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**The Price Effects of
Classification.**

**An Empirical Analysis of the
U.K. Beef Market.**

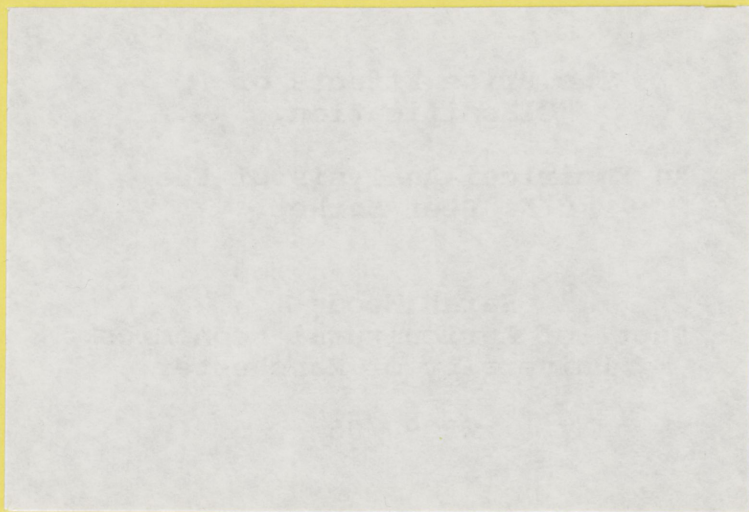
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WP 90/05



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Introduction

The hedonic technique is motivated by the hypothesis that differences in quality characteristics relevant to the purchasers' decision to buy affect the price they are willing to pay. Thus some portion of the observed price (an equilibrium price) is explained by different characteristic levels. This should result in 'price differentials' for significantly different (in the buyers' mind) types of the same good.

Here the technique is exploited to test the significance of weight, sex, conformation and fatness in the different prices paid for beef carcasses in the U.K. From the analysis it is hoped that some light can be shed on the questions that follow:

1. Do characteristics like sex, weight, conformation and fatness affect price determination?
2. If made explicit, as in the Meat and Livestock Commission (MLC) carcass classification scheme, do these characteristics have a different impact on price determination?
3. How do two markets compare when one uses explicit classification and one does not, in terms of the price relationship with the characteristics?
4. How do these examples compare with some optimal situation? - What is optimal?

5. Can something be said about the information states of the two markets relative to each other and the optimal? What is the value of the information provided by the classification of carcasses?

6. What are the incentives to use the classification scheme, for those already using the scheme, and for those who are not?

7. What are the conclusions for the use and efficiency of the MLC carcass classification scheme from these results? The analysis makes use of some 'optimal' situation. The definition of this optimal position will be discussed as it arises below, and will form something of a digression before continuing with the empirical analysis.

The data are in two sets:

1. The prices and characteristics for explicitly classified carcasses;
2. The same for implicitly or 'shadow-classified' carcasses.

These data sets are referred to, respectively, as:
the classified market (CM)

and

the shadow-classified market (SM).

Before presenting the results and discussion the assumptions made for the estimation and the expected results will be considered. This will be followed by some discussion of the data and econometrics involved. Then the results will be presented and interpreted.

The Hedonic Price Function Methodology.

The approach owes its revival to Griliches(1961,1971),but the idea that the observed price of a good may be determined by the value attached to its qualities as defined by its' characteristics is an old one. Waugh(1928) as early as 1928 was estimating hedonic price functions for asparagus, tomatoes and cucumbers for his doctoral thesis.

To give a more rigorous definition:

The hedonic price function assumes that the price paid for product i (p_i) is some function of the marginal yield of product attribute j provided by product i ($MP_{i,j}$) multiplied by the marginal implicit price of attribute j (MIP_j), for all attributes of product i

or more concisely:

$$p_i = F(MPV_{i,j});$$

$$MPV_{i,j} = MP_{i,j} * MIP_j.$$

where P_i is the equilibrium price for good i ;

$MPV_{i,j}$ is the marginal product value of attribute j in good i ;

$MP_{i,j}$ is the marginal product (i.e. quantity) of attribute j in good i ;

MIP_j is the marginal implicit price of attribute j .

The $MP_{i,j}$ are taken as datum (though actually observing these quantities is probably the greatest test of the approach) and the market price is then regressed upon these observations. The resultant coefficients are the MIP_j , or the shadow price of attribute j implicit in the market price

paid for good i.

Here a hedonic price function is used to determine empirically the implicit prices of the characteristics of beef carcasses (conformation, fatness, sex and weight) and the results are used to give a value to the information from classification and to assess the incentives to use classification.

As is usual in this type of analysis the data are cross-section. It is hoped to extend the methodology to pooled data, but this will be far more demanding in terms of specification, and computation.

Expected Results

The classification scheme uses sex, weight and two subjectively assessed characteristics, fatness and conformation. Fatness is measured on a scale with seven divisions, from 1, denoting low fatness, to 5H, for very fat carcasses. Conformation (shape of the carcass) is measured on a scale with eight divisions, E implying a good 'blocky' carcass, and P- a poor scraggy carcass.

In the SM the classification characteristics, conformation and fatness are not expected to be as significant in the determination of price, though some relation should be expected otherwise the basis of the classification scheme would be severely undermined. If the CM is truly affected by the classification scheme then conformation and fatness must be expected to significantly

determine prices.

Specifically, in the CM, fatness is expected to be more important than conformation, as the degree of fatness affects the percentage lean yield (PLY) more than conformation (see table 1), though better conformation gives a better distribution of high value cuts, so some trade-off may be expected.

Percentage Saleable Lean Yield (PLY) from M.L.C. Estimates.¹
Table 1.

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	1	2	3	4L	4H	5L	5H
E	75.6	74.7	73.6	72.3	70.9	68.7	66.1
UP	75.3	74.4	73.4	72.0	70.6	68.4	65.8
UM	74.9	74.0	72.9	71.6	70.2	68.0	65.4
R	74.4	73.5	72.4	71.1	69.7	67.5	64.9
OP	73.7	72.8	71.7	70.4	69.0	66.8	64.2
OM	72.7	71.8	70.7	69.4	68.0	65.8	64.3
PP	71.3	70.4	69.3	68.0	66.6	64.4	62.9
PM	69.4	68.5	67.4	66.1	64.7	62.5	61.0

¹ See MLC Beef Yearbook 1987.

The MLC suggests that optimal prices should be directly related to the PLY. It is unlikely that the results of the analysis will give optimal price differentials as the system is unlikely to be in long-run equilibrium, or at an optimal constellation of factors relating to the market. More likely is a mix of price differentials which discount extremes of fatness and conformation as undesirable. As an example see table 2 for a distribution of premia and discounts relative to the price offered for an R4L carcass.

However, the suggestion by the M.L.C. is in agreement with the ideas developed about optimal or steady state price differentials. That is, the observed price, which, according

Expected Direction of Price Differentials Relative to R4L.
Table 2.

	1	2	3	4L	4H	5L	5H
E	+/-	+/-	+/-	+	+/-	+/-	-
UP	+/-	+	+	+	+/-	+/-	-
UM	+/-	+	+	+	+/-	+/-	-
R	+/-	+	+	0	-	-	-
OP	+/-	+	+	-	-	-	-
OM	+/-	+/-	+/-	-	-	-	-
PP	+/-	+/-	+/-	-	-	-	-
PM	-	-	-	-	-	-	-

to the hedonic price theory is the sum of the products of the quantity of the attributes in the good and their implicit prices, should fully reflect the productive (or utility) value of the good. In this case the productive value of the carcass is the meat it produces, i.e. the percentage lean yield (and some factors reflecting the eating quality of the resultant lean, the data for which is unavailable).

The form in which conformation and fatness enter the equation should reflect the M.L.C.s contention that the classification scheme is not a grading scheme, i.e. the classification variables should explain price better when they appear as purely dummy variables, not when entered as scaled values, as the latter would imply some ranking of the classes other than by the resultant price.

In both CM and SM the sex variable is likely to be important as it is believed to affect the quality of the meat from a carcass in terms of tenderness and flavour. It is also a highly visible characteristic requiring little skill in differentiation. The weight variable is unlikely to be of great importance except in extreme cases. The prices are expressed as per kilogram so weight is only important as a proxy for size of carcass which may affect production techniques.

Steer carcasses should command the highest premium in both markets, although bull carcasses are becoming increasingly popular (according to Milk Marketing Board data on the sale of calves and the slaughtering patterns recorded by the M.L.C). Heifer and cow carcasses will suffer a discount relative to steers and bulls, especially cull cow carcasses.

A particularly important variable that will be omitted from the analysis is the breed of cattle. When on the hoof this is another highly visible characteristic, and one that is often cited as an indicator of the potential productivity of the carcass¹ and certainly in the SM may play an important role in the determination of price. It is omitted because it is not used in recording the deadweight price data. Once slaughtered, of course the breed is not obvious, but then neither is the sex, except by distribution of the fat. However, the information will still play an important role in the decision to buy/sell and hence the price paid.

There are other variables that could also be included.

For example, no account here is taken of the characteristics of the buyer and seller in determining price, or other characteristics describing the carcass which are not detailed above. The fat colour, and lean colour may also affect the price. As a result of the provisos, the coefficient of determination is not expected to be overwhelmingly close to one, and the Durbin-Watson statistics may well give an indication of the problems due to omitted variables.

Data and Estimation

The data used are the MLC data collected for the deadweight price recording exercise.

The data are collected from a sample of abattoirs, including some which do not in fact use the MLC classification scheme in their production, but permit MLC fatstock officers to 'shadow-classify' their carcasses (these carcasses are still graded for the beef premium and intervention purposes). Unfortunately the CM data includes these observations and there is no obvious way to extract them as the data available for the CM is at an aggregated level. However, the returns from the abattoirs concerned are available separately and these have been aggregated in a manner similar to that for the CM data to give the SM data. It must be remembered that the SM data are a subset in effect of the CM data. However, due to problems in collecting this data the time periods examined are only close, not exact. It is hoped that the portion of the sample that is shadow-

classified is small relative to the whole sample, so that any bias introduced into the CM sample should be small. The sample sizes per week for the CM are about 200, and for the SM about 80, so this is not a forlorn hope.

It is interesting to note, however, that the MLC have been using these data for the deadweight price reports for the EC's assessment of the EC classification schemes effectiveness, and indeed the MLC use them for monitoring. Both the MLC and EC have been disappointed with the results obtained from Britain on the relation between prices and carcass classification. This has been credited to the practice of 'batch buying'. Another possibility is that because the data set is not purely of the classifying section of the beef slaughtering industry the relationship is being obscured by spurious data points from the shadow-classifying part. It seems that these two groups in the data set should be separated. These points also raise the problem that this study may also run foul of this distortion in the data and not find any significant relation between price and class, as the MLC has found. However, the analysis here is different from that used by the MLC.

Since the abolition of the variable premium and certification the shadow classified data has ceased to be collected, and this exercise will no longer be possible for data after April 1989. Since this date the MLC has reported an increase in the number of abattoirs registering for classification, though not as many as used certification.

The CM data are for the week commencing 11/01/89 with a

static comparison with week 08/02/89. The SM data are for the weeks 12/11/88 and 01/12/88. These two time periods for each data set allow tests for structural change (other than time dependent shifts in the base price) and an analysis of how the coefficients do change between time periods. Although the results for the two sets of data are not directly comparable their performance is, as are the resultant price differentials which are assumed to be non-time varying.

The alternative specifications, detailed below, estimated for each data set. Since each specification is linear in its parameters ordinary least squares can be used for estimation. However, since the data are cross-sectional this may be inefficient as the estimator will not use the between observation variance, which is probably important. Also one expects heteroskedasticity to be important for cross section data and other estimators will account for this, e.g. generalised least squares. To choose between the different specifications standard tests were employed (tests for heteroskedasticity, auto-correlation {which would imply misspecification or omitted variables for cross-section data}, goodness of fit etc.).

The Equations Examined

Broadly three types of equation were considered. The first type relied on the use of dummy variable groups for the different characteristics. The second used scale variables

for the characteristics. The third uses the PLY corresponding to each class, implying a perfect interpretation of the classification of a carcass by the market participants.

The first type means that all the results are interpreted in relation to some base set of conditions as one dummy from each set of dummy variables is dropped to solve the equation. This allows the interpretation of the constant as a 'base price'. This form imposes no relation between the different levels of the characteristics. It does use up quite a large number of degrees of freedom. This number increases as the complexity of the classification scheme increases. There were two approaches within this type of equation. One was to create fifty-six dummies, one for each cell of the conformation/fatness grid (indeed if this approach were taken to its ultimate conclusion you could set up a model with

$56 \times 4 \times 5 = 1120$ dummies for the CM, and

$56 \times 3 \times 3 = 504$ dummies for the SM, giving a dummy variable for each class/sex/weight combination.). Obviously this approach eats up the degrees of freedom and as a result is not easily estimated with any degree of confidence. It also does not allow easy interpretation of the results with so many discrete dummies. Therefore the second approach was used. This approach treats each dimension of the grid as separable, or at least the price effects as separable. Therefore there are four sets of dummy variables: conformation, fatness, weight, and sex.

The second type of equation uses scale variables

representing the different divisions of the classification dimensions. For example, conformation classes E, U⁺, U⁻, R, O⁺, O⁻, P⁺ and P⁻, can be given values of 3, 2, 1, 0, -1, -2, -3, and -4 respectively, and similarly for fatness (1, 2, 3, 4L, 4H, 5L, 5H as 3, 2, 1, 0, -1, -2, -3) and weight (a declining scale from high weights to lower weight groups). By scaling in this way it is possible to still have a "base" result at R4L of zero.

(These scales were also combined to give an aggregate scale value for each class, in a similar vein to the PLY. This was an attempt to see if market participants weighted the classes this way in their buying and selling decisions. See table 3 for the resultant scale values. This gives a problematic value to the various classes implying that certain classes are equivalent which is not satisfactory. Unsurprisingly the results are very poor.)

These scales obviously assume that greater weight is given to improving conformation scores, declining fatness scores and heavier or larger carcasses. The sex variable was not scaled as this was felt to be inappropriate.

These scaled variables were examined in a linear form and in a quadratic form. The first should be rejected as inferior to the latter as the MLC are adamant that the classification scheme is not a grading scheme as an acceptance of the linear scaled model would imply. The second form, the quadratic, if found superior, would give support to the hypothesis that extreme conformation types and fatness types are discounted relative to median types.

Resultant scale values if the scales for conformation and fatness are combined.

Table 3.

	1	2	3	4L	4H	5L	5H
E	6	5	4	3	2	1	0
UP	5	4	3	2	1	0	-1
UM	4	3	2	1	0	-1	-2
R	3	2	1	0	-1	-2	-3
OP	2	1	0	-1	-2	-3	-4
OM	1	0	-1	-2	-3	-4	-5
PP	0	-1	-2	-3	-4	-5	-6
PM	-1	-2	-3	-4	-5	-6	-7

The third type of equation assigns the values from table 1 to each observation in the data set as appropriate, with, for example, cell R4L set equal to 71.1% and so on. This form was also examined in a linear and quadratic form. The expected results from these equations are not clear. Hopefully in the CM a clear indication of the correspondence between class descriptors (conformation and fatness) and class results (PLY) will appear. This is unlikely to be the case for the SM data. A possible route to examine this explicitly would be to put both class descriptors and PLY in an equation and check for serious multi-collinearity in the equation. This simple check indeed reveals serious multicollinearity between PLY and the individual dummy variables.

Following other work in the hedonic field these different types of equation were estimated in both a

straightforward linear form and a semi-logarithmic form. This gives fourteen equations to be examined in each market.

Results

The complete results and the tests undertaken on the different models are recorded elsewhere². Presented here are the best equations. These were the dummy variable equations (type one), with the price as the dependent variable. This was the case for both CM and SM.

The estimates of the best fitting equations are reproduced here for convenience:

CM Equation 1:

$$\begin{aligned}
 P = & 201.30 - 0.29E + 4.51UP + 2.92UM - 0.93OP - 4.69OM \\
 & (2.58)^* \quad (4.86) \quad (2.22) \quad (1.52) \quad (1.43) \quad (1.29) \\
 & - 12.53PP - 23.96PM - 0.41ONE - 0.40TWO + 0.67THREE - \\
 & \quad (1.68) \quad (4.36) \quad (2.59) \quad (1.93) \quad (1.87) \\
 & 2.57FOURH - 9.19FIVEL - 7.73FIVEH - 6.27H - 4.27B - 35.13C \\
 & (1.76) \quad (1.92) \quad (2.26) \quad (2.52) \quad (1.96) \quad (2.10) \\
 & - 1.34LT215 + 2.41LT250 + 1.57BT250 + 4.67GT250 + \\
 & \quad (3.14) \quad (2.17) \quad (3.26) \quad (2.62) \\
 & 1.48GT300 . \\
 & (2.30)
 \end{aligned}$$

$$ESS = 6422.59$$

$$R^2 = 0.85 \quad \text{adj. } R^2 = 0.84$$

$$DW = 1.77$$

*-standard errors in parentheses.

SM Equation 1:

$$\begin{aligned} P = & 199.57 + 8.51U^+ + 6.18U^- + 5.75O^+ - 5.84O^- - 17.53P^+ \\ & (5.25)^* (10.36) (5.81) (4.85) (6.16) (17.84) \\ & - 7.92ONE - 0.16TWO - 1.64THREE - 11.79FOURH + \\ & (13.30) (5.83) (5.31) (5.55) \\ & 25.36FIVEL + 82.97FIVEH - 108.10H + 2.57B + 3.92LT250 \\ & (10.84) (18.82) (6.73) (4.36) (3.17) \\ & - 5.31GT300 . \\ & (4.43) \end{aligned}$$

ESS = 18009.7

R² = 0.85 adj. R² = 0.82

DW = 2.17.

*-standard errors in parentheses.

Discussion

- The CM equation 1

This equation is a straightforward equation and as such its performance is better than might have been expected. However, this might imply that there is little systematic relationship perceived between the different classes, and that fatness is viewed as separable from conformation in valuing a carcass (and vice versa). Looking at the fitted price differentials for the different classes as suggested by equation 1 (table 4) it seems clear that although conformation and fatness have been separated in the equation,

the interaction of the two sets of dummies in forming price differentials give plausible results. Indeed these are surprisingly close to the tentatively suggested direction of the price differentials given in table 2. None of the resultant differentials are ridiculously large. They also follow the pattern suggested by equation types 6 (quadratic scaled variables). That is extreme classes suffer a discount relative to those closer to R4L.

CM Equation 1 Price Differentials.

Table 4.

	1	2	3	4L	4H	5L	5H
E	-0.69	-0.69	0.38	-0.29	-2.88	-9.48	-8.02
UP	4.11	4.11	5.17	4.51	1.92	-4.68	-3.22
UM	2.51	2.52	3.58	2.92	0.33	-6.28	-4.81
R	-0.40	-0.40	0.67	0.0	-2.59	-9.19	-7.73
OP	-1.33	-1.33	-0.27	-0.93	-3.52	-10.12	-8.66
OM	-5.09	-5.09	-4.02	-4.69	-7.28	-13.88	-12.42
PP	-12.93	-12.93	-11.86	-12.53	-15.12	-21.72	-20.26
PM	-24.37	-24.36	-23.30	-23.96	-26.55	-33.15	-31.69

The range of the price differentials is quite wide, at a maximum of 5.17 p/kg for a U+3 carcass, and a minimum of -33.15 p/kg for class P-5L. U+ and U- are the only conformation types that attract a premia and only one fatness type does so, fatness 3.

This means a majority of differentials are discount not premia. This suggests that the market is better at communicating its dislikes rather than its preferences. This may result in a weaker positive response to the

classification scheme, since farmers are discouraged from producing poorer carcasses quite persuasively, but the incentives to actively improve the fat levels and conformation of their carcasses are low. If the costs of changing production techniques to produce these better cattle are greater than benefits suggested by equation 1 price differentials, and costs can be further reduced under existing regimes then such a set of price differentials may not be sufficiently varied and extreme to improve the overall productive quality of the carcasses being produced. This of course ignores the dynamics of the market, but these considerations must be left for another paper! In the short run, however it seems the market is not giving very positive signals to farmers.

The coefficients on the sex variables give the expected preference for different sexed carcasses:

1st Steer

2nd Bull

3rd Heifer

4th Cow.

All these variables were highly significant. The discount on cow carcasses was particularly severe, while those for bulls and heifers were more moderate(see CM equation 1).

The weight of the carcass was the least important characteristic in determining price, and only one weight group gave an individually significant price differential over the BT250 weight group, the GT250 group. However, jointly these variables were significant and so it seems the

size of a carcass may have some effect on prices but not one of great significance.

- The SM equation 1

It is clear from equation one that even in the SM price can be explained by some salient characteristics of the carcass. The most important is quite clearly sex, with fatness next and then conformation, and finally weight. Only fatness and sex prove jointly significant, and only four single coefficients are significant out of the sixteen estimated. Compared with equation 1 CM, this equation also suffers from a poor Durbin-Watson statistic implying that there is some problem with the specification. The R^2 statistics are high, while significant variables are few. There could well be additional problems of multicollinearity. The performance is quite clearly worse than that for the CM.

The resultant price differentials for SM equation 1 are presented in table 5. There were no carcasses of conformation E and P- in the sample and so no price differentials can be calculated for these classes. The price differentials range from 93.12 p/kg (U+5H) to -27.68 p/kg (P+4H). It is quite apparent that there is a problem with the estimates for the SM data. The price differentials are far from rational given the meaning of the classification. It must be emphasised that the carcasses do not not have a conformation and fatness type if they are not classified, they merely do not have those characteristics explicitly identified and communicated. It

seems that the insignificant conformation coefficients which give a rational array of values for conformation classes (U+ preferred to U-, preferred to O+, preferred to O-, preferred to P+) are being replaced by the fatness of the carcase as an indicator of yield, since the highest (and significant) coefficients are on the fattest carcase classes, 5L and 5H. It seems that there is some confusion in this market over what the carcase will yield related to the fatness and shape of the carcase. They are effectively overvaluing fat and wasteful carcasses. This is clearly a case of misinformation and inefficiency.

SM Equation 1 Price Differentials.

Table 5.

	1	2	3	4L	4H	5L	5H
E	*****	*****	*****	*****	*****	*****	*****
UP	2.22	9.98	10.14	8.50	-1.65	35.50	93.12
UM	-0.10	7.66	7.82	6.18	-3.97	33.18	90.80
R	-6.28	1.47	1.64	0.0	-10.15	26.99	84.62
OP	-0.53	7.22	7.39	5.75	-4.40	32.74	90.36
OM	-12.12	-4.37	-4.20	-5.84	-15.99	21.15	78.77
PP	-23.81	-16.05	-15.89	-17.53	-27.68	9.47	67.09
PM	*****	*****	*****	*****	*****	*****	*****

Interestingly, in the SM, bull carcasses are most highly prized, steers second and heifers an immensely poor third. Again the weight variables were insignificant, with lighter carcasses preferred to medium and heavy ones.

It is clear that since the best equations for both

markets were the 'type 1' equations, the classification scheme is not viewed as a simple grading scheme, as the price differentials do not give a ranking of the class cells consistent with that. The CM prices are clearly more closely related to the classification characteristics than in the SM. However, the relation still seems to exist in the SM albeit rather tenuous, and it is quite possible that an important variable in the SM (breed?) has been omitted. These results will now be used for some comparisons and assessment of the information content of the classification scheme.

Some Comparisons and Assessments.

Price Differentials and Ranking the Classes

It is possible to use the coefficients to rank the classes in order of the market preference, where preference is assumed to be reflected in the market valuation of different types of carcass, the most preferred type of carcass being that with the greatest premia attached to it. This was the basis for the statements concerning the sex of carcasses and their weight. Here this idea will be extended to the more interesting characteristics of conformation and fatness.

There are quite a number of cases to consider. There are the actual price differences observed and the implied rank of the classes; the price differences and rank implied by the estimated equations, the price differentials and the ranking

implied by the PLY values.

The latter are a somewhat special case and it is here that the digression on 'optimality' promised earlier will appear.

Price differentials, optimality and benchmarks

- a digression.

The need for this digression arises from the perennial thorny problem in non-experimental empirical analysis. To analyse the results we wish to compare the policy results (of classification) in a short-run equilibrium with the policy off situation and with the expected long run policy on situation. Here the data available allow the former to some extent, but we must beware that the two markets do not operate in isolation. The latter however is unobservable - tomorrow never comes. The nature of the real world is ever-changing, and a short-run equilibrium can rarely be related to an observed long run equilibrium for the same market conditions. Still, we can make use of partial results - where we assume ceteris paribus and a long run result is imposed on the structure in the short run. It is admittedly ad hoc, but as long as these limitations and difficulties are recognised it is useful. Hence the following:

In order to make some meaningful comments on the results some benchmark is needed. This will allow prescriptive statements to be made if possible. Later on too, when the discussion turns to the information content in the markets

and the use of such information, a benchmark of a particular information state and its results will be indispensable. To this end we return to the MLC's contention that prices *should* be related directly to the PLY of the class.

Why is this interesting? The word *should* in an economists book usually implies the belief that if this is so then the results are optimal in some sense.

In the very long run, in a perfect market, where all information needed for optimal decisions is fully available and is utilised in a rational way, prices in that market should reflect fully the value to the agents in that market of the commodity. That is any differences in prices between items in a commodity group are not due to supply and demand imbalances but should reflect only the marginal utility or productivity of that item.

If this is accepted, then assuming that the PLY estimates accurately reflect the utility (productivity) of a particular class of carcass, the price differentials should in the long run be equal to the differences in PLY. If the market operates optimally, the base price will be optimal and the price differentials will equal some percentage of the base price. Therefore, the PLY can be used to calculate optimal price differences using the short-run base prices available. If these obtained then we could say that the information in the market available for determining the productive quality of the carcass was perfectly used by the market. This would be a 'full-information' situation as far as classification was concerned.

Since the class R4L has been the base all along the 'optimal' price differentials for each case considered are calculated by multiplying the base price by $(\text{PLY}-71.1)/71.1$. 71.1 is the PLY for the R4L class (see tables 1, 6 and 7.).

End of digression.

Comparing the Price Differentials and Ranks of CM1 and SM1.

CM Equation 1 and the Optimal:

In tables 4 and 6 the price differentials per class for the CM equation 1 and those for the 'optimal' situation (using 201.3p/kg as the base) are presented. In table 7 the class rankings for the two sets of price differentials are given. The rank and price differentials have been compared using a simple rank correlation. This gives an idea of the average direction of the difference and the average size of the difference.

The rank correlation between the predicted and optimal ranks for the CM data was 0.784. This implies that the optimal and predicted price differentials rank the class cells in a similar order, and the actual ranking is not enormously dissimilar.

The actual price differences are an average of 2.96p/kg different, again the optimal prices exceeding the predicted ones. The average actual difference was about $\pm 7.7\text{p/kg}$. This seems better than might be expected.

'Optimal' Price Differentials, CM Equation 1.
Table 6.

	1	2	3	4L	4H	5L	5H
E	12.74	10.19	7.08	3.40	-0.57	-6.79	-14.16
UP	11.89	9.34	6.23	2.55	-0.57	-7.64	-15.01
UM	10.76	8.21	5.10	1.42	-2.55	-8.78	-16.14
R	9.34	6.79	3.68	0.0	-3.96	-10.19	-17.55
OP	7.36	4.81	1.69	-1.98	-5.95	-12.17	-19.54
OM	4.53	1.69	-1.13	-4.81	-8.78	-15.01	-19.25
PP	0.57	-1.98	-0.03	-8.78	-12.74	-18.67	-23.22
PM	-4.81	-7.36	-10.48	-14.16	-18.12	-24.35	-28.60

Class Rank as indicated by the Price differentials.
Optimal|CM Equation 1.
Table 7.

	1	2	3	4L	4H	5L	5H
E	1 18	4 18	9 11	16 15	23 24	34 39	44 36
UP	2 3	5 3	11 1	17 2	25 9	36 28	46 25
UM	3 8	7 7	12 5	20 6	28 12	37 33	48 30
R	5 16	10 16	15 10	22 13	29 23	40 38	49 35
OP	8 21	13 21	19 14	26 20	33 26	42 40	53 37
OM	14 31	18 31	24 27	30 29	37 34	46 46	52 42
PP	21 44	26 44	32 41	37 43	43 47	51 49	54 48
PM	30 52	35 52	41 50	44 51	50 54	55 56	56 55

SM Equation 1 and the 'optimal'.

The relevant price differentials and rankings are in tables 5, 8 and 9.

'Optimal' Price Differentials, SM Equation 1.

Table 8.

	1	2	3	4L	4H	5L	5H
E	*****	*****	*****	*****	*****	*****	*****
UP	11.79	9.26	6.18	2.53	-0.56	-7.58	-14.88
UM	10.67	8.14	5.05	1.40	-2.53	-8.70	-15.99
R	9.26	6.74	3.65	0.0	-3.93	-10.10	-17.40
OP	7.30	4.77	1.68	-1.96	-5.89	-12.07	-19.37
OM	4.49	1.96	-1.12	-4.77	-8.70	-11.88	-19.09
PP	0.56	-1.96	-5.05	-8.70	-12.63	-18.81	-23.02
PM	*****	*****	*****	*****	*****	*****	*****

Class rank as indicated by the price differentials.

Optimal|SM1.

Table 9.

	1	2	3	4L	4H	5L	5H
E	*****	*****	*****	*****	*****	*****	*****
UP	1 22	3 13	8 12	13 15	20 28	28 7	35 1
UM	2 26	5 17	9 16	16 20	23 29	29 8	37 1
R	3 34	7 24	12 23	18 25	24 35	32 10	38 4
OP	6 27	10 19	15 18	21 21	27 32	33 9	41 3
OM	11 36	14 31	19 30	25 33	29 38	35 11	40 5
PP	17 41	21 39	26 37	29 40	34 42	39 14	42 6
PM	*****	*****	*****	*****	*****	*****	*****

The rank correlation for the predicted and optimal price differentials in the SM is -0.349. This indicates an opposed ranking between the two differentials and a poor match between the ranks of the cells of the classification grid.

The price differentials themselves differ by an average

of 16.92p/kg (that's almost 6 times the difference noted in the CM comparison). This is again an excess of the predicted prices over the optimal.

The deviation of the SM from the optimal far outstrips that of the CM and optimal. It seems probable that this deviation is attributable to the use of the classification scheme in the CM and not in the SM. In efficiency terms this lack of information seems to be costing the SM market dear. What may be making things worse in the SM market is the apparent confusion over fat and lean yield that seems to be suggested by the estimated equations. However, while there may be a loss of efficiency in both markets and an extreme loss where classification is not used at all, let alone optimally, is there any obvious incentive to change the circumstances in the market?

Here a discussion of the information value of the classification scheme is warranted as a preamble to the incentive to classify in the two markets studied here.

Information From the Classification Scheme.

Following Freebairn's treatment of information³ the introduction of classification should increase the homogeneity of the perceived products by grouping carcasses in more homogenous groups. Thus in the CM the prices should be less spread round the mean than in the SM. This is indeed the case:

CM: Mean price: 192.93

Standard Deviation: 14.58

SM: Mean Price: 188.60

Standard Deviation: 38.86.

In any case it is clear from the results of the hedonic price functions that the additional information concerning conformation and fatness is important in determining prices in the CM, and the lack of that explicit information in the SM appears to be resulting in irrational prices. However, it would be useful to measure how much information is given by the classification scheme as it stands.

How does additional information help an economic agent? It helps in informing his decision-making process. If he can form an expectation of the future with an estimable degree of error then his plans can be that more accurate and his risk assurance less. Resources will not be wasted insuring against unforeseen circumstances. Efficiency is improved.

In the case of classifying carcasses, this can be exemplified by the greater accuracy of price prediction. Expected prices can be calculated using the expected class of the carcass and the price differentials corresponding to that class. Attached to the predicted price therefore is a probability of receiving that price. The greater the probability of receiving a price the less the surprise (or 'news') there is in the event of that price being received. That is, if the probability of receiving a price is low, say:

$$\Pr(P_1) = 0;$$

then the news content is:

$$N_{PI} = \infty ;$$

As the probability of an event occurring rises the news that the event occurs falls in value. Information and news are inverse to each other.

Comparing the CM and SM markets is difficult because in one there is no identifiable information regarding the class of a carcass. Thus the probability attached to a price differential for conformation and fatness differences is unavailable. Indeed they are probably 0. The news from a price differential being paid would therefore be infinite. The relative information between the two markets is also infinite, as the probability attached to a price differential is zero in SM and positive in most cases in CM. The relative information is some positive upon zero, i.e infinitely more information in the CM than in the SM. By the same argument there is infinitely more news in the SM than in the CM upon a price differential being paid. Equivalently there is zero information in the SM relative to the CM and zero news in the CM relative to the SM.

Is there any way of realistically estimating the value of the information difference? The propositions here may not be completely satisfactory, but they may go some way towards answering the question. The first approach looks at the error terms and uses expectation analysis to try to gain some measure, while the second is an extension to the approach taken in comparing the observed and predicted results with the optimal.

If the information states are the same in each market

and all other factors are the same then the markets are indistinguishable, and:

$$P_{cm}^* = P_{sm}^* = f_3(\text{base price, sex, conformation, fatness}) + w_1; \\ = P^*$$

where: P^* - price in combined markets;

w - error when markets are combined $(0, \sigma_w)$;

If there is no information gap between the two markets then $P_{cm} - P_{sm} = 0$, and expectations of the price in each market under rational assumptions would deviate from the actual price only by some white noise error.

Clearly, if conformation and fatness are not made explicit in the SM then they are not considered explicitly in the prediction of prices.

In terms of expected prices using the hedonic price models the problem can be encapsulated in the error terms.

In the SM:

$$P_{sm} = f_1(\text{base price, sex}) + u_1$$

In the CM:

$$P_{cm} = f_2(\text{base price, sex, conformation, fatness}) + v_1$$

where: P_i - price in the i market;

f_i - function i ;

u - error in SM (μ, σ_u^2) .

v - error in CM $(0, \sigma_v^2)$.

The lack of information in the SM concerning the effects of conformation and fatness on price means that systematic error in the price predictions will be made. This is captured by the non zero mean of the variance u_1 , set to μ above.

Using the simple additive form of equation 1 for each

market:

$$P_{cm} - P_{sm} = BP_{cm} - BP_{sm} + \sum_1 (\alpha_{sm31} - \alpha_{cm31}) DS_1 + \sum \alpha_{cm11} DC_1 + \sum \alpha_{cm21} DF_1 \\ + v_1 - u_1;$$

If the base prices and the valuation of sex are equal between the two markets, and the error term, u , is the only variable that picks up other imputed value attached to implicit characteristics, this reduces to:

$$P_{cm} - P_{sm} = \sum \alpha_{cm11} DC_1 + \sum \alpha_{cm21} DF_1 + v_1 - u_1;$$

In the equations estimated this is clearly not the case, and the above equation could be used to put a value on the information that is available in the CM that is not available to the SM.

Equivalently the error in the SM equation above can be assumed to include systematic errors due to the implicit valuation of conformation and fatness, equal to those coefficients estimated in SM1. This can be interpreted as the value of information implicit in the market. The problem with either measure is that neither of them is able to measure the value of information dynamically, i.e. what the effect on the CM the withdrawal of classification would have, and what effect its' introduction would have in the SM. They are necessarily static comparisons, from different views of the market.

The expectation form of this analysis allows a more explicit treatment of the latter proposition above:

$$SM: E(P_{sm}) = BP + \sum Pr(S_1) \cdot P_{s1} + \mu;$$

$$CM: E(P_{cm}) = BP + \sum Pr(S_1) \cdot P_{s1} + \sum Pr(C_1) \cdot P_{c1} + \sum Pr(F_1) \cdot P_{f1};$$

where: BP - the base price for ,e.g. an R4L steer carcase
weighing LT300;

Pr(.) - the probability of event (.) occurring;

S_i - event carcase is sex i;

C_i - " " " conformation i;

F_i - " " " fatness i;

P_{x*i*} - Price differential due to event xi occurring.

The information available to SM agents but not explicitly used is witnessed by μ from the error term, and the additional accuracy of predictions in CM due to the additional information from classification is given by the last two terms in CM, for conformation and fatness variables.

If the price differentials implied by equations CM1 and SM1 (see tables 4 and 5) and the probability of a carcase being of class i (see tables 10 and 11), which are calculated direct from the data, are used to calculate these two quantities it is found that, given the classification of the carcasses in the two markets in the weeks under consideration, the expected price differentials due to conformation and fatness are:

CM1: -1.37p/kg;

SM1: +3.08p/kg;

A similar calculation including the price differentials and probabilities related to the sex and weight of a carcase gives expected price differentials:

CM1: -1.53p/kg;

SM1: -4.25p/kg;

Sample Probabilities of a carcass being of class ij from the CM Data.

Table 10.

	1	2	3	4L	4H	5L	5H
E	0.00000	0.00073	0.00146	0.00122	0.00049	0.00000	0.00000
UP	0.00024	0.00171	0.00439	0.01097	0.00610	0.00000	0.00024
UM	0.00000	0.00805	0.04170	0.07047	0.02487	0.00146	0.00024
R	0.00000	0.01049	0.03169	0.17288	0.08169	0.00707	0.00122
OP	0.00000	0.01049	0.07023	0.16606	0.06437	0.02463	0.00146
OM	0.00049	0.01049	0.03536	0.03877	0.02097	0.00463	0.00146
PP	0.00049	0.00341	0.00732	0.00488	0.00195	0.00000	0.00000
PM	0.00073	0.00146	0.00073	0.00024	0.00000	0.00000	0.00000

N.B. If the distribution of carcasses over the classification grid were uniform then each cell would have a probability of $1/56=0.01786$.

The probability of a carcass being of sex i, and of being weight j, for CM data, week one.

Prob(steer) = 0.55084;
 Prob(bull) = 0.20897;
 Prob(heifer) = 0.21166;
 Prob(cow) = 0.02853;
 Prob(lt215) = 0.02073;
 Prob(lt250) = 0.07023;
 Prob(bt250) = 0.05779;
 Prob(gt250) = 0.33065;
 Prob(lt300) = 0.16728;
 Prob(gt300) = 0.35308.

If a uniform distribution of carcasses over the conformation, fatness, sex and weight groups is assumed, i.e. an equal probability of a carcass falling into each cell of the characteristics groups, the expected price differentials would be substantially different from those above, viz.:

CM1: -17.13p/kg;

SM1: -14.56p/kg;

Sample Probabilities of a carcass being of class ij from the SM Data.

Table 11.

	1	2	3	4L	4H	5L	5H
E	*****	*****	*****	*****	*****	*****	*****
UP	0.00420	0.00000	0.01288	0.00000	0.00429	0.00000	0.00000
UM	0.00000	0.03433	0.03863	0.03433	0.01288	0.00000	0.00000
R	0.00000	0.03433	0.16738	0.12017	0.03433	0.00429	0.00429
OP	0.00429	0.03433	0.16309	0.14592	0.03863	0.00429	0.00000
OM	0.00000	0.02146	0.05150	0.01288	0.00858	0.00429	0.00000
PP	0.00000	0.00429	0.00000	0.00000	0.00000	0.00000	0.00000
PM	*****	*****	*****	*****	*****	*****	*****

N.B. If the distribution of carcasses over the classification grid were uniform then each cell would have a probability of $1/56=0.01786$.

The probability of a carcass being of sex i, and of being weight j, for SM data, week one.

Prob(steer) = 0.47639;
 Prob(bull) = 0.07296;
 Prob(heifer) = 0.45064;
 Prob(lt250) = 0.22747;
 Prob(bt250) = 0.51502;
 Prob(gt250) = 0.27897.

These last figures result in an expected price in the CM of 184.17p/kg, and in the SM an expected price of 185.00p/kg. These are very close.

These results imply that CM price predictions are more accurate by an average of 1.37p/kg, than they would be if classification were not used (ceteris paribus, of course!) and predictions in the SM could be 3.08p/kg more accurate if classification were explicit. These do not show what might happen if the two situations were changed. They do imply

that farmers in the SM are responding overall in a more rational way to the implicit price differentials available for classification characteristics, since their classification distribution gives the farm level an expected premia on average. In the CM the distribution is such that at the farm level there is a discount on average. This is a somewhat surprising result. When the sex and weight distributions are taken into account the premium in the SM changes to a substantial discount due to the discounts on sex offsetting the premiums for fat carcasses, while the expected discount in the CM is virtually unchanged by the inclusion of the weight and sex characteristics. If the distribution of carcasses amongst the characteristics is uniform then the expected price differentials in both markets are discounted and quite large. It is interesting that under this assumption the two markets' expected prices are very close. However, this should not necessarily have too much read into it.

Calculating the same quantities using the 'optimal' price differentials for each market (see tables 10 and 11) it is found that even with optimal prices the quality distribution of the carcasses in the CM are such that they would still on average expect a discount of 1.12p/kg. In the SM market a premium could be expected of 0.90p/kg. This in particular is surprising. Since classification is explicit in the CM it would be expected that the quality distribution would be more favourable in that market, not the other! This might be explained by the relationship between sex and

classification, but this will not be explored here.

This sort of analysis could be taken further by examining the expected price differentials as they change through time. Again this analysis will not be undertaken here.

So far the ability to predict the probability of a price differential for a class of carcass has been skated over. Quite simply in the SM such a prediction would be meaningless. Only in the CM would such a problem be valid. And, while this is of interest in its own right, it does not address the original question: How much value is there in the information available in the CM that is unavailable in the SM? The analysis of the prediction of the probability of the class of a carcass is not useful here.

An alternative approach is as follows:

By using the results from the best equation estimated for the CM, the equivalent prices for the SM can be calculated. These would be the prices which might occur if the classification information were made explicit in the SM. These prices can again be compared with the optimal prices, as a benchmark, and with the actual prices.

A step further involves the calculation of the revenues that would arise using these price calculations. This will reveal the impact of the distribution of carcasses over the classification grid on the incentive structure arising from these results. However, it is expected that the distribution

of carcasses on the grid is affected by the classification scheme, as farmers and abattoirs are able to identify profit opportunities vis-à-vis different classes. This is not possible in the SM. Thus these comparisons are made under the restrictive assumption that the classification distribution would be the same under classification as it is without. This is of course unrealistic, but once again the problem arises of 'what would have happened if...., but didn't in fact happen at all'. An exactly similar experiment is undertaken on the SM best fit equation using the best CM results.

Furthermore, the slaughtering industry carcass costs can be analysed in an analogous manner. Here the important price is that of carcass required for a kilogram of output meat. Thus the PLY estimates are used to adjust the prices received by the farm industry to per kilo output prices (or the quantity purchased) using $2\text{-PLY}/100$ as the adjustment. That is the slaughterer must buy $2\text{-PLY}/100$ times the carcass weight to obtain that same weight of output lean. This is obviously a far from perfect measure but sheds some light on the possible value of classification information to the two market participants at the level of the market analysed here: The slaughtering industry and the beef farms. The results may suggest who gains most and loses most in the different markets and hence the incentives to classify.⁴

In table 12 below the mean price, its standard deviation and the total revenue or cost for the market sample are presented for four cases: The CM farm revenue, the CM slaughtering industry costs, the SM farm revenue and the SM

slaughtering industry costs. For each case four possible prices are used to calculate the figures given. These four are (ceteris paribus): the predicted prices for the given market using the estimated equation results for the market; the prices obtained by imposing the alternative market equation estimates on the data for the given market (In this case using SM estimates on CM data, the same coefficient on Heifer was used for cows, and the LT250 coefficient was used for weight groups less than 250 kgs, and the GT300 coefficient for groups greater than 300 kgs. For the opposite case the coefficients not required were simply dropped out. Of course this increases the errors in these rather crude figures anyway); the 'optimal' prices obtained if prices reflect PLY (These included the weight and sex coefficients from the given market equation); and the actual prices paid in the given market.

Prices, Revenues and Costs in the CM, equation 1.

Given the sample distribution of carcasses over the classification grid in the CM (see table 10), the farmers revenue is very close to the optimal. They would lose out in total revenue if they ceased to classify their output. Looking at the mean prices shows a difference of about 2.5p/kg only between the predicted (actual) and the optimal. And the variance of the optimal and the predicted are less than a penny different. If the conditions that prevail in the SM sample transferred to the CM the average price would drop

quite significantly (35p/kg). There is clearly no incentive to cease classifying from the CM farmers point of view given this analysis and some incentive to see it work optimally.

The Value of Classification and the Incentives to do so.
Table 12.

Market Base.	Equation used to give results	mean price	std. dev ⁿ	Total Rev/Cost
CM Farm Revenue	CM1	192.93	13.45	816,142.79
	SM1	157.92	58.23	708,463.51
	Optimal	194.32	12.93	817,005.11
	Actual	192.93	14.58	816,561.45
CM Slaug. Cost	CM1	443.23	29.19	1,871,234.20
	SM1	362.79	133.88	1,623,887.69
	Optimal	446.36	26.82	1,875,125.25
	Actual	443.23	31.90	1,872,201.48
SM Farm Revenue	SM1	188.60	35.84	45,509.54
	CM1	196.82	5.25	46,175.41
	Optimal	185.89	39.84	45,000.21
	Actual	188.60	38.86	45,743.40
SM Slaug. Cost	SM1	431.38	81.03	103,990.56
	CM1	450.44	10.08	105,543.11
	Optimal	425.03	89.99	102,812.13
	Actual	431.38	88.08	104,523.26

n.b. the cost is the price the slaughterer pays in kgs of carcass to obtain a kilo of lean saleable meat. In the case of the optimal cost, this is the cost of a kilo of lean meat at optimal carcass prices.

The slaughterers in the CM, however, are losing from classification as it operates at present. They would do better with no classification (*ceteris paribus*), and they

would do even worse if classification worked optimally. However, they would sacrifice some of the predictability of costs. The deviation of the mean predicted price is 29.19, of the optimal 26.82 and of the SM prices 133.88p/kg. This gives an average range of price of: 414-472p/kg; 420-472p/kg and 229-495p/kg. respectively. The lack of classification would considerably increase the uncertainty attached to cost predictions. This is what might be expected.

- the SM, equation 1.

Farmers revenue would be increased if classification were operated in the SM market (*ceteris paribus*), but only marginally, given the existing classification distribution. The divergence in the average prices gives an indication that the gains might be greater - a difference of 8.22p/kg on average might imply even better returns given a more favourable carcass distribution. However, if the scheme operated optimally it would not look so good. Both the average price received given current carcasses and the revenue would be lower under a optimal prices.

The slaughtering industry has little incentive to classify given the CM result imposed on the SM market to calculate costs - the average price per kilo of output would rise from 431.38p/kg to 450.44p/kg. However, something that might interest him is the lower variance on that price, which might give the industry greater ability to plan accurately. The average price in the SM market varies by +/-81.03p/kg,

while that predicted by the CM estimates varies only by 10.08p/kg. The total cost differences are not that enormous considering the great average price difference. This suggests that, while here the distribution of carcasses over the classification grid is ignored, doing so is dangerous. If optimal prices prevailed there would be a greater incentive to use classification as both average price and total cost would be lower than they are in the SM, but, surprisingly, the deviation around the mean is quite high and might therefore deter the slaughterer from classifying because the certainty of gaining is insufficient.

From these 'back-of-an-envelope' calculations, it seems that the farmers stand to gain most given the existing carcass distributions in both the SM and CM, while the CM wholesalers are losing out and the SM wholesalers would gain only if optimal prices obtained. These results are somewhat surprising given the market power structures between these two layers. It would be more likely that the wholesalers would be able to ensure price structures that gave them a better return under classification. It may be that the increased information from classification has in fact corrected an asymmetry in information between the farmers and the slaughterers, in the farmers favour.

What is most troubling about the results for the SM is that there was a clear indication that there was a problem in pricing fat animals. However, despite the overpricing of obviously low PLY carcasses, the farmer lost out without

classification and the slaughterer gained. It may be that there is a correlation between the sex of the carcass and its fatness (remembering that multi-correlation was a possible problem in the SM equation) and thus the very fat carcasses are generally heifers which attract a hefty discount, and therefore, the prices received by farmers are artificially lessened due to this and equally the costs to the slaughterers.

Despite this discussion, it is still difficult to attach a value to the information provided by the classification of carcasses. The best that can be offered is the divergence between the optimal and actual in the CM and the SM in revenues and costs. The value of the information 'unused' in the CM is worth 862.32p/kg revenue to the farm sector and 1891.05p/kg in costs to the abattoir sector (revenue or cost predicted for cm -optimal revenue or cost). The value of information lost in not using the classification scheme in the SM is 665.87p/kg foregone in revenue to the farmer and 1552.55p/kg costs saved by the slaughterer (revenue/costs predicted - those predicted if classification had the same effect as in CM). Thus the net gain is to the wholesalers in the CM who gain due to the imperfect utilisation of the information provided. And likewise in the SM. If the distribution of the carcasses in the classification grid is taken into account as in the expectations approach it is clear that the SM farmers are taking better advantage of the underlying differentials due to classification, than the CM farmers.

Conclusions.

It is clear from the results of this paper that the price for a beef carcass is related to the characteristics of the carcass, and that this relationship is affected by the explicit use of classification. Measuring the value of the information given by classification and the incentives to classify is not straightforward. The actual figures depend very much on the distribution of the carcasses in the sample data over the classification characteristics. Furthermore, the act of classification changes the operation of the market and the usual problem of measuring the effects of policy on/policy off situations rears its ugly head. Despite these problems some useful figures can be calculated that give an idea of the improvements in price predictions, and therefore of the improved opportunity to plan more efficiently, and of the incentives to use classification given these improvements. There is clearly much to be gained in the accuracy of predictions in the SM, and accuracy is improved in the CM. Only the slaughtering industry already classifying would benefit from not doing so, and even then, may find the variation in costs, and thus the increased inaccuracy of predicted costs, and deviation from planned profits, irksome.

It will no doubt please the MLC that these results are so favourable to the classification scheme they developed. However, there is much more analysis that could be undertaken given the wealth of data available at the MLC, and much

investigation that cannot be undertaken until agents in the agro-food industry gather more data on the effects of the many other quality evaluation schemes that operate in the U.K., Europe and the rest of the world. Even within the beef market, there is precious little information about the effects of classification beyond the abattoirs (at retail and at consumer level). In particular the problems arising from the change in form of the beef product through the market (from animal to carcase to joint to meal) are currently inadequately explored.

Following this analysis further work has been carried out examining in more detail the CM data, and price differentials from week to week. A similar analysis for comparison with these results will be made using data on the pig carcase classification scheme.

Apart from the specific results relating to the beef classification scheme, this analysis seems to be one of the first uses of the hedonic price technique, not merely as an end in itself, but as a way of extracting information about the way quality evaluation works. It is a fairly straightforward methodology, and it is hoped that it will be used by others to examine the value of quality evaluation schemes.

Footnotes.

¹.see MLC yearbooks 1980... and other pamphlets (see bibliography for details).

².PhD Thesis submission, by author forthcoming.

³.see Freebairn's classic article (see bibliography).

⁴.The revenue and cost calculations are given in units of pence per kilogramme output. This is due to the data being given in weight groups rather than the actual weight for each carcass, which means actual revenue and cost cannot be calculated. What is calculated is the revenue and cost for a representative kilogram from each carcass traded.

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