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VARIATIONS IN THE RETAIL VALUE OF CARCASSES OF ABERDEEN-ANGUS CROSS STEERS AND HEIFERS AND THEIR RELATION TO CONFORMATION, BONE CONTENT AND FINISH

by

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Scientific evaluation of beef carcasses involves separation of anatomical joints into muscle, bone, subcutaneous and intermuscular fat, possibly coupled with chemical analysis as in the work of Callow (1960). Generally speaking, carcasses with the lowest level of fat consistent with good cooking and eating qualities and the highest ratio of muscle to bone, will be of greatest value to the butcher, although he is also interested in the distribution of lean meat between the high priced and low priced parts of the carcass. This last feature is usually referred to as "conformation" and is assessed purely subjectively in day to day buying and selling and even in some experimental work when dissecting facilities are not available. In evaluating the results of scientific investigations where carcass composition data are obtained, however, it is important to appreciate the relative significance of these various attributes in determining the value of a carcass to the butcher.

This paper describes a small-scale investigation which gave some information on this problem. It was concerned with cattle of one particular type only, which were jointed into wholesale and retail cuts in a standard manner.

THE SAMPLE OF CATTLE

The cattle were those already used in a study of the relation of carcass measurements to yields (Bodwell, Harrington, Pomeroy & Williams, 1959). These were specially purchased in Aberdeen market by a representative of a large firm of multiple butchers in March, April and May, 1959. He was asked to select typical animals of both sexes over as wide a weight range as possible. All cattle were Aberdeen Angus crosses, probably Aberdeen Angus x Beef Shorthorn although it was not always possible to confirm that this was the cross involved. The following table gives the means and ranges of live weight at the abattoir, cold carcass weight and dressing percentage for steers and heifers, together with their approximate ages.

		Liveweight (lb.)	Cold carcass weight (lb.)	Dressing percentage	Age (years)
Steers (22)	Mean	1159	688	60.2	3 from 1 -1½ 17 from 1½-2
	Range	952-1400	557-828	57.0-66.8	1 from 2 -2½ 1 unknown
Heifers (14)	Mean	974	569	59.4	6 from 1 -1½ 8 from 1½-2
	Range	868-1120	501-652	57.0-61.5	

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METHODS

The 36 cattle were slaughtered in Aberdeen, split into sides which were then quartered between the 9th and 10 ribs by a cut following the line of the ribs and sent to London. There, the quarters from both sides of each carcass were cut into wholesale joints by a method similar to the London and Home Counties style illustrated in the earlier paper (Bodwell et al., 1959). The joints from the left side were then made into retail cuts according to the standard procedure of the co-operating firm. Weights of all cuts and trimmings were recorded to the nearest ¼ oz. (that is approximately 7 gm.). The same experienced butcher did all cutting during the trial and the procedure was standardised in that he attempted to conform to the same pattern throughout.

The method of retail preparation did not involve the boning out of the whole carcass. Instead, the least valued joints (the brisket, forequarter flank and hindquarter flank) received only superficial trimming, as did the valuable cuts from the back, namely the loin, fore-rib and a part of the middle rib. These together represented some 40% of the carcass weight; the remaining 60% was boned out, that is reduced to bone and waste (tendon, etc.), trimmed fat, and lean meat of four grades, stewing steak, braising steak, roasting meat and high quality steak for grilling or frying. All portions of roasting meat were made up into "rolls" or joints of saleable size, incorporating a certain amount of fat, an amount judged necessary for the meat to cook satisfactorily in accordance with the practice and quality trade of this particular firm. In some cases this fat was that already attached to the lean, in others it was transferred from another part of the carcass (particularly from the cod fat or rump), or in exceptional cases it was added from another carcass.

CALCULATION OF RETAIL VALUE

The retail prices for each joint and for each type of trimming that were used to calculate the carcass values are given in Table 1 in British shillings per pound weight and American dollars per kilogram weight. Where possible this table also indicates the names of the joint which are approximately equivalent to our joints in French and German practice, according to published information (O.E.E.C., 1959 and a Hungarian Meat Journal).

This table shows that the "rolls" from the topside, top rump and aitchbone cuts were worth 5 shillings per lb. compared with 4.67 for those from the silverside. The effect of the transference of fat from one part of the carcass to another was therefore to allow some trimmed fat that might have been priced at 4 pence per lb. (0.33 shillings) in calculating the retail value of the carcass, to be priced at the value of the roll or roasting joint in which it was incorporated - as high as 5 shillings per lb. in the case of the topside rolls.

For the purpose of this analysis, retail value has been re-calculated on the assumption that all trimmed fat was priced at the low value per lb. (0.33 shillings) and only the trimmed lean meat used in making up the "rolls" has been priced at the full retail value of these rolls. Retail value per lb. side weight calculated in this manner naturally differed markedly from the value calculated by the co-operating firm, the difference between the two values ranging from 1.67 pence/lb. down to zero. The correlation between the two values was 0.81 for these 36 carcasses, the relation being shown in the Figure.

Whereas the method of the retail preparation used by the co-operating organisation is well suited to its own relatively high quality trade, it is possible that for more general sale

less fat might have been utilized in making up such roasting joints. The method of calculation used here is therefore probably of more general relevance, although it must be emphasised that some added fat may be necessary with some of these roasts for efficient cooking by standard methods.

Conformation for this analysis has been measured by the percentage yield of the cheap cuts from the underline of the animal, the brisket, forequarter flank and thin flank.

RESULTS AND DISCUSSION

Table 2 shows the retail value of each carcass in pence/lb., the side weight, and the yields of cheap cuts, cuts that were boned out, of the trimmed lean meat, fat trimmings, bone and waste from these cuts, all expressed as percentages of side weight. Retail value calculated on the basis used here ranged from 35.9 pence/lb. (92.3 cents/Kg.) to 38.6 pence/lb. (99.3 cents/Kg.) with an average of 37.2 (95.7). This range of 2½ pence/lb. represents a difference of some £5 ($14.6) in total value between carcasses weighing 500 lb. (227 Kg.).

There was a slight tendency for value to decrease with weight, the correlation being -0.38 ($0.01<p<0.05$) within sexes. Previous work (Harrington & Pomeroy, 1959) has shown that wholesale value tends to become less as carcasses from the same type of animal become heavier, due to the greater proportionate increase of the cheap cuts from the underline of the animal, the brisket and flanks. Retail value can be expected to be influenced in the same way, coupled with the fact that the heavier animals are likely to be more finished and therefore require more fat to be trimmed off.

Although the lighter carcasses of the heifers were fatter than those of the steers (11.8% of side weight was fat trimmings compared with 10.5%), they had less bone (10.4% compared with 10.9%) and were less fully developed in conformation giving a lower proportion of the cheap cuts (16.1% compared with 16.9%). These effects cancelled out, so that the carcasses from steers and heifers were, in this case, of similar value as retail cuts (steers 37.11 pence/lb. or 95.4 cents/Kg., heifers 37.26 pence/lb. or 95.8 cents/Kg.).

Interrelations between some factors influencing retail value are shown in Table 3. The yield of cheap cuts, which naturally had a high negative correlation with the yield of boned out cuts, was not significantly correlated with the yields of fat or bone from these cuts. The yield of trimmed lean had a high negative correlation with the yield of fat trimmings, but the leaner carcasses tended to have more bone. Retail value showed high correlations with the yields of cheap cuts, lean and fat. It is possible to examine the relative importance of these factors from the regression analyses shown in Table 4.

Although the total yield of trimmed lean meat from those cuts boned out was the best single predictor of retail value in the table an improvement in the accuracy of prediction of retail value was achieved by including the yield of lean from those cuts which were boned out in the hind quarter and in the forequarter separately. This shows that distribution of lean meat between high and low valued parts of the carcass varied appreciably in carcasses with a similar total amount of lean meat from the boned out cuts.

Inclusion of fat and bone with lean in regression equations progressively increased the accuracy of prediction of retail value, until 10% of the variation only remained to be explained. The relative importanceof the four factors in determining retail value is gauged from the standardised partial regression co-

efficients, which may be calculated from the regression coefficients in Table 4 and the standard deviations in Table 2 (standard deviations for lean in fore and lean in hind quarters were 0.77 and 1.08% of side weight respectively). These were:-

Forequarter lean	0.13
Hindquarter lean	0.60
Trimmed fat	-0.48
Bone and waste	-0.46

Yields of fat and bone were of about the same importance in determining retail value, but variations in lean in the hindquarter were between four and five times more important than variations in lean in the forequarter, presumably because of the greater price weighting they receive.

Table 4 shows that the yield of cheap cuts improved the predictive value of the tissue yields. In particular when added to the four characteristics used above in a regression equation, the variance remaining unexplained was reduced to 7.0%. The standardised partial regression coefficients were:-

Forequarter lean	0.06
Hindquarter lean	0.39
Trimmed fat	-0.59
Bone	-0.55
Cheap cuts	-0.27

These show that among animals with a constant proportion of the cheap cuts, bone and fat variations were more important than variations in lean percentage in determining retail value - in fact the regression coefficient for forequarter lean percentage was no longer significant. Although about half as important as variations in fat and bone, the variations in the yield of cheap cuts played an important role in determining retail value of these carcasses.

This is of particular interest in view of the similarity of "type" among these animals; although all were of the same cross, variations in "conformation" as measured by the yield of the cheap cuts along the underline had a big influence on the value of the beast to the butcher purchasing it. Previous work on carcasses from pure dairy x beef steers killed at a constant level of finish and hence at a wide range of ages failed to show any differences between these in the average yield of prime wholesale cuts or wholesale value (Bodwell, Harrington & Pomeroy, 1959). These results therefore confirm the desirability of extending such commercial comparisons of carcasses from different types of cattle beyond wholesale cutting to obtain retail yields.

"Finish" in this paper has been measured by the yield of fat trimmings from those parts of the carcass that were completely boned out; about 2/3 of this yield is made up by the large deposits round the kidney and by the cod fat. In fact, the correlation between the percentage yield of fat trimmings and the average thickness of subcutaneous fat over the eye muscle at the 11th rib was not significant in this study. This confirms the desirability of cutting tests or dissections as a supplement to carcass measurements in beef carcass evaluation, for this yield was shown above to be the most important in determining retail value. In this connection, it is of interest to note that J.C. Pierce and his co-workers at the United States Department of Agriculture, in their endeavours to develop methods for predicting the "cutability" (retail value on a completely boned out basis) of beef carcasses, find it necessary to supplement eye muscle and fatness measurements with a subjective evaluation of internal fat (Murphey et al., 1960).

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SUMMARY

Thirty-six carcasses of Aberdeen Angus cross steers and heifers were reduced to retail cuts in the manner usually employed by one large firm in Great Britain, involving the boning out of some 60% of the carcass. The relation between the retail value of these carcasses to conformation, measured by the percentage yield of the cheap cuts, to finish, measured by the percentage yield of fat trimmings, and to bone content has been examined.

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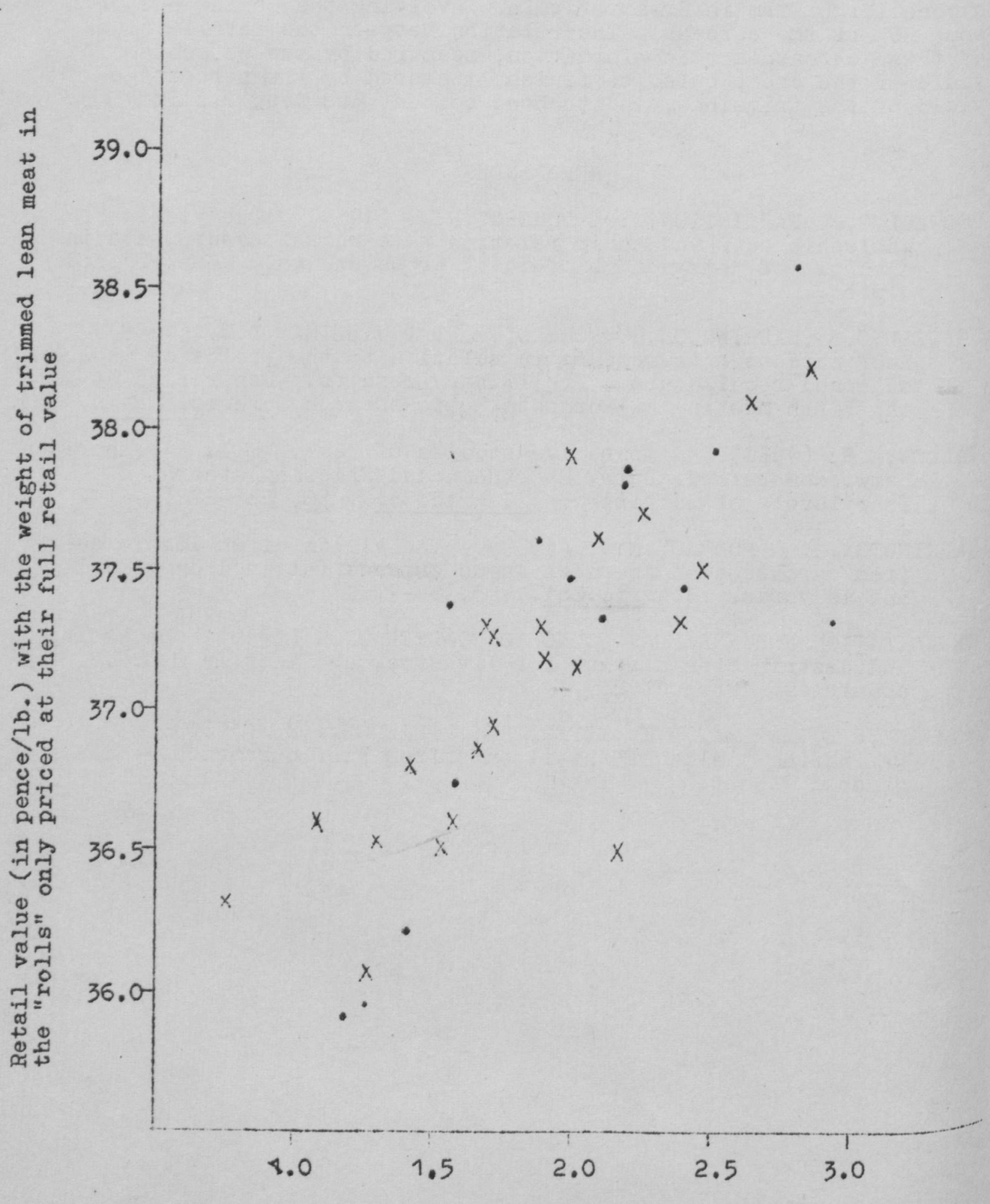
Retail value (in pence/lb.) with the weight of trimmed lean meat in the "rolls" only priced at their full retail value
39.0
38.5
38.0
37.5
37.0
36.5
36.0
1.0
1.5
2.0
2.5
3.0
Retail value (in pence/lb. less a constant factor) with the total weight of the prepared "rolls" priced at their full retail value

Table 1. Prices used in the calculation of retail value in this paper, in shillings per pound weight, and dollars per kilogram weight. Approximately equivalent names for the various cuts in French and German are also given.

	sh./lb.	$/Kg.	Approximate* French equivalent	Approximate* German equivalent
TRIMMED CHEAP CUTS				
Brisket	2.00	0.62	Poitrine	Brust
Forequarter flank	1.67	0.51	Tendron	Nachbrust
Thin flank	1.67	0.51	Flanchet	Fleischdünnung
Skirt	2.17	0.57	(Diaphragme)	(Zwerchfell)
CUTS FROM BACK				
Sirloin	5.17	1.59	Faux-filet	Rostbeef
Wing-rib	5.00	1.54		Hochrippe
Fore-rib	3.50	1.08	Entrecôtes	Fehlrippe
Back & top rib	3.17	0.98	Basse-côtes -plat de côte couvert et decouvert	Spannrippe
STEAK				
Fillet steak	8.67	2.67	Filet	Filet
Rump steak	8.00	2.47	Rumsteak-culotte	Blume
Skirt steak	4.67	1.44	-	-
Braising steak	4.17	1.29	-	-
Stewing beef	3.50	1.08	-	-
"ROLLS"				
Topside rolls	5.00	1.54	Tende de tranche	Oberschall
Silverside rolls	4.67	1.44	Gîte-noix	Schwanzstück
Aitchbone roll	5.00	1.54	-	-
Top rump rolls	5.00	1.54	Tranche grasse	Kugel
Suet	0.83	0.26	Graisse de rognon	Nierenfett
Other fat trimmings	0.33	0.10	Graisse	Rinderfett
Bones	0.17	0.05	Os	Knochen

* Sources:- O.E.E.C. Project 285 and a Hungarian Meat Trades Journal

Table 2. The 36 sides ranked in decreasing order of retail value per lb. weight, with side weight and yields of cheap cuts, boned-out cuts, trimmed lean, fat trimmings, and bone, and means, standard deviations and coefficients of variation.

Sex	Retail value of side (pence/lb.)	Side weight (lb.)	Yield* of cheap cuts	Yield* of boned-out cuts	Yield* of trimmed lean meat	Yield* of fat trimmings	Yield* of bone and waste
H	38.59	258	15.3	60.5	40.0	10.0	10.2
S	38.23	361	16.5	59.0	39.0	8.9	11.2
S	38.11	303	16.2	58.8	38.8	9.4	10.4
H	37.93	270	14.6	62.5	40.3	10.5	11.6
S	37.91	345	16.6	58.7	38.7	8.1	11.8
H	37.87	307	16.3	59.5	38.4	10.7	10.1
H	37.81	279	15.1	60.0	38.3	11.2	10.4
S	37.71	315	16.2	59.1	38.7	9.3	11.0
S	37.63	315	17.4	58.4	37.8	9.2	11.1
H	37.61	329	16.1	57.6	38.0	12.2	9.3
S	37.51	340	16.8	60.0	38.3	10.9	10.2
H	37.48	276	15.7	60.4	38.4	11.2	10.5
H	37.44	252	15.3	60.7	37.8	11.4	11.2
H	37.38	297	17.0	59.7	36.2	11.0	10.2
H	37.34	284	15.6	58.8	36.8	11.6	10.4
S	37.33	279	16.7	60.1	38.8	10.3	10.9
H	37.32	299	16.4	59.0	36.4	12.6	9.9
S	37.30	316	15.7	59.6	38.5	8.4	12.3
S	37.30	284	16.1	58.9	36.8	11.1	10.8
S	37.26	367	16.2	59.0	37.4	10.1	11.3
S	37.18	367	17.1	58.9	37.2	11.4	10.0
S	37.16	333	16.3	60.2	38.0	11.8	10.2
S	36.94	386	16.6	60.4	38.2	11.2	10.7
S	36.86	325	17.6	58.6	36.9	11.2	10.4
S	36.80	298	17.2	59.0	36.7	11.4	10.8
H	36.74	309	16.1	60.4	36.9	13.2	10.1
S	36.63	398	16.6	59.0	36.8	10.9	11.1
S	36.60	358	18.1	58.0	36.4	10.6	11.0
S	36.53	411	16.6	59.0	36.2	11.4	11.2
S	36.51	350	16.2	58.1	35.5	11.1	11.3
S	36.50	416	18.4	55.2	33.4	13.2	8.4
S	36.30	332	17.6	59.7	37.2	10.6	11.7
H	36.22	273	16.9	59.7	36.1	13.1	10.3
S	36.07	414	18.6	57.1	35.0	11.3	10.6
H	35.95	291	16.0	60.6	35.8	13.7	10.9
H	35.91	292	18.4	58.4	35.1	13.2	9.9
Mean	37.17	322	16.6	59.2	37.4	11.0	10.7
S.D.	0.67	45	0.9	1.2	1.4	1.4	0.7
C.V. (%)	1.8	13.9	5.5	2.1	3.9	12.2	6.9

* All as a percentage of side weight

S = Steer

H = Heifer

Table 3. Correlations between retail value of the 36 carcasses and various percentage yields. These have to be greater than 0.33 for significance at the 5% level(*), 0.42 at the 1% level (**) and 0.52 at the 0.1% level (***).

	Percentage yield of				
	Cheap cuts	Boned-out cuts	Trimmed lean	Fat trimmings	Bone and waste
Retail value	-0.59***	0.32	0.82***	-0.63***	0.02
% cheap cuts		-0.73***	-0.65***	0.18	-0.15
% boned-out cuts			0.70***	-0.04	0.27
% trimmed lean				-0.65***	0.33*
% fat trimmings					-0.62***

Table 4. The results of calculating the regressions of retail value on various combinations of yields (all expressed as percentages of total side weight). The standard deviation for retail value was 0.67 pence/lb.

Independent variables (yield as % of total side weight)	Unexplained variance as % total variance	Residual standard error	Degrees of freedom of error	Partial regression coefficients of retail value (pence/lb.) on:-					
				X_1 Yield of trimmed lean meat	X_2 Yield of lean from hind-quarter	X_3 Yield of lean from fore-quarter	X_4 Yield of fat trimmings	X_5 Yield of bone	X_6 Yield of cheap cuts
X_1	33.2	0.38	34	0.38	-	-	-	-	-
X_4	61.6	0.52	34	-	-	-	-0.31	-	-
X_5	100.0	0.67	34	-	-	-	-	0.02	-
X_6	66.6	0.54	34	-	-	-	-	-	-0.43
X_2, X_3	23.7	0.32	33	-	0.51	0.17	-	-	-
X_1, X_4	32.5	0.38	33	0.33	-	-	-0.09	-	-
X_1, X_4, X_5	14.2	0.25	32	0.30	-	-	-0.48	-0.27	-
*X_2, X_3, X_4, X_5	9.9	0.21	31	-	0.37	0.11	-0.27	-0.35	-
X_1, X_6	33.6	0.39	33	0.35	-	-	-	-	-0.07
X_4, X_6	38.4	0.41	33	-	-	-	-0.27	-	-0.36
X_5, X_6	68.2	0.55	33	-	-	-	-	-0.06	-0.44
X_1, X_4, X_6	31.2	0.37	32	0.24	-	-	-0.13	-	-0.15
X_1, X_4, X_5, X_6	9.0	0.20	31	0.15	-	-	-0.36	-0.53	-0.24
X_2, X_3, X_6	24.6	0.33	32	-	0.51	0.18	-	-	0.01
*X_2, X_3, X_4, X_5, X_6	7.0	0.18	30	-	0.24	0.05	-0.34	-0.43	-0.19