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Beef production signal under the EUROP grade system

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Abstract: Increasingly parties within the agri-food supply chain, i.e. producers, processors and retailers, need to respond to consumers' demands for product quality and safety. The beef sector has numerous stages in its supply chain, and therefore price signals are very important in passing market signals along the chain. This paper uses weekly R3 and R4 steer and heifer prices in the regional markets of the UK and the Republic of Ireland to examine the effectiveness of the EUROP grade system in sending signals to the farm gate.

Keywords: market signal; EUROP grade system; beef cattle

1 Introduction

Increasingly parties within the agri-food supply chain, i.e. producers, processors and retailers, need to respond to consumers' demands for product quality and safety. The beef sector is no exception. One notable feature of the beef supply chain is the length of the chain; i.e., the product (from calf to beef) changes hands at least three or four times before reaching consumers. Given the number of stages in the beef supply chain, price signals are very important in passing market signals along the chain. This paper focuses on the cattle producer-processor (abattoirs) stage of the beef supply chain. This stage is chosen because finished cattle are the sole raw input in beef production and are a key determinant of the quality of the final product. Within the UK, most finished cattle are sold to processors on a deadweight basis (around 80% in GB and even higher in NI, AHDB 2015, Oxford Economics 2013), which is based on the EU wide grading system (EUROP). This paper draws on economic theory and time-series econometric analysis to examine the effectiveness of the EUROP system in sending quality requirement signals to cattle producers.

Products may be described by their multiple dimensions of attributes, only a subset of which concern their quality. Within the literature, product attributes are categorised into three categories: search attributes, experience attributes and credence attributes (Darby and Karni, 1973; Raynaud *et al.* 2005). Search attributes are attributes that can be evaluated before purchasing; experience attributes are those that can be evaluated after consuming the product; while credence attributes are those that even the consumption does not bring information on the quality (Raynaud *et al.* 2005). Using beef as an example, the weight of a piece of beef is its search attribute, the taste an experience attribute and antibiotics used in raising the cattle a credence attribute. Search attributes can be defined and measured before purchasing; hence easily communicated through prices. However, there is the problem of asymmetric information between sellers and buyers for the experience and credence attributes and therefore price may not be a very useful tool. In the case of beef (and other food products as well), a further complication is that the evaluation of experience attributes is often subjective. Another factor, together with the difficulty in measurement, that contribute to the cloudy relationship of quality and price is the variability in product quality (Raynaud *et al.* 2005). In the beef sector, given the complexities in defining and measuring “quality” the price discovery process is difficult from the very beginning of the chain.¹

The EU-wide EUROP grading system classifies carcass based on their conformation and fat class. The name EUROP refers to grades of conformation, where E is excellent, U is

¹ Price discovery and price determination are two different concepts. Distinguishing the two is helpful (but not always easy) in analysing the supply chain problem. As defined in Schroeder et al. (1997): “*Price discovery is the process of buyers and sellers arriving at a transaction price for a given quality and quantity at a given time and place.*” And “*price determination is the interaction of the broad forces of supply and demand which determine the market price level.*” “...transaction prices fluctuate around that market price level. This fluctuation is attributable to the quantity and quality of the commodity brought to market, the time and place of the transaction, and the number of potential buyers and sellers present.”

very good, R is good, O is fair and P is poor. Fat class is denoted by a scale of 1 to 5, with 1 being low, 3 being average, and 5 for very high fat cover (RPA,2011). The meat science literature suggests that conformation and fat class together serve as proxy measures of lean meat yield (LMY), which is different from saleable meat yield (SMY) (Craigie *et al.* 2012). As SMY depends on the fat content desirable in the meat (an experience attribute involves subjectivity), it is very difficult to obtain a harmonised definition of SMY. In the context of the EUROP system, desirable grades generally command price premiums. However, the price premium may vary across regions because of differences in preferences. Investigations of price differences among the various grades help to highlight issues within the supply chain.

Moreover, gaining a better understanding of price differences also sheds light on the effectiveness of the signals sent to producers under the EUROP system. Price differences are not constant over time; and can be small or even inconsistent in signs (+/-). Changes in price differences are caused by the relative supply and demand of the various grades. Inconsistency in signs implies the signals reaching the farm gate are misleading in terms of quality (in other words, prices simply reduce to X cents per kilo of beef for cattle producers). If consistent but small, price differences may still be ignored by producers since these may be over-shadowed by the price fluctuations of the commodity. For example, keeping livestock longer usually results in a heavier weight and therefore producers may still gain if price declines slightly due to general lower prices or grade deterioration or a combination of the two.

This paper uses the time series price data of cattle of different grades (namely, R3 and R4) in six regional markets within the UK and the Republic of Ireland to empirically investigate the EUROP grading system. The availability of detailed carcass information permits the value of a particular carcass under different pricing systems to be analysed, giving insights on what kind of signals a particular pricing system generates (Feuz, Wagner and Fausti, 1992; Johnson and Ward, 2006).

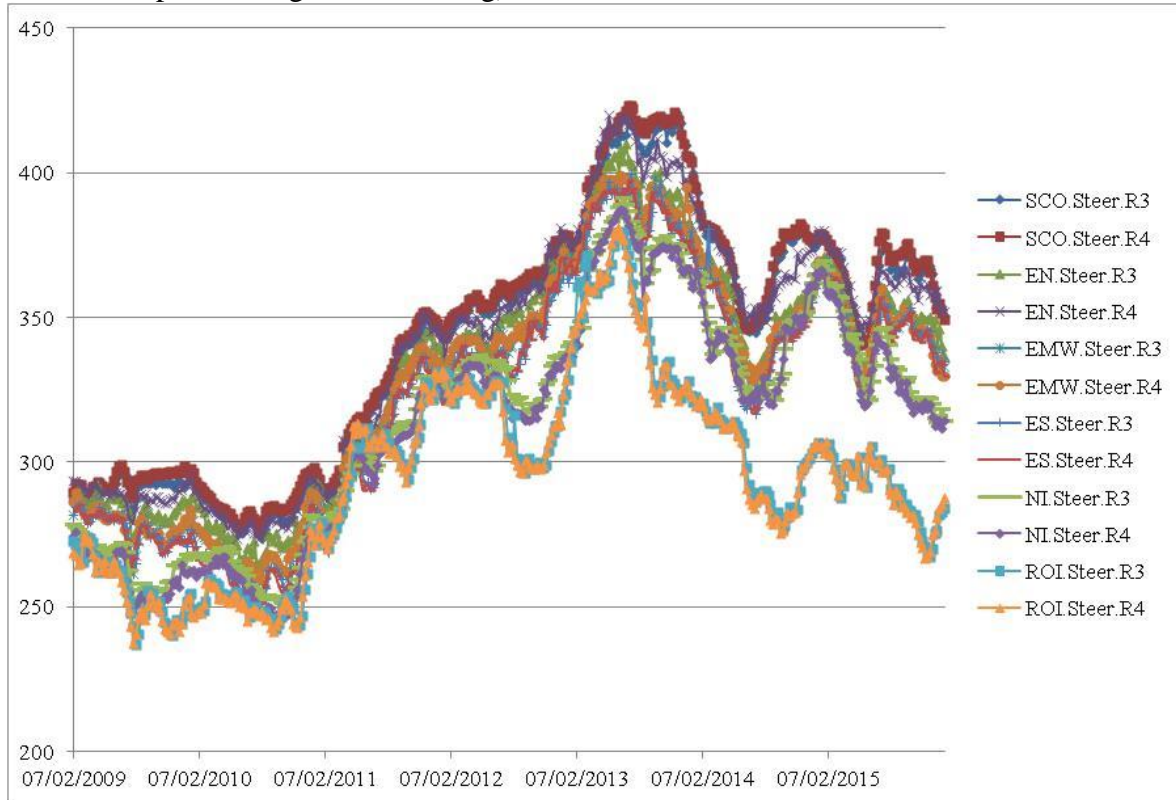
2 Data

The data set consists of R3 and R4 steer and heifer weekly prices (pence per kilogram in Sterling, from February 07, 2009 to January 16, 2016) for the markets of Northern Ireland, Scotland, Northern England, England Midlands and Wales, Southern England and the Republic of Ireland, totalling 24 series, with 363 observations each. Cattle prices in the Republic of Ireland are converted from euro based on weekly exchange rate.

Prices of R3 and R4 grades (together with O grade cows, which are traded at a large discount compared to the other two) are the most commonly reported by industry in the UK. In practice, the conformation and fat class are further disaggregated into sub-grades (usually three for conformation and three for fat class in the UK). However, the disaggregation varies across different regions. Therefore, prices at the aggregate level are more comparable.

R3 and R4 steer prices are shown in Figure 1. Across these twelve price series, R4 in Scotland is the highest, exceeded only very occasionally by R4 in Northern England, while prices in the Republic of Ireland are the lowest. Prices of R4 in Scotland were below but close to 300 p/kg in 2009 and 2010 and increased to around 425 p/kg in the beginning of 2013 and fluctuated around 375 p/kg at the end of the investigation period. The range of prices indicates volatility in cattle prices and a simple regression on weeks suggests R4 Scottish prices increased by 0.32 p/kg per week on average. The rates of increase are slightly lower (0.30 or 0.29 p/kg per week) for the other series within the UK. However, this is not the case for the Republic of Ireland. There were two sharp price drops in the Republic of Ireland, which were barely present in the UK markets, in August 2012 and August 2013. The latter price drop was due to the horse meat scandal, after which the price paths in the Republic of Ireland diverged from the ones in the UK. A simple regression on weeks suggests prices increased by 0.16 p/kg per week on average in the Republic of Ireland.

Figure 1 Weekly R3 and R4 Steer prices of Scotland, Northern England, England Midlands and Wales, Southern England, Northern Ireland and the Republic of Ireland (07/02/2009—16/01/2016 pence/kilogram in Sterling)



3 Methodology

3.1 Analysing the price differences between grades: test of equality of mean

Price differences between R3 and R4 grade cattle of each week are calculated for steer and heifer of individual regional markets. The simple t-test of equality of mean is then applied to confirm whether the price differences are statistically significant.

3.2 Price trends: unit root and cointegration tests

As shown in Figure 1, cattle prices are fairly volatile. To investigate whether price changes in different regional markets follow the same trend, unit root tests are firstly applied to the full sample of each data series to test for the presence of a unit root. The Augmented Dickey-Fuller (ADF) test of the following form is used:

$$\Delta y_t = \mu + \tau t + \rho y_{t-1} + \sum_{j=1}^k C_j \Delta y_{t-j} + \epsilon_t \quad [1]$$

where y_t is the price and t represents the trend term. The null hypothesis is that there is unit root in the data.

This test is widely used as a preliminary test for cointegration analysis. When the data series is confirmed to be integrated of order 1, the cointegration test and estimation can be applied to the multiple series using the vector error correction model (VECM). An example of system involving two variables is shown as follows:

$$\Delta y_{1,t} = c_1 + \alpha_1 (c_3 + \beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \sum_{i=1}^p \Gamma_{i,1} \Delta y_{1,t-i} + \sum_{k=1}^p \Gamma_{k,2} \Delta y_{2,t-k} + \epsilon_{1,t} \quad [2]$$

$$\Delta y_{2,t} = c_2 + \alpha_2 (c_3 + \beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \sum_{n=1}^p \Gamma_{n,1} \Delta y_{1,t-n} + \sum_{j=1}^p \Gamma_{j,2} \Delta y_{2,t-j} + \epsilon_{2,t} \quad [3]$$

where $\{y_{1,t}\}$ and $\{y_{2,t}\}$ denote the two price series and p is determined by the Schwarz Information Criterion (SIC). $(c_3 + \beta_1 y_{1,t-1} + \beta_2 y_{2,t-1})$ can be interpreted as the long-term equilibrium relationship between the two data series in which c_3 is the constant term. In the two variable system, β_1 is normalised to one and β_2 indicates change in y_1 with respect to 1 unit change in y_2 . A negative value of β_2 indicates the two prices move in the same direction. The coefficient α_i (in absolute terms) can be interpreted as the speed that y_i adjust to the changes that disturb the equilibrium. Statistical significance of the cointegration relationship is tested using the procedure developed in Johansen (1991, 1995).

4 Results

4.1 What are the price differences between grades?

Table 1 shows the average price differences between R3 and R4 grades for steer and heifer respectively in the regional markets of the UK and the Republic of Ireland during the seven year period. The weekly price differences are tested to be significantly different from zero statistically for all the series. In absolute terms, the average price differences range from

0.36 to 7.60 pence per kilogram. The range may appear to be wide; however, compared to cattle prices, these convert to between 0.1% to just over 2% of the cattle price.

Price differences between gender (i.e. steer versus heifer) for the same grade are also calculated and tested. Northern Ireland and the Republic of Ireland are the only markets that see heifers attract premiums over steers.

The most notable result is that the price differences have opposite signs in different markets. For Northern Ireland, Southern England and the Republic of Ireland, R3 grade animals have a premium over R4 grade animals, indicating that these regions sell beef to markets in which leaner beef is preferred. In contrast, in Scotland, Northern England and England Midlands and Wales, R3 grade animals are discounted against R4 animals, indicating that these regions sell beef to markets in which fatter beef is preferred. In Northern England in particular, R4 steers attract large premiums relative to R3 steers but that for heifers is much smaller.

Table 1 Price differences between grades and gender in regional markets

Regions where there is premium on R3 over R4					Regions where there is discount on R3 relative to R4				
	Gender	Average price difference between grades (R3-R4)	Average price difference between gender (steer - heifer)			Gender	Average price difference between grades (R3-R4)	Average price difference between gender (steer - heifer)	
			R3	R4				R3	R4
Northern Ireland	Steer	3.29	-1.36	-0.85	Scotland	Steer	-2.40	1.54	1.9
	Heifer	3.80				Heifer	-2.04		
Southern England	Steer	0.40	1.23	1.36	Northern England	Steer	-7.60	1.6	7.68
	Heifer	0.53				Heifer	-1.52		
Republic of Ireland	Steer	0.45	-9.18	-8.89	England Midlands and Wales	Steer	-0.68	0.46	0.78
	Heifer	0.74				Heifer	-0.36		

4.2 Do prices follow the same trend?

The unit root test shows that unit root is present in each of the price series. To test for cointegration, steer prices of different regional markets are used.² The significance levels of the cointegration relationship for each market are shown in Table 2. Price series in England and Wales are highly cointegrated with each other. For Scotland, cointegration is significant only at the 0.10 level. All the β 's in Equations [2] and [3], i.e. price change in one variable in response to the other, are close to 1.

Northern Ireland is an interesting case. Here the results indicate that R4 prices move closer to prices in England and Wales than R3 prices. This is probably due to logistic reasons, with Northern Ireland being closer to the northern part of Great Britain and therefore relatively more beef from R4 cattle is exported. However, Northern Ireland is the regional market where R4 cattle receive the most discount in the whole UK.

Table 2 Significance level of the cointegration relationship in R3 and R4 steer prices

	Significance level of cointegration
England and Wales (R3 and R4 together)	<0.05
England, Wales and Scotland R3	<0.1
England, Wales and Scotland R4	<0.1
England, Wales and Northern Ireland R4	=0.1
England, Wales and Northern Ireland R3	>0.1
Prices in the Republic of Ireland are not cointegrated with the UK.	

4.3 Are price differences consistently greater or smaller than zero?

After confirming most of the price series follow the same trend, the price differences between grades are further investigated. The proportion of weeks in which the R4 price is higher than the R3 is calculated in each market. The R4 prices are also compared to lags of

² After unit root test, an ARIMA model is applied to each of the series. Applying this model demonstrates that the behaviour of steer prices among regions are more similar than that of heifer prices. Modelling steer prices involves autoregressive terms of up to order of 2 while modelling heifer prices sometime involves autoregressive terms of a higher order. This may reflect the fact that heifer prices are affected by restocking and destocking of the herd in general. Cointegration among steer and heifer prices within each regional market is tested to be highly significant.

the R3 prices of one to eight weeks. The purpose of the procedure is to examine the magnitude of the premium or discount against short term price fluctuations. Results are summarised in Table 3.

As expected, in regions where the R3 attracts a premium over R4, the chances that R4 price is higher than R3 are all less than 50%. The smaller the premium, the closer the proportion is to 50%. The opposite applies to regions where R3 is discounted against R4. When compared to lags of R3 prices, these proportions move towards 50%. In Southern England and England Midlands and Wales, where the price differences are the smallest (but still significantly different from zero), these proportions are very close to 50%. This indicates that the signal that one grade is preferred to the other has weakened. Steer in Northern England is an exception. The large premium for R4 helps to support the superiority of the grade throughout.

Table 3 Proportions of weeks with R4 price higher than R3 price (or its lags) in regional markets

Regions where there is premium on R3 over R4	Gender	Price difference (R3-R4)	Chances of R4 price higher than R3 the same week	Chances of R4 price higher than R3 after 1 weeks	Chances of R4 price higher than R3 after 4 weeks	Chances of R4 price higher than R3 after 8 weeks	Regions where there is discount on R3 relative to R4	Gender	Price difference (R3-R4)	Chances of R4 price higher than R3 the same week	Chances of R4 price higher than R3 after 1 weeks	Chances of R4 price higher than R3 after 4 weeks	Chances of R4 price higher than R3 after 8 weeks
Northern Ireland	Steer	3.29	5%	11%	31%	38%	Scotland	Steer	-2.40	98%	85%	70%	66%
	Heifer	3.80	2%	9%	28%	36%		Heifer	-2.04	91%	81%	69%	64%
Southern England	Steer	0.40	38%	43%	47%	49%	Northern England	Steer	-7.60	99%	98%	92%	83%
	Heifer	0.53	35%	44%	46%	48%		Heifer	-1.52	72%	69%	60%	58%
Republic Of Ireland	Steer	0.45	40%	42%	45%	40%	England Midlands and Wales	Steer	-0.68	69%	61%	53%	56%
	Heifer	0.74	24%	40%	43%	42%		Heifer	-0.36	62%	56%	50%	54%

Note: "Chance" refers to proportion of weeks in which R4 price higher than R3 (or its lag) out of all weeks.

5 Conclusion and discussion

Our analysis covers six regional markets in two countries. Regional cattle prices in the UK generally follow the same trend. Prior to 2013, prices in the Republic of Ireland also closely followed those in the UK but less so after the horse meat scandal.

Price differences between grades vary across regional markets both in magnitude and signs, even within the UK. Preferred grades general command a price premium. Therefore, price differences reflect to some extent the fact that regional preferences differ. However, if one is to pursue building quality into the grading system (such as the ones in the US or Australia), how is this pursuit and the diversity in regional preference to be reconciled?

Under the current EUROP system, price differences between grades are found to be significantly different from zero in all the regional markets in the UK and the Republic of Ireland. However, these differences are small in most cases, especially when compared to the cattle prices. The data also reveals which is the preferred grade in a particular region. The chance that a less preferred grade yields a value more than the preferred grade increases when prices of neighbouring weeks are examined. In other words, the price differences can be easily over-shadowed by cattle price fluctuation. With the prices under the current system, producers have motive to pay more attention to short-term market fluctuations than to the grades. This suggests that there may be an insufficient incentive for producers to shift from a production oriented approach to a consumer oriented approach whereby producers target the most sought-after grades. This cast doubts on what signal the EUROP system sends to the farm gate.

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