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Choice Modelling of Rhino Horn Demand in Vietnam

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The Allure of the Illegal: choice modelling of rhino horn demand in Vietnam.

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ABSTRACT.

Demand for rhino horn products is the main driver of illegal hunting of African rhinos. Using choice modelling we identify the main drivers of demand and estimate consumer willingness to pay for rhino horn attributes of high policy relevance among Vietnamese users and potential users. We find that wild or semi-wild sourced horn, harvested humanly from least rare species is the most valued among Vietnamese consumers. Furthermore, consumers are willing to pay more for illegally-traded horn, indicating that the international ban on the trade has generated a premium for illegal horn.

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1. Introduction

Demand for animal parts used in traditional Asian medicine remains stubbornly high and represents an immediate threat to the survival of many species including tiger and rhino (Saif et al 2016, Milliken and Shaw, 2012). To counter the illegal international wildlife trade, the global community is committed to supply-side trade restrictions and demand reduction (COP, 2016), however, serious questions marks remain concerning the effectiveness of these measures, whilst poaching rates remain stubbornly high. This is due partly to the incentives provided by the very high prices and profits of illegal animal products in Asian medicinal markets (Challender and MacMillan, 2014). Calls to legalise the trade to undermine poaching have so far been rejected by the international community, fearing it may fuel demand (Biggs et al, 2013) although crucial aspects of demand and supply for horn remain poorly understood and under-researched (Collins et al, 2013).

In this paper, we focus on demand for rhino horn in Vietnam and using choice models. Stated preference methods are particularly well-suited to investigate determinants of demand for illegally-obtained wildlife products, and offer advantages over revealed preference methods in contexts where data on actual behaviour is hard to acquire precisely because these behaviours are illegal (St John et al, 2011). Choice Experiments (CE) have been used previously to investigate consumer demand for illegally-hunted wildlife products. For example, the method has been employed to estimate the willingness of rural households in Tanzania to reduce consumption of bushmeat (Moro et al, 2015); the willingness of illegal bushmeat hunters in Tanzania to reduce time spent hunting (Moro et al, 2013); to investigate the nature of demand for jungle meat in Vietnam (Shairp et al, 2016) and the demand for bear bile, a product used in Traditional Asian medicine (Dutton et al, 2011). Studies have found a preference for wild-sourced animal products over farmed alternatives, but this depends on the specific market and cultural context (Shairp et al, 2016).

We find evidence that a legal trade regime in rhino horn could reduce poaching, in part because Vietnamese consumers of traditional medicines prefer horn humanely harvested from living wild

animals. Moreover, we find that willingness to pay among both existing and potential consumers falls if the trade is legalised, perhaps because consumption of high value, illegal products generates social prestige (Lu and Su, 2007; Drury, 2011). Legalisation could therefore potentially 'crowd out' illegally-poached rhino horn by reducing the willingness to pay of consumers for poached animals, as has been observed for crocodilians (MacGregor, 2006; Moyle, 2013).

Whilst the extent of this crowding out of demand, and the consequent net impact on poaching activity, would also depend on supply side effects (such as changes in the costs of exporting now-legalised products: Hsiang and Sekar, 2016), the maintenance of enforcement measures, security of the supply chain, and the capacity of a legal supply to match market needs, our findings show that legalising trade in endangered rhino could result in a downward shift of the demand curve for rhino horn, and thus contribute to the conservation of these endangered animals.

2. Methodology: choice, design and implementation.

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). Whilst the trade which supplies rhino horn to these Vietnamese consumers remains illegal at the global level (COP, 2016), demand from consumers of these products is thought to be a major driver of incentives for illegal killing of rhinos in Africa and the subsequent export of horn products from Africa to South-East Asia.

Our experimental design was based upon four attributes and their associated levels (Table 1). The attributes describe three current potential sources of rhino horn (from the wild; semi-wild or ranched;

farmed), whether rhinos are killed or not in obtaining the horn, how rare the rhino species is from which horn is obtained, and the price to consumers in Vietnam (expressed here in US dollars). These attributes were identified from interviews with local traditional medicine practitioners in Vietnam. Each respondent was presented with 8 choice sets, involving 3 choices (Product A, Product B or neither) – an example choice card is shown in Figure 1.

The sample was divided into two scenarios that explored the possible impact of legalising the trade on consumer demand, with one half of the sample (every second respondent) being asked to consider their choices under a scenario where a regulated legal trade in rhino horn was allowed, and the other half responding under the status quo condition of continuing illegal trade. Respondents who stated that they were "definitely not interested" in purchasing rhino horn products in the future were not invited to continue to the choice experiment section of the survey.

All interviews were conducted in Vietnamese, in the strictest confidence and under conditions of full anonymity. Price levels and experimental design were confirmed following a pilot study of 48 consumers. The full survey involved face-to-face interviews during 2016 with over 800 Vietnamese citizens, and was conducted by a local Vietnamese company. Due to the clandestine and sensitive nature of the subject, interviewees were recruited via 16 experts in traditional Asian medicine who also acted as key informants, with subsequent interviewees identified using the snowball sampling technique (Newing et al, 2011). Hence our sample was not a random draw from the (unknown) population of current purchasers of illegally-sourced rhino horn products, but does represent the only large survey of rhino horn users ever conducted.

A total of 857 respondents completed the CE part of the questionnaire which comprised 8 choice cards, resulting in a sample with 6,856 choice observations. As Table 2 shows, the sample consists of predominantly young adults, as over half of all respondents were under the age of 29 (56%), with 72% under the age of 39. The modal age category is 18-28 and the mean age falls within the 29-38 age category. This is similar to the Vietnamese population as a whole, where the mean is 30.4 years (see

Statistics Vietnam (2016)). A large proportion of the respondents were female (61%). This breakdown is not representative of Vietnamese society as a whole where the gender balance is around 50% women. About half of the respondents (47%) have a university degree, with a further 8% qualified at postgraduate level. personal income ranged from less than 3 million to over 20 million VND per year. Mean income across the whole sample was estimated at between VND 5-10 million, which is much higher than the average income for Vietnam (VND 2.64 million) but in line with Hanoi and HCM, where most of the interviews were conducted (VND 6.7 million and VND 9.6 million). According to the respondent statements, 719 (84%) respondents had used animal-containing traditional medicine, including 244 (28%) respondents who had either used or purchased traditional medicine that contained rhino horn. Of course, some respondents may not have stated their use of such products honestly, due to their illegal source. Moreover, 433 (51%) said that it was highly probable that they would buy rhino horn-containing traditional medicine in the future.

We estimated several discrete choice models, including random parameters logit (RPL) and latent class random parameter model (LCRP), with or without interactions with socio-demographic variables (see Table 3). The best fitting model amongst those estimated was an RPL model with dummy variables corresponding to attribute levels, in which variability of attribute coefficient mean values is significantly explained by demographic variables (gender, age, education, and income); being a current buyer; and whether the purchase scenario was legalised or illegal trade. The attributes which are significant for explaining choices are price (with demand declining with increases in price); rhino horn source, with respondents having negative preferences for farmed rhino compared to horn obtained from a wild species; and rarity, with consumers on average preferring 'non-rare' species over 'very rare'.

In the LCRP model, demographic variables partly determine latent class membership probabilities, with better educated and higher income respondents, and those who have purchased rhino horn in the past more likely to be members of Class 3 (70% of all rhino horn product buyers are in this class).

Across all 3 latent classes, price was significant but compared to the RPL model, we observe more variability in size and significance of the mean attribute coefficients across classes. Class 1 members, who constitute about 33% of the sample and who are more likely to be lower income, consider price to be the only important attribute. For Class 2, only the coefficient for rare species is statistically significant and negative. Class 3 members prefer rare over either very rare and non-rare species, and prefer non-lethally harvested over lethally harvested horn. They also prefer wild sourced horn over both semi-wild or farmed varieties.

Willingness To Pay (WTP) for different combinations of the attributes – that is, for different rhino horn products under a legal or illegal trade scenario – can be estimated from the preference parameters and the parameter on price. In Table 4 we observe considerable variation in WTP (USD/100 grams) for different rhino horn "product types" under the legal and illegal trade scenarios. These product type values represent the overall average value placed by the survey respondents, after taking into account the variables that statistically influenced choices. Product types 1 and 2 are equivalent to horn from poached animals, and have a lower WTP than horn with the characteristics of a supply from semi-wild (Type 4) and farmed (Type 5) rhino horn. Horn obtained from wild animals but with non-lethal harvesting (Type 3) has the highest WTP. Under a legal market, a similar picture emerges, with Product Type 3 most valued and Types 1 and 2 least valued. Across all horn types, the most consumers are willing to pay for legally-traded horn is around 60% of their maximum WTP for an equivalent illegal horn product. Consumers are thus willing to pay a premium for illegal horn over legal sourced horn, which could be related to the product's social value to wealthy elites, who may consider consumption a mark of status and esteem (Shairp et al, 2016; Moyle, 2013).

4. Conclusions.

Our results have a high degree of relevance to the current policy debate on the effects legalizing trade in rhino horn; and by implication, on legalizing the trade in elephant ivory. Aside from price, we find

that the method of harvesting (lethal or non-lethal) 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 products, as 'wildness' is associated with greater power and/or effectiveness in the context of traditional medicinal practice (Gratwicke et al, 2008). Our finding that consumers who are most likely to purchase and/or use rhino horn products strongly prefer horn acquired from non-lethal harvesting is surprising, and has not been reported previously. Although trade bans are known to increase prices and stimulate clandestine hunting (Rivalan et al, 2007; MacMillan and Han, 2011), our study is the first to show that removal of a trade ban could reduce WTP by shifting down consumers' demand for the products derived from illegal killing of rhinos.

Perhaps most importantly we find that consumers' WTP is significantly lower under a legal trade scenario. This finding gives credence to the notion that rare wildlife products such as rhino horn and pangolin may be especially sought because it is highly illegal to consume, much in the same way that drug enforcement efforts have had difficulty confronting the allure of consuming banned substances such has cocaine (Chand and Califano, 2007). Given that price is a key driver of poaching activity, any reduction in price is likely to reduce incentives to poach. Given the economies of scale which may emerge from a managed legal supply, it is possible that legalising trade would crowd out poachers, especially if horn production could quickly rise to meet demand (Biggs et al, 2013).

Although our study represents the only major study of rhino horn demand that interviews rhino horn users directly, we also note that our sample was not a random draw from the (unknown) population of current purchasers of illegally-sourced rhino horn products, since we had to use a snowball sampling strategy. Moreover, we may not have adequately sampled people who do not currently buy rhino horn products, but who would if trade was legalised. Both of these sampling biases need to be taken into account in any attempt to aggregate up demand effects. Moreover, it is possible that a legal international *trade* in rhino horn could still leave a residual market in illegally-hunted rhino horn products perhaps because consumers may continue to favour illegal horn on the grounds of quality or

status. Our results relate solely to a legalised but still regulated market. If both legal and illegal markets were to persist after trade was legalised, then the incentives for illegal hunting would depend on the relative price changes to legal and illegal markets for rhino horn. Poachers might find they could still sell illegally-obtained horn at price that still incentivises the illegal killing of rhinos. Again, the overall impact on rhino populations would be uncertain in this scenario.

Further research is of course required to explore the full economics of horn production under a legalised trade scenario, with production costs, the sequence and synchronisation of interventions and policy measures relating to stock consumption and accumulation, and laundering safeguards such as certification being crucial factors in determining the extent to which a legal trade would displace poaching. In relation to production costs, our results suggest a premium would be still be attached to horn sourced from wild rhino. The economic and management implications of harvesting from the wild population would also require further research, as costs are likely to be higher than for ranched or farmed horn.

Given the uncertainty about the future success of demand reduction campaigns and other enforcement efforts in Asia (Challender and MacMillan, 2014), where consumption is shaped by a complex array of factors such as personal preferences, family and community tradition, and business culture (Lee, 1998) we suggest that the international community is open at least to the legalisation process by exploring some of the issues raised by our research. A legal trade, with all its risks (that would need to be mitigated) would re-establish interest in sustainable wildlife management model that would generate significant revenues to poor rural communities and help offset the escalating costs of conserving African rhinos and other species in the wild (Cooney et al, 2015; Di Minin et al., 2015).

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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*) 3 levels (*Very Rare, Rare* and *Not Rare*)
Rarity of Rhino Species	*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 (USD per 100 grams)	8 levels (*1,200; 2,400; 3,600; 4,800; 6,000; 7,200; 8,400; 9,600*)

Table 2. Socio-demographic characteristics of the sample

Characteristics	Sample	Population
Female share (%)	61	50
Age (years):		
Modal (range)	18-28	
Mean (range)	29-38	30.4
Share of respondents with a university degree	0.47	
Income (mln VND):		
Mean (range)	5 ÷ 10	2.64
Median (range)	3 ÷ 5	
Mode (range)	5 ÷ 10	

Table 3. Estimation results for Mixed Logit (RPL) and Latent Class Mixed Logit (LCRP) models with attribute level-dummy variables and demographic variables.

	Mixed Logit (RPL)	**Latent Class Mixed Logit**		
		Class 1	**Class 2**	**Class 3**
ASC	-4.950*** (1.470)	3.412*** (0.871)	-4.473*** (0.349)	0.152 (0.286)
Semi-Wild	0.091 (0.143)	-0.026 (1.004)	-0.016 (0.087)	-0.410* (0.211)
Farmed	-0.303*** (0.111)	-0.166 (0.806)	-0.048 (0.120)	-0.702*** (0.204)
Rare	-0.120 (0.083)	0.868 (0.656)	-0.277** (0.122)	0.721*** (0.233)
Not Rare	0.109* (0.059)	0.113 (0.856)	0.009 (0.078)	0.228 (0.185)
Non-Lethal	0.120 (0.462)	0.597 (0.173)	0.096 (0.123)	1.203*** (0.209)
Price (in 1,000 USD)	-0.099*** (0.017)	-0.678*** (0.173)	-0.041*** (0.016)	-0.169*** (0.032)
ASC × Legal		-1.176 (0.848)	-1.182*** (0.351)	0.127 (0.373)
ASC × Buyer		-2.347*** (0.700)	4.544*** (0.462)	-6.596*** (0.842)
ASC × Income	-0.213*** (0.042)			
ASC × Education	0.850*** (0.850)			
Semi-Wild × Legal		-0.816 (0.937)	-0.208* (0.124)	-0.231 (0.279)
Semi-Wild × Buyer	0.337** (0.155)	-0.224 (0.729)	0.664*** (0.174)	-0.990* (0.512)
Semi-Wild × Age	-0.010** (0.004)			
Farmed × Legal	-0.446*** (0.155)	-1.225 (0.767)	-0.541*** (0.166)	-0.053 (0.264)
Farmed × Buyer		-0.121 (0.671)	0.590*** (0.213)	-1.435*** (0.433)
Rare × Legal		-0.619 (0.673)	0.559*** (0.181)	-0.750** (0.321)
Rare × Buyer		-0.122 (0.577)	-0.077 (0.244)	-1.184** (0.554)

Not Rare × Legal		1.453* (0.845)	0.025 (0.109)	-0.096 (0.239)
Not Rare × Buyer	-0.458*** (0.124)	-0.530 (0.671)	0.057 (0.146)	-1.977*** (0.355)
Non-Lethal × Legal		0.813 (0.616)	-0.186 (0.182)	-0.187 (0.285)
Non-Lethal × Buyer	0.748*** (0.283)	-1.472*** (0.557)	1.942*** (0.263)	-2.534*** (0.542)
Non-Lethal × Income	-0.043** (0.020)			
Non-Lethal × Education	0.145* (0.084)			
Price × Legal	-0.081*** (0.022)	0.100 (0.164)	-0.118*** (0.024)	0.060 (0.042)
Price × Buyer	-0.070** (0.028)	0.245** (0.123)	0.015 (0.037)	-0.121** (0.053)
Std. dev (SQ const.)	7.159*** (0.442)			
Std. dev (Semi-Wild)	0.391*** (0.131)			
Std. dev (Farmed)	0.863*** (0.159)			
Std. dev (Non-Lethal)	1.845*** (0.145)			
Std. dev (Price)	0.152*** (0.017)			
Pr(class)		0.327	0.496	0.178
Pr(class) × Female		-0.094 (0.261)	-0.421* (0.246)	
Pr(class) × Age		-0.014 (0.009)	-0.020** (0.009)	
Pr(class) × Income		-0.053** (0.026)	0.004 (0.024)	
Pr(class) × Education		-0.379*** (0.130)	-0.483*** (0.126)	
Nr of observations	6,856		6,856	
Pseudo R2	0.3759		0.3800	

LogLik	- 4,700.6568	-4,669.7466
AIC/n	1.378	1.390

Notes: 1. The estimates of standard deviation for random coefficient distributions in the LCRP model are not reported because none of them are significant.

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

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

Table 4: Willingness to pay for different rhino horn products under legal and illegal CE scenarios (per 100g of product)

	Illegal trade scenario	**Legal trade scenario**
Product Type 1: wild, least rare, lethal (equivalent to poached white rhino)	19,890 (12,630-29,920)	11,910 (6,480-18,070)
Product Type 2: wild, very rare, lethal	19,830 (12,600-29,710)	11,690 (6,730-18,160)
Product Type 3: wild, least rare, non-lethal	24,300 (16,290-35,660)	16,900 (11,410-23,920)
Product Type 4: semi-wild, least rare, non-lethal	23,100 (15,280-33,930)	15,370 (9,870-22,340)
Product Type 5: farmed, least rare, non lethal	21,670 (13,630-33,060)	12,780 (7,350-19,560)
Product Type 6: farmed, least rare, lethal	17,250 (10,050-26,820)	7,790 (2,700-13,920)

Note: The estimates are based on Mixed Logit model with attribute level dummies and attribute-demographic variable interactions. The 95% confidence intervals provided in parentheses are calculated using the Krinsky-Robb procedure. The three attribute levels specified for each product type are used to derive willingness to pay measures from the preference parameters in Table 3, in conjunction with the parameter on the price of rhino horn.

Figure 1: Example of Choice Card used in the Experiment

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