Effectiveness of Price Signals under the EUROP Grading System: Analysis of Beef Prices in Northern Ireland

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1.   Background

Increasingly, supply chains need to respond to consumer needs more effectively as preferences are becoming more sophisticated, specific and varied. Some supply chains within the agri-food sector have responded to these needs through introducing tighter forms of coordination, with upstream and downstream components of the supply chain working more closely together (MacDonald, 2015). For example, contracts are used extensively by retailers and processors in the pigs and poultry sectors to enforce greater process control, with firms benefiting from predictable throughput. This trend is less apparent in the beef sector, where differences in production characteristics mean that it is more difficult to implement tighter coordination strategies. For example, the wide genetic base of livestock in the beef sector reduces the ability to produce consistent products for consumers. In addition, beef production is characterised by multiple stages of production, with cattle potentially being transferred to several farms prior being sold to market. It is more difficult for beef finishers to enter long-term contracts that contain quality specifications as they do not fully control their supply chain (Lawrence and Hayenga, 2002).

As a result, spot markets will continue to play an important role in coordinating production within the beef sector. Prices within the spot market provide a mechanism to pass market signals along the supply chain. Prices of similar transactions should converge to a common "market price" as buyers avoid paying excessively high prices and sellers do not accept excessively low ones. For consumers, market prices signal the degree of product scarcity and stimulate production of product attributes that consumers prefer. For sellers, market prices provide signals of buyer preferences and elicit flows of inputs and services (MacDoanld *et al.*, 2004). Thus, market prices within the spot market system should directly signal consumer preferences to producers and guide production decisions to fulfil consumer demand.

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 classification scale (EUROP). Under the EUROP grading system, carcasses are classified based on their conformation and fat class. The name EUROP refers to grades of conformation, where E is excellent, U is 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 (Rural Payments Agency, 2011). Animals receive bonuses/penalties according to whether they meet certain specifications of the major retailers regarding grade, weight, age, Farm Quality Assurance and Country of Origin. However, many commentators have raised question marks regarding the effectiveness with which market signals are transmitted within the grid pricing system. This is apparent in Northern Ireland, with a

high proportion of animals not meeting retail specification requirements. For example March 2016 figures indicate that only 34% of steers and heifers fulfilled all the retail specification requirements in Northern Ireland. To some extent this may reflect the failure of all plants to strictly impose price penalties (LMC, 2012). However, as reported by Simmons *et al*. (2003) problems with out-of-spec animals has been a persistent issue for the red meat sector in the UK. The authors partly attributed the slowness of many producers to respond to price signals due to continued allegiance to the 'production concept', where animals are pushed onto the market based on what farmers have traditionally produced on their farm or what they believe to grow best there, rather than adopting a more consumer oriented approach. In addition, opportunistic trading by both buyers and sellers within the spot market also potentially contributes to the out-of-spec problem, with stock being held back or pushed forward based on short term market fluctuations.

If the spot market fails to send appropriate signals along the supply chain producers will not produce the product attributes desired by consumers, which will ultimately undermine consumption. This may partly explain the long-term decline in per capita consumption for beef in the UK, which fell by 19% between 1985 and 2014 (Figure 1). In contrast, during the same time per capita consumption for poultry increased by 80%[1].

Figure 1: Per capita meat consumption trends in the UK (Total new supply divided by UK population)
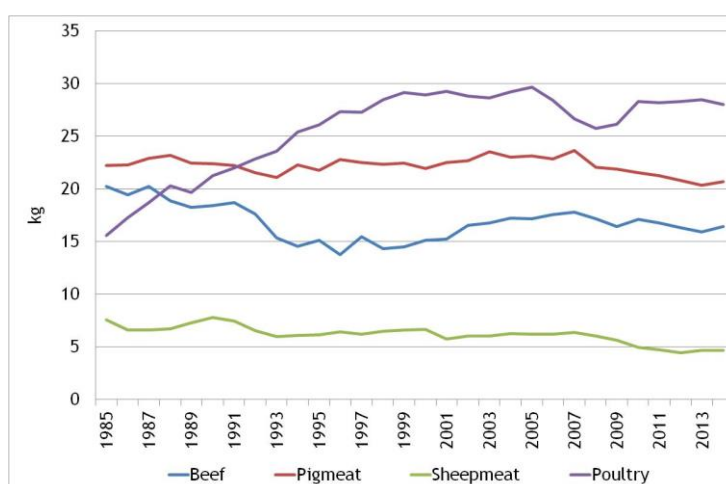
Source: Agriculture in the UK

As a result, it is important to empirically quantify the incentives provided by prices within the EUROP grading system to determine to what extent concerted efforts should be made to improve this grading system and its effective implementation within the food chain. Within EUROP, desirable grades should command price premiums. However, price

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[1] These figures are based on Agriculture in the UK meat supply data. While this measure incorporates stocks it provides a measure of trends in meat consumption and is used as a measure of per capita consumption within the literature, e.g. Kanerva (2013).

premiums may vary across regions due to differences in consumer preferences. Moreover, price differences may be small and vary over time (even displaying inconsistent signs (+/-; *i.e.* specific grades receive a premium during certain time periods and are discounted in others)). Changes in price differences are caused by the relative supply of and demand for the various grades. Inconsistency in signs implies the signals reaching the farm gate are misleading in terms of quality. Even if the signs are consistent, if they are small, price differences may be ignored by producers since they 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 even if the carcass commands a slightly lower price per kg due to a delay in response to lower general prices or grade deterioration.

This paper analyses the time series price data for cattle of different grades (namely, R3 and R4) in six regional markets within the UK and the Republic of Ireland to empirically investigate the effectiveness of the signals sent to producers under the EUROP system. The availability of detailed carcass information permits the value of a particular carcass within different regional markets to be investigated and thereby provide insights on the signals within the supply chain (Feuz, Wagner and Fausti, 1992; Johnson and Ward, 2006).

2.   Main Findings

This section provides an overview of the main findings. A detailed description of the dataset and analysis is provided in the Appendix.

Grade and Gender Price Differentials

- The results reveal different price premiums within Northern Ireland compared to other regions in the UK. With regards to carcass grades, R3 grade animals have a premium over the fattier R4 grade animals in Northern Ireland, which is in direct contrast with Scotland, Northern England and England Midlands & Wales. The difference in the values attached to the grades should reflect consumer preferences regarding meat leanness and fat content, with the results suggesting that there is a preference for lean beef in Northern Ireland and fattier beef in certain regions of GB. Note, the price premium for R4 in Scotland may also reflect the more widespread presence of premium breeds, e.g. Aberdeen Angus, which are more likely to be killed-out at the R4 grade (Oxford Economics, 2013).

- The price differential between R3 and R4 grades is negligible in RoI.

- With regards to gender, Northern Ireland is the only region in the UK in which heifers attract a price premium compared to steers. The difference in price premiums for steers and heifers is puzzling as there is little evidence for divergences in consumer preferences in meat eating quality based on gender of animal (MLC Blueprint, 1990). The premium for heifers in Northern Ireland

may be partly related to links with the RoI market as heifers also attract a premium in the south but to a greater extent.

- The contrasting price signals in NI compared to other regions supports the argument that the quality information provided by the EUROP grading system is limited and hence there is little incentive passed up the chain to encourage quality improvements.

- If there are genuine differences in consumer preferences across regions it will be difficult to build these diverse preferences within enhanced quality grading systems, such as those in the US or Australia, as these systems are parameterised based on specific consumer preferences.

Short-term Price fluctuations

- Although there is evidence of statistically significant price premiums for different grades, these differences are small relative to overall cattle prices and can easily be over-shadowed by short-term market price fluctuations. The limited differentials mean that the price signal that one grade is preferred to another weakens over a short period of time.

- This weakening in grade price signals casts doubt on the effectiveness of the premiums within the current grading system since producers may be more motivated to pay more attention to short-term overall market fluctuations rather than the grades of the carcass. It is questionable therefore, whether the incentives under the EUROP grading system are sufficient for producers to shift from a production oriented approach to a consumer oriented approach whereby producers target the most sought-after grades.

Appendix: Detailed information on Data, Methodology and Results

A.1 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 following markets:

- Northern Ireland,
- Scotland,
- Northern England,
- England Midlands and Wales,
- Southern England and
- Republic of Ireland.

This yields 24 series, with 363 observations each. Cattle prices in the Republic of Ireland are converted from euro based on the 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 grades) 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 A1. 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 A1 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)
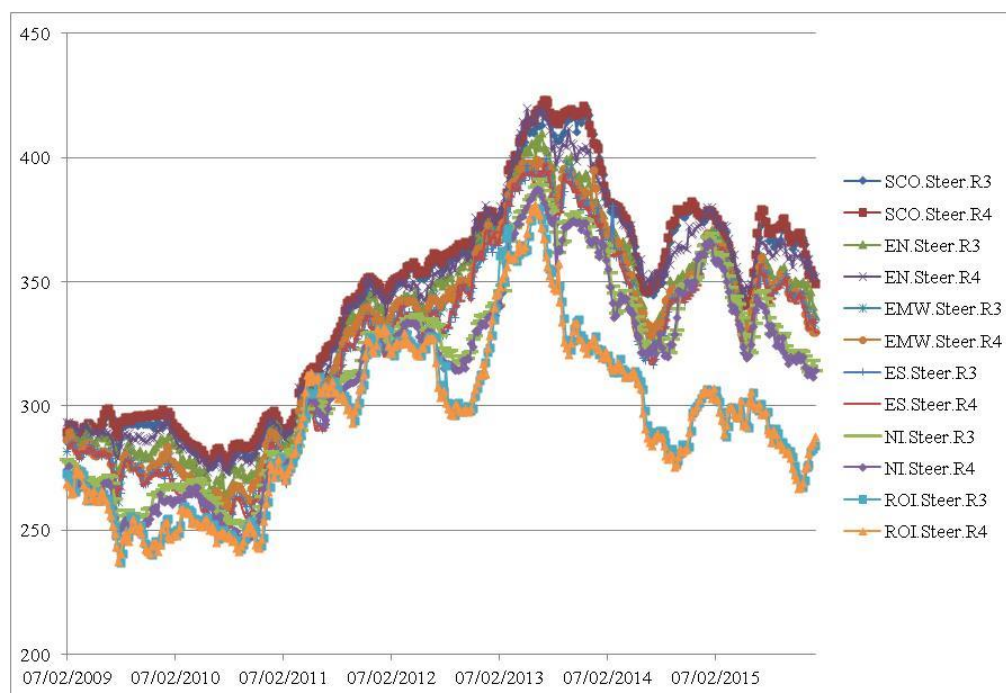
A.2 Methodology

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.

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:

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

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:

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

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

where $\{y_{1,t}\}$ and $\{y_{2,t}\}$ denote the two price series and p is determined by the Schwarz Information Criterion (SIC). $\big(c_3 + \beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}\big)$ 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, B_1 is normalised to one and B_2 indicates change in y_1 with respect to 1 unit change in y_2. A negative value of B_2 indicates the two prices move in the same direction. The coefficient a_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 Johanen (1991, 1995).

A.3 Results

What are the price differences between grades?

Table 1 shows the average price differences between R3 and R4 grades for steers and heifers 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		

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 ß's in Equations [2] and [3], *i.e.* price changes 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 of the UK.

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[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.

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

	Significance level of coinegration
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.	

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 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.

The chance that a less preferred grade yields a value more than the preferred grade increases when prices of neighbouring weeks are examined. 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 weakens overtime. In other words, the price differentials can be easily over-shadowed by cattle price fluctuations over a short timeframe. As a result, producers may be motivated to pay more attention to short-term market fluctuations than to the grades.

The steer category 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 in 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 in 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.

References

Feuz D, Wagner J and Fausti S (1992). An Empirical Analysis of the Efficiency of Four Alternative Marketing Methods for Slaughter Cattle. Department of Economics Staff Paper Series, Paper 90. South Dakota State University: Brookings, South Dakota, USA. Available at: http://openprairie.sdstate.edu/cgi/viewcontent.cgi?article=1089&context=econ_sta ffpaper

Johnson HC and Ward CE (2006). Impact of beef quality on market signals transmitted by grid pricing. *Journal of Agricultural and Applied Economics* 38: 77-90.

Johansen, S (1991). Estimation and hypothesis testing of cointegration vectors in gaussian vector autoregressive models. *Econometrica* 59, 1551-1580.

Johansen, S (1995). *Likelihood-based Inference in Cointegrated Vector Autoregressive Models*. Oxford, UK: Oxford University Press.

Kanerva, Minna (2013). Meat consumption in Europe: Issues, trends and debates. Bremen: Artec, ISSN 1613-4907.

Lawrence, John D., and Marvin L. Hayenga (2002). "The US pork and beef sectors: divergent organizational patterns, paradoxes and conflicts." Paradoxes in Food Chains and Networks: 512-521.

LMC (2012). Penalties and deductions on weight. LMC Bulletin No. 2241, 3rd November 2012.

MacDonald, James M., Janet Perry, Mary Clare Ahearn, David Banker, William Chambers, Carolyn Dimitri, Nigel Key, Kenneth E. Nelson, and Leland W. Southard (2004). "Contracts, markets, and prices: Organizing the production and use of agricultural commodities." USDA-ERS Agricultural Economic Report 837.

MacDonald, James M (2015). "Trends in Agricultural Contracts." Choices 30, No. 3.

MLC. (1990). A Blueprint for improved consistent quality beef. In). Milton Keynes: The Meat and Livestock Commission.

Oxford Economics (2013). Regional price disparities in deadweight cattle: understanding the NI/GB price differential. UK. Available at: https://www.lmcni.com/site/wp-content/uploads/2015/04/regional-price-disparities-in-deadweight-cattle-dec13.pdf

Rural Payments Agency (2011). Beef carcase classification scheme: guidance on dressing specifications and carcase classification. UK. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/299230/bccs2_nov_2011_v_4.0.pdf

Simmons, David, Mark Francis, Michael Bourlakis, and Andrew Fearne (2003). "Identifying the determinants of value in the UK red meat industry: A value chain analysis approach." Journal on Chain and Network Science 3, no. 2: 109-121.