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Consumer Demand for Rhino Horn in Vietnam: insights from a choice experiment.

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Abstract

The international demand for endangered animal and plant species as traditional medicine, luxury foods and curios is strong and rising, especially in eastern Asia. The illegal poaching of wildlife to supply this market represents an immediate and growing threat to the survival of many endangered species. To counter the illegal international wildlife trade, the global community remains committed to supply-side trade restrictions and enforcement of poaching laws. However, despite these actions recovery in the populations of many species is being threatened by rising poaching rates over the last 10 years. In this paper, we use a choice experiment undertaken with over 800 residents of Vietnam, in order to investigate how the demand for rhino horn varies according to its source attributes. The survey sample includes 130 respondents who reported having either purchased or used rhino horn medicinal products in the past 5 years and a further 345 who expressed some interest in purchasing rhino horn medicinal products in the future. In particular, we estimate willingness to pay for horn that differs according to source (farmed, semi-wild, farmed) harvesting method (lethal and non-lethal), rarity of the rhino species and price. We also compare preferences elicited in the context of illegal trade in rhino horn, compared to legalised trade, and how consumer preferences vary according to socio-economic variables such as income. We find that preferences are significantly influenced by source and harvesting method and income level, with non-lethal harvesting and wild sourced horn generally preferred especially by the richest consumers, who are also the consumers most likely to have previously bought horn products. Under a legal trade demand would fall for all horn types and consumer groups.

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Introduction

The international demand for traditional medicine, luxury foods and curios sourced from endangered animal and plant species is strong and rising, especially in eastern Asia (Challender 2011; NTCA 2012; Biggs *et al.* 2013; Underwood *et al.* 2013). Illegal hunting of wildlife to supply this market represents an immediate and growing threat to the survival of many endangered species such as tiger (*Panthera tigris),* Chinese pangolin (*Manis pentadactyla)* and various rhino species (e.g. *Rhinoceros sondaicus*).

To counter the illegal international wildlife trade, the global community remains committed to supply-side trade restrictions and the enforcement of poaching laws (Challender and MacMillan, 2014). However, recovery in the populations of rhino species in particular continues to be threatened by rising poaching rates over the last 10 years. For example, the number of rhinos poached in South Africa has risen from around 60 in 2007 to 1400 in 2015, due to strong demand in Asian economies (Challender and MacMillan 2014). Prices for illegal poached horn are also thought to have increased substantially in recent years, from around USD7,500 per kg (at 2013 prices) in 1993 (Loh and Loh, 1994), to USD 28,000-100,000 per kg in 2013 (Viet Nam News, 2013; Halter, 2013).

Policy interest is now turning to the implementation of demand reduction programmes to reduce incentives for poaching, because it is anticipated this will lead to lower prices and profits from illegal hunting, and thus complement existing strategies such as the enforcement of poaching regulations. The Sixteenth Session of the Conference of the Parties (COP16) of CITES (Convention on the International Trade in Endangered Species of Wild Fauna and Flora) required member countries implicated in the rhino horn trade, to '*develop and implement long-term demand reduction strategies or programmes and immediate actions aimed at reducing the illegal movement and consumption of rhino horn products*'. (COP 16; Decision 16.85)

Although there have been some claims of dramatic success of demand reduction campaigns for certain species, the evidence base is rather patchy and lacks coherence (e.g. HSI, 2014; Whitcraft et al., 2014) and considerable uncertainty surrounds their efficacy in an Asian context. In Asian society, wildlife consumption is shaped by a complex array of factors such as personal preferences, family and community tradition,

and business culture, as well as relative affluence and purchasing power (Shairp et al. 2016). Furthermore, in hierarchical, collectivist Asian societies, rhino horn consumption is a measure of status and respect rather than shame or embarrassment (Li and Su, 2007). With this scenario in mind and given the significant economic benefits associated with a legal trade the Kingdom of Swaziland has proposed tabling a proposal to legalize the international trade in white rhino horn at the COP 17[1] in 2016. In more detail, the proposal is to alter the existing annotation on the Appendix II listing of Swaziland's white rhino, adopted at the 13th Conference of Parties in 2004, so as to permit a limited and regulated trade in white rhino horn which has been collected in the past from natural deaths, or recovered from poached Swazi rhino, as well as horn to be harvested in a non-lethal way from a limited number of white rhino in the future.

Crucial aspects of demand for illegally-hunted animal products in Asia remain poorly understood and under-researched. In this paper we report on a choice experiment involving 675 Vietnamese citizens, who have purchased and/or used rhino horn, or have expressed an interest in doing so. In Vietnam rhino horn is principally used in traditional medicine as a treatment for various ailments and conditions such as fever, delirium, convulsions, irregular palpitations, shortness of breath and as a purgative. More recently there are reports of rhino horn being promoted as a cure for cancer and as a hangover cure or detox treatment, and to enhance sexual performance (TRAFFIC, 2013). We identify the main drivers of demand for rhino horn, and estimate demand elasticities for 3 attributes of high policy relevance: species rarity, harvesting method, and source of horn. Finally, we explore how consumer type affects willingness to pay for horn with different attributes.

Literature Review

Choice experiments have been used to a rather small degree to investigate consumer demand for illegally-hunted wildlife products. One set of papers focuses on the demand for illegally-hunted bushmeat. For example, Moro et al (2015) estimate the willingness

[1] 17th meeting of the Conference of the Parties Johannesburg (South Africa), 24 September – 5 October 2016 - Proposal to amend Swaziland's annotation to the appendix II rating of its Southern White Rhinos (*Ceratotherium simum simum*) - CITES Management Authority of Swaziland 27 April, 2016.

of rural households in Tanzania to reduce consumption of bushmeat in terms of increased purchases of chicken or fish. Shairp et al (2016) use choice modelling to investigate the demand for bushmeat in Vietnam, comparing demand for bushmeat to farmed alternatives for 5 species including pangolin. Moro et al (2013) focus on hunters rather than consumers, and estimate the changes in other sources of income or the expected costs of being caught hunting that would be required to reduce illegal bushmeat hunting.

Another set of papers has considered demand for non-meat products. Dutton et al (2011) analyse the demand for bear bile, a product used in Chinese medicine. They find that consumers prefer wild to farmed bear bile, and that in some circumstances the introduction of a farmed alternative could actually increase demand for wild animal sourced bile. Of particular relevance to our study is the context in which demand was estimated – respondents were told to imagine a situation where wild bear bile came from a "legal, sustainable supply". This elicitation strategy was used to counter possible under-reporting incentives for consuming an illegal product.

Beyond stated preference methods, other approaches have been used to investigate consumer demand for illegally-hunted animal products. For example, Gratwicke et al. (2008) surveyed 1880 residents in 6 Chinese cites to understand their demand for products made from wild tigers. Of 43% of respondents who had consumed products made from tigers, 71% said that they preferred wild- to farm-sourced products. The authors conclude that lifting a trade ban on farmed tiger parts might cause an increase in demand for products obtained from wild tigers.

Choice Experiment Design

Choice experiments are a well-established stated preference method of estimating consumer demand and willingness to pay for changes in product attributes (Hanley and Barbier, 2009). They have been increasingly used in the analysis of conservation policy (eg Moro et al, 2013; Dallimer et al, 2014). Our experimental design was based upon four attributes and their associated levels (Table 1). These attributes were identified

from interviews with local traditional medicine practitioners in Vietnam, and comprised:

- The source of rhino horn (from wild, semi-wild or farmed animals);
- The "harvesting" method for rhino horn (lethal or non-lethal);
- The rarity of the rhino species being hunted;
- The price paid for the product.

All interviews were conducted in the strictest confidence and under conditions of full anonymity. Price levels were confirmed following a pilot study of 48 consumers.

Each respondent was presented with 8 choice sets, involving 3 choices (Product A, Product B or neither) – an example choice card is shown in Appendix 1. When the 'Neither' choice was selected, interviewees were asked if they would rather purchase a cheaper synthetic alternative based on a fraction (0.1; 0.25; 0.5; or 1) of the lowest price of Product A/B used in that particular choice set.

The sample was divided into two scenarios that explored the possible impact of legalising the trade on the attributes of demand, with one half of the sample being asked to consider their choices under a scenario where a regulated legal trade in rhino horn was allowed, and one half responding under the current condition of illegal trade. This split allows us to independently test for differences in respondent choice under the 2 scenarios – specifically we are interested to know if attribute preferences vary significantly if trade was legalised.

The initial design was generated assuming underlying conditional (or multinomial logit (MNL) model with zero coefficients for all attributes except for price, for which we included a prior of the coefficient having a negative sign[2]. After the pilot data on 48 respondents were collected, we estimated a mixed (or random parameters,) logit (RPL) model and used its results to form the priors for coefficient distributions in the design model. A new D-efficient experiment design[3] was generated for RPL model, and the resulting design with five blocks with eight choice cards in each block was used in the main experiment.

[2] We used Ngene to compute the model

[3] D-efficiency quantifies the goodness of efficiency in the experimental design.

Data description

We interviewed in excess of 800 Vietnamese citizens, though we use choices of only 675 respondents in current analysis, excluding those survey respondents who stated that they would definitely not be interested in purchasing rhino horn in the future. A local Vietnamese company conducted the survey using face to face interviews. Due to the clandestine nature of the subject interviewees were recruited via traditional medicinal practitioners in the first instance, with subsequent interviewees identified using the snowballing technique (Newing et al., 2014). Importantly, our results do not depend on interviewees revealing how much rhino horn they purchase illegally. The sample was sourced from the entire country but most respondents came from the major cities such as Ho Chi Minh and Hanoi. As intended, about half of the respondents (47%) made their choices in a hypothetical framework of regulated legal trade in rhino horn, while the other 53% considered the choice cards in the current context of illegal trade. This allowed a test of whether legalising trade would increase demand, ceteris paribus.

As Table 2 shows, the sample consists of predominantly young adults (median age 23 years, mean age 32 years) with somewhat higher share of females (61%). About half of the respondents (48%) have a university degree. The median reported monthly income falls into the 3-to-5 million VND range, with the average monthly income being 6.5 million VND. Among the respondents, about 75% said that they had neither purchased or used products containing rhino horn, 20% had used (including 8% who had also purchased) and 11% had purchased (including 3% who stated that they have purchased but not used) This is the largest survey of rhino horn users/buyers ever conducted in Vietnam.

Econometric Model

Preference elicitation methods are based on the assumption that individuals have preferences defined over a set of choice alternatives via utility functions. This utility maximization framework is very well described in (Train, 2009) in application to discrete choice experiment (DCE) models, so we just use the probability formulas derived there as a starting point for our model description.

One of the most widely used models is the random parameters logit (RPL) model, often called the mixed logit model, as its specifications are versatile enough to model a wide spectre of respondent behaviour. The model formulation is similar to the multinomial logit model (MNL) for choices of an individual *i* who faces a choice situation *t* with J alternatives described by K attributes:

$$\Pr(y_{it} = j) = \frac{\exp(\alpha_{ij} + \boldsymbol{\beta}_i' \mathbf{x}_{ijt})}{\sum_{q=1}^{J} \exp(\alpha_{iq} + \boldsymbol{\beta}_i' \mathbf{x}_{iqt})}, \tag{0.1}$$

where choice-specific constants and individual-specific taste parameters vary around fixed means and are modelled as follows:

$$\begin{aligned} \beta_{ik} &= \beta_k + \boldsymbol{\delta}_k' \mathbf{z}_i + \sigma_k \nu_{ik}, \\ \alpha_{ij} &= \alpha_j + \boldsymbol{\delta}_j' \mathbf{z}_i + \sigma_j \nu_{ij}, \end{aligned} \tag{0.2}$$

and where β_k is the population mean, ν_{ik} is the individual specific heterogeneity, with mean zero and standard deviation one, and σ_k is the standard deviation of the distribution of β_{ik} around β_k (we assume the normal distribution). The means of the parameter distributions are also allowed to be heterogeneous with observed demographic data z_i.

The latent class random parameters (LCRP) model allows to model two layers of preference heterogeneity: it assumes that there are several classes of individuals in the population that are additionally distinguished by different distribution of parameters within each class. The specification of LCRP model with Q classes is as follows:

- the unconditional choice probability:

$$\Pr(choice_i \mid \mathbf{x}_i) = \sum\nolimits_q \Pr(class = q) * \Pr(choice_i = j \mid \mathbf{x}_i, \boldsymbol{\beta}_{i|q}), \tag{0.3}$$

- class membership probability, dependent on demographics z_i:

$$\Pr(class = q) = \pi_{iq}(\mathbf{z}_i, \boldsymbol{\theta}) = \frac{\exp(\boldsymbol{\theta}_q' \mathbf{z}_i)}{\sum_{q=1}^{Q} \exp(\boldsymbol{\theta}_q' \mathbf{z}_i)}, \boldsymbol{\theta}_Q = \mathbf{0}, \tag{0.4}$$

- conditional choice probability, with individual-specific taste parameters:

$$\Pr(choice_i = j \mid \mathbf{x}_i, \boldsymbol{\beta}_{i|q}) = \frac{\exp([\boldsymbol{\beta}_q + \boldsymbol{\Delta}_q' \mathbf{z}_i + \mathbf{w}_i]' \mathbf{x}_{ijt})}{\sum_{q=1}^{J} \exp([\boldsymbol{\beta}_q + \boldsymbol{\Delta}_q' \mathbf{z}_i + \mathbf{w}_i]' \mathbf{x}_{iqt})}, \quad (0.5)$$

where $\mathbf{w}_{i|q} \sim Normal(\mathbf{0}_q, \boldsymbol{\Sigma}_q)$ is the individual-specific within-class random variation of taste parameters.

Results

We estimate several discrete choice experiment models, starting from a multinomial logit to a random parameters logit to latent class random parameter model (developed in (Greene & Hensher, 2013)), with or without interactions with socio-demographic variables (see Table 3). Due to the categorical nature of the choice attributes, we choose to represent three non-price characteristics of a choice situation with a set of attribute level dummies. The price attribute is modelled as a continuous variable. The baseline levels are Wild for rhino horn source, coming from Very Rare species for rarity level, and Lethal harvesting method. All model coefficients, including the alternative-specific constant corresponding to the baseline utility of the 'Neither of the two' option, are assumed to follow the normal distribution.

The best fit model is the RPL model with dummy variables corresponding to attribute levels, in which attribute coefficient mean variability is significantly explained by demographic variables (gender, age, education, income) and previous experience and scenario dummies (being a buyer and assuming legalized rhino horn trade during the choice experiment). The attributes that are significant explaining choice are price, with demand declining with price as one would expect, and rarity, with consumers on average preferring non-rare species over very rare.

The LCRP model, where latent class membership probabilities are explained by demographic variables, and individual taste heterogeneity is explained by the experience (being a buyer) and scenario (legal vs. non-legal framework) dummies,

provides only slightly inferior fit to the RPL, and as it provides much better insights into respondent preferences, we discuss the estimation results of the LCRP model further.

The only significant demographic variable that determines the latent class membership probabilities is Income. That is consumer choice is significantly influenced by income. The income coefficients are negative for the first two classes, and the absolute value of the coefficient in Class 1 is higher than in Class 2. This means that as the personal income of the respondents grow, they tend to be classified less as members of Class 1 and more as members of Class 3. Overall, we found that 70% of all buyers and 50% of users fell into Category 3 (probabilistically, the highest income respondents).

With such classification in mind, let us consider the observed variation in taste parameters between classes. Compared to the RPL model, where only ASC, Not Rare, and Price population coefficient means are significant, in the latent class random parameter model we observe more variability in size and significance of the mean attribute coefficients across classes. Class 1 members do not consider the price attribute important, and find rhino horns harvested from Semi-Wild and Not Rare species less attractive compared to the Wild and Very Rare baseline. This low income group, lacking funds and experience in buying, are perhaps displaying their 'aspirational preferences' for what they consider to be superior attributes of products made from wild animals.

Among the estimates for Class 2 taste parameters, only the coefficient for Rare species is statistically significant and negative, while the price coefficient is only marginally statistically significant (at about 11%). In terms of the estimates for Class 3 members (who are most likely to have used and/or bought rhino horn), utility parameters show that they prefer Rare over rare and non-rare species and non-lethally harvested over lethally harvested rhino horn. They also prefer wild sourced horn over both Semi-Wild or Farmed varieties. The price coefficient estimate for Class 3 members is highly significant and equal to that in the RPL model.

Importantly, the estimates of variance of parameter distributions are not significantly different from zero for the taste coefficients in all three classes. We therefore conclude that the additional layer of taste heterogeneity modelled via latent classes does a reasonably good job of capturing the observed significant individual variance for the ASC, Non-Lethal, and Price parameters in the RPL model.

Following the lines of (Swait & Adamowicz, 2001), we can also say that the positive and significant 'Neither of the two' option constant (ASC in the Table 3) for Class 1 means that, given the baseline attribute levels, the respondents from this class generally prefer the Neither option (not purchase). At the same time, the respondents from Class 2 prefer one of the two proposed alternatives, and the respondents from Class 3 are indifferent between the alternatives. Buyers of rhino horn products (ASC*Buyer coefficients) are more likely to select one of the 'purchase' alternatives, with the effect especially pronounced for the Class 1 respondents. However, some of these findings change if we consider the impact of the scenario in which the choice experiment was presented, as shown by the (ASC*Legal) results). Class 3 respondents who are told that the rhino horn trade has been legalized are more willing to choose a rhino product, with respondents in Classes 2 and 3 (people on lower income) less likely to choose a rhino product .

Both the legal framework of the choice experiment and previous experience with purchasing rhino products turn out to be important factors in explaining individual variability of attribute coefficients. Quite often, these dummies drive the attribute coefficient in the opposite directions in different latent classes. In particular, while the Legal dummy has no effect on the price coefficient for Class 3 ('well-off') members, it increases their sensitivity to changes in rhino horn price (make the coefficient more negative) for Class 2 members and decreases price sensitivity for Class 1 respondents. Being a Buyer reduces the price coefficient (makes it more negative) for the Class 1 members and increases it for the other two classes.

Estimation of marginal WTP values

Marginal Willingness to Pay is the negative ratio of an attribute coefficient to the price coefficient, which is frequently used to estimate the monetary value of a change in choice attributes in valuation studies (see, among others, (Hensher, 2010), (Cerda, Ponce and Zappi, 2013), and (LaRiviere et al., 2014)).

The average WTP values for the simple RPL and RPL model with demographic variables are quite similar and vary in the range USD 1700–4730 for the significant parameter

estimates (Table 4). Notably, the average WTP values for Class 3 of LCRP model are also very close to the respective WTP numbers coming from the RPL models. Looking at individual estimates of marginal WTP we can see considerable variation within the bigger picture depending on Class and policy scenario. For example, wealthier consumers in Class 3 WTP more for wild under both the illegal and legal scenario, but consumer in Class 1 WTP more for farmed horn under a legal scenario. Non-lethal harvesting is significantly preferred by Classes 2 and 3, but not Class 1.

Looking now at differences between policy scenarios we find that the legal trade appears to favour a more 'pro-conservation' interpretation in some important respects. Most importantly we find that WTP is much lower for horn of any description under the legal trade scenario including horn sourced from wild, non-rare species, lethally harvested. Some variation across classes can also be observed, with Class 3 respondents in the legal scenario more positive pro-conservation in the sense that they look more favourably on semi-wild and farmed horn. Class 2 respondents ('middle class') demonstrate a positive demand for horn products with these characteristics if they are making choices in the Non-Legal scenarios, but require compensation if they are in the Legal framework. The latter probably means that they prefer the Wild species products if the rhino horn trade is legalized, thus demonstrating similarities with the increasing demand for luxury goods in line with growing personal income.

Policy Implications

Our discussion focuses on the relevance of our results to the current policy questions regarding the elimination of poaching and the introduction of a legal international trade in rhino horn. We focus on 3 issues. First, what are the main drivers of trade? Second, what is the potential impact of a legal trade on demand? Third, what are the implications for future demand reduction strategies under the status quo (no trade)?

Aside from price, we find that method of harvesting and source of horn are the two most important drivers of trade. As expected, consumers tend to prefer wild horn over semi-wild or farmed as this is consistent with findings from other literature (e.g. Shairp et al 2016; Dutton et al, 2011) and can be related to the notion that consumers of wildlife

products in Asia prefer 'wildness', as it is associated with greater power and/or effectiveness in the context of traditional medicinal practice (Gratwicke et al. 2008).

The finding that consumers in Classes 2 and 3, (the most likely to purchase and/or use rhino horn products) prefer horn acquired from non-lethal forms of harvesting is more surprising, as is the finding that the rarity of a species is the least influential attribute. Class 3 consumers, for example, prefer horn from non-rare species compared to very rare, under both legal and illegal trade scenarios. This contradict a widely held belief that the rarest species somehow attract a premium (Gratwicke et al. 2008)

Our results also provide insights relevant to the current debate about introducing a legal trade. The case for regulated legal trade in rhino horn is based on a number of arguments but principally, reductions in rhino fatalities from poaching and to a lesser extent on more equitable socio-economic benefits for local communities and private ranchers (Cooney et al., 2015; Biggs et al., 2013).

Our findings are very interesting in this regard. First and most importantly we find that WTP is significantly lower under the legal trade and hence we suggest that the introduction of a legal trade may reduce demand and there is no evidence in this data set that legalising the trade in horn will lead to any demand boost due to a 'de-stigmatisation effect'. Others have argued that legalisation could de-stigmatise consumption and lead to an overall increase in demand at any given price, with concerns that this demand surge would, in part, be met from increased poaching (Dutton et al, 2011). Our results support a contrasting hypothesis that legalisation could have a "reverse stigma" effect , whereby the introduction of a legal supply of horn would result in a fall in demand due to the loss of prestige associated with consuming what would now be a legal product (Milliken and Shaw 2012; Shairp et al., 2014).

We also find that respondents tend to make more pro-conservation choices under a legal trade. For example, Class 3 consumers, (which includes most of existing buyers/users) appear to have preferences that would align well with a potential sustainable trade model – preferring non-rare species over very rare, and non-lethal over lethal harvesting. On the other hand they do prefer horn harvested from wild animals.

Although it is possible to source horn from wild populations using non lethal methods, yields will be lower and production less efficient than under a farmed or ranched system, and thus there may be a risk that poached horn may not be effectively 'crowded out'. There is some variability in both the size and sign of the coefficients for this attribute across both policy scenarios for the other two classes. For example, under the illegal trade, Class 1 members have strong negative preference for farmed horn, whereas Class 2 members have positive preferences. These preferences are reversed under the legal trade scenario.

Our results also have some relevance to current efforts to reduce demand for rhino horn. Current policy to maintain the ban on trade is likely only to succeed in meeting its conservation objectives if demand for horn can be significantly reduced. Achieving this goal will be highly challenging for a high value, high prestige good such as rhino horn (Shairp et al 2016). Furthermore, Olmedo (unpublished dissertation, 2015) recently reviewed 9 rhino horn and elephant ivory demand reduction interventions in Viet Nam and found major flaws in design and implementation and did not reliably measure demand reduction.

Our study suggests that the most obvious approach to reduce demand for poached rhino horn would be to legalise the trade as on average consumers are willing to pay more for horn that is poached illegally. In other words, the illegal nature of the trade appears to increase demand across all consumer groups. Aside from legalising the trade, our study suggests that demand reduction campaigns should focus on the attributes of poached horn that are least appealing such as lethal harvesting, and in the case of Class 3 members, who include most of existing buyers, promoting the link between horn purchase/use and the threat to very rare rhino species may also highlight some issues that make future consumption less attractive.

Conclusions

Overall, we found that under the current policy scenario of a ban on trade, demand is influenced by the source of horn and by harvesting method (i.e. non lethal preferred over lethal. Species rarity is less important. Our analysis also indicates that the creation

of a legal trade in horn will reduce demand for poached horn with the most negative conservation impact (i.e. 'wild, lethal, very rare'). This is true for all consumer group and across all horn types and provides evidence that a reverse stigmatisation effect may lead to more pro-conservation choices under a legal trading scenario. Our results are therefore quite encouraging for the countries currently entertaining the possibility of adopting pro-trade policies, but some issues need further consideration specifically, that is the preference consumers appear to have for wild sourced horn to effectively 'crowd-out poached horn. Furthemore, we believe the introduction of a legal trade must be accompanied by an intensive information campaign to encourage existing consumers to switch allegiance from illegal sources, supplemented with a robust certification system to prevent the laundering of illegal products (Kasterine et al., 2012; Shepherd and Nijman, 2012).

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Table 1. Attributes and levels of the choice situations.

Attribute	Levels and description
Source	3 levels (*Farmed, Semi-Wild,* or *Wild*)
Rarity of Rhino Species	3 levels (*Very Rare, Rare* and *Not Rare*): *Very Rare* – less 100 of these species in the wild *Rare* – less than 5,000 animals of these species left in the wild *Not rare* - more than 10,000 animals of this species left in the wild
Harvesting Method	2 levels (*Lethal* and *Non-Lethal*)
Price	8 levels (*1,200; 2,400; 3,600; 4,800; 6,000; 7,200; 8,400; 9,600*) For this exercise please imagine this is the price you would actually have to pay (in USD per 100 grams)

Table 2. Socio-demographic characteristics of the sample

Characteristics	Sample values
Female share	0.61
Age (years):	
Min	23
Max	83
Average	32
Median	23
Scenarios:	
Share of respondents facing choice situations in a legal framework	0.47
Share of respondents who stated they have used rhino horn products	0.20
Share of respondents who stated they have bought rhino horn products	0.14
Education level:	
Median	University
Share of respondents with a university degree	0.48
Income (mln VND):	
Average	6.48
Median	3 ÷ 5
Mode	Up to 3

Table 3. Estimation results for RPL and LCRP models with attribute level-dummy variables and demographic variables.

	Mixed Logit		Latent Class Mixed Logit					
			Class 1		Class 2		Class 3	
ASC	-10.336***	(2.486)	6.275***	(2.376)	-4.693***	(0.570)	0.080	(0.281)
Semi-Wild	-0.056	(0.396)	-8.115***	(2.476)	-0.032	(0.095)	-0.347*	(0.183)
Farmed	-0.596	(0.504)	-15.35	(128.49)	0.033	(0.134)	-0.701***	(0.186)
Rare	-0.005	(0.575)	1.227	(0.992)	-0.306**	(0.132)	0.461**	(0.209)
Not Rare	0.600*	(0.347)	-6.968***	(2.316)	-0.030	(0.085)	0.098	(0.159)
Non-Lethal	-0.259	(0.714)	1.987	(1.573)	0.100	(0.135)	0.862***	(0.186)
Price (in 1,000 USD)	-0.137*	(0.072)	-0.053	(0.303)	-0.026*	(0.016)	-0.137***	(0.028)
ASC*Legal	-0.247	(0.644)	3.230**	(1.475)	5.210***	(0.621)	-6.230***	(0.740)
ASC*Buyer	-3.246**	(1.386)	-7.599***	(2.270)	-3.930***	(1.112)	-2.684***	(0.599)
ASC*Gender	1.110*	(0.666)						
ASC*Age	0.069**	(0.032)						
ASC*Income	-0.184**	(0.078)						
ASC*Education	1.204***	(0.34)						
Semi-Wild*Legal	-0.177	(0.123)	2.500*	(1.429)	-0.472**	(0.221)	0.091	(0.197)
Semi-Wild*Buyer	0.385*	(0.203)	5.354**	(2.104)	-3.871***	(1.079)	0.693***	(0.219)
Semi-Wild*Gender	0.163	(0.125)						
Semi-Wild*Age	-0.011**	(0.005)						
Semi-Wild*Income	0.0089	(0.013)						
Semi-Wild*Education	0.0159	(0.058)						
Farmed*Legal	-0.420***	(0.153)	0.962	(1.178)	-0.726***	(0.236)	0.121	(0.219)
Farmed*Buyer	0.338	(0.262)	14.018	(128.49)	-5.608***	(1.353)	1.005***	(0.275)
Farmed*Gender	-0.0942	(0.155)						
Farmed*Age	-0.0004	(0.006)						
Farmed*Income	0.0067	(0.016)						
Farmed*Education	0.0732	(0.073)						
Rare*Legal	0.0101	(0.176)	-0.614	(0.960)	0.666**	(0.262)	-0.209	(0.252)
Rare*Buyer	-0.681**	(0.333)	-0.598	(1.053)	-4.307***	(1.199)	-1.284***	(0.366)
Rare*Gender	0.124	(0.179)						
Rare*Age	0.0074	(0.008)						
Rare*Income	0.008	(0.020)						
Rare*Education	-0.076	(0.082)						

Not Rare*Legal	0.089	(0.106)	2.128	(1.397)	0.425**	(0.207)	-0.014	(0.172)
Not Rare*Buyer	-0.204	(0.181)	5.484***	(1.931)	1.255	(0.909)	-0.316*	(0.189)
Not Rare*Gender	0.0629	(0.107)						
Not Rare*Age	0.000	(0.005)						
Not Rare*Income	-0.0089	(0.011)						
Not Rare*Education	-0.111**	(0.05)						
Non-Lethal*Legal	0.377*	(0.221)	2.615**	(1.053)	0.752***	(0.232)	-0.874***	(0.229)
Non-Lethal*Buyer	1.053***	(0.394)	-1.928	(1.606)	-3.882***	(0.991)	0.721**	(0.352)
Non-Lethal*Gender	0.0516	(0.225)						
Non-Lethal*Age	-0.00124	(0.009)						
Non-Lethal*Income	-0.0696***	(0.024)						
Non-Lethal*Education	0.184*	(0.103)						
Price*Legal	-0.0545**	(0.023)	0.680***	(0.257)	-0.137***	(0.036)	-0.008	(0.033)
Price*Buyer	0.0141	(0.043)	-0.499*	(0.262)	0.406***	(0.137)	0.074*	(0.044)
Price*Gender	-0.0085	(0.024)						
Price*Age	0.000	(0.001)						
Price*Income	0.0012	(0.003)						
Price*Education	0.0101	(0.01)						
Std. dev (SQ const)	7.499***	(0.579)						
Std. dev (Non-Lethal)	1.556***	(0.147)						
Std. dev (Price)	0.101***	(0.018)						
Pr(class)			0.257		0.377		0.366	
Pr(class)*Income			-0.137***	(0.038)	-0.075***	(0.023)		
Pseudo R2	0.3648				0.3589			
LogLik	-3768.5293				-3802.8709			
AIC/n	1.416				1.443			

Notes: 1. For the class membership probabilities, only the variable that is significant (Income) is reported, though the model includes four demographic variables (Gender, Age, Income, Education).

2. The estimates of standard deviation for random coefficient distributions in the LCRP model are not reported because none of them are significant.

3. The baseline attribute levels are Wild, Very Rare, and Lethal, and dummies for them are not included in the model.

4. Standard errors of the estimates are provided in parentheses. ***, **, * indicate significance at 1%, 5%, 10% level.

Table 4. Comparative table of marginal WTP values for different models (expressed in USD 1,000 per 100g of product).

	Mix Logit simple	Mixed Logit Demographics	Latent Class Mixed Logit		
			Class 1 'least wealthy'	Class 2 'middle class'	Class 3 'most wealthy'
		Sample average			
ASC	-29.09	-26.05	-32.74	-51.20	-22.95
Semi-Wild	-1.70	-1.90	29.90	-12.09	-1.78
Farmed	3.74	-3.74	62.98	-16.34	-4.09
Rare	-1.04	-0.85	-4.11	-7.95	1.79
Not Rare	0.01	0.28	25.32	5.58	0.45
Non-Lethal	4.73	4.65	-14.02	1.48	3.92
		Illegal scenario			
ASC – very rare		-32.55	54.79	408.08	-1.37
ASC – non-rare		-31.02	40.09	408.60	-1.21
Semi-Wild		-1.49	-75.11	32.60	-2.16
Farmed		-2.53	-138.40	40.79	-4.65
Rare		-1.16	11.57	58.00	2.59
Not Rare		-0.13	-63.65	-7.28	0.52
Non-Lethal		3.97	17.81	22.01	7.16
		Legal scenario			
ASC – very rare		-21.51	-15.15	1.11	-46.28
ASC – non-rare		-20.59	-12.58	1.06	-46.13
Semi-Wild		-2.18	8.81	-7.00	-1.37
Farmed		-4.57	22.52	-9.83	-3.50
Rare		-0.63	-0.96	-0.44	0.92
Not Rare		0.57	7.45	4.11	0.38
Non-Lethal		5.13	-7.63	3.82	0.41

Note: Estimation results for the RPL Simple model are available on request.

Appendix 1: Example of Choice Card used in the Experiment

Attribute	**Choice A**	**Choice B**	**Neither A or B**
Source	Semi-Wild 	Wild 	
Rare?	Rare	Very Rare	
Harvesting method	Non-Lethal 	Lethal 	
Price per 100 grams	9,600 USD	2,400 USD	