# *6. Now You See It, Now You Don't: Why Packer Market Power is So Elusive*

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## *Abstract/Summary*

*Cattle production follows a dynamic cycle and cattle markets receive much scrutiny because of the potential for packer market power. The relationship between the two has been little studied, however. This paper provides a simple conceptual framework to study how the cattle cycle and buyer market power jointly affect the bargaining position between producers and packers. A larger cattle stock leads to a lower fed cattle price when beef packers have market power in cattle procurement. This is intuitive, but what is not obvious is the feedback effect on the cycle itself. The authors find that the cattle stock's negative effect on price is magnified by the degree of buyer market power in cattle procurement but that over the cycle, the effects can be short-lived. Empirical findings support the posited theoretical relationships. The research is important to help understand why research into market power in cattle procurement can give such varied results.*

# Now You See It, Now You Don't; Why Packer Market Power Is So Elusive

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## Background

Cattle markets have received much attention because of the potential for buyer market power. Recently, for example, producers and other industry participants urged the U.S. Department of Justice (DOJ) to reject the proposed acquisition of both National Beef and Smithfield Beef by multi-national JBS Beef because of market power fears (The DOJ ultimately responded by allowing the acquisition of Smithfield, but not of National). However, research conclusions regarding the existence and/or extent of market power in cattle procurement markets have been mixed. Table 1, for example, reveals that studies conducted during various time periods over the past 50 years have reached very different conclusions. Some researchers have found market power in cattle procurement to be fairly small (e.g. Azzam 1997; Morrison Paul 2001), while others have found it to be considerably more pronounced (Crespi and Sexton 2004, 2005). Another very common postulate is that the ability to exercise market power should be related to the level of industry concentration. From 1976 to 2007, the four firm concentration ratio (a common measure of industry concentration) has increased from 25% to 80% (USDA, Packers and Stockyards Program 2009, Ward 2002). As a result, producers and policy makers have become increasingly concerned about the potential for market power in cattle procurement markets (McEowen, Carstensen and Harl 2002; Rogers 2002). However,

even the seemingly common sense conclusion that market power and concentration are directly related has been refuted by some previous studies (e.g. Stiegert, Azzam and Brorsen (1993)).

The obvious question that arises is, Why have previous studies of market power in fed cattle procurement markets reached such differing conclusions, resulting in unresolved legal and policy debates? We hypothesize that the answer to that question may well lie in an as-of-yet un-explored relationship between buyer market power, and the well known cattle cycle. Specifically, a primary reason for differing results may rest in the simple fact that alternative time periods (different phases of the cattle cycle) were examined in the different studies of market power in cattle procurement markets (Table 1.).

It is well known that cattle production follows a dynamic cycle, and numerous previous researchers have examined the nature and causes of the cattle cycle (e.g. Marsh 1994, 1999; Rosen, Murphy and Scheinkman 1994, and Hamilton and Kastens 2000). How the cattle cycle interacts with the potential for market power in cattle procurement remains, however, an unanswered question. The answer to this question could have important welfare and policy implications for various cattle industry participants. While no published research could be found that specifically examined the interaction between the cattle cycle and market behavior, previous researchers have found that when cattle supplies were *unexpectedly* low, packers competed more aggressively for cattle (Stiegert, Azzam, and Brorsen 1993). We extend that proposition by suggesting that market

participants may have the ability to intentionally alter cattle supplies, which may jointly influence the potential for market power.

In this study we provide a conceptual framework to study how the cattle cycle and buyer market power jointly affect the bargaining position of producers and packers. In this conceptual model, the cattle procurement market contains several packers and a large number of cattle producers. Producers allocate their young adult female cattle stocks between either selling to packers for slaughter or breeding. This decision is made based on current cattle prices, expected cattle prices in future periods, breeding and feeding costs, fertility and weaning rates, and the natural death rate of cattle. On the other side of the market, each packer considers not only the effect of current purchase decisions on profit in the current period, but also the effect on profit in subsequent periods, through the effect of current decisions on future cattle stocks. The conceptual model provides insight regarding why the time period of the cattle cycle may be related to the degree of market power, thus providing at least one explanation for the disparate results of previous market power studies. We then test the implications of the conceptual model by conducting an empirical estimation of these effects in U.S. cattle markets.

**The Conceptual Model**

The conceptual model is based on a profit maximization objective on the part of cattle producers and processors. The cattle production industry is assumed to be competitive (individual firms have no ability to influence price) up through the feedlot phase. The cattle production sector in the aggregate makes decisions regarding how many heifer

calves to retain for breeding based on a multi-period profit maximization problem. Producers are factoring in current cattle prices, costs of maintaining a herd, and expectations regarding future cattle prices. Higher current cattle prices and higher costs of herd maintenance are expected to encourage selling cattle rather than retaining breeding stock, while higher expected future cattle prices down the road should encourage heifer retention. There are of course the physical constraints of time delay between the choice to retain for breeding and actually calving, and subsequent additional time delays associated with future calf crops reaching market (or breeding retention) weight. There are also the realities of death loss, and less than 100% breeding success rates.

On the processing side, we assume that the processed beef (boxed beef) market is competitive, so that any potential for market power is in the input (cattle) purchasing component. Therefore, a processor is assumed to know that quantity choices in time period t impact the price of cattle in time t. This impacts cattle producer retention choices, which will ultimately impact cattle stocks (and prices) in future periods. The result is that quantity choices on the part of individual packers impact not only current prices (and profits), but future prices and profits as well.

Without going into a lot of detail in this paper (request Crespi Xia and Jones 2009 for the complete details), in the process of packers and producers trying to jointly maximize profits over time, the price of cattle at time t becomes a function of the packer's gross profit margin, current cattle stocks, expectations of future cattle prices, and the cost of maintaining cattle.

If the cattle procurement market is perfectly competitive, the fed cattle price is equal to the per-unit gross profit of beef packing net of cattle purchases (resulting in zero economic profit). If this is in fact the case, small changes in adult cattle stocks (as a result of packer procurement decisions) and the dynamic interaction between the current cattle procurement and future cattle stocks have no effect on contemporary fed cattle price. We hypothesize that this is in fact not always the case in the following proposition.

PROPOSITION 1: *The adult cattle stock has a negative effect on the fed cattle procurement price if beef packers have market power in procurement while the cattle stock has no effect on the cattle price if the cattle procurement market is perfectly competitive. More importantly, the magnitude of the negative effect of the adult cattle stock on the cattle price is increasing in the degree of buyer market power in cattle procurement.*

The effect described in proposition 1 has not been reported in previous studies. If true it implies a cycle of the bargaining position between cattle producers and beef packers, and that the fluctuation of this bargaining position is greater if the cattle procurement markets become less competitive. The economic insight behind this important result is straightforward. A larger adult cattle stock in the market means that the supply of cattle for slaughter is also larger. Thus, more cattle are procured by packers at the equilibrium. When beef packers have market power in cattle procurement, each packer finds her optimal quantity of cattle to procure where the marginal revenue from the last unit purchased and processed is equal to that unit's marginal expenditure (ME) of procurement. If the marginal revenue, is unchanged under different cattle stock levels, maintaining the same marginal expenditure of procurement with a larger quantity of

purchases means that a packer's markdown, the difference between ME and the cattle price, must be larger because a packer knows that she has to pay the price increment caused by the purchase of the last unit for a larger quantity of cattle. A larger markdown and the same marginal expenditure indicate that the cattle price will be lower. When beef packers have more buyer market power in cattle procurement, each packer faces a steeper ME curve, i.e. the markdown is larger at a given quantity level and the markdown is increasing at a higher rate as the quantity increases. The higher increasing rate of markdown means an increase in cattle stock will result in a larger markdown and, accordingly, a larger cattle price decrease. That is, the negative effect of the adult cattle stock on the cattle price is magnified by the degree of buyer market power in cattle procurement. Figure 1 illustrates the price effect of the cattle stock in two scenarios with different levels of buyer market power.[1]

We also hypothesize that market power could be further amplified by the physical realities of cattle production in future time periods being somewhat driven by packer purchase decisions today.

PROPOSITION 2: *The dynamic interaction between current cattle procurement and future adult cattle stock causes further negative effects on the current cattle price when packers have buyer power. Packers' current cattle procurement is negatively associated with their expected profit in future periods.*

[1] In figure 1, an increase of cattle stock from $S_0$ to $S_1$ will reduce the cattle price in both case (a) and (b), but the cattle price decrease ( $P_0^b - P_1^b$ ) in case (b), in which buyer market power is stronger, is larger than the cattle price decrease ( $P_0^a - P_1^a$ ) in case (a).

The intuition behind proposition 2 is that additional current cattle purchases reduce the breeding stock; a lower breeding stock means that adult cattle stocks in the future are lower, and the lower future cattle stocks lead to higher cattle prices and lower profits in the future. Thus, this dynamic interaction reduces packers' incentives to purchase in the current period so that packers procure fewer cattle and the current cattle price is lower than what would prevail if the dynamic interaction did not exist. Similarly, the magnitude of the negative effects of this dynamic interaction on cattle prices is increasing in the degree of buyer market power over cattle procurements in future periods.

Finally, we postulate that other supply factors can impact fed cattle prices, and these factors may be magnified by the ability to exercise market power as set forth in proposition 3.

PROPOSITION 3: *When beef packers have market power in the cattle procurement market, in addition to the adult cattle stock itself, other supply factors can affect the fed cattle price. The price of cattle for slaughter is decreasing (increasing) in the cost (benefit) of keeping cattle in the breeding stock. That is, the cattle price is decreasing in the cost of maintaining breeding stock and future variable production costs and increasing in the producers' expectations of future cattle prices. The magnitudes of all of these price effects are also increasing in the degree of buyer market power in cattle procurement due to similar economic insights as those discussed above in the explanation of the cattle stock's price effect.*

**An Empirical Examination**

Based on the conceptual model, we conducted a simple empirical study to examine the effects of cattle stocks, buyer market power, costs of production, and other factors on the cattle price which we hope will add insight into why researchers have been getting different results in the previously mentioned studies.

Assuming a representative producer and packer have unbiased predictions for prices and quantities in future periods, our theoretical model yields the following non-linear, econometric model representing the average price of cattle in year t as:

$$\begin{aligned} P_t^* = {} & \beta_0 + \beta_{1,t}(N_t)R_t + \beta_{2,t}(N_t, h_t)S_t + \beta_{3,t}(N_t, r_t)[P_{t+1} - h_{t+1}] \\ & + \beta_{4,t}(N_t, r_t)[P_{t+3} - (1+r_t)h_{t+2} - h_{t+3}] \\ & + \beta_{8,t}(\beta_{1,t}(N_t), N_{t+1}, r_t, Q_{t+1}) + \beta_{9,t}(\beta_{1,t}(N_t), N_{t+3}, r_t, Q_{t+3}) \\ & + \varepsilon_t. \end{aligned} \quad \text{and}$$

$$Q_t^* = f(P_t^*)$$

Where $P_t^*$ and $Q_t^*$ represent the equilibrium price and quantity of cattle, respectively, at time period t, and other variables are defined in the following text.[2]

For data, we start with 293 monthly observations from January 1988 to December 2006, aggregating monthly data where appropriate to match up with the physical cattle cycle realities associated with the conceptual model. All prices and costs have been converted into real (2008) dollars. The price ($/cwt) for live cattle sold to beef packers each month, $P_t$, is obtained by averaging the reported USDA/AMS weekly prices for each month (dressed cost basis) for steers. This price in real terms averaged $121/cwt with a minimum of $75 and a high of $228.

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[2] The other functions are $\beta_{1,t} = N_t/(N_t+1) \in [0.5, 1]$, $\beta_{2,t} = -g_t/(N_t+1)M < 0$, $\beta_{3,t} = (1-\delta)/(N_t+1)(1+r) > 0$, $\beta_{4,t} = \lambda/(N_t+1)(1+r)^3 > 0$, $\beta_{5,t} = -\beta_{3,t} < 0$, $\beta_{6,t} = -(1+r)\beta_{4,t} < 0$, $\beta_{7,t} = -\beta_{4,t} < 0$, $\beta_{8,t} = -\beta_{1,t}[(1-\delta)/M(1+r)]E_t(g_{t+1}Q_{t+1}/N_{t+1}) < 0$, and $\beta_{9,t} = -\beta_{1,t}\left[\lambda/M(1+r)^3\right]E_t(g_{t+3}Q_{t+3}/N_{t+3}) < 0$.

For $N_t$ we used the annual number of federally-inspected beef-packing plants reported by USDA/GIPSA in their annual statistical reports. Although the number of plants is not the same as the number of firms, Crespi and Sexton (2005) found evidence that plants, rather than firms could be a good proxy and we do not have data on the number of firms over time. One must be mindful about the use of the number of packing plants as a measure of competition in an industry. Hence, while the theoretical model could assert that $N_t$ was synonymous with competition, in the real world, the relationship is not as clear.

$R_t$ is the value for the processed beef less cost of production (net of cattle purchases). We use the USDA/AMS reported weekly price ($/cwt) of boxed beef (averaging the price of "choice" and "select") and average these weekly prices to obtain the monthly value. On average this boxed-beef price was $164 ranging from $121 to $230. For costs we use the annual measure of operating costs as a percentage of sales for the top 40 beef packing firms as reported by USDA/GIPSA in their annual statistical reports. These cost data exist from 1992 to 2006, average 18.95 percent ranging from a low of 15 to a high of 24 percent. The values have trended upward in a nearly linear manner over the time period and a simple linear trend line fit to these data had an $R^2$ of 0.90. We thus used the estimated trend for the time period in our study. As these costs are reported on a percentage of sales basis, we estimated $R_t$ as one minus the operating expense multiplied by the price of the boxed beef.

We do not have detailed data on the monthly size of the stock of cattle, thus the adult cattle stock, $S_t$, is the annual USDA estimate of the number of head in the adult herd in the U.S. and remains constant for a given year. $S_t$ averaged roughly 100 million head ranging from 95 million to 114 million head per year. The number of head slaughtered, $Q_t$, is a monthly average of the weekly reported numbers collected by USDA. The slaughter averaged 2.2 million from a minimum of 519 thousand to a maximum of 3 million head. Both $S_t$ and $Q_t$ are measured in 1000s in the model. The variable $r_t$ is the interest rate on agricultural lending loans for operations in the $10^{th}$ Federal Reserve District and varied from a low of 7% to a high of 18% with an average of 10.7% over the time period. The variable cost of producing cattle ($h_t$) is dependent on a variety of factors. Extension economists at Kansas State University have developed a weekly break-even price ($/cwt) that shows the minimum price an average producer would have to receive in order to just cover her costs of production (Kansas State University 2008). This value had an average of $103/cwt and varied from $77 to $139/cwt.

Estimation of the empirical equation allows us to examine the effect on buyer market power in cattle markets over a long period of time. The estimation reveals how cattle prices have changed over time as the stock of cattle has changed ($\beta_{2,t}$), and the price effects of the dynamic interaction between current cattle procurement and future cattle stock ($\beta_{8,t}$ and $\beta_{9,t}$). In addition, market power changes over time are measured by $\beta_{1,t}$.

Table 2 shows the parameter estimates along with the statistics for the various functions. The statistical fit very high, and most of the signs are as predicted by the conceptual model. The exception is the parameter that basically measures the impact of concentration on market power ($\alpha_1$ in $\beta_{l,t}$). As discussed earlier, there is no reason why competition and $N_t$ have to be inversely related in reality. Declining numbers of firms may just as easily indicate a highly competitive market if competition has driven out inefficient firms. Even by the end of our sample, $N_t$ was 168, hardly a small number.

The market power function, $B_{l,t}$, has a mean of roughly 0.8, which indicates that overall in this data series the market could be classified as non-competitive though farther on average from the monopsony level of ½ and closer to the perfectly competitive value of 1. This suggests that over the period of study, buyer power could be classified as an oligopsony, which is in line with many of the studies discussed previously. To discuss this and the other functions with respect to the time period of our data set, we present figures 2 through 4 in order to put the concept of buyer power in the context of the cattle cycle.

Figure 2 shows the cattle cycle over the time period along with the percentage markdown from a hypothetically competitive cattle price. We determine this price by setting $\beta_{l,t} = 1$ and subtracting it from the actual cattle price, then converting to a percentage. Our average percentage markdown is somewhat larger than those found in the majority of studies (our average is 20 percent whereas most studies find average markdowns below 10 percent), though our more recent calculated markdowns are at

lower levels, in line with the levels found in other studies. These markdowns support the main hypothesis of this paper. The percentage markdown from the competitive level clearly follows the cattle cycle. In the remaining figures, we can break down the dynamics of this effect.

Figure 3 compares the functions $B_{1,t}$ and $B_{2,t}$. Like Stiegert, Azzam and Brorsen (1993), we find that market power has been declining over time ($B_{1,t}$ is getting larger in our study) even as concentration in the processing market has been increasing. However, we also find that the general trend on what we term the "magnification effect" of market power ($B_{2,t}$), which is the negative price effect of the cattle stock, is becoming more negative over the same time period. What this means is that even though procurement markets are becoming more competitive, the magnification of market power on the cattle stock's negative price effect today is larger than it was in the past. This is seen in figure 2, as well, where the percentage markdown is generally declining (more competitive) as supplies have declined over time, but at the same time has become more volatile because the magnification effect is increasing (in absolute value). This is an important and previously unrecognized phenomena and adds further credence to the assertion that previous measures of market power may differ importantly because of the time periods under study. As our theoretical model predicted and as our empirical model seems to support, there is an implication for regulators here. In short, even if the industry is becoming more competitive, the potential impact from market power is greater today than in the past, something to watch carefully when the cattle cycle turns to a period of increased supplies.

In figure 4, $\beta_{3,t}$ and $\beta_{4,t}$ are positive and increasing over time. What figure 4 implies is that both expectations of future prices of cattle and future costs of production have more of an effect today on the going cattle price than they did in the past. Two possible reasons come to mind. First producers may be more apt to look at forward price and cost indicators than they have been in the past. Second, we find more potential for market power than in the past, so consistent with monopsony behavior packers may be taking expectations more seriously.

The main implication for the empirical model as shown in figures 2 through 4 are these. First, our primary hypothesis regarding a connection between market power potential and the cattle cycle appears to be supported. Second, the empirical model indicates that buyer market power has declined over time ($\beta_{1,t}$ has become larger). Third, market power, if it exists, has a potentially bigger effect today ($\beta_{2,t}$) than in the past, however it may be less affected by processors' manipulation of the cattle cycle today ($\beta_{8,t}$ and $\beta_{9,t}$) than in the past. Most importantly, in support of the key implication of the theoretical model, markdowns are anything but constant and definitely appear to rise and fall with the cattle cycle.

**Conclusion**

The model outlined in this paper yields the following results. A larger cattle stock does not just simply lead to a lower fed cattle price, it leads to an even lower fed cattle price when beef packers have more market power in cattle procurement. Hence, the

cattle stock's negative effect on price is magnified by the buyer market power in cattle procurement. Thus, the cycle itself is very importantly related to a posited cycle of bargaining position between cattle producers and beef packers. The intuition behind these results is that the cattle stock reduces the cattle price through its positive effect on packers' quantity of cattle purchased and, in turn, on their markdown. In a less competitive market, beef packers' markdowns will increase at a higher rate as quantity increases so that an increase in cattle stock will result in a larger cattle price decrease.

Our research also suggests that the dynamic interaction between current cattle procurement and future adult cattle stocks can reduce current cattle prices. In essence, purchasing one more animal today not only raises the current cattle price, but also increases future cattle prices by reducing future cattle stocks due to a lower current breeding stock. Thus, packers may procure fewer cattle in the current period and the equilibrium cattle price is lower than what would prevail if the dynamic interaction did not exist.

One should expect that in periods of large national and regional supplies, feedlots have lower bargaining power than when supplies are tight. We are aware of no previous work that examined whether this explains why different researchers come to such different conclusions. However, we feel that these findings have important implications for policy makers and regulators charged with overseeing competitive livestock markets. At a time when the buyer concentration is increasing, the need to understand the impact of the cycle on market power and vice versa will only increase.

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**Table 1**. **Literature on Market Power in Cattle Procurement.**

| *Study* | *Conclusion on Procurement Market Power?* | *Time Period in Study* |
|---|---|---|
| Schroeter (1988) | – | 1951-1983 |
| Azzam (1992) | + | 1988-1991 |
| Schroeter & Azzam (1990) | + | 1976-1986 |
| Azzam & Park (1993) | – | 1955-1977 |
| Azzam & Park (1993) | + | 1982-1987 |
| Koontz et al. (1993) | + | 1980-1982 |
| Koontz et al. (1993) | +, but lower than in 80-82 | 1984-1986 |
| Stiegert, Azzam and Brorsen (1993) | + | 1972-1986 |
| Morrison Paul (2001) | – | 1992-1993 |
| Crespi & Sexton (2005) | + | 1995-1996 |

Notes: "–" means little to no evidence of market power in the purchasing of cattle; "+" means evidence of market power.

**Table 2**. **Empirical Estimation of Cattle Prices.**

| Parameter | Estimate | Std Err | |
|---|---|---|---|
| $\beta_0$ | 6.640 | 2.989 | * |
| $\alpha_0$ | -2.650 | 0.202 | * |
| $\alpha_1$ | 3.76E-03 | 3.15E-04 | * |
| $\alpha_2$ | -1.70E-04 | 7.10E-05 | * |
| $\alpha_3$ | 2.460 | 7.671 | |
| $\alpha_4$ | 7.970 | 3.822 | * |
| $\alpha_5$ | -2.00E-05 | 8.72E-06 | |
| $\alpha_6$ | -1.00E-05 | 1.10E-05 | + |
| $R^2$ | *0.972* | | |
| Function | Mean | Std Err | Min | Max |
| $\beta_{1,t}$ | 0.817 | 0.071 | 0.668 | 0.896 |
| $\beta_{2,t}$ | -5.851E-05 | 1.833E-05 | -1.08E-04 | -3.24E-05 |
| $\beta_{3,t}$ | 0.008 | 0.004 | 0.003 | 0.014 |
| $\beta_{4,t}$ | 0.020 | 0.010 | 0.007 | 0.040 |
| $\beta_{5,t}$ | -0.008 | 0.004 | -0.014 | -0.003 |
| $\beta_{6,t}$ | -0.043 | 0.021 | -0.082 | -0.015 |
| $\beta_{7,t}$ | -0.020 | 0.010 | -0.040 | -0.007 |
| $\beta_{8,t}$ | -0.819 | 0.511 | -2.398 | -0.252 |
| $\beta_{9,t}$ | -0.723 | 0.436 | -2.123 | -0.082 |

Notes: dependent variable is the price of cattle ($/cwt); 293 monthly observations; * indicates significance at 5% hypothesis level; + indicates significance at a 10% hypothesis level; time period is 1988-2006.

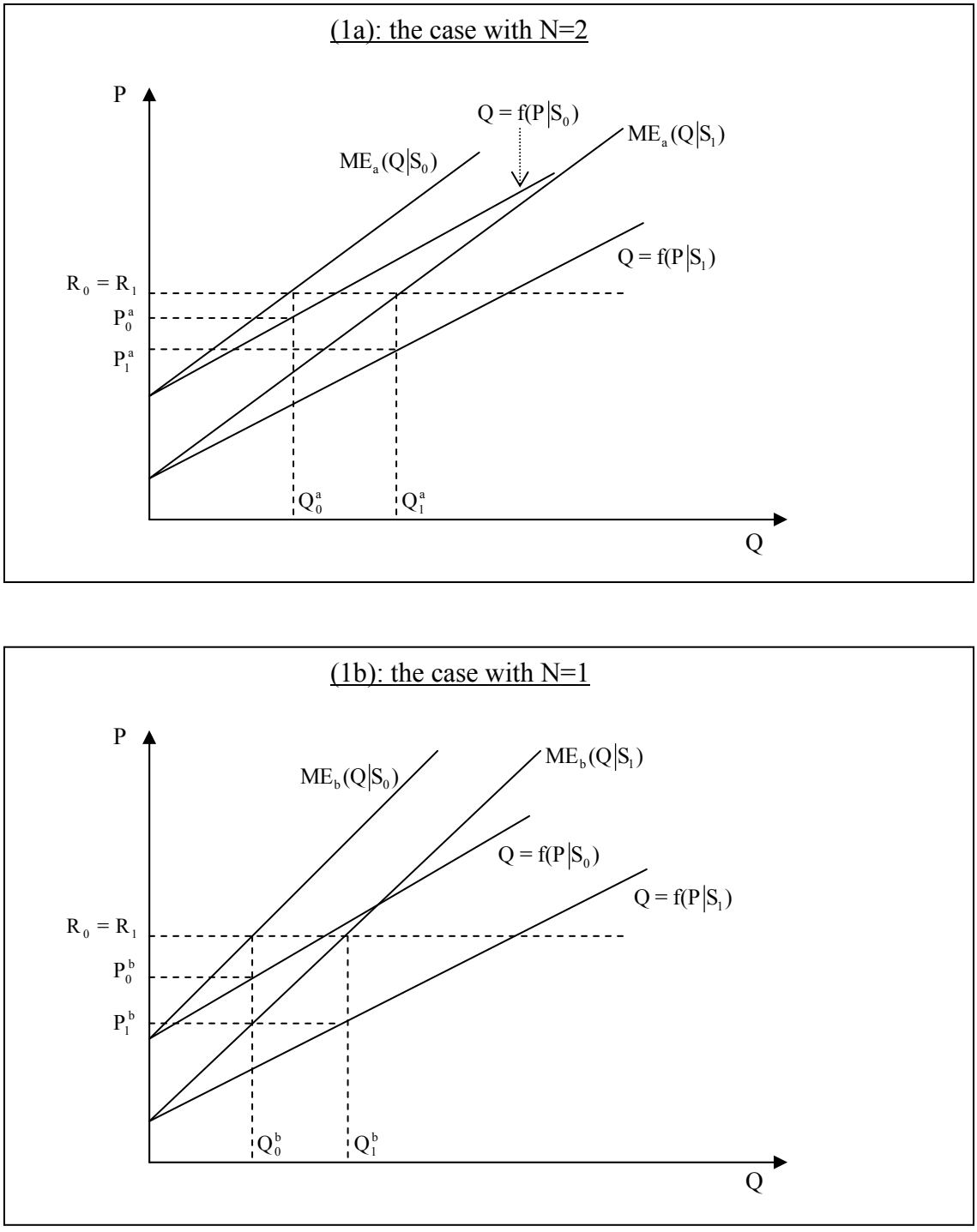


**Figure 1. The Effect of Adult Cattle Stock on Cattle Procurement Price.**

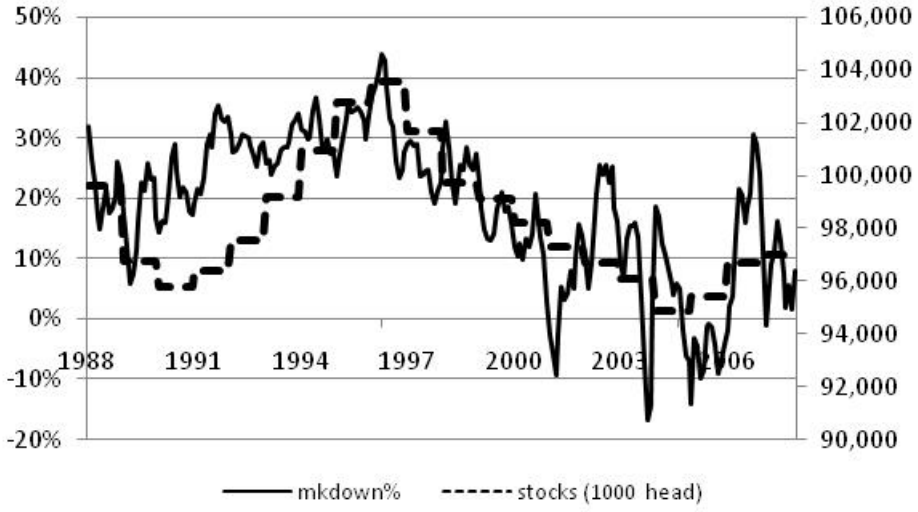


**Figure 2. Oligopsony markdown follows the cattle cycle.**

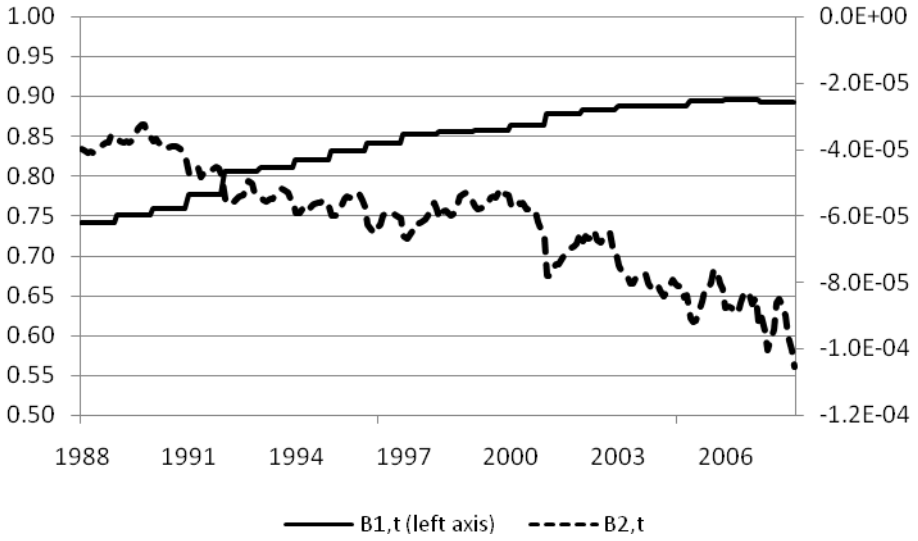


**Figure 3. Market power has declined ($B_{1,t}$ has increased) but the magnification effect ($B_{2,t}$) has increased in absolute value over time.**

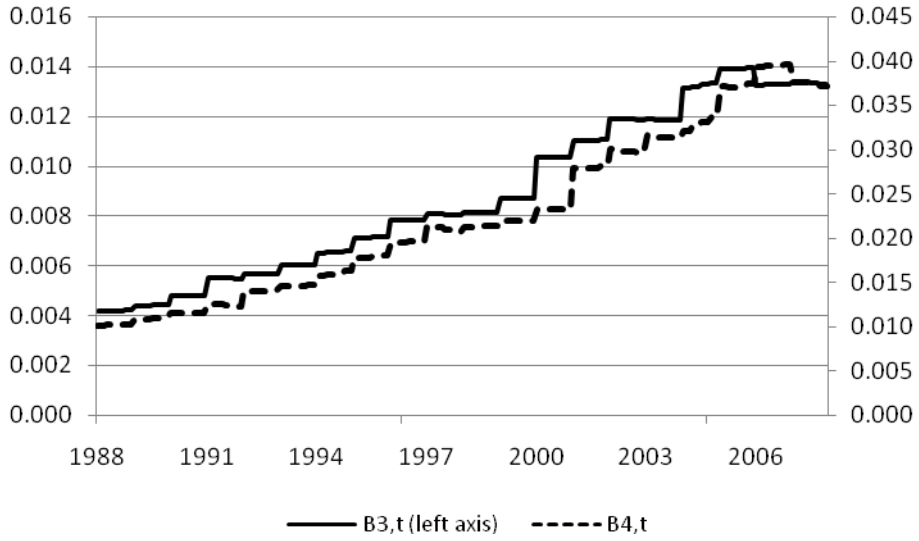


**Figure 4. Price (and cost) expectations today have more of an effect on prices than in the past.**