**Hedonic Analysis of Consumers’ Valuation of Country of Origin of Meat in the United Kingdom**

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**Abstract**

We estimate the implicit prices consumers are willing to pay for country of origin labels, using hedonic price methods and panel data for meat and meat products in the United Kingdom (UK). Our results show that consumers place significant value on origin information across fresh and processed meat products, especially since the horsemeat incident in 2013. The findings also suggest that retailers have increased the use of voluntary labelling of processed meat products since the incident. Hence, further extension of existing mandatory labelling requirements to processed meat products may not be required at least in the short term.

**Key Words:** Consumer Preference, Hedonic Price, Meat, Country of Origin Labelling, UK

**JEL:** D120

1. **Introduction**

Consumers are continually confronted with a wide range of product quality attributes signalled through packaging, branding, advertising and other channels. Among these attributes is country of origin labelling (CoOL) information which may influence consumers’ preferences and purchase choice. Research suggests that CoOL effects consumer evaluations of products with consumers using CoOL as an extrinsic cue to make judgments about quality (Agrawal and Kamakura, 1999). Essentially, origin information contributes to food choices, consumer knowledge and perceptions of quality (Deselnicu et al., 2013; Bonroy and Constantatos, 2015). Such beliefs and resulting expectations may exist even when consumers are largely unaware of origin labelling laws (Tonsor et al., 2013).

The use ofCoOL for food has increased markedly because of growing awareness and concern about food quality and safety as many consumers place value on the traceability of the food they eat (Herrmann and Teuber, 2011). In particular, meat authenticity and origin has attracted the attention of European food regulators, industry and consumers, following the undeclared but intentional substitution of beef with horsemeat in 2013 (HM Goverment, 2014). This substitution affected a wide range of products including minced beef, burgers and ready meals such as lasagnes, pastas and pizzas sold in the United Kingdom (UK) and the European Union (EU). In total 4,144 beef products were tested for horse DNA across the EU and 192 beef samples contained horsemeat at the time. The largest number of positive tests for undeclared horsemeat was for products for sale in France (House of Commons, 2013). More disturbingly, some of the substitute meat came from horses not approved for human consumption as the meat contained a potentially harmful veterinary drug phenylbutazone or bute. The UK had the largest number of positive results for bute (House of Commons, 2013). Tests also revealed the presence of substantial pork meat and traces of pork DNA in a range of processed beef and chicken products (HM Government, 2014).[[2]](#footnote-2) Media coverage of the incident may well have affected consumer confidence in imported meat. A YouGov (2013) poll found that 79% of UK consumers preferred to buy UK-sourced meat and poultry compared to imported meat.

The implications for food policy and industry practices are significant, highlighting serious challenges in ensuring authenticity and preserving reputation within complex EU meat supply chains. Subsequently, the EU Commission initiated a range of administrative and legislative reforms to increase industry compliance with existing CoOL for beef. The legislation requires producers to provide a unique product identification number, the name of the EU member state or third country in which the animal or group of animals were born, raised and slaughtered as well as the licence number of the cutting plant (European Parliament, 2014). In addition, as of April 2015, fresh, chilled and frozen pig, poultry, sheep and goat meat have to indicate the animal’s country of rearing and slaughter (European Parliament, 2013).

Nevertheless, existing EU CoOL regulations do not apply to beef or other non-beef products sold unlabelled over the counter and uncooked meat that has been seasoned or is included as an ingredient (e.g. steak and kidney pies). As a result, there were calls for extending the existing CoOL labelling for fresh meat to all processed meat to ensure the authenticity of these products (European Parliament, 2015). Despite the significant shift in EU CoOL policy toward stricter controls, the apparent changes in the industry sourcing practices and reported changes in consumer valuation of CoOL, it remains to be demonstrated: (a) whether or not consumers actually or are prepared pay a premium for meat and meat products labelled with British or other trusted CoOLs; or (b) if consumer valuation of different origins has indeed changed as a result of the horsemeat incident.

We provide empirical evidence of UK consumers’ valuation of CoOL for meat. We use a unique revealed preference data set on aggregate meat retail sales within a multilevel hedonic price modelling approach. We estimate the implicit prices consumers’ have paid for CoOL across a sample of top-selling meat and meat product lines in the UK from 2010 to early 2015 using monthly retail data. Our results contribute to the literature on meat origin labelling in the UK, and in particular on the potential effect of the recent horsemeat incident on consumer demand. In addition, most existing research takes CoOL to be a static construct. However, with exogenous shocks to the food system such as food scares, there can be significant changes in the values attached to CoOL. Our data enables us to track changes over time, including identification of the effects of the horsemeat incident.

Our use of the hedonic price approach is motivated by two important issues. First, CoOL is a credence attribute which consumers’ value but cannot verify even after consumption and therefore have to rely on other information such as brand reputation (Lim et al., 2013). An hedonic regression of meat price with respect to CoOL identifies the implicit price for the attribute (Costanigro and McCluskey, 2011; Schulz et al., 2012). Second, our study is one of the first to use revealed preference methods to examine CoOL generally (e.g. Taylor and Tonsor, 2013) and specifically within the UK. Indeed there is virtually no revealed preference research on meat origin labelling, or on the potential impact of the horsemeat incident on demand, for the UK.

We begin by reviewing the literature on hedonic price function estimation for food with a specific focus on meat, as well as empirical research on CoOL. Section 3 describes the data we use which influences our model estimation strategy, discussed in Section 4. Section 5 presents our results and the final section concludes.

1. **Hedonic Analysis, CoOL and the Horsemeat Incident**

Rosen (1974) formalised the hedonic price model, consisting of two stage regressions, although most studies only implement the first stage, as we do here (Costanigro and McClusky, 2011). In the first stage, the prices of goods are regressed on the goods’ attributes to estimate an implicit price for each attribute. The coefficients in this regression are econometrically interpreted as the (marginal) market price for an attribute (Bajari and Benkard, 2005). Thus, if we assume that a market is in equilibrium, this marginal price can be viewed as a lower bound measure of willingness-to-pay (WTP) for consumers who purchase a product with that attribute, whilst the marginal price becomes the upper bound WTP for consumers who do not purchase the same product (Griffith and Nesheim, 2013).

Hedonic price functions have been widely employed to determine implicit prices of food and beverage attributes (especially for fish and wine) for which there is no separate market (Costanigro and McCluskey 2011). However, there are only a small number of studies that have examined meat products using hedonic price functions and virtually no studies that have explicitly addressed meat and CoOL.

With regard to meat, the majority of studies reported in the literature consider US data including Hahn and Matthews (2007), Parcell and Schroeder (2007), Schultz et al. (2012) and Vickner (2015). Studies undertaken in other countries include Ahmad and Anders (2012) in Canada. Many older studies focussed on beef with more recent research beginning to examine a wider set of meat products including chicken (Ahmad and Anders, 2012) and sausages (Vickner, 2015).

Most studies have employed a relatively simple range of functional forms (e.g., linear, log-linear, log-log) and associated econometric specifications (e.g. Ordinary Least Squares (OLS), Least Squares Dummy Variables and Within Fixed Effects), which may reflect a lack of formal theory to guide model specification. The literature to date provides limited guidance on which variables to include explicitly within a model specification, and little discussion of how unobserved variables may bias results. In contrast, with regard to seafood both Asche et al. (2015) and Bronnmann and Asche (2016) have noted the need to use error clustering so as to take account of the fact that standard errors may be correlated within specific economic units (e.g. supermarkets) within a dataset.

However, the literature does suggest that branding meat products yields a price premium for retailers (Parcell and Schroeder, 2007; Schultz et al., 2012). It has also been established that convenience generates a price premium (Vickner, 2015) which has important implications for future product development. However, there is virtually no consideration of CoOL in this literature, reflecting the lack of data on country of origin, and what there is has a US focus. For example, Taylor and Tonsor (2013), used retail grocery-store scanner data to estimate a Rotterdam demand model of meat products. Although not estimating an implicit price for CoOL, Taylor and Tonser (2013) do not find any changes in demand for meat following the US introduction of mandatory requirements for meat origin, and argue that producers and consumers may have experienced a welfare loss due to the compliance costs imposed on the meat industry.

In contrast to the limited research using revealed preference data and hedonic price functions to examine CoOL, there is a much larger literature using stated preference research which reflects the need to understand consumer preferences prior to the introduction of CoOL. This research has been conducted in many countries and much of the literature has focussed on beef. In a recent review of this literature, Balcombe et al. (2016) note that that consumers, across countries, appear to place a positive value on CoOL for meat, though there is limited research conducted in the UK. One exception is Meas et al.(2014) who used a discrete choice experiment (DCE) to assess British consumers’ preferences for domestic and imported beef. They found a strong preference for domestic beef in autumn 2013, which might partly reflect the effects of the horsemeat incident. Balcombe et al. (2016) also report the results of an extensive DCE for 12 meat products. In keeping with the existing literature they also report positive estimates of willingness to pay for CoOL, although the strength of preferences was much greater for fresh meat compared to processed products such as chicken curry and pepperoni pizza.

Finally, we also note that has been limited research examining the impact of the horsemeat incident. Using retailer specific data, Yamoah and Yawson (2014) report a significant fall in demand for certain meat products sold by Tesco’s in the six weeks immediately following the horsemeat incident. In contrast, Agnoli et al. (2016) used a DCE to examine how consumers in six European countries reacted to the horsemeat incident, finding that consumers are clearly concerned about meat authenticity and that domestically sourced meat is preferred.

In summary, the existing literature lacks economic analysis of the horsemeat incident and the real value placed by UK consumers on CoOL for meats. No one has used market data to determine whether (a) consumers stated preferences (measured by value) actually translate into revealed preferences, and (b) how these preferences have been influenced over time as a response to the horsemeat incident.

1. **Data**

We use aggregate level market data obtained from the Kantar World panel for fresh and processed retail meat sales of beef, lamb, pork and chicken over a five year period between February 2010 and January 2015.[[3]](#footnote-3) The market level data we use were generated as the sum of all purchases of the products we examine, providing the unit price per product and the equivalent price per kilogram. We restricted our focus to a sample of the highest selling meat product lines (i.e., stock keeping units (SKUs)), identified and generated by Kantar. Thus, although our product coverage is selective it does mean that our analysis does examine consumer use of CoOL in detail.

Specifically, our dataset is an unbalanced monthly panel comprising 19 SKUs, containing single or multiple retail products yielding 881 observations over the data period. Within any SKU containing multiple retail products, we are able to differentiate products by packaging size and other marketing attributes such as branding. Importantly, as far as this study is concerned each SKU captures products with the same intrinsic attributes such as species and the use or not of a mandatory CoOL. Crucially, the data capture products legally required to carry a CoOL (mostly fresh beef products), alongside a range of other products for which existing legislation does not require such a label. Products without recorded CoOL are labelled here as undeclared, although some products, such as beef lasagne for example, may well carry a voluntary CoOL stating that the beef comes from the UK.

A description of the variables used in our analysis is provided in Table 1.

**{Approximate Position of Table 1}**

In Table 1, our dependent variable, unit price, has been adjusted for inflation and quality changes over the years, using the UK National Statistics Office’s Consumer Price Index (CPI) for meat (Office of National Statistics, 2014). The mean adjusted price in our data is £5.75/Kg, with a range from £1.62 to £18/Kg. Highest prices are for products labelled as British origin, followed by New Zealand (for lamb), with most products sold for between £2.5/Kg and £7/Kg. There are a small number of premium fresh and processed products with average prices greater than £10/Kg.

Our deflated prices identify the effects of changes in quality on price. In the context of meat labelling, two types of quality changes may have occurred over our data period: (i) compositional change, which may have resulted from reformulation of processed meat product; and (ii) (CoOL) innovation (e.g. increased voluntary labelling) which may have affected consumers’ perception of quality. The price index allows us to control for the quality effect due to, for example, any reformulations of the processed products to improve quality or change composition following the horsemeat incident. Thus, we can isolate and investigate any exogenous changes related to changes in the labelling of these products which may have had significant effects on consumer valuation of CoOL.

The data include country of origin indicators for: British, English, Irish, and New Zealand and undeclared.[[4]](#footnote-4) Importantly, our data capture all top-selling products labelled with these origins. The reason for the limited number of countries is in part explained by the fact that in 2016 92% of UK beef imports came from the EU with almost 70% of total imports coming from Ireland. The limited number of trading partners and the associated composition of trade reflects many issues including the external border tariffs imposed by the EU on meat products.

Table 2 provides a summary of number of data points by CoOL and species,

**{Approximate Position of Table 2**}

which shows that 70% of the products covered by the data are for beef, which also shows much more variation in CoOL designations . The independent or control variables we use are: value category; species; product category; retailer; quality. Brand value has three categories: finest value coding for premium fresh meat cuts, mid-range value coding for most branded fresh meat and chilled or frozen processed products, and value coding for the lowest value mostly processed products such as pizza, lasagne and burgers. Previous research has shown that brand value is an important determinant of price (Owen et al., 2000; Sogn-Grundvåg et al., 2014). Also Roheim et al. (2007) and Bronnmann and Asche (2016) have found that, in addition to brand, that package size, product and process types have an impact on implicit prices.

Our species are: beef; pork; lamb; chicken. We grouped the products into: meat cuts (such as loins, steaks, leg joints); processed products (such as minced meat, burgers, pizza etc). The retail coding identifies the five major UK retailers (Tesco Asda, Sainsburys, Morrisons and M&S) selling the top 20 SKUs in our data. These retailers currently[[5]](#footnote-5) have a grocery market shares of 29%, 16.9%, 16.7%, 11.1 and <2.7%, accounting collectively for more than 70% of UK grocery sales. However, we only have a single product for M&S. Therefore, to avoid biases due to infrequency of recorded sales by this retailer but to retain data for certain products, we merged M&S with Sainsbury, a supermarket which has more overlap with M&S in market share compared to other retailers in the data.

Quality of a product is captured as a dummy variable. Specifically, if quality (e.g., lean, thin cut, etc.) is explicitly signalled on a food label this is coded one. If there is no specific indicator of quality, we refer to this as a standard product and this is coded as zero). Finally, we also included seasonal dummies (i.e., Spring, Summer, Autumn and Winter) to check if the implicit prices are affected by any changes in demand over the year.

1. **Hedonic Price Model Specification**

We use a flexible mixed effects (ME) model, specifically to consider error clustering, since it is reasonable to expect that the horsemeat incident affected the price of different meats differently. As noted, chilled and frozen processed beef products were mainly affected by horsemeat adulterations but significant inter-species cross-contaminations were also found in a range of other processed products e.g. pork in beef lasagnas or Halal-labelled pies. These cross-species effects may have resulted in within-product correlations of unobserved product characteristics. Furthermore, the reported pledge by some supermarkets to source more meat locally suggests that the incident may have altered industry labelling practices such that a greater number of processed products may have been subsequently labelled voluntarily with origin cues e.g. flags. As our data only captures the mandatory origin labels, there may well be further heterogeneity within product category correlations if voluntary labels have affected the consumer preferences in term purchase choice.

Since the effect of the incident on the price of individual products may be clustered at the within product (i.e. SKU) and category levels (e.g. lasagna versus ham pizza), a correlation structure is imposed on the data (Asche et al., 2015; Bronnmann and Asche, 2016). Such a restriction clearly invalidates the classic assumption of independence – that is zero autocorrelation and a constant variance in the error term or non-heteroskedasticity. Hence, hedonic price estimations based on common techniques such as OLS or standard panel models such as the fixed effects model may result in inefficient estimates, which are avoided using a flexible mixed effects (ME) model.

Let $P $denote a $n×1$ vector of prices consumers pay for a unit of meat product and $X' $is a $n×q $ matrix of meat quality attributes desired by consumers. We specify a hedonic price function based on a ME model to describe the relationship between the price and attributes of a particular product as follows:

$P\_{it}= β\_{0}+X'\_{it}β\_{j}+Z'u\_{i}+ ε\_{it}$ (1)

where $β\_{0}$is constant term and$β\_{j} $is a vector of parameters of product attributes. Subscript $i$ identifies a product ($i=1,…,I$),$ j$ is the number of attributes or choices across different products ($j=1,…,J$) and$ t$ is the time of product purchase ($t=1,…,T$). $Z$ is defined as a set of observable product attributes and $u\_{i}$ and $ε\_{it}$ are independent, identically distributed (i.i.d) errors where $u\_{i}\~N(0, Σ\_{u})$ and $ε\_{it}\~N(0, σ\_{ε}^{2})$, and $ Σ\_{u}$ is the variance-covariance matrix of the random effects parameters in this model.

With this model specification, we can allow **Z** to correlate with $u\_{i}$ whilst also offering flexibility to impose a range of possible covariance structures on $Z'u\_{i}$. Given equation (1) how $Z$is modelled yields various specifications. For example, when $Z=0$ we have the standard pooled OLS specification, whereas a random effects (RE) specification is yielded when $Z=1$ (Cameron and Trivedi, 2009). In the latter case, treating $u\_{i}$ as an observed random effect drawn from the population alongside $P\_{it}$ and$ X'\_{it}$, a ME model or RE panel model[[6]](#footnote-6) can be used to estimate effects of changes in one or more of the product attributes $X\_{i}$ on the implicit prices, whilst accounting for the effects of the unobserved heterogeneity $u\_{i}$ on prices. Specifically, equation (1) allows us to model price as a linear ME model with a $n×q$ matrix of fixed effects, $β\_{j}$, which quantify the impact of each of the independent variables, $X\_{it}$, along with an associated random intercept, $Z'u\_{i}$ and an idiosyncratic error term clustered at the product level$ ε\_{it}$ (Bronnmann and Asche, 2016). In this setting, the overall model intercept, $β\_{0}$ can shift randomly. The random parameters for the covariance of $Z'u\_{i}$ measure the extent to which the regression intercept for observations within a given product-level deviates from the overall averaged constant $β\_{0}$.

The main advantage of our approach is that it allows an efficient estimation of $X'\_{it}β\_{j}$, the derivation of correct standard errors for the vector $\hat{β}$ and consistent estimation of $Σ\_{u}$ and $σ\_{u}^{2}$ even if $ε\_{it}$ is heteroscedastic, providing that the overall model error is homoscedastic.[[7]](#footnote-7)

* 1. **Empirical Specification**

We considered several different empirical specifications, including linear-linear, log-linear and log-log. However, as most variables in our data are categorical measures whose response to the changes in the dependent variable cannot be interpreted as absolute marginal changes but rather relative to a base or reference level within each variable, we focussed on linear-linear ME models and evaluated these based on tests for the presence of REs, normality of the residuals and model misspecification[[8]](#footnote-8).

The model we specify in equation (2) is a hedonic price model based on the empirical specification of equation (1):

$Price\_{it}=β\_{0}+β\_{1j}cool\_{it}+β\_{2j }branv\_{it}+β\_{3j}packz\_{it}+β\_{4j }retai\_{it}+β\_{5j }speci\_{it}+β\_{6j }prodc\_{it}+β\_{5j}eatq\_{it}+β\_{7j}Seasonality\_{it}+SKUcodeu\_{i}+ε\_{it}$ (2)

All variables in the model are described in Table 1 and the subscript $i$ identifies the product, $i=1, …19$, whereas $j$ identifies different levels of an attribute or number of choices across different products, e.g. for CoOL there are countries of origin registered for different products plus one undeclared origin, thus five alternative attribute choices $j$=1...5. Finally, ***Z*** is our panel identifier which is equation (2) is modelled using the variable SKUcode.

We are primarily concerned with estimating the average valuation of CoOL across product items and over time. Specifically, consumers’ valuation of different origin labels may have changed over time as result of the horsemeat incident, even if producers and retailers have maintained the same origin information for a product over the data period (e.g. under the mandatory requirement for fresh beef). On the other hand, the producers and retailers may have voluntarily used an origin-label or provided related cues on processed products as result of the shock. Therefore, a ‘random-intercept’ ME model is appropriate in both cases, providing that the unobserved heterogeneity in the model is specified correctly. Following Cameron and Trivedi (2009), we satisfy this condition with the specified random part of the model – that is (a) the use of a maximum likelihood estimator (MLE), and (b) allowing $u\_{i}$ to be correlated with 𝒁 our panel identifier (i.e. SKUCode)and clustering of the variance $Σ\_{u}$ around the same identifier. As $u\_{i}$ reflects an unobserved heterogeneity specific to individual product attributes and it is correlated with the observable product characteristics, the time-varying error component $ε\_{it} $captures unobserved heterogeneity across the SKUCode due to any exogenous changes such as shifts in consumers’ preferences toward or away from consumption of a product(s) with a certain CoOL. Furthermore, given that the dependent variable is price per kilogram, the time varying component of the error term also accounts for the effect of any relative changes in the volume and price of other products labelled with origins not captured by our data.

* 1. **Detecting Structural Breaks**

An advantage of our monthly retail consumption data is that it allows for accuracy in the matching of any consumption changes due to the horsemeat incident and tests of structural change in parameters in the estimated models (Taylor and Tonsor, 2013). For this purpose, we generate a time dummy, *d*, with $d=0 $coding meat sales before January[[9]](#footnote-9) 2013, and *d =1* from February 2013, and we interact $d$ with CoOL, so that we can test for structural changes in the parameters due to the horsemeat incident. The addition of these new regressors means that we modify equation (2) as follows:

$Price\_{it}=β\_{0}+δ\_{1}d\_{t}+β\_{1j }cool\_{it}+δ\_{2j}d\_{t}\*cool\_{it}+β\_{2j }branv\_{it}+β\_{3j}packz\_{it}+β\_{4j }retai\_{it}+β\_{5j}speci\_{it}+β\_{6j }prodc\_{it}+β\_{5j}eatq\_{it}+β\_{7j}Seasonality\_{it}+SKUcodeu\_{i}+ε\_{it}$ (3)

The adjusted model represented by equation (3) is a special case of what is known as a ‘random trend model’*,* with both $d\_{t}$ and $Z'u\_{i}$ allowed to be correlated with the product identifier, so that the mean implicit prices for different CoOLs depend on a product-specific time trend, in addition to the random intercept $ u\_{i}$ (Wooldridge, 2002). Importantly, if $δ\_{2}$ is statistically different from zero, the parameters for individual CoOLs have changed, meaning consumers preferences have shifted across different SKUCodes in the data. Therefore, equation (3) has a causal interpretation: holding other regressors and $ u\_{i} $constant, the difference between the slopes for CoOL category levels is a direct measure of the effect of exogenous changes in preferences from the respective declared origins following the horsemeat incident.

1. **Model Results**

First, we examine our CoOL implicit price results for our general model specification (equation (2)). Then we consider the effects of the horsemeat incident using equation (3), focusing on beef products only as horsemeat was typically substituted for beef.

**{Approximate Position of Table 3}**

Table 3 reports the CoOL results (equation 2). With regard to CoOL, the coefficients for English and Irish origin are both negative and statistically insignificant. In contrast, the coefficient for Undeclared origin is negative and statistically significant, suggesting that consumers are willing to pay on average £2/Kg less for unlabelled products compared to those labelled with a British origin which is set as a reference level. Although we may have a priori expected a negative estimate for the Undeclared category there is good reason to suspect that this set of products may contain voluntary country of origin information that might be considered valuable by consumers.

The coefficient for New Zealand is statistically significant, positive and relatively large. After adjustment for any differences in covariates, the mean difference in price for a product originating in New Zealand was approximately £2.5/Kg greater than for the same product, with the same SKUcode, of British origin. The New Zealand origin label effect captures the long-established market penetration in the UK.

With regard to control covariates, the coefficients for mid-range and value brands are both negative and statistically significant, suggesting that consumers place less value on these brands compared to the premium brands, as expected. The category for processed products is on average valued about £1/Kg less compared to fresh meat cuts. Results also suggest that there are significant differences in how price responds to sales by different retail outlets relative to the reference outlet, ASDA. In contrast, there is little statistical evidence of any effect of species, eating quality or seasonality on prices.[[10]](#footnote-10)

The results justify our decision to correlate the product characteristics and use MLE with unstructured covariance. The estimated coefficient for variance for SKUcode is statistically significant, based on the size of the reported standard errors. Furthermore, a likelihood ratio (LR) test for null hypothesis that the estimated two-level model performs no better than a OLS model with a single constant intercept (and hence ignoring the random intercept for SKUCode) is strongly rejected by the data, Chi2= 119, P value=0.0. However, the variance for the random effects correlated with the product characteristics, $ Zu\_{i}$ is much smaller than the variance associated with$ ε\_{it}$, suggesting that, contrary to our expectation, much of the heteroscedasticity detected during the model selection stages is associated with the idiosyncratic error component. Nevertheless, our unstructured covariance specification has ensured that that the estimated two-level model returns exactly the same estimates as the corresponding random-effects model (i.e. implicitly assuming overall i.i.d error term) with clustered errors. With regard to goodness of fit, the estimated ME model has Wald Chi2 test statistic of (16) =77.9 and is statistically significant at the 1% level.

* 1. **Horsemeat Incident and the Impact on Demand**

As discussed, our extended model specification that includes a dummy variable for the horsemeat incident (i.e. equation 3) allows us to examine the specific effects of how the horsemeat incident impacted the demand for meat and the role played by CoOL before and after the incident. We run two structural models to better understand the impact of the horsemeat incident: one model for all products in the data to detect any indirect effect of the incident, and a second for beef only to detect any direct effect of the incident on beef products.

The coefficients for CoOLs and other model parameters are reported in Tables 4 (all products) and 5 (beef only).

**{Approximate Position of Tables 4 and 5}**

In Table 4, we can see that the null hypothesis that $δ\_{2}$ (for d\*cool) is zero is strongly rejected for the model for all origins; hence, except for lamb from New Zealand, there has been a shift in preferences for products in the data following the horsemeat incident. The parameters for $δ\_{2} $are all positive and significant at the 10% significance level, including the slope for products not governed by the mandatory labelling scheme i.e. Undeclared. The fact that after the horsemeat incident that the Undeclared parameter is now positive and significant may well indicate that the voluntary CoOL has been more positively used by consumers. Finally, we also note that the results for control covariates are broadly similar to those from the general model (Table 3) as the variables for these were not interacted with the structural dummy.

The results for the model for beef only are reported in Table 5. The sign and magnitude of the parameter for Irish origin has changed significantly from -£1.23/Kg to £2.62/Kg (hence $δ\_{2}$=1.39) relative to the British origin, whilst the magnitude of parameter for English origin has changed little in magnitude, although it is valued significantly different from British following the horsemeat incident. We again see, as in Table 4, that Undeclared origin is positively affected by the horsemeat incident which again suggests that the use of voluntary labels has increased.

Taking these results together, our analysis suggests that consumer preferences have been significant influenced by the exogenous effect of the horsemeat incident with increased demand for origin-labelled products. They also point to possible changes in industry practices. The change of signs of parameters for English and Irish origins from negative to positive and the highly significant parameter for Undeclared origin supports this interpretation. Thus, it appears that producers and retailers started to declare the origin of many products after the horsemeat incident by making greater use of the voluntarily labelling option, since consumers purchased less processed products with neither origin labels nor other related cues such flags or statements such as “100% British beef”, as observed by Yamoah and Yawson (2014).

Such a shift in consumer choice toward products carrying origin labels or related cues (albeit not legally required) may have been an adaptive response to the horsemeat incident, due to, for example, unfavourable beliefs about the foreign provenance of meat historically incorporated in processed products with no declared origin cues (Lusk et al., 2014). Indeed, as already mentioned, consumers’ confidence in these products has been dented, precisely because of the widely publicised lack of control of authenticity of imported meat which reportedly involved long and complex supply chains (Crane and Brown, 2013, HM Goverment, 2014). As 35% of UK domestic meat consumption was met by imports before the incident, it is not surprising that consumers’ valuation shifted toward relatively more trusted origins such Irish, a country with not only a longstanding beef trade with the UK, but also reported to have discovered the horsemeat incident in the first place (HM Goverment, 2014).

1. **Conclusion**

We have assessed UK consumers’ valuation of CoOL for meat in light of the horsemeat incident. Our findings suggest that consumers do place a significant value on CoOL for meat, with most origin labels becoming more valued following the incident. We find that, on average, the meat labelled as Irish or English are not valued differently from British origin but those with no declared origin are valued £2/Kg less than the British origin. Furthermore, our results reveal that, except for New Zealand origin (relating only to lamb), the consumers’ valuation of origin labels has increased significantly for all products but more so for beef since the horsemeat incident. We conclude that the horsemeat incident has likely resulted in significant changes in industry practices. Due to the greater consumer awareness of meat authenticity, demand appears to have shifted in favour of origin-labelled products, and consequently industry has probably started to take greater advantage of the voluntary labelling option to label processed products.

Given our results, two broad policy relevant implications can be drawn from our analysis.

First, the combination of a change in consumer valuation of CoOL and stricter meat regulation with a potentially expanded scope of the current mandatory scheme across species and product categories appears to have motivated the industry to voluntarily origin-label more processed products. Clearly, such developments reduce the need for any extensions of a mandatory scheme for all meat products, at least in the short run. However, given the voluntary nature of the industry effort to date, the effectiveness of such practice is uncertain in the longer run because of the potential decline of consumer concerns over time and the resulting industry re-adjustments in meat sourcing toward imports.

There is also the cost associated with mandatory labelling that needs to be considered. For example, it has been estimated by the USDA (2015) that mandatory CoOL will reduce producer surplus by approximately $1 billion (US) over 10 years. Similar conclusions have also been reached in Sweden by Carlsson et al. (2014). In contrast, however, Baltussen et al. (2013) provide much smaller costs estimates resulting from the mandatory implementation EU CoOL for pork and poultry. Clearly, with such mixed evidence it remains unclear as to whether or not a move toward greater mandatory CoOL makes economic sense.

Second, the growth in the use of voluntary CoOLs may potentially have trade implications, if consumer demand for CoOL persists and mandatory labels are used on an ever growing range of products. On the one hand, CoOLs attracting positive valuations may stimulate high-value exports from third countries such as New Zealand. On the other hand, the exporters of less valued CoOL products may face a significant decline in their export revenues. Indeed, there is a precedent for how changes to CoOL labelling can cause trade tensions. Less than one year after new mandatory CoOL labelling rules were introduced in the US, Canada and Mexico challenged these rules in the World Trade Organization (WTO), arguing that the scheme has a trade-distorting impact by reducing the value and number of cattle and hogs shipped to the US market, thus violating WTO trade commitments agreed to by the US (Greene, 2015). If any sort of CoOL trade dispute involved the UK, especially being outside the EU, the associated lawsuits and WTO hearings may call into question the relative value of mandatory CoOL labelling to consumers as compared to costs faced by both domestic meat processors and trading partners. Such an eventuality may be more foreseeable, especially if after leaving the EU, the UK quest for greater markets in beef producing countries is met with a demand for relatively lesser protectionist policies in agricultural trade.

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**Table 1: Sample Data from Kantor World Panel for Meat Products (2010-2015)**

|  |  |  |
| --- | --- | --- |
| **Variable** | **Description** | **Categories/Range** |
| *SKUCode* | Panel identifier (product type) | 1 to 19 |
| *price* | Price/per Kg of meat product (£)  | Average = £5.75 (£1.62-£18/Kg) |
| *pool* | Country of origin label | British, England, Irish, New Zealand, Undeclared |
| *branv* | Brand value categories | Premium, mid-range, value |
| *retai* | Retailers | Asda, Morrisons, Sainsburys, M&S, Tesco |
| *eatq* | Eating quality | Standard, quality-described |
| *epeci* | Meat specie | Beef, lamb, pork and chicken |
| *prodc* | Product categories | Meat cuts, processed products |
| *year* | Year of purchase | 2010 to 2015 |

**Table 2: Frequency of Observations across Species and Country of Origin, N=881**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Species** | **British** | **English** | **Irish** | **New Zealand** | **Undeclared** | **Total (%)** |
| Beef | 383 | 36 | 93 | 0 | 107 | 619 (70) |
| Chicken | 0 | 0 | 0 | 0 | 80 | 80 (9) |
| Lamb | 0 | 0 | 0 | 60 | 0 | 60 (7) |
| Pork | 88 | 0 | 0 | 0 | 34 | 122 (14) |
| Total | 471 | 36 | 93 | 60 | 221 | 881 (100) |

**Table 3: Mixed Effects Estimated Coefficients and Random Parameters (N=881)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Price*** **(Dependent variable)** | **Coeff.** | **S.E** | **z** | **P>|z|** |
| *CoOL* (*base=British*) |  |  |  |  |
| English | -1.26  | 0.79 | -1.58 | 0.11 |
| Irish | -0.54 | 0.65 | -0.83 | 0.41 |
| New Zealand | 2.50 | 1.03 | 2.43 | 0.01 |
| Undeclared | -2.19 | 0.65 | -3.38 | 0.00 |
| *branv (base=premium)* |  |  |  |  |
| Mid-range | -3.14 | 0.91 | -3.45  | 0.00 |
| Value | -2.57 | 1.09 | -2.36 | 0.02 |
| *prodc (base=meat cut)* |  |  |  |  |
| Processed | -1.12 | 0.55 | -2.05 | 0.04 |
| *retai (base=Asda)* |  |  |  |  |
| Morrisons | -1.90 | 0.60 | -3.15 | 0.00 |
| Tesco | -0.24 | 0.54 | -0.45 | 0.65 |
| Sainsbury/M&S | -1.50 | 0.65 | -2.30 | 0.02 |
| *speci (base=Beef)* |  |  |  |  |
| Chicken | 1.30 | 1.33 | 0.97 | 0.33 |
| Pork | -0.35 | 0.54 | -0.65 | 0.52 |
| *eatq (base=standard)* |  |  |  |  |
| Quality | -0.61 | 0.54 | -1.11 | 0.26 |
| *Seasonality* |  |  |  |  |
| S1 (Jan-March) | -0.01 | 0.12 | -0.12 | 0.91 |
| S2 (April-June) | 0.09 | 0.11 | 0.78 | 0.43 |
| S3 (July-Sept) | -0.01 | 0.11 | -0.11 | 0.92 |
| *Intercept (*$β\_{0}$*)* | 11.33 | 1.16 | 9.76 | 0.00 |
| Random effects parameters $(SKUCodeu\_{i})$  | Coeff. | SE |  |  |
| Var($β\_{0})$ | 0.36 | 0.13 |  |  |
| var(Residual) | 1.47 | 0.07 |  |  |
| LR test vs. linear model | Chi-bar2(1) = 119.21, Prob > chibar2 = 0.000 |  |
| Goodness of fit | Wald Chi2(16) =77.90 Prob>Chi2 = 0.000 |  |

Note: There is no species variable for lamb as this is perfectly correlated with the New Zealand CoOL and so had to be excluded from the model.

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| **Table 4: Estimated Coefficients and Structural Parameters for All Products (No of observ=881)** |
| ***Price* (Dependent variable)** | **Coeff.** | **S.E** | **z** | **P>|z|** |
| *CoOL*(*base=British*) |  |  |  |  |
| Englishd\*English  | -2.13  1.41  | 0.880.43  | -2.433.32  | 0.010.00 |
| Irishd\*Irish | -1.37  1.46  | 0.70 0.28  | -1.98 5.22  | 0.05 0.00  |
| New Zealandd\*New Zealand | 2.190.49  | 1.090.33  | 2.01 1.48  | 0.040.14 |
| Undeclaredd\*Undeclared | -2.340.33  | 0.69 0.20  | -3.40 1.65  | 0.000.10  |
| *branv (base=premium)* |  |  |  |  |
| Mid-range | -3.06  | 0.96  | -3.20  | 0.00 |
| Value | -2.55  | 1.15  | -2.23  | 0.03 |
| *prodc (base=meat cut)* |  |  |  |  |
| Processed | -1.15  | 0.57  | -2.00  | 0.05 |
| *retai(base=ASDA)* |  |  |  |  |
| Morrisons | -1.89  | 0.63  | -2.97  | 0.00 |
| Tesco | -0.26  | 0.57  | -0.46  | 0.65 |
| Sainsbury/M&S | -1.41  | 0.68  | -2.07  | 0.04 |
| *speci (base=Beef)* |  |  |  |  |
| Chicken | 1.31  | 1.40  | 0.93  | 0.35 |
| Pork | -0.35  | 0.56  | -0.63  | 0.53 |
| *eatq (base=standard)* |  |  |  |  |
|  Quality | -0.62  | 0.57  | -1.09  | 0.27 |
| *Seasonality* |  |  |  |  |
| S1 (Jan-March) | -0.02  | 0.11  | -0.20  | 0.84 |
| S2 (April-June) | 0.10  | 0.11  | 0.89  | 0.37 |
| S3 (July-Sept) | -0.00  | 0.11  | -0.05  | 0.96 |
| *Intercept (*$β\_{0}$*)* | 11.29  | 1.22  | 9.24  | 0.000 |
| Goodness of Fit | Wald chi2(21) =116.18 Prob > chi2= 0.000 |

Note: There is no species variable for lamb as this is perfectly correlated with the New Zealand CoOL and so had to be excluded from the model.

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| **Table 5: Estimated Coefficients and Structural Parameters for Beef Only (No of observ= 619)** |
| ***Price*** **(Dependent variable)** | **Coeff.** | **S.E** | **z** | **P>|z|** |
| *CoOL*(*base=British*) |  |  |  |  |
| Englishd\*English  | -0.45 1.32  | 0.520.46  | -0.87 2.88  | 0.390.00  |
| Irishd\*Irish | -1.231.39  | 0.33 0.30  | -3.73 4.62  | 0.000.00  |
| Undeclaredd\*Undeclared | 0.620.69  | 0.420.28  | 1.48 2.45  | 0.140. 01  |
| *branv (base=premium)* |  |  |  |  |
| Mid-range | -0.65  | 0.45  | -1.43  | 0.15 |
| Value | 0.61  | 0.54  | 1.14  | 0.25 |
| *prodc (base=meat cut)* |  |  |  |  |
| Processed | -1.87  | 0.29  | -6.49  | 0.00 |
| *retai (base=ASDA)* |  |  |  |  |
| Morrisons | -1.79  | 0.30  | -5.87  | 0.00 |
| Tesco | -1.92  | 0.33  | -5.84  | 0.00 |
| Sainsbury/M&S | -1.46  | 0.29  | -5.07  | 0.00 |
| *eatq (base=standard)* |  |  |  |  |
|  Quality | -2.04  | 0.26  | -7.72  | 0.00  |
| *Seasonality* |  |  |  |  |
| S1 (Jan-March) | 0.05  | 0.15  | 0.37  | 0.71 |
| S2 (April-June) | 0.26  | 0.14  | 1.82  | 0.07 |
| S3 (July-Sept) | 0.15  | 0.14  | 1.05  | 0.29 |
| *Intercept (*$β\_{0}$*)* | 10.18  | 0.55  | 18.48  | 0.00 |
| Goodness of Fit | Wald chi2(17) = 256.71 Prob > chi2= 0.000 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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| **Hedonic Analysis of Consumers’ Valuation of Country of Origin of Meat in the United Kingdom**Mohamud Hussein and Iain Fraser**On-Line Appendix A****Table 3A: Estimated Coefficients and Structural Parameters for Beef and Pork (No of observations =741)** |
| ***Price* (Dependent variable)** | **Coeff.** | **S.E** | **Z** | **P>|z|** |
| *CoOL*(*base=British*) |  |  |  |  |
| English | -1.62 | 0.80 | -2.02 | 0.04 |
| Irish | -0.57 | 0.64 | -0.90 | 0.37 |
| Undeclared | -1.69 | 0.68 | -2.46 | 0.01 |
| *branv (base=premium)* |  |  |  |  |
| Mid-range | -3.05 | 0.89 | -3.42 | 0.00 |
| Value | -2.07 | 1.10 | -1.88 | 0.06 |
| *prodc (base=meat cut)* |  |  |  |  |
| Processed | -1.93 | 0.68 | -2.84 | 0.00 |
| *retai(base=ASDA)* |  |  |  |  |
| Morrisons | -1.58 | 0.61 | -2.58 | 0.01 |
| Tesco | -0.08 | 0.53 | -0.16 | 0.87 |
| Sainsbury/M&S | -1.31 | 0.64 | -2.03 | 0.04 |
| *speci (base=Beef)* |  |  |  |  |
| Pork | -0.76 | 0.57 | -1.34 | 0.18 |
| *eatq (base=standard)* |  |  |  |  |
|  Quality | -1.07 | 0.58 | -1.83 | 0.07 |
| *Seasonality* |  |  |  |  |
| S1 (Jan-March) | 0.08 | 0.13 | 0.53 | 0.59 |
| S2 (April-June) | 0.18 | 0.13 | 1.37 | 0.17 |
| S3 (July-Sept) | 0.05 | 0.13 | 0.39 | 0.69 |
| *Intercept (*$β\_{0}$*)* | 11.84 | 1.17 | 10.07 | 0.00 |
| Goodness of Fit | Wald chi2(14) = 48.89 Prob > chi2= 0.000 |

 |
| ***Price* (Dependent variable)** | **Coeff.** | **S.E** | **Z** | **P>|z|** |
| *CoOL*(*base=British*) |  |  |  |  |
| English | -1.62 | 0.80 | -2.02 | 0.04 |
| Irish | -0.57 | 0.64 | -0.90 | 0.37 |
| Undeclared | -1.69 | 0.68 | -2.46 | 0.01 |
| *branv (base=premium)* |  |  |  |  |
| Mid-range | -3.05 | 0.89 | -3.42 | 0.00 |
| Value | -2.07 | 1.10 | -1.88 | 0.06 |
| *prodc (base=meat cut)* |  |  |  |  |
| Processed | -1.93 | 0.68 | -2.84 | 0.00 |
| *retai(base=ASDA)* |  |  |  |  |
| Morrisons | -1.58 | 0.61 | -2.58 | 0.01 |
| Tesco | -0.08 | 0.53 | -0.16 | 0.87 |
| Sainsbury/M&S | -1.31 | 0.64 | -2.03 | 0.04 |
| *speci (base=Beef)* |  |  |  |  |
| Pork | -0.76 | 0.57 | -1.34 | 0.18 |
| *eatq (base=standard)* |  |  |  |  |
|  Quality | -1.07 | 0.58 | -1.83 | 0.07 |
| *Seasonality* |  |  |  |  |
| S1 (Jan-March) | 0.08 | 0.13 | 0.53 | 0.59 |
| S2 (April-June) | 0.18 | 0.13 | 1.37 | 0.17 |
| S3 (July-Sept) | 0.05 | 0.13 | 0.39 | 0.69 |
| *Intercept (*$β\_{0}$*)* | 11.84 | 1.17 | 10.07 | 0.00 |
| Goodness of Fit | Wald chi2(14) = 48.89 Prob > chi2= 0.000 |

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2. The incident involved a food processor in France, its subsidiary in Luxembourg, a subcontractor in Cyprus, a meat trader in the Netherlands, abattoirs in Romania, and a number of food businesses in the UK and across Europe selling the end products (National Audit Office, 2013). [↑](#footnote-ref-2)
3. Kantar have a panel of approximately 30,000 of households, who are geographically and demographically representative of the UK population. Panel members scan the products they purchase using scanner technology provided by Kantar who then retrieve data. In order to validate shopper-scanned data, Kantar also collects copies of purchase receipts. Each scanned item is identified by a unique stock keeping unit, a barcode used by retailers to manage stocks. [↑](#footnote-ref-3)
4. We have include English as CoOL as it was explicitly identified in the data even though this is not specifically a mandatory requirement. [↑](#footnote-ref-4)
5. Grocery Market Share, 12 weeks ending 01.02.2015, <http://www.kantarworldpanel.com/en/grocery-market-share/great-britain>. [↑](#footnote-ref-5)
6. A REs model with clustered errors yields exactly the same standard error estimates as a ME model if a maximum likelihood estimator is used. However, a ME model allows us to specify a far richer covariance structures for the random part of the model (Cameron and Trivedi, 2009). [↑](#footnote-ref-6)
7. We model the effects of error correlations using a product-level ME model with an unstructured variance-covariance matrix for the random parameters. This model is estimated using the Stata command *xtmixed* with the random part of the model specified as *||SKUCode: mle cov(unstructured) variance*. Thus, $Z'u$ is not estimated directly, it has no associated coefficient, but it is characterised by the variance-covariance matrix $Σ\_{u}$. [↑](#footnote-ref-7)
8. We carried out the Breusch and Pagan Lagrangian multiplier test for random effects which strongly rejected the null hypothesis: $var(u\_{i}) = 0$. The Doornik–Hansen test for multivariate normality for price strongly rejected the null hypothesis. We also examined the selected model for collinearity using the Variance Inflation Factor. [↑](#footnote-ref-8)
9. Republic of Ireland reported first the horsemeat contamination in January 2013. Soon after that, a number of other countries including the UK reported similar findings (See HM Government, 2014). [↑](#footnote-ref-9)
10. We can also report, following a suggestion by a referee, that a model specification for beef and pork yield results similar to those reported in Table 3 with regard to CoOL. As such, we are confident that our results are robust to the data and model specification employed. These results are available in our on-line Appendix A. [↑](#footnote-ref-10)