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Modelling WTP for sustainably farmed fish: A contingent valuation study in Ireland and Norway

Stephen Hynes[1*], Elisa Ravagnan[2], Brita Gjerstad[2]

1. Socio Economic Marine Research Unit, Whitaker Institute, National University of Ireland Galway
2. NORCE Environment, Stravanger, Norway

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*Corresponding author: Stephen.hynes@nuigalway.ie
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Modelling WTP for sustainably farmed fish: A contingent valuation study in Ireland and Norway.

Stephen Hynes[1], Elisa Ravagnan[2], Brita Gjerstad[2]

Abstract

In this paper Norwegian and Irish consumers' willingness to pay for salmon that is produced under more sustainable aquaculture practices is examined using the contingent valuation method. A bivariate probit model is estimated where the consideration of environmentally friendly fish farming at time of purchase is jointly estimated with willingness to pay. The predicted joint probabilities of the bivariate probit model are calculated in order to examine if concerns for the environmental credentials of salmon aquaculture translate into willingness to pay a price premium for sustainably farmed fish. The results suggest that environmental concerns and attitudes are not the sole motivating factors influencing consumption behaviours.

Keywords: salmon farming, aquaculture, contingent valuation method, bivariate probit, WTP.

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*Corresponding author: Stephen.hynes@nuigalway.ie

Introduction

The public's attitudes towards aquaculture are often framed in the context of their understanding of the sustainability of many of the practices used in fish farming. Consumers in North/Western Europe and other industrialized countries for example may be more concerned about how their seafood/farmed fish was produced compared to consumers in developing nations. Therefore, as Whitmarch and Palmieri (2011) point out, the social acceptability of aquaculture is shaped by people's perception of sustainability and such perceptions are likely to influence consumer behaviour. In the context of this research 'sustainably farmed fish' is defined as best practise being followed in producing the fish in terms of; preservation of the natural environment and biodiversity; preservation of water resources; preservation of diversity of species and wild populations (e.g., preventing escapes which could pose a threat to wild fish); responsible use of animal feed and other resources; animal health (no unnecessary use of antibiotics and chemicals); and social responsibility (e.g. health and safety of workers is paramount, good community relations).

Early work by Young et al. (1999) provided evidence that the demand for aquaculture produce is influenced by the environmental attributes of the product. Previous research has also shown that the promotion of the sustainability of the aquaculture production process can result in product differentiation and associated higher price premiums (Ankamah-Yeboah et al., 2016; Asche et al., 2015; van Osch et al., 2019). Elsewhere it has been demonstrated that certain consumers segment demand additional ethical values and animal welfare standards from the seafood products they purchase and expect to pay higher prices for such attributes (Feucht and Zander, 2015; Kalshoven and Meijboom, 2013; Risius et al., 2017; Zander and Feucht, 2018). With

this in mind, this paper examines the Norwegian and Irish public's willingness to pay (WTP) a premium for sustainably farmed salmon using the Contingent Valuation Method (CVM).

Several previous studies have examined the consumer benefits from improvements in the sustainability of salmon farming (Whitmarsh and Wattage 2006; Johnston et al. 2008; Yip 2012; Martínez-Espiñeira et al. 2016). Positive consumers' WTP was identified in several studies for salmon produced in an environmentally friendly manner (in Scotland by Whitmarsh and Wattage (2006), in the US West coast by Yip et al. (2017) and in Canada by Barrington et al. (2010)). Whitmarch and Palmieri (2011) found that increased concern over the sustainability of the salmon farming industry is associated with a lower propensity to purchase salmon amongst Canadian consumers. In an earlier choice experiment based study, Olesen et al. (2010) showed that Norwegian consumers had a WTP a premium of approximately 15% for organic and animal welfare-labelled farmed salmon relative to the conventionally farmed alternative.

Elsewhere, a contingent valuation survey carried out by Whitmarsh and Wattage (2006) found that Scottish respondents were willing to pay a price premium for salmon that was farmed using production methods that minimized pollution caused by nutrient discharge. Also using a CVM approach, Martinez-Espiñeira et al. (2016) found that the environmental benefits from an integrated multi-trophic aquaculture (IMTA) system accrue to both regular consumers and households who do not regularly purchase salmon. A number of other studies have also assessed consumer's WTP a premium for labelled IMTA seafood (Barrington et al., 2010; van Osch et al.

2017; van Osch et al. 2019) and for closed containment aquaculture systems (Yip 2012).

One of the most comprehensive CVM studies of seafood products in terms of product type and geographical coverage is a recent study by Zander and Feucht (2018). In that study the authors analyse consumer preferences and their WTP for fish under different sustainability criteria and identify consumer segments according to their WTP. The questionnaire was carried out across nine European countries. Clear differences between countries were found in the study regarding preferences for different sustainability criteria. On average across all countries, additional WTP was found to be highest for fish that is organically produced, followed by 'sustainably produced' and thirdly being produced with higher animal welfare standards. The study also found that a proportion of the consumers were willing to pay significantly higher prices for sustainably produced fish from Europe under conditions where 'trustful standards' were applied and were 'well communicated'.

This research adds to the above literature in a number of respects. Firstly, the Irish and Norwegian public's WTP a price premium for sustainably farmed salmon is estimated using a single bound dichotomous choice probit model. Secondly, a joint bivariate probit model is estimated where consideration of environmentally friendly fish farming at time of purchase has on a person's purchasing decision is jointly estimated with WTP. This second modelling approach is one that has not been considered in the literature previously but as shown here may provide more useful information to the aquaculture industry than the more standard modelling approaches used in a single bound dichotomous choice CVM. The predicted joint probabilities of

the bivariate probit model are calculated in order to examine if concerns for the environmental credentials of salmon aquaculture translate into WTP a price premium for sustainably farmed fish.

Research design and valuation methodology

Data for the analysis was collected via a nationwide survey conducted in Ireland and Norway over a 3 month period from April to June in 2016. In the Irish case this was through a face to face survey while in the Norwegian case it was via telephone interviews. Only respondents aged 18 years or older were interviewed in both countries. The interviews resulted in 959 complete Irish surveys and 1001 Norwegian surveys. In the Irish case a quota controlled sampling procedure was followed to ensure that the survey was nationally representative for the population aged 18 years and above[1].

The quotas used were based on known population distribution figures for age, sex and region of residence taken from the Irish National Census of Population, 2011. In the Norwegian case a similar quota controlled sampling procedure was also followed. Representative sampling weights based on Census of Population statistics for Norway are also used in the analysis to insure that the telephone interviewed sample is fully representative of the national population. Residents from 25 of the 26 counties in Ireland are represented in the Irish sample while in the Norwegian case residents from all of the 19 counties in Norway are represented.

[1] The aim of quota controlled sampling is to 'design' the composition of the final achieved sample. The design attempts to replicate the true composition of the population of interest. In the case of the Norwegian and Irish surveys it aims to generate a sample based on known census proportions for a number of key characteristics.

Pilot testing of the survey instruments was conducted in the months prior to the main survey. Along with observations from earlier focus group discussions, results from the pilots were used to refine the questions asked in the main surveys. Respondents were asked a series of questions related to their attitudes toward the marine environment and aquaculture[2], their fish eating habits and a CVM question to ascertain their WTP a price premium for a fillet of salmon that was produced under more sustainable aquaculture practices. A number of socio-demographic questions were also asked related to age, gender, marital status, occupation, working status, income, number of persons in household and education. Questions were also asked about how respondents perceived a number of industries impacted the marine environment. This was done as it has been shown that public sentiment toward aquaculture may be influenced by attitudes towards other coastal or marine related activities not directly related to aquaculture but which can impact the marine environment (Froehlich et al., 2017). Attitudinal dummy variables related to renewable energy, oil and gas and wild fishing are included in the 'concerned[3]' portion of the binomial probit models to test for this influence. Summary statistics for the sample are presented in table 1.

- **Table 1 here**

The CVM question was only asked of those respondents who indicated that they ate salmon (650 in the Irish case and 861 in the Norwegian case). Respondents were first asked: "Consider your grocery budget and the following two options. You have an

[2] The responses to the attitudinal questions are not presented here but are fully reported on in Hynes et al. (2018). Note however that 100 additional completed surveys are involved in the analysis presented in this paper in the Irish case.

[3] The part of the model that estimates the likelihood that the respondent will be concerned about the environmental friendliness of the production process used to generate the farmed salmon, at the time of purchase.

option of a conventional fillet of fresh farmed salmon costing €15.50[4] per kg and the option of Eco-labelled farmed salmon of the same weight. An average size fillet to feed 1 person weighs about 150 -200 grams and might cost €2.75 per person for a conventional fillet of salmon."

In any CVM analysis it is vital that the respondents are given clear information in terms of what the contingent scenario is that they are being asked to pay a price premium for. In this study, an eco-label was used in the WTP question to deliver the information on the sustainable farmed salmon alternative. The respondents were informed that the 'eco-labelled farmed salmon' meant that best practise had been followed in producing the fish in terms of; preservation of the natural environment and biodiversity; preservation of water resources; preservation of diversity of species and wild populations (e.g., preventing escapes which could pose a threat to wild fish); responsible use of animal feed and other resources; animal health (no unnecessary use of antibiotics and chemicals); and social responsibility (e.g. health and safety of workers is paramount, good community relations). Although the respondents were not informed of the fact, these criteria are in line with those of the Aquaculture Stewardship Council's standards for responsible aquaculture.

Individuals in the survey were then asked if, when they were making a purchase which salmon they would be more likely to buy; a conventional salmon for €15.50 per kg (approx. €2.75 per person) or an eco-labelled salmon for €X_1 per kg (approx. €X_2 per person). In this single-bound dichotomous choice question format, each respondent was offered a single bid value for the eco-labelled salmon. Six different

[4] The starting value for the conventional fillet was marginally higher at €15.56 in the Norwegian case and were presented in Norwegian kroner.

paired bid values for X_1 and X_2 were used in the surveys. The individual would be expected to choose the eco-labelled salmon if his/her WTP a price premium for the environmentally sustainably produced salmon is greater than the difference between the offered bid amount and the price of the standard, unlabelled, farm salmon, and choose the standard, unlabelled fillet if his/her WTP a price premium for the environmentally sustainably produced salmon is less than the difference between the offered bid amount and the price of the standard, unlabelled, farmed salmon.

The CVM question was formatted the same in both Norway and Ireland although the prices used for the questionnaire were slightly higher in the Norwegian case to reflect the difference in the price of farmed salmon in both countries. In the Irish case the bid values used for the eco-labelled salmon were €16, €17, €18, €19, €20 and €21 and in the Norwegian case they ranged from 160 Kroner to 210 Kroner which at the time was approximately equivalent to the integer range of €17 to €22.

Based on the above single-bound dichotomous choice question format the WTP function for individual *i* can be written as:

$$\ln(WTP_i) = x_i\beta + \varepsilon_i$$

where *x* is the vector of explanatory variables, $\boldsymbol{\beta}$ is the vector of parameters to be estimated, and $\boldsymbol{\varepsilon}$ is the error term. In this case

$WTP_i \geq bid_i$ if the offered bid amount for the sustainably produced salmon is accepted

$WTP_i \leq bid_i$ if the offered bid amount for the sustainably produced salmon is not accepted

Denoting $y_i = 1$ if bid_i is accepted and $y_i = 0$ if bid_i is not accepted then the probability of $y_i = 1$ is a function of the explanatory variables x and can be written as:

$$Pr(y_i = 1|x_i) = \Pr(x_i\beta + \varepsilon_i > \ln(bid_i)) \text{ or}$$

$$Pr(y_i = 1|x_i) = \Pr(\varepsilon_i > \ln(bid_i) - x_i\beta)$$

The standard probit model is employed to estimate the above specification where it is assumed that the error term ε_i has a normal distribution $N(0, \sigma^2)$. Therefore:

$$Pr(y_i = 1|x_i) = \Phi\left(\frac{x_i\beta}{\sigma} - \frac{\ln(bid_i)}{\sigma}\right)$$

where $\Phi(.)$ denotes the standard cumulative normal distribution function. The probit model is estimated with x_i and bid_i as explanatory variables, and the estimates of β/σ, the vector of coefficient estimates associated to each of the explanatory variables are obtained ($\widehat{\beta/\sigma}$ and $-1/\widehat{\sigma}$ the coefficient estimate on $ln(bid_i)$).

To test the influence of believing that sustainable forms of salmon farming are an important consideration at time of purchase on WTP, two alternative model specifications are estimated separately on the Norwegian and Irish data. In the first probit model a dummy is included that indicates if environmentally friendly production is an important consideration for the respondent when considering buying salmon. This dummy (*Enviro_matters*) is based on the response to a ranking question that appeared early in the survey instrument that stated "Thinking of buying and eating salmon, how important are each of the following aspects in choosing which salmon to buy? 1. Environment-friendly produced." If a respondent indicated that this

issue was important or very important to them then the dummy is given a value of 1 and 0 otherwise.

To further test for the influence of considering how environmentally friendly the production method is on WTP a bivariate probit model is next estimated on both the probability of accepting the bid value and the probability of environmental friendly production being considered at time of purchase by the respondent. In the bivariate probit model, there are two separate probit models with correlated disturbances such that:

$$Pr(y_i = 1|x_{1i}) = \Pr(\varepsilon_{1i} > \ln(bid_i) - x_{1i}\beta_2)$$

$$Pr(EnvMatters_i = 1|x_{2i}) = \Pr(\varepsilon_{2i} > x_{2i}\beta_2)$$

$$\rho = corr(\varepsilon_{1i}, \varepsilon_{2i})$$

where the subscripts 1 and 2 on x, β and ε indicate if the vector of explanatory variables, parameters and error terms relate to the model of accepting the bid value or the binary '*concerned'* model, respectively. In estimating the bivariate probit model it is assumed that the errors are independent and identically distributed as a standard bivariate normal (Φ_2) with correlation ρ; that is

$$\varepsilon_{1i}, \varepsilon_{2i} \sim \Phi_2(0, 0, 1, 1, \rho)$$

If $\rho = 0$, then the two errors are independent and Φ_2 reduces to two separate standard normal distributions. If $\rho \neq 0$, then the two errors are correlated and the probability of one error is dependent on the value/probability of the other. This rho coefficient therefore captures some unobservable characteristic that correlates the respondents'

probability of being willing to pay the bid amount presented in the CVM question and considering, at time of purchase, the key underlying issue behind the CVM scenario – environmentally friendly fish farming practises. Of particular interest also are the predicted joint probabilities of y_i and $EnvMatters_i$ as these give an indication of the interrelationship between the consideration of environmental friendly production at time of purchase and responding positively to the bid value offered;

$$\Pr(y_i = 1,\ EnvMatters_i = 1) = \ \Phi_2(x_{1i}\hat{\beta}_1, x_{1i}\hat{\beta}_1;\ \hat{\rho})$$

$$\Pr(y_i = 1,\ EnvMatters_i = 0) = \ \Phi(x_{1i}\hat{\beta}_1) - \ \Phi_2(x_{1i}\hat{\beta}_1, x_{1i}\hat{\beta}_1;\ \hat{\rho})$$

$$\Pr(y_i = 0,\ EnvMatters_i = 1) = \ \Phi(x_{2i}\hat{\beta}_2) - \ \Phi_2(x_{1i}\hat{\beta}_1, x_{1i}\hat{\beta}_1;\ \hat{\rho})$$

$$\Pr(y_i = 0,\ EnvMatters_i = 1) = \ 1 - \ \Phi(x_{1i}\hat{\beta}_1) - \Phi(x_{2i}\hat{\beta}_2)\Phi_2(x_{1i}\hat{\beta}_1, x_{1i}\hat{\beta}_1;\ \hat{\rho})$$

The probit and bivariate probit models are presented for Norway and Ireland in the following section along with WTP estimates calculated at the mean of the explanatory variables in each case. The predicted joint probabilities of the bivariate probit model are also analysed. All models were estimated by maximum likelihood methods which require the numerical maximization of the respective log likelihood functions.

Results

In the first set of single bound dichotomous choice CVM probit models (table 2), a dummy variable is included that indicates if environmentally friendly production is an important consideration for the respondent when considering buying salmon. In table 3 the results of the bivariate probit model that jointly estimates both the probability of accepting the bid value and the probability of the respondent considering

environmental friendly production as being important at time of purchase are presented.

- **Table 2 here**

For the standard probit models it was observed that being a student, having fewer members in the household, eating fish at least once a week, partaking in coastal recreation more than 10 times per year and higher incomes levels all positively influence the probability of being willing to pay a price premium at a 5% level of significance in the Irish case. Respondents believing that there are fish farms in their local area also have a positive influence on the probability of being willing to pay a price premium but only at the 10% level of significance.

In the Norwegian case, being a student, being employed, being retired, being female, having fewer members in the household, eating fish at least once a week, believing that sea lice from fish farms has a significant impact on wild stocks, higher incomes levels and lower bid values offered, all positively influence the probability of being willing to pay a price premium at a 5% level of significance. Eating fish at least once a week was not found to be significant in the Norwegian case but as can be seen in the summary statistics of table 1 almost everyone in the sample (94%) eat fish at least once a week compared to just 62% in the Irish case.

In both country cases the bid values offered in the WTP question are highly significant (at the 1% level) and are found, as expected, to negatively influence the probability of being willing to pay a price premium for sustainably produced salmon. The Enviro_matters variable in both country models, which indicates if how

environmentally friendly the production of the salmon was is an important consideration for the respondent when considering buying salmon, is positive and highly significant in both cases as expected. This suggests that when respondents consider environmental friendly salmon farming as important at time of purchase, they are more likely to pay the price premium for the more sustainably produced salmon[5].

Given that the standard probit model presented above suggest that one of the determinants of WTP is the degree to which the consumer considers the environmental credentials of the product when going shopping and at the same time the consideration of the environmental credentials of the product depends on the respondents attitudes to marine environmental issues and other socio-demographical characteristics, a better model should be one that considers the correlation between the WTP and the consideration of environmental friendly salmon farming practices. Therefore, the bivariate probit models for both countries are estimated. The bivariate probit model also allows for the estimation of the joint probabilities of considering environmentally friendly practices important (or not) and being WTP a price premium (or not). These joint probabilities facilitate answering the question raised in the title of the paper; will concerns for the environmental credentials of salmon aquaculture translate into WTP a price premium for sustainably farmed fish?

[5] While not presented here probit models were also estimated based solely on the subsample of respondents who indicated that environmentally friendly production is an important consideration when buying salmon. This reduced the sample in the Irish case to 531 respondents and in the Norwegian case to just 486 respondents. In both cases it was found that the sign and significance of the coefficients are broadly similar to that of the main probit models. However, in the Norwegian case, being retired and believing that sea lice from fish farms has an impact on wild stocks no longer has a significant influence. As expected it was again observed that the coefficient on the bid value is negative and statistically significant. The magnitude of the bid value coefficient increases relative to the standard model although the difference is only statistically significant in the Irish case. This would suggest that the price premium offered has less influence on the likelihood of WTP for the consumer who considers the environmental credentials of the product when going shopping.

- **Table 3 here**

The bid value variable is only included in the WTP equation and not in the equation generating the probability that considering the environmentally friendly practices in the production of salmon as important (columns headed 'Issue of Concern' in table 3) as it is assumed that it is only after considering the importance of environmentally friendly practices in the production of salmon that a consumer would consider if he or she is willing to pay a price premium; i.e. the price does not determine the attitude to such production practices but should influence WTP. To further allow for identification in the bivariate probit, three dummy variables are included in the 'Concerned' part of the model that are equal to 1 if the respondent agreed or strongly agreed with the statements that (a) renewable energy, (b) oil and gas and (c) wild fishing are a threat to the marine environment. The positive coefficients on these variables in the 'concerned' model for both country specifications shows that respondents who believe that these industries pose a threat to the marine environment are more likely to consider the environmental credentials of farmed salmon at the time of purchase. This result is significant at the 5% level or higher in the case of renewables and oil and gas for Ireland and for oil and gas and wild fishing for Norway[6]. This is in line with the findings of Froehlich et al. (2017) where it was found that attitudes towards the environmental impacts of other marine industrial activities will often influence public perceptions towards aquaculture.

[6] As shown in the summary statistics in table 1 the percentage of respondents who see oil and gas, renewables and wild fishing as threats to the marine environment is much higher in the Irish case that in the Norwegian even though the size of oil and gas and wild fishing sectors in Ireland would only be a fraction of that observed in Norway. The tendency for the Irish public to express high levels of concern related to marine environmental issues compared to their European counterparts has been previously noted by Hynes et al., 2014).

It is interesting to note that where variables are common in both parts of the biprobit model they tend to only have a significant influence in one. For example being employed, female, younger and believing that sea lice from fish farms has a significant impact on wild stocks positively influences the likelihood of considering the environmental credentials of farmed salmon when going shopping in the Irish case whereas these variables are insignificant in the WTP part of the model. Being a student, having fewer numbers in the household and partaking in coastal recreation at least 10 times a year positively influence WTP in the Irish case. Eating fish at least once a week is the only common variable that has a significant (and positive) influence in both parts of the Irish model.

In the Norwegian case being female and believing that sea lice from fish farms has a significant impact on wild stocks are statistically significant in both parts of the model. Gross income also has a significantly positive influence on WTP in the Norwegian case while the number of persons in the household has a negative influence on WTP but only at the 10% level of significance. Once again the bid value is highly significant in the WTP part of the model for both Norway and Ireland and of the expected negative sign.

It can also be seen from Table 3 that the rho coefficient is positive and significant in both country bivariate probit specifications. The rho coefficient captures some unobservable characteristic that correlates the respondents' likelihood of answering positively the CVM question and believing environment-friendly production important. This result suggests that there are some unobservable characteristics that

both increase the likelihood of responding positively to the WTP a price premium question and believing that environment-friendly salmon farm production is important at time of purchase. The log-likelihood of the standard probit models for each country was also compared to the joint log-likelihood for the bivariate probit models using a likelihood ratio test. The result of the test support the hypothesis that the bivariate probit model fits the data better than the separate probits.

- **Table 4 here**

The predicted joint probabilities from the bivariate probit models are shown in table 4. The probability of 0.44 and 0.43 in the Irish and Norwegian case respectively for the joint probability of considering environmentally friendly practices important and being WTP a price premium (Pr (WTP= 1, Enviro_matters= 1)) demonstrates that the salmon farms environmental credentials are an important driver of the purchase decision. However, the relatively high joint probability observed in the Irish case (Pr (WTP= 0, Enviro_matters= 1) = 0.36) for considering environmentally friendly practices important but not being WTP a price premium and in the Norwegian case for not considering environmentally friendly practices important but being WTP a price premium (Pr (WTP= 1, Enviro_matters= 0) = 0.21) would suggest that there are other incentives driving the purchase of the marketed good beyond considering the importance of environmentally friendly practices. This would suggest that concerns for the environmental credentials of salmon aquaculture do not always translate into WTP a price premium for sustainably farmed fish. This issue is returned to in the discussion section.

- **Table 5 here**

Finally, the WTP estimates from all models are shown in table 5. No statistically significant differences in WTP across the alternative model specifications within each country was found. In the Irish case the mean WTP estimates are approximately €19 per kg while in the Norwegian case the mean WTP is slightly higher at approximately €22 per kg. The willingness-to-pay estimates are however statistically different between the two countries. Given the higher prices for food items in Norway compared to Ireland this latter result was not unexpected. For the bivariate model the average price premium that the consumers are willing to pay for the sustainable alternative is €3.52 and €6.45 for Ireland and Norway, respectively.

Discussion and Conclusions

In this paper the main issue investigated was if concerns for the environmental credentials of salmon aquaculture translate into WTP a price premium for sustainably farmed salmon using a contingent valuation scenario question. If WTP is a function of the concern for the environmental credentials of the fish farming operation was tested for based on an ex ante question related to how important consideration of environmental friendly production methods in aquaculture are when the respondent is considering purchasing salmon. The determinants of this concern were also examined by estimating a joint bivariate probit model of concern and WTP. The analysis finds that respondents who believe that environmentally friendly fish farming practices are a relevant consideration when buying a fillet of farmed salmon are more likely to be willing to pay a price premium for the proposed produce.

However, the predicted joint probabilities from the bivariate probit models also indicated a relatively high joint probability in the Irish case (0.36) for considering

environmentally friendly practices important but not being WTP a price premium and in the Norwegian case for not considering environmentally friendly practices important but being WTP a price premium (0.21). This may reflect the fact that environmental concerns and attitudes are often not the sole motivating factors explaining why people engage in certain consumption behaviours. As Lavell and Fahy (2012) point out attitudes towards perceived moral obligation, perceived entitlement to resources as well as behavioural experience can all influence a person's behaviour; either directly or indirectly. For Norway it may be case that some respondent genuinely do not care about how sustainably produced the farmed salmon is but are still willing to pay the price premium for it, as they recognise it is in the greater interest of Norwegian society or perhaps they feel peer pressure to do so. They may also associate the alternative production methods with further health benefits[7]. The Irish result is harder to explain but may reflect the fact that Ireland was coming out of a difficult economic period when this survey was carried out so while some respondents believed environmentally friendly farming practises is an important consideration they were still not willing to pay extra for same.

In a related study Vanhonacker et al. (2013) investigated consumer opinions towards a series of food choices with lower ecological impacts. They found a significant willingness to *consume* more meat from animals with lower environmental impact and more sustainable farmed fish amongst consumers. However, the same consumers were significantly less positive in terms of WTP a price premium (based on a 1-5

[7] In the Norwegian case a question related to importance of health benefits from eating salmon allowed us to also run a bivariate probit where the probability of ranking health benefits the main reason for a consumer eating salmon and being WTP a price premium for salmon produced in the more environmentally friendly manner were jointly estimated. In this case, the joint probability of considering health benefits the most important reason for eating salmon and being WTP a price premium was 0.37. However, the rho coefficient in this alternative bivariate probit was highly insignificant.

likert scale question) for the same produce. The authors suggest that this reflects segmentation in the market for these alternative food choices. This consumer segmentation is also reflected in the results from the joint probabilities in the bivariate probit models and is an important consideration for stated preference market research. Also of relevance to the Norwegian joint probabilities noted above, the same authors point out that many consumers underestimate the ecological impact of animal production, including aquaculture production.

From a policy perspective the insights provided by the results of this paper are of importance to producers and marketers using the outcomes of such analysis to better position these products in the market. Interpreting the results of such studies as positive attitudes to a new good on the market may not necessarily follow through to the consumers being willing to pay for that good. In such situations, the observation by Vermeir and Verbeke (2006) that the positive relationship between the level of sustainable behaviour of producers and the extent to which the consumer believes that his/her personal efforts in food choices can provide a solution to an environmental problem may be more influenced through education, communication and targeted information provision. Therefore salmon producers wishing to charge a price premium because of the differentiating environmental credentials of their product should endeavour to clearly demonstrate those credentials though clear labelling that catches the consumer's eye at time of purchase and at the same time educates the consumer as to the wider benefits of such production practices.

Given the previous discussion around the joint probabilities from the bivariate probit model, if the goal is to encourage more sustainably forms of fish farming then perhaps

imposing taxes on unsustainably produced salmon or subsidizing the development of IMTA production processes or other sustainable alternatives may have a greater influence on the consumption and production of more environmentally friendly farmed salmon. This is especially the case, such as was found in this study for Ireland, where believing the policy change is important still may not influence the WTP for the policy change when the policy change relates to a market good.

It should also be noted that while there are many CVM and choice experiment studies that estimate the WTP for aquaculture produce, it has been argued that stated preference surveys involving a potential private market good, such as sustainably farmed salmon, are not incentive compatible given the lack of a coercive payment mechanism (Carson and Groves, 2007). The common speculation is that, assuming the survey is influential, respondents may over-reveal demand for the new market good. This would increase the chance that the potentially desirable good is made available in the market, but consumers then have the option of not buying it.

Although a stated preference survey for a new market good is not incentive compatible, it is an open question as to whether the sufficiency conditions identified for public goods elicitations may be important in getting us closer to truthful demand revelation for private goods. Indeed, previous methodological comparisons have shown that hypothetical bias in CVM, when analysing WTP for private goods, is much lower than might be expected (Grunert et al., 2009; List and Gallet, 2001; Lusk and Schroeder, 2004). Also, in an effort to reduce this bias in this study the respondents were encouraged to consider their budget constraints seriously and, following best practice (Kallas and Gil, 2012), the scenario described in the CVM

question was kept as realistic and simple as possible so that it would be easily understandable. The results in this study still suggest a clear demand for farmed salmon with higher environmental credentials. The question asking respondents whether they care about environmentally friendly farming practices when buying salmon suggests whether the respondent has demand for a salmon product that meets certain standards, and in this sense, it is not surprising that this is jointly determined with WTP.

Furthermore, it should be noted that the study is based on information collected on indicated levels of WTP instead of actual purchase data. A consumer can of course already buy sustainably produced salmon in both Ireland and Norway and certification agencies and eco-labelled salmon exists across many countries. An interesting area for further research would therefore be to use market data from both countries to identify the price premium, or implement an experiment involving actual purchases. In this manner the reliability of the WTP estimates generated using the CVM approach could be evaluated.

While the results imply that a WTP for a price premium of 22% in the Irish case and 41% in the Norwegian case, which should translate to higher revenues, fish farm operator's profitability also depends on the marginal costs of providing higher sustainable levels in production. This and other similar studies results indicate consumers are willing to pay a price premium for sustainable farmed salmon but, in the absence of regulations, getting farming companies to effectively apply sustainable production methods will ultimately depend on the cost of doing so being within the premium range of WTP of consumers. Modelling the impact of changes in

technology and costs on potential profitability is therefore an important area that also requires further research. These caveats aside, the findings of this study should still be helpful to the salmon farming industry in both Ireland and Norway in assessing the market potential for new forms of salmon aquaculture that use more environmentally friendly production techniques and in developing marketing and pricing strategies for promoting sustainably farmed produce.

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval:
This article does not contain any studies with animals performed by any of the authors.

References

Ankamah-Yeboah, I., Nielsen, M. and Nielsen, R. (2016). Price premium of organic salmon in
Danish retail sale. *Ecological Economics*, 122, 54–60.

Asche, F., Larsen, T., Smith, M., Sogn-Grundvåg, G. and Young, J. (2015). Pricing of eco-labels with retailer heterogeneity. *Food Policy*, 53: 82–93.

Barrington, K., Ridler, N., Chopin, T., Robinson, S. and B. Robinson (2010). Social aspects of the sustainability of integrated multi-trophic aquaculture. *Aquaculture International* 18(2): 201-211.

Froehlich, H., Gentry, R., Rust, M., Grimm, D. and B. Halpern (2017). Public Perceptions of Aquaculture: Evaluating Spatiotemporal Patterns of Sentiment around the World. *PLoS ONE* 12(1): e0169281

Carson, R. and T. Groves (2007). Incentive and informational properties of preference questions. *Environmental and Resource Economics*, 37(1): 181–210.

Feucht, Y. and Zander, K. (2015). Of earth ponds, flow-through and closed recirculation systems — German consumers' understanding of sustainable aquaculture and its communication. *Aquaculture,* 438, 151–158.

Grunert, K., Juhl, H., Esbjerg, L., Boutrup Jensen, B., Bech-Larsen, T. Brunsø, K. and Øland Madsen, C. (2009). Comparing methods for measuring consumer WTP for a basic and an improved ready made soup product. *Food Quality and Preference*, 20, 607–619.

Hynes, S., Norton, D. and R. Corless (2014). Investigating societal attitudes towards the marine environment of Ireland. *Marine Policy*, 47: 57–65.

Hynes, S. Skoland, K., Elisa Ravagnan, E., Gjerstad, B., Vatland Krøvel, A. (2018) Public attitudes toward aquaculture: An Irish and Norwegian comparative study, *Marine Policy*, 96, 1-8.

Johnston, R., Roheim, C., Joglekar, D. and R. Pomeroy, 2008. Estimating preferences for non-market attributes of aquaculture and sustainable seafood production: methods and empirical applications. *International Journal of Environmental Pollution*, 33 (4), 469–484

Kallas, Z. and Gil, J. (2012). Combining contingent valuation with the analytical hierarchy process to decompose the value of rabbit meat. *Food Quality and Preference*, 24, 251–259.

Kalshoven, K. and Meijboom, F. (2013). Sustainability at the crossroads of fish consumption and production. Ethical dilemmas of fish buyers at retail organizations in The Netherlands. *Journal of Agriculture and Environmental Ethics*, 26, 101–117.

Lavelle, M. and F. Fahy (2012). ConsEnSus lifestyle survey - Environmental concern results. [http://www.consensus.ie/wp/wp-content/uploads/2013/10/Environmental-Concern-survey-results.pdf - Accessed 3rd June 2017]

List, J. and Gallet, C. (2001). What experimental protocol influence disparities between actual and hypothetical stated values? *Environmental and Resource Economics*, 20, 241–254.

Lusk, J. and Schroeder, T. (2004). Are choice experiments incentive compatible? A test with quality differentiated beef steaks. *American Journal of Agricultural Economics*, 86, 467–482

Martinez-Espiñeira, R., Chopin, T., Robinson, S., Noce, A., Knowler, D. and W. Yip (2016). A contingent valuation of the biomitigation benefits of integrated multi-trophic aquaculture in Canada, *Aquaculture Economics and Management*, 20, 1-26.

Olesen, I., Alfnes, F., Rora, M.B. and K. Kolstad (2010). Eliciting consumers' WTP for organic and welfare-labelled salmon in a non-hypothetical choice experiment. *Livestock Science*, 127, 218-226.

Risius, A., Janssen, M. and Hamm, U. (2017). Consumer preferences for sustainable aquaculture products: Evidence from in-depth interviews, think aloud protocols and choice experiments. *Appetite*, 113, 246–254.

Whitmarsh, D. and P. Wattage (2006). Public attitudes towards the environmental impact of salmon aquaculture in Scotland. *European Environment* 16, 108-121.

Whitmarsh, D. and M. Palmieri (2011). Consumer behaviour and environmental preferences: a case study of Scottish salmon aquaculture. *Aquaculture Research*, 42, 142-147

Yip, W. (2012). Assessing the WTP in the Pacific Northwest for salmon produced by integrated Multi-Trophic Aquaculture". Master's thesis. Simon Fraser University. Retrieved from < http://rem-main.rem.sfu.ca/theses/YipWinnie_2012_MRM530.pdf>

Yip, W., Knowler, D. Haider, W. and R. Trenholm (2017). Valuing the Willingness-to-Pay for Sustainable Seafood: Integrated Multi-trophic versus Closed Containment Aquaculture. *Canadian Journal of Agricultural Economics*. Vol. 65 (1), 93–117.

Vanhonacke, F., Van Loo, E., Gellynck, X. and W. Verbeke (2013). Flemish consumer attitudes towards more sustainable food choices. *Appetite*, 62, 7–16.

van Osch S., Hynes S., O'Higgins T., Hanley N., Campbell D. and S. Freeman (2017). Estimating the Irish public's WTP for more sustainable salmon produced by integrated multi-trophic aquaculture. *Marine Policy* 84: 220–227.

van Osch, S., Hynes, S., Freeman, S., O'Higgins, T. (2019). Estimating the Public's Preferences for Sustainable Aquaculture: A Cross Country Comparison. Sustainability, 11, 569.

Vermeir, I. and W. Verbeke (2006). Sustainable food consumption. Exploring the consumer attitude–behavioral intention gap. *Journal of Agricultural and Environmental Ethics*, 19, 169–194.

Young, J., Brugere, C. and J. Muir (1999). Green grow the fishes-oh? Environmental attributes in marketing aquaculture products. *Aquaculture Economics and Management* 3, 7-17.

Zander, K. and Feucht, Y. (2018). Consumers' WTP for Sustainable Seafood Made in Europe, *Journal of International Food & Agribusiness Marketing*, 30:3, 251-275

Tables

Table 1 Summary statistics

Variable	Ireland Mean (S.D)	Norway Mean (S.D.)
Employed	0.55 (0.50)	0.61 (0.49)
Student	0.06 (0.23)	0.26 (0.44)
Retired	0.18 (0.38)	0.10 (0.30)
Female	0.52 (0.50)	0.43 (0.50)
Age	46.22 (16.65)	49.57 (18.00)
Number of persons in household	3.03 (1.37)	2.60 (1.33)
Eats fish at least once on a weekly basis	0.62 (0.49)	0.94 (0.23)
Respondent believes that there are farms in local area	0.14 (0.34)	0.26 (0.44)
Respondent believes that sea lice from fish farms has significant impact on wild stocks	0.30 (0.46)	0.26 (0.44)
Partakes in coastal recreation activity more than 10 times per year	0.29 (0.45)	0.48 (0.50)
Annual Gross Income (€)	32,185 (17,156)	77,766 (27,276)
Renewables seen as a threat to marine environment	0.37 (0.48)	0.08 (0.28)
Oil and Gas seen as a threat to marine environment	0.69 (0.46)	0.34 (0.48)
Wild capture fishing seen as a threat to marine environment	0.31 (0.46)	0.12 (0.32)
Thinking of buying and eating salmon that it is produced in an environment-friendly manner is important (Enviro_matters)*	0.82 (0.39)	0.56 (0.50)

* Only for the proportion of the samples that indicated they eat salmon (650 for Ireland, 861 for Norway)

Table 2 Probit Models of WTP

VARIABLES	Ireland Standard Probit	Norway Standard Probit
Employed	0.187 (0.13)	0.749** (0.28)
Student	0.703** (0.31)	0.533* (0.31)
Retired	0.170 (0.21)	0.649** (0.33)
Female	-0.055 (0.10)	0.313*** (0.09)
Age	0.013 (0.02)	0.024 (0.02)
Age Squared	-0.0002 (0.001)	-0.0003* (0.001)
Number of persons in household	-0.092** (0.04)	-0.076* (0.04)
Eats fish at least once on a weekly basis	0.242** (0.12)	0.303* (0.18)
Respondent believes that there are farms in local area	0.311* (0.15)	-0.061 (0.11)
Respondent believes that sea lice from fish farms has significant impact on wild stocks	0.105 (0.11)	0.148** (0.11)
Partakes in coastal recreation activity more than 10 times per year	0.313*** (0.11)	0.054 (0.09)
Ln (Annual Gross Income)	0.236** (0.10)	0.386** (0.17)
Enviro_matters	0.306**(0.13)	0.816 ***(0.10)
Bid value	-0.121*** (0.03)	-0.139*** (0.02)
Constant	-0.703 (1.21)	-2.922 (1.87)
Log likelihood	-420.97	-472.54
LR or Wald chi2	54.31***	156.71***
AIC	875	1046
BIC	937	1112
Observations	650	861

Standard errors in parenthesis. *** indicates significance at 1%, ** indicates significance at 5%, * indicates significance at 10%.

Table 3. Bivariate Probit models

	Ireland		Norway	
	Issue of Concern	WTP	Issue of Concern	WTP
Employed	0.298**	0.209	-0.0455	0.678**
	(0.152)	(0.137)	(0.278)	(0.271)
Student	0.0405	0.703**	-0.0383	0.477
	(0.368)	(0.315)	(0.310)	(0.304)
Retired	0.136	0.180	-0.325	0.501
	(0.243)	(0.212)	(0.328)	(0.325)
Female	0.291**	-0.033	0.292***	0.378***
	(0.119)	(0.103)	(0.091)	(0.095)
Age	-0.067***	0.009	0.00737	0.025
	(0.025)	(0.020)	(0.018)	(0.018)
Age Squared	0.0006**	-0.0001	-0.0005	-0.0003*
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Number of persons in household	0.044	-0.088**	-0.001	-0.071*
	(0.052)	(0.045)	(0.040)	(0.042)
Eats fish at least once on a weekly basis	0.303**	0.266**	0.041	0.292
	(0.134)	(0.121)	(0.197)	(0.191)
Respondent believes that there are farms in local area	-0.137	0.297*	0.163	-0.008
	(0.174)	(0.158)	(0.104)	(0.109)
Respondent believes that sea lice from fish farms has significant impact on wild stocks	0.313**	0.128	0.336***	0.240**
	(0.137)	(0.112)	(0.104)	(0.108)
Partakes in coastal recreation activity more than 10 times per year	0.005	0.313***	0.167*	0.102
	(0.132)	(0.113)	(0.090)	(0.094)
Ln (Annual Gross Income)	0.082	0.241**	-0.104	0.324**
	(0.118)	(0.097)	(0.152)	(0.163)
Bid value	-	-0.120***	-	-0.128***
		(0.031)		(0.022)
Renewables seen as a threat to marine environment	0.500***	-	0.185	-
	(0.143)		(0.156)	
Oil and Gas seen as a threat to marine environment	0.277**	-	0.387***	-
	(0.139)		(0.097)	
Fishing seen as a threat to marine environment	0.163	-	0.286**	-
	(0.139)		(0.141)	
Constant	0.638	-0.469	-0.155	-2.053
	(1.302)	(1.187)	(1.709)	(1.810)
Rho		0.19**		0.45***
		(0.076)		(0.051)
Log likelihood	- 703		- 1028	
LR chi2(28)	99***		155***	
AIC	1468		2119	
BIC	1607		2267	
Observations	650		861	

Standard errors in parenthesis. *** indicates significance at 1%, ** indicates significance at 5%, * indicates significance at 10%.

Table 4. Predicted joint probabilities from bivariate probit model

	Ireland		Norway	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Pr(WTP= 0, Enviro_matters= 0)	0.113	0.064	0.229	0.098
Pr(WTP= 0, Enviro_matters= 1)	0.364	0.110	0.139	0.084
Pr(WTP= 1, Enviro_matters= 0)	0.081	0.044	0.204	0.082
Pr(WTP= 1, Enviro_matters= 1)	0.442	0.129	0.428	0.121

Table 5. WTP estimates

Model	Average Total WTP (€ per kg)	Standard Error	95% Confidence Interval	Average Premium (€ per kg)
Ireland				
WTP Standard Probit Model	19.05	0.467	(18.13, 19.96)	3.55
WTP Bivariate Probit Model	19.02	0.461	(18.12, 19.93)	3.52
Norway				
WTP Standard Probit Model	21.96	0.59	(20.82, 23.11)	6.40
WTP Bivariate Probit Model	22.01	0.603	(20.83, 23.19)	6.45


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