The Australian Wool Industry: A hedonic pricing analysis of the factors affecting price of Australian wool

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Contributed Paper prepared for presentation at the 55th Annual Conference of the Australian Agricultural & Resource Economics Society Melbourne, Victoria, 9-11 February 2011

Topics: Agribusiness, Demand & Price Analysis, Livestock Production/Industries, Marketing

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Abstract

We estimate a hedonic pricing model to quantify the relationship between clean price of lots of wool and individual lot characteristics for all superfine, fine, medium and broad wool types. We expand on existing literature by controlling for key macroeconomic conditions at the time of sale and are able to examine the longer term trend in global demand for wool by utilizing data over a number of selling seasons. Our results indicate fibre diameter, strength, breed group, vegetable matter base and fleece contamination play a key role in the purchase decision. Premiums accrue for finer, strong wool which has been grower classed, while discounts have been identified for wool tainted by branding contamination, unscourable colour or the presence of skin pieces. Key market conditions such as world economic growth, price of substitutes and exchange rates with key trading partners have been found to significantly affect Australia's competitiveness in the global market for wool.

1. Introduction

The last two decades have seen significant changes in the flock composition and economic importance of the Australian wool and sheepmeat industries. Although less important than in the past, the wool industry remains a competitive player in the international market for wool. Australian Merino wool is regarded as the world's best woollen fibre by international buyers (Australian Bureau of Statistics 2003), with quality largely attributed to the efforts of woolgrowers in selective breeding and careful management of their flock.

To remain competitive in the global market for wool, growers must be provided with a better understanding of changed market conditions. In this study we address asymmetric information in the wool market by quantifying the effect of certain wool characteristics and macroeconomic conditions on clean price of wool. By identifying those characteristics which significantly influence price, woolgrowers will be able to take advantage of the premiums paid for attributes and avoid the severe discounts attributable to other traits.

We use a hedonic pricing model to estimate the value of individual lot characteristics, using data for all lots of wool sold at auction through the Australian Wool Exchange (AWEX) for the period July 2004 to March 2010. As data relate to sales from 2004 onwards, we can assume price is determined by free market forces, and thus we are able to avoid biases associated with previous studies which used data from markets affected by the Reserve Price Scheme (RPS) and its aftermath. As wool is a heterogeneous product, we adapt our approach for each of the four wool types: superfine, fine medium and broad wool. The inclusion of a number of selling seasons in our analysis will allow us to examine the longer term trend in global demand for Australian wool. We are also able to build upon the existing literature by controlling for key macroeconomic factors which may influence the competitiveness of Australian wool. Results of this study should provide stakeholders from both supply and demand sides with an insight into the key factors affecting demand for Australian wool.

The remainder of this article proceeds as follows. After a brief discussion of the current state of the wool industry, we provide an overview of the hedonic method and its theoretical framework. Next we provide an analysis of the data, describe the included variables and justify our chosen functional form. We then present our econometric results and relate our findings to the broader literature. Finally we conclude with a summary of important findings and possible implications for growers and other interested stakeholders in the wool industry.

2. Background

Over the last 20 years the Australian wool industry has undergone significant change, both in economic importance and flock structure (Curtis 2009). Flock numbers have declined from 170 million head in 1989-90 to 76.3 million head in 2009/10 (Wilcox and Curtis 2009), and greasy wool production has declined from 655 million kilograms in 1995-96 to just 330 million kilograms in 2009/10 (AWI April 2010).

The micron profile has also changed since producers moved to production of finer wool to take advantage of premiums paid during the 1990s. Average fibre diameter fell from 21.6 micron to 20.7 micron between 1990 and 2005 (Peart *et al*. 2006), and increased slightly to 20.9 in 2009 (AWEX 2010). The national wool clip is currently concentrated around 18.6-21.5 micron diameter[2] (AWI August 2010).

The prospect of earning more profitable returns from alternate enterprises has led to a restructuring of the national flock. Wool prices have remained relatively constant from 1993-1994 to 2009-2010, while the prices received for beef, lamb, mutton and live sheep have risen since the early 2000s. As relative prices of alternative enterprises increase, woolgrowers are responding by either adjusting their product mix (between wool and prime lambs) or by leaving the industry. Increasingly, a higher proportion of merino ewes are joined to terminal sires to produce offspring for lamb meat, while wethers are progressively culled for mutton or exported as live produce. Returns to sheep are now balanced equally between meat and

[2] Recent changes in breed mix composition (increased exotic and cross breeds for sheep meat) have increased production of broader wool (+24.6 micron) to 14.6 per cent of total production, an increase of 2 per cent from 2008/09 (AWI, April 2010, p. 5).

wool, whereas in the late 1980's, wool accounted for about 85 per cent of total gross value (Curtis 2009).

The reduced profitability of wool has largely been the result of a weakening in global demand for woollen clothing, from which demand for the raw fibre is derived. Key factors affecting demand for wool include rising interest rates, changing consumer tastes, population growth, increased general costs of living (such as petrol and energy costs) and the relative prices of substitute fibres (such as cotton, and synthetic fibres). Through the mid 2000s, a strong exchange rate with the $US has increased the price of Australian wool to processors, thus reducing competitiveness in the global market (Wilcox and Curtis 2009). Mature, developed markets with high per capita incomes such as the US and Europe have historically consumed wool at retail, but now have aging populations, and older consumers are not generally a target market for luxury apparel (Ashton *et al*. 2000). As wool is used to produce luxury apparel, constrained budgets force consumers to rethink spending priorities or opt for cheaper alternatives (such as woollen apparel mixed with synthetic fibres). Subdued economic growth over the past fifteen months in particular has seen consumer confidence decline, with global demand for wool falling by 20 per cent from 1995 to 2008 (International Wool Textile Organisation 2009). However, a global shortage of supply is expected to improve prices (AWI August 2010), and demand prospects are positive since the recovery of some wool consuming countries in 2010. Domestic apparel consumption in China is expected to be a strong factor in supporting short-term demand for Australian wool (ABARE 2009). China is also the world's largest processor of raw wool, and its wool processing industry serves both its domestic market and is increasingly exporting to apparel markets in Japan, the United States of America and the European Union (Wilcox 2009).

As key wool consuming countries recover, there has been an increased demand for new products made from fine wool (less than 21 microns) in growing markets for active leisurewear, easy-care fashion and next-to-skin undergarments (York 2010). The new products require fine, soft-feeling, strong fabrics with excellent thermal qualities. The development of these new markets is positive for the Australian wool industry which supplies over 90 per cent of global fine wool (Wilcox 2009), with 50 per cent of the national clip measuring 20 micron or under.

Future viability of the wool industry will depend upon the ability of the Australian wool industry to influence demand for woollen apparel in countries where incomes are rapidly rising, such as China and India (Wilcox and Curtis 2009). The wool Industry must also target new markets for woollen fibre (new active leisure wear and close-to-skin undergarments) and improve wool's competitiveness with substitute fibres[3]. Quantifying the effects of wool characteristics and macroeconomic factors on clean price will improve industry knowledge of quality aspects in wool, and will aid producers in making decisions which maximise returns to wool growing.

3. Literature Review

The analysis in this study follows the hedonic pricing model developed by Rosen (1974) which in turn was based on the new approach to consumer theory proposed by Lancaster (1966). In this seminal paper Lancaster suggested that traditional theory (see, for example, Marshall 1946; Theil 1975; Cochrane and Bell 1956) did not sufficiently deal with variations in product quality (Lancaster 1966, p.34). He proposed a new approach by which goods are no longer considered the object of utility; rather it is the properties of those goods from which utility can be derived (Lancaster 1966). Rosen (1974, p. 34) defined hedonic prices as "…the implicit prices of attributes that are revealed…from observed prices of differentiated products and the specific amounts of characteristics associated with them." Rosen conceptualised the hypothesis that differentiation of goods should be based on the value of each good's utility bearing attributes and that it is through these attributes that one may derive utility.

The work of Lancaster (1966) and Rosen (1974) was the basis for development of subsequent hedonic pricing models. Ladd and Suvannunt (1976) and Ladd and Zober (1977) provided extensions of Lancaster's work by relaxing the assumption of nonnegative marginal utilities of product characteristics, while Ladd and Martin (1976) and Dreze and Hagen (1978) developed a neoclassical model to focus on the role of inputs in the production process. These approaches are appropriate for an anlysis of the value of wool attributes given that wool is a non homogenous good (Beare and Meshios 1990). Using a hedonic analysis we are able to attribute dispersion in wool quality to the intrinsic heterogeneity of its characteristics.

Hedonic analysis has been applied in studies of product heterogeneity in many agricultural commodities. Hill (1988), Espinosa and Goodwin (1991) and Ahmadi-Esfahani and Stanmore (1994) focused on differing aspects of asymmetric information in the wheat market. Perrin (1980), Gillmeister *et al*. (1996) and Lenz *et al*. (1994) considered both availability and accuracy of information in the soybean and milk markets. Ethridge and Davies (1982) and Ethridge and Neeper (1987) employed the input approach to analyse the

[3] This has already started with CSIRO's development of "Quick-dry Merino", aimed at competing with synthetics such as polar fleece.

implicit market for cotton characteristics, while Bowman and Ethridge (1992) extend hedonic application to model market structure.

Under the Inputs Characteristics Model of Ladd and Martin (1976), attributes of a good are purchased not for final consumption, but as inputs into further production (Houthakker 1951, 1952). Demand for raw wool (or farm-gate demand) can be derived from demand for woollen apparel at retail. Consumption decisions are made by the spinner, who selects yarn suitable to convert into fabric desired by the consumer at retail (Drummond, 1993). The spinner's purchase decision will weight on the inherent characteristics of the yarn which affect its processing requirements and quality of the final product (Skinner 1965).

The Ladd and Martin (1976) inputs approach has been applied in a number of studies which focus on statistical relationships between wool characteristics and price in the Australian wool market. Simmons (1980) and Bramma *et al.* (1985) found significant price premiums and discounts associated with wool of differing fibre diameter and level of vegetable matter content. Beare and Meshios (1990) extended the work of Bramma *et al.* (1985), allowing for substitution between fibre diameters. Angel *et al*. (1990) and Stott (1990) found significant price premiums and discounts associated with the staple measurement characteristics of length and strength, with Angel *et al.* (1990) also considering relevance of end use. Jackson and Spinks (1982), Spinks and Lehmer (1986) and Gleeson *et al*. (1993) investigated wool characteristics and arbitrage within the Australian and New Zealand markets. Such studies provide evidence of demand for quality attributes associated with wool, information which can be used by woolgrowers and other interested stakeholders to ensure wool quality meet market demand. However, price data employed in previous analyses of the wool market during the 1980s and 1990s were, to some extent, influenced by the fixed pricing schedule of the Reserve Price Scheme (Gleeson *et al*. 1993). Stock sales carried out at the termination of the Scheme in 1991 may also have affected the relative price for wool types in studies conducted during the 1990's. This study will avoid such bias as data is collected from 2004 onwards, where prices are determined by free market forces.

The Australian wool market largely relies on global economic conditions to promote wool exports, although the effect of such macroeconomic factors (such as exchange rates, economic growth and the influence of substitute fibres) remains largely unexplored in the existing literature. Such influences have been explored in the hedonic literature pertaining to the housing market (Kalra and Chan 1994; Leung, Cheng and Leong 2002a; Ho and Wong 2003; Leung 2004; Leung, Leong and Wong 2006), the European car market (Goldberg and Verboven 2001) and the market for thoroughbred yearlings (Karungu, Reed and Tvedt 1993;

Buzby and Jessup 1994; Neibergs and Thalheimer 1997). Within the market for thoroughbred yearlings, it has been commonly accepted that the state of the global environment will either encourage or discourage investors (Neibergs and Thalheimer 1997). Karungu, Reed and Tvedt (1993), Neibergs and Thalheimer (1997) and Buzby and Jessup (1994) concluded exchange rates, interest rates and a change in U.S. federal tax policy to have positive effects on the price of yearlings.

As far as we are aware, there are no previous studies of the Australian wool industry which include macroeconomic effects. This study aims to control for the effect of global influences (such as exchange rates, interest rates and economic growth of our major importing countries and the influence of substitute fibres in the global market for apparel) on the price of Australian wool. We also control for a wider range of wool characteristics than previously explored, and provide a comprehensive analysis of the longer term trend in demand for Australian wool.

4. Methodology

4.1 The Model

Four hedonic pricing models have been developed to estimate the relationship between clean price of wool and individual lot characteristics for each sub category of wool (superfine, fine, medium and broad). Our analysis expands on previous studies as we also control for the influence of key macroeconomic conditions at the time of sale.

The theoretical framework is based on the Input Characteristics Model of Ladd and Martin (1976). The model is relevant for the analysis of raw wool as useful properties can be derived from fibre attributes which are then used in the production of market apparel and other products (Ladd and Martin 1976). The derivation of this relationship can be found in Appendix I. Multiple regression analysis is the most appropriate method of assigning monetary values to input characteristics (Ladd and Martin 1976).

Hedonic models may take on a variety of functional forms. As noted by Halvorsen and Pollakowski (1981) hedonic price equations are reduced-form equations which reflect both supply and demand influences. Thus on theoretical grounds, it would be inappropriate to generalize a specific functional form. Given this, we must take care in selecting a model that provides a good fit to the data. After testing various functional forms we have chosen the semi-log form. The literature supports the semi log model as an appropriate form; its non-linear properties are both essential in producing a continuous first derivative, and necessary in minimising the problem of identification, in quasi-utility functions (Rasmussen and Zuehlke 1990; Ekeland *et al*. 2002). If the relationship between characteristic and price is not constant across the full range of values then we must allow for a discontinuous relationship to avoid bias within the regression (Gleeson et al. 1993). Employing a semi-log model allows us to avoid such bias, as we have observed non-linear relationships between the dependent variable and several regressors (ie/ micron, length and strength). Knowledge of this relationship would render the use of a linear form ineffective (Ekeland *et al*. 2002). The model will also facilitate ease of interpretation as we are able to infer percentage changes in the clean price of wool.

The generic form of our hedonic model, estimated in semi-log form is:

$$Ln\ Pi = a_0 + \sum_{i=1}^{n} \beta iZi + \sum_{i=1}^{n} \delta idi + \sum_{i=1}^{n} \theta iqi + \varepsilon i$$

where

lnP_i is the natural log of clean price, for all lot number i (cents/kg),

α_i is the constant term,

$\sum \beta_i b_i$ is the sum of objectively measured characteristics,

$\sum \delta_i d_i$ is the sum of qualitative characteristics,

$\sum \theta_i q_i$ is the sum of macroeconomic influences and

e_i is the error term.

This generic form has been adapted for all superfine, fine, medium and broad wool categories. Each model is estimated using Ordinary Least Squares (OLS) in Stata and includes a range of linear, quadratic (ie/ micron squared) and interaction terms (ie/ the product of micron and strength) to ensure that all effects are captured.

4.2 Data

Data for Merino and other lots of wool sold at auction have been obtained through the Australian Wool Exchange (AWEX). The AWEX sells approximately 86 per cent of all Australian wool sold annually through open cry auction. The data covers auction price and lot characteristics for all lots of wool sold during the period July 2004 to March 2010 (a total of 1,278,512 observations). Although we have both cross sectional and time series components (as in, for example, Beare and Meshios 1990) we have treated the data as pooled data with dummy variables for years, rather than as panel data since there is no obvious variable for the cross section.[4]

Because wool is a heterogeneous input used in the production of many distinct outputs, demand for inherent characteristics will vary with the production process required for each end use. To ascertain demand for characteristics of different wool types, the data have been divided into four sub categories: superfine (18.5 micron or finer) fine (18.6 to 20.5), medium (20.6 to 23.5 micron) and broad (23.6 and above). This is in accordance with industry reporting practices (AWEX 2010). Sample size for superfine wool is 358,290 observations (28 per cent), for fine wool 422007 observations (33 per cent), for medium wool 375, 664 observations (29 per cent) and for broad wool 122, 551 observations (10 per cent).

Data for macroeconomic variables have been collected from a variety of sources. These variables reflect conditions at the time of sale for each wool lot sold through AWEX. Monthly data for the $A/$US and $A/Euro exchange rates were obtained from the Reserve Bank of Australia (Reserve Bank of Australia 2010). Real Gross Domestic Product (GDP for the US) also comes from the RBA archives and is recorded as a quarterly index. Monthly data for cotton and oil prices comes from the International Financial Statistics Database (International Monetary Fund 2010). Cotton and crude oil prices are represented by the A Index (cents/kg) and average spot price ($US/barrel), respectively. A global price for synthetics is obtained using the Synthetic Producer Price Index (PPI) as reported by the U.S. Bureau of Labor Statistics (United States Department of Labor 2010).

To ensure that we capture the non-contemporaneous relationship between clean price and the macroeconomic variables, monthly exchange rates, and world prices for cotton, oil and synthetic fibres have been lagged two periods, while GDP has been lagged one quarter. The lagged variables have been chosen as we found the current period variables to be slightly more correlated than the lagged variables. Given the nature of time series data we are aware that these data contain unit roots. However we do not expect their presence to severely affect our results as this is not the focus of our analysis, rather we have merely attempted to control for such market effects.

4.3 Variables

This study extends coverage of characteristics included in past literature (Simmons 1980; Angel *et al*. 1990; Stott 1990; Gleeson *et al*. 1993). We include objective measurements such

[4] We also explored the possibility of using pseudo panel data (Deaton 1985; Inoue 2005), with date of sale as the cross section. However we found this was not feasible as date of sale is not consistent through the sample period.

as fibre diameter (micron), vegetable matter base (VMB), fibre length, strength and position of breakage (POB), and subjective aspects such as breed group, wool category, classing method and colour. By breaking down the industry's appraisal code (the AWEX-ID) we have been able to identify and control for wool style, vegetable matter type (burr, seed, shive etc.) and an extensive range of fleece contamination (branding, stains, skin pieces, and black and medullated fibre). We also acknowledge changing consumer attitudes regarding mulesing of lambs (Lee and Fisher 2007; AWI August 2008; Phillips 2009) by factoring in mulesing status and controlling for the introduction of the National Wool Declaration (NWD) in July 2008. We include geographic, time and other variables such as location, quarter, date of sale and number of sales in each auction. Finally, we control for global market factors which may influence demand (such as exchange rates, interest rates and economic growth in major wool importing countries, as well as the influence of cotton and synthetic prices, substitute fibres in the market for apparel).

Each model differs slightly in terms of variables included, as relevance will vary according to market demand for each end use[5]. A description of wool characteristics and macroeconomic factors included in our analysis can be found in Table 1 in Appendix II.

5. Results

5.1 Summary Statistics

Summary statistics for the estimation of the superfine, fine, medium and broad wool models are reported in table 1.

Table 1 Summary statistics

Model Statistics	Superfine	Fine	Medium	Broad
No. of Obs.	358 289	422 007	375 664	122 550
R^2 (Adj.)	0.7746	0.8445	0.8398	0.9767
F-value	16863.94	26968.31	22903.74	10888.89
Pr > IFI	0.0000	0.0000	0.0000	0.0000
Root MSE	0.1258	0.0706	0.0617	0.1023

All models are highly significant as indicated by their large F-statistics, while the high values for R^2 show that the raw wool characteristics and macroeconomic variables included in each model largely explain variation in clean price. Our values for R^2 are slightly higher than those for Simmons (1980), Angel *et al*. (1990), Ryan (2006) and Bruckback (2009),

[5] For example, wool contaminants such as dark stains and branding are of less concern in broad wool used to produce industrial carpet, than if found in fine apparel wool.

although, they are not as high as those reported by Gleeson *et al*. (1993) and Hansen and Simmons (1995; 1997). The difference may be due to a variation in decomposition technique, as data in Gleeson *et al*. (1993) and Hansen and Simmons (1995; 1997) were broken down by style rather than fibre diameter.

Results for each of the four models are presented in Tables 2 and 3. Overall, the signs and magnitudes of each coefficient are consistent with previous studies (for example, Angel et al. 1990; Beare and Meshios 1990; Gleeson et al. 1993; Simmons and Hansen 1995; 1997). Most variables are significant, mostly at the 1 per cent level. Those with the most influence on clean price include fibre diameter, strength, style and vegetable matter base. High premiums were associated with Australian superfine and choice wool, while specific vegetable matter type and certain fleece contaminations resulted in severe discounts.

5.2 Objectively measured characteristics

5.2.1 Fibre diameter, length and strength

Fibre diameter is significant across all four wool categories and its effect on price is strongest for superfine wool. This is consistent with prior expectations, as demand response for finer wool will increase with expected processing efficiency and superior quality for end use products. The price of fine wool is considerably less responsive to changes in fibre diameter than superfine wool, and this is consistent with industry knowledge (AWI 2010). In the medium micron range synthetic fibres may be progressively substituted for woollen fibres, meaning that statistical significance of micron is lowest in this model. In the broad category increases in fibre diameter can be excessive and have a large affect on end use of the yarn. As fibre diameter approaches the upper limit of the broad category unit increases in micron reduce price by 22 per cent.

Staple length, although significant at the 1 per cent level, has limited economic impact on clean price in the superfine, fine and broad models[6]. This can be explained intuitively as modern wool processing technology allows for variance in the lengths of fibres (Bruckback 2009), while medium wool is often blended with synthetic yarn in the production of cheaper

[6] Length is insignificant in the medium model.

Table 2 Results for superfine and fine models

	Superfine			Fine		
Variable	Parameter Estimate	t-ratio	p > t	Parameter Estimate	t-ratio	p > t
Intercept	25.3192	216.27	0.00	7.5130	94.68	0.00
Number of sales	0.0000	29.89	0.00	0.0000	13.39	0.00
Measured Attributes						
Micron	-1.9991	-260.00	0.00	-0.05	-40.37	0.00
Length	-0.0016	-3.98	0.00	0.0026	9.00	0.00
Strength	0.0711	126.30	0.00	0.0301	66.31	0.00
Micron*Micron	0.0248	257.30	0.00	(omitted)		
Micron*Strength	-0.0044	-141.35	0.00	-0.0014	-60.58	0.00
Micron*Length	0.0000	1.40	0.16	-0.0002	-12.46	0.00
Strength*Strength	0.0000	32.32	0.00	-0.0001	-65.95	0.00
Strength*Length	0.0000	30.20	0.00	0.0001	54.52	0.00
Length*Length	0.0000	-0.53	0.59	0.0000	-10.53	0.00
POB	0.0000	-43.58	0.00	-0.0003	-49.17	0.00
Year of Sale (relative to 2004)						
2005	1.2022	35.89	0.00	-0.0116	-0.71	0.48
2006	-1.5605	-79.80	0.00	-2.2763	-219.70	0.00
2007	0.3913	22.10	0.00	0.3274	35.26	0.00
2008	-0.6086	-47.64	0.00	-0.9627	-149.92	0.00
2009	-0.3663	-20.26	0.00	-0.5536	-59.45	0.00
National Wool Declaration	0.0271	11.38	0.00	-0.0045	-3.03	0.00
Sale Location (relative to Melbourne)						
Newcastle	0.0030	3.16	0.00	0.0137	24.98	0.00
Sydney	0.0125	22.42	0.00	0.0021	7.32	0.00
Freemantle	0.0060	6.19	0.00	-0.0028	-8.40	0.00
Launceston	-0.0445	-25.23	0.00	0.0002	0.16	0.87
Classing Method (relative to "classed grower lot")						
Other grower lot	-0.0055	-1.89	0.06	-0.0203	-17.43	0.00
Classed bulk lot	-0.0266	-10.02	0.00	-0.0343	-36.40	0.00
Other bulk lot	-0.0449	-23.72	0.00	-0.0392	-54.37	0.00
Interlotted	-0.0421	-12.81	0.00	-0.0405	-37.68	0.00
Matched lots	-0.0511	-9.88	0.00	-0.0428	-22.20	0.00
Breed Group (relative to Merino)						
Australian superfine	0.1386	118.15	0.00	0.1156	17.26	0.00
Wool Category (relative to fleece)						
Pieces	-0.0125	-0.57	0.57	0.1399	1.98	0.05
Bellies	(omitted)			0.3484	2.21	0.03
Style (relative to best)						
Choice	0.6338	86.61	0.00	0.0013	0.02	0.99
Best spinners	0.2975	70.85	0.00	0.2711	8.58	0.00
Spinners	0.0432	37.14	0.00	0.0105	7.50	0.00
Good	-0.0082	-15.96	0.00	0.0026	8.55	0.00
Average	-0.0323	-23.33	0.00	-0.0159	-30.57	0.00
Inferior	-0.1066	-21.22	0.00	-0.0748	-41.32	0.00
Colour (relative to good)						
Unscourable L	-0.0319	-34.82	0.00	-0.0142	-37.44	0.00
Unscourable M	-0.0663	-14.60	0.00	-0.0490	-31.42	0
Unscourable H	-0.1935	-3.44	0.00	-0.1107	-7.19	0.00

	Superfine			Fine		
Variable	Parameter Estimate	t-ratio	p > t	Parameter Estimate	t-ratio	p > t
Age (relative to adult)						
Weener	-0.0296	-50.79	0.00	-0.0050	-9.55	0.00
Fleece Prep Type (relative to fleece)						
Pieces	-0.0973	-4.44	0.00	-0.2296	-3.25	0.00
Vegetable Matter Contamination*						
VMB	-0.0248	-72.42	0.00	-0.0205	-129.51	0.00
VMB*burr	-0.0044	-10.62	0.00	-0.0041	-24.56	0.00
VMB*seed	-0.0065	-12.02	0.00	-0.0047	-17.73	0.00
VMB*shive	-0.0056	-15.16	0.00	-0.0052	-29.80	0.00
VMB* noogoora	-0.0064	-4.00	0.00	-0.0071	-17.91	0.00
VMB*boganflea	-0.0010	-0.82	0.41	-0.0028	-9.07	0.00
Fleece Contamination						
Black pigment	(omitted)			-0.1016	-3.22	0.00
Branding L	-0.0177	-2.73	0.01	-0.0091	-4.56	0.00
Branding M	-0.1319	-11.18	0.00	-0.1061	-27.04	0.00
Branding H	-0.1451	-9.71	0.00	-0.1129	-22.34	0.00
Dags L	(omitted)			-0.0599	-3.18	0.00
Darkstain	-0.1323	-17.51	0.00	-0.0940	-32.55	0.00
Dermatitis L	(omitted)			-0.0312	-10.74	0.00
Dermatitis M	(omitted)			-0.0438	-6.76	0.00
Dermatitis H	(omitted)			-0.0650	-3.05	0.00
Jowls L	(omitted)			-0.0703	-1.72	0.09
Kemp L	(omitted)			-0.0855	-6.18	0.00
Kemp M	(omitted)			-0.2655	-10.62	0.00
Mud L	(omitted)			-0.01	-1.21	0.227
Mud M	(omitted)			-0.1344	-11.08	0.00
Mud H	(omitted)			-0.2113	-5.98	0.00
Shanks L	(omitted)			-0.0901	-10.75	0.00
Skin pieces L	-0.0167	-1.38	0.17	-0.0219	-3.93	0.00
Skin pieces M	-0.3047	-13.65	0.00	-0.2247	-30.86	0.00
Skin Pieces H	-0.3120	-16.37	0.00	-0.2986	-51.81	0.00
Soft cott L	0.0294	0.62	0.54	(omitted)		
Soft cott M	-0.3526	-2.80	0.01	(omitted)		
Sweat/Frib	(omitted)			-0.0025	-1.40	0.16
Waterstain L	-0.0758	-3.07	0.00	-0.0143	-4.37	0.00
Waterstain M	(omitted)			-0.0634	-7.72	0.00
Waterstain H	(omitted)			-0.0408	-1.63	0.10
Macroeconomic Variables						
05*LagExRateUS	-1.6235	-36.27	0.00	-0.0428	-1.95	0.05
06*LagExRateUS	2.2540	89.81	0.00	3.1385	237.26	0.00
07*LagExRateUS	-0.1160	-6.01	0.00	-0.0575	-5.69	0.00
08*LagExRateUS	0.9835	64.59	0.00	1.3425	175.83	0.00
09*LagExRateUS	0.5517	26.63	0.00	0.8185	76.94	
LagExRate Euro	-0.2258	-10.65	0.00	-0.1364	-12.92	0.00
LagGDP US	-0.0152	-31.66	0.00	0.0043	18.03	0.00
Lag WP Cotton	0.0021	67.87	0.00	0.0021	146.90	0.00
Lag WP Oil	-0.0008	-17.03	0.00	-0.0037	-156.00	0.00

* Scale measure: L = light M = medium H = heavey

knitwear (Wilcox and Curtis 2009). For these reasons, length has become less important in the purchase decision.

Strength of the yarn has a significant positive relationship with clean price in each micron category. Premiums were attracted for increases in strength for all wool types, although the coefficient for the superfine model was substantially higher, and each unit increase in strength results in a 7 per cent increase in clean price. As expected, the magnitude of this effect declines as fibre diameter increases through to the broad micron category.

5.2.2 Quadratic and interaction terms

The high statistical significance of a positive squared term for micron confirms a greater dependence of clean price on diameter for finer wool than for coarse wools within each group (Gleeson *et al*. 1993). Essentially, this quadratic term tells us about the shape of the price curve in relation to changes in micron. For superfine wool we see higher prices, with associated premiums increasing with each unit drop in micron. For lower styles of medium and broad wool, the micron/price curve becomes much flatter[7].

The squared term for strength is statistically significant for all four models, indicating that the change in clean price for a given change in strength is different at different levels of strength (Gleeson *et al*. 1993). For superfine, fine and broad wool categories, the positive coefficients indicate that the rate of price change increases for stronger wool. However, the negative coefficient for length squared tells us that as length increases, the rate of increase in price diminishes as wool fibre gets longer in superfine, fine and medium wools. For broad wool, this rate of change becomes positive.

The presence of statistically significant interaction terms for micron and strength indicates that the effect of changes in micron on price also depends on the level of strength. The negative coefficients for this term in the models for superfine, fine and medium wool indicate that the effect of strength on clean price is less important as wool gets coarser in each wool category. However, the effect of strength increases with increases in strength for broad wool. This may be because broad wool is used in the production of carpets and upholstery where processing demands a high degree of fibre strength (Teasdale 2006).

[7] The squared term for micron in the fine model was omitted due to a correlation coefficient of 0.999 with micron.

5.3 Qualitative Characteristics

5.3.1 Vegetable matter base (VMB) and Type

Both the amount and type of vegetable matter affect processing, and are highly influential in the purchase decision. The coefficients for total vegetable matter base (VMB) are all negative and indicate that a 1 per cent increase in vegetable matter content leads to a price decrease of between 3 per cent (for the superfine model) and 2 per cent (for the medium model). Generally, increases in total vegetable matter contamination raise both cost and level of processing required, thus for a given level of vegetable matter, discounts vary depending on type of matter present.

Interaction terms for percentage of vegetable matter content and type of matter indicate that buyers are most concerned about the presence of seed and shive contaminants which attract discounts of around 0.5 to 0.6 per cent for both superfine and fine wools[8] . This is because seed and shive become closely entwined within the fibre and its removal results in a high degree of fibre breakage, and hence a significant reduction in yield. If VMB contains greater than 3 per cent seed and shive matter, processors are reluctant to comb the yarn, as it is unable to be used in the worsted system (Teasdale 1999). Burrs result in a slightly smaller discount in all wool groups as they are more easily removed without excessive fibre damage. However, presence of noogoora burrs reduces wool value by 0.7 per cent in the broad model. These hard headed burrs are particularly avoided by buyers as their hard shell is unable to be crushed during carbonizing and causes severe damage to processing equipment (AWTA 1986).

Other contaminants such as bogan flea and moit have mixed effects on clean price across wool types. The presence of both is insignificant in the superfine model, but they have a small negative influence on clean price for medium wools. In the broad category the presence of moit results in a full 1 per cent discount in clean price. This may be because there was very little contamination in finer wools, while the percentage of bogan flea and moit in total vegetable matter base were higher for broader wools. Differences in seasonal conditions for key wool-growing areas will also play a role in determining the percentage of contamination present in each category.

[8] These effects are less important in both the medium and broad categories.

5.3.2 *Breed group, wool category and style*

Wool quality is primarily dependent on the breed of sheep. Finer micron wool from Australian superfine sheep attracts significant premiums of 14 per cent for superfine and 12 per cent for fine wool types (relative to merino). Lower quality wool from downs[9] and crossbred sheep in the broad wool model attracts discounts of 21 per cent and 8 per cent respectively. Crossbred sheep are likely to contain a high percentage of dark or medullated fibres which are unsuitable for dying in apparel end uses (AWTA 2001).

Wool prepared as fleece is considered superior in the superfine and fine models but is less influential in the other categories. Weaner fleece attracted a 3 per cent discount in the superfine group, as fleece from younger sheep is considered "tender" and often results in higher fibre breakage than adult fleece. For most wool types, bellies and pieces were insignificant in the purchase decision.

Higher styles of choice, best spinners and spinners attract premiums in the superfine and fine categories (relative to best), whilst good, average and inferior significantly detract from wool value. As we progress to broader wool categories, statistical significance of style decline. We suspect style is less important for products made from broader wool, such as carpet and upholstery (Teasdale 2006).

5.3.3 *Colour*

Whiter wools are associated with brighter colours after dying and are sought by spinners for their versatility in end use (Turk 1993). All grades of unscourable colour were significant in reducing clean price, with discounts increasing with severity of colour damage. In the broad category, heavy unscourable colour resulted in a 24 per cent discount. This is twice that of medium unscourable colour and twelve times higher than the discount for light colour damage. Similar effects were found across superfine, fine and medium wool types.

5.3.4 *Classing method*

Wool classed as "grower lots" received a significantly higher price than wool classed by other methods. All other classing methods vary in their compliance with the AWEX Code of Practice (AWTA 2008). In the broad model, "other grower lot" is not classed by a registered wool-classer, and hence attracts a 2 per cent price discount relative to "grower lot". "Bulk classed" and "interlotted" lots involve further deviation from compliance standards thus

[9] The "Downs" breed group is presumed to contain a mix of Dorset Downs and Hampshire downs. These breeds are predominantly bred as terminal sires for prime lamb production as average fibre fineness is around 26 micron for Dorset, or up to 30 micron for Hampshire (Breedersales 2009).

received discounts of around 4 per cent. “Matched” lots suffer the greatest discount of 6 per cent.

5.3.5 Fleece contamination

The presence of various types of fleece contamination has been found to significantly reduce the price received per lot of wool. Increases in contamination severity increase the associated discounts, although this effect declines as fibre diameter increases (for example, the penalty for black pigment in fine wool is five times greater than that in broad wool). Little contamination was found in superfine wool compared to fine, medium and broad wool types. We presume this is largely attributable to strict conditions required for the production of superior quality fleece.

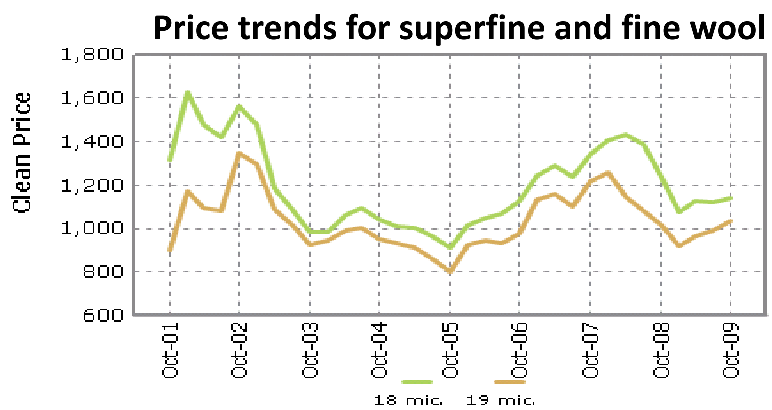
The magnitude of discounts associated with most contaminants varies with wool categories and desired end use. Branding contamination and dark stains result in severe discounts across all wool types, as they are difficult to remove during processing and will limit possible end use. The presence of skin pieces removed inadvertently during shearing also results in across the board discounts. Heavy levels of mud reduce wool value by 21 per cent for fine wool, though the effect is lower for medium and broad wool types. In medium wool there is a greater incidence of dermatitis, shanks and cotting. Each of these contaminants significantly reduces clean price for medium wool, possibly as there is a higher percentage of crossbred sheep which may be more susceptible to these types of contamination. In the broad model, most contaminants have a smaller economic effect on price. The exception is for shanks where there is a severe price discount.

5.4 Selling centre location

Regional variation had a significant influence on price attained at auction. Premiums are associated with sales in Sydney and Newcastle (relative to Melbourne) for superfine and fine wools. This may be attributed to the close proximity of these centres to finer wool-growing regions of the Northern and Central Tablelands of New South Wales (Ryan 2006). Medium and Broad wools sold in Sydney also received a slightly higher price than if sold in Melbourne. Fine wool sold in Sydney had little economic effect, though our results suggest a positive influence on price. Most wool types sold in Freemantle received lower prices than if they were sold in Melbourne. We suggest it may be a combination of low buyer expectations of Western Australian wool and Freemantle’s remote location that has placed downward pressure on prices.

5.5 Sale year

Results for sale year depict volatility in clean price for all wool types over the sample period, although variation is most pronounced in the fine wool category. This is consistent with trends reported by Australian Wool Innovation (AWI) for 2004 to 2009, as shown in Figures 1 and 2 below (AWI 2010). In the 2005/06 selling season wool experienced its most recent low. 2007/08 saw a recovery in wool prices across all wool types with clean price peaking in early to mid 2007. Since then prices have drastically fallen across all wool types, the most significant declines felt by fine to medium wool. This is supported by our results with strong negative effects and high statistical significant of the 2008 and 2009 year variables for fine and medium wool groups. At the end of 2009 there has been a slight recovery in prices for superfine, fine and medium wool. Broad wool has suffered the least variation with prices and was higher at the end 2009 than in 2004.



Source: AWI

Figure 1 Price trends for superfine and fine wool

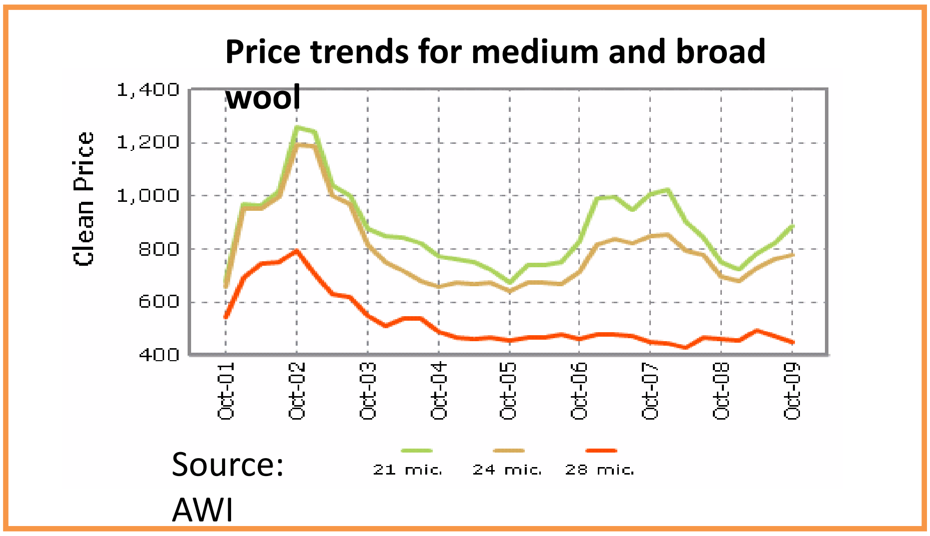


Figure 2 Price trends for medium and broad wool

5.6 Mulesing Status and the National Wool Declaration

No price benefits appear to have accrued from declaring wool from non mulesed sheep (Gunning-Trant 2009), although this is difficult to establish through our analysis as the declaration was only introduced in the 2008 selling season. It should also be noted that most wool sold in the 2009 season was sold to Chinese processors who are less likely to consider the mulesing status in their purchase.

5.7 Macroeconomic Variables

The macroeconomic variables reflect significant influences on the competitiveness of Australian wool in the global market. These results are consistent across all wool types, indicating an important relationship exists between clean price of wool and most of the included variables (US exchange rate, GDP and world price of cotton and oil).

Appreciation of the Australian dollar against the $US and the Euro significantly influences the competitiveness of Australian wool in all models, though effects on price is different for each currency. As seen in Figure 3 below, the $A/$US exchange rate is quite variable, while the $A/Euro is relatively stable across the sample period. We have interacted the $A/$US with year to provide a clear analysis across the sample period. With the $A/Euro exchange rate, we have found a consistent negative influence over clean price for superfine, fine and medium wools. This is intuitive, as an appreciation of the Australian dollar against the euro will reduce demand for Australian wool as it is more expensive for wool buyers in Europe, and hence the price of Australian wool will fall.

Increases in global growth have a positive relationship with the price of Australian wool in the fine and medium models, though the economic effect is only slight at 0.4 per cent. Increases in global growth lead to increased consumer demand for luxury goods made from wool. Because wool supply is considered fixed in the short run, increased demand will force the price of wool upwards.

Our results for prices of substitute fibres are mixed. For all wool types, an increase in the price of cotton will shift consumer demand towards wool as it becomes relatively cheaper. As wool supply is fixed in the short we see an increase in the price of wool. World price of cotton is statistically less significant in the purchase decision for superfine wool than for fine and medium grades, indicating that substitution between fibres increases with increased fibre diameter. Our results for world price of oil (used in the manufacture of synthetic fibres) show a positive relation with clean price of wool. Though this does not conform to prior expectations it is possible that synthetic fibres are now a complement for wool. Given the recent decline in the global economy, consumers are purchasing cheaper alternatives to pure woollen garments, such as knitwear which is often blended with synthetic fibres.

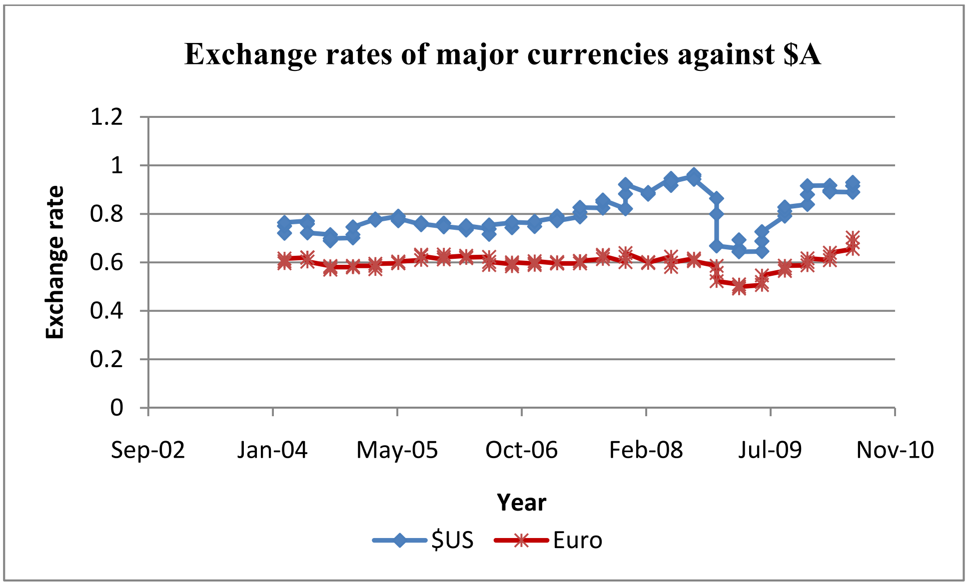


Figure 3 Exchange rates of major currencies against $A

6. Summary and Conclusions

The last two decades have seen significant changes in composition and economic importance of Australia's sheep flock. We have developed a hedonic pricing model to estimate the value of individual lot characteristics and adapted our approach to accommodate each specific wool type (superfine, fine, medium and broad). Utilising a data sample over a number of selling seasons, whilst also controlling for key market conditions at the time of sale, has allowed us to examine the longer term trend in global demand for Australian wool. Analysis of various factors influencing clean price and their relative change in importance will reduce asymmetry of information in the marketplace, and will allow woolgrowers to take advantage of premiums associated with various attributes and avoid discounts associated with undesirable characteristics.

Our results are consistent with recent price trends for the period 2004 to 2010 for all wool types. Since the most recent decline in 2008, wool prices have begun to recover in early 2009. Changes in national flock composition in favour of prime lambs are likely to lead to a shortage of supply for fine wool. Emerging consumer demand for new products made from finer quality wool may have prompted renewed demand for superfine wool. To improve the competitiveness of wool in these new markets industry research and innovation should be directed towards finding a cost-effective method of measuring "fabric feel" for next to skin comfort (York 2010).To improve profit margins woolgrowers should focus on producing Australian superfine and Merino sheep breeds and promote wool which has been "grower classed".

Woolgrowers also need to be aware of the penalties associated with fleece and vegetable matter contamination, as we have found discounts accrue for severely damaged fleece. Of the vegetable matter types, seed and shive resulted in the largest penalties closely followed by the presence of burrs. Farmers need to upgrade pest management approach, better manage flock rotations and time shearing at the end of winter to reduce the incidence of vegetable matter contamination. Emphasis should be placed on reducing branding, dark stains and heavy unscourable colour as these fleece contaminants attract considerable discounts. More care should also be taken during shearing to reduce the presence of skin pieces. To lessen the incidence of dark and medullated fibre damage farmers need to ensure merino flocks are kept separate form crossbred sheep and prevent joining with terminal sires.

Our research indicates that penalties apply for most fleece and vegetable matter contamination and tender or weak yarn. We have also shown that demand for wool is influenced by macroeconomic conditions, with increases in global growth, the $A/$US exchange rate and world price of substitutes all significantly affecting the competitiveness of Australian wool in the global market. Though we are able to inform woolgrowers of key influences over clean price, this study has considered only the demand side. Our suggestions for changing industry focus and management practices can only be justified after careful consideration of input and production and other such supply side costs.

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Appendix I

The relationship between an input such as raw wool, and its inherent characteristics can be seen in Ladd and Martin (1976, p. 22-23). Closely following Ryan (2006), we apply the derivation to wool. Total value (*Y*) of each wool lot sold (w_i) can be attributed to the sum of its inherent characteristics (x_i):

$$\mathbf{Y_w = \mathit{f}_w (x_{1.w}, x_{2.w}, \dots , x_{n.w})} \qquad \textbf{(1)}$$

Mathematically, Equation (1) shows that the value of woollen output (w_i) is a function of the amount of fleece and fibre characteristics (x_i) each lot contains. Total quantity of each characteristic can be expressed as a function of both quantity of raw wool and characteristic input-output coefficient, such that x_{jw} can be written as:

$$\mathbf{X_{jw} = X_{jw} (v_{1w}, v_{2w}, \dots , v_{nw}, x_{j1w}, x_{j2w}, \dots , x_{jnw})} \qquad \textbf{(2)}$$

In Equation (2): v_{iw} represents the quantity of the *i*th input used to produce the *h*th woollen product, x_{ij} is the total quantity of characteristic *j* that enters the production of woollen product *w*. Equation (2) can be re-written as Equation (3), from which we are able to produce the profit function in Equation (4).

$$\mathbf{Y_w = G_w (v_{1w}, v_{2w}, \dots , v_{nw}, x_{j1w}, x_{j2w}, \dots , x_{jnw})} \qquad \textbf{(3)}$$

$$\mathbf{\prod_{w=1}^{W} = \sum Pw.fw\ (x1.w, x2.w, \dots, xnw) - \sum_{w=1}^{w} \sum_{i=l}^{n} Ri\ viw} \qquad \textbf{(4)}$$

In the profit function (Equation 4), P_w and R_i describes the price received for the wth woollen product, and price paid for the *i*th input, respectively. Buyers of raw wool (wool processors) are assumed to maximise profit (π). By differentiating Equation (4) and solving for R_i yields Equation (5):

$$\mathbf{R_i = P_w \sum_j (\delta / \mathit{f}_w / \delta x_{j.w}) . (\delta x_{j.w} / \delta v_{iw})} \qquad \textbf{(5)}$$

From Equation (5), the price paid for the *i*th characteristic used in the production of *w* can be interpreted as the imputed price paid for the *n*th characteristic:

$$\mathbf{P_w \mathit{f}_w / \delta x_{j.w}} \qquad \textbf{(6)}$$

Appendix II

Table 1: Definition of Variables Used in Wool Hedonic Pricing Model

Variable	Description	Unit of Measure	Expected Sign

Dependent Variable			
Log of Clean Price	Clean price = greasy price x yield	c/kg	n/a
Objectively Measured Characteristics			
Fibre diameter (micron)	Diameter is considered the most important characteristic in processing (Gleeson *et al*. 1993). Fine wools are used in apparel, while broader fibres are used in carpets and other furnishing. Eveness of yarn is also influenced by micron (Cottle 2000, p. 320). Price received per lot of wool is expected to decline as diameter increases.	μm	-
Length	Length influences surface texture of the yarn, which determines the type of processing system required (Carding wool < 50mm, Combing wool >50mm). Length is expected to have a positive influence on the price of wool up until a point. Extremely long yarn is considered weak and will have a lower value.	mm	+ then -
Strength	Strength is important for early stage processing, as weakness results in fibre breakage, rendering the fibre useless.	Newtons per kilotex (Nkt)	+
POB (midpoint)	Point of Breakage is reported as the percentage of staple that breaks in the tip, middle or base third of the fibre. Midpoint breakage is of most concern as this will cut the fibre in half.	per cent	-
VMB	Vegetable matter base is the total percentage of dry vegetable matter present in the sample. VMC should negatively affect clean price as removal will require increased processing.	per cent	-
Qualitative Characteristics			
Breed group	Australian Merino wool is considered one of the world's best woollen fibres (Wilcox and Curtis 2009). Of Merino wool the top 15 per cent are considered a premium breed "Australian Superfine". Both Australian Superfine and Merino wool are expected to attract premiums, relative to crossbred, downs and carpet breeds which produce broader, coarser wool. These exotic breeds are also expected to contain a higher percentage of dark and medullated fibre, further reducing price.	Binary (Relative to Merino)	+ AS -X -D -C
Wool category	Fleece is the most desired wool category and is expected to attract a premium for quality compared to shorter fibres from bellies, crutchings and locks. Crutchings (from the breech of the sheep) is likely to contain a higher level of contamination thus attract a discount.	Binary (Relative to Fleece)	-B -C -L
VM Type	Vegetable matter is one of the most commonly encountered contaminants in wool (AWTA 1986). Both level and type of matter present will significantly affect clean price. Seed and shive contaminants often result in fibre breakage which significantly reduce yield, which in turn reduces clean price. Hard head burrs such as noogoora burrs are particularly troublesome to detangle during processing. Bogan flea is a small flea shaped seed which, once caught in the sheep's wool,	Binary 1 if present 0 if not	-Burr -Seed -Shive -Noogo -Moit -BoganF

	breaks apart causing a dense matting of the wool (AWTA 1986, p. 31).		
Style	Style is ranked on a scale of 1 to 5. Choice, best spinners and spinners are expected to gain premiums relative to best, while good, average and inferior are expected to attract discounts.	Binary (Relative to best)	+Choice +BestSp +Spin -Good -Average -Inferior
Colour	Colour is ranked on a scale of 1 to 4. Light, medium and heavy unscourable colour is expected to attract discounts relative to good colour.	Binary (Relative to good)	- L -M -H
Classing method	Wool classed as grower lot (P) originates from a single farm, is certified by an AWEX registered classer and meets all requirements under the AWEX code of practice (AWTA 2008). Other grower lot (D) is the same as (P) but not certified by a registered classer. Bulk classed lots (Q) and (B) come from multiple farms, (B) may not meet the Code of Practice. Class (I) and (M) represent interlotted and objectively matched lots, respectively (AWTA 2008).	Binary (Relative to P)	-D -Q -B -I -M
Fleece Contamination	All fleece contaminants are expected to attract discounts, although certain contaminants may detract more from clean price. These include: water and dark stains, dags, cotting (both soft and medium), shanks, dermatitis, skin pieces, branding fluid, mud and black or medullated fibres.	Binary 1 if present 0 if not	- for all
Mulesing Status	Mulesing status is only available from mid 2008 onwards. Mulesed, ceased mulesing, not mulesed and mulsed with pain relief will be compare to a base of not declared. Not mulsed and ceased mulesing are expected to attract premiums, closely followed by mulsed with pain relief, while mulsed is expected to detract from price.	Binary (Relative to not declared)	+Not +PainRel +Ceased -Mulsed
NWD	Introduced on 21st July 2008, the National Wool Declaration requires woolgrowers to declare mulesing status (as above). It also requires farmers to state whether their flock has been contaminated by exotic breeds, increasing risk of dark and medullated fibre. This could have either a positive or negative effect on price depending on what is declared.	Binary 1 post 21st Jul 2008 0 if earlier	+or-
Geographic Variables			
Location of sale	Sales are carried out in 5 locations; Newcastle, Sydney, Melbourne, Launceston and Freemantle, with Melbourne holding a slight majority. It is expected that prices might be slightly higher in the larger capital cities than in regional locations. Quality of production may also differ given the diversity in climate and seasons across the country.	Binary (Relative to Melbourne)	+S -L -F -NC

Quarter of sale	The year has been split into quarters, using the fourth quarter (end of the selling season) as a base. This allows us to account for seasonal variation in price.	Binary (Relative to Q4)	+or-
Date of sale	Date of sale enables us to match global market conditions to sales and account for price variation through time.	Binary (Relative to 2004)	+or-
No. of sales in auction	More sales in a day means a larger supply, thus clean price should go down.	Number	-
Macroeconomic Variables			
Ex Rates $A/$US $A/Euro	We expect exchange rates will influence the competitiveness of Australian wool in the global market. We hypothesise an appreciation of the Australian dollar in terms of $US to reduce demand for Australian wool, and hence reduce clean price.	$A/$US $A/Euro	- -
Real GDP US	Gross Domestic Product of the U.S. is used as an indicator for world growth. As growth increases, demand is likely to increase, although this will depend on preferred characteristics and specific end use.	Index 2000=100	+
World Price of Cotton	An increase in the price of cotton (a substitute fibre for wool) will imply a shift in consumer demand towards wool, thus will result an increase in the price of wool as supply is fixed in the short run.	c/kg	+
World Price of Oil	Oil is a key input into the production of synthetic fibres, thus an increase in the cost of producing a substitute fibre will have a positive effect on clean price.	$/barrel	+
World Price of Synthetics	Synthetics (such as nylone or polyester) are considered a rival to woollen fibre, thus an increase in the price of synthetics is likely to increase demand for wool and like cotton, increase the price of wool.	PPI	+