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EXCHANGING PRICE INFORMATION CAN BE EFFICIENT:

per se offences should be legislated very sparingly

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Abstract:

In this paper we draw upon relevant theory of auctions to show that information exchange among firms that leads to an agreed schedule of prices may not be price fixing, and may enhance welfare. A case is described in which *per se* illegal communication among industry players that produced such agreements enhanced welfare. In the circumstances of the case communication substituted for information exchange that would have been provided by a forward market that was too costly to establish. The results are in accord with a growing body of literature that suggests that *per se* illegality under competition law should be used very sparingly.

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1. Introduction

In many countries price fixing is illegal *per se*. It is not necessary for a complainant to show that the conduct in question had an inefficient effect in order to establish a breach of competition law. However, recent literature suggests that co-ordinated acts, including price collusion, can improve welfare (see for example Fershtman and Pakes, 2000, and Groenewegen, 1994). These findings pose the question of whether rule of reason should not be confined to penalty in these cases, but perhaps extended to the co-ordinated acts themselves.

In this paper we suggest a particular, different reason why information exchange about prices may be efficient. Information exchange between competitors may act as a substitute for a missing (forward) market. Markets that provide forward contracts of various sorts are markets where actual and potential market participants implement actions based upon their information and views about the future. They thus reconcile and reveal information. We argue that, particularly where this information involves elements of common values, such forward markets will enhance efficiency. We also argue that in some circumstances – for example, where transactions costs are relatively high – forward markets may not form, even though their price discovery process advances efficiency and is in the private interests of participants. In such a case information exchange even among a subset of (potential) participants may be relatively economically efficient.

Our empirical work is based upon a particular case involving meatpacking companies in New Zealand. In this industry there is a great deal of uncertainty about the weekly supply of livestock at any given price and there is considerable uncertainty about the prices companies will receive for the processed product. On both sides we argue there are strong common value elements that are difficult to lay off and yet which affect the procurement price of livestock.

In April 1995, the New Zealand competition authority (the Commerce Commission) raided the offices of various meat companies and obtained evidence of “fixed” procurement prices and regular company meetings that produced these prices. The Commission initiated legal proceedings against twelve meat companies and some of their senior officers, alleging price fixing between October 1992 and April 1995. The litigation was eventually settled, with penalties totalling \$5.5 million being approved by the High Court in August 1998.¹

There were a number of intriguing characteristics of the case. First, there were 12 companies involved which is a very large number to sustain adherence to an agreement (Phlips ch. 2). The cost structure of these companies was very different, rendering co-ordinated actions very difficult to enforce (Tirole 2000, 242). Secondly, the fixed price was always the minimum procurement-transactions price: where the maximum might have been expected under price fixing that limited the amount companies paid for livestock. Thirdly, despite transactions prices always exceeding the agreed price, the companies’ livestock managers, and occasionally their chief executives, met each week without fail to exchange information and fix a price. If the information exchange was not setting a maximum procurement price, why were the meetings so important?

These puzzles are explained by the hypothesis that these companies were exchanging information to mitigate the winners’ curse associated with common value elements in procurement. In this paper we specify this hypothesis precisely and test it. The evidence of our empirical work is that livestock suppliers (ie, farmers) were better off under the price fixing that took place as a consequence of information exchange. Thus, information exchange and agreed prices were not at the expense of suppliers; and because the price fixing was participated in voluntarily over time, it was in the interest of the procuring companies. This outcome is not

¹ The companies acknowledged breaching section 27(1) (but not section 30, which is the specific price fixing section) of the Commerce Act and agreed to pay certain penalties, ranging between \$70,000 and \$1.5 million (yielding a total of \$5.510 million). The \$1.5 million is the highest individual penalty imposed

what we would expect if the meat companies were successfully colluding. In this case information exchange entailed mitigation of the winner's curse and not collusion against suppliers.

We represent the livestock market by the mechanism of a repeated auction, and we consider that the findings represent the proposition propounded by Klemperer (2002) that auction design is not "one size fits all", rather the outcome of auctions is very institutional and circumstance specific: the details and context matter.

In the next section we describe the relevant market and in Section 3 we examine the circumstances, process and outcome of price fixing. In Section 4 we consider the information and transactional issues posed by the market. The interaction between the institutional characteristics of this case and relevant price discovery features of auctions is used to develop the hypotheses of this paper in Section 5. The empirical model is developed and implemented to test hypotheses in Section 6, and Section 7 provides final comments.

2. Institutional Setting

In the livestock market, meat processing companies purchase lambs, sheep and cattle from farmers. Most of the resulting meat products are exported and while the use of forward contracts has since increased, a significant proportion of New Zealand export meat was processed in anticipation of, and sold at, spot prices in foreign markets over the period of our analysis (1992-1999). The fact that all companies were exporting a significant fraction of their product at spot prices meant that they all faced the common value issue for the price of their product. Most companies, but particularly the larger ones, obtained their product from such a wide geographic region that they were in the same animal-procurement market.

Entry barriers have been relatively low since delicensing of entry in 1980, and there has been a continual stream of entry and exit by processing companies since that time. Also, the industry has been adjusting to relative price changes since the complete removal of agricultural subsidies in 1985, and to technological change in transport and processing.² Figures A1.1 and A1.2 of Appendix 1 depict the very active exit and entry of export processing companies and processing plants throughout the period. In tandem with this industry change, at any time there existed processing firms of a variety of sizes and cost structures.³ Smaller new plants often had cost advantages over older and larger plants, in part because of their more rapid adoption of more flexible labour contracts.⁴

The structure of the market at a representative point in the relevant period is indicated in Table A1.3 of Appendix 1. There were approximately 20 processing firms in the industry and 75% of procurement market shares were held equally by the largest three firms. The number of firms and the market shares are not suggestive of dominance or of collusive behaviour: particularly when, as already described, costs varied significantly across companies.

Livestock suppliers are widely and diffusely scattered throughout the geographic market for procurement. Communication among them occurred by word of mouth but in insufficient detail or time to be particularly informative. While prices being paid in any week would diffuse through the region the quality of the stock to which they related was not clear. In fact, prices, qualities, quantities and players were not observable, at least in a timely manner, because the bidding meat companies were not all at one geographic location or exchange. Rather, on any

2 New Zealand completely de-regulated agriculture in the three years 1985-88 (see Evans, Grimes and Wilkinson, and Teece (1996) for a review of the economy-wide reforms that took place in New Zealand over the period 1985-1991). The withdrawal of subsidies particularly affected the price of sheep relative to other land uses and the numbers of animals have declined steadily since 1985. However, the production and value added attached to those sheep that have remained has increased for a variety of reasons to do with increased processing and technological advances.

3 Production of livestock is seasonal, and the processing industry has traditionally had capacity set by demands of the peak season. In consequence many plants have high fixed costs (much of which is sunk), that for a portion of the year are typically underutilised and that render profitable vigorous price competition outside the peak period.

day, a number of transactions occurred on a number of farms scattered through the region. There was no centralised register of transactions, and because the meat companies purchased some stock through agents, the quality, speed and reliability of information flowing to companies and suppliers was limited.⁵

There were over 20,000 farmers in the region and thus the co-ordination of forward contracts by competing procurement companies would entail significant transactions costs. These would have been compounded by the need to procure on a daily basis and by the price and climatic uncertainty. The amount farmers supplied at any given price varied significantly through the year and the region.⁶ Climatic effects on supply occurred abruptly at times imparting volatility in what could be procured at a given price. These factors presented the processing companies with another very uncertain and common factor: the relationship between procurement supply and price.⁷

Companies reported that they derived their reservation price for stock by estimating the minimal value of processed animals to them. This involved estimating the price in foreign markets and relevant future exchange rates. For each particular type and weight of animal, the company added the known and estimated prices for each resulting product from that animal to calculate an estimated gross value. The deduction of estimated costs of processing from gross value, including a profit margin calculated to achieve a certain rate of return on shareholders' funds, yielded the price the company anticipated it could pay up to and not incur losses. This price

4 New labour law introduced in 1991 enabled more flexible labour contracts.

5 The case relates to actions taken before the availability of internet communication and trading services. Widespread use of the internet in New Zealand, in common with other countries, started to grow rapidly from low levels in 1995 (see Enright (2000)).

6 Farmers rely on pasture growth to feed their animals, and New Zealand's climate, and hence grass production, is volatile. Where pasture production was low (high) livestock would be supplied at lower (high) prices than otherwise.

7 The farmer was generally paid within two weeks of slaughter, while the processing company may not realise all of its returns from an animal until many weeks later.

was denoted the “schedule”.⁸ The schedule was calculated by Friday of each week for the following week. We shall argue that it was affected by risk.

3. Price Fixing

During the period to which the case related, the livestock managers and, occasionally, chief executive officers of twelve North Island meat companies participated in meetings or conference telephone calls, generally on a Thursday of each week. In all, there were about 90 such meetings. During the meetings and conference calls, the companies discussed supply and demand conditions in foreign output markets, prices in foreign output markets, supply and demand conditions in the livestock market, prices in the livestock market and profitability of companies.

The written evidence of the meetings and conference calls contains voluminous references to livestock market prices (including previous bids and proposed prices and premiums), references to livestock market capacity and demand conditions, references to livestock market supply conditions and some references to foreign output market supply conditions, prices, exchange rates and profitability of companies. The output of this information exchange was typically a list of prices relating to livestock.⁹

In many ways the behaviour of the meat companies appears to be consistent with attempted price fixing. For example, the records of the case reveal frequent accusations of breach of alleged price agreements, and threats to initiate price wars. But several features of the livestock market imply that collusion might have been quite difficult to sustain. As we have mentioned,

⁸ Prior to the Commerce Act 1986, there was an agreed national schedule. However, at the insistence of the Commerce Commission, this practice stopped in 1987, when each company started to set its own schedule. For a time certain of the processing companies published their schedules. Companies pay premiums above the schedule price for several particular reasons that include: volume sales, encouraging out of season production, or to maintain farmer loyalty or for a range of competitive reasons, including inducing supply in non-peak periods when operating below capacity.

company size varied a lot and there were several smaller, lower cost players. Barriers to entry were low, livestock and output markets volatile and information flows costly and imperfect, rendering collusive agreements harder to reach, and detection of cheating on agreements more difficult. Finally, the high fixed costs of processing plants and overcapacity at that time stemming from a variety of causes, but in part from the adjustments farmers were making to the removal of price supports, increased the incentive for firms to deviate from any collusive agreement.

In fact, the actual prices companies paid each week almost invariably exceeded the prices on the list produced during the meetings and conference calls. Figures A2.1 and A2.2 of Appendix 2 illustrate the differences between the weekly actual prices paid by one of the companies for bulls and cows and the weekly “agreed” prices. The distributions for other North Island meat companies’ prices are similar.

The excess of actual over agreed prices and the repetition of “collusion conferences” at least 90 times, is intriguing. It meant that the “agreed” prices each week were effectively minimum, not maximum, prices. Why would the meat companies repeatedly persist in attempting to fix prices for so long when it appeared to be a futile exercise?

One reason may be that, even though the actual prices paid were not as low as those agreed, they were still lower than they would have been in the absence of any discussions. In other words, the meat companies were successful to a degree in fixing prices that were lower to livestock suppliers than they otherwise would be.¹⁰ This is a proposition that we test against an

9 Genesove and Mullin (2001) analyse notes of the weekly meetings of the Sugar Institute that operated in the United States from 1927 to 1936. They argue that the members of the Institute successfully colluded by agreeing not on prices or market shares, but on business rules, which facilitated detection of secret price cuts. There is no evidence of such an approach in the present case.

10 Some meat company executives reported that on occasions they believed that the meetings were resulting in lower prices than would otherwise have been the case.

alternative hypothesis that also fitted the facts: that information exchange mitigated common value elements of the exchange that benefitted the companies and the livestock suppliers.

4. Price Discovery

In this section we draw on the theory of auctions to explain the connection between the information exchange by the companies and posit hypotheses as to its likely effect on resultant procurement prices within the economic environment we have described.

When selling livestock in the spot market, suppliers generally sought bids from competing meat companies, and accepted the highest one. In the environment previously described, the livestock spot market can be characterised as if it were an auction market: in fact, the livestock-procurement mechanism is probably best described as a mixture of elements of first-price, sealed-bid auctions, and ascending-bid auctions. The sealed-bid element reflecting the very imperfect knowledge of transactors.

The institutional setting described above implies that the livestock auction has both private value and common value elements:¹¹ The key common value element is the future (export) price of livestock products. Each meat company purchases livestock, processed it and sold the products in the same, or related, mainly international output markets. While there is some product and geographical differentiation between companies, it seems reasonable to assume that there is a high degree of correlation among the companies' output prices and therefore among their livestock valuations. Furthermore, during the period of analysis a significant proportion of the product was not sold forward and its price was uncertain at the time of livestock purchase. Private value elements arose for a number of reasons that included the meat processing

11 See McAfee and McMillan (1987) for a more complete description of these concepts.

companies' differences in their marketing abilities, product mixes, and costs and contractual obligations.

We view a company's derived (reservation) livestock price as:

$$v_i = r_i - c_i \tag{1}$$

where:

- v_i = the value of an animal to company i ,
- r_i = the expected revenue to company i from that animal, and
- c_i = the expected costs to company i incurred in processing, transporting and marketing that animal (including a profit margin).

In general, revenue from export had a bigger influence on derived value than did costs.¹² Given that export prices are largely common to all meat companies, and that many costs will also be common, it seems reasonable to conclude that the common value elements of the livestock auction dominate the private value elements. Characteristics of auctions enable the effect of information exchange on bid level to be hypothesised.

In a common value auction, each bidder makes an estimate of the true value of the item. In a symmetric equilibrium, the winning bidder will be the one who receives the highest signal. Thus winning may convey's bad news to the winner, because it means that everyone else estimated the item's value to be less. A bidder will win often when the true value is over-estimated, but only rarely when underestimated. Consequently, even if the value estimates are unbiased, they will be systematically high for the winner, thereby engendering the winner's

12 In fact, v_i/r_i ranged between 0.65 and 0.75. Source: Schedule calculations of one company, and discussions with an employee of another company.

curse.¹³ In short, “Suppose the i^{th} bidder’s information about the item’s true value v can be represented by a number x_i , such that a bigger value of x_i implies a bigger true value of v , then

$$E(v|x_i) > E(v|x_i, x_i > x_j \text{ for all } j \neq i)”$$

(McAfee and McMillan, 1987, page 721). The x_i are signals to each bidder about the true value. The left side of this inequality is the bidder’s expectation about the item’s value before bidding; the right side shows that person’s expectation after having won. If bidders are rational, they will mitigate the winner’s curse by discounting their bids: indeed to an extent that varies with the auction and yields expected revenues that are less than the (expected) common value.¹⁴

John Kagel and Dan Levin (1986) and Kagel (1995) have carried out experimental work with common value auctions that is informative for the livestock case. Their simple model is as follows:¹⁵

- The common value V is drawn randomly from a uniform distribution on the domain (\underline{v}, \bar{v}) .
- Each bidder receives a signal x_i that is independently drawn from a uniform distribution on $(v - \epsilon, v + \epsilon)$. A lower ϵ indicates greater signal precision. As such, the x_i constitute unbiased estimates of v (or could be used to compute unbiased estimates in conjunction with the endpoint values \underline{v}, \bar{v} (Kagel and Levin, 1986)).

For signals from the interval $[\underline{v} + \epsilon, \bar{v} - \epsilon]$:

¹³ Models involving both common value and private value elements also include aspects of the winner’s curse (Milgrom (1985)).

¹⁴ For examples see Krishna (2002, ch.6).

$$E(v|x_i) = x_i$$

$$E(v|x_i, x_i > x_j \text{ for all } j \neq i) = x_i - \varepsilon \frac{n-1}{n+1}$$

where n is the number of bidders. This indicates that the severity of the winner's curse increases as the uncertainty – indicated by ε – about the true value increases.

The “linkage principle” is also relevant. Intuitively, a bidder's expected profit from an auction is greatest when that person holds private information that the item being sold is valuable.¹⁶ The intuition of the linkage principle is that the auctions yielding the highest average prices are those that are most effective at undermining the privacy of the winning bidder's information, thereby transferring some profits from the bidders to the seller.¹⁷ According to the principle, privacy is undermined by linking price to information other than (but affiliated with) the winning bidder's private information.

One application of the linkage principle (due to Milgrom and Weber, 1982a) involves ranking the different auction forms in terms of expected revenue to the seller. In an ascending-bid auction, the equilibrium price depends on the information of losing bidders through the bids they place. That linkage is absent in the sealed-bid auction. Its presence in the ascending-bid auction leads to a higher predicted price, provided that the bidders' information is affiliated. The first-price auction, with no linkages to the other bidders' estimates, yields the lowest expected price.¹⁸ A key explanation for this result is that, when bidders are uncertain about their valuations, they can acquire useful information by scrutinising the bidding behaviour of their competitors during the course of the ascending-bid auction. That extra information weakens the

15 This example satisfies the formal definition of affiliation (Klemperer, 1999). See Milgrom and Weber (1982a) for a rigorous definition of affiliation, and Klemperer (1999) for a more informal definition.

16 See Milgrom (1985) and Milgrom (1987).

17 See Krishna (2002, ch.7) for a detailed discussion of the linkage principle.

winner's curse and leads to more aggressive bidding. The exchange of information by meat companies may have had this effect.

There are some important distinctions between the version of the ascending-bid auction usually analysed in the literature (the so-called English version) and the livestock auction. In an English auction, the price is continuously raised by an auctioneer, exit is irrevocable, all bidders are in one spot, and they can all perfectly observe drop out prices. In the livestock market the schedule and maximum premium levels are set in isolation (as noted above, this is the first-price component), and the meat companies "call" the bids, rather than watch the price rise continuously on an electronic display. Furthermore, the meat companies are not in one spot and they act through agents – they accordingly cannot perfectly observe rivals' behaviour. Instead information about rival bids comes from a mixture of direct and indirect sources, reducing its reliability and speed of transfer among market participants.

For all of these reasons, one would expect the livestock price discovery mechanism to be less effective at mitigating the winner's curse than an English auction.¹⁹ In these circumstances, auction theory predicts that the meat companies will discount their estimates of value to account for the winner's curse.

Following Kagel and Levin *op cit* the severity of the winner's curse increases as the uncertainty about the true value increases. If information exchange increases signal precision (that is, reduces ϵ), the winner's curse will be mitigated, and bids will be higher for any given signal (x_i) of the common value.

18 The second-price auction falls in between. Note that Bikhchandani and Riley (1991) show that the ascending-bid auction can yield lower expected revenue than the second-price auction if asymmetric equilibria are also considered. Furthermore, Perry and Reny (1999) show that the linkage principle does not generally hold in multiunit auctions.

19 See Harstad and Rothkopf (1998) for support of this argument.

Similar ideas have been examined in other models. For example, DeBrock and Smith (1983) consider the information pooling effects of joint bidding for offshore petroleum tracts in the USA. Joint bidding reduces the number of bidders. However, it also pools estimates of true value which changes the information structure of the auction. DeBrock and Smith show that the variation of the joint venture's estimating process varies inversely with the number of members. Consequently, larger joint ventures are better able to estimate the true value and bid more aggressively. Allocative efficiency also improves.

Krishna and Morgan (1997) also analyse the efficiency of information sharing between joint bidders in auctions. They compare the equilibrium bidding behaviour of individual bidders with that of symmetric bidding groups. They find that symmetric joint bidding groups bid more aggressively than individual bidders. There are two effects causing this. The first is the information pooling effect of DeBrock and Smith (1983). The second results from the fact that the expected value of exceeding all other pooled signals is greater than the expected value of exceeding all of the signals individually. This results in a mitigation of the winner's curse, leading the winning bidder to be more optimistic about the value of the object. Krishna and Morgan point out that this "information" effect is the result of inferences drawn from the pooling of other bidders' information. Pooling and inference each raise the level of bids.

Assuming for the moment that firms tell the truth, this literature implies that information exchanges that entail pooling and inference among bidders should result in higher common value auction prices. There are also additional results in auction theory that suggest reducing informational asymmetries among bidders results in higher expected revenues to the seller (see, for example, Milgrom and Weber 1982b).

We now consider whether or not the companies would reveal truthful information in their exchanges and the implications of revelation for what has been observed.. The auction literature

does not address the issue of the incentives on bidders (particularly better informed ones) to misinform others about their private information. More generally, this literature does not specifically address the incentives of bidders to exchange information. There is an oligopoly literature on information exchange, but this also has generally assumed that firms will truthfully reveal their private information (Vives, 1990).

If truth-telling is relaxed, information exchanges may still reduce uncertainty and therefore result in higher prices. For example, analysis based on Hausch (1988) in the context of repeated auctions may explain why the companies appeared to exchange, or “agree” on, a minimum price. In particular, the game played in week t can be thought of as consisting of two stages. In the first stage, after receiving its signal about the “true value”, each company determines what information it will release. In the second stage, after the information exchange, each company determines its bid. The “information release” strategy and the bidding strategy of each company will both be functions of its true signal; the bidding strategy will also be a function of the information learned from the exchange. In the first stage, each company has an incentive to understate its true signal; a company would do this in order to try to persuade its rivals to bid low, so that the “deceiver” can outbid them and gain market share. However, all companies would understand this incentive, or would at least learn about it quickly, and would therefore adjust the signals they receive from each other upwards in equilibrium.

Hausch (1988) assumed that bidding strategies are invertible. Under this assumption all meat companies can deduce each other’s true signal. While this lack of deception may appear paradoxical, Hausch’s explanation can also be applied to the present circumstances; as the incentive for deception exists, a player who releases their actual signal knows the other players will overestimate the player’s type and will be ‘overcompetitive’ in the second stage.

Accordingly, the information released by each player will reduce uncertainty, mitigating the winner's curse, and leading to more aggressive bidding.²⁰

Given the incentive to deceive, companies exchanging signals that each knows will be the minimum price is possibly a more credible, and therefore sustainable, information exchange mechanism than one involving some other descriptor of the location of the distribution of bids. For example, agreeing on the maximum bid is most unlikely to yield a credible descriptor in the competitive environment of procurement.

In sum, in the circumstance of the companies, auction theory suggests a number of reasons why information exchange may have precipitated more aggressive bidding and thereby more efficient price discovery. The desire to reach credible and useful agreement may have led the companies to agree on a location of the distribution of prices given by the minimum.

5 The Model

In the absence of information exchange between the meat companies, auction theory predicts that:²¹

$$v > p \tag{1}$$

where:

²⁰ The one-shot game analysed above is repeated each week by the meat companies, with an infinite horizon. This repetition is unlikely to affect the conclusions because the meat companies are likely to have had relatively small discount factors during the relevant period (ie, they were relatively impatient), because of the uncertain dynamically changing industry of the time.

²¹ If bids are discounted in accordance with rational equilibrium bidding, the winning bid will on average be below the items's true but unknown value (McAfee and McMillan, 1998).

v is the "reservation value" of an animal (described in (1) above as being essentially the revenue from that animal less the costs incurred in producing that revenue, including a specified profit margin), and

p is the price of an animal, set by the highest bid.

The winner's curse is a function of uncertainty. Accordingly, if information exchange between the meat companies reduces uncertainty, the winner's curse will be reduced, the meat companies will bid more aggressively, and the livestock price will be higher. This prediction is the opposite of what we would expect to observe if the meat companies were colluding effectively to lower prices to suppliers. The hypothesis can be described as follows:

$$v > p^{ie} > p^{nie} > p^c$$

where:

p^{ie} is the price of an animal (set by the highest bid) with information exchange,

p^{nie} is the price of an animal (set by the highest bid) with no information exchange, and

p^c is the price of an animal (set by the highest bid) with successful collusion.

The livestock price will be higher when the meat companies exchange information than when they do not, holding everything else, including the derived value, constant.

A secondary hypothesis is that the variance of the livestock price is lower when the meat companies exchange information than when they do not. Intuitively, exchange of estimates

should improve the ability of companies to identify whether or not their signal is an outlier, and thereby adjust their bid.²²

To formalise these hypotheses equation:

$$p^b = \alpha + \beta v + \delta X + \gamma Z + \varepsilon \quad (2)$$

is posited, where:

p^b is the firm's bid price (for period $t + 1$),

$v = r - c$ (as in (1)) is the firm's estimate of the value of an animal in period $t + 1$, set in period t . It is the reservation value of the firm set by a company on the basis of its private information,

r is the estimated revenue from the output produced from that animal (based on public information and the firm's own private information about demand and supply conditions in the output markets),

c is the estimated costs of processing, transporting and marketing that animal (based on the firm's own private information about its costs),

X is public information about demand and supply conditions in the livestock market in period $t + 1$, and

Z is private information held by other firms in period t about demand and supply conditions in the livestock and output markets, and other relevant matters (for example, the financial position of other firms) in period $t + 1$.

The parameter γ is known to the firm, but Z is only known to it with information exchange (Z is assumed to be independent of v and X).

Equation 2 applies whether or not there is information exchange between the meat companies.

With information exchange, the bid price is $p^b|_{v,X,Z}$. Without information exchange, it is

$p^b|_{v,X}$. In both cases, the econometrician does not see Z and estimates:

$$p^b = \alpha + \beta v + \delta X + u \quad (3)$$

where $u = \varepsilon + \gamma Z$. Using this model we express our hypotheses as:

	With enforced non-exchange	Relationship	With information exchange
H.1	$\frac{\sqrt{\text{Var}(p^b v, X)}}{p^b}$	>	$\frac{\sqrt{\text{Var}(p^b v, X, Z)}}{p^b}$
H.2	α	<	α^*
	β	=	β^*

Hypothesis 1 states that the coefficient of variation²³ of the livestock price when there is information exchange will be lower than when there is no information exchange. With information exchange, p^b is conditioned on the additional information Z , while in the absence of information exchange, Z forms part of the error term. Note that we might also expect this result if the meat companies were colluding to lower procurement prices.

Hypothesis 2 is a formalisation of the argument that the livestock price will be higher with information exchange than without it, as discussed above. This hypothesis is inconsistent with collusion. It is a specialisation of $\alpha = \alpha^*$ and $\beta = \beta^*$, where $*$ denotes the information exchange period. We examine this more general specification by checking whether $\beta = \beta^*$

23 The coefficient of variation is used, rather than the variance, to control for the different scale of the variable between the information and non-information exchange periods. Note that our hypothesis applies the unconditional variances which we shall use for this aspect of the test.

and $\alpha < \alpha^*$ in our specification tests. While Hypothesis 2 is met by either (a) $\alpha^* > \alpha$ and $\beta^* = \beta$ or (b) $\alpha^* = \alpha$ and $\beta^* > \beta$, they have quite different implications. In both cases the price paid to farmers will be higher under information exchange, but in case (b) volatility in bid price due to volatility in this valuation will be higher than if (a) obtained.

6. Empirical Analysis

The following econometric specification of the model (2) was implemented:²⁴

$$p_t^b = A_t + \alpha_d I_t + \beta p_t^o + u_t \quad (4)$$

where:

A_t includes the intercept term, all of the dummy variable terms²⁵ except $\alpha_d I_t$, a trend²⁶, and a term controlling for rainfall. These terms represent the elements of X and c of our basic specification (2),

$\alpha_d = \alpha^* - \alpha$ is the increment in bid price, resulting from information exchange,

p_t^b is the livestock bid price in week t ,

p_t^o is the indicator (output) company gross value for week t calculated by the company, and

$I_t = 1$ if week t falls before the end of the information exchange period (6 April 1995)
 $= 0$ otherwise.

24 See Mellsop (2001) for the full specification.

25 The dummy variables of A_t are described in Appendix 1.

26 A trend variable was used as a surrogate for changes in processing costs, which have fallen steadily since deregulation in 1980.

The data are described in more detail in Appendices 3 and 4. The variable p^b in Equation 3 is the *ex post*, average, winning bid price (each week or month). This data is a proxy for the bid price determined in week t for week $t+1$ (in accordance with Equation 1). The variable p^o is our measure of the gross value – the element r - of v , and c is captured by variables in A that describe the path of costs over time.²⁷ These are provided in more detail in Appendix 3.

The data have come from two sources. A North Island meat company (Company A) that was involved in the information exchanges supplied 2 sets of beef and one set of lamb data. The Meat and Wool Economic Service of New Zealand (MWES) supplied beef data. Thus there were four usable series in total. We describe our approach for Company A's beef data only.²⁸ Analysis of the other series followed the same procedure.

Company A supplied the following (weekly) beef time series data for the period commencing 4 October 1992 through to the week ending 29 May 1999 (a total of 346 observations):

- The average price the company paid each week for bull (category 295/320) and cow (category 170/195), in cents per kilogram and exclusive of levies and transport costs (p_t^b in Equation 4); and
- The processed Bull and Cow prices it used each week in the schedule setting process, in New Zealand cents per kilogram (FOB) (p_t^o in Equation 4).²⁹

27 It was not possible to calculate c directly because it depends upon company choices about pricing in relation to marginal or average cost and cost information that was not available. It is incorporated by including variable s_t that allow for changes in costs over time.

28 For more details about the data see Appendix 4.

29 Because these are the figures used by Company A in the schedule setting process, the livestock price in week t can be regressed against the indicator price given for week t ; there is no need for any lag. There would be a need for a lag, for example, if the indicator prices given for week t were *ex post* realisations.

Given out time series of data, a key issue for estimation concerns the presence or absence of nonstationarity. According to standard tests, the price data were nonstationary. The span of the data is so short that there is reason to be quite uncertain about this conclusion. Nevertheless, the price data are in nominal terms and nonstationarity is a possibility. Tests of non-stationarity, and the implications of any nonstationarity for the results, were studied in detail. The investigation indicated that treating the empirical findings as if the price data are stationary does not affect the interpretation of the key statistics, although it does the specification of the model for estimation.³⁰

Hypothesis 1 – comparison of coefficients of variation

To test Hypothesis 1, the bull and cow price time series were split into two parts: the information exchange period (being the first 130 observations), and the period after the Commerce Commission raid (being the final 216 observations). Tables 1 to 4 set out relevant statistics for the Company A livestock and value indicator data.

In all cases the coefficient of variation of p^b is lower in the information exchange period than in the non-information exchange period which is in accord with Hypothesis 1. Furthermore, this occurs despite the fact that the coefficient of variation of p^o in the first period is somewhat higher than in the second period.

The same qualitative findings were obtained for Company A lamb data, and for MWES beef data. Thus all four data series are in accord with Hypothesis 1.

³⁰ See Mellsop (2001) for details. Very briefly, Phillips-Perron tests implied that the equations were cointegrated. Accepting this, the equations were re-estimated allowing for serial correlation in the disturbance term by adding leads and lags of the indicator price differenced. The t-statistics of the variables other than the indicator price then have the standard interpretation, and in each equation the conclusions remained unaffected. The t-statistic on the cointegrating coefficient on the indicator price in each equation retains its interpretation because the Newey and West variance estimator has been used.

Table 1: Company A bull price statistics with information exchange

Series	Number of observations	Mean	Standard deviation	Variance	Coefficient of variation
p^b	130	287.58	30.16	909.73	0.105
p^o	130	417.55	62.09	3854.50	0.149

Table 2: Company A bull price statistics without information exchange

Series	Number of observations	Mean	Standard deviation	Variance	Coefficient of variation
p^b	216	219.85	33.07	1093.4	0.150
p^o	216	275.79	33.47	1120.4	0.121

Table 3: Company A cow price statistics with information exchange

Series	Number of observations	Mean	Standard deviation	Variance	Coefficient of variation
p^b	130	220.05	27.46	754.24	0.125
p^o	130	391.94	59.64	3556.6	0.152

Table 4: Company A cow price statistics without information exchange

Series	Number of observations	Mean	Standard deviation	Variance	Coefficient of variation
p^b	216	160.94	29.91	894.34	0.186
p^o	216	250.80	31.34	982.05	0.125

Hypothesis 2 – impact of information exchange on mean livestock price

The model that we estimated allowed both α and β of our model to vary between the information exchange and nonexchange periods in the following way.

$$p_t^b = A_t + \alpha_d I_t + \beta p_t^o + \bar{\beta} I_t p_t^o + u_t \quad (5.1)$$

$$= A_t + \alpha_d + (\beta + \bar{\beta}) p_t^o + u_t \quad \text{with information exchange } I_t = 1 \quad (5.2)$$

$$= A_t + \beta p_t^o + u_t \quad \text{without information exchange } I_t = 0 \quad (5.3)$$

Diagnostic tests of our estimated model (5) indicated the presence of heteroscedasticity and autocorrelation. In consequence, we used the Newey and West (1987) estimator of the covariance matrix of the least squares estimator for autocorrelated disturbances with an unspecified structure (Greene, 1993). This estimator is also heteroscedasticity-consistent (Kennedy, 1992). The desirable number of lags for this procedure were checked in various ways.³¹ Lags of 1 and 6 for bull, and 1, 3 and 7 lags for cow met the specification tests, however, the results for each of these regressions were very similar, and accordingly only those for 6 lags for bull, and 3 lags for cow, are reported (see Table 5). They are robust against heteroscedasticity and serial correlation. Furthermore, the qualitative results that follow are unaffected by changing the specification to a log-linear functional form.

Table 5: Company A: bull and cow Model (using the Newey and West procedure with 6 lags for bull and 3 for cow)

Parameters	β		$\bar{\beta}$		α_d	
	Estimate	t-value	Estimate	t-value	Estimate	t-value
Bull	0.52	5.52	-0.19	-1.37	79.07	2.09
Cow	0.46	7.00	-0.10	-1.22	47.09	2.11

The results reported in Table 5 imply that the coefficient β is positive and statistically significant. They support the hypothesis that $\bar{\beta} = 0$ and hence that β does not change between the information exchange and non-exchange periods. The information dummy coefficient, α_d , then captures the model's difference between the two periods. It is positive and statistically significant implying that procurement prices were relatively higher in the information exchange period. These results are squarely in accord with Hypothesis 2.

The econometric results for the MWES beef data reported in Mellsop (2001) also support Hypothesis 2. The econometric results for the Company A lamb data support Hypothesis 1 – that the variance in prices paid was lower in the information exchange period: however, they are not in accord with Hypothesis 2 (see Mellsop (2001 p. 167)). However, the data for lamb are much more problematic for a test of this hypothesis than is the data for beef. The Company's indicator of value for the lamb analysis is not nearly as comprehensively representative of company total animal revenue as that available and used for the beef analysis, and the processing treatment of lamb was changing in a way that was transforming a commodity product into a higher value-added product, and this change would have had the effect on the results that Mellsop (2001, p.167) reports.³² We include the lamb results for completeness, but we do not consider them to be nearly as informative about our hypotheses as the three sets of beef results.

7. Concluding Comment

The results indicate that during the information exchange period the volatility in prices was lower than when information exchange was prohibited. Furthermore, controlling for internal assessments of the value of the final product to companies, the evidence is that companies paid

more for livestock in the information exchange period. The evidence is that the agreed prices set in the regular meetings were minimum transaction prices, not the maxima that might have been expected under price fixing. These facts and the volatile dynamic industry in which these events took place suggest that the regular company meetings were discovering information that is likely to have had the effect of mitigating the winner's curse.

Given that the added security afforded by information exchange improved prices to suppliers and that it was voluntarily chosen by the companies, efficiency gains from trade attended the information exchange for which the companies were prosecuted. If, as seems to have been the case, these gains arose from the resolution of the winner's curse, why for these repeated transactions would not some institutional arrangement, such as a forward market, arise that had the same effect? We consider that the transactions costs in forming such a market given the informational and locational characteristics – particularly the separate scattered nature of one side of the market, the need to verify quality and the costs of goods exchanged – may have outweighed the gains from trade that it would imply. However, the potential for much lower-cost information exchange exists now under internet technologies and long-term quality-adjusted risk-sharing contracts are becoming more common in the industry.

In common with the competition law of many countries, under the New Zealand Commerce Act it is not necessary to show that the conduct in question had an inefficient effect in order to establish a breach of the price fixing provision (section 30). The rationale for using such a *per se* approach is that it economises on the costs of monitoring and enforcing antitrust laws, and it provides a clear statement of the law, arguably reducing uncertainty. However, the evidence of this research is that, in an auction market characterised by common value elements and significant uncertainty, co-ordination between competitors can be welfare enhancing. Indeed

32 Over the period lamb markets and the extent to which processing was taken to the point of chilled cuts – as opposed to frozen carcasses – increased dramatically. Our indicator did not relate to the higher valued chilled product.

such information exchange is an activity of forward markets. Fershtman and Pakes (2000) and Groenewegen (1994) also suggest that collusion can raise welfare. Accordingly, the disadvantage of the *per se* approach is that it can prohibit potentially efficient arrangements. This research suggests that *per se* offences should be specified very sparingly indeed.

It may be conceptually difficult to distinguish price fixing from the ordinary behaviour of forward markets where prices reflect existing information, expectations of the future and past behaviour. Gains from trade should not be threatened by rigid rules specified by competition law.

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Appendix 1: Indicators of the State of the Market

Figure A1.1

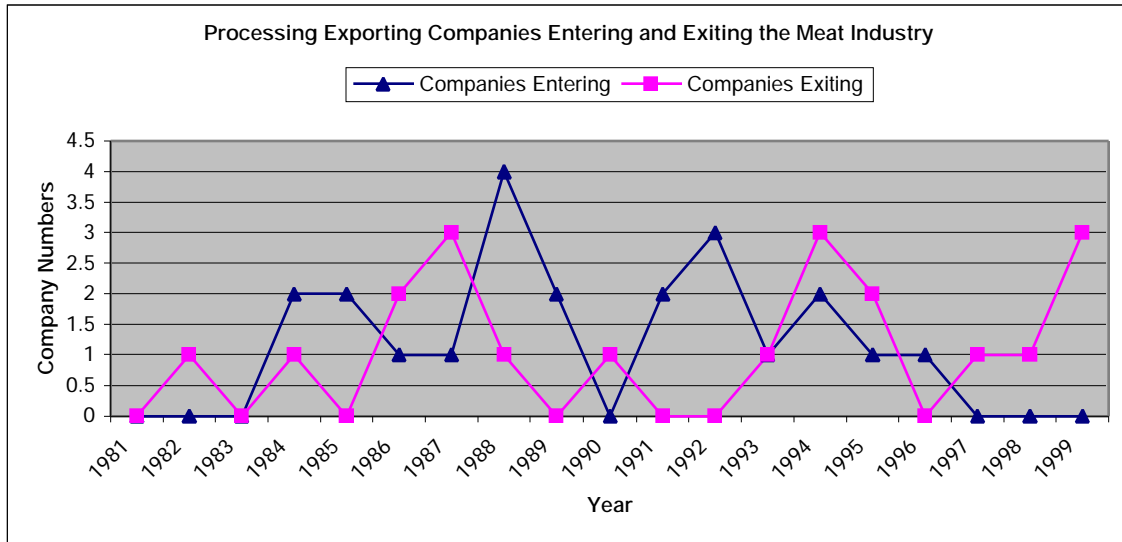


Figure A1.2

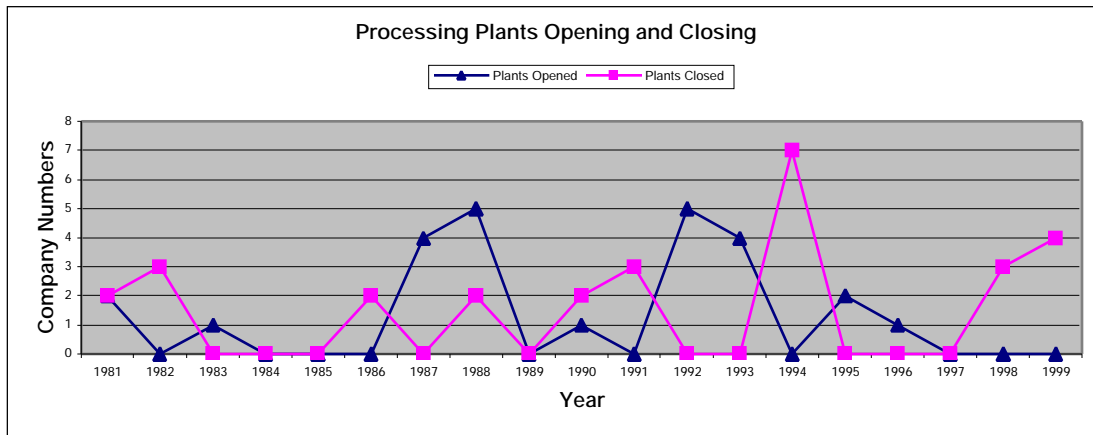


Table A1.3: Procurement Market Shares: 1994

Company	Sheep (%)	Beef (%)
AFFCO (cooperative company)	25.0	30.0
Weddel (private company)	26.9	18.4
Richmond (public unlisted company)	22.7	9.9
Low Walker (private company)	6.0	20.5
Benmore (private company)	0.0	5.0
Others (about 15)	19.4	16.2
	100.0	100.0

Source: Calder and Tyson (1999).

Appendix 2: The “Agreed” Price was a Price Floor

Figure A2.1

Figure 1: Company A actual less agreed bull prices

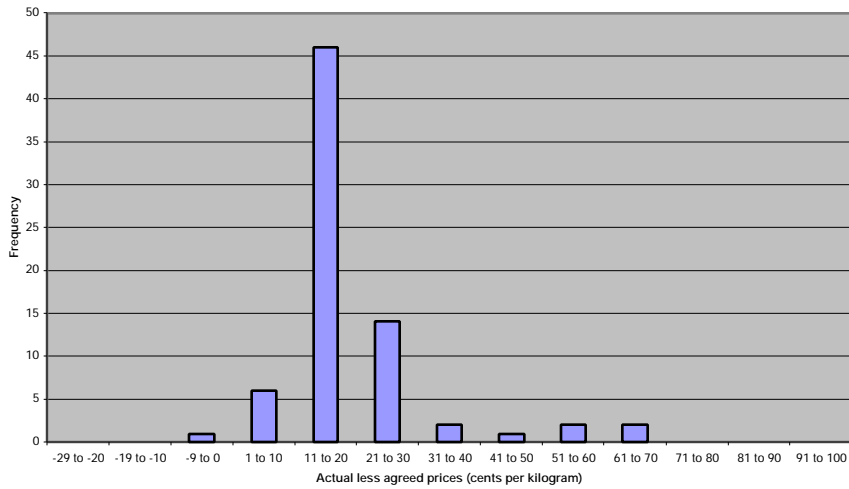
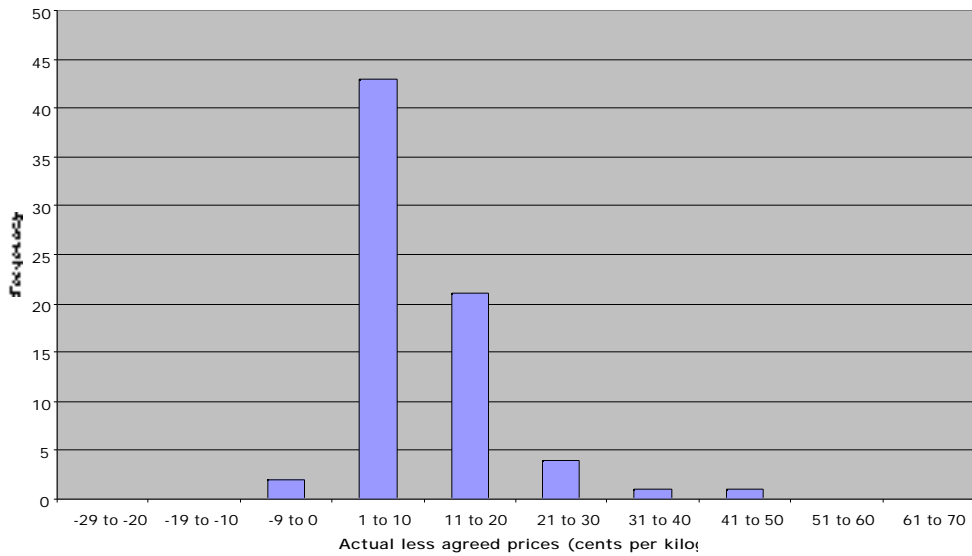


Figure A2.2

Figure 2: Company A actual less agreed cow prices



Appendix 3: Representing Seasonality, Policy and Industry Change

Dummy variables were used in the econometric specification to represent the following:

- A change in the quota allocation mechanism in 1995. Certain key export markets impose quantitative restrictions on imports of New Zealand meat. The mechanism for allocating this quota among meat companies was changed on 1 January 1995, as the previous mechanism was felt to provide an extra incentive to procure market share, resulting in higher livestock prices and possibly overcapacity.
- Misperceptions about the future quota allocation mechanism, which were perceived to have caused particularly high livestock prices in July, August and September of 1993.
- The seasonality of the industry. In the off-peak season, companies are willing to bid higher in order to increase their plant throughput. To capture this effect, twelve dummy variables were specified, one for each month.
- Plant capacity and livestock supply changes. Ideally the model would include variables measuring capacity and the capital stock of livestock. However, appropriate data were not available, and so annual dummy variables were used. Together with the trend variable, these should control for systematic effects related to time over the period. Furthermore, a dummy variable was used for the significant shock to capacity caused by the collapse of one particularly significant processor in 1994.

Appendix 4: Description of Variables

Dependent variable (p^b)

The variable to be explained is the livestock price, which is set under the auction mechanism by the winning bid.³³

The data for this variable have come from two sources. The first is a North Island meat company that was involved in the information exchanges and that we have described as “Company A”. Company A supplied both beef and lamb data.

The second source of data is the Meat and Wool Economic Service of New Zealand (MWES). The MWES collects livestock price data from a number of North Island meat companies, and supplied beef data for this research.

Each meat company may enter into hundreds of transactions with farmers a week. The data used are the average price paid each week (or month in the case of the MWES data) for particular benchmark livestock classes. Examples of benchmark livestock classes are bull from 295 to 320 kilograms (“bull 295/320”) and manufacturing cow from 170 to 195 kilograms (“M cow 170/195”).³⁴

Explanatory variables

A number of variables may influence the livestock price. The key ones are discussed below.³⁵

Estimated unit revenue: (p^o an indicator of v)

As explained above, a key explanatory variable for the livestock price is the estimated price that the derived products will sell for, particularly in overseas markets. It is assumed in this research

33 Note that the winning bid of a firm in period $t+1$ might be different to the bid price it set in period t for period $t+1$ (in accordance with the bidding decision hypothesised by equation 1). A firm may be able to purchase livestock at a lower price than it was prepared to pay. Alternatively, it may be forced by competition to pay more.

34 Note that the benchmark livestock classes can at times represent very small fractions (eg, less than 10%) of all animals of that class, ie, in a particular week bull 295/320 may only represent 8% of the total number of bulls processed in that week.

35 See Mellsop (2001, chapter 7) for more detail.

that prices for products in foreign markets are not caused by conditions in New Zealand for any company. While there may be some degree of market power on occasions (from product differentiation, for example), the meat companies can probably be broadly characterised as price takers in their output markets.

Any particular animal can produce numerous saleable products. For practical reasons, weekly price data for all of these products could not be obtained for this research. Instead, prices for indicator products were used, ie, prices for important products whose price changes broadly reflect the overall revenue changes from a particular animal.

For example, indicator products for bull 295/320 and M cow 170/195 are:

- 95 CL Bull in the US for bull 295/320 (ie, frozen bulk packed boneless bull meat with a chemical lean content of greater than 95%); and
- 90 CL Cow in the US for M cow 170/195 (ie, frozen bulk packed boneless cow meat with a chemical lean content of greater than 90%).

These indicator products constitute a significant proportion of the total boneless meat produced off the carcase of bull 295/320 and M cow 170/195 respectively. Their use will mean that $\beta = 1$.

Information exchanges:

The litigation related to the information exchanges between 14 October 1992 and 6 April 1995. However, from an economic perspective the 14 October date appears to be an arbitrary boundary. Accordingly, the econometric specification uses one dummy variable to split the time series up into two sections: pre-6 April 1995; and post-6 April 1995.