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AN ANALYSIS OF PREMIUMS FOR STAPLE MEASUREMENT, AND PRICE DIFFERENTIALS FOR LENGTH AND STRENGTH PROPERTIES OF MERINO COMBING WOOL

Kerry J. Stott*
Australian Wool Corporation, Melbourne

Abstract

Staple measurement (SM) is a marketing innovation which provides an objective measure of the staple length and staple strength of combing wool. These characteristics are the next most important after fibre diameter in determining the performance of combing style wool in worsted processing, and the properties of the yarn and fabric produced from it.

It is likely that improved knowledge of length and strength will enable buyers to better meet the needs of individual processors who have diverse preferences, processing technologies and purchasing powers. Therefore, as processors learn to use the new measurements it is expected that buyers will begin to pay a premium for wool sold with SM. It is also possible that their valuation of the length and strength properties of combing wool will change.

Hedonic price models for greasy wool sold to the trade during the 1988/89 wool selling season were used to determine the average size of premiums for wool with SM, and the size of premiums for various levels of staple length and staple strength of Merino combing wool. The results obtained apply specifically to the grades of wool and time periods examined: premiums will change over time along with shifts in demand for the final product, with technology changes and as supplies of different wool types change.

In this study, an average premium of about 3 cents/kg clean (or 0.3% of price) was observed for wool sold with SM. This compares with testing costs of about 5 cents, and the premium in the Reserve Price Schedule of 10 cents.

A premium was detected for increasing staple strength between 30 and 50 N/ktex in Merino combing wool. The premium rose continuously by smaller and smaller amounts as strength increased, and was greater for finer wool than coarser wool. "Tender" wool (ie. wool with staple strength less than about 30 N/ktex) was found to attract a greater discount when tested. Premiums for staple length also rose in a continuous fashion at a diminishing rate; and the broad relationship between staple length and price was consistent with the relative prices paid for A, B anc C length wool, as defined in the AWC type list.

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AN ANALYSIS OF PREMIUMS FOR STAPLE MEASUREMENT, AND PRICE DIFFERENTIALS FOR LENGTH AND STRENGTH PROPERTIES OF MERINO COMBINING WOOL

1. Introduction

Presale Staple Measurement (SM) for combing wool has been available to woolgrowers since January 1985. During 1988/89 the national adoption rate was 17.6% of these types, and in 1989/90 the adoption rate is about 50%.

Staple measurement was introduced to enable more precise specification of the staple length and staple strength qualities of combing wool - attributes which have only been subjectively appraised in the past. Length and strength are next in importance to fibre diameter in determining the spinning performance of wool in worsted processing and the characteristics of the yarns and fabrics produced from it (Hunter, 1980).

It is expected that SM will enable buyers to better meet the needs of individual processors, who have diverse preferences, processing technologies and purchasing powers. Potential benefits to processors include increased predicitability in top production[1], improved efficiency in wool purchasing and higher productivity within wool combing firms (Spinks and Lehmer, 1986).

The first of these effects has been studied by Spinks and Lehmer (op.cit.) and Vlastuin (1988). Spinks and Lehmer found that mills participating in commercial trials benefitted by about 6 cents for each kg of clean top produced from better prediction of top length (hauteur). Vlastuin updated this work and extend it to include prediction of noil percentages. However he did not find conclusive evidence that processors' revenues would improve by using SM, partly because the general predictive formulas for noils performed badly and those for hauteur did not perform as well for finer more valuable wool types. He concluded that predictive formulas developed to-date require further refinement before they could stand on their own in a commercial environment.

After Freebairn (1967), it is possible to show using indifference analysis that processors would express their increased satisfaction for the more precisely specified product by offering a higher average price for it. That is, the demand curve for Australian wool would shift to the right with the adoption of SM. Another important factor which would tend to shift the aggregate demand curve to the right comes from attracting additional customers because the better specified commodity has greater value to potential buyers (e.g. current users of synthetic fibres).

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1 Tops are produced by scouring and combing greasy wool. When finished, a top is a continuous stand of untwisted fibres from which the shorter fibres or noils have been removed.

Disregarding the testing costs, it is not clear that all producers will benefit from the introduction of SM. Freebairn (op. cit.) states that the outcome of a grading scheme for individual producers depends on the grade produced and the time period considered. Some producers will receive a higher level of returns in all adjustment periods following the innovation. For example, subjective assessment of staple strength (by manually flicking a staple with a force of about 30 N/ktex) can only detect major deficiencies, yet staple strengths of up to 50 N/ktex are known to affect hauteur and noil percentages, so SM may allow premiums to be paid for staple strength above about 30 N/ktex. In the short and intermediate run the returns to other producers may be unaffected or reduced. For example, tender categories may be more heavily and/or consistently discounted by the buying trade once the true extent of any strength deficiency is known. In the intermediate run producers of these wool types can increase returns by making adjustments along their long run supply curve. However, the long run assumption of free mobility of all resources may not always apply because of technical constraints.

It is difficult to anticipate the long run effects of SM on returns to growers and their competitive position because the demand curves for particular types are interdependent and not static, and demand is subject to structural variations due to changing technology, tastes, incomes and preference patterns. The focus of this paper is the short run. The aim is to determine whether wool sold with SM does indeed receive a market premium over wool sold without SM, and to determine whether prices paid for length and strength properties of wool are changing.

2. Methodology

The approach used to estimate buyers' valuation of SM, staple length and strength is based on the consumer demand theory of Lancaster (1971). It involves quantifying the relationship between the price of individual lots sold at auction and the bundle of raw wool characteristics and lot details pertaining to each lot. It is important that these "hedonic" price models are applied to the wool industry during periods when market prices are not influenced by AWC intervention, i.e. when AWC purchase rates are low. Previous applications of Lancaster's methodology to the Australian wool market include Angel et al (1989), Bramma et al (1985), Jackson and Spinks (1982) and Simmons (1980).

By assuming prices are a linear function of characteristics of sale lots, the general form of the price equation to be estimated is:

$$P_i = a + \sum_{k=1}^{K} b_k x_{ik} + u_i$$

where p_i is the clean price per kilograme for lot i;

a is the constant term;

b_k is the value or "implicit price" of an additional unit of the characteristic k;

x_{ik} is the amount of the k^{th} characteristic of lot i; and

u_i is the error term.

The major value-determining characteristics of raw wool are mean fibre diameter, yield, vegetable matter content, staple length and strength (Pattinson, 1983). Apart from yield, these raw wool characteristics are included in equation 1. Yield effects on price are accounted for by using clean price as the dependent variable. The possibility also exists that attributes have an interactive affect on price. For example wool which is both short and very strong may attract a premium above the sum of the individual valuation of these attributes, and greater fibre length and strength may be more valuable in finer wool types. Potential price shifters, which are also relevant characteristics for inclusion in the model, are sale day and whether or not the wool has been staple measured.

3. The Data

The Data used in this analysis was obtained from the AWC's Catalogue History System. The SM premium was estimated from six samples, each comprising about 12,000 lots sold in Brisbane, Sydney, Newcastle, Goulburn, Melbourne, Geelong, Adelaide and Fremantle between mid-November 1988 and mid-February 1989. AWC purchases during this period totalled only 4% of the national offering. The sale lots selected were typed by AWC appraisers as best topmaking Merino combing fleece, Merino French combing wool of best style and length, Merino skirtings, combing lambs and weaners.

Half of each sample comprised all the lots sold with SM during the study period. The other half contained a random selection of lots sold without SM, each of which could be matched with an SM-lot of the same wool type and sold in the same sale-week. Each stratified random sample was selected with replacement, so lots which were not staple measured could appear in more than one of the samples. The samples were balanced in this manner since the composition of sales varied between sale weeks.

The portion of sound and tender wool in the samples was about equal to the national averages for 1988/89, ie 83:17. The data used did not include lots purchased by the AWC at auction, which attract an additional 10 cent premium over the relevant floor price. Interlotted and bulkclassed wool and wool sold without objective measurement of fibre diameter, yield and vegetable matter content was also excluded.

Descriptive statistics for the second sample, which was also used exclusively to determine buyers' valuations of length and strength, are shown in Table 1.

TABLE 1 : Descriptive Statistics for the Sample Data

Variable	Unit	Mean	Standard Error
(a) Non-SM Sale Lots (5786 observations, 79.1% sound : 17.4% W1 : 34% W2 : 0.1% V)			
Price	c/kg clean	920.9	308.5
Yield	%	72.8	4.3
Fibre Diameter	um	21.5	1.6
Vegetable Matter	%	0.6	1.0
Length	mm	na	na
Strength	N/ktex	na	na
CV Length	%	na	na
(b) SM Sale Lots (5791 observations, 72.5% sound : 20.9% W1 : 6.4% W2 : 0.2% V)			
Price	c/kg clean	915.8	285.3
Yield	%	73.0	4.2
Fibre Diameter	um	21.6	1.6
Vegetable Matter	%	0.6	1.0
Length	mm	93.1	10.0
Strength	N/ktex	35.4	7.8
CV Length	%	16.0	3.9

Analysis

4.1 The Premium For Wool Sold with SM

Ordinary least squares was used to estimate the premium for SM. After adjusting out the effects of sale week and type, the variation in the clean price of the sample data was explained by the following value-determining characteristics: fibre diameter, vegetable matter content, tenderness category (sound, W1, W2 or V) and whether or not the wool was staple measured. These variables consistently explained over 90% of the variation in price of the sample data.

Statistical details of the analysis for the second random sample are shown in Appendix 1. The size of the SM premium estimated from each of the random samples is shown in Table 2, along with its associated standard error. The mean result indicates that a premium occurs for SM wool with 90% certainty, and the best estimate of this premium is about 3 cents/kg clean.

TABLE 2 : Estimates of the SM Premium
(c/kg clean)

Sample	Premium	Standard Error	Probability that Estimated Premium is not Zero
#1	3.47	2.40	85%
#2	5.43	1.56	99%
#3	2.34	2.42	70%
#4	2.98	2.39	80%
#5	4.21	1.61	99%
#6	2.59	2.36	70%
Mean	3.50	2.12	90%

4.2 Length and Strength Premiums for Sound Wool

Premiums for incremental increases in the length and strength of objectively measured, sound wool were estimated from the second pooled sample using observations for best topmaking, SM wool only. Until staple measurement was introduced, it was not possible to estimate premiums for wool stronger than about 30 N/ktex, and discrete premiums for length could only be estimated for the A, B and C length categories.

The raw wool characteristics used to explain the variation in clean price of the staple measured wool were: fibre diameter, vegetable matter content, staple length, the coefficient of variation of length and staple strength. Price shifters were also included to allow for changes in the average level of price between sale weeks. Consideration was also given to the interactive effects of attributes on price. For example, wool which is both short and very strong may attract a premium above the sum of the individual valuations of these attributes, but in this analysis the effect was not found to be statistically significant. Also increasing staple length and strength may be more valuable for finer types than coarser types, this effect was indeed observed. Statistical details of the analysis are shown in Appendix 2. About 97% of the variation in price was explained by the raw wool characteristics considered.

Clean price rose significantly as staple length increased across the entire micron r nge. The relationship between price and length for 18, 21 and 24 micron wool is shown in Figures 1, 2 and 3 respectively. With fine wool, the length premium increases at a faster rate and by a greater amount than for coarser wool.

FIG 1: PREMIUMS FOR STAPLE LENGTH
18 MICRON WOOL

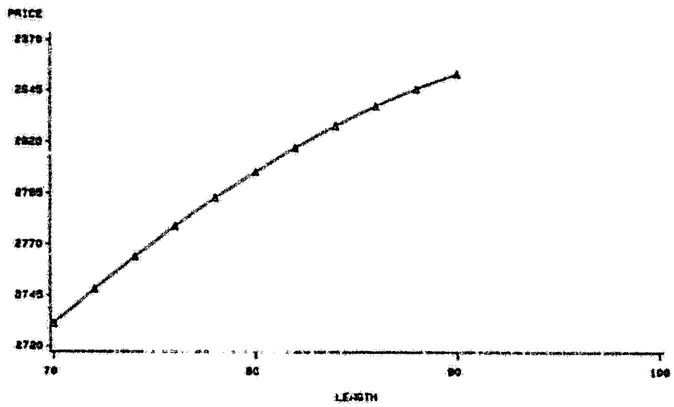


FIG 2: PREMIUMS FOR STAPLE LENGTH
21 MICRON WOOL

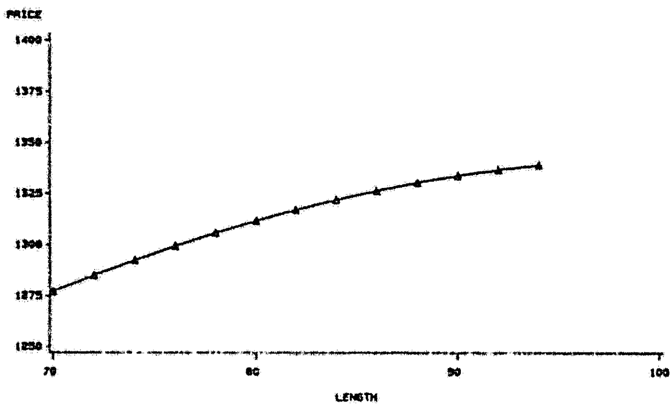
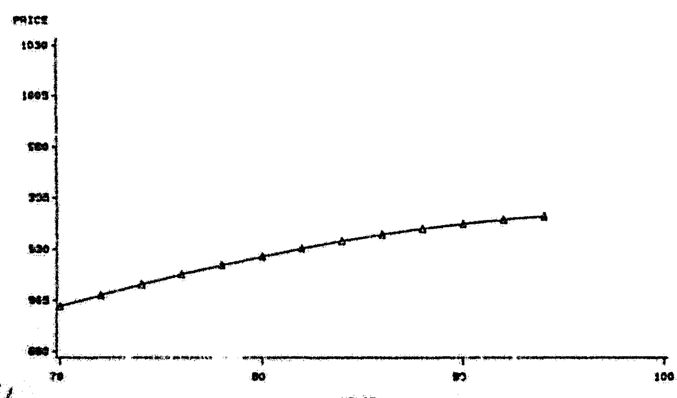


FIG 3: PREMIUMS FOR STAPLE LENGTH
24 MICRON WOOL



Premiums were also found for increasing strength of sound wool up to about 50 N/ktex. The observed premiums for 18, 21 and 24 micron wool are shown consecutively in Figures 4, 5 and 6. As with the length premium, the strength premium is greater for finer wool.

FIG 4: PREMIUMS FOR STAPLE STRENGTH
18 MICRON WOOL

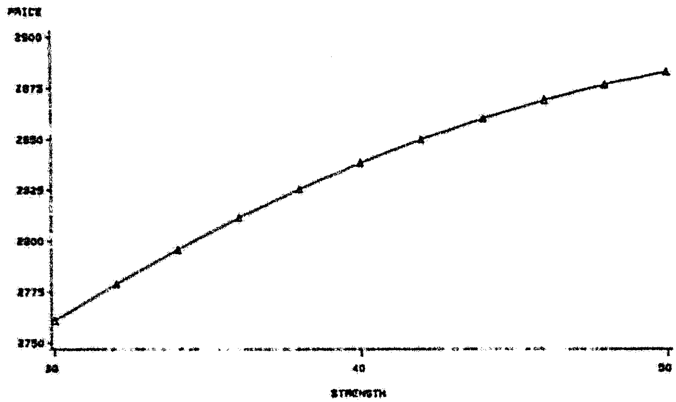


FIG 5: PREMIUMS FOR STAPLE STRENGTH
21 MICRON WOOL

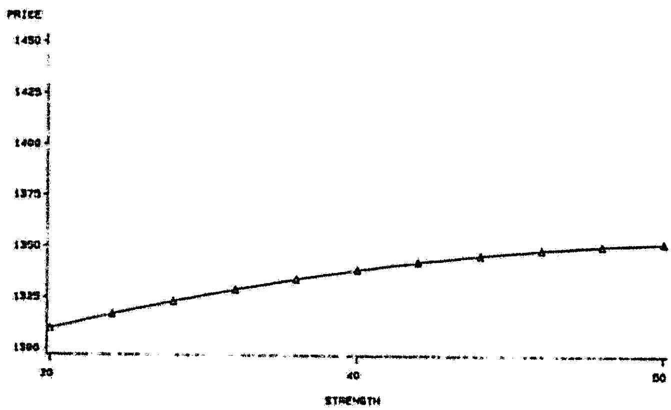
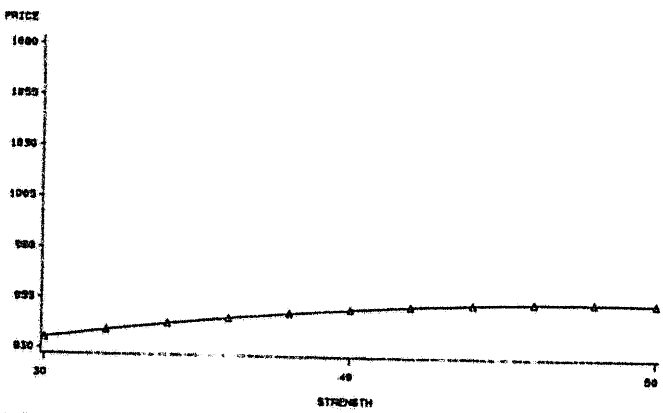


FIG 6: PREMIUMS FOR STAPLE STRENGTH
24 MICRON WOOL



4.3 Comparison of Prices Paid for Length and Strength Categories of Subjectively and Objectively Measured Wool.

Prices paid for wool in the various length and strength categories were estimated from the second pooled data set by fitting a price equation separately to the data on SM and non-SM wool.

The raw wool characteristics used to explain the variation in clean price were: fibre diameter, vegetable matter content, length category (A, B or C) and tenderness category (Sound, W1 or W2). Price shifters were included to allow for changes in the average level of price between sale weeks. Interaction effects between the length and strength categories, with fibre diameter were also included. For both the SM and non-SM wool 96% of the variation in price was explained. Statistical details of the analysis are contained in Appendix 3.

Comparison of the estimated equations shows that staple measurement causes little or no difference in the prices paid for A, B and C lengths. The analysis did reveal, however, that the discounts for tenderness have changed with SM. Discounts for the tender categories relative to sound wool are shown in Figure 7 for subjectively assessed wool, and in Figure 8 for objectively measured wool. Comparison of the two figures shows that tender wool is more severely discounted once the true extent of any deficiency is known.

5. Conclusions

The analysis of sale results for the 1988/89 season suggests that premiums for SM are becoming more widespread. In this study, an average premium of about 3 cents/kg clean (or 0.3% of price) was observed for wool sold with SM. This compares with testing costs of about 5 cents, and the premium in the Reserve Price Schedule of 10 cents.

A premium was also detected for increasing staple strength between 30 and 50 N/ktex in Merino combing wool. The premium rose continuously by smaller and smaller amounts as strength increased, and was greater for finer wool than coarser wool. Tender wool was found to attract a greater discount when tested. Premiums for staple length also rose in a continuous fashion at a diminishing rate; and the broad relationship between staple length and price was consistent with the relative prices paid for A, B and C length wool, as defined in the AWC type list.

FIG 7: DISCOUNTS FOR TENDERNESS OF SM WOOL

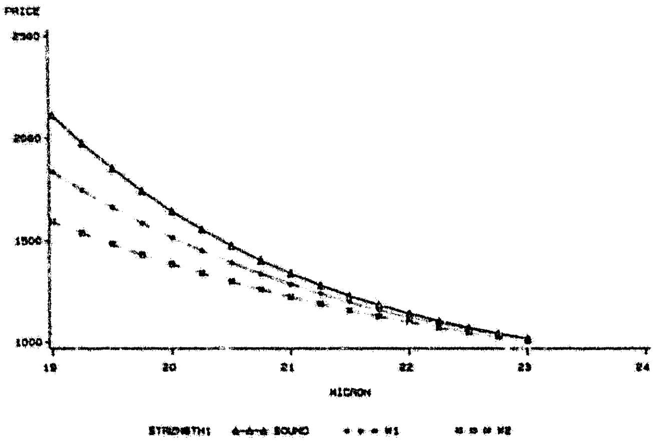
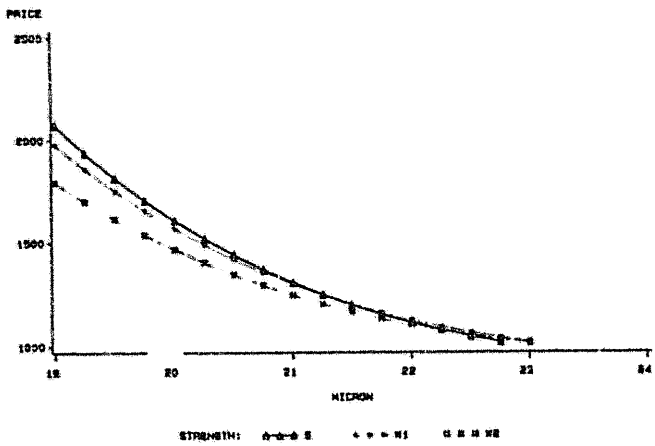


FIG 8: DISCOUNTS FOR TENDERNESS OF NON-SM WOOL



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Appendix 1: STATISTICAL ESTIMATION OF THE SM PREMIUM

In this analysis a price equation was fitted to the data using regression analysis to estimate the relationship between price and the value-determining characteristics. The equation est'mated was:

$$CPRICE_i = a + b_1 MIC_i + b_2 MICSQ_i + b_3 VM_i + b_4 W1_i + b_5 W2 + b_6 V + b_7 SM + e_i$$

where

$CPRICE_i$ is the price of lot number i in cents/kg clean, calculated by dividing the Schlumberger Dry Combing yield into the greasy price;

MIC_i is the fibre diameter of lot i measured in tenths of a micron;

$MICSQ_i$ is the square of the fibre diameter of lot i. This term allows for a non-linear relationship between micron and price (i.e. as fibre diameter increases, price increases at an increasing rate);

VM_i is the vegetable matter content of lot i measured as a percentage by weight of the greasy wool;

$W1_i$ is a 0-1 class or dummy variable for part-tender wool;

$W2_i$ is a dummy variable for tender wool;

V_i is a dummy variable for rotten wool;

SM_i is a dummy for pre-sale staple measurement;

e_i is the error term;

a is the constant term; and

b_{1-7} are coefficients estimated in the analysis.

The equation was fitted to the data using the GLM procedure in the SAS statistical analysis package. The effects of sale week and type on price were absorbed prior to fitting the regression equation. Observations were weighted so that each type was represented according to its prominance in the national clip.

The proportion of the total variation in clean price accounted for by the wool attributes specified is high: the adjusted R-square is 0.96, and the root mean square error of the predicted price is 82.96 cents/kg clean, compared with the average for clean price of 1257.39 cents. In general the estimated coefficients are significant at the 1% level and correctly signed. Of most importance is the coefficient on the SM variable which was 5.43, indicating that SM wool receives a premium, on average, of about 5 cents/kg clean over non-SM wool for this sample. The t-statistic was 3.47, indicating that we can be about 99% sure that the estimated premium is different from zero (i.e. the coefficient is statistically significant at the 1% level).

Appendix 2: STATISTICAL ESTIMATION OF THE PRICES PAID FOR LENGTH AND STRENGTH PROPERTIES OF MERINO COMBING WOOL

Premiums for incremental increases in length and the strength of sound wool were estimated using data on best-topmaking, staple measured wool only. Premiums were obtained using the REG procedure in SAS by regressing price on the relevant value-determining raw wool characteristics. Non-linear relationships with fibre diameter, length and strength were modelled. Interaction terms between fibre diameter, length and strength were also considered. Observations were weighted so that each type was represented according to its prominance in the clip. The equation was:

$$\begin{aligned} LNPRICE_i = {} & a + b_1 MIC_i + b_2 MICSQ_i + b_3 VM_i + b_4 LENGTH_i + b_5 LENSQ_i \\ & + b_6 LENM_i + b_7 STRENGTH_i + b_8 STRSQ_i + b_9 STRM_i + b_{10} CVL_i \\ & + b_{11} CVLM_i + b_{12} D1_i + \ldots + b_{20} D9_i + e_i \end{aligned}$$

where

$LNPRICE_i$ is the natural logarithm of the clean price of lot number i in cents/kg clean;

MIC_i)

$MICSQ_i$) Are as defined in Appendix 1;

VM_i)

$LENGTH_i$ is the staple length of lot i measured in mm;

$LENSQ_i$ is the square of the staple length of lot i;

$LENM_i$ is the interaction between the length and fibre diameter of lot i;

$STRENGTH_i$ is the staple strength of lot i measured in N/ktex;

$STRSQ_i$ is the square of the staple strength of lot i;

$STRM_i$ is the interaction between the strength and fibre diameter of lot i;

CVL_i is the coefficient of the variation in length of lot i;

$CVLM_i$ is the interaction between the coefficient of variation in length and fibre diameter of lot i;

$D1_i$ - $D9_i$ are dummy variables for the various sale weeks;

e_i is the error term;

a is the constant term;

b_{1-20} are coefficients estimated in the analysis;

The estimated model is reported in Table 2.1. The overall explanatory power of the model is high, as indicated by an adjusted R-square of 0.97. The root mean square error is 0.04 compared with the mean of the dependant variable of 7.15. The length and strength terms and their squares are all highly significant and correctly signed. The interaction terms with fibre diameter are insignificant for length, and significant at the 5% level for strength.

TABLE 2.1: Regression Results

Wool Attribute	Implicit Price	t-Statistic (a)
constant	20.7585	118.70 **
MIC	-1.1553	-91.88 **
MICSQ	0.0228	70.71 **
VM	-0.0065	-3.25 **
LENGTH	0.0102	6.37 **
LENSQ	-0.0001	-6.78 **
LENM	0.0000	0.65 NS
STRENGTH	0.0104	5.04 **
STRSQ	-0.0001	-4.40 **
STRM	-0.0002	-2.41 **
CVL	-0.0030	-7.61 **
CVLM	0.0000	7.50 **
D1	-0.0389	-12.96 **
D2	-0.0782	-24.77 **
D3	-0.0938	-26.34 **
D4	-0.0448	-12.13 **
D5	0.0514	13.58 **
D6	0.0203	5.29 **
D7	-0.0409	-10.58 **
D8	-0.0365	-10.93 **
D9	-0.0557	-18.77 **

*(a) A ** signifies that the coefficient is significant at the 1% level. NS means not significant.*

Appendix 3 : **A STATISTICAL COMPARISON OF THE PRICES PAID FOR LENGTH AND STRENGTH CATEGORIES OF OBJECTIVELY AND SUBJECTIVELY MEASURED WOOL.**

A mathematical function was fitted separately to the data on SM wool and non-SM wool in the pooled data set using the REG procedure in SAS. The price equation was:

$$LNPRICE_i = a + b_1MIC_i + b_2MICSQ_i + b_3VM_i + b_4B_i + b_5C_i + b_6BM_i + b_7CM_i + b_8W1_i + b_9W2_i + b_{10}W1M_i + b_{11}W2M_i + b_{12}W1MSQ_i + b_{13}W2MSQ_i + b_{14}D1_i + \ldots + b_{22}D9_i + e_i$$

where $LNPRICE_i$, MIC_i, $MICSQ_i$, VM_i are as defined in Appendices 1 and 2;

B_i is a dummy variable for B length wool;

C_i is a dummy variable for C length wool;

BM_i is the B length dummy multiplied by fibre diameter;

CM_i is the C length dummy multiplied by fibre diameter;

$W1_i$, $W2_i$ are as defined in Appendix 1;

$W1M_i$ is the part-tender wool dummy multiplied by fibre diameter;

$W2M_i$ is the tender wool dummy multiplied by fibre diameter;

$W1MSQ_i$ is the part-tender wool dummy multiplied by the square of fibre diameter;

$W2MSQ_i$ is the tender wool dummy multiplied by the square of fibre diameter;

$D1_i$-$D9_i$, e_i, a, b_{1-22} are as defined in Appendix 2

The estimated model for both sets of data is reported in Table 3.1. The model fitted the data well, with the adjusted R-square being 0.96 for both data sets. The length and strength terms and the interaction terms with fibre diameter are all highly significant. The coefficients on the length dummies are similar in magnitude for the SM wool and the non-SM wool. The coefficients on the strength dummies, and their significance levels, are however quite different.

TABLE 3.1 : Regression Results

Wool Attribute	Subjectively Assessed Wool		Objectively Measured Wool	
	Implicit Price	t-statistic (a)	Implicit Price	t-statistic (a)
Constant	21.4830	156.61**	21.0948	152.31**
MIC	-1.1790	-92.60**	-1.1404	-88.71**
MICSQ	0.0238	80.62**	0.0228	76.67**
VM	-0.0030	-1.51NS	-0.0055	-2.80**
B	-0.0713	-3.13**	-0.0709	-3.24**
C	-0.2225	-5.71**	-0.1865	-4.87**
BM	0.0029	2.78**	0.0031	3.01**
CM	0.0092	4.94**	0.0074	4.03**
W1	-1.1176	-3.97**	-4.4471	-14.49**
W2	-2.7937	-3.72**	-7.8081	-15.93**
W1M	0.0887	3.33**	0.3863	13.45**
W2M	0.2211	3.11**	0.6679	14.60**
W1MSQ	-0.0017	-2.78**	-0.0084	-12.54**
W2MSQ	-0.0043	-2.60**	-0.0143	-13.45**
D1	-0.0436	-14.74**	-0.0385	-13.64**
D2	-0.0773	-24.69**	-0.0740	-24.93**
D3	-0.0852	-24.30**	-0.0871	-26.09**
D4	-0.0406	-11.27**	-0.0408	-11.88**
D5	0.0475	13.50**	0.0508	15.07**
D6	0.0303	8.19**	0.0287	8.12**
D7	-0.0413	-11.02**	-0.0385	-10.74**
D8	-0.0298	-9.01**	-0.0329	-10.45**
D9	-0.0445	-15.20**	-0.0502	-18.07**

*(a) A ** signifies that the coefficient is significant at the 1% level. NS means not significant.*