistic is computed as $X^2_n = n(n+2)\sum r_k^2 / n-k$ where $r_k = \sum e_t e_{t-k} / \sum e_t$ where e_t is the residual sequence.

²⁸ The percentage error of forecast was calculated as $(RMSE/Dep.mean)*100$.

for malting barley are presented in Table 24 in Appendix C. The ARIMA (5,1,3) model appears to perform best and was used in the step-wise forecast of quarterly barley prices. Monthly prices for milling oats were also aggregated to obtain quarterly data, once differenced and several ARIMA models, were also estimated using the dummy variables to account for seasonal effects.

The results for the most satisfactory three models for oats are presented in Table 25 in Appendix C. Even though the ARIMA(8,1,4) model is preferred on the basis of the RMSE and the X^2 statistic, the AIC statistic is more satisfactory for the ARIMA(6,1,3) model and not much is gained by including two additional AR terms and one additional MA term. Thus the ARIMA(6,1,3) model was chosen for the step-wise forecast of quarterly price for milling oats. The autocorrelation functions both for the simulated series of malting barley prices and milling oats prices exhibited similar patterns with their sample autocorrelation functions, again indicating the models were not misspecified. The percentage forecast error was 5.7 percent for barley and 6.3 percent for oats.

Structural Price Expectations Model

A time series model is described as a "structural" model when its form is derived from underlying economic theory. The term "structural" is more often used when talking about multi-equation models such as supply-demand models or macroeconomics models. In this study single equation price forecast models are developed for forecasting wheat and barley prices. This time series model assumes that a farmer understands the economic environment in which he operates and in particular the development in the Common

Agricultural Policy (CAP). The basic structure of the CAP and its historical evolution were described in part one. Recall that the intervention price for a commodity is a guaranteed price for producers and can be considered to play an important role in forming farmers' expectations of future prices. Future grain prices are also influenced by large carryover stocks of grains on farms, which usually result in lower grain prices in the following marketing year. Thus a variable indicating an amount of stocks on farms in the end of the marketing year was included in the models.

To account for movements in market prices in forming price expectations, a dynamic structure is specified and lagged dependent variables are included in the model. A single equation structural price forecast model is then specified as follows:

$$P_{t,i} = \alpha_i + \sum_{j=1}^k \beta_{i,j} P_{t-j,i} + \beta_{i,k+1} PINT_{t,i} + \beta_{i,k+2} STOCKS_{t,i} \quad (8.6)$$

where	P	= annual average market price (from 1986 to 1991 gross of coresponsibility levy-viz.Part One)
	PINT	= intervention price
	STOCKS	= stocks on farms in England
	t	= time operator
	k	= number of lags
	I	= wheat or barley

After 1976, the CAP program for wheat included two intervention prices: the intervention price for soft wheat and the intervention price for wheat of bread making quality. After 1992, under the 1992 CAP reforms, the intervention price for soft wheat

was abolished. Thus, even though the dependent variable in the wheat price model is the annual average price of all wheat, the variable PINT in the wheat price model was constructed from the intervention price for wheat of bread making quality for period 1976-1995 and from the intervention price for all wheat prior to 1976. This model specification assumes that only the intervention price for wheat of bread making quality was relevant in forming farmers' expectations about future wheat prices.

The majority of wheat and barley in the UK is planted in the fall months, then harvested in the late summer of the following year, and then marketed. Thus a two-step forecast process is required. To understand why the expected price should be forecasted in two-steps, consider the following simple example: In the fall of 1993, a farmer makes a decision about how much to plant of each crop or whether to plant at all based on the expected price at which the crop will be sold in the following marketing year 1994-1995. At the time of the decision, the farmer does not know what the overall price will be even for the marketing year 1993-1994. Thus the price expectations for 1994-1995 are also based on the expected price for 1993-1994.

For clarity, consider the illustration of this example in the framework of the theoretical model developed in the equation 8.6. In the first step, a price for 1993-94 is forecast as follows:

$$P_{93/94} = \alpha + \beta_1 P_{92/93} + \beta_2 P_{91/92} + \beta_3 P_{90/91} + \beta_4 PINT_{93/94} + \beta_5 STOCKS_{June\ 93} \quad (8.7)$$

In the second step a price for the 1994-1995 marketing year is forecast using expected price from the first step PHAT. The forecast equation can be written as follows:

$$P_{94/95} = \alpha + \beta_1 PHAT_{93/94} + \beta_2 P_{92/93} + \beta_3 P_{91/92} + \beta_4 PINT_{94/95} + \beta_5 STOCKS_{Sept. 93} \quad (8.8)$$

The assumption is made that a farmer knows the exact intervention price for the following marketing year, which was not always the case. However, debates of the CAP cereal policies in the Council of Ministers and the EU Commission proposals often provided accurate information about future movements of the intervention prices. In the second step, stocks on farms in the end of September are used because it is the last month when the farmer can observe stocks before planting decisions for wheat are made. In this fashion, the two-step forecast models are then estimated for wheat and barley annual average producer prices. Several different lags on the market price were specified in the wheat and barley structural price forecast models.

Table 6 presents the most satisfactory structural models for wheat price forecast. High R^2 adjusted and F-values indicate a good fit. The percentage error of forecast (%RMSE) shows a small deviation of forecasted values from observed values, which also indicates a good fit.²⁹ This measure is similar to Theil's U statistics which is the squared root of the ratio of the mean square error of the predicted change to the average squared actual change. In both steps, coefficients for the variable PINT are significant at the 1% level indicating an important role for the intervention price in the wheat market. These results also confirm Colman's findings that policy prices are transmitted imperfectly.

²⁹ The percentage error of forecast was calculated as $(RMSE/Dep.mean) * 100$.

Table 6. Two-step Forecast Model for the Price of Wheat

FIRST STEP $t = 73/74$ to 94/95		SECOND STEP $t = 74/75$ to 94/95	
Variable	Parameter Est.	Variable	Parameter Est.
INTERCEPT	35.748 (8.35)	INTERCEPT	32.357 (4.72)
P_{t-1}	-0.218 (-1.63)	$PHAT_{t-1}$	-0.133 (-0.64)
P_{t-2}	0.052 (0.41)	P_{t-2}	-0.032 (-0.21)
P_{t-3}	0.269 (2.61)	P_{t-3}	0.415 (2.87)
$PINT_t$	0.604 (7.55)	$PINT_t$	0.605 (6.52)
$STOCKS_{June\ t}$	-0.021 (-3.51)	$STOCKS_{Sept.\ t}$	-0.002 (-1.71)
Number of observations 22		Number of observations 21	
Adj R^2 0.9710 F-value 141.440		Adj R^2 0.9518 F-value 79.979	
DW 1.397 %RMSE 3.44%		DW 2.342 %RMSE 3.92%	

(The values of T-statistics are reported in parentheses)

Note that parameter estimates for the variable STOCKS have expected signs in both steps, and are significant at the 1% and 10% level, respectively.

Table 7 presents the most satisfactory structural forecast model for the price of barley. The results are not as satisfactory as for the price of wheat forecast model. Nevertheless the adjusted R^2 's and F-values indicate a fairly good fit. The percentage forecast errors are higher than for the wheat price models, but are still quite small. As in the wheat forecast model the intervention price is significant at the 1% level in the barley forecast model.

Table 7. Two-step Forecast Model for the Price of Barley

FIRST STEP $t = 73/74$ to 94/95		SECOND STEP $t = 74/75$ to 94/95	
Variable	Parameter Estimates	Variable	Parameter Estimates
INTERCEPT	32.9783 (2.05)	INTERCEPT	29.1847 (2.07)
P_{t-1}	0.1096 (0.43)	$PHAT_{t-1}$	0.0337 (0.09)
P_{t-2}	0.1470 (0.96)	P_{t-2}	0.1987 (0.86)
$PINT_t$	0.4676 (3.36)	$PINT_t$	0.5189 (3.48)
$STOCKS_{June\ t}$	-0.0176 (-0.62)	$STOCKS_{Sept.\ t}$	-0.0003 (-0.22)
Number of observations 22		Number of observations 21	
Adj R^2 0.9433 F-value 88.416		Adj R^2 0.9183 F-value 57.207	
DW 1.795 %RMSE 4.97%		DW 1.709 %RMSE 5.14%	

(The values of T-statistics are reported in parentheses)

Parameters estimates for the variable STOCKS have correct signs in both steps but neither is statistically significant. Even though the barley model does not perform as well as the wheat price model, it is still quite satisfactory. The marketing price for 1995-1996 was not available, thus the last observation in both models, the forecast price for 1995-1996 marketing year, had to be calculated as an out of sample forecast. All explanatory variables for 1995-1996 forecast in both models were available and therefore did not have to be forecasted themselves.

Naive Price Expectations

In the "naive" price expectations, the producer is assumed to consider the current period price to be the price that will be obtained in the next period. This study considers three possibilities for the mechanism by which farmers formulate naive price expectations. First, the naive expected price in period t is assumed to be equal to the actual annual average producer price of the previous year.³⁰ Second, the naive expected price in period t is assumed to be equal to the actual intervention price in the previous year. As was explained earlier, the intervention price is the guaranteed minimum price; thus, it is of interest to test the impact of this price on the producer's decisions. Third, the naive expected price in period t is assumed to be the higher of the observed annual average producer's price and the actual intervention price in the previous year.

Summary

In this section, alternative five price forecast models have been developed for each commodity of interest (wheat, barley and oats). The two more sophisticated types of models are the ARIMA time series price forecast models and "structural" time series price forecast models. The performance of the expected prices estimated from these two models together with expected prices constructed by naive expectations methods will be evaluated in context of the wheat and barley acreage response models reported in chapter 10.

³⁰ The same price as was used in the development of the structural price expectations model in the previous section.

Yield Expectations Model

A common approach to estimating yield expectations models is to specify yield as a function of a simple time trend to account for technological progress, or as a function of that time trend and the real fertilizer price in the previous year. The limitation of simple time trend models is that they assume that technological change occurs at a constant linear rate over time and thus do not impose any restrictions on yield growth.

In this study, several yield trend models with different functional forms are estimated.³¹ A time trend variable is used as a proxy for technological change, but the estimated yield trend models do not assume that technological change occurs at a constant rate over time. In fact, yields may increase over time but at a decreasing rate. The following three yield trend models are estimated for each of the eight production region and for each crop:

MODEL 1. Exponential quadratic

$$Y_{ij} = e^{\alpha + \beta_1 * T + \beta_2 * T^2}$$

MODEL 2. Nonlinear negative exponential

$$Y_{ij} = \beta_0 - \beta_0 * e^{-\beta_1 * T}$$

MODEL 3. Nonlinear

$$Y_{ij} = \beta_0 + \beta_1 * T^\gamma$$

where Y_{ij} is annual average yield in the i 'th region for the j 'th crop (wheat or barley), and T is the time trend. The performance of these three models for each region and each crop is compared using the percentage error of the forecasted models calculated as

³¹ The impact of real fertilizer price of previous year on yields was also tested, however, with unsatisfactory results.

(RMSE/Dep.Mean)*100. Plots of predicted values are also compared with plots of actual values in each model.

The exponential quadratic model (Model 1) is estimated by OLS procedure in SAS (1989) for each region and crop.³² The coefficient β_1 is significant and positive in all eight regions, while β_2 is significant and negative in all regions but the North and North West. These results confirm the earlier assumption about concave upward sloping yield curve.³³

The nonlinear negative exponential model (Model 2) is estimated for each region and crop by NLIN procedure in SAS using the Gauss-Newton technique. This model performs reasonably well for wheat, but not for barley.

The nonlinear time trend model (Model 3) is also estimated for each region and crop by the NLIN procedure in SAS using the Gauss-Newton technique. Positive values for coefficients β_1 and coefficient $\gamma < 1$ indicate that yields increased over time at a decreasing rate. The fit of the predicted values from Model 3 is almost identical to the fit of predicted values from Model 1. In all three models, the null hypothesis of no autocorrelation among residuals ($\rho=0$) is not rejected at a 5% significance level based on the D.W. statistics table. Table 8 presents the percentage deviation of the forecasted value from the dependent mean for wheat and barley in each region. Model 2 for barley is not reported due to its poor fit.

³² OLS procedure was applied after taking logs of both sides of Model 1 equation.

³³ The disadvantage of the Model 1 is that the squared term on variable T would eventually force predicted yields in out-of-sample forecast to decline, which might not be the real case.

Table 8. Percentage Deviation of the Forecasted Values from the Dependent Mean.

REGION	WHEAT			BARLEY	
	Model #1	Model #2	Model #3	Model #1	Model #3
North	10.04%	17.91%	9.93%	8.79%	8.70%
York&Hum.	8.79%	14.90%	8.92%	7.25%	7.18%
East Midlands	10.16%	15.40%	10.03%	8.99%	8.77%
East Anglia	9.93%	14.69%	9.45%	7.79%	7.57%
South East	10.24%	13.90%	9.72%	8.28%	8.34%
South West	9.88%	12.50%	8.84%	9.02%	8.46%
West Midlands	9.63%	14.10%	8.89%	9.45%	9.18%
North West	9.89%	13.93%	9.20%	1.13%	1.07%

Yield trend models for each region and crop with the lowest percentage deviation of forecasted value from the dependent mean were selected (in Table 8 printed in bold), and estimated forecasted values from these models were used as expectations of future yields in the wheat and barley acreage response model.

Measure of Uncertainty

The approach taken here to develop a measure of gross revenue uncertainty is similar to the approach used by Masow and Weersink (1993). As noted above, revenue uncertainty derives from both uncertainty about future yields and prices.

The theoretical estimation model developed in Chapter 6 assumes that uncertainty about future returns is what is important to farmers rather than uncertainty about individual variances in future yields and prices. The revenue uncertainty is defined as the

variance of the mathematical product of yield and price rather than a simple variance of returns (calculated as price times yield). The variance of returns is then specified as follows:

$$\begin{aligned}\sigma_{PY_t}^2 = & E(P_t)^2 \sigma_{Y_t}^2 + E(Y_t)^2 \sigma_{P_t}^2 + 2E(P_t)E(Y_t) \sigma_{PY_t} - (\sigma_{PY_t})^2 + \\ & + E[(P_t - E(P_t))^2 (Y_t - E(Y_t))^2] + 2E(Y_t)E[(P_t - E(P_t))^2 (Y_t - E(Y_t))] + \\ & + 2E(P_t)E[(P_t - E(P_t)) (Y_t - E(Y_t))^2]\end{aligned} \quad (8.9)$$

The assumption that price and yield are independent implies that (8.9) can be simplified as follows:

$$\sigma_{P_{t,j}Y_t}^2 = E(P_{t,j})^2 \sigma_{Y_t}^2 + E(Y_t)^2 \sigma_{P_{t,j}}^2 + \sigma_{P_{t,j}}^2 \sigma_{Y_t}^2 \quad (8.10)$$

The subscript j in equation 8.10 stands for the expected price estimated from the pure time series forecast model or the expected price estimated from the structural forecast model.

The independent variances of price and yield are calculated as follows; the variance of yield was specified as a weighted sum of the squared deviations of past yields from their expected values, with declining weights. Declining weights used in this study were 0.5, 0.333, and 0.166 respectively. The variance of yield for wheat and barley in each region was then calculated as follows:

$$\sigma_{Y_t}^2 = 0.5 [Y_{t-1} - E(Y_{t-1})]^2 + 0.333 [Y_{t-2} - E(Y_{t-2})]^2 + 0.166 [Y_{t-3} - E(Y_{t-3})]^2 \quad (8.11)$$

where $E(\cdot)$ is the expectation operator, Y is the regional crop yield, and t is the time operator. The observations on yields for each region were available for the period 1974-1995. Thus, the variance of yield illustrated in equation 8.11 could be calculated only for the period 1977-1995. In order to preserve two degrees of freedom for the estimation of the wheat and barley acreage response models, the variance of yield for 1976 is calculated differently, as follows:

$$\sigma_{Y_t}^2 = 0.6 [Y_{t-1} - E(Y_{t-1})]^2 + 0.4 [Y_{t-2} - E(Y_{t-2})]^2 \quad (8.12)$$

and the variance of yield for the year 1975 is assumed to be equal to the variance of the yield of the previous year (1974).

$$\sigma_{Y_t}^2 = [Y_{t-1} - E(Y_{t-1})]^2 \quad (8.13)$$

The measure of uncertainty about future prices is developed and calculated in exactly the same fashion as shown in equations 8.11, 8.12, and 8.13. The variances of returns for wheat and barley computed as illustrated in equation 8.10 were used as a measure of uncertainty in the wheat and barley acreage response models.

CHAPTER 9

WHEAT AND BARLEY ACREAGE RESPONSE ESTIMATION MODELS AND EMPIRICAL RESULTS

The previous chapter described different price and yield forecast models and the development of measures of revenue uncertainty. This chapter presents empirical results obtained from several alternative wheat and barley acreage response (WBAR) models. First, we compare the relative performance of the five different price forecast variables developed in chapter 8. Next, we compare the performance of the regional forecasted yields developed also in chapter 8 with the naive yield forecast in which the current yields are expected to be equal to the yield in the previous year. The predicted prices obtained from pure time series model and predicted yields obtained from trend forecast models are then used to estimate WBAR models that include variables to account for price and yield uncertainty and to test the hypothesis that increasing gap between the threshold and intervention price for wheat has had a significant impact on planted acreage for wheat and barley.

The empirical results presented in this chapter provides insights about the effect of relative output prices, relative yields, the role of risk and the impact of the CAP set aside programs on planted wheat and barley acreage. The results are discussed and summarized at the end of the chapter.

Econometric Method and Variables Definitions

The estimation equation developed in Chapter 6, equation 6.4, includes a large number of potential explanatory variables, creating a problem with respect to degrees of freedom in the estimating of the individual models for each region. To obtain more efficient parameter estimates, the regional data for the period 1975-1995 are combined, creating a time series-cross sectional data set. No previous study has estimated an acreage response model for the UK using time series-cross section regional data. The use of combined time series-cross section (TS-CS) data creates some difficulty in estimation and requires the appropriate stochastic specification of the model. Two commonly used approaches in estimating TS-CS models are the fixed effect (FE) approach and the random effect (RE) approach. Mundlak (1978) provides a detailed discussion on the relation and estimation of FE models and RE models. Simplifying, the RE model saves some degrees of freedom, thus generates more efficient estimates of regression parameters. Conversely, if the cross sections characteristics (individual effects) are correlated with the explanatory variables, the estimated parameters of the RE model are biased and inconsistent.

The advantage of the FE model is that, if the individual effects are correlated with the explanatory variables, the estimated parameters do not suffer from bias and inconsistency. On the other hand, the inclusion of dummy variables in the FE models is costly in terms of degrees of freedom, creating loss of efficiency, especially when the FE model uses a longitudinal data set.³⁴

³⁴ See Kmenta (1986) and Greene (1993) for further discussion.

Regional dummy variables were included into the wheat and barley acreage response (WBAR) models in order to avoid the specification error caused by the correlation between individual effects and explanatory variables. The usual assumption about the least square dummy variable (LSDV) model, that the error term $\epsilon_{i,t}$ satisfies the requirements of the classical normal linear regression model, could not be maintained in this study because analysis of the data revealed the presence of first order autocorrelation that varied across regions. Further, because the regions in this study are geographically adjoining and are not drawn from a large sample, statistical independence among cross sectional units (regions) could not be assumed. The WBAR models were therefore estimated by Time Series Cross Section Regression (TSCSREG) Procedure in SAS using the PARKS method.³⁵ The error term in the PARKS method is considered to have the following structure:

$$\begin{aligned}
 E(\epsilon_{i,t}^2) &= \delta_{i,t} && (\text{heteroscedasticity}) \\
 E(\epsilon_{i,t} \epsilon_{j,t}) &= \delta_{i,j} && (\text{contemporaneously correlated}) \\
 \epsilon_{i,t} &= \rho_i \epsilon_{i,t-1} + u_{i,t} && (\text{autoregression})
 \end{aligned}$$

where I-is the cross section (regional) operator and t is the times series operator.

Definitions of the variables used in the estimation of wheat and barley acreage response model are presented in Table 9.

³⁵ See Chapter 18 in SAS/ETS User's Guide (1993) and Parks (1967).

Table 9. Definition of the Variables Used in the WBAR Models

Name	Definition	Data used
BAWHPR3 OAWHPR3 WHBAPR3 OABAPR3	Barley to wheat price ratio Oats to wheat price ratio Wheat to barley price ratio Oats to barley price ratio	Expected prices of the third quarter of the year forecasted from the time series model using the market spot prices
BAWHHAT2 WHBAHAT2	Barley to wheat price ratio Wheat to barley price ratio	Expected prices forecasted in two-steps from the structural model using the average annual producer prices
BAWHLAG WHBALAG	Barley to wheat price ratio Wheat to barley price ratio	Average annual producer prices of the previous year
BAWHINLG WHBAINLG	Barley to wheat price ratio Wheat to barley price ratio	Intervention prices of the previous year
BAWHCOM WHBACOM	Barley to wheat price ratio Wheat to barley price ratio	Combination of the higher prices of the producer price and the intervention price of the previous year
YILBAWH YILWHBA	Barley to wheat yield ratio Wheat to barley yield ratio	Actual yields of the previous year
BAWHYIP WHBAYIP	Barley to wheat yield ratio	Expected yields forecasted from the yields trend models
WHTHINLG	Wheat threshold to intervention price ratio	Threshold and intervention prices of the previous year
BATHINLG	Barley threshold to intervention price ratio	Threshold and intervention prices of the previous year
RWHPR3	Measure of uncertainty	Variance of the wheat gross revenue
RBAPR3	Measure of uncertainty	Variance of the barley gross revenue
CAP1992	CAP 1992 set aside program	One for years 1993-1995, zero otherwise
SETAS88	CAP five and one year set aside program	One for years 1988-1992, zero otherwise

The Comparison of Different Expected Price and Yield Variables

A large number of alternative specifications for the WBAR models were estimated using each of the five expected price variables and two alternative expected yield variables. In this section results from a representative model are presented to permit a discussion of the relative performance of the different price and yield expectations models.

To illustrate the performance of the alternative price and yield variables each model uses different price or yield expected variable but an identical set of additional explanatory variables. For simplicity, Tables 10 and 11 present models where in addition to price and yield variables only the regional dummy variables and the CAP set-aside program variables are included in the model specification. The pattern of the results illustrated in Tables 10 and 11 are largely replicated for models that include other sets of explanatory variables.

In Tables 10 and 11 Model 1 is based on expected prices for the third quarter of the year developed from time series models.³⁶ Model 2 is based on the expected prices developed from the structural models for each commodity price and Models 3,4 and 5 are based on each of the three naive price expectations models. The coefficients and the values of t-statistics for each expected price variable are printed in bold.

³⁶ The prices for the third quarter of the year are used in the representative model, because in model estimation they outperformed the forecasted prices for fourth quarter. The potential explanation is that most of the grains are marketed after harvest in August and September and spot prices are more important for farmers in this time than later in the year when the open intervention purchases begin in November.

Table 10. Comparison of Price Expectations Variables (WHEAT)

Dependent variable: WHEAT ACREAGE					
Number of Cross Sections 8		Time Series Length 21		DFE 156	
	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
Independent variable	Param. estimate	Param. estimate	Param. estimate	Param. estimate	Param. estimate
INTERCEPT	442.950 (15.97)	309.934 (6.97)	414.129 (9.20)	357.194 (6.49)	445.160 (12.41)
BAWHPR3	-77.152 (-3.15)				
BAWHHAT2		54.884 (1.21)			
BAWHLAG			-51.439 (-1.18)		
BAWHINLG				4.446 (0.08)	
BAWHCOM					-75.174 (-2.11)
YILBAWH	-86.029 (-7.19)	-83.368 (-7.13)	-84.991 (-7.07)	-80.481 (-6.80)	-97.613 (-6.93)
North	-256.013 (-25.09)	-257.834 (-26.10)	-257.480 (-25.57)	-258.510 (-27.07)	-259.961 (-32.52)
York&Hum.	-93.835 (-6.67)	-107.970 (-12.83)	-104.670 (-10.97)	-106.798 (-12.17)	-108.488 (-12.54)
Eastmidl.	26.252 (2.77)	25.592 (3.02)	26.011 (2.86)	26.056 (3.04)	26.547 (3.30)
Southeast	100.357 (3.72)	100.975 (4.34)	101.560 (4.51)	101.913 (4.61)	103.701 (5.21)
Southwest	-144.413 (-13.46)	-147.659 (-20.09)	-147.517 (-17.38)	-147.966 (-19.77)	-148.463 (-29.00)
Westmidl.	-173.488 (-17.90)	-175.918 (-21.23)	-175.560 (-19.57)	-176.519 (-21.73)	-176.850 (-26.76)
Northwest	-287.057 (-22.03)	-289.337 (-23.32)	-288.898 (-22.85)	-290.154 (-24.15)	-291.954 (-28.61)
CAP1992	12.794 (2.09)	12.411 (1.82)	17.828 (3.24)	17.479 (2.32)	25.176 (4.30)
SETAS88	16.176 (3.35)	13.806 (2.88)	15.458 (3.63)	15.394 (2.78)	20.557 (4.83)
adj. R ²	0.912	0.910	0.909	0.909	0.917

(The values of T-statistics are reported in parentheses)

Table 11. Comparison of Price Expectations Variables (BARLEY)

Dependent variable: BARLEY ACREAGE					
Number of Cross Sections 8		Time Series Length 21		DFE 156	
	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
Independent variable	Param. estimate	Param. estimate	Param. estimate	Param. estimate	Param. estimate
INTERCEPT	401.175 (14.26)	194.451 (3.95)	235.558 (4.51)	182.060 (3.04)	293.317 (7.72)
WHBAPR3	-80.098 (-3.20)				
WHBAHAT2		119.943 (2.63)			
WHBALAG			74.586 (1.56)		
WHBAINLG				109.219 (2.11)	
WHBACOM					19.839 (0.60)
YILWHBA	-58.089 (-7.14)	-56.296 (-7.18)	-51.296 (-6.36)	-45.320 (-6.32)	-52.898 (-6.33)
North	-126.691 (-12.81)	-123.507 (-12.69)	-124.347 (-12.67)	-124.156 (-13.81)	-123.842 (-15.63)
York&Hum	-14.840 (-2.49)	-13.727 (-2.80)	-14.078 (-2.40)	-13.352 (-2.29)	-13.536 (-2.60)
Eastmidl	-31.408 (-2.68)	-28.725 (-3.03)	-28.415 (-2.98)	-26.433 (-2.71)	-25.813 (-3.62)
Southeast	54.057 (2.72)	54.483 (3.45)	54.379 (3.23)	57.673 (3.57)	54.869 (3.09)
Southwest	-24.058 (-4.05)	-22.590 (-4.26)	-22.848 (-4.03)	-22.611 (-4.10)	-21.969 (-4.42)
Westmidl	-98.048 (-14.31)	-95.398 (-15.20)	-95.769 (-14.97)	-95.485 (-15.70)	-94.895 (-16.99)
Northwest	-175.169 (-10.14)	-164.991 (-7.96)	-168.685 (-8.80)	-166.639 (-9.25)	-171.803 (-12.42)
CAP1992	-70.171 (-11.82)	-65.608 (-9.65)	-68.268 (-10.60)	-60.502 (-7.63)	-75.416 (-12.20)
SETAS88	-36.349 (-7.77)	-31.435 (-6.55)	-31.704 (-6.47)	-26.183 (-4.46)	-36.850 (-8.11)
adj.R ²	0.849	0.845	0.836	0.837	0.846

(The value of T-statistics are reported in parentheses)

Coefficients for the variable BAWHPR3 in Model 1 for wheat and the variable WHBAPR3 in Model 1 for barley are both negative and statistically significant at a one percent level. The coefficient for the ratio of the expected price of barley to the expected price of wheat in Models 2, 3, 4 and 5 either have incorrect signs or are not statistically different from zero. Only when in Model 5, the annual average producer price of the previous year was combined with the intervention price of the previous year were the results more satisfactory for wheat. In each wheat and barley model, the coefficient for the ratio of barley to wheat yields in the previous year were negative, as expected, and statistically significant at the 1 percent level of significance. The adjusted R^2 statistics is almost identical for each model. However, in Models 1 and 5 for wheat and barley the values of adjusted R^2 's are slightly higher.³⁷ In general the adjusted R^2 is higher for wheat models than for barley models indicating better fits for the former. Model 1, in which the expected price variables were forecast of third quarter spot prices seems to be the most satisfactory in explaining changes in wheat and barley acreage planting decisions.

Next we compare the performance of a widely used naive yield expectations variable (YILBAWH, YILWHBA), where the expected yield in year t is assumed to be equal to actual yield in year $t-1$, with the more sophisticated yield expectations variable developed from the yield trend models (BAWHYIP, WHBAYIP). Model 1 from Tables 10 and 11, which incorporates the most satisfactory expected price variables, was reestimated with these two alternative expected yield variables. Table 12 presents the

³⁷ Because the TSCSREG procedure does not provide comparable measure of goodness of fit, the predicted values and residuals were obtained from regression equations and the adj. R^2 was calculated as follows: $1 - (1 - [1 - SSE/SST]) * (N - 1/N - K)$.

results for the wheat acreage response model. The magnitude and statistical significance of the coefficient for the variable BAWHYIP are substantially higher than for the variable YILBAWH.

Table 12. Comparison of Yield Expectations Variables (WHEAT)

Dependent variable: WHEAT ACREAGE		
	MODEL 1.1	MODEL 1.2
Indep. variable	Param. estimate	Param. estimate
INTERCEPT	442.950 (15.97)	709.126 (26.61)
BAWHPR3	-77.152 (-3.15)	-29.481 (-1.37)
YILBAWH	-86.029 (-7.19)	
BAWHYIP		-491.330 (-16.13)
North	-256.013 (-25.09)	-252.569 (-22.02)
York&Hum.	-93.835 (-6.67)	-80.941 (-7.05)
Eastmidl.	26.252 (2.77)	35.277 (4.77)
Southeast	100.357 (3.72)	111.607 (4.40)
Southwest	-144.413 (-13.46)	-135.236 (-13.53)
Westmidl.	-173.488 (-17.90)	-156.331 (-19.09)
Northwest	-287.057 (-22.03)	-286.601 (-22.36)
CAP1992	12.794 (2.09)	-12.730 (-2.29)
SETAS88	16.176 (3.35)	6.303 (1.45)
adj.R ²	0.912	0.904

(The value of T-statistics are reported in parentheses)

Further, the negative coefficient for the CAP 1992 set-aside program in Model 1.2 seems to be more plausible than the positive coefficient for the same variable in Model 1.1. Given that majority of farmers in the UK participated in the CAP 1992 set-aside program,

it is reasonable to expect wheat acreage to decrease, despite the fact that this set-aside program is not crop specific (see chapter 6).

Table 13. Comparison of Yield Expectations Variables (BARLEY)

Dependent variable: BARLEY ACREAGE		
Number of Cross Sections	8	Time Series Length 21 DFE 156
	MODEL 1.1	MODEL 1.2
Indep. variable	Param. estimate	Param. estimate
INTERCEPT	401.175 (14.26)	665.917 (10.31)
WHBAPR3	-80.098 (-3.20)	-38.744 (-1.27)
YILWHBA	-58.089 (-7.14)	
WHBAYIP		-294.719 (-6.01)
North	-126.691 (-12.81)	-129.873 (-13.68)
York&Hum.	-14.840 (-2.49)	-29.429 (-3.70)
Eastmidl.	-31.408 (-2.68)	-40.454 (-4.55)
Southeast	54.057 (2.72)	32.832 (1.68)
Southwest	-24.058 (-4.05)	-35.792 (-6.43)
Westmidl.	-98.048 (-14.31)	-114.076 (-16.28)
Northwest	-175.169 (-10.14)	-178.509 (-14.41)
CAP1992	-70.171 (-11.82)	-59.135 (-8.87)
SETAS88	-36.349 (-7.77)	-31.602 (-6.13)
adj.R ²	0.849	0.841

(The value of T-statistics are reported in parentheses)

It must be noted that the t-statistic for the variable BAWHPR3 in Model 1.2 is substantially lower than in Model 1.1.³⁸ Table 13 presents similar results for the variables

³⁸ The results hold for different sets of explanatory variables.

WHBAYIP and YILBAWH in the barley acreage response models. Note, however, that the values of the t-statistics for YILBAWH is slightly higher.

Even though the results for the barley Model 1.2 are not as satisfactory as the results for wheat Model 1.2, the yield expectations variables obtained from the optimal non-linear time trend model seem to play a more important role in the farmers' planting decisions than a naive forecast based on the actual yield of the previous year. The latter clearly suffers from the impact of random year-specific effects.

The Wheat and Barley Acreage Response Models under Uncertainty

The importance of risk in wheat and barley planting decisions is examined using expected spot price variables and expected trends in yields variables to estimate variances. The variance of own gross revenue is introduced in Model 1.2 to estimate the impact of revenue uncertainty on planted acreage. Table 14 and 15 presents the results which indicates that wheat acreage was insensitive to changes in revenue variances whereas barley acreage has a significant negative response to changes in the variances of barley revenue.³⁹ The coefficients for RBAPR3, the risk variable, in the estimated barley models presented in Table 15 are significant at either the 5 percent or at the 1 percent level. In addition, similar results were obtained for the ratio of the expected price of oats to the expected price of wheat (OAWHPR3) and for the ratio of the expected price of oats to the expected price of barley (OABAPR3). While oat prices had a negligible impact on wheat

³⁹ Coefficients for the ratio of the fertilizer price to crop price and the ratio of the slaughtered animal price to crop price were in estimation models statistically insignificant and thus excluded from the analysis.

planted acreage, the coefficient for OABAPR3 in the barley acreage model is negative and significant at a 1 percent level suggesting the importance of oat prices in the barley planting decision.

Table 14. Wheat Acreage Response Model under Uncertainty

Dependent variable: WHEAT ACREAGE			
Number of Cross Sections 8		Time Series Length 21	
	MODEL 1.2.1 DFE 155	MODEL 1.2.2 DFE 154	
Independent variable	Param. estimate	Param. estimate	
INTERCEPT	695.968 (23.39)	639.665 (15.47)	
BAWHPR3	-34.358 (-1.54)	-35.815 (-1.41)	
OAWHPR3		11.638 (0.74)	
BAWHYIP	-468.177 (-12.79)	-405.154 (-7.84)	
RWHPR3	0.00003 (-0.24)	0.00001 (0.82)	
North	-256.084 (-27.69)	-258.132 (-28.25)	
York&Hum.	-94.343 (-10.03)	-91.953 (-9.50)	
Eastmidl.	34.286 (5.26)	33.999 (5.43)	
Southeast	115.283 (5.22)	114.294 (5.59)	
Southwest	-136.736 (-19.09)	-138.540 (-17.25)	
Westmidl.	-159.173 (-26.31)	-162.706 (-25.63)	
Northwest	-290.123 (-27.11)	-291.478 (-26.42)	
CAP1992	-2.283 (-0.42)	0.088 (0.01)	
SETAS88	12.054 (2.81)	14.225 (2.87)	
adj.R ²	0.911	0.912	

(The value of T-statistics are reported in parentheses)

Table 15. Barley Acreage Response Model under Uncertainty

Dependent variable: BARLEY ACREAGE			
Number of Cross Sections 8		Time Series Length 21	
	MODEL 1.2.1 DFE 155	MODEL 1.2.2 DFE 154	
Independent variable	Param. estimate	Param. estimate	
INTERCEPT	630.315 (8.77)	566.681 (7.65)	
WHBAPR3	-58.939 (-1.96)	-35.656 (-1.12)	
OABAPR3		-56.230 (-2.84)	
WHBAYIP	-247.634 (-4.49)	-176.753 (-3.04)	
RBAPR3	-0.001 (-2.30)	-0.002 (-3.48)	
North	-129.001 (-13.25)	-127.967 (-12.88)	
York&Hum.	-25.149 (-3.63)	-21.159 (-2.94)	
Eastmidl.	-34.910 (-4.68)	-33.771 (-3.57)	
Southeast	39.033 (2.07)	37.890 (1.55)	
Southwest	-33.297 (-6.30)	-30.194 (-5.35)	
Westmidl.	-110.325 (-15.48)	-104.932 (-13.93)	
Northwest	-177.009 (-12.12)	-177.210 (-12.05)	
CAP1992	-66.916 (-10.56)	-68.272 (-10.20)	
SETAS88	-37.409 (-7.86)	-42.477 (-8.47)	
adj.R ²	0.862	0.872	

(The value of T-statistics are reported in parentheses)

Why planted acreage for wheat has been insensitive to uncertainty and changes in producer prices over the estimated period is investigated below in relation to evidence on the links between changes in the ratio of threshold prices to intervention prices and incentives for varietal innovations in the UK wheat industry.

The coefficients for the CAP1992 and SETAS88 set-aside dummies variable provide interesting insights. The results of the wheat and barley models indicates that most of the CAP set aside requirements has been satisfied by reductions in barley acreage. Even though the coefficient for SETAS88 in the wheat models is positive, as expected the sum of the coefficients on SETAS88 from both wheat and barley models is negative.

Table 16 presents own price and yield elasticities for wheat and for the effect of changes in the variance of wheat returns on wheat acreage. Cross elasticities for the effects of barley prices, oats prices and barley yields on wheat acreage are also reported. The elasticities are calculated at the sample means of the data.

Table 16. Elasticity of Wheat Acreage

Elasticity of wheat acreage calculated from the wheat MODEL 1.2.2 with respect to:			
Wheat price	+0.13	Barley price	-0.18
Wheat yield	+1.58	Oats price	+0.05
Variance of wheat returns	+0.0003	Barley yield	-1.58

The own price elasticity and cross price elasticity for barley and oats in the wheat equation indicate that over the period of estimation wheat acreage was not very responsive to price changes. In contrast, the yield elasticities from the wheat equation are much larger (greater than one), implying that changes in relative yields played an important role in determining planted wheat acreage.

Table 17 presents similar elasticities estimates for barley. The elasticities in Table 16 and 17 indicate that barley acreage is more responsive to changes in relative prices than is wheat acreage. In addition, the barley acreage is more sensitive to changes in variance

of own returns than wheat acreage. Table 17 again shows that barley and wheat yield elasticities are elastic and instrumental in the explanation of barley acreage response.

Table 17. Elasticity of Barley Acreage

Elasticity of barley acreage calculated from the barley MODEL 1.2.2 with respect to:			
Barley price	+0.48	Wheat price	-0.20
Barley yield	+1.29	Oats price	-0.28
Variance of barley returns	-0.05	Wheat yield	-1.29

The results for own and cross price elasticities from Tables 16 and 17 are consistent with results reported by Colman (1970).

As pointed out earlier, Just (1977) has suggested including the variances of prices and yields separately in supply response models. Separate variance of prices and yields (calculated as described in equations 8.11-8.13) were introduced into the Model 1.2 for wheat and barley, and the results are reported in Table 26 and 27 in Appendix D. In both models, the estimated coefficients associated with price variances (RWHPR3SP, RBAPR3SP) suggests that barley acreage is more sensitive to uncertainty about future prices than is wheat acreage. In both models the coefficients on the variances of yields (RWHYIPSP, RBAYIPSP) are negative and significant, indicating that changes in uncertainty about future yields affect both wheat and barley planting decisions.

Developments in Wheat and Barley Yields and the CAP Prices

The empirical results described above indicate that while changes in relative prices do not appear to have had large effects on barley or wheat acreage, changes in relative

yields have played a more important role. This, however, does not mean that prices do not matter in the decision making processes. The regression analysis presented above show the effects of changes in various expected prices on planted acreage. It must be noted that producer and intervention prices were rather stable through the period of estimation, which is perhaps not surprising given that stable prices have been one of the objectives of the CAP. Prices in the Community did not change considerably, but were well above world wheat and barley prices for most of the estimated period. These artificially high prices motivated farmers to intensify the use of fertilizer and to introduce new high yielding varieties of crops.

The data presented in Tables 18 and 19 show that developments in wheat and barley yields had a significant impact on grain production in the UK. The evidence is only for wheat and barley production in England as a whole, thus somewhat oversimplifying the total picture of the UK grain situation. Table 18 presents average values of wheat and barley acreage and yields from all eight production regions in England in the periods 1975-77 and 1990-92. The period 1990-92 is selected for comparison because it precedes the implementation of the major set aside program of 1992 CAP Reforms.

Table 18 the Average Acreage (000 ha) and Yield (t/ha) Figures for Wheat and Barley

	WHEAT	BARLEY	TOTAL
Acreage 1975-77	1082.7	1799.2	2881.9
Yield 1975-77	4.35	3.69	
Acreage 1990-92	1886.7	998.8	2885.5
Yield 1990-92	6.97	5.48	

These data indicates that in the two periods 1975-77 and 1990-92 the total annual average acreage planted to wheat and barley was almost identical. Where, then, did the increase in grain production come from? Table 19 shows total output of wheat and barley for the same periods. The second row of Table 19 shows that, if the acreage planted to wheat and barley had remained unchanged, total cereal output would increase by 6057.4 thousand tons (that is over 50 percent) simply because of increases in yields. Wheat yields were already higher than barley yields in 1975-77 and between 1975 and 1992 increased by almost 1 percent per year more than did barley yields. Therefore, the shift of cereal acreage from barley to wheat caused total production to increase by an additional 1217.4 thousand tons. Recall from Figure 2 and 3 in Appendix B that the wheat acreage steadily increased through the time while the barley acreage steadily declined and the plots of these data are almost mirror images of each other.

Table 19. The Average Production (000 Tons) Figures for Wheat and Barley

	WHEAT	BARLEY	TOTAL
Acreage 1975-77	4709.7	6639.2	11348.9
Yield 1975-77			
Acreage 1975-77	7546.4	9859.9	17406.3
Yield 1990-92			
Acreage 1990-92	13150.3	5473.4	18623.7
Yield 1990-92			

The two tables illustrate that changes in wheat and barley yields had a large impact on wheat and barley production in the UK both because of reallocation of land between wheat and barley production and because yields for both crops has substantially grown

(though more slowly in the case of barley).

Prior to and during the early 1970's the major focus in the UK was on developing a new high yield dwarf variety of feed wheat. In 1979 and 1980, the semi-dwarf varieties of wheat of bread-making quality, Bounty and Avalon, were released. Blaxter and Robertson (1995) have argued that the release and wide acceptance of these new varieties was primarily due to EU protection against import of high protein wheat by means of an import levy and the introduction of a higher intervention price for home-grown wheats suitable for bread making in 1976-77. Further, the new Chorleywood process of bread making allowed the use of a larger proportion of the UK wheats in bread-making flours.⁴⁰

The reference to the new bread-making technology raises an important issue--the demand for domestic wheat. Often directly estimated single commodity supply response studies do not consider the commodity demand situation at all. In the EU, both the new bread-making technology and a boom in the wheat-washing industry greatly affected wheat production.⁴¹ Leuck (1991) has pointed out that one of the reasons the wheat-washing industry experienced such a boom was the increasing gap between the threshold price and the intervention price for wheat in the EU. For the bread-making industry, this increasing gap meant that the cost of flour from imported hard wheat increased more

⁴⁰ The Chorleywood process added more mechanical power in the dough mixing process. This process ensured even mixing, developed the extensibility of dough and produced a denser "bread-piece" which was better in bread baking. (See Blaxter and Robertson, 1995)

⁴¹ The wheat-washing industry separates the starch, gluten, and minor fractions in wheat flour in relatively fixed proportion. The wheat gluten is used in increasing the protein content of medium-protein flour which is then used in baking; thus, this fortified flour is a substitute for high protein flour from imported hard wheat. (See Leuck, 1991)

rapidly than the cost of gluten-fortified flour in which the essential gluten is produced by the wheat-washing industry. This created economic incentives to displace flour from imported wheat with gluten-fortified flour from domestically produced wheat. Further, it created incentives to produce medium protein home-grown wheat in the EU because the medium-protein wheat was mixed with pure gluten. Leuck further argues that the expansion of the wheat-washing industry occurred first in the UK and as much as 1.6 million tons of British wheat imports in 1981-82 could have been replaced by gluten-fortified flour.

Recall from chapter 6 that during the period of estimation the threshold price--the price for which wheat is imported--was increasing more rapidly than the relevant intervention price (See figure 4 in Appendix B). To examine whether changes in the threshold and intervention prices influenced the crop planted acreage, the ratio of the threshold price to the intervention price for the relevant crop was introduced into the WBAR models for wheat and barley. Table 20 presents the results for wheat acreage response models. The coefficient for the ratio of the wheat threshold price to the wheat intervention price in the previous year, WTHINLG, was positive and statistically significant at a 1 percent level.

This result provides support for the hypothesis that the relative increase in wheat threshold prices caused an increase in wheat planted acreage. Note that the introduction of the variable WTHINLG considerably improved the value of the t-statistics for the coefficient the ratio of the expected price of barley to the expected price of wheat.

Table 20. Wheat Acreage Response Model (with the Threshold Price)

Dependent variable: WHEAT ACREAGE				
Number of Cross Sections 8 Time Series Length 21				
	MODEL 1.3.1	DFE 154	MODEL 1.3.2	DFE 153
Independent variable	Param. estimate		Param. estimate	
INTERCEPT	488.741		441.516	
	(7.34)		(6.50)	
BAWHPR3	-94.228		-99.541	
	(-3.73)		(-3.82)	
OAWHPR3			13.066	
			(0.79)	
BAWHYIP	-231.129		-183.277	
	(-3.49)		(-2.70)	
WHTHINLG	69.919		72.203	
	(2.89)		(3.03)	
RWHPR3	0.0001		0.0003	
	(0.88)		(1.79)	
North	-257.375		-258.248	
	(-31.75)		(-32.04)	
York&Hum.	-107.563		-108.580	
	(-12.84)		(-12.96)	
Eastmidl.	27.338		26.709	
	(3.92)		(3.88)	
Southeast	104.855		103.318	
	(5.87)		(6.14)	
Southwest	-144.743		-146.575	
	(-24.19)		(-23.75)	
Westmidl.	-169.891		-172.370	
	(-26.67)		(-27.07)	
Northwest	-290.383		-291.145	
	(-28.78)		(-28.37)	
CAP1992	-9.263		-5.650	
	(-1.25)		(-0.77)	
SETAS88	5.872		8.511	
	(1.04)		(1.46)	
adj. R ²	0.922		0.924	

(The value of T-statistics are reported in parentheses)

However, the value of the coefficient and the t-statistics for the relative yield variable declined. Note, that in the Model 1.3.1 and 1.3.2 wheat acreage is again

unaffected by changes in expected oats prices and variance of gross revenue. Results for barley acreage response models are presented in Table 21.

Table 21. Barley Acreage Response Model (with the Threshold Price)

Dependent variable: BARLEY ACREAGE			
Number of Cross Sections 8		Time Series Length 21	
	MODEL 13.1 DFE 154	MODEL 13.2 DFE 153	
Independent variable	Param. estimate	Param. estimate	
INTERCEPT	650.173 (9.26)	580.358 (8.12)	
WHBAPR3	-74.174 (-2.53)	-58.751 (-1.88)	
OABAPR3		-54.096 (-2.84)	
WHBAYIP	-170.617 (-3.16)	-73.094 (-1.25)	
BATHINLG	-87.506 (-2.93)	-105.992 (-3.39)	
RBAPR3	-0.0057 (-1.23)	-0.0010 (-2.03)	
North	-130.004 (-14.99)	-127.621 (-14.73)	
York&Hum.	-21.252 (-3.28)	-14.741 (-2.13)	
Eastmidl.	-31.999 (-4.20)	-27.445 (-2.84)	
Southeast	47.544 (2.46)	52.521 (1.94)	
Southwest	-30.279 (-5.76)	-25.440 (-4.38)	
Westmidl.	-105.806 (-15.70)	-97.877 (-13.73)	
Northwest	-172.435 (-9.87)	-170.467 (-10.15)	
CAP1992	-51.011 (-6.51)	-52.188 (-6.57)	
SETAS88	-30.902 (-5.79)	-35.682 (-6.48)	
adj. R ²	0.865	0.879	

(The value of T-statistics are reported in parentheses)

The results confirm that an increase in the relative price of flour from imported wheat caused wheat planting to increase and barley planting to decrease as the CAP policy prices for both wheat and barley follows a similar pattern. Thus, the negative, significant coefficient for BATHINLG, the ratio of the barley threshold price to the barley intervention price, reflects the fact that when the gap between threshold and intervention price was increasing, farmers reduced cereals acreage planted to barley in order to expand wheat production. As in the wheat acreage response model, the introduction of the threshold to intervention price ratio increased the statistical significance of the coefficient associated with the ratio of the price of wheat to the price of barley, but the t-statistic associated with the wheat to barley yield ratio declined. Barley acreage continued to be more sensitive to changes in the expected price of oats and to own revenue uncertainty.

Summary of Empirical Results

This study has examined several different possible mechanisms of formulating the expected prices and yields. Of the five expected price variables examined here, expected price forecasts obtained from pure time series models performed most satisfactorily in the WBAR model. Yield forecasts based on trend models also performed better than yield forecasts where expected yield in current year was assumed to be equal to the yield in the previous year. The empirical results for the WBAR models indicate that changes in the ratio of expected wheat and barley prices and changes in expected wheat and barley yields played a significant role in determining overall acreage response. The results further suggest that acreage planted to wheat was insensitive to changes in expected oats prices

and variance of own gross revenue. On the other hand, acreage planted to barley showed significant response to changes in expected oats prices as well as the variance of own gross revenue. The null hypothesis, that a more rapidly increasing threshold price (therefore price of flour from imported hard wheat) rather than the intervention price (therefore the price of gluten-fortified flour from domestically produced wheat) caused increase in acreage planted to wheat in the UK, was not rejected on 1% level of significance. The increase in wheat planting caused decrease in barley planting. The five-year set aside program implemented in 1988 and additional one-year set aside program requirements were primarily fulfilled out of barley planting, while wheat planting slightly increased. The 1992 CAP Reform set aside program resulted in a slight decrease in acreage planted to wheat; however, again the most of the acreage set aside program requirements were satisfied by reducing the amount of land planted to barley.

CHAPTER 10

CONCLUSION

In this study, wheat and barley acreage supply response models have been estimated using time series-cross section data for eight major UK production regions over the twenty one year period from 1975 to 1995. It is the first study to consider the separate effects of crop prices and crop yields in cereal planting decisions in the UK.

Previous studies, confronted with a paucity of degrees of freedom, have combined prices and yields to form revenue per acre variables. Expected price and yield variables in this study enter the regression equations in the form of ratios in which own prices and yields are in the denominator, thus accounting for changes in relative profitability across competing agricultural enterprises. The evidence indicates that relative prices have statistically significant effects on planting decisions. However, the ratio of wheat yields to barley yields is quantitatively more important. These results confirm Just's observation that relative prices and relative yields may have different quantitative effects on planting decisions.

The role of expectations about future prices or yields in farmers' planting decisions has long been recognized. However, little attention has been paid to the relative performance of competing forecast models or how these expectations are formed. This study considered five possible mechanisms in modeling the price expectations variables

and compared performance of those variables in the framework of the wheat and barley acreage response models. ARIMA (6,1,3) models for wheat and oats and an ARIMA (5,1,3) model for barley, which were used to forecast third quarter spot prices, performed most satisfactorily, while naive price forecast models in which current prices were set equal to the previous year's intervention prices performed quite poorly. This finding indicates, that despite the complex price support system of the CAP, expectations about spot market prices have an important influence on planting decisions. From an econometric prospective, this result is particularly interesting given that cereals market and policy prices were rather stable throughout the period of estimation.

This study also compared different yield expectation models. Despite some mixed results, forecasts of yields derived from nonlinear time trend models performed more satisfactorily than naive forecast model in which expected yields were simply set equal to the previous year's actual yields. The naive yield forecast model clearly fails to "clean" the data of random year specific events. Regardless of which yield forecast models were used, however, the results of this study indicate that changes in relative expected yields played an important role in wheat and barley planting decisions.

The primary feature of cereals production in the UK in last twenty five years has been the shift from barley production to wheat production. One reason has been that wheat yields increased at an annual average growth rate that was almost one percentage point higher than the annual average growth rate for barley yields over this period. The results presented in this study confirm that changes in relative yields were instrumental in farmers' decisions to shift land from barley production to wheat production.

Second reason why farmers shifted land into wheat production was related to a technical innovations and developments in bread-making and wheat-washing industries. The new Chorleywood process for bread making developed in the late 1970's allowed the use of a larger proportion of the UK wheats in bread-making flours.⁴² Further, changes in CAP intervention and threshold prices resulted in an increase in the price of flour produced from imported hard wheat relative to the price of gluten-fortified flour produced from domestic wheat in which gluten was produced from domestic wheat by the domestic wheat-washing industry. The result was that the bread-making industry substituted domestically produced gluten-fortified flour from medium-protein domestic wheat for flour produced from imported hard red wheat. Evidence in the support of this argument has been provided in this study in that coefficients on the ratios of threshold prices to intervention prices have significant positive signs in the wheat acreage response models and significantly negative sign in the barley acreage response models.

The results of this study also indicate that while changes in revenue variability have had significant negative impacts on barley acreage planting decisions, wheat acreage planting decisions have been unaffected by revenue uncertainty.

In addition, the results indicate that, for the most part, the 1992 cereals CAP set aside requirements have been fulfilled out of barley acreage while, during the 1988 CAP set aside program, wheat acreage increased. This was possible because the set aside programs applied to total cereals acreage and were not crop specific.

⁴² The agronomic advances in the timing of nitrogen fertilize application also improved protein content of wheat grains.

A useful extension of this study would involve a more detailed examination of the different classes of wheat planted in the UK. In this study, data on planted acreage for different wheat classes were unavailable and thus, as in most previous studies, wheat has been treated as if it is a homogenous product. It would be interesting and useful to investigate the degree to which the expansion in planted wheat acreage can be accounted to by feed wheat and wheat of bread making quality. In addition, it would be useful to examine whether the overall increase in wheat yields was also associated with the adoption of new wheat varieties of bread making quality. Nevertheless, the empirical results of this study provide several new and interesting insights about wheat and barley acreage responses under the CAP in the UK for the period 1975-1995. They also indicate that combining cross section and time series data may improve the precision with which parameters can be estimated in agricultural supply response models.

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APPENDICES

APPENDIX A

HISTORY OF THE EU AND THE CAP

Table 22 History of the EU and the Common Agricultural Policy with attention to cereals.

Year	The major event
1957	--March 27, the Treaty of Rome was signed by France, West Germany, Italy, the Netherlands, Belgium and Luxembourg establishing the EEC, (EC-6);
1958	--January, the Treaty of Rome came into the force; --July, the objectives of the CAP were stated at the conference at Stresa;
1962	--establishment of EAGGF; --agreement on the common policies for cereals, also for pigmeat, poultry meat, eggs, fruit vegetables and wine; --introduction of common denominator - the Agricultural Unit of Account;
1964	--common price level for cereals;
1966	--common prices and the common organization of the cereal market came into force;
1968	--introduction of the Common Custom Tariff; --establishment of the Custom Union; --the Mansholt plan;
1969	--introduction of the MCA for West Germany and France; --the CAP fully operable;
1971	--system of the MCA and "green" money in all EC member sates;
1973	--UK, Ireland and Denmark joined the EC (EC-9);
1975	--introduction of European Unit of Account (EUA);
1976	--special intervention price for wheat of bread making quality
1979	--establishment of European Monetary System (ESM); --introduction of the European Currency Unit (ECU); --contribution to the EC budget mainly by the VAT component;
1981	--Greece joined the EC, (EC-10);
1982	--introduction of the measure "Guarantee Threshold";
1984	--abolishment of the positive MCA and introduction of the switchover coefficient;
1986	--the Single European Act-the proposal of creating the European Union;
1986	--Spain and Portugal joined the EC, (EC-12); --introduction of basic co-responsibility levy;
1988	--introduction of the "Automatic Price Stabilizer for grains" (maximum guarantee quantity); --change in the contribution to the EC budget from the VAT system to the percentage amount of the members Gross National Product (GNP);

Table 22. (Continues)

Year	The major event
1988	--adoption of five-year set-aside program; --introduction of additional co-responsibility levy;
1991	--adoption of additional one-year set aside program;
1992	--development of the major CAP reform; --abolishment of co-responsibility levies;
1993	--CAP reform came into the force: support price reduction paid set aside program compensation payments abolishment of the intervention price for feed wheat the intervention prices for cereals were set to be equal; --Maastrich Treaty-establishment of the European Union (EU);
1994	--proposal of Agrimonetary system reform;
1995	--Austria, Finland, Sweden joined the EU, (EU-15); --elimination of the switchover mechanism;

APPENDIX B

WHEAT AND BARLEY ACREAGE, PRICES AND YIELDS

Figure 2.

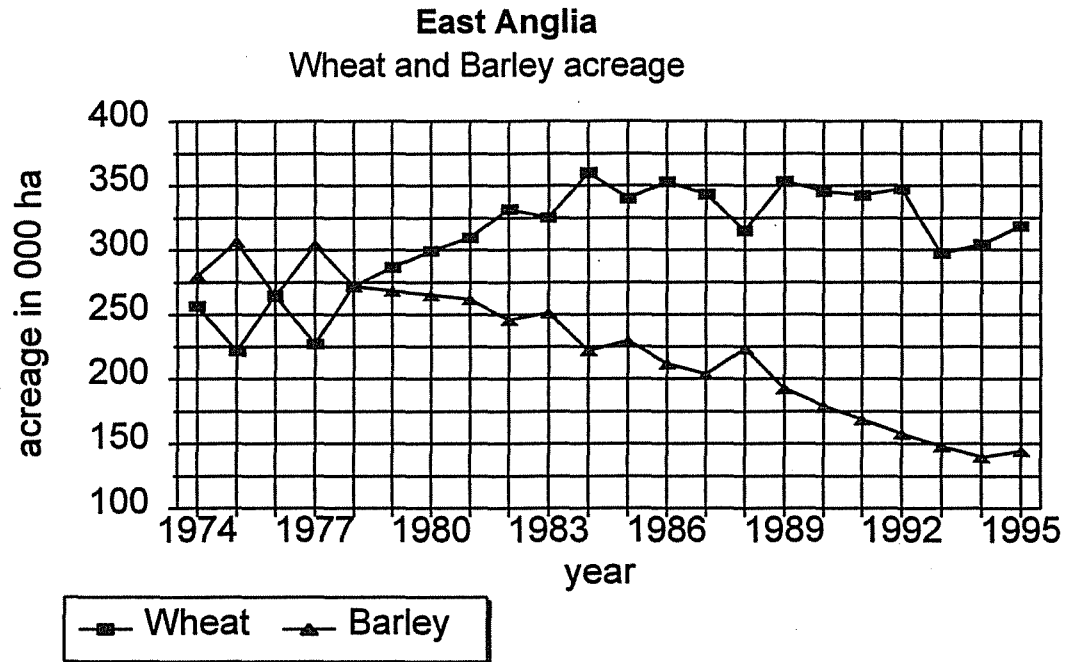


Figure 3.

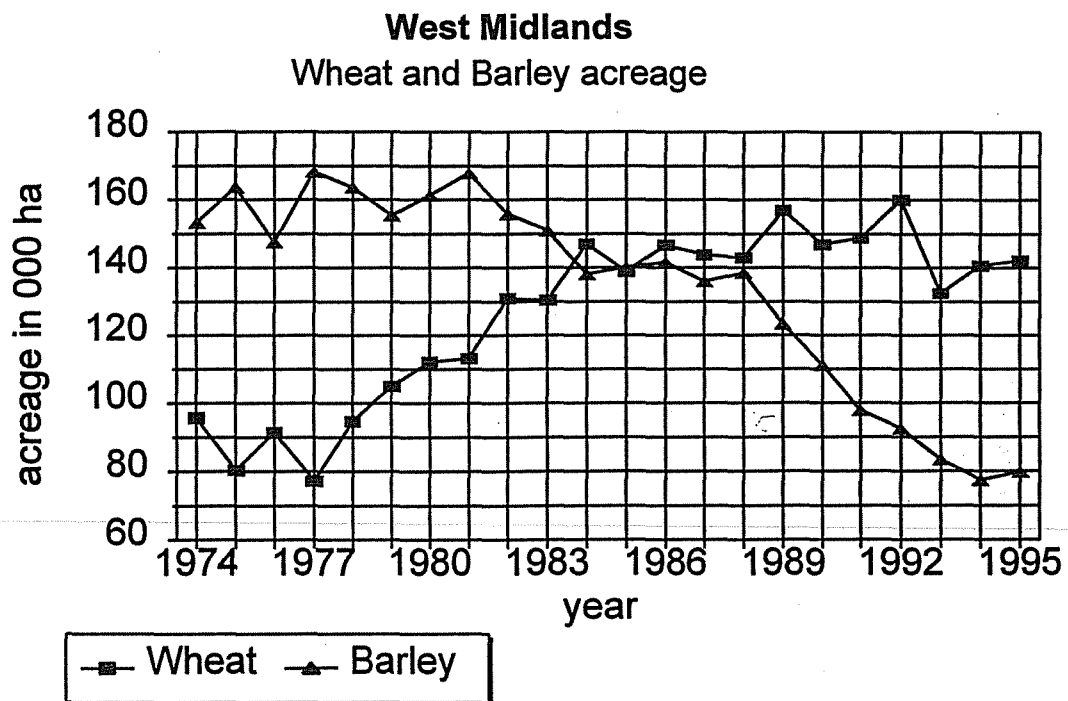


Figure 4.

Wheat and Barley policy and producer prices

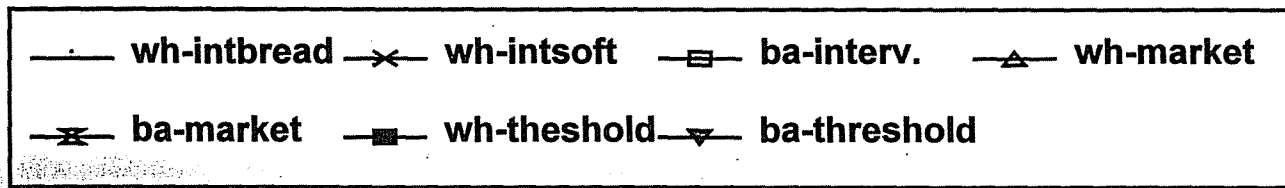
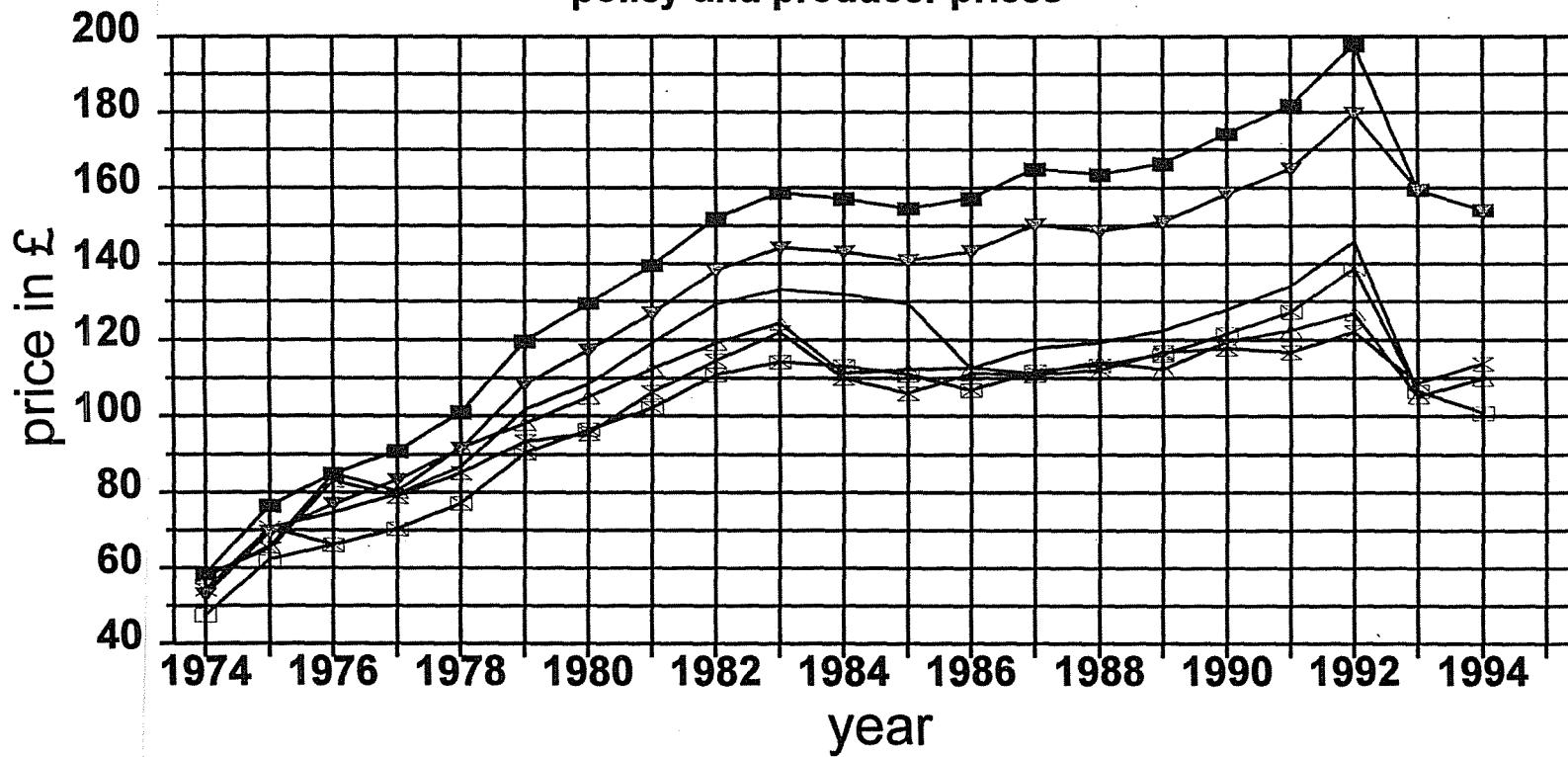
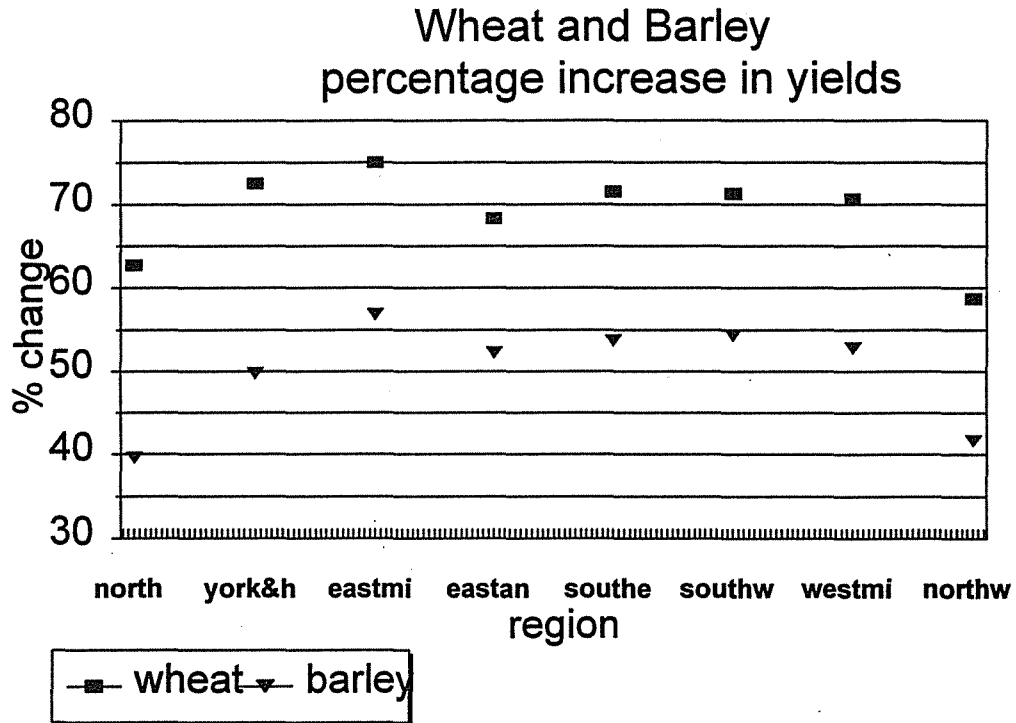


Figure 5.



The percentage change in yields for each region was calculated as follows:

$$\% \text{ change}_i = \left(\frac{AVG_i^{94}}{AVG_i^{76}} - 1 \right) * 100$$

where AVG_{94} and AVG_{76} are average yields calculated as follows:

$$AVG_i^{76} = (Y_i^{1975} + Y_i^{1976} + Y_i^{1977}) / 3 \quad AVG_i^{94} = (Y_i^{1993} + Y_i^{1994} + Y_i^{1995}) / 3$$

Y_i is the regional yield in particular year. The subscript 'i' stands for wheat or barley.

APPENDIX C

ARIMA FORECAST MODELS FOR
WHEAT, BARLEY AND OATS

Table 23. The ARIMA models--forecasts of wheat expected spot prices

ARIMA(4,1,2)														
Paramater	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	first	second	third	fourth
Estimate	0.178	0.268			0.401	-0.111	0.096	-0.084			3.161	4.231	-4.821	1.417
Std.Error	0.620	0.612			0.620	0.626	0.259	0.216			1.211	1.209	1.210	1.189
AIC = 658.628 RMSE = 5.706				X ² - Chi-Square		Degr. of freedom		Probability		Method = Maximum likelihood Number of residuals = 101				
				11.64		12		0.475						
				13.16		18		0.782						

ARIMA(6,1,1)														
Paramater	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	first	second	third	fourth
Estimate	-0.113				0.110	-0.319	0.064	-0.159	0.001	-0.097	3.133	4.236	-4.800	1.416
Std.Error	1.085				1.078	0.263	0.371	0.150	0.184	0.105	1.278	1.275	1.276	1.255
AIC = 660.056 RMSE = 5.689				X ² - Chi-Square		Degr. of freedom		Probability		Method = Maximum likelihood Number of residuals = 101				
				11.32		11		0.417						
				12.98		17		0.737						

ARIMA(6,1,3)														
Paramater	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	first	second	third	fourth
Estimate	-1.020	0.028	0.579		-0.732	-0.071	0.301	-0.187	0.046	-0.066	3.119	4.262	-4.811	1.423
Std.Error	0.735	1.214	0.739		0.740	1.016	0.667	0.229	0.285	0.133	1.235	1.234	1.235	1.214
AIC = 658.342 RMSE = 5.529				X ² - Chi-Square		Degr. of freedom		Probability		Method = Maximum likelihood Number of residuals = 101				
				7.99		9		0.535						
				9.76		15		0.835						

Table 24. The ARIMA models--forecasts of barley expected spot prices

ARIMA(4,1,3)														
Parameter	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	first	second	third	fourth
Estimate	1.279	0.357	-0.668		1.161	0.402	-0.639	0.044			2.042	-1.211	3.100	0.778
Std.Error	1.347	2.659	1.348		1.336	2.448	1.109	0.121			1.349	1.347	1.343	1.318
AIC = 673.663 RMSE = 6.079				X ² - Chi-Square	Degr. of freedom		Probability		Method = Maximum likelihood Number of residuals = 101					
				37.51	11		0.000							
				43.48	17		0.000							
ARIMA(5,1,3)														
Parameter	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	first	second	third	fourth
Estimate	0.059	-0.613	0.646		0.054	-0.562	0.349	0.054	-0.22		1.863	-1.291	3.0911	0.573
Std.Error	0.3043	0.350	0.446		0.297	0.209	0.335	0.120	0.113		1.233	1.234	1.234	1.211
AIC = 658.366 RMSE = 5.556				X ² - Chi-Square	Degr. of freedom		Probability		Method = Maximum likelihood Number of residuals = 101					
				12.66	10		0.243							
				18.92	16		0.273							
ARIMA(6,1,4)														
Parameter	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	first	second	third	fourth
Estimate	-0.119	-0.637	0.477	0.028	-0.139	-0.598	0.214	0.020	-0.224	-0.103	1.880	-1.275	3.081	0.543
Std.Error	1.682	0.390	0.944	1.181	1.679	0.370	0.894	0.746	0.178	0.385	1.228	1.229	1.228	1.206
AIC = 662.087 RMSE = 5.550				X ² - Chi-Square	Degr. of freedom		Probability		Method = Maximum likelihood Number of residuals = 101					
				12.23	8		0.141							
				18.41	14		0.189							

Table 25. The ARIMA models--forecasts of oats expected spot prices

ARIMA(4,1,3)																
Paramater	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	AR7	AR8	first	second	third	fourth
Estimate	-0.827	0.577	0.801		-0.563	0.766	0.507	-0.378					4.033	0.551	-5.410	4.395
Std.Error	0.222	0.260	0.222		0.196	0.247	0.199	0.103					1.006	1.008	1.006	0.992
AIC = 660.947 RMSE = 5.699				X ² - Chi-Square		Degr. of freedom		Probability		Method = Maximum likelihood estimation / no intercept Number of residuals = 101						
				15.69		11		0.153								
				20.58		17		0.246								

ARIMA(6,1,3)																
Paramater	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	AR7	AR8	first	second	third	fourth
Estimate	0.642	0.344	-0.556		0.732	0.311	-0.591	-0.024	0.058	-0.184			4.020	0.554	-5.395	4.309
Std.Error	0.357	0.521	0.324		0.359	0.551	0.378	0.151	0.155	0.137			1.056	1.056	1.056	1.036
AIC = 660.502 RMSE = 5.572				X ² - Chi-Square		Degr. of freedom		Probability		Method = Maximum likelihood estimation / no intercept Number of residuals = 101						
				5.53		9		0.786								
				10.74		15		0.771								

ARIMA(8,1,4)																
Paramater	MA1	MA2	MA3	MA4	AR1	AR2	AR3	AR4	AR5	AR6	AR7	AR8	first	second	third	fourth
Estimate	1.122	-0.465	-0.429	0.146	1.193	-0.518	-0.394	0.124	0.014	-0.217	0.213	-0.283	4.060	0.614	-5.378	4.271
Std.Error	0.426	0.663	0.666	0.417	0.412	0.677	0.696	0.458	0.185	0.186	0.188	0.142	1.086	1.086	1.086	1.065
AIC = 662.518 RMSE = 5.453				X ² - Chi-Square		Degr.of freedom		Probability		Method = Maximum likelihood estimation / no intercept Number of residuals = 101						
				3.12		6		0.793								
				7.68		12		0.809								

APPENDIX D

WHEAT AND BARLEY ACREAGE RESPONSE MODELS
WITH SEPARATE PRICE AND YIELD VARIANCES

Table 26. Wheat Acreage Response Model with separate price and yield variances

Dependent variable: WHEAT ACREAGE				
Number of Cross Sections 8 Time Series Length 21				
	MODEL 1.2.1	DFE 164	MODEL 1.2.2	DFE 153
Independent variable	Param. estimate		Param. estimate	
INTERCEPT	682.384		652.856	
	(17.18)		(15.60)	
BAWHPR3	-41.474		-46.140	
	(-1.66)		(-1.76)	
OAWHPR3			8.681	
			(0.52)	
BAWHYIP	-435.054		-400.687	
	(-8.72)		(-8.25)	
RWHPR3SP	-0.005		0.007	
	(-0.12)		(0.16)	
RWHYIPSP	-4.466		-3.169	
	(-2.32)		(-1.85)	
North	-256.729		-257.432	
	(-28.06)		(-26.87)	
York&Hum.	-92.693		-89.268	
	(-8.87)		(-8.16)	
Eastmidl.	34.537		34.517	
	(5.22)		(5.40)	
Southeast	114.912		114.688	
	(5.46)		(5.50)	
Southwest	-137.593		-138.403	
	(-20.91)		(-18.95)	
Westmidl.	-161.490		-163.388	
	(-25.05)		(-24.87)	
Northwest	-291.725		-292.491	
	(-27.62)		(-26.69)	
CAP1992	-9.335		-7.928	
	(-1.57)		(-1.30)	
SETAS88	8.280		9.922	
	(1.84)		(2.12)	
adj. R ²	0.907		0.907	

(The value of T-statistics are reported in parentheses)

RWHPR3SP is the variance of wheat prices (see equations 8.13-8.15).

RWHYIPSP is the variance of wheat yields (see equations 8.13-8.15).

Table 27. Barley Acreage Response Model with separate price and yield variances

Dependent variable: BARLEY ACREAGE			
Number of Cross Sections 8		Time Series Length 21	
	MODEL 1.2.1 DFE 154	MODEL 1.2.2 DFE 153	
Independent variable	Param. estimate	Param. estimate	
INTERCEPT	643.056 (9.55)	588.500 (8.70)	
WHBAPR3	-42.470 (-1.40)	-19.285 (-0.58)	
OABAPR3		-55.152 (-2.66)	
WHBAYIP	-268.990 (-5.30)	-205.687 (-3.97)	
RBAPR3SP	-0.060 (-2.06)	-0.072 (-2.38)	
RBAYIPSP	-9.782 (-1.56)	-17.021 (-2.52)	
North	-129.249 (-13.04)	-128.588 (-12.99)	
York&Hum.	-26.924 (-3.70)	-23.400 (-3.13)	
Eastmidl.	-37.089 (-4.47)	-36.148 (-3.43)	
Southeast	38.515 (2.08)	39.897 (1.81)	
Southwest	-34.170 (-6.49)	-31.276 (-5.75)	
Westmidl.	-111.827 (-16.28)	-106.902 (-15.28)	
Northwest	-177.504 (-13.43)	-177.318 (-13.13)	
CAP1992	-61.046 (-8.42)	-64.184 (-8.40)	
SETAS88	-35.991 (-7.42)	-40.571 (-7.76)	
adj. R ²	0.855	0.865	

RBAPR3SP is the variance of barley prices (see equations 8.13-8.15).

RBAYIPSP is the variance of barley yields (see equations 8.13-8.15).