Assessing household preferences for wastewater fed fish: Lessons from a field experiment in Peru

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Abstract:

Abstract This paper used choice experiment to assess households' preferences for wastewater fed fish in Lima, Peru. The study considered four fish attributes, price, source, certification and information on additives. In total, 443 households' participated in the field experiment. Results from the estimation of the random parameter logit (RPL) model in both the willingness to pay (WTP) and preference space showed that in general, households expressed positive preferences for fish raised in wastewater, freshwater and wild fish as well as certification and use of additives. Our findings show that household WTP for fish raised in the wild and in freshwater were positive and more robust as compared to WTP for wastewater fed fish which was influenced by factors such as certification. We find that households are willing to pay premiums of $0.69, $1.06 and $2.98 for wastewater, freshwater and wild fish respectively. We also find evidence to suggest that health and food safety concerns are the most important consideration in household preferences for wastewater fed fish amongst a set of perceptions variables examined in this study.

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Keywords: Wastewater fed fish, willingness-to-pay, informational attributes, Peru, choice experiment, random parameter logit (RPL)

1. Introduction

With the increasing global climate challenges, many policy makers are seeking alternative options to mitigate both the direct and indirect impacts of climate change on society. Concurrently water, which is essential for life, is decreasing at an alarming rate and many developing countries are considered to be water stress at the present time or potentially into the future. Many countries in Africa, Asia and Latin America face significant threats of water scarcity and this has implications for growing populations, rising incomes and demand for water (World Bank, 2016; Rijsberman, 2004). A fundamental cause of this situation is that water supply has become erratic and uncertain and if this trend continues and recent climate change models are correct, the impact of water scarcity will be observed in regions where it does not currently exist. At the same time, most of these countries have increasing amounts of wastewater being generated which is causing significant harm to humans and the environment. The concept of "circular economy" which builds on the resource recovery and reuse paradigm shift has been proposed because it offers the opportunity to augment sustainable use of water resources and increase food security.

There are increasingly innovative business-oriented reuse systems such as wastewater-based aquaculture that can enhance the pace of investments in a "circular economy". In the case of the use of wastewater for aquaculture for example, households are able to secure relatively cheaper water for farming, obtain fresh fish at relatively lower prices, and save freshwater which can then be reallocate to other pressing needs. The positive externalities from these practices include improved community sanitation outcomes due to the reduction in the volume of untreated wastewater that is disposed-off into surface water. As a result of the numerous potential benefits, policy makers and several international organizations are beginning to realize the double value proposition in water reuse (Jimenez et al., 2010; Wichelns et al., 2015). Lima, the capital city of Peru is an ideal case study to assess the value of wastewater reuse for aquaculture because of the 17.6m^3/s wastewater flows, only 9% is treated. Most of the wastewater is discharged directly into rivers and eventually into the ocean, causing contamination of surface water and of agricultural products[1]. As a coastal city, Lima has suitable conditions to develop a strong and diversified aquaculture sector (Figure 1). Local fish consumption grew at an average annual rate of 3.2% from the 1960s to 2013, double the rate of population growth (Camacho, 2016). It is obvious that as disposable incomes increases, consumers make changes to their diet, and introduce more protein in the form of meat and fish. Though the industry remain small compared to the country's giant fishmeal, the segment is growing rapidly. The government has recognized the benefits of this segment to the economy and in 2016, published a regulation to stimulate, guide, and regulate sustainable aquaculture in the country (Camacho, 2016).

In reality, however, a few wastewater-fed aquaculture systems[2] have been successfully implemented (i.e., Agriquatic-Bangladesh, Terraqua-Peru; Wastewater enterprises-Ghana). Also, areas where wastewater-fed aquaculture exists, the practice is threatened or declining for diverse reasons. This is in spite of supply-side technological advancements in the treatment of water and other reuse practices. As the final end users of fish, households have an important role to play in creating a market for products and incentivizing producer uptake. The case of wastewater-fed fish is peculiar in several respects. While wastewater aquaculture can be a viable approach towards the attainment of food security goals, the conservation of water and improved health outcomes, there may be perceived health and safety risks associated with the consumption of wastewater-fed fish (Keraita et al., 2015). This can be significant due to the credence nature of fish. In the presence of information asymmetry, quality assurance mechanisms such as certification can dampen the effect of these perceptions and increase consumer acceptance. Stated this way, the degree of trust in the food governance institutions that provide labelling and certification information can play an important role. It is also conceivable that concerns about the environment, particularly as it relates to water scarcity may override these potential health and safety concerns. This notwithstanding, the nature of the interaction between these factors and how they impact household preferences for wastewater fed fish has not been previously addressed.

While several studies have examined consumers preferences for different fish attributes in different countries (Cox and Gallagher, 1995; Honkanen and Olsen, 2009; Olsen et al., 2010; Fernandez-Polanco et al., 2013; Conte et al., 2014; Fonner and Sylvia, 2015; Darko et al., 2016),

[1] SWITCH Training guide. http://www.switchtraining.eu/home/

[2] Although the practice of wastewater use in aquaculture in Africa, Asia and Latin America is not new per se (see Edwards, 1992).

not much has been done to elicit preferences for wastewater fed fish. Darko et al., (2016) examined preferences for fish attributes by a sample of respondents in Tanzania. The study specifically looked at preferences for tilapia attributes-price, production type (wild versus farmed), form (fried, dried, smoked or fresh) and size (small, medium or large). The study found that consumers have higher preferences for fresh, wild tilapia and medium-large fish. Similar results were reported from the assessment of fish preferences in Hawaii (Davidson et al., 2012). In addition to the variation in preferences by fishing method, the Davidson et al., (2012)'s study also found that preferences for different varieties of fish were not identical. Fernandez-Polanco et al., (2013) examined Spanish consumers' preferences for sea bream attributes. Attributes examined include price, harvesting method, sustainability, health and safety attributes. Amongst these attributes, the highest WTP was associated with harvesting method - respondents had a higher preference for wild sea bream relative to farmed sea bream. To an extent, these preferences are driven by attitudes towards fish products and different quality, health and safety perceptions. Conte et al., (2014), suggested that the variation in fish preferences by harvesting method, for example, are driven by differences in attitudes towards animal welfare and sustainability. Other factors such as taste, environmental concerns and product labelling have also been identified (Davidson et al., 2012). This study expands on previous ones by looking at freshwater, wild and wastewater-fed fish attributes. Unlike previous studies, the study also incorporate quality information and quality assurance attributes such as certification and labelling and examine the role of trust, health and environmental perceptions on WTP. To the best of the authors knowledge this has not been previously done in the literature. The results of our study provides useful information that can aid the development and management of the wastewater fed aquaculture industry in Peru. The lessons drawn for the results of this study can be applicable in other developing countries where wastewater fed aquaculture is being promoted as a strategy to reduce food insecurity, conserve water and improve community health outcomes.

Figure 1: Map of Peru showing Lima
(Source: https://www.mcgill.ca/trauma-globalhealth/countries/peru/profile)

2.1 Study Design and methodology

The choice experiment survey was conducted in 2014 in Lima, Peru (Figure 1). The respondents for the study were households sampled from urban and rural areas in the study area. The specific urban and rural sites selected for the study were based on the wastewater generation levels, aquaculture practices and population size. A total of 443 households were randomly interviewed for the study. Households were presented with choice sets and the good in this case is wastewater fed fish with various attributes. A comprehensive literature review was conducted to arrive at the key attributes for the study (Forner and Sylvia, 2015;Ortega et al., 2011;Ubilava et al., 2009). To arrive at the final attributes, we collaborated with local partners and conducted multiple focus group discussions. In some cases, it was difficult obtaining the exact changes and levels in attributes characteristics, hence, a qualitative approach was used to select the levels. The choice profile consisted of attributes from four categories: price, source, certification and additives (Table 1). In the context of fish attributes, safety issues often arise from lack of trust between producers and consumers with respect to product-specific attributes. This may be particularly relevant for wastewater-fed fish because of concerns about household perceptions on the health risks associated with wastewater reuse and subsequent toxic chemical residue on fish. Third-party certification could serve as a quality assurance indicator, which may influence household purchasing decisions (Ortega et al., 2011, Forner and Sylvia, 2015). Another significant variable that could influence household purchasing decision is product labeling. Having information on products with labels which indicates whether certain additives have been added or not could either increase or decrease consumers demand for fish. In addition to the production method and quality assurance attributes, different price levels of fish were included in the choice experiment. Local partners provided information on the price levels and additional information was obtained through a scoping study. Three levels of prices were chosen ranging from USD 2.00 per kg to USD 3.00 per kg, which reflected the low-end and high-end prices that could be observed in actual fish markets in Lima. The household heads in the selected sample were provided with choice cards with information on fish reared in different sources of water, additive information, their respective prices and whether the fish was certified or not (Table 1). The selected attributes were clearly explained to each participant before the interview. The data was coded based on the attribute levels (Table 1). The price attribute was coded as a cardinal variable. The certification and additives attributes were coded as dummy variables while the source attribute was coded as three-level dummies (i.e., wastewater, freshwater, and wild).

Table 1. Attribute levels and descriptions used in the field experiment

Categories	Attribute Levels	Description	Coding
1. Price of fish in USD/kg	2; 2.5; 3	Refers to the retail price of fish or market price of fish where respondents typically shop.	Continuous variable
2. Information on medium or source used to raise the fish - source of fish (SOURCE)	- None; - Farmed fish (freshwater); - Wastewater-raised fish (wastewater) -Wild fish	Fish product carries information regarding the medium used to rear the fish; - None denotes if there is no information on the source of water used to raise fish; - Farmed fish (freshwater) indicates that freshwater is used to raise fish; - Wastewater-raised fish indicates that wastewater is used to raise fish.	Dummy variables
3. Certification for quality (CERT)	Yes; No	If present product carries a label issued by an organization [a] assuring that the product was inspected throughout the production process for safety and quality.	Dummy variable
4.Additive Information(ADD)	Yes; No	Product carries a label indicating whether the fish was raised with additives, including but not limited to hormones, antibiotics and additives.	Dummy variable

[a] Trustworthy organization that provides food certification services in Peru. USD = United States Dollar; Sol = currency used in Peru; 1 USD = 0.31 Sol. Tilapia is a very commonly consumed

fish in Peru, and represents one of the few species of fish that can be reared in freshwater and treated wastewater and thus was used in the market experiments.

Prior to implementing the field experiments, a pre-test was conducted among a small sample of respondents in urban areas in Lima to ensure the suitability of the choice experiment instrument. During the actual field experiment, respondents were fully educated on the experimental procedures, the choice sets and the rationale of the choice of attributes. A key consideration was given to the different options defining each choice set and the different levels of the specific attributes. In addition, pictograms were used to facilitate the comprehension of the different options available in the different choice sets. All the interviews were conducted by a researcher along with local translators to ensure respondents fully understood the experimental procedures.

We use a fractional factorial design approach to obtain optimal design that allowed for the estimation of all the main and two-way interaction effects. This was implemented in SAS 9.4. Based on the feedback received from the pretest of the experiment, especially with respect to the challenges of completing the initial efficient design of 18 profiles, we decided to use the saturated design of 9 profiles to avoid this issue. The respondents were required to indicate their preferred option for each choice set, which contained alternatives A, B, C and D (status quo) or a neither option (Table 2). Such an "opt out" option can be considered as a status quo or baseline alternative. The inclusion of "opt out" option allows our experimental study to mimic everyday decision making and allows respondents to decline to make a choice if none the options presented is preferred.

Table 2. A sample choice set for the field experiment

Fish Attributes	**Option A**	**Option B**	**Option C**	**Option D**
Price in USD/ kg	2	2.5	3	If options A, B, and C were all that was available at my local shop I would not purchase fish from that shop.
Product Source Information	Freshwater	Wastewater	Wastewater	
Certification	No	Yes	No	
Additive Information	No	Yes	No	
I would choose…	○	○	○	○

2.2 Empirical approach

Stated preference methods and choice-based conjoint analysis are the most common methods used to estimate consumers' preferences and willingness to pay for food products. While many studies tend to use contingent valuation to value food products, a choice experiment is appropriate for this study due to the aim of estimating household preference heterogeneity of fish attributes. Ortega et al. (2011) used choice experiment to value Chinese consumers preferences for food safety attributes for pork. Olsen et al. (2010) estimated WTP for fish welfare and

Vanhonacker et al. (2011) and Honkanen and Olsen used the approach to estimate demand for farm fish.

Choice experiment is based on the random utility theory, where a given household obtains utility from choosing alternative i from a finite set of J alternatives contained in a choice set C. The household utility function is comprised of deterministic and stochastic components, but the former depends on the attributes of an alternative. Let X_{ijt} represent a vector of attributes for the j^{th} alternative, $\beta_i \sim f(\beta|\Psi)$ is a vector of the i^{th} household-specific taste parameters and ε_{ijt} is a stochastic component of utility that is independently and identically distributed, and takes a type-one extreme value or Gumbel distribution. Also, let Z^*_{ijt} represent indirect utility, which is not directly observed and Ψ denote parameters characterizing the distribution of the random parameters. Assuming the indirect utility function is linear, then each household's utility function can be specified as:

$$Z^*_{ijt} = \beta_i' X_{ijt} + \varepsilon_{ijt} \qquad (1)$$

In Random Parameter Logit (RPL) framework (Train, 2009), the probability that household i selects alternative j from choice set C in choice task t is given as:

$$P(V_{ijt} = 1 | X_{i1t} \ldots X_{ikt}, \Psi) = \int \frac{\exp(\beta_i' X_{ijt})}{\sum_{k=1}^{k} \exp(\beta_i' X_{ikt})} f(\beta|\Psi) d\beta \qquad (2)$$

It is difficult to estimate the closed form of equation (2) and we have to rely on a simulated approach for the probabilities. Halton draws, which provide better coverage of density function and faster convergence, were utilized at 2000 draws per iteration in the simulated maximum likelihood estimator (Train, 2009).

We used two estimation methods for the choice data analysis. The first approach is preference space, which deals with household's preferences of the attributes. In this estimation, it is appropriate to make an assumption with respect to the distribution of each of the random coefficients. The two main alternative assumptions are a normal and a log-normal distribution. Applying a log-normal distribution means that we restrict all households to have the same sign of each coefficient. In our case, this is not appropriate, since we expect different households to have positive and negative preferences for the different attributes of fish. It is also reasonable to expect that there is a correlation between the randomly distributed parameters. Thus, we used a normal distribution for the estimated coefficient of mean preference and constant household taste variables over all the choices, but with variation from one household to the other (Train, 1998).

In the second approach, we used the willingness-to-pay space approach model (Scarpa et al., 2008; Klaiman et al., 2016; Waldman et al., 2017) to estimate coefficients that directly represent trade-offs households' are willing to make in the context of fish quality attributes. This approach directly controls the distribution of household preferences for various attributes and help researchers to differentiate variation in preference and scale heterogeneity (Waldman et al., 2017). To estimate the willingness-to-pay space model, there is the need to re-parameterized equation 2. This requires specification of various distributions for the price coefficient from which to draw the random parameters. Previous researchers have used several methods to re-parameterized equation 2, but several challenges have been noted as well. For instance, Revelt and Train (1998) noted that when the price coefficient is normally distributed, it is possible to violate the downward-sloping demand curve theory. Scarpa et al. (2008) highlighted that the use of log-normal distribution for price coefficient may be consisted with demand theory, but the empirical distributions of utility coefficients do not necessarily imply convenient distribution for WTP. Instead of using the marginal utility coefficients, the model can be re-parameterized such that the estimated coefficients are the WTP for each attribute (Train and Weeks, 2005; Waldman, et al., 2017). To illustrate this, let p represent the price and k_i denotes the scale parameter. We define $\delta_{ijt} = \frac{\varepsilon_{ijt}}{k_i}$, and $\lambda = \frac{\alpha_i}{k_i}$. Also, θ denote a vector of WTP for the product attributes that is independent of scale. WTP for an attribute is obtained when the price is defined by the attribute of the coefficient, then $\theta_i = \frac{\beta}{\alpha_i}$. We assume that the utility function in equation (1) is separable in price, p and non-price, x, attributes. We divide the utility function by the scale parameter and obtains:

$$Z^*_{iji} = -\left(\frac{\alpha_i}{k_i}\right)P_{ijt} + \left(\frac{\beta_i}{k_i}\right)' X_{ijt} + \delta_{ijt} \quad (3)$$

Equation (3) then becomes:

$$Z^*_{ijt} = -\lambda_i P_{ijt} + (\lambda_i \theta_i)^i X_{ijt} + \delta_{ijt}, \quad (4)$$

3. Results and Discussion

3.1. Socio-Demographic Characteristics of Households

The respondents who participated in the survey were either heads of the household or spouses of the household. Of the 443 households interviewed, there were more females than males with an average age of 35 years (Table 3). Most of the respondents had some form of formal education, with about 40% having advanced education including university degrees, indicating a moderate literacy rate of the sample. Over 80% of the respondents reported a total annual income of less than USD 1564.60. The annual average household income of USD 741.62 for the surveyed sample is significantly lower than the national average. This disparity may be reflective of households' reluctance in disclosing their income particularly in developing countries; and may have caused a downward bias in the study results. We considered total assets for the sample as the number of cars per households and whether a household has a refrigerator or not. The survey results show more than 50% of the respondents have a car with a mean of 1.14. Concerning refrigerators, almost every household has one. This basic statistics provides an understanding of households' structure and distribution, which could be vital in business decision making and policy development in Lima.

Table 3: Summary statistics of households in the sample

Characteristics	Definition	Statistic
Gender	Male	36%
	Female	64%
Age	Mean age (std. dev)	34.76(15.59)
Educational	Level of educational attainment	
	Basic education	60%
	Advanced education	40%
Annual Household income	Income earned in previous year	
	Less than s/.1,000	27%
	Less than s/.2,000	36%
	Less than s/.3,000	19%
	Less than s/.5,000	11%
	Less than s/.10,000	6%
	More than s/.10,000	1%
Number of cars	Ownership of assets (cars)	
	0	30%
	1	44%
	2	12%
	3	9%
	4	5%
Refrigerators	Ownership of assets (refrigerators)	
	Yes, I have	93%
	No, I don't have	7%

3.2 Households preferences and willingness to pay for fish attributes

The results from the estimation of the random parameter logit (RPL) model in both the WTP and preference space are reported in Table 4. All the statistical analyses were conducted in NLOGIT 5, with 2000 Halton draws to simulate the random components of the model. The random parameters in the model are certification and additive. The other attributes were modelled as fixed parameters due to challenges such as model convergence. The estimate of the "opt-out" was negative and highly significant which suggested that respondents tended to prefer one of the fish profiles as opposed to the "no-choice" scenario. Also, the significance of the standard deviations of the random parameters suggests that fitting the mixed distribution was appropriate and that there is preference heterogeneity across the households in the sample.

Table 4: Random Parameter Logit with Preference Space and WTP-Space Results

	Preference space		WTP-space	
Non-random parameters	Coefficient	Std. error	Coefficient	Std. error
Price	-4.40***	0.15	-4.35***	0.25
Wastewater	0.69***	0.21	0.69*	0.76
Freshwater	1.07***	0.11	1.06**	0.58
Wild	3.01**	0.12	2.98***	0.65
Wastewater*Certification	-10.39***	0.74	-10.57**	0.10
Freshwater *Certification	1.46***	0.14	1.43***	0.60
Opt-out	-10.39***	0.36	-10.25****	1.09
Random parameters				
Certification	-0.26**	0.11	-0.29	0.81
Additive	1.37***	0.12	1.30***	0.43
Standard deviations				
Certification	1.60***	0.11	1.59***	0.35
Additive	2.06***	0.135	2.09***	0.26
Log Likelihood ratio	-2815.76		-2621.24	
Pseudo R-squared	0.49		0.55	
AIC	5655.50		5268.50	
Number of observations	3978		3978	

Note: Random Parameter Logit (RPL) model estimated with NLOGIT 5.0 with 2000 Halton draws used for simulated maximum likelihood. ***, **, * indicate significant levels at the 1%, 5% and 10%.

The mean parameter estimates of the model in the preference space for fish raised using wastewater and freshwater were both positive and significant. Households also had a positive preference for fish raised in the wild. Households preferred lower price fish as compared to more expensive fish and also discounted certified fish. The preference for fish raised with additives was positive and significant. The impact of certification also differs by production method. As evident from Table 4, while preferences for certified freshwater fish is positive and significant, households discount certified wastewater fish.With regards to household WTP (WTP-space), the results show that households are willing to pay premiums of \$0.69, \$1.06 and \$2.98 for wastewater, freshwater and wild fish respectively. They heavily discount certified wastewater fish (-\$10.57) while willing to pay a premium of \$1.30 for certified freshwater fish. To extent, the higher WTP for fish raised in the wild as compared to freshwater and wastewater fish is consistent with previous studies (Darko et al., 2016; Davidson et al., 2012; Fernandez-Polanco et al., 2013). This is in spite of the differences in context between our study and the cited studies

3.2 WTP and perceptions variables

In figure 2, we show the distribution of WTP[3] for wastewater fed fish by different perception scales: health and food safety, trust in certification institution and environment benefits. For the health and food safety scale, respondents were asked, "I think that freshwater-fed fish is safer than wastewater-fed fish". With regards to concerns about the environment, respondents were asked, "Farmed fish (wastewater-fed and freshwater-fed fish) is better for fish resources conservation", while for the assessment of institutional trust respondents were asked, "I trust information that I receive about fish from the government more than other sources (e.g. private certification)".Each of the three statements were assessed on a 5-point Likert type scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). In general, WTP for wastewater fed fish is positive related to environmental perceptions and trust in information provided by the government and other food governance institutions. This notwithstanding, the difference in WTP between the two polar categories of the scale i.e. "strongly disagree" and "strongly agree" were not statistically significant. Specifically, for the environmental perception WTP was (-\$0.09 versus -\$0.08) and (-\$0.08 versus -\$0.06) in the former and latter category respectively. In contrast, health concerns have a more significant role. Respondents who strongly disagreed with the statement that freshwater fed fish is safer than wastewater fed fish had significantly higher discount (-\$0.09) on wastewater fish than those who strongly agreed with the statement (-\$0.05). To the extent that these influence of these perception scales are comparable it seems that health

[3] Based on coefficients of a logit model that include sociodemographic characteristics.

and food safety concerns are an important driver of household preferences for wastewater fed fish.

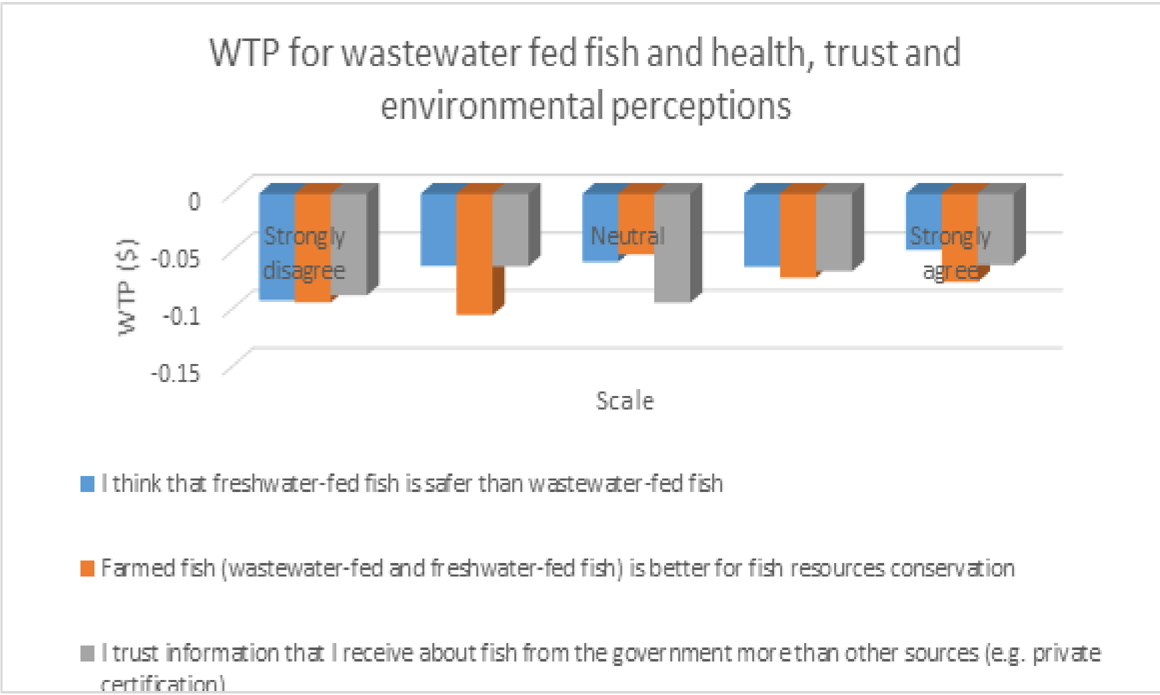

Figure 2: Household perceptions and WTP for wastewater fed fish

3.3 Opt-out and opt-in analysis

Typically, with choice experiments, it is possible that some respondents will choose none of the options provided. It is relevant to profile these respondents and understand their characteristics. This information will be useful for policy decision making, especially, understanding their preferences and what other options may be welfare enhancing for them. Overall, we had about 30% of the respondents who opted out of the choice tasks presented. The characteristics of this sample were compared with the rest of the sample and the result is presented in Table 5. Apart from age and gender, most of the demographic and perceptions variables considered were significant across the two samples. In particular, those who opted-in have relatively higher health concerns than those households who opted-out of the survey. This suggests that those who opted-out are less worried about current level of risk for foodborne disease from fish. With respect to environmental concerns, those who opted-out perceived farmed fish is not a better strategy for fish resource conservation. All other differences across the two samples are presented in Table 5.

Table 5: Characteristics of households that opted-in and opted-out field experiment

Variable	Opt-in	Opt-out	p-value
Gender (Female %)	50.6	51.2	0.729

Age (years)	35.15	33.81	0.526
Income(mean)	2.42	2.10	0.08*
Assets(Cars) (mean)	0.93	1.78	0.000***
Assets(Refrigerator)(mean)	1.06	1.18	0.028***
Fish consumption (yes %)	98.7	73.8	0.000***
Perceptions variables (mean)			
Health concerns	3.51	3.46	0.028***
Taste concerns	3.00	3.29	0.000***
Environmental concerns	3.42	2.66	0.000***
Harvesting techniques	3.64	3.77	0.000***
Observations	320	123	

Note: Harvesting technique respondents were asked: fish product processing is relevant for choice between wastewater fed fish, freshwater fed fish and wild fish.

4. **Conclusion**

The preliminary results reported in this study has a number of significant implications for the development of wastewater aquaculture in Peru and for all the key stakeholders in the value chain. Although our results suggests that respondents generally considered fish as a "wild" source of protein and expressed significantly higher WTP for the fish raised in the wild a potentially viable avenue exists for the development of wastewater fed fish. This is evident from the positive WTP for wastewater fed fish reported in this study. However, for this potential to be realized a number of mitigating factors must be addressed. First, measures that engender trust in the food governance institutions should be encouraged. From our results it seems that while respondents have positive preferences for wastewater fed fish, they tend to discount the product when it is certified. This is in contrast to freshwater fed fish where positive premiums were expressed for certified fish. Although this seems counterintuitive, our analysis of the impact of trust in the information provided by government on WTP for wastewater fed fish suggests that this may be due to the lack of trust in the information provided by the government. We also see a commingling of the effect of food safety concerns and trust in the differential role of certification. It seems that when food safety concerns are low as in the case of freshwater fed fish the role of certification is less nuanced as compared to the situation when they may be high wastewater fed fish. Indeed, our results suggest that concerns about the potential food safety risk involved in the consumption of wastewater as compared to freshwater fed fish remains an important intervening factor in household preferences. Policy wise, this implies that a credible third party certifier may be required to provide the necessary reassurance to consumers. This is in addition to greater education about the degree of exposure to risk from the consumption of wastewater fed fish, if any.

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