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The Economic Analysis of Consumer Attitudes Towards Food Produced Using Prohibited Production Methods: Do Consumers Really Care?

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An Economic Analysis of Consumer Attitudes Towards Food Produced Using Prohibited Production Methods: Do Consumers Really Care?

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Abstract

We report the findings from a hypothetical discrete choice experiment (DCE) examining UK consumer attitudes for food produced using agricultural production methods currently prohibited in the UK i.e., hormone implants in beef; Ractopamine in pig feed; chlorine washed chicken; and Atrazine pesticide. Our results reveal that on average the public have very negative values for these forms of agricultural production methods. We also find that respondents highly value food products that observe EU food safety standards. Our willingness to pay estimates show that the positive values for food safety are frequently greater than negative values placed on the food production methods examined. Similarly, UK country of origin was highly valued but organic production was not valued as highly. These results clearly indicate that the only attribute that is negatively valued across all DCE are the production methods that are currently not allowed within the EU or UK.

Key Words: Discrete Choice Experiment, Willingness to Pay

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1. Introduction

Now that the United Kingdom (UK) has officially left the European Union (EU) there is much discussion surrounding the form and content of future trade agreements with the EU and the rest of the world (Sampson, 2017). There is the possibility, as a result of new trade deals coming into force, that the UK trading arrangements, associated rules and regulations regarding food could depart significantly from those that have prevailed whilst being a member of the EU (Sheldon, 2019). For example, there has been much speculation surrounding what form a trade agreement with the United States (US) might take (Office of the United States Trade Representative, 2019; Millstone et al, 2020). One aspect of such a trade deal that has received a great deal of attention relates to how trade in agricultural produce and food might change. Historically, the extent of agricultural trade between the US and the UK has been small, only $1.7 billion in 2015 which is equivalent to 1.3 percent of total US agricultural exports. However, the US has expressed a strong preference for allowing trade to occur in food produced using agricultural production methods common in the US but not currently permitted by the EU or UK e.g., chlorine washed chicken and beef grown using hormone implants.[1] Clearly, with any change of this sort to existing trade arrangement it is necessary to understand the economic consequences and in this case the likely reaction of consumers. However, there is currently no economic analysis of UK consumer preferences regarding food products produced in this way. Without appropriate economic estimates of relative value it is difficult to know if the resulting welfare changes that might emerge from a trade deal that involves products of this type will be considered beneficial to UK consumers.

In this paper, we examine consumer preferences with regard to food that may have been produced using various production technologies including several currently not authorised n the EU. The specific set of food items and production technologies we examine are as follows: hormone implants in beef; Ractopamine in pig feed; chlorine washed chicken; and Atrazine pesticide in corn production. Actual purchase on consumer purchase data on revealed preferences would be useful (e.g., Hussein and Fraser, 2018). However, as there are no consumer purchase data for these products in the UK, we have employed a hypothetical discrete choice experiment (DCE) to generate estimates of a consumer's willingness-to-pay (WTP) for a specific food type with a given set of product attributes.

[1] In the Office of the United States Trade Representative (2019) the following negotiating objective is explicitly stated: *"Establish a mechanism to remove expeditiously unwarranted barriers that block the export of U.S. food and agricultural products in order to obtain more open, equitable, and reciprocal market access."*

Although the context in which this research is framed is of concern and interest in terms of potentially new trading arrangements that the UK may face post-Brexit there are several other important contributions that the research makes.

First, our research adds to the growing number of stated preference papers that have examined consumer attitudes to food being produced using new, novel or previously prohibited production methods. There already exists a large literature examining consumer attitudes and preferences regarding the use of novel technologies in food production (e.g. Frewer, 2017). The scope of this literature ranges from studies examining genetically modified organisms (GMOs) (e.g. Grebitus et al., 2018), the use of RNA interference (RNAi), a gene editing technology employed in beef production (Britton and Tonsor, 2019), through to the use of nanotechnology in food safety (Erdem, 2015, 2018). There is also a related literature examining food safety. For example, Miller et al. (2016) note that the literature indicates that enhanced food safety frequently yields very high estimates of WTP and that these estimates are frequently higher than those for animal welfare or environmental concerns.

Second, our research also contributes to the wider discussion surrounding country of origin (CoO) food labelling. In the literature the evidence on consumer use and value attached to CoO suggests that although CoO is wanted by consumers it is not as highly valued as other food attributes e.g., price, taste, appearance and duration (Balcombe et al, 2016). The evidence in literature, has not, however, led to calls for less use of CoO post Brexit. In fact, there have been calls to extend mandatory CoO labelling post-Brexit. For example, a 2018 UK parliamentary Food and Rural Affairs Committee (House of Commons, 2018) explicitly acknowledged the need to extend mandatory CoO labelling to include more food products such as bacon, sausages and cheese. This position can be viewed as emerging out of a need to support the UK farming food industry. Also, Benton et al. (2017) report that 67% of survey respondents prefer to buy UK food with 27% claiming they would buy more British produce even if imported food prices declined. The analysis we present adds further insight into how consumers value CoO especially when this information is combined with other types of credence attribute information relating to forms of agricultural production.

Third, although the focus of the current paper is on consumer preferences regarding specific types of agricultural production, these issues are also part of the ongoing trade negotiations between the EU, UK and US in terms of agriculture. Over time various changes to the trading arrangements have been made. For example, the EU and US, have had a tariff rate quota (TRQ) in place for non-hormone treated beef for several years. The TRQ means that the US can export up to 45,000 metric tonnes although only 17,500 was exported during 2013-15 via the USDA Non-Hormone Treated Cattle (NHTC) program which partly reflects the increased costs associated with program compliance (Beckman and Arita, 2017).[2] Within the literature that has evaluated the potential economic consequences of relaxing trade restrictions such as non-tariff measures (NTMs), such as those in place via the World Trade Organisation (WTO) (i.e., Sanitary and Phytosanitary (SPS) arrangements or the Agreement on Technical Barriers to Trade (TBT)) any economic models used needs to include consumer preferences so to be able to predict responses accurately.[3] For example, Arita et al. (2017) conducted an analysis of removing the many barriers to trade in food between the US and EU (tariffs and NTMs) using a computable general equilibrium (CGE) model. The results of this study indicate that gains from trade from removing all barriers would be $11.6 billion but when they adjust for consumer preferences the gains fall to $7 billion. Now of course, in CGE models the level of detail employed to describe consumer preferences and the resulting response can be highly aggregated such that the results potentially simplify how EU consumers will react. But, how best to capture consumer preferences is also complicated even when employing a more disaggregated model. For example, Soon and Thomson (2019) employ a partial equilibrium model of the international beef market that allows for differentiation between hormone- and non-hormone-treated beef so as to study the US, Canada and EU dispute with respect to beef. This analysis assumes that EU consumers will buy hormone-treated beef if the price is sufficiently discounted i.e., 15 percent. Clearly, the results of any modelling study are a function of the assumption they make regarding consumer preferences, especially in trade models. In this study, we are able to provide a detailed examination of consumer preferences that needed to be taken into account if the results of any trade models examining changes in trading arrangements are to be taken seriously.

The structure of this paper is as follows. In Section 2, we briefly review the relevant literatures given the scope of the DCE and methodological issues being examined. Then in Section 3, we detail how we designed and implemented our DCE. In Section 4, we detail our econometric specification and in Section 5 we report our results. Finally, in Section 6 we conclude and discuss the wider implications of the results presented.

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[2] For NHTC program details see: https://www.ams.usda.gov/services/imports-exports/nhtc

[3] Another stand of the trade literature that has examined aspects of NTMs in agriculture, specifically chlorine washed chicken and hormone beef, considers the politically economy of the development of trade barriers and how protectionism can arise as a result of scientific uncertainty (see Calzolari and Immordino, 2005).

2. Literature Review

2.1. Food Production and Food Safety

There is a large literature that considers consumer attitudes globally and the values they attach to food and how these are affected by modes of agricultural production. In general, it has been found that consumers are non-accepting of what Frewer (2017) refers to as enabling agrifood technologies. Kamrath et al. (2019) report that with the future challenges of food security and safety it is important that consumers embrace new technologies but like Frewer (2017) they identify why consumers are reticent to do so. Thus, as consumers are generally non-accepting of the food produced using new technologies this can act as a constraint on the potential commercialisation of the technology. There are numerous examples of economic analysis of such technologies e.g., genetically modified organisms (GMOs) (Grebitus et al., 2018), the use of RNA interference (RNAi), a gene editing technology employed in beef production (Britton and Tonsor, 2019), transgenic rye used to produce bread (Edenbrandt et al., 2018), through to the use of nanotechnology in food safety (Erdem, 2015, 2018). Muringai et al. (2020) also examine gene editing technology, in this case for potatoes, and the preferences of the Canadian consumer. They report what is a common result in the literature that consumers need to be offered a discounted price to consider buying food that has been produced using non-standard technologies.

There is also a part of this literature that has examined some of the specific production practices examined in this paper. By far the largest number of studies focus on the use of growth hormones in beef. For example, Tonser et al. (2005) examine the types of trades-offs European consumers are prepared to make when it comes to food attributes. They report that UK consumers are prepared to pay reasonably high amounts to avoid hormone-grown beef. Konstantinos et al. (2018) also examined consumer preferences for beef steak that might have been produced with the use of growth hormones. This study identified that informed consumers typically did not express a positive preference for beef that had been produced with the use of growth hormones.

In another relevant study, Yang et al. (2017) examine consumer perceptions of hormone use in meat production. This study is interesting as it neatly summarises the use of hormones in US meat production, limited to beef production, but at the same time reveals that many US consumers assume that hormones are used in the production of other types of meat, e.g. chicken and pork. This misconception on the part of consumers is partly down to the use of a food label that allows produce to be sold as "no added hormones" (NAH). This misconception is unsurprising as the debate surrounding the use of hormones in agricultural production has become polarised in the US (see Norwood et al., 2015).

Turning to UK focussed research, Lewis et al. (2017) conducted a DCE to estimate the value attached by consumers to a hormone-free label for beef (as opposed to no label). The results of this study indicate that respondents valued hormone-free beef very highly compared to various other attributes examined. Of course there is no hormone produced beef entering the UK because of existing trade restrictions and as such this means that the hormone-free label only has meaning if the DCE informed respondents that the products on offer could be produced using growth hormones. This issue aside, the magnitude of the WTP for the hormone-free label was approximately £1.30 for 375 grams of steak or 35 pence per 100 grams. Lewis et al. (2017) provide several results on CoO, in particular that UK consumers required a discount of 60 percent on US beef. Finally, they also report that those respondents who valued the hormone-free label also considered food safety as important in terms of beef consumption. A similar finding in terms of food safety has also been reported by Miller et al. (2016) who note that the literature indicates that enhanced food safety frequently yields very high estimates of WTP and that these estimates are frequently higher than those for animal welfare or environmental concerns.

Once we consider production practices other than hormones in beef there are far fewer studies of interest. For chlorine washed chicken it is the act of washing that is examined within the context of food safety. In particular, the literature considers consumer preferences for the use of chlorine washed chicken as a means to reduce *Campylobacter* (a food borne bacterium that can cause various forms of illness) which is a concern for the UK government (MacRitchie et al., 2014). A particularly relevant study is that by Kawata and Watanabe (2018) who estimate Japanese consumers' WTP to reduce food related illness using a large set of approaches. Amongst the set of options available is chlorine wash. Interestingly, MacRitchie et al. (2014) report that the set of technologies considered to be used to enhance food safety include several that UK consumers have previously expressed negative preferences towards (e.g. irradiation and chlorine wash).

There has also been research conducted on pork by Ortega et al. (2020) who examine how consumer preferences in the US, China, Italy and the US are affected by information provision for a GM 500 gram pork loin. This study is interesting in that it finds that preferences for GM change depending on the specific benefit of the GM technology. In this case they report that if the benefit of using GM technology is to improve food safety then this gives rise to greater acceptance on the part of respondents. However, for all the benefits of GM considered WTP for GM pork remained negative.

Finally, there is a large literature on pesticide use and consumer attitudes (e.g., Chalak et al, 2008; Peschel et al., 2019). However, there is no literature specifically examining Atrazine, the pesticide we examine in this study. That aside, what we can take from the literature is that consumers generally prefer the use of less pesticide and if feasible, agricultural production that is pesticide free and as such organic. A recent example of this type of finding is provided by Peschel et al. (2019) who examine a pesticide-free food label for dates.

2.2. Food Labels and CoO

The UK introduced mandatory CoO food labels for various types of unprocessed meat including pigs and poultry in 2015 via Commission Implementing Regulation (EU) No 1337/2013. CoO labelling was already in place for beef before this. However, there is only voluntary CoO labelling in place for semi-processed meat and when meat is used as an ingredient in processed food. The distinction between mandatory and voluntary labels is important (Roe et al., 2014). Mandatory labels generally correct market inefficiencies such as asymmetric information. So with regard to Regulation No 1337 this is in place to ensure that consumers are informed about the origin of food. In contrast, voluntary labels are used to signal differences in product quality and to highlight specific credence attributes. At the same time, Roe et al. (2014) observes, with evermore products providing some form of indication of origin consumers simply expect origin information.

Within the CoO literature, we know that the relative importance of CoO information differs by product type. For example, Balcombe et al. (2016) observe that CoO is highly valued for fresh meat produce but less so for processed meat in the UK. Asante-Addo and Weible (2020) report that Ghanian consumers' value domestic chicken more than imported with a specific preference for antibiotic hormone-free produce. Otieno and Ogutu (2019) also report that Kenyan consumers also prefer hormone-free meat. Aboah and Lees (2020), who undertook a review of the literature, also report that CoO matters more for beef and lamb than it does for chicken for which organic is considered most important. They put this finding down to how existing CoO legislation can require information about geographic origin with regard to animal raising stages of production whereas activities such as chlorine washing of chicken do not.

It is also the case that the value attached to CoO is for food that originates from the respondent's own country. This implies that the value of CoO information tends to be highly origin dependent i.e., a home-country bias. However, the strength of the home-country bias can be reduced by the existence of other information. For example, it is reported by Slade et al. (2019) that Canadian consumers positively value imports of dairy products if they are accompanied by a geographical indications (GIs). These results are in contrast to those reported by Norris and Cranfield (2019) who report that Canadian consumers would require a significant price discount to buy imported dairy products as a result of a new trade deal with the EU.[4] In a different context, using an economic experiment to test information preferences, Beiermann et al. (2017) report that a high proportion of respondents (i.e. 80 percent) use CoO information when free and that demand increases when combined with food safety benefits associated with local production.

What the existing literature highlights is that even though CoO appears to be valued by consumers the interaction between CoO and other product attributes that are either included or exclude within a study can impact consumer values. It is likely in many cases that consumers are using CoO as a quality cue and subsequently drawing an inference about quality. However, it is also the case that when CoO is not required other attributes become relatively more important, such as organic production for chicken.

2.3. Summary

The existing literature on provides useful insights into how consumers value the type of production methods under consideration in this study. However, it also needs to be remembered that production method information is an example of a credence attribute, and how it is conveyed to consumers via food labels at the point of purchase matters as well (Lusk and McCluskey, 2018). The influence of food labels on consumer choice and preferences is an important issue in its own right and this is particularly the case when examining credence attributes (Messer et al., 2017). Furthermore, the combination of attributes used is important as there is evidence of attributes being included or excluded from choice sets can impact the way in which attributes are valued.

Clearly the production practices examined are currently not authorised in the UK or the EU. This means that the majority of the literature available presents studies that have been conducted in the US. Up

[4] Canada has moved away from protecting its domestic dairy industry with the introduction of trade agreements such as the Comprehensive Economic and Trade Agreement (CETA) with the EU.

until the 2016 vote to exit the EU, it has not been deemed necessary to consider these production practices within the EU or UK. Thus, the evidence generated by the current study fills what is a significant gap in the literature on consumer valuation of food production technologies.

3. The Production Practices and DCE Design

3.1. Production Practices

As explained, our DCE examined four food products that are currently unavailable to UK consumers: chlorine washed chicken; beef produced with the use of growth hormones; pork feed hormone additives (e.g. Ractopamine) during production; and atrazine pesticide in corn production. Before we provide detailed information regarding the design and implementation of the DCE, we first outline the production practices and product treatments we examined.[5]

3.1.1. Chlorine Washed Chicken

Chlorine is used in certain countries (e.g. US) to rinse whole chickens to kill microorganisms on the surface of the bird, specifically bacteria such as species of Salmonella and Campylobacter. This practice is sometimes referred to as pathogen reduction treatment and chicken treated this way have been excluded from the EU market since 1997. Importantly, the European Food Safety Authority (EFSA) does not view the use of chlorine in this context as unsafe. The EU operates a "farm-to-fork" approach to reduce meat-borne bacteria at all points along the meat supply chain. This is perceived to meet food safety requirements while also delivering higher animal welfare. The economic rationale for undertaking a chlorine wash is that it can reduce the overall costs of production because fewer efforts are made to control bacteria in the supply chain while still ensuring food safety for the consumer.

3.1.2. Hormone Treated Beef

Hormones are naturally occurring and as a result are found in both plants and animals. The use of additional hormones in animal production is reasonably common in countries such as the USA and Australia. In beef production the hormone is typically released into the animal over time by means of an implant. The economic case for using hormones is that they allow the animal to grow bigger more

[5] The continued use of these production methods in agriculture can in large part be explained by the increases in productivity obtained by producers. See Maples et al. (2019) for an insightful analysis of the US beef and pork industries.

rapidly whilst consuming less feed which reduces the costs of production. Also, because of the resulting changes in the diet of the animals they will have a leaner carcass that in turn satisfies consumer preferences for less fatty meat and reduces the amount of cholesterol consumed.

Although the dosage levels of hormones are relatively low, the European Commission banned the use of hormones in animal production on potential safety grounds. This precautionary approach is still in operation as there remains uncertainty and insufficient evidence about the types of hormones being used and what doses can be considered safe. To address potential consumer concern in the US, a negative labelling regime is in place, i.e. beef produced without the use of hormones can be labelled "No hormones (beef)". There are specific sets of farming practice that need to be followed for this statement to be allowed.[6]

3.1.3. Food Additives in Pork Production

Pork producers in the US are allowed to use Ractopamine as a feed additive to increase the rate of animal growth. Ractopamine (a beta agonist growth promotant) increases protein synthesis, thereby making the animal more muscular, reducing the fat content of the meat and therefore increasing the return per animal. Unlike hormone implants, Ractopamine does not affect the hormone status of the animal.

The use of Ractopamine is currently not authorised in the EU because the EFSA argued that there was insufficient evidence to declare this product safe. More importantly, it is argued that this type of food additive has a detrimental impact on animal welfare through the way in which it changes animal growth rates and allows production systems to be organised. The EU's position on Ractopamine has recently been followed by Thailand which has banned pork imports grown using this additive.

3.1.4. Atrazine Pesticide and Corn

Different regulatory regimes allow different pesticides to be used. For example, the EU does not permit the use of Atrazine, a herbicide frequently used in the US on crops such as maize and sweetcorn

[6] More details are provided by the USDA: https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/food-labeling/meat-and-poultry-labeling-terms/meat-and-poultry-labeling-terms/!ut/p/a1/jZDNCsIwEISfxQcI2doqepSCtFVbRNSYi6ya1kCblCYq-vRaREHxp7unZb5hh6GcMsoVHmWGVmqFeX3z7hqm0HX6PkRJ3xlCGC-mycj3oTfr3IDVDyB2G_q_zAD--aMGD9rVxJ9klJdo90SqVFOWCUtQmZOoDGWp1jtiMBX2TFLcWmL2QtiHkONG5FJllBUCa9eOlPqQ2-r8lIgVVWH-A0vKX-OCc9swdmdeEMUuJN478KHPO_C9sLKYs8t4EIAMW1dofMrM/#top

where its use is recommended in combination with other chemicals. In the US herbicides are applied to 97 percent of corn planted land with Atrazine accounting for 60% of herbicide active ingredients (USDA, 2017). The EU's main concern with Atrazine is the off-site environmental impact and specifically the contamination of groundwater. As with all chemicals, small (and safe) residue levels are tolerated in food e.g. 0.05 mg/kg.

3.2. Food Products and DCE Attributes

Having identified the set of production and processing methods, we next identify the specific food products with which to examine consumer attitudes. We selected food products that are frequently purchased on a weekly shopping trip in the UK. This choice was informed during several one-to-one focus group sessions we ran to consider product type of choice of DCE attributes as well an examination of product sales data in the UK. With this information, we selected the following set of products:

1. 500 grams chicken breast
2. 250 grams beef sirloin steak
3. 1 kg pork loin joint
4. 2 pack of corn on the cob

Next, we considered the appropriate set of attributes to include within the DCE. Based on one-to-one feedback during the initial stages of the design of the DCE, we arrived at the following set of attributes and levels that are summarised in Table 1.

[Approximate Position of Table 1]

In terms of the Price attribute this was described in the DCE as follows:

> *For any specific product you are shown, the prices presented are based on those currently found in food retail outlets in the UK.*

Next, Country of Origin (CoO) was described in the following way:

Country of Origin *informs consumers clearly about the origin of food they may or may not choose to buy. In this survey we indicated Country of Origin with the following information:*

- *UK*
- *EU*
- *Non-EU*

We described organic production as either:

- ***Organic*** *– this describes a farming system that does not use various forms of chemicals in the production process.*
- ***Conventional*** *– this describes a farming system that employs intensive livestock production, using fertilizer, pesticides and chemicals, with an emphasis on production and profit.*

In the resulting experimental design it was decided that we could not allow attribute combinations of organic and the associated production methods for beef, pork and corn on the cob because these are combinations that could not exist. Therefore, the experimental design was constrained to rule these combinations out.

Next, we described food standards as follows:

All the food for sale in the UK meets the required legal standards with regard to food safety. However, there are differences in standards in different countries of the world. To reflect this, we labelled food standards as either Meets EU standards or does not meet EU standards:

- *Meets EU food standards (Yes)*
- *Does not meet EU food standard (No)*

In terms of quality assurance standards we used two types. For the chicken, we included three quality standards as well as a "no standard" option.

This attribute indicates if the food was produced to recognised industry quality standards for food safety, hygiene, animal welfare and the environment, and reflects best industry practice – remember, food always meets UK legal minimum quality standards.

- *No quality assurance standard indicated (None)*
- *RSPCA Assured*
- *Quality Assurance International (QAI)*

- *Red Tractor*

It was necessary to modify the quality assurance standards for the three other products because the production methods being considered are inconsistent with the RSPCA and QAI quality standards. Therefore, we simplified the quality assurance standards attribute to be either no quality assurance standard or Red Tractor. The use of the Red Tractor is feasible as the assurance standard is not limited to agricultural production only undertaken in the UK.

Finally, the last attribute included in the DCE was the production method of specific interest. In this case four variants were used to describe each of the methods of interest.

Chlorine Washed Chicken

If chicken is labelled as chlorine washed this means that the carcass has been treated with a chlorine solution to prevent the meat from carrying bacteria such as Campylobacter and Salmonella. Alternatively, a 'farm to fork' approach can be employed which concentrates on reducing the risks of contamination at all stages of the food supply chain as well as being viewed as positive for animal welfare. So we have either:

- *Chlorine Washed*
- *Not Chlorine Washed*

Hormone Treated Beef

If beef is labelled as hormone treated, this means that hormones have been used in production. The use of hormones allows the animal to grower faster, consuming less feed and resulting in a leaner carcass that is less fatty. But there is disagreement about the safe levels of hormone to apply and so some countries ban the use of hormones. So we have either:

- *Hormone Treated (Yes)*
- *Not Hormone Treated (No)*

Hormone-Treated Feed in Pork Production

Pork producers sometimes use hormone feed additives to increase the rate of animal growth. For example, Ractopamine is used to make animals more muscular, reducing the fat content of the meat *and increasing the return per animal. However, Ractopamine is banned in some countries as there is insufficient evidence to declare the product safe, and it has also been linked to negative animal welfare effects. So we have either:*

- *Hormone Feed Used (Yes)*
- *Hormone Feed Not Used (No)*

Pesticides use and corn on the cob

Producers of corn on the cob in some countries frequently use pesticides such as Atrazine to deal with weed infestations. However, this pesticide is banned in several countries because of environmental impacts such as the contamination of ground water. So we have either:

- *Atrazine is Used (Yes)*
- *Atrazine is Not Used (No)*

3.3. Experimental Design

With the identified set of attributes, we then considered the levels for each attribute for each product. These are summarised in Table 1.

{Approximate Position of Table 1}

Given the products and the set of attributes employed, this meant that for some of the food products examined we needed to include a constraint within the design because several combinations were deemed to be infeasible. As noted, we did not allow organic production to occur simultaneously with the use of hormone implants in beef, the use ractopamine with pig production or Atrazine use for corn on the cob. We also modified the set of quality assurance levels between the products to again ensure that respondents did not treat some combinations as unrealistic.

Given the number of attributes and attribute levels, a balanced design required that we generated multiples of 12. It was decided to generate 48 cards each with 3 options employing 4 blocks yielding 12 cards per respondent. We employed an efficient design assuming an MNL utility specification assessed using D-error (Scarpa and Rose, 2008). We assumed uninformative priors such that our design can be considered conservative. To implement our experimental design, we employed Ngene version 1.1.2 (Choice Metrics 2012). The constrained design of 48 cards of 4 blocks of 12 yielded an MNL D Error equal to 0.081295.

3.4. Example Choice Card

A series of choice cards were designed based on the design described. An example of the final online choice card is presented in Figure 1.

{Approximate Position of Figure 1}

In Figure 1, it is shown that we first asked respondents to make a selection from one of the options available. We then subsequently allowed them to indicate if they would reject this option and as such select no choice. This approach to the collection of DCE data is referred to in the literature as the dual-response method (Brazell et al., 2006). The benefit of designing the choice cards in this way is that a full set of conditional choice data was obtained. In the econometric analysis presented, we do employ the no choice responses.

4. Model Estimation

To analyse our DCE data we employed a Bayesian (random parameter) mixed logit (MXL) specification to estimate the preference parameters of respondents. Within Bayesian circles this model is also referred to as the Hierarchical Bayesian Logit (Balcombe et al. 2016). This model allows for heterogeneity across respondents so that each respondent has their own preferences. Accordingly, the WTP attributes can be elicited at the individual level. It is also important to recognise that the MXL model employed allows for heterogeneity of responses. This means that differences in respondent characteristics which may be expected to lead to differences in WTP, such as income levels, are "allowed for" in the model specification and captured in the estimates produced.

The use of Bayesian methods is now well established in the stated preference literature. There are several reasons why we use a Bayesian specification to undertake model estimation. Most importantly, within the literature Bayesian methods are recognised at being better able to deal with difficulties of empirical identification associated with Classical approaches to simulation. Also, by adopting, as we have done, a WTP space approach to model estimation, model parameters are directly interpretable as WTPs.

Our model specification can be formally defined as follows. Let x_{ijs} denote a $k \times 1$ vector of attributes from the DCE presented to individual j ($j = 1,\ldots, J$) in the ith option (i=1,…I) of the sth choice set ($s = 1,\ldots,S$). Next, let U_{ijs} be the utility that the individual j attains from x_{ijs}. In addition, let y_{ijs} be an indicator variable that is equal to one if individual j chooses option i within the sth choice set, and zero otherwise.

Given these definitions, it then follows that an individual j is assumed to receive linear utility from the ith choice in the sth choice set, although the parameters may be transformed. Consequently, the utility function is of the form:

$$U_{ijs} = x'_{ijs} t(\beta_j) + e_{ijs} \tag{1}$$

where β_j is a $(k \times 1)$ vector describing the preferences of individual j and $t(.)$ is some transformation of the parameters. As typically assumed, the β_j is taken to be an independently and identically normally distributed vector with mean α and variance covariance matrix Ω. However, the function $t(.)$ can take a number of forms. For example, we might employ the log-normal for the price coefficient and the normal distribution for all other parameters. Finally, the error term e_{ijs} in equation (1) is assumed to be extreme value (Gumbel) distributed, independent of $x`_{ijs}$ and uncorrelated across individuals or choices, which leads to a logistic likelihood of an individual choosing a given option in any given task.

We estimate our models in WTP space Thus, to estimate the MXL in WTP space, we employed a parameterisation of the form:

$$t(\beta_j) = exp(\beta_{1j})(1, \beta_{2j}, \ldots, \beta_{kj})' \tag{2}$$

where the quantities $\beta_{2j}, \ldots, \beta_{kj}$ are the marginal rates of substitution (MRS) with the numeraire being the first attribute, which will always be the price or cost attribute within the given DCE. These therefore represent estimates of the WTP for each of the specified attributes

As already noted, the re-parameterisation shown in equation (2) provides important benefits. For example, when we estimated our model in preference space we would first estimate marginal utilities and the various MRS are derived from these. By estimating in WTP space the MRS are estimated directly and it has been found previously in the literature that this approach can significantly reduce the instability associated with WTP estimates recovered from preference space (Balcombe et al., 2010).

Estimation for this study was conducted using the Software STAN, (https://mc-stan.org/) which employs Hamiltonian Monte Carlo Markov Chain algorithms to simulate the posterior distribution for both the individual parameters and mean and variances of these parameters. For further details about these algorithms and software, readers are referred to the User Guide in the link above. For all the models we ran, we employed a "Warm-up" of 5000 iterations followed by 2000 draws from 5 independent chains (10,000 draws in total). Convergence was monitored visually using trace-plots, and using the Rhat (Vehtari et. Al. 2019) diagnostic. All models converged well according to these criteria, and indicative traceplots are presented in Appendix B.

5. Survey Implementation and Results

5.1. Pilot Survey

Having designed our choice cards for each of the food products, we first implemented a pilot of the survey instrument. The pilot was implemented online yielding a total of 35 for the Chicken DCE. The pilot data revealed that the survey instrument and associated DCE had worked appropriately. Model results in terms of attributes and associated values all appeared plausible. In addition, the level of respondent engagement was as good based on feedback.

5.2. Socio-Economic Data and Descriptive Statistics

In total, some 1,600 survey responses were collected. Overall, our sample data shows that we recruited slightly more males (51 percent) than females (49 percent) for all four DCE. The age composition of each DCE was close to a uniform distribution with slightly more responses collected from those in the over 65 age group. Household size had a mode of two and almost 60 percent of respondents live in a household with children. In terms of household income the sample mean was in the range £26,000 up to £31,199 which is consistent with the UK population. In terms of educational attainment, the mode for all DCE is an undergraduate degree. Next, we asked all respondents about their shopping habits and attitudes to food and Brexit. More than 60 percent of respondents are responsible for all or most of the food and grocery shopping. We also asked respondents if they thought EU exit will have a positive, neutral or negative effect on food over the next couple of years. The responses provided indicate that more respondents think that EU exit will have a negative effect on food (36 percent) than a positive effect (24 percent). Also, there are approximately 40 percent of respondents for all DCE who think the effect will be neutral or do not know. Finally, we asked respondents with regard to food if they thought that the quality of food can be judged by its price. Four out of five respondents agreed that the quality of food can be judged by price.

5.3. Model Specifications

All DCE data were estimated using a MXL specification estimated in WTP space with all attributes assumed to be random parameters with normal distributions. The only exception was for price which was modelled as a log-normal distribution. Given the set of attributes employed our econometric specification is as follows:

$$U_{ijs} = V_{ijs} + e_{ijs} \tag{4}$$

where V_{ijs} is the systematic utility component and e_{ijs} is the random error. For the Chicken case we specified

$$V_{ijs} = \exp(\beta_{1,j})\big[-Price_{ijs} + \beta_{2,j}Chlorwash_{ijs} + \beta_{3,j}EU\ FS_{ijs} + \beta_{4,j}Organic_{ijs} + \beta_{5,j}CoO\ EU_{ijs} + \beta_{6,j}CoO\ UK_{ijs} + \beta_{7,j}QS\ RedTrac_{ijs} + \beta_{8,j}QS\ RSPCA_{ijs} + \beta_{9,j}QS\ QAI_{ijs} + \beta_{2,j}OptOut_{ijs}\big] \tag{5}$$

and where the $OptOut_{ijs}$ captures the no choice option.

Turning to the other model parameters, Chlorwash is a dummy for whether the chicken has been chlorine washed; EU FS is a dummy indicating that the food meets EU food safety standards; CoO UK and CoO EU are dummy variables relative to the excluded level non-EU; Organic is the type of farm production system with the reference level being Conventional; QS RedTrac, QS QAI and QS RSPCA are dummies for the quality standard relatively to the excluded level of no quality assurance (for the other products it will only be QS Red). For the Cases of Corn, Pork and Beef. Chlorwash was replaced with Atrazine (for Corn), Hormone in Feed (for Pork), and Hormone Implants (for Beef). For these goods the quality assurance only contained the Red Tractor vs none option (i.e. no RSPCA, or QAI attribute). Thus, for these three goods we had

$$V_{ijs} = \exp(\beta_{1,j}) \left[-Price_{ijs} + \beta_{2,j}ProdMethod_{ijs} + \beta_{3,j}EU\ FS_{ijs} + \beta_{4,j}Organic_{ijs} + \beta_{5,j}CoO\ EU_{ijs} + \beta_{6,j}CoO\ UK_{ijs} + \beta_{7,j}QS\ RedTrac_{ijs} + \beta_{2,j}OptOut_{ijs}\right] \quad (6)$$

The priors used for all the models were standard normal for the prior mean of $\beta_{k,j}$ along ith Gamma(1,1) distributions for the precision parameters. Additionally for the parameters $\beta_{k,j}$ k>1 represent willingness to pay truncated so we imposed the condition that its absolute size must be less than or equal to the total difference to maximum and minimum price for the experiment. i.e., no one attribute can be worth more than the total price variation in the experiment to and individual. For the means we imposed the condition that this must be less than 75% of this amount.

5.4. DCE Results

We now examine our DCE econometric results. In all of the results tables presented we place the attributes in descending order of WTP. First, we begin by examining the results for chlorine washed chicken that are presented in Table 2.

{Approximate Position of Table 2}

The first point to note about the estimates in Table 2 is that the estimates for chlorine washed chicken are negative. In terms of the magnitude of the WTP estimates in Table 2, the RSPCA quality assurance attribute is very highly valued along with the Red Tractor label and the EU Food Safety attribute. A high value is also placed on UK production compared to that from the EU or Non-EU. Finally, although positively valued, organic production has the lowest WTP estimate. This result is maybe less surprising when we consider that Gschwandtner and Burton (2020) report a negative WTP for organic chicken for a DCE conducted in the UK.

Another interesting feature provided in Table 2 is the proportion of respondents reporting a positive value for the attributes (extreme right hand column in both tables). The mean estimates can be misleading where they mask considerable variation. The actual posterior distributions for individuals confirms – as might be expected – substantial variations in responses. For example, while people on average do not like chlorine washed chicken, with some hating it, around 40 percent express a positive valuation of it (see in Table 2). Thus, as always, we need to be careful simply reporting mean estimates as they can masks heterogeneity of preferences. This result is in strong contrast for the other attributes where there is considerably less heterogeneity in response.

The other products and the respective WTP estimates are reported in Tables 3, 4, and 5.

{Approximate Position of Tables 3, 4 and 5}

The results in Tables 3, 4, and 5 are very much in keeping with those reported in Table 2. There are negative estimates for all of the production methods examined. The magnitude of these estimates is almost as strong as the positive estimates for the other attributes used. Interestingly, the proportion of respondents expressing a positive value for the method of production are all less than 20 percent and this is significantly lower than for chlorine washed chicken. As already noted, this result might occur because of the potentially high value some consumers place on food safety in terms of possible food poisoning. However, examining this motivation in more detail is beyond the scope of the current research. That said, it has been the case that chlorine washed chicken has received a considerable amount of attention within the UK media recently as a result of the decision to exit the EU and this might have modified attitudes to this specific production practice.

We also produced WTP results for the three types of meat using a common per unit measure (i.e. per 100 grams) (See Appendix A). The results indicate that, per 100 grams, the largest negative estimate is for hormone implants in beef, followed by hormone in food for pork and finally chlorine washed chicken. It is also the case that the relative magnitude of the WTP estimates is greatest for beef, although the quality assurance attributes for chicken are highly valued. In summary, the results generated for our DCE are generally consistent in terms of the magnitudes and the importance attached to each attribute.

6. Concluding Comments and Discussion

In this paper, we have described the design, implementation and evaluation of a DCE designed to examine consumer values with regard to food and associated forms of food production ie, hormone implants in beef; Ractopamine in pig feed; chlorine washed chicken; and Atrazine pesticide used in corn production. The DCE have yielded results that are internally consistent and, in every case, the production methods have yielded negative WTP estimates whereas all other attributes have produced positive WTP estimates. Interestingly, for all food products examined the negative WTP estimates for production are not absolutely larger than the positive WTP estimates reported for the most highly valued attributes.

For one of the production methods examined, chlorine washed chicken, our results also reveal that a minority of consumers view this practice positively. As we have already discussed, this result may well be capturing attitudes towards food safety and hygiene. This aspect of our results potentially warrants further detailed research. The importance of food safety is also explicitly observed for the other three food products examined. In terms of CoO, we find that UK production is highly valued, especially so for beef, pork and corn and that Non-EU production is not valued even relative to generic EU CoO.

The magnitude of the negative WTP are not insignificant if we consider them as a percentage of the case price. For chicken the negative WTP equates a price reduction of approximately 30 percent, for beef it is 50 percent and for pork it is nearly 70 percent. In each case this price reduction is considerably larger than the estimated used in the models examining the economic benefits from removing existing trade restrictions between the US and the EU. Furthermore, even if these products could be allowed into the UK it is difficult to imagine, for example, that US beef producer would be willing to sell their meat at a price 50 percent below that prevailing in the market.

In terms of the wider issue of food production and consumer choice several interesting issues arises. First, it is unclear if the UK will retain the same CoO regulations or whether they will change the way in which CoO is used once the UK leaves the EU (Fraser and Balcombe, 2018; Millstone et al, 2019). This matters if we believe that consumer welfare is enhanced if consumers can make more informed food choices. If as a result of specific types of trade deals being agreed, consumers are allowed to choose between types of meat product that have been produced using different production methods, then providing information such as CoO could be seen as being fundamental to support informed consumer choice. However, any meat products that enter the UK that are going to be used in processed food do not need to declare CoO. Thus, unless method of production becomes a required piece of information to provide to consumers they will not be able to make an informed choice regarding specific meat products. However, existing WTO rules would appear to rule out the use of labels indicating method of production or process under what is sometimes referred to as the “consumers right to know” (Hobbs and Kerr, 2006; Smyth et al., 2017). In this context, especially if consumers express a strong dislike of specific production methods, it is unclear how consumers can make an informed choice at the point of purchase.

One potential solution to this dilemma is for an increase in the use of information technology so that consumers can be informed about the food they are consuming. For example, Fraser and Balcombe (2018) discuss the potential benefits from employing blockchain technology and the use of SmartLabels initiative. With the development of trusted information technology there is less reason for food products to be offered to consumers without full disclosure of the source, method of production and supply chain to final product be made available. Thus, any asymmetric information that has given rise to sub-optimal food choice can be corrected even for processed food that meets the demands of consumers for convenience. However, unless the provision of this is made mandatory there appears to be little reason to see why importers would adopt this approach to information provision. Furthermore, as noted by Hobbs and Kerr (2006) the use of mandatory labelling is restricted by the WTO. Therefore, in a situation in which the existing barriers to trade are removed it is far from clear how UK consumers will be able to identify food products that have been produced using alternative modes of production unless they are allowed to be brought to the attention of consumers in any resulting bilateral trade agreement. Indeed, there may well be benefits to consumers from the UK being able to pursue bilateral trade agreements in part because of the limitation of the WTO in terms of consumer protection as opposed to producers (Hobbs and Kerr, 2006). But, even if two countries could agree a bilateral trade agreement and include labels that support consumers' right to know a third country could challenge the agreement and the costs of actual implementing this type of policy will be substantial (Smyth et al., 2017).

Second, in much of the existing research that has looked at the costs and benefits of new trade deals between the EU and US there is an apparent aversion to using the estimates of value expressed by consumers' derived using stated preference methods. This issue regarding the value attached to stated preference estimates is important as it can dramatically change the resulting balance of how a change in trade arrangements is assessed. For example, Arita et al (2017) observe that stated preference research yields estimate of consumer value that are frequently considered to be on the high side which in turn leads researchers to employ values significantly lower than those reported. Similarly, as noted Soon and Thomson (2019) employed a price discount of 15 percent for hormone-treated beef if entering the EU and an even bigger discount for a smaller group of consumers. Both studies are useful as they provide potential magnitudes of welfare gains from a trade deal. However, questions can be raised as to whether the level of price reduction is sufficient, given stated preference regarding hormone-treated beef. Also, assuming that consumers will be buy hormone treated beef if the price is low enough significantly downplays the general view reported that consumers will simply not buy hormone treated beef no matter how low the price is. Finally, the general lack of support for stated preference estimates within trade models maybe explains why the price reductions modelled are smaller than suggested by the stated preference results reported in the literature. It is also interesting that this negative attitude to stated preference estimates is at odds with how many governments openly endorse and support the use of stated preferences estimates especially in the area of environmental policy evaluation (e.g., H.M. Treasury 2018).

Finally, the importance of meat within the diet of consumers in generally seen as a problem. For example, Bonnet et al. (2020) and González et al. (2020) both comment on how excess meat consumption yields animal welfare, public health and environmental problems and as result they call for policies to bring about reductions. However, at the same time it is reported by Frontier Economics (2020) that growth in veganism is associated with a decline in weekly expenditure on meat products in the UK declining from 3.7 percent in 2013 to 3.2 percent by 2017. Therefore, it is far from clear if a trade deal that reduces the real cost of meat to consumers can be supported once the wider societal economic costs associated with meat consumption are taken into considerations whilst there is also an apparent decline in the relative importance of meat in UK consumers' diets which reduces any welfare gains from a trade deal that would remove existing barriers.

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Table 1: Summary of Attributes and Levels for All Products

Product:	Attribute	Description and Levels
500grams breast chicken	Price	2.00, 3.00, 3.99, 4.75, 6.50, 9.25
	Country of Origin	UK, EU, Non-EU
	Organic	Yes/No
	Food Standards	Meet EU and Does not meet EU
	Quality Assurance	None, RSPCA, QAI, Red Tractor
	Chlorinated Chicken	Yes/No

Product:	Attribute	Description and Levels
250 grams beef sirloin steak	Price	2.50, 2.95, 3.40, 4.00, 5.00, 6.25
	Country of Origin	UK, EU, Non-EU
	Organic	Yes/No
	Food Standards	Meet EU and Does not meet EU
	Quality Assurance	None, Red Tractor
	Hormone Implants	Yes/No

Product:	Attribute	Description and Levels
1kg pork loin joint	Price	4.00, 5.50, 6.99, 8.00, 11.99, 15.50
	Country of Origin	UK, EU, Non-EU
	Organic	Yes/No
	Food Standards	Meet EU and Does not meet EU
	Quality Assurance	None, Red Tractor
	Hormone in Feed	Yes/No

Product:	Attribute	Description and Levels
2 pack of corn on the cob	Price	0.85, 0.99, 1.24, 1.50, 2.00, 2.50
	Country of Origin	UK, EU, Non-EU
	Organic	Yes/No
	Food Standards	Meet EU and Does not meet EU
	Quality Assurance	None, Red Tractor
	Pesticide Use (Atrazine)	Yes/No

Table 2: WTP Estimates Chicken

	Mean	SE Mean	Stdv	Median	25%	75%	Prop>0
Logged Negative Price *	-0.71	0.03	0.64	-0.67	-1.11	-0.2	0.17
Chlorine Wash	-0.81	0.11	2.29	-0.49	-2.38	0.66	0.4
EU Food Safety	2.24	0.06	1.25	2.16	1.36	2.97	0.98
Organic	0.9	0.03	0.68	0.86	0.43	1.35	0.92
EU COO vs Non EU	0.74	0.01	0.28	0.71	0.55	0.91	1
UK COO vs Non EU	2.18	0.06	1.25	1.97	1.31	2.88	1
Red Tractor	2.36	0.03	0.61	2.32	1.97	2.65	1
RSPCA	2.27	0.02	0.35	2.23	2.03	2.47	1
QAI	1.69	0.01	0.2	1.68	1.56	1.79	1
Opt-out	-1.23	0.14	2.99	-2.75	-3.64	1.17	0.34

Note: SE – Standard Error; Stdv –Standard Deviation; Prop –Proportion.

Table 3: WTP Estimates Corn

	Mean	SE Mean	Stdv	Median	25%	75%	Prop>0
Logged Negative Price**	0.71	0.02	0.45	0.88	0.43	1.07	0.91
Atrazine Pesticide	-0.46	0.02	0.48	-0.57	-0.87	-0.12	0.18
EU Food Safety	0.45	0.01	0.28	0.42	0.22	0.65	0.97
Organic	0.38	0.01	0.27	0.36	0.17	0.53	0.95
EU COO vs Non EU	0.21	0.01	0.16	0.21	0.11	0.32	0.92
UK COO vs Non EU	0.63	0.01	0.28	0.62	0.42	0.79	1
Red Tractor	0.39	0.02	0.35	0.34	0.12	0.63	0.88
Opt-out	-0.64	0.03	0.62	-0.97	-1.1	-0.29	0.19

Note: SE – Standard Error; Stdv –Standard Deviation; Prop –Proportion.

Table 4: WTP Estimates Pork

	Mean	SE Mean	Stdv	Median	25%	75%	Prop>0
Logged Negative Price**	-0.81	0.04	0.85	-0.74	-1.36	-0.03	0.24
Hormone in Feed	-3.24	0.15	3.17	-3.7	-5.68	-1.04	0.17
EU Food Safety	3.27	0.09	1.83	3.2	1.86	4.37	0.99
Organic	2.03	0.09	1.96	1.92	0.73	2.94	0.88
EU COO vs Non EU	0.58	0.02	0.47	0.54	0.29	0.86	0.91
UK COO vs Non EU	2.97	0.08	1.69	2.82	1.82	3.88	0.98
Red Tractor	2.67	0.1	2.14	2.48	1.12	3.93	0.9
Opt-out	-3.48	0.2	4.11	-5.2	-6.79	-0.37	0.23

Note: SE – Standard Error; Stdv –=Standard Deviation; Prop –=Proportion.

Table 5: WTP Estimates Beef

	Mean	SE Mean	Stdv	Median	25%	75%	Prop>0
Logged Negative Price**	-0.14	0.04	0.73	-0.07	-0.64	0.44	0.45
Growth Hormone	-1.07	0.04	0.83	-1.1	-1.74	-0.49	0.11
EU Food Safety	1.3	0.03	0.65	1.27	0.81	1.72	0.99
Organic	0.83	0.03	0.62	0.8	0.41	1.15	0.93
EU COO vs Non EU	0.58	0.02	0.4	0.58	0.34	0.8	0.94
UK COO vs Non EU	1.61	0.03	0.58	1.56	1.2	1.93	1
Red Tractor	1.34	0.04	0.82	1.32	0.72	1.93	0.97
Opt-out	-1.78	0.05	1.01	-2.28	-2.53	-1.13	0.09

Notes: SE – Standard Error; Stdv – Standard Deviation; Prop - Proportion.
*,** - The logged negative price is the mean logged coefficient of the negative of price(β_1) in equations (5) and (6)

Figure 1: WTP Online Example

ConjointExample

An Example Choice Card is Shown Below

You are undertaking your weekly shop. You are provided with three options of the product you are considering buying - 500grams of chicken breast

XX/13

Which option (A, B or C) would you select?

	Option A	Option B	Option C
Price (£)	2.00	9.25	3.00
Country of Origin	Non-EU	EU	UK
Organically Produced	No	Yes	Yes
Meets EU Food Standards	Yes	Yes	No
Quality Assurance	None	Red Tractor	RSPCA Assured
Chlorine Washed	Yes	Yes	No
Please tick your preferred option	○	○	○

You must select one option A, B, C.

You first tick your preferred option.

And then after each choice card, you will be able to indicate if you would <u>not</u> actually choose A, B or C

Appendix A

Table A1: WTP Estimates (Per 100 grams of meat)

	Mean	SE Mean	Stdv	Median	25%	75%
Chlorine Wash	-0.162	0.022	0.459	-0.099	-0.477	0.132
EU Food Safety	0.448	0.012	0.25	0.432	0.271	0.593
Organic	0.179	0.006	0.136	0.173	0.085	0.271
UK COO vs Non EU	0.437	0.012	0.249	0.393	0.262	0.575
UK COO vs Non EU	0.437	0.012	0.249	0.393	0.262	0.575
Red Tractor	0.472	0.006	0.121	0.464	0.394	0.531
RSPCA	0.453	0.003	0.069	0.447	0.406	0.495
QAI	0.337	0.002	0.04	0.335	0.311	0.359

Note: SE – Standard Error; Stdv - Standard Deviation; Prop - Proportion.

Table A2: WTP Estimates Pork (Per 100 grams of meat)

	Mean	SE Mean	Stdv	Median	25%	75%
Hormone in Feed	-0.324	0.015	0.317	-0.37	-0.568	-0.104
EU Food Safety	0.327	0.009	0.183	0.32	0.186	0.437
Organic	0.203	0.009	0.196	0.192	0.073	0.294
EU COO vs Non EU	0.058	0.002	0.047	0.054	0.029	0.086
UK COO vs Non EU	0.297	0.008	0.169	0.282	0.182	0.388
Red Tractor	0.267	0.01	0.214	0.248	0.112	0.393

Note: SE – Standard Error; Stdv – Standard Deviation; Prop – Proportion.

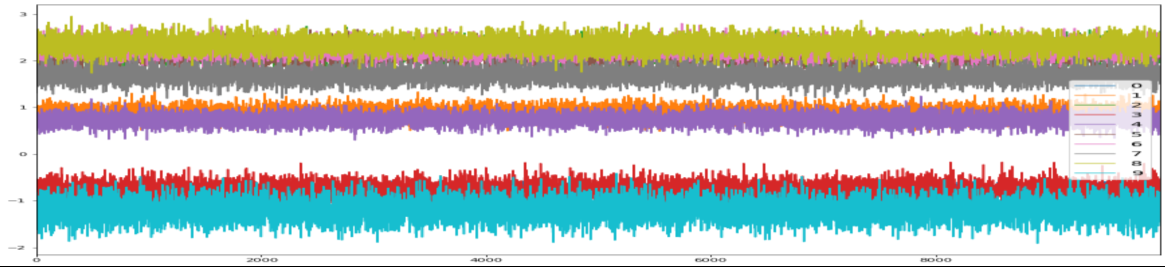
Table A2: WTP Estimates Beef (Per 100 grams of meat)

	Mean	SE Mean	Stdv	Median	25%	75%
Growth Hormone	-0.428	0.016	0.332	-0.441	-0.695	-0.195
EU Food Saftey	0.52	0.013	0.262	0.51	0.324	0.69
Organic	0.332	0.012	0.247	0.318	0.162	0.462
EU COO vs Non EU	0.232	0.008	0.159	0.231	0.134	0.319
UK COO vs Non EU	0.643	0.011	0.23	0.624	0.479	0.771
Red Tractor	0.534	0.016	0.326	0.529	0.289	0.77

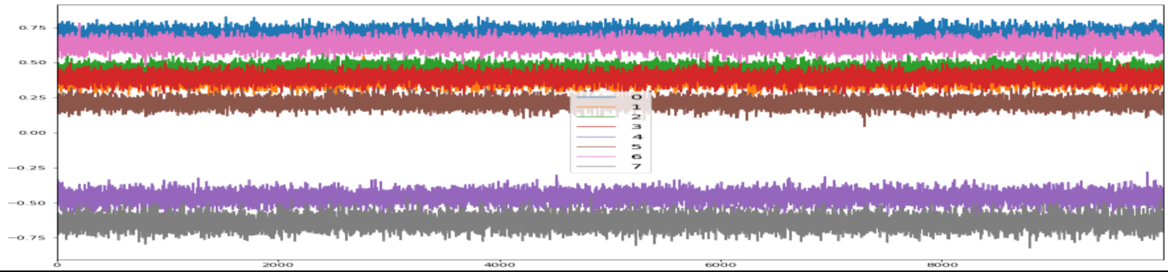
Note: SE – Standard Error; Stdv – Standard Deviation; Prop - Proportion.

Appendix B: Traceplots for MCMC Convergence

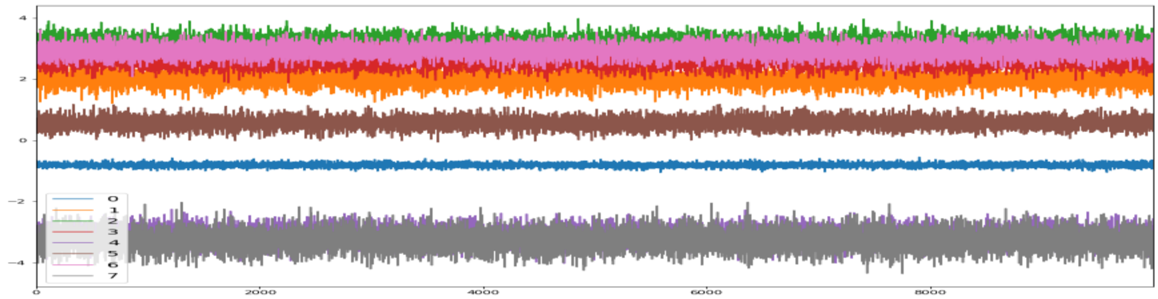
Chicken (Mean Coefficients)



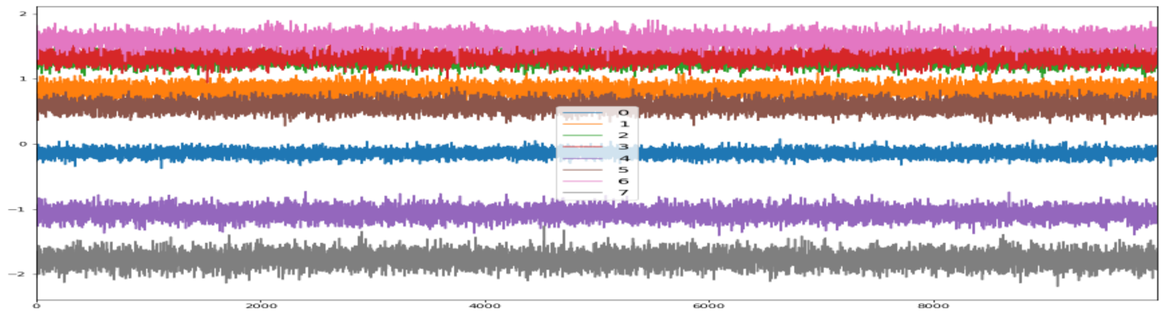
Corn (Mean Coefficients)



Pork (Mean Coefficients)



Beef (Mean Coefficients)



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