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# Dundee Discussion Papers in Economics

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## CAP Reform and the Distribution of Farming Income in Scotland

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# **CAP reform and the distribution of farming income in Scotland**

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## **Abstract**

This paper explores the redistributive impact of Common Agricultural Policy reform with reference to the distribution of farming incomes in Scotland. A measure of redistribution is proposed that is based on the change in the absolute value of the Gini coefficient and which is valid even though average pre-support farming incomes would be negative. The distribution of support is found to have exacerbated the inequality of farm incomes in Scotland in 1999/00. Moreover, the changes envisaged in the current reform process would have had virtually no effect on this negative redistributive outcome.

*Keywords:* Income redistribution, Common Agricultural Policy, Scotland

*JEL Class:* D63 I38 Q18

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## **1. Introduction**

*'Income support, which depends almost exclusively on price guarantees, is largely proportionate to the volume of production and therefore concentrates the greater part of support on the largest and the most intensive farms. ... The effect of this is that 80% of the support provided by FEOGA is devoted to 20% of farms which also account for the greater part of the land used in agriculture.'* (European Commission, 1991, p.2)

*'Many commentators have observed that a minority of farmers enjoys the benefits of the majority of direct payments. The direct payments of the 1992 reform have lost their compensatory character over time and have become income payments, raising the question of whether the distribution of direct support is optimal.'* (Commission of the European Communities, 2002b, p.8)

The Common Agricultural Policy (CAP) was established with a primary goal of 'securing a fair standard of living for the farming community'. Historically, the principal means of support has been through intervention in agricultural commodity markets to maintain the prices that farmers receive for their output above world market levels. However a common feature of successive reform packages since the MacSharry Plan of 1992 has been for support prices to be cut with farmers receiving (partial) compensation for these cuts by means of the payment of direct aids. This switch towards the use of direct payments would have implications for the distribution of farming incomes even if the overall level of support remained unchanged. For a start, direct payments are generally related to crop areas or livestock numbers rather than to output levels, which will imply some redistribution of support given variation in yield levels across farms. More fundamentally, the use of direct payments enables agricultural support to be targeted in a way that was not

previously possible while also making the resultant distribution of support more transparent and hence open to question.

The primary goal of this paper is to explore the redistributive impact of the ongoing process of CAP reform with reference to the distribution of farming incomes in Scotland. The distributional effects of the CAP have previously been considered in an Organisation for Economic Co-operation and Development (OECD) study (OECD, 1999) which employs grouped data on gross output, direct payments, market price support and incomes in the European Union (EU) in 1995, with the groupings all based on the same ranking of farms by gross farm sales. The study draws the conclusion that total agricultural support slightly attenuated the inequality of farming incomes on the basis that the distribution of total support was a little less concentrated than that of gross output. However, this conclusion may be misleading given that the use of grouped data does not allow for the effects of any re-ranking of farms that may arise from differences between farms in the generation of income from sales and in the receipt of benefits from agricultural support policies. Jenkins shows that the failure to take account of re-ranking in the empirical analysis of income redistribution can lead to significant biases in estimates of both the degree of inequality and redistributive effects.

Keeney, in a study of Irish agriculture based on individual farm records, disaggregates family farm income into direct payments and market-based income where the latter includes the benefits derived from market price support. By means of a decomposition of the Gini coefficient of family farm income by income components, Keeney demonstrates that the payment of direct aids following the MacSharry reforms led to a more equal distribution of family farm incomes than would otherwise have been the case. But it does not necessarily follow that a switch towards the greater use of direct payments in place of market price support would have the effect of further reducing

inequality.<sup>1</sup> Moreover the analysis does not serve to provide an explicit characterisation of the redistributive properties of the CAP *per se*.

In general terms, the redistributive effect of agricultural policy may be defined as the difference between the inequality of pre-support and post-support farm household incomes. But the measurement of this effect poses a methodological problem because of the incidence of negative farm incomes or losses. Amiel, Cowell and Polovin note many standard aggregative measure of inequality are simply undefined for negative incomes. But even those inequality measures that are defined for both positive and negative incomes may not give rise to well-behaved measures of redistribution if pre-support incomes are negative on average. In particular, the Gini coefficient  $G$ , which is the standard choice in the public finance literature to analyse the redistributive impact of tax and welfare programmes, is not suitable for this purpose because the sign of the coefficient is determined by the sign of average income. A second contribution of this paper is to propose a generalisation of the standard Gini-based measure of redistributive effect that is valid whether pre-support and post-support average incomes are positive or negative. This measure is decomposed into vertical and horizontal components in the manner of Kakwani (1984) to show how the distribution and scale of support determine the size of the redistributive effect given the distribution of pre-support income.

The paper is organised as follows. The next section introduces the measures that are used to characterise and quantify the redistributive effects of agricultural policy. Section 3 sets up the empirical application by considering the data issues involved in the

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<sup>1</sup> For example, consider the use of deficiency payments to partially replace a market price support scheme such that the two transfer mechanisms are operationally equivalent with benefits strictly proportional to revenues in both cases. As a result, the distribution of farming income will not change, but market-based income will become more unequally distributed if farming is subject to decreasing average costs. Indeed, the greater the proportion of total revenue accounted for by the deficiency payments, the more unequal the distribution of market-based income becomes and the greater the apparently 'equalising' effect of the deficiency payments.

construction of both the distributions of pre-support and post-support Scottish farming incomes. Baseline results are presented showing the redistributive impact of the CAP in 1999/00, the last farm accounts year before the beginning of the phased introduction of the Agenda 2000 reforms, when average family farm income on full-time commercial farms in Scotland was just £11650 per farm in spite of direct payments of £26300 per farm (Scottish Executive Environment and Rural Affairs Department (SEERAD)) and the support of agricultural commodity prices above world market levels. Section 4 explores the distributional implications of the ongoing process of CAP reform by means of a counterfactual analysis of what the impact of the reforms would have been if they had been fully implemented in 1999/00. The final section offers a summary and some brief concluding remarks in the light of the empirical findings.

## 2. Measurement of the redistributive effect of agricultural support policy

Following Musgrave and Thin, the overall redistributive effect of a farm income support programme could be measured by an index  $R$  defined as the difference between the Gini coefficients of pre-support and post-support income,  $G_0$  and  $G_1$  respectively. Kakwani (1984) shows that  $R$  may be written as the sum of vertical and horizontal equity components:

$$R = G_0 - G_1 = [G_0 - C_1] + [C_1 - G_1] = V + H \quad (1)$$

where  $C_1$  is the concentration index obtained when post-support incomes are ranked by pre-support income.<sup>2</sup> The vertical component  $V = [G_0 - C_b] [b/(1+b)]$  provides a measure of gross redistributive effect, which is itself determined by the progressivity and scale of

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<sup>2</sup>  $C_1$  is defined in relation to the concentration curve obtained by plotting cumulative post-support income against the cumulative proportion of the population ranked by pre-support income in the same way that  $G$  is defined in relation to the ordinary Lorenz curve (see Lambert). Note that  $C_1 = G_1$  if the ranking of farms by pre-support and post-support incomes is identical.

programme benefits where  $C_b$  is the concentration coefficient of benefits ranked by pre-support income<sup>3</sup> and  $b$  is the ratio of average benefits to average pre-support income. Progressivity is captured by the Kakwani (1977) disproportionality index  $P = [G_0 - C_b]$ , which measures the extent to which the average rate of programme benefits falls or rises with pre-support incomes.  $P$  is positive (negative) if support is progressive (regressive) such that the poorest farmers receive a larger (smaller) share of benefits than of pre-support income and equals zero if the average benefit schedule is proportional. For any given  $P$ , the gross redistributive effect is proportional to the scale of benefits  $s = [b/(1+b)]$ , measured as the ratio of average benefits to average post-support income. The horizontal component  $H$  is the re-ranking index due to Atkinson, Plotnick, which captures the effect of changes in the ranking of farms between the pre- and post-support income distributions.  $H$  is non-positive by definition, implying that any re-ranking that does occur has a negative impact on the overall redistributive effect of the programme.

However, problems with this approach to the measurement of the redistributive effect arise if average pre-support income is negative. In this case  $G_0$  will be negative and  $R$  no longer provides a valid measure of the change in inequality. If average post-support income is also negative then positive values of  $R = G_0 - G_1$  would have to be taken to imply that inequality has increased not decreased. Whereas if average post-support income is positive then  $R$  must be non-positive due to the change in the sign of average income, whether or not the policy increases the inequality of income. These problems with  $R$  also carry over into the decomposition of the index. Most obviously,  $R = V$  in the absence of re-ranking, so  $V$  will exhibit the same failings as  $R$ . Moreover, if average post-support income is negative then  $H$  no longer provides a valid measure of the re-ranking effect since the

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<sup>3</sup>  $C_b$  is defined analogously to  $C_l$ . Note that  $C_b$  will be negative (positive) if farmers with low pre-support incomes receive a larger (smaller) share of support than those with high ones, and will equal zero for a universal flat-rate benefit.



Lorenz curve for post-support income will lie above the corresponding concentration curve such that  $G_I < C_I < 0$ . Hence,  $H = C_I - G_I > 0$ , but the re-ranking effect must be non-positive, whatever the overall redistributive effects of the programme (Atkinson).

These problems arise because the sign of the Gini coefficient is determined by the sign of average income (Amiel, Cowell and Polovin). Indeed the sign of  $G$  merely reflects whether average income is positive or negative, as is evident from the definition of  $G$  as the average absolute difference between all distinct pairs of incomes in the population, expressed as a proportion of average income:

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

where  $y_i$  is the income of individual  $i$  ( $i=1, \dots, n$ ) and  $\bar{y}$  is average income. Accordingly this paper proposes a generalised index of redistributive effect  $R' = |G_0| - |G_I|$  based on the difference between the absolute values of the two Gini coefficients,<sup>4</sup> which may be decomposed in the manner of Kakwani (1984) to yield:

$$R' = I_0 G_0 - I_I G_I = [I_I (G_0 - C_I) + (I_0 - I_I) G_0] + [I_I (C_I - G_I)] = V' + H' \quad (3)$$

where  $I_0$  is an indicator variable equal to 1 if average pre-support income is positive and -1 otherwise, and  $I_I$  is defined likewise for post-support income.  $R'$ ,  $V' = I_I V + (I_0 - I_I) G_0$  and  $H' = I_I H$  can be seen to generalise the standard indices  $R$ ,  $V$  and  $H$  given that (3) yields (1) as a special case when both pre-support and post-support average incomes are positive. Two other cases are of interest.

The first case is if both average pre-support and post-support incomes are negative.

$R'$ ,  $V'$  and  $H'$  will simply equal minus  $R$ ,  $V$  and  $H$  respectively, with the reversals of sign

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<sup>4</sup> The treatment of  $|G|$  as a measure of inequality follows naturally from the identification of the degree of inequality with twice the area bounded by the line of perfect equality and the Lorenz curve, whether the curve lies above or below the diagonal.

restoring the standard properties and interpretations of these measures. Formally, the results are comparable to those of imposing a tax on (positive) income, with flat-rate support increasing inequality if not generous enough to make incomes positive on average.

The more relevant case for agricultural policy analysis is if average pre-support income is negative but average post-support income is positive. Under these conditions the sole difference between the standard and generalised indices is due to the additional term  $(I_0 - I_1)G_0 = -2G_0 \geq 0$  in  $V'$ , which accounts for the effects of the change in the sign of  $G$  as a result of the change in the sign of average income. By definition, positive (negative) values of the generalised vertical index  $V'$  continue to imply that support will reduce (increase) inequality in the absence of re-ranking. Moreover  $H'=H$  will be non-positive.

To consider the redistributive effects of support in this case, it is useful to examine first the impact of a hypothetical programme under which benefits are paid to farmers in proportion to losses incurred while those making profits are taxed at the same rate.  $P=0$  since transfers are proportional to pre-support incomes and  $R'=0$  since the absolute value of the Gini coefficient is invariant to the scaling of incomes, but the policy completely inverts the rank order with the generalised vertical and re-ranking indices,  $V'$  and  $H'$ , exactly cancelling out.

Now if benefits are progressive instead then  $P > 0$  but  $R'$  will be unambiguously negative, implying that the level of inequality will increase if those with the largest losses get a disproportionately large share of support and the level of support is high enough for average post-support income to be positive. The reason for this counter-intuitive result is that a progressive support policy not only reverses the rank ordering, as was the case with equiproportional transfers, but is even more generous to those with the most negative pre-support incomes.

Finally, if support is regressive then the sign of  $R'$  will depend both on the regressivity and scale of the support, where it should be noted that the average support ratio  $s$  is high for levels of support that are only just sufficient to turn average income positive and tends to one for arbitrarily high levels of support. With a mildly regressive support scheme, such as a system of flat-rate benefits payable to all farmers for which  $P = G_0 < 0$ , then the redistributive effect  $R'$  will be negative at levels of support below which  $s > 2G_0/P$ , but positive at higher levels of support since any initial differences in income will cease to matter if the transfers are large enough. As the regressivity of the support increases, i.e. as  $P$  becomes more negative, then the scale of transfers required to secure a reduction in inequality will also increase. And if the support is so regressive that the distribution of support is more unequal than the distribution of pre-support income, i.e.  $C_b > |G_0|$ , then inequality will increase whatever the level of support.

The normative significance of  $V'$  and  $H'$  is revealed by using a welfare index  $W = \bar{y}(1 - |G|)$  in the spirit of Sen. Let  $W_I$  be welfare in the post-support income distribution and let  $W_E$  be welfare under a hypothetical policy of proportional benefits equal in total value to the actual support programme. Then:

$$W_I - W_E = \bar{y}_0(1 + b)R' = \bar{y}_0(1 + b)(V' + H') \quad (4)$$

where  $\bar{y}_0$  is average pre-support income. The (negative) re-ranking term  $H'$  takes away from any welfare superiority of the actual benefit schedule over a distributionally neutral one.

### **3. Farm income redistribution in Scotland, 1999/00**

To examine the redistributive impact of agricultural policy on farming incomes in Scotland, the distribution of farms by both pre-support and post-support farming income is constructed using individual farm record data extracted from the Scottish Farm Accounts Survey (FAS) for 1999/00 and raising factors calculated from the June Agricultural Census returns on the distribution of agricultural holdings in Scotland by type of farming and size of business in 1999. The FAS is a representative survey of about 500 full-time commercial farms carried out each year on behalf of the Scottish Executive (SEERAD).<sup>5</sup> It provides a wide range of physical and financial data, including detailed information on crop areas, livestock numbers, quotas, production, sales, revenues, subsidies and costs, which allows for the identification of policy benefits. Given a population of around 17,500 full-time farms in Scotland, the sampling fraction for each farm size and type is approximately 3 per cent.

Farming income is measured by Family Farm Income (FFI), which represents the return to the farm's own capital and all unpaid labour (farmers and spouses, non-principal partners and directors and their spouses and family workers) based on the actual tenure and indebtedness of the farm business. FFI is thus a measure of farm business income with the distribution of FFI per holding providing 'an important guide to the existence and locations of holdings generating small amounts of income for their occupiers' (Hill, p.43). The FAS does not provide sufficient information on either non-farm sources of farm household income or farm household composition to support a broader analysis of the distributional impact of the CAP on the overall welfare of the agricultural community.

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<sup>5</sup> The sampling frame excludes very small farms (less than 8 Economic Size Units (ESU)), very large specialist livestock units (greater than 200 ESU), and certain minor farm types.

Pre-support FFI is defined as (post-support) FFI less that part of gross policy transfers that is estimated to accrue to farm occupiers as owners of factors of agricultural production. This approach recognises that farm occupiers may not be the ultimate beneficiaries of farm support programmes (Floyd) and, in particular, allows for the effective incidence of support to vary depending on the way in which that support is provided (OECD, 2002b). The analysis thereby serves to identify the contribution of support to the inequality of post-support farming incomes, but it does not allow for the impact of agricultural policy on the distribution of pre-support incomes. To do so would require a model of the impact on individual farm incomes of adjustments in both farm production choices and the state of agricultural input and output markets in response to agricultural policy changes. However it seems unlikely that the results of such an equilibrium displacement modelling exercise would be robust given the magnitude of the changes that would be entailed by the complete abolition of support for agriculture (Gardner).

Three types of policy instrument are identified in the analysis. With respect to market price support measures, estimates are taken from the OECD PSE database (OECD, 2001) of the gap between the EU domestic market and border prices for the main agricultural commodities, measured at the farmgate level. These estimates are adjusted to reflect the difference between United Kingdom (UK) and EU average producer prices and then used to calculate the impact of market price support in terms of inflating both the value (net of direct payments, grants and other subsidies) of observed output quantities and the cost of purchased feed and seed inputs. Direct payments are explicitly identified in the FAS and cover payments under the various CAP commodity regimes, voluntary set-aside schemes and the UK Hill Livestock Compensatory Allowances scheme. But account is also taken of the implicit loss in revenues resulting from the obligatory set-aside

requirements under the Arable Area Payments scheme (AAPS) in calculating the net value of these payments. Finally, the value of other grants and subsidies includes all other payments to farmers except for those in respect of permanent improvements.

The net economic benefit to farmers of these transfers will depend on the extent to which the transfers result in increased returns to the farm-owned factors of production, including management, and hence in increased farming incomes. The effect on farming income of a unit increase in output revenues, whether due to market price support, output payments or a reduction in set-aside requirements, is estimated as the combined cost share of the farm-owned factors of production, while that of a unit increase in direct payments, grants or subsidies to individual inputs (i.e. land and livestock) is simply calculated as the farm-owned share of those inputs. Estimates of factor cost shares are obtained on the assumption that Scottish agriculture may be characterised by an aggregate Cobb-Douglas production technology exhibiting constant returns to scale. Allowing for fixed farm-specific and year-specific effects, the parameters of the Cobb-Douglas production function are estimated from an unbalanced panel of observations formed from the FAS samples for 1995/96 through 1999/00 (Roberts, Phimister and Gilbert). This yields shares for total labour, land and buildings, livestock capital, and all other purchased inputs of 15.2%, 9.5%, 8.6%, and 41.4% respectively. With these attributable costs accounting for 74.8% of total revenue, the residual 25.2% is identified as the return to the farmer's (fixed) management input. Farm-owned shares of factors of production are derived for each farm in the FAS sample, with 81.0% of labour, 58.4% of land and buildings and 100% of livestock capital being supplied on average by farm occupiers in 1999/00. Hence the average net benefit to farmers of an extra £1 of market price support or output-related payments; AAPS or other area-related payments; livestock headage payments, subsidies or grants; and purchased input subsidies would have been £0.517, £0.584, £1 and £0 respectively.

**Table 1. The redistributive effects of the CAP**

<i>Policy Scenario</i>		CAP	Agenda	Mid-Term Review			
		1999/00	2000	Commun -ication	legislative proposals	final agreement	
		<i>Average £ per farm in 1999/00</i>					
(Post-support) FFI		11656	13368	10142	10913	11422	
% of farms with post-support FFI < 0		23.9%	20.6%	25.2%	22.7%	24.0%	
Total transfers		40132	38914	35131	35309	36439	
<i>Of which due to:-</i>	<i>Market price support</i>	14216	7314	6820	5267	6597	
	<i>(Net) direct payments</i>	23699	29383	26093	27825	27625	
	<i>Other grants and subsidies</i>	2217	2217	2217	2217	2217	
Total net benefit to farmers		30119	31831	28606	29377	29885	
<i>Of which due to:-</i>	<i>Market price support</i>	7637	3897	3567	2774	3531	
	<i>(Net) direct payments</i>	20723	26176	23280	24845	24596	
	<i>Other grants and subsidies</i>	1758	1758	1758	1758	1758	
Pre-support FFI		-18464	-18464	-18464	-18464	-18464	
% of farms with pre-support FFI < 0		87.4%	87.4%	87.4%	87.4%	87.4%	
.....							
Gini coefficient for post-support FFI	$G_1$	0.939	0.839	1.021	0.958	0.936	
Gini coefficient for pre-support FFI	$G_0$	-0.605	-0.605	-0.605	-0.605	-0.605	
Concentration coeff. of post-support FFI	$C_1$	0.458	0.338	0.514	0.464	0.445	
Concentration coeff. of total net benefits	$C_b$	-0.193	-0.209	-0.208	-0.208	-0.204	
Index of redistributive effect	$R'$	-0.335	-0.234	-0.417	-0.353	-0.332	
Index of vertical redistribution	$V'$	0.146	0.267	0.090	0.141	0.160	
<i>Of which due to:-</i>							
	<i>Departures from proportionality</i>	$I_1V$	-1.062	-0.942	-1.119	-1.069	-1.049
	<i>Changed sign of average income</i>	$(I_0 - I_1)G_0$	1.209	1.209	1.209	1.209	1.209
Index of re-ranking	$H'$	-0.481	-0.501	-0.507	-0.494	-0.492	
Disproportionality of net benefits from: -							
total support	$P$	-0.411	-0.396	-0.397	-0.397	-0.401	
market price support		-0.559	-0.563	-0.551	-0.529	-0.556	
(net) direct payments		-0.350	-0.364	-0.366	-0.375	-0.372	
Other grants & subsidies		-0.496	-0.496	-0.496	-0.496	-0.496	
Average net benefit ratio	$s$	2.584	2.381	2.820	2.692	2.617	
<i>Of which due to:-</i>	<i>market price support</i>	25.4%	12.2%	12.5%	9.4%	11.8%	
	<i>(net) direct payments</i>	68.8%	82.2%	81.4%	84.6%	82.3%	
	<i>other grants &amp; subsidies</i>	5.8%	5.5%	6.1%	6.0%	5.9%	

The first column of figures in Table 1 presents findings on the distributional impact of the CAP in 1999/00. In that year, the average level of FFI per farm was just £11656 in spite of market price support worth £14216, (net) direct payments of £23699 and other grants and subsidies totalling £2217. In practice farmers do not receive the full benefit of these transfers so the total impact of agricultural support on average family farm income is predicted to have been £30119 rather than £40132. Even so, pre-support FFI would have been -£18464 on average with nearly 90 per cent of farms recording losses. These results highlight the chronic dependence of farming on state aid.

The Gini coefficient for post-support FFI was positive in 1999/00 since average farming income was positive, with the value of 0.939 indicative of a high degree of inequality. In contrast, the Gini coefficient for pre-support FFI was negative as pre-support FFI was negative. Comparing the absolute values of the two Gini coefficients, we find that the distribution of post-support income was more unequal than that of pre-support income. Hence agricultural policy in 1999/00 had a negative redistributive effect on the distribution of FFI, with the value of  $R'$  equal to -0.335 or slightly more than half the size of the Gini coefficient for pre-support income.

The decomposition of  $R'$  reveals the factors underlying this negative outcome. The first point to note is that farmers with negative or low pre-support incomes received more than an equal share of total benefits, but that their share of benefits was less than their share of overall losses. Hence the distribution of benefits was regressive as is indicated by the negative value of the index  $P$ . And the departure-from-proportionality effect  $I_1V = Ps$  is also negative given that average post-support income and hence the ratio of benefits to post-support income  $s$  was positive. Nevertheless the scale of benefits was sufficiently generous not only to change the sign of average income but also to begin to moderate initial differences in farming income. Thus the index of vertical redistribution  $V'$  is



positive implying that agricultural policy would have made the distribution of farming income slightly more equal were it not for the adverse distributional consequences of re-ranking as measured by the index  $H'$ .

OECD (2002a) argues that farm support measures do not change the income distribution in any significant way because farm support measures are still primarily based on production or production factors. Thus it comes as no surprise that the CAP is ineffective as a redistributive tool. What the study adds to this conventional wisdom is the observation that the CAP is also inefficient as a redistributive tool because of the negative impact of the re-ranking induced by the operation of the policy. One likely cause of this horizontal inequity is the organisation of the CAP on a commodity basis, with the level of support varying across commodities. However this would not appear to be the sole explanation given that results from a disaggregated analysis by farm type (not reported) show that the re-ranking index  $H'$  for the agricultural sector as a whole is not consistently higher than the comparable indices for individual farm types. Further work is required to resolve this issue.

#### **4. Distributional implications of the current process of CAP reform**

The main thrust of the changes initiated by the agreement in 1999 on the so-called 'Agenda 2000' reforms has been to deepen and widen the 1992 reform of the CAP (European Commission, 2002a), with further cuts in the support prices of selected farm commodities partially offset by increases in direct payments. However, Agenda 2000 also saw the introduction of the principle of 'modulation', which refers to the transfer of money from direct payments to a wider range of rural development measures and involves the reduction in direct payments to which farmers would otherwise be entitled. Modulation offers new possibilities to improve the targeting of direct payments which the Commission sought to

exploit in the proposals they put forward in the ‘Mid-Term Review’ (MTR) of Agenda 2000. Thus the initial MTR Communication of July 2002 (European Commission, 2002b) included proposals both for the exemption of direct payments below a certain level (the so-called ‘franchise’) from now compulsory EU-wide modulation rates, and for the imposition of a maximum threshold on payments per farm. Following opposition from the UK and Germany to the principle of capping, the latter proposal was replaced in the Explanatory Memorandum/Legislative Proposals of January 2003 (European Commission, 2003b) by a progressive modulation schedule in which the marginal, and hence also the average, modulation rate rose with the level of payments to the farm (the so-called ‘system of degression’). However the final agreement of June 2003 (European Commission, 2003a) defers the introduction of degression pending the need for financial discipline,<sup>6</sup> so that the only means by which payments will definitely be targeted in future is through the operation of the franchise.

This study considers the hypothetical impact of the reform process when complete, which will not be before 2007/08 according to the MTR final agreement. Table 2 provides details of the main elements of the reform process that are taken into account in the analysis. Note that no allowance is made for the effect of changes in domestic agricultural support policies such as the replacement of UK Hill Livestock Compensatory Allowances with the Less Favoured Areas Support Scheme. Nor does the analysis allow for behavioural responses to policy changes, so it is unable to capture the possible impact of either the modulation-funded expansion of agri-environmental schemes, the proposed expansion of milk quotas, or the decoupling of payments that would result from the MTR scheme for a single farm income payment.

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<sup>6</sup> The financial discipline mechanism will be activated if forecast expenditures exceed a preset budgetary threshold, leading to a reduction in direct payments and the possible introduction of a system of degression over above the franchise mechanism.

Table 2. Definition of CAP reform scenarios in terms of changes to CAP of 1999/00<sup>1</sup>

	Agenda 2000 reform agreement		MTR Communication		MTR legislative proposals		MTR final agreement <sup>5</sup>	
Arable crops	Cut in cereals support prices 15%		Cut in cereals support prices 20%		Cut in cereals support prices 20%		Cut in cereals support prices 15%	
	Changes in payment rates: <sup>2</sup>		Changes in payment rates: <sup>2</sup>		Changes in payment rates: <sup>2</sup>		Changes in payment rates: <sup>2</sup>	
	Cereals/Arable silage	+ €8.66/t	Cereals/Arable silage	+ €11.66/t	Cereals/Arable silage	+ €11.66/t	Cereals/Arable silage	+ €8.66/t
	Oilseed rape	- €31.24/t	Oilseed rape	- €28.24/t	Oilseed rape	- €28.24/t	Oilseed rape	- €31.24/t
	Protein crops	- €5.99/t	Protein crops	- €2.69/t	Protein crops	- €2.69/t	Protein crops	- €5.69/t
	Linseed	- €42.10/t	Linseed	- €39.10/t	Linseed	- €39.10/t	Linseed	- €42.10/t
Set-aside	Change in payment rate <sup>2</sup> + €8.66/t		Change in payment rate <sup>2</sup> + €11.66/t		Change in payment rate <sup>2</sup> + €11.66/t		Change in payment rate <sup>2</sup> + €8.66/t	
			End to non-food crop scheme		End to non-food crop scheme Exemption for SPS claims under 20 ha.			
Milk & milk products	Cut in support prices 15%		No specific proposal but options		ii 'Global' cut in support prices 28%		'Global' cut in support prices 21%	
	New milk quota payment €17.24/t		carrying on with Agenda 2000 reforms		New milk quota payment €32.20/t		New milk quota payment €35.50/t	
Beef & veal	Cuts in beef support prices 20%		No specific proposal but options		ii Continuation of Agenda 2000 reforms		Continuation of Agenda 2000 reforms	
	Changes in Premium rates:		continuation of Agenda 2000 reforms					
	Beef Special:						10% of direct payments to be withheld	
	Steers + €41.3/head						Scottish beef envelope scheme.	
	Bulls + €75.0/head							
	Suckler Cow <sup>3</sup> + €54.6/head							
	Extensification: <sup>4</sup> High + €28/premium							
	Low + €4/premium							
	New Slaughter Premium							
	Bulls, steers, cows €80/head							
Calves €50/head								
End to Calf Processing Aid scheme								
Modulation of direct payments	UK rate 4.5%		EU rate 20%		EU rate on payments:		Combined EU and Scottish rates 10%	
			Franchise of €5000 + €3000 per AWU at		below €5000 0%		Franchise of €5000 exempt from modulat	
			AWU exempt from modulation		€5000 to €50000 12.5%			
			Payments capped at €300000 + franchise		above €50000 19%			

Notes:

1. The table lists only those changes within the reform packages that are taken into account in the study. Neither Agenda 2000 nor the MTR contain proposals for reform of the commodity regimes for sheepmeat, pigmeat, poultrymeat or eggs.
2. Area payment rates are obtained by multiplying by the cereal reference yield. The cut in payment rates for non-cereal crops is due to the alignment of all rates with those for cereals. MTR payments for protein crops includes the stand-alone supplement of 55.57 €/ha converted using the non-LFA Scotland reference yield.
3. Heifers aged 8 months and over may be submitted up to a specified maximum of the total number of cattle on which the premium is claimed.
4. The high rate is payable if stocking density is less than 1.4LU/ha (previously 1.0LU/ha) and the low rate if between 1.4 and 1.8 LU/ha (previously 1.0 and 1.4 LU/ha).
5. The final agreement provides for certain flexibilities in the operation of policy. The definition of the scenario takes into account the key decisions of the Scottish Executive on the implementation of CAP reform in Scotland (Wilson, 2004).

The study explores the possible redistributive impact of the reforms by simulating the effect that the reforms would have had on the distribution of FFI in 1999/00, the last year before the Agenda 2000 reforms began to be implemented. The last four columns of Table 1 presents the results of this simulation exercise, detailing the effects of the hypothetical policy scenarios of full implementation in 1999/00 of the Agenda 2000 agreement, the initial MTR Communication, the revised MTR legislative proposals and the MTR final agreement. Note that the level of pre-support FFI is identical in all five columns since the only differences that are considered are those due to differences in the support regimes under the alternative policy scenarios.

It is predicted that the effect of Agenda 2000 would have been to slightly reduce the total level of transfers, as farmers would have received compensation in the form of higher direct payments for only 50% of the cuts in market price support and all direct subsidy payments would have been subject to modulation at the voluntary UK rate. But FFI increases because the proportion of total support that accrue to farmers in the form of returns to farm-owned factors of production is higher for (net) direct payments than for market price support. In contrast, both the MTR Communication and the legislative proposals would have led to a fall in average FFI, both in relation to the predicted Agenda 2000 and the observed 1999/00 levels, due to the sizeable adverse effect on total transfers of the proposed modulation arrangements. The subsequent watering down of the modulation proposals in the MTR final agreement benefits farmers, but average income levels would have still only be on a par with those actually observed in 1999/00.

With regard to redistribution, the main finding is that the inequality of post-support FFI would have been virtually identical under the MTR Final Agreement to that observed in 1999/00, though inequality would have been lower under Agenda 2000 and higher under either set of MTR proposals. These distributional outcomes partly reflect the predicted

changes in the scale of net benefits. In particular, the positive redistributive impact of Agenda 2000 is largely driven by the increased scale of net benefits which leads to a marked reduction in the proportion of farmers who would have had negative incomes. But the distributional outcomes also reflect specific changes to the CAP that will result from the reform process. Under all four policy scenarios, the effect of the rebalancing of support would have been to make the distribution of support less regressive since the distribution of (net) direct payments is less regressive than that of market price support. In contrast, the impact of changes to the direct payment schemes themselves would generally have been to increase the regressivity of (net) direct payments, with the position actually worse under the MTR final agreement than the Agenda 2000 reforms.

The latter outcome may appear surprising given the Commission's concern to improve the targeting of direct payments in the MTR. However the operation of the franchise would have had negligible impact on the regressivity of (net) direct payments with 98.3% of Scottish farms receiving the maximum value of relief available under the MTR final agreement. Moreover, it would appear that the abandoned capping proposal in the MTR Communication would also have been largely ineffective with no farms at all in the FAS sample subject to this mechanism. And although the differential modulation rates envisaged in the MTR legislative proposals would have had some bite, with 34.3% of farms receiving payments subject to the full modulation rate, the redistributive impact of degression would have been adverse because net direct payments are negatively correlated with pre-support incomes given the dependence of farmers on state aids.

## **5. Summary and conclusions**

The principal focus of the paper is the measurement of the redistributive impact of the CAP. One possible criticism of such an exercise is that the distribution of agricultural policy transfers reflects goals other than income support to do with the environment, sustainability and rural development. However measures specifically targeted to these other objectives still only account for a relatively small share of total support, whereas the direct payments that were first introduced by the MacSharry reforms of the CAP and now account for the bulk of support, had the stated objective of compensating farmers for the adverse income effects of cuts in support prices. The OECD Committee for Agriculture (OECD, 1998) has identified equity and targeting as operational criteria for the evaluation of agricultural policy.

In general terms, the redistributive effect of agricultural policy may be defined as the difference between the inequality of pre-support and post-support farm household incomes. The paper proposes a measure of redistributive effect, based on the change in the absolute value of the Gini coefficient, that is valid whether pre-support and post-support average incomes are positive or negative. The measure is decomposed into vertical and horizontal components in the manner of Kakwani (1984) to show how the distribution and scale of support determine the size of the redistributive effect given the distribution of pre-support income. In particular, it is demonstrated that if average pre-support income is negative and the aim of policy is both to secure positive levels of income on average and to reduce inequality then support must be regressive, but if support is too regressive then the rich will simply get richer.

The possible redistributive impact of the current process of CAP reform is explored by simulating the effect that the proposed reforms would have had on the distribution of Family Farm Income in 1999/00. The results of this counter-factual study need to be

interpreted with some care given that the analysis does not allow for the impact of agricultural policy on the distribution of pre-support incomes. Nevertheless the empirical findings do serve to indicate that the observed distribution of support in 1999/00 exacerbated the inequality of family farm incomes (FFI) in Scotland. Moreover, it would appear that the changes envisaged in the MTR final agreement would have had virtually no effect on this negative redistributive outcome, with the slight positive vertical redistribution effect arising from the rebalancing of support offset by a minor increase in the negative horizontal re-ranking effect. Indeed, if it should prove necessary to invoke the financial discipline mechanism then the overall redistributive impact of the current reform process might well be adverse.

The conclusion may reasonably be drawn that the current package of reforms represents yet another missed opportunity to exploit the potential of direct payments to target support to those most in need of assistance. This continuing failure may in part be attributed to the inherent difficulty of reaching agreement on common EU thresholds for the targeting of payments given the considerable differences between the agricultural structures of the various member states. In particular, the UK has a long-standing record of opposition to the principle of degression on the basis that a disproportionate share of the payments to UK farmers would be subject to the higher rates of modulation. This opposition does not appear to have been assuaged by the MTR agreement that every member state receive at least 80% of its modulation funds, rather than those funds simply accruing to the EU budget to finance the general expansion of the rural development programme and further market reforms as had originally been envisaged in the MTR proposals (see Beckett, 2003). One alternative might be for the EU to establish (common) national targets for modulation savings and then allow member states to set their own national thresholds for the degression of payments within this framework.

However the more fundamental problem is that the redistribution of agricultural income will remain ineffective so long as the overwhelming bulk of support remains tied to either current or historical levels of production. This problem cannot be resolved through the degeneration of existing payment schemes, requiring instead that support be targeted on the basis of need if direct income payments are to be delivered to those that policy-makers might deem to warrant assistance. Whether such a redistribution of agricultural income support could ever be achieved through reform of the CAP is very doubtful. But even before contemplating such a radical reform one might want to follow the OECD in considering whether the general tax and social security system might not in any case be better placed 'to identify low incomes among agricultural households and ensure equal treatment vis-à-vis other classes of household' (OECD, 2002a, p.11).



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## **Appendix: Data and documentation**

### *Farm Accounts Survey panel dataset*

The primary source of data employed in the study is the panel dataset constructed by Roberts, Gilbert and Phimister (2002) of farms in the Scottish Farm Accounts Survey (FAS) over the period 1995/96 through 1999/00. The FAS is the principal source of microeconomic data on the performance of Scottish agriculture and forms part of the EU's Farm Accountancy Data Network (FADN). FAS data is Crown Copyright and may not be provided to any third party nor made public without the prior permission of the Scottish Executive Environment and Rural Affairs Department (SEERAD).

The FAS is an annual survey of Scottish farms carried out on behalf of SEERAD. The FAS has a sample of around 500 farms, virtually all of which have accounting years ending between the 30<sup>th</sup> of September and the 31<sup>st</sup> of May. The average end of year is early March so FAS data on the financial performance of the agricultural sector for the accounting years 1995/96 through 1999/00 relates approximately to the calendar years 1995 through 1999.

The farms in the survey are intended to be full-time commercial undertakings where the occupier is mainly but preferably wholly engaged in working or managing the farm; they should provide work for at least one person; and part-time farms with substantial involvement in other associated agricultural activities such as contracting or wholesaling are excluded. The surveyed farms are chosen to be representative of size and type, where size relates to the economic size of the business and the type classification of the farm depends on the relative importance of the various crop and livestock enterprises (see Table 1). Individual farm results can be weighted according to the number of farms of that type and size enumerated in the (annual) June Agricultural Census, to yield statistics for the whole sector. Given a population of around 17,500 full-time farms in Scotland, the sampling fraction for each farm size and type is estimated to be approximately 3%.

Once recruited, farms can stay in the sample for an unlimited period provided they do not change so much as to no longer be classified as full-time commercial enterprises. The panel dataset has been constructed by linking data on individual farms in the survey over time. The panel for 1995/96 through 1999/00 contains observations on a total of 657 different farms, of which 621 were present in two or more years, and 383 were present in all five of the years.

The information contained in the FAS comprises a wide range of financial and physical detail on the farms in the survey. Physical details include such information as area, tenure, quotas, labour, stocking, production and sales. Financial details include data on the revenue from the sale of all the main agricultural products and subsidies and also on expenditure on costs such as labour, rent, feed, seed and fertilisers. Though not an exhaustive list, information is also available on the value of farm products used on the farm, and in the farmhouse; the opening and closing valuations of crops, livestock, machinery and other items of cost; capital investment and disinvestment in the accounting year.

[More information on the FAS can be found in *Farm Incomes in Scotland* (online at: [http://www.scottishexecutive.gov.uk/publications/a\\_to\\_z.aspx?letter=F](http://www.scottishexecutive.gov.uk/publications/a_to_z.aspx?letter=F)) which provides a description of the survey together with summary results]

**Table 1. Farm Accounts Survey sampling frame**

SEERAD Farm Type	Description	Size (Economic Size Units)
1. Specialist Cereals <i>UK main farm type 1</i>	Farms where more than two-thirds of the total standard margin comes from cereals and oilseeds	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 and over
2. General Cropping <i>UK main farm type 2</i>	Other farms where more than two-thirds of the total standard gross margin comes from all crops.	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 and over
3. Dairy <i>UK main farm type 9, 10</i>	Farms where more than two-thirds of the total standard margin comes from dairy cows.	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 - 199.9
4. LFA Specialist Sheep <i>UK main farm type 11, 14(part)</i>	Farms in LFAs with more than two-thirds of the total standard gross margin coming from sheep	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 - 199.9
5. LFA Specialist Beef <i>UK main farm type 12, 14(part)</i>	Farms in LFAs with more than two-thirds of the total standard gross margin coming from cattle	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 - 199.9
6. LFA Mixed Cattle & Sheep <i>UK main farm type 13, 14(part)</i>	Farms in LFAs with more than two-thirds of the total standard gross margin coming from sheep and beef cattle together.	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 - 199.9
7. Lowground Cattle & Sheep <i>UK main farm type 15</i>	Farms outside LFAs with more than two-thirds of the standard gross margin coming from sheep and beef together.	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 - 199.9
8. Mixed <i>UK main farm type 16 - 20</i>	Farms where no enterprise contributes more than two-thirds of the total standard gross margin	Small: 8 - 39.9 Medium: 40 - 99.9 Large: 100 and over

Notes:

The sampling frame excludes (specialist) 'Horticulture', (specialist) 'Pigs and Poultry' and 'Other' UK robust farm types.

The sampling frame excludes farms smaller than 8 Economic Size Units (ESU) and specialist livestock farms (farm types 3 to 7) larger than 200 ESU: specialist livestock farms larger than 200 ESU were dropped from the dataset.

*Calculation of pre-support Family Farm Income (FFI)*

The FAS provides a range of indicators of the economic performance of the sector. Family farm income (FFI) represents the return to the farm's own capital and all unpaid labour

(farmers and spouses, non-principal partners and directors and their spouses and family workers) based on the actual tenure and indebtedness of the farm business. It thereby ‘accords broadly with the notion of profit from farming’ (Hill, *Farm Incomes, Wealth and Agricultural Policy*, (2nd. Edition) Aldershot: Avebury, 1996) and is used by the European Commission in the Farm Accountancy Data Network.

Pre-support FFI is defined as (post-support) FFI less the benefits that are farmers deemed to receive from the operation of the CAP. The first step in this calculation is to work out the size of the transfers due to the three types of policy instrument separately identified in the study:

- (i) *Market price support.* Estimates are taken from the OECD PSE database (OECD. *OECD Agricultural databases: 2001 edition*. Paris, 2001) of the gap in 1999 between the EU15 domestic market and border prices of common wheat, maize, barley, oats, other grains, milk, beef and veal, pig meat, poultry meat, sheep meat and eggs, measured at the farmgate level. These commodities account for the overwhelming bulk of Scottish agricultural output subject to market price support given that oilseeds and protein crops are not subject to border protection, potatoes and wool are not covered by the CAP and the FAS sample excludes specialist horticultural holdings. The estimates are adjusted to reflect the difference between UK and EU average producer prices using data from the “Agricultural Situation in the European Union” report for 2001 (Commission of the European Communities, Brussels, 2001). The resulting price gaps are used to identify the impact of market price support in terms of inflating both the value of output, net of direct payments, grants and other subsidies, and the cost of feed and seed, as given in the FAS data.

In the CAP reform scenarios, we adjust the market price support transfer estimates for any proposed changes in farm commodity support prices on the assumption that cuts in support prices lead to similar percentage falls in domestic producer prices.

- (ii) *Direct payments.* Direct payments are explicitly identified in the FAS and cover payments under the Arable Area Payment and Small Cereals Producer Schemes, set-aside payments, Hill Livestock Compensatory Allowances, Beef Special Premium, Suckler Cow Premium, Sheep Annual Premium and payments under the Small Milk Producer scheme. We calculate the net value of AAPS payments to farmers by subtracting an estimate of the loss in crop revenues due to obligatory

set-aside requirements where both the obligatory set-aside area and the level of crop returns can be identified from the FAS data.

In the CAP reform scenarios, we assume that changes in direct payment rates impact directly on transfers. However, working out the possible effects of changes to the operational rules governing existing schemes and the introduction of new ones is less straightforward. We assume that the end of the non-food crop scheme will lead to the loss of output from the industrial crops grown on set-aside land in 1999/00. Exemptions from set-aside for small claims are identified on the basis of relevant areas in 1999/00 with the value of the exemption equal to the crop revenues that would have been generated on land set-aside. Farmers are assumed to have made claims covering their entire suckler cow premium quota in 1999/00 such that the relaxation of the rules to allow heifers to be submitted as part of the claim would have had no effect. Eligibility for the new higher rate of extensification premium is deduced from the receipt of extensification premium in 1999/00, while eligibility for the new lower-rate is estimated on the basis of actual stocking densities in that year. Eligibility for the new direct payments to milk producers is based on the individual reference quantity available on the holding; with no change foreseen in the aggregate level of milk quota in Scotland. The effect of the new beef slaughter premium scheme is deemed to be equivalent to an increase in market price support, with the percentage increase conservatively estimated as the ratio of the premium rate for bull, steers and cows to the average UK price for class R3 male bovine animals in 1999. Finally the value of the franchise and degression under the various MTR modulation schemes is calculated on the basis of revised levels of direct payments and, in the case of the MTR Communication franchise, the total number of labour units on the farm in 1999/00.

- (iii) *Other grants and subsidies.* Other grants and subsidies are also identified in the FAS and cover all other payments to farmers except for those in respect of permanent improvements. These payments are not affected by the proposed reforms to the CAP.

The second step in the calculation is to work out the net economic benefit to farmers of these transfers, which will depend on the extent to which the transfers result in increased returns to the farm-owned factors of production, including management, and hence in increased farming incomes. The effect on farming income of a unit increase in output

revenues, whether due to market price support, output payments or a reduction in set-aside requirements, is estimated as the combined cost share of the farm-owned factors of production, while that of a unit increase in direct payments, grants or subsidies to individual inputs (i.e. land and livestock) is simply calculated as the farm-owned share of those inputs as identified in the FAS data.

### *Estimation of factor cost shares*

Estimates of factor cost shares are obtained on the assumption that Scottish agriculture may be characterised by an aggregate Cobb-Douglas production technology exhibiting constant returns to scale. Output is defined as farm output, net of direct payments, grants and other subsidies, in constant 1996 prices, where the various components of output are deflated using the appropriate UK Index of Producer Prices (online: <http://statistics.defra.gov.uk/esg/datasets/apiyear.xls>). Production is specified as a function of four separate input categories. ‘Labour’ is defined in physical terms using FAS data on total annual labour units. ‘Land and buildings’ is identified as a separate cost category in the FAS data and includes an imputed item for the rental value of owner-occupied land. Costs are defined in constant 1996 prices: price deflators are constructed for land costs by farm type from the FAS panel data on land costs and areas while the various components of building costs are deflated using the relevant UK Index of Purchase Prices of the Means of Agricultural Production (online: <http://statistics.defra.gov.uk/esg/datasets/apiyear.xls>). The value of ‘livestock capital’ is available in the FAS data and is converted into constant 1996 prices using a price deflator for each livestock type constructed from the FAS panel data on opening and closing valuations and quantities. ‘All other purchased inputs’ encompasses the FAS machinery, crop, livestock and miscellaneous cost categories and is expressed in constant price terms by deflating individual cost components using the relevant UK Index of Purchase Prices of the Means of Agricultural Production. Finally, the specification allows for fixed farm-specific and year-specific effects.

The parameters of the Cobb-Douglas production function are estimated from the unbalanced FAS panel dataset for 1995/96 through 1999/00 using the fixed-effects linear regression model estimator ‘xtreg’ in STATA7 (StataCorp, 2001, ‘Stata Statistical Software: Release 7.0’, College Station Texas.). The output is shown below.

Fixed-effects (within) regression		Number of obs	=	2508
Group variable (i) : shortid		Number of groups	=	626
R-sq: within	= 0.0781	Obs per group: min	=	1
between	= 0.8492	avg	=	4.0
overall	= 0.8087	max	=	5
corr(u_i, Xb)	= 0.7201	F(8,1874)	=	19.85
		Prob > F	=	0.0000

  

log(output)	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
log(labour)	.1520864	.042736	3.56	0.000	.0682712	.2359015
log(land&bldgs)	.0954522	.0276076	3.46	0.001	.0413073	.1495971
log(livestock)	.0864826	.0363486	2.38	0.017	.0151947	.1577705
log(oth_purchased)	.4141415	.0501372	8.26	0.000	.3158109	.5124721
_1996/97	.0185354	.0166328	1.11	0.265	-.0140854	.0511562
_1997/98	.0481039	.0159633	3.01	0.003	.0167962	.0794115
_1998/99	.0468698	.0157111	2.98	0.003	.0160566	.0776829
_1999/00	-.0068957	.0155707	-0.44	0.658	-.0374334	.023642
_cons	4.513541	.6308414	7.15	0.000	3.276315	5.750766
sigma_u	.48851374					
sigma_e	.23743846					
rho	.80890615	(fraction of variance due to u_i)				

  

F test that all u_i=0:	F(625, 1874) =	6.52	Prob > F =	0.0000
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The estimated output elasticities imply cost shares for total labour, land and buildings, livestock capital, and all other purchased inputs of 15.2%, 9.5%, 8.6%, and 41.4% respectively. With these attributable costs accounting for 74.8% of total revenue, the residual 25.2% is identified as the return to the farmer's (fixed) management input.

#### *Analysis of income redistribution*

The redistributive analysis is based on the farm-level data on (post-support) FFI and the farm-level estimates of pre-support FFI and of transfers and net economic benefits by policy instrument. All summary statistics are calculated using weighted data where the weights are calculated from information supplied by SEERAD from the June Agricultural Census returns on the distribution of agricultural holdings in Scotland by type of farming and size of business in 1999. (the 'Economic Report on Scottish Agriculture 2000 edition' (SEERAD, 2000. Online: <http://www.scottishexecutive.gov.uk/agri/documents/ersa-00.asp>) contains a tabulation of this joint distribution, but provides less detail than the information on which the study is based).



The various Gini and Concentration coefficients are calculated using the Gini formula given in Lerman & Yitzhaki (Journal of Econometrics, 42 (September 1989), pp.43-47) for use with weighted data. Thus to calculate the Gini coefficient  $G$ , let  $w_i$  and  $y_i$  be the weights and incomes in a sample of  $n$  observations where  $\sum w_i=1$  by definition. Assume that the individuals are ranked in order of increasing income and define the empirical distribution function  $F(y)$  as:

$$F_i(y) = \frac{w_i}{2} + \sum_{j=0}^{i-1} w_j \quad \text{for } i=1, \dots, n; \quad \text{where } w_0 = 0.$$

The formula for the Gini coefficient  $G$  is then equal to:

$$G = \frac{2 \sum_{i=1}^n w_i (y_i - \bar{y})(F_i - \bar{F})}{\bar{y}}$$

where  $\bar{y}$  and  $\bar{F}$  are the weighted means of  $y$  and  $F$  respectively. In the case of the Concentration coefficients of post-support FFI and benefits,  $C_l$  and  $C_b$  respectively, the same formulae are employed but the individuals are ranked not by the variable of interest itself but in order of increasing pre-support FFI.