Wool Futures and Type Premium ɔr Discount Risk

C. J. Cunningham

Wool International

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Address for correspondence:

C. J. Cunningham, Wool International, GPO Box 4867, Melbourne, Victoria 3001, Australia

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Chris Cunningham
Wool International

ABSTRACT

Since the removal of the Reserve Price Scheme in 1991, interest has risen in price risk management using wool futures. The ability to shift price risk is affected by price relationships between different wool 'types' in the spot market, particularly the change in type premiums and discounts over time. The incentive to hedge will only exist if type premiums and discounts remain predictable and stable over time regardless of whether prices rise or fall.

A problem facing hedgers using the current 22 micron wool futures contract is that premiums or discounts between the 22 micron indicator and the price of a particular wool type may not be predictable or stable. Cointegration analysis has been used to show that changes in type premiums and discounts relative to the 22 micron indicator are asymmetrical. That is they depend on the direction in which the value of the 22 micron indicator moves over time. The asymmetry of type premiums and discounts generates type premium and discount risk and necessitates the use of ratio hedging when attempting to achieve more certain hedge outcomes.

Key Words: Wool futures
Price risk
Cointegration
Type premiums and discounts

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Introduction

A commodity futures market which functions properly improves the process of price discovery, facilitates the management of inventories through time, enables some of the business risk associated with price volatility to be shifted, and provides benefits throughout the marketing chain. Since 1960, there has been a wool futures market in Australia conducted by the Sydney Futures Exchange. Despite some short bursts of activity the wool futures market has mostly been little used. The existence of the Australian Wool Corporation and the operation of the Reserve Price Scheme (RPS) between the early 1970s and mid-1991 did not provide the conditions conducive to the development of a robust market in wool futures.[i] Overall, in the past, the volume of trade on the wool futures market in Australia has been too small for futures to be an attractive risk-shifting option for most woolgrowers, processors and speculators. An active wool futures market will only develop and operate successfully if price fluctuations in the wool market make hedging desirable, if it provides opportunities for speculators to profit, and if the specifications of the contract make risk-shifting possible.

The paper is organised as follows. First, the importance is discussed for the effective hedging of Australian wool of the price relationship between the indicator of the micron category used in the futures contract and that of other micron categories. Second, preliminary estimates of the relationships which existed between the prices of different micron categories of wool over the period 1991-1993 are determined using cointegration analysis. These estimated relationships which existed between the 22 micron indicator, on which the futures contract is based, and the other micron category indicators over this period are tested and found to produce asymmetry in type premiums and discounts. Finally, some conclusions are drawn about the implications of these price relationships and the possibility for ratio hedging strategies.

Hedging With Many Different Wool Types

Australian apparel wool is a very heterogeneous product. Prior to sale wool is graded into types according to characteristics such as fibre diameter, fibre length, fibre strength, vegetable matter content and colour. Fibre diameter is the most important determinant of price. Most wool produced is bought and sold at auction and prices can fluctuate markedly. The price risks may be shifted by trading in wool futures contracts which, over the period of this analysis, were specified in terms of a 22 micron (μ) indicator price comprising a weighted average of eleven, 22 micron wool types.[ii]

Hedging relies on the fundamental relationship between futures prices and cash prices in the underlying commodity market. That is the tendency that as contract maturity approaches the cash price of contract-specific wool and the futures price converge. When hedging contract-specific wool, convergence will occur by defininition, however, convergence to zero is less likely or may not occur when hedging non-contract-specific wool.

The optimal futures position for a risk-averse competitive producer depends on a number of interrelated variables, e.g. the nature of the price, basis and production risks (Lapan and Moschini 1994). In this paper, production risk is ignored. Basis risk occurs whether or not delivery is made on the futures contract. The settlement price on the futures contract is imperfectly correlated with the cash price at the time of sale, a sale which is made necessary because it is usually undesirable or infeasible for a producer to deliver the product in order to settle the futures contract.

An important reason for this infeasibility is that the specifications of the product grown by the producer and that specified in the futures contract are different. Letting f_t be the futures contract price at time t for delivery at time t+1, f_{t+1} be the settlement price at time t+1, and p_{t+1} be the cash price at time t+1 of the commodity satisfying the specification of the futures contract, then the basis at contract maturity is given by $(f_{t+1} - p_{t+1})$ and the unit profit from hedging is given by $(f_t - f_{t+1})$. At the time that the hedge is placed, the grower knows with certainty only f_t, the other two prices being imperfectly correlated random variables.

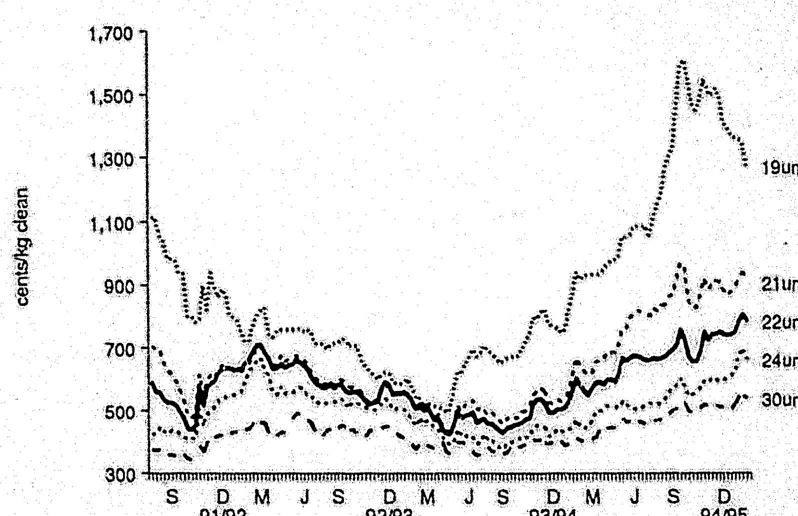
For growers producing wool other than those types which belong to the 22 micron category, there is an additional, potential source of risk, namely, the possibility of the imperfect correlation between the 22 micron indicator (p_{22}) and the cash price of other wool types (p_i). Therefore, the total price risk facing growers of category i wool comprises basis risk and what will be referred to in the remainder of the paper as type premium ($p_i > p_{22}$) or type discount ($p_i < p_{22}$) risk. Hence, the basis for wool category i at contract maturity (time $t+1$) can be partitioned as:

$$(f_{t+1} - p_{i,t+1}) = (f_{t+1} - p_{22,t+1}) + (p_{22,t+1} - p_{i,t+1}).$$

To hedge non-contract specific wool effectively using the 22 micron futures contract, the premium or discount between the 22 micron indicator and the cash price of the type of wool that they wish to hedge, i.e. $(p_{22,t+1} - p_{i,t+1})$, must be predictable and the relationship between them stable over the contract period. This relationship must remain predictable and stable regardless of whether prices rise or fall over the life of the contract if there is to exist an incentive to hedge, otherwise there is another source of risk for the grower to contend with. Ultimately, it is the combined movements in the type premium or discount and the basis over time which determines the outcome of the hedge.

The price of each type of wool is determined at auction, and the relationship between the 22 micron indicator and the price of another wool type may not necessarily remain stable over time. The demand and supply of different wool types vary during the year and, hence, type premiums or discounts are not likely to remain constant for the life of a hedge. Some recent empirical evidence (Figure 1) illustrates that the price differences between micron categories have not been constant: they have narrowed as prices have fallen and have widened as prices have risen. As the effectiveness of a hedge for a particular type of wool depends in part on the relationship between movements in the 22 micron indicator and movements in the price of that type, potential hedgers face risk associated with the movements in the price premium or discount of the relevant wool types. This risk is the chance that when a hedge is closed out and the wool is sold at auction, the relationship between the price of the hedged wool type and the 22 micron indicator required or anticipated to achieve an effective hedge, will differ from the type premium or discount realised in the spot market. If the actual outcome is different from that anticipated in an unpredictable way, then the effectiveness of hedging is diminished because the potential to lock-in a price by hedging is reduced.

Figure 1: Eastern Category Indicators 1991/92 to Feb 1995



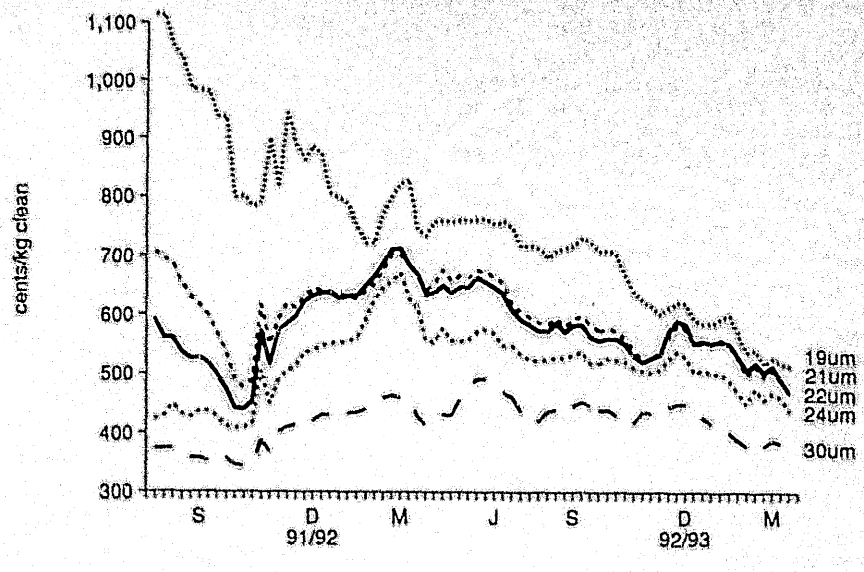
Hedging wool with futures contracts may involve replacing some price risk with some type premium or discount risk. When the relationship between the 22 micron indicator and the price of a wool type changes over the life of the contract, the overall cash position of the hedger is either better or worse than it would have been had the relationship remained stable. In the presence of the risk that the type relationship may change, the risk associated with wool returns is only reduced if an uncertain outcome (the future spot market price) is replaced by a more certain outcome (the hedged anticipated price). This happens only if the risk associated with the type premium or discount is less than the risk that the cash price of the wool type will change over the period of interest. If the characteristics of the type premiums and discounts in the wool market of the past could be modelled econometrically, and if information from the past about movements in type relationships were relevant to the post Reserve Price Scheme Australian wool market, such information could enhance the capacity for wool buyers and sellers to hedge effectively with wool futures.

The Relationship Between the Spot Prices of Wool

The ability to hedge successfully will depend in part on the price behaviour of particular wool types relative to that of the grade specified in the futures contract. The more strongly and positively correlated are the prices of the different types of wool, the more probable it is that conditions will exist for successful hedging. The aim of the analysis is to determine whether the relationships between the category of wool specified in the SFE futures contract, i.e. the 22µ category and each of the other micron categories were predictable and stable during the sample period. This was done by testing whether long-run, equilibrium relationships existed between the 22 µ indicator and the other category indicators using cointegration analysis.

The sample period was August 1991 to April 1993. The data were the end week indicators for the 19 to 30 micron categories.[iii] The data, for a subset of the micron categories, are shown in Figure 2. The indicators of the different categories tended to move in a similar way, although there is some evidence that the indicator for the 19µ category of wool followed a different pattern during the early part of the sample period.

Figure 2: Category Indicators August 1991 to April 1993



There are essentially three steps required to test the hypothesis that the price indicator of any category of wool followed a long-run, equilibrium relationship with the 22μ indicator, i.e. a cointegration relationship. In the first step, the order of integration of each of the indicator series has to be determined, as series which are not of the same order of integration cannot be cointegrated. In the second step, and assuming that the indicator of the category of wool of interest and the indicator of 22μ wool are integrated of order one, then an ordinary least squares (OLS) regression can be estimated using the indicator for 22μ wool as the independent variable and the indicator of the category of interest as the dependent variable. In the third step, it has to be shown that the residuals from this regression are integrated of order zero for the cointegration regression to be valid, i.e. that the two indicator series form a long-run, equilibrium relationship. If it is concluded that the indicator for a particular category of wool and the indicator of 22μ wool were cointegrated, then this would mean that the market conditions were more conducive to successful hedging of that category of wool than would have been the case in the absence of such a relationship.

Preliminary Results

The Dickey-Fuller test was used to identify the order of integration of each indicator series and the results are given in Table 1. It is concluded that all the indicator series, with the exception of those for categories 19μ and 20μ, were $\sim I(1)$ and, therefore, that each could form a cointegration relationship with the 22μ indicator series.

Table 1 The Dickey-Fuller Stationarity Tests for the Sample Period

$\Delta p_{i,t}$	$\beta p_{i,t-1}$	β / s_β	Integration of $p_{i,t}$
19	-0.012404	-2.33	I(0)
20	-0.009909	-1.99	I(0)
21	-0.006520	-1.41	I(1)
22	-0.004038	-0.88	I(1)
23	-0.002252	-0.49	I(1)
24	-0.001200	-0.27	I(1)
25	-0.000899	-0.23	I(1)
26	-0.000631	-0.17	I(1)
27	-0.000333	-0.09	I(1)
28	-0.000184	-0.05	I(1)
29	-0.000291	-0.08	I(1)
30	-0.000489	-0.14	I(1)

$\Delta\Delta p_{i,t}$	$\beta \Delta p_{i,t-1}$	β / s_β	Integration of $\Delta p_{i,t}$
19	-	-	-
20	-	-	-
21	-1.0204	-8.76	I(0)
22	-1.0400	-9.02	I(0)
23	-1.1309	-9.79	I(0)
24	-1.0819	-9.30	I(0)
25	-0.8936	-7.69	I(0)
26	-1.0195	-8.72	I(0)
27	-0.9102	-7.87	I(0)
28	-0.8645	-7.48	I(0)
29	-0.8060	-6.96	I(0)
30	-0.9591	-8.00	I(0)

Note: The critical value for Dickey-Fuller "t-ratio" at (5%, n=50) is -1.95, and at (1%, n=50) is -2.62 (Fuller 1976).

The cointegration regression for the i^{th} category of wool with the 22µ category may be estimated by OLS for the equation:

$$p_{i,t} = \alpha_0 + \alpha_1 p_{22,t} + u_t, \tag{1}$$

where $p_{i,t}$ and $p_{22,t}$ are each $\sim I(1)$ series, $i = 21, 23, 24, \ldots, 30$. The results from these regressions are given in Table 2. From the t-statistics, it is concluded that there is a positive and significant relationship between each indicator series and the indicator for 22µ wool. In all equations the null hypothesis that $\alpha_1 = 0$ is rejected. However, for these equations to be meaningful and to be cointegration relationships, the residuals must be $\sim I(0)$.

Table 2 **Estimated Cointegration Equations for the Sample Period**

Pi,t	α_0	$\alpha_1 p_{22,t}$	R^2
19	-	-	-
20	-	-	-
21	91.69 (2.84)	0.890 (15.59)[a] (-1.84)[b]	.76
23	-5.20 (0.29)	0.948 (29.75) (-1.63)	.92
24	20.55 (0.84)	0.866 (19.91) (-3.09)	.84
25	26.65 (1.06)	0.824 (18.52) (-3.96)	.82
26	69.12 (2.96)	0.722 (17.47) (-6.74)	.80
27	104.77 (4.25)	0.636 (14.59) (-8.37)	.74
28	108.59 (4.14)	0.619 (13.33) (-8.22)	.70
29	130.26 (4.86)	0.550 (11.61) (-9.49)	.64
30	175.13 (7.27)	0.435 (10.21) (-13.3)	.58

Note: a - The t-statistic under the null hypothesis that $\alpha_1 = 0$

b - The t-statistic under the null hypothesis that $\alpha_1 = 1$

The Dickey-Fuller test was used to determine the order of integration of the residuals from each regression. The results are given in Table 3.

Table 3 Dickey-Fuller Tests for Cointegration

$\Delta u_{i,t}$	$\beta u_{i,t-1}$	β / s_{β}	Order of integration of $u_{i,t}$
19	-	-	-
20	-	-	-
21	-0.08776	-3.24	I(1)
23	-0.17019	-4.12	I(0)
24	-0.19072	-4.85	I(0)
25	-0.19284	-4.20	I(0)
26	-0.17232	-4.23	I(0)
27	-0.12879	-3.00	I(1)
28	-0.11559	-2.77	I(1)
29	-0.09501	-2.37	I(1)
30	-0.09370	-2.31	I(1)

Note: Critical Value for (5%, n=50) is -3.67, for (10%, n=50) is -3.28, from Engle and Yoo 1987.

It is concluded that the relationship between $p_{21,t}$ and $p_{22,t}$ was not a cointegration relationship at the 5% or 10% levels of significance. However, the power of this test is not high and it may be reasonable to reject H_0, as the probability value is just in excess of 0.1. For the remaining grades, a cointegration relationship appears to have existed for the grades 23µ to 26µ inclusive but not for grades 27µ to 30µ inclusive.

The implications of these results for the chances of having successfully hedged wool over the period August 1991 to April 1993 are mixed. Producers of the finest wool, 19µ and 20µ, and producers of the coarser wools, 27µ to 30µ inclusive, would not have been able to hedge successfully using a routine risk-spreading strategy because of the lack of any cointegration relationship between these categories of wool and the 22μ category. Greater volatility was observed in the indicator series for the finest wools than that observed in the 22μ indicator series and less volatility was observed in the indicator series for the coarser wools. On the other hand, producers of wool types which are closer in quality to the 22μ category, namely 21μ, and 23μ to 26μ inclusive, would have been in a better position to hedge because of the cointegration relationship which existed between each of these categories and the indicator for 22μ wool. The existence of these relationship implies reduced type premium or discount risk, when hedging some wool types within these categories because the relationships were stable and the type discounts predictable.

Type Premiums or Discounts and the Cointegration Equations

The long-run linear relationship which existed between the 22 micron indicator and each of the non-standard micron indicators during the post-RPS period, are given in Table 2. The coefficient, α_1, in each of these cointegration equations, represents the slope of the linear relationship between the 22μ indicator and the relevant micron indicator and represents the change in the micron indicator of wool category *i* per unit change in the 22μ indicator. For the type premium or discount to remain constant through the contract period, this slope parameter must be unity. From the results shown in Table 2, it is apparent in each regression that the null hypothesis, $\alpha_1 = 1$, is rejected at a level of significance of 0.05 for grades 24μ to 30μ inclusive and at a level of significance of 0.1 for all grades. In each regression, the alternative hypothesis that $\alpha_1 < 1$ would be accepted at the 0.1 level of significance.

The further from unity is α_1, the larger the anticipated change in the type premium or discount for a given change in the 22 micron indicator. According to these equations, the type discount will widen (narrow) for a given increase (decrease) in the 22 micron indicator. Hence, the characteristics of the type discounts were asymmetrical in that they depended on the direction in which the 22 micron indicator changed, with the degree to which changes in the type discounts occurred dependent on the size of α_1 in relation to unity. For example, the anticipated change in the type discounts would be larger for 26 micron wool than for 23 micron wool, because, from Table 2, α_1 is 0.722 for the former but 0.948 for the latter, implying a smaller correlation between 26μ and 22μ wool than between 23μ and 22μ wool.

Before accepting the asymmetry in the type discount, it is necessary to establish that the slopes of the cointegration relationships shown in Table 2 are the same for rising as for falling values of the 22 micron indicator, otherwise, the asymmetry may be spurious. An *F*-test was used to determine simultaneously whether the intercept and the slope of the relationship between changes in the 22 and 24 micron indicators were the same when price changes were positive as when they were negative. Three regression equations were estimated by OLS using the stationary series Δp_{22} as the explanatory variable and Δp_{24} as the dependent variable. The unrestricted model comprised two equations: one for those observations for which Δp_{22} was positive; and the second for those periods when Δp_{22} was negative. The restricted model imposed the equality of intercepts and the equality of slopes on both partitions of the data. These restrictions represented the null hypothesis. The resulting *F*-statistic was 0.62 while the critical value, $F^*_{(2,71)}$ was approximately 3.14. Therefore, the restrictions were acceptable, implying that the slope parameter was the same for price increases and price decreases and that there is an the asymmetry in the type discount.

Hedging with an Asymmetrical Type Discount

The size of the slope parameter in equation (1) relative to unity has implications for the design of hedging strategies. When short hedging 23, 24, 25 or 26 micron wool, the realisation of an expected hedge outcome depends not only on the behaviour of the basis and the asymmetrical type discount but also on the amount of wool being hedged with each contract.

Consider a short hedge in which contracts are sold such that the amount of wool represented by the contracts is equivalent to the amount of wool (23μ to 26μ) to be hedged. That is the ratio of the total amount of wool represented by the contracts to the amount of physical wool being hedged is 1:1. As the slope parameter α_1 for all these categories is other than unity (asymmetrical type discount), the outcome of such a hedge is uncertain and dependent on the direction in which prices move. This is because, if the 22 micron indicator falls and the type discount narrows, a more favourable outcome occurs than if the slope parameter was unity (constant type discount). That is the futures profit would more than offset the loss in the spot market. However, if the 22 micron indicator rises and the type discount widens, then a less favourable outcome would occur as the gain in the spot market would not cover the futures loss. In both situations, i.e. when the 22 micron indicator falls and when it rises, the non-constancy of the type discount increases the futures gain and loss relative to the change in value of the physical, respectively and reduces the certainty of the hedge outcome. For risk-averse producers, such outcomes are to be avoided and, hence, a different hedging strategy is suggested.

To hedge effectively, net losses (gains) in the futures market must be offset by net gains (losses) in physical wool. To improve hedge effectiveness and the certainty of outcome, a ratio hedging strategy which accounts for the asymmetry of type premiums and discounts is more appropriate. By altering the amount of wool being hedged by each contract, more effective and certain hedge outcomes may be achieved. The slope parameter α_1 of the cointegration relationship between the indicator of the type of wool being hedged and the 22 micron indicator, can be used to determine the amount of each micron category of wool which can be more effectively hedged per contract.

For example when hedging 23 to 36 micron wool, a more certain hedge outcome may be achieved by holding $(1/\alpha_1)$* 2,500 kilograms of wool for every open contract. That is the ratio of wool represented by each contract to the amount of physical wool being hedged should be $1 : (1/\alpha_1)$.

Assuming the change in the basis is zero, i.e $(f_t - p_{22,t}) = (f_{t+1} - p_{22,t+1})$, then if the cointegration relationship holds, regardless of whether prices rise or fall the net change in the futures position will be more closely offset by the net change in the value of the basket of physical wool.

Example of ratio hedging

Futures			Physical		
Mass of contract wool (kg)	Change in 22 micron indicator (cents/kg)	Net change in futures position (cents)	Amount of wool being hedged (kg)	Change in value of hedged wool (cents/kg)	Net change in value of physical wool (cents)
2,500	x	2,500x	$(1/\alpha_1)$*2,500	α_1*x	2,500x

In this example the change in the futures price and the 22 micron indicator during the life of the hedge was x cents/kg. Consistent with the existing cointegration relationship, the change in the value of the physical wool was α_1*x cents/kg. As the change in the price of the physical wool α_1*x was spread over $(1/\alpha_1)$*2,500 kg of wool, the change in the total value of the physical wool was 2,500x. This is offset by the opposite change in the futures position resulting in a certain hedge outcome regardless of whether prices rise or fall. In practise, the certainty of hedge outcomes will also be reduced by changes in the basis during the life of the hedge as cash and futures prices converge. Despite this, more certain outcomes may be achieved when hedging non-contract-specific wool by using ratio hedging strategies based on price relationships like those estimated in this paper.

Conclusions

The outcome of a hedge using the Sydney Futures Exchange 22 micron wool futures contract has been shown to depend in part on the characteristics of the type premium or discount during the life of the hedge.

It was established that type premiums and discounts are asymmetrical in that they depend on the direction in which the value of the 22 micron indicator changes.

Cointegration relationships existed between the 22 micron indicator and the 23 to 26 micron indicators during the period of this analysis. These relationships were stable and the type discounts predictable.

The existence of these relationships would have improved the potential to effectively hedge 23 to 26 micron wool using the 22 micron contract, while hedging of finer and coarser wool would not have been as successful.

The asymmetry of the anticipated type premiums and discounts generates type premium and discount risk and necessitates the use of ratio hedging when attempting to achieve more certain hedge outcomes.

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Endnotes

[i] However, even before the RPS, futures were not commonly used by woolgrowers. For instance, in an early study Phillips (1966) found that out of 560 woolgrowers surveyed, only 6 had used futures.

[ii] During the wool selling season, wool is sold at open auction at selling centres around the country. The general level of market prices for wool is indicated by a weighted average of the 165 representative wool types sold, calculated each sale day using national closing quotes for clean wool. To provide information about prices for wool of specific diameters, these types are grouped according to fibre diameter to produce thirteen micron combing indicators and two carding indicators, each made up of eleven types. For example, the 22 micron indicator is calculated using the values of eleven 22 micron wool types, seven of which are fleece wool, with the remaining being skirtings. The Sydney Wool Futures contract is cash settled and based on the weighted average price of the eleven wool types that make up the 22 micron indicator. A SFE wool futures contract is a legally binding agreement to buy or sell 2,500kg clean weight combing wool in the 22 micron category.

[iii] Results of the cointegration analysis for the pre-RPS period and for the RPS period are available.