Investigating the effects of sample heterogeneity on the travel cost model for coral diving in Southeast Asia.

Amar Doshi[a], Sean Pascoe[b]

a. School of Economics and Finance, Queensland University of Technology, Brisbane, Queensland, Australia
b. CSIRO Marine and Atmospheric Research, Dutton Park, Queensland, Australia

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Abstract

In mid-2010, an impact assessment was undertaken to ascertain the non-market value of coral reefs to scuba divers in Thailand, Malaysia and Indonesia. A travel cost method was employed and it was found that divers had a consumer surplus of about US$590 per dive. However, given the sample consisted of a much larger proportion of international visitors (84%), an analysis was undertaken to ascertain the effects of the sample heterogeneity on the economic value estimates. The results indicated that the pooled results were biased towards the international sub-sample. Domestic visitors had a much lower consumer surplus of about US$130 per dive. In addition, the split-sampling suggested that the assumption of endogenous stratification using count data models was not appropriate for the international sub-sample. Applying the split-sampling based to the three separate countries illustrated further large disparities in consumer surplus, with Thailand the highest at US1200 per dive and Malaysia the lowest at US$260 per dive. This proves consequential in determining the appropriate user fee structure given the different resulting effects on returning divers based on their origins and diving destinations.

Keywords:
Travel cost method, coral diving, sample heterogeneity

1. Introduction

Coral reefs and other associated marine life in Southeast Asia represent among the most diverse and extensive in the world (Burke *et al.* 2011). Hence, coastal communities benefit from both domestic and, more importantly, international tourism related to scuba diving. However, the reefs in this region have become increasingly threatened by local and global threats, the latter of which having long term effects from global climate change (Hoegh-Guldberg *et al.* 2007; Burke *et al.* 2011). Resources for effective management are limited, but there is potential to establish a user fee structure that can fund conservation efforts given the growth of eco-tourism (Balmford *et al.* 2009).

Consequently, the demand for non-market valuation studies has increased among conservation bodies to justify management and policy action (Lubchenco 2012). These studies help to establish potential user fees by deriving economics values in excess of current prices. Most site-specific studies in the region only provide general non-market values for aggregated visitors (Pham and Tran 2003; Ahmed *et al.* 2007; Tapsuwan and Asafu-Adjaye 2008). However, other studies in the region, particularly by Seenprachawong (2001; 2003) suggest that international visitors have a significantly higher willingness to pay. Hence, there is potential bias induced by the heterogeneity not captured by most coral valuation studies.

In mid-2010, significant increases in water temperature were observed in waters around Thailand, Malaysia and Indonesia[1], with many areas facing between 4 and 16°C-weeks[2] stress and lasted approximately six months (Heron *et al.* 2012). These patches of thermal stress

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[1] This was captured by NOAA's 'near-real-time' Coral Reef Watch satellite (http://coralreefwatch.noaa.gov/satellite/index.html).

[2] Degree Heating Week (DHW) is a unit of measurement derived from the NOAA satellite to measure the "accumulated thermal stress" experienced by coral reefs. A 2°C-week represents an increase of surface temperature of 2°C, above the expected temperature for the season, for one week or 1°C for two weeks. Often a 10°C-week or over is followed by severe bleaching and coral mortality. (http://www.osdpd.noaa.gov/PSB/EPS/method.html)

were found to be the cause of bleaching in key dive spots of the region (Thomas and Heron 2011; Heron *et al.* 2012; Maynard *et al.* 2012) with some areas experiencing a more severe bleaching than occurred in 1997-1998 (Tan and Heron 2011). As part of a rapid-response assessment, a choice experiment based on hypothetical scenarios was undertaken. The results suggest that divers had a consumer surplus value of US$164 per dive with the loss from bleaching being estimated at between US$44 and US$58 a dive (assuming bleaching between 60-80%) (Doshi *et al.* 2012). However, these results suffered from two potential shortcomings; (1) it was susceptible to hypothetical bias and (2) it assumed homogeneity among respondents who were both domestic and international and were surveyed from dive sites across the three countries.

In this study, a travel cost method (TCM) was employed to ascertain the non-market value of diving in the three countries. Despite being conducted during the bleaching event, travel decisions were made prior to knowledge of bleaching and hence, bleaching did not form a constitutive element in this analysis. More importantly, given the inherent heterogeneity in decision-making among visitors, split-sampling was employed to derive economic values based on diver origins and dive destinations. The results suggest that international visitors had a much higher consumer surplus than domestic divers and the higher proportion of international visitors surveyed had skewed the estimated for a pooled analysis. This was also observed in the country-based analysis. Implications for the potential implementation of user fees in the region are discussed.

2. Travel cost methodology

There has been significant use of TCM in environmental resource valuation studies pertaining to tourism. These include valuation of recreational sites like marine parks (Pendleton 1995;

Park *et al.* 2002; Bhat 2003), lakes and wetlands (Costanza *et al.* 1989; Fleming and Cook 2008) and most important to this study, coral reef sites (Seenprachawong 2001; Carr and Mendelsohn 2003; Seenprachawong 2003; Ahmed *et al.* 2007; Andersson 2007; Tapsuwan and Asafu-Adjaye 2008). TCM has also been used to value the demand for specific activities like recreational fishing (Grogger and Carson 1991; Shrestha *et al.* 2002; Rolfe and Prayaga 2007; Prayaga *et al.* 2010; Properjohn and Tisdell 2010), whale watching (Loomis *et al.* 2000) and marine related diving (Du Preez *et al.* 2012).

TCM allows for the derivation of a demand function from which consumer surplus can be calculated. The quantity demanded (number of dives) is taken as a function of the price (travel cost), individual demographic characteristics and site attributes or more generically;

$$r_{ik} = f(tc_k, y_i, z_k) \quad (1)$$

where r_{ik} is the number of trips/dives by individual i to site k; tc_k is the total travel cost to site k; y_i are demographic characteristics of individual i; and z_k are attributes of site k (Parsons 2003). Travel cost has a predicted negative relationship with the number of trips and produces a typical downward sloping demand curve.

The dependent variable is a non-negative integer and hence, applying a traditional OLS regression would be unsatisfactory (Hellerstein and Mendelsohn 1993). Count data models would be a more apt representation (Creel and Loomis 1990) with a Poisson distribution being the most common, given by

$$Pr(r_{ik} = n) = \frac{e^{-\lambda_i *} \lambda_i^n}{n!},\ n = 0,1,2,\ldots \quad (2)$$

where n is the observed number of trips to site k and λ is the mean and variance of each covariate in the Poisson distribution, which is given as

$$\lambda_i = e^{(\boldsymbol{x}_i \boldsymbol{\beta})} = E(r_{ik} | \boldsymbol{x}_i \boldsymbol{\beta}) \quad (3)$$

such that $\boldsymbol{\beta}$ is a vector of coefficients of $\boldsymbol{x}$, which itself is a vector of parameters that impact demand. These parameters are estimated by maximum likelihood estimation. The function for the individual consumer surplus per dive collapses to

$$CS = -\frac{1}{\widehat{\beta_{tc}}} \quad (4)$$

where denominator is the coefficient of the travel cost variable. The negative sign is necessary given the expected negative coefficient of the travel cost variable. The marginal effect of a particular coefficient is then given by

$$ME = -\frac{\beta_{\eta}}{\widehat{\beta_{tc}}} \quad (5)$$

where the numerator is the coefficient of the variable of interest (Haab and McConnell 2002). A positive value would indicate a marginal benefit for an increase in the variable (or 1 value for a dummy) and conversely, a negative value would suggest a marginal loss.

However, the Poisson model is criticised from suffering from a form on intrinsic heteroskedasticity caused by the assumption of equidispersion (Cameron and Trivedi 2005; Martínez-Espiñeira and Amoako-Tuffour 2008) where the variance and mean are assumed equal. Most TCM samples suffer from overdispersion, often caused by unobserved heterogeneity (Winkelmann 2008) inferred from the large variance of costs for lower frequencies and vice versa. The most common alternative is to apply a negative binomial model where for a given mean, λ_i, the variance is

$$var(r_i|x_i\beta) = \lambda_i(1 + \alpha\lambda_i) \quad (6)$$

where α is a variance (dispersion) parameter; a degree of how much the conditional variance will exceed the conditional mean (Cameron and Trivedi 2005). If α is significantly more than 0, overdispersion is present and Poisson regression would be inappropriate. The functional form of a negative binomial distribution is given as

$$Pr(r_{ik} = n) = \frac{\Gamma(n+\alpha^{-1})}{\Gamma(\alpha^{-1})\Gamma(n+1)} \left(\frac{\alpha^{-1}}{\alpha^{-1}+\lambda_i v}\right)^{\alpha^{-1}} \left(\frac{\lambda_i v}{\alpha^{-1}+\lambda_i v}\right)^{n} \quad (7)$$

such that $\Gamma(\cdot)$ is a Gamma distribution and v is an independently and identically distributed (IID) random variable; $v>0$ with gamma density $g(v|\alpha)$[3]. The parameter v captures unobserved heterogeneity in λ_i. When $\alpha=0$, the distribution collapses to the Poisson distribution in (2) (Cameron and Trivedi 2005; Martínez-Espiñeira and Amoako-Tuffour 2008).

The samples in TCM are also subject to two additional sources of bias: truncation and endogenous stratification. The former is the result of non-users (and the resulting travel costs) not being surveyed (Haab and McConnell 2002) and the latter is the result of the correlation of the frequency of visitors and the likelihood of being surveyed i.e. those who take more frequent trips have a higher probability of being sampled (Shaw 1988; Cameron and Trivedi 2005). The truncated Poisson model is given by

$$Pr(r_{ik} = n | r_{ik} > 0) = \frac{e^{-\lambda_i} * \lambda_i^n}{n!} \left(\frac{1}{1-e^{-\lambda_i}}\right), n = 1,2, \dots \quad (8)$$

assuming equidispersion. An allowance for endogenous stratification simply involves reducing the number of dives in the model by one (Haab and McConnell 2002).

If overdispersion is significant, the truncated negative binomial model is given as in (9a) and adjusted for endogenous stratification as in (9b)

$$Pr(r_{ik} = n | r_{ik} > 0) = \frac{\Gamma(n+\alpha^{-1})}{\Gamma(\alpha^{-1})\Gamma(n+1)} \left[\frac{(\alpha\lambda_i v)^n}{(1+\alpha\lambda_i v)^{(n+\alpha^{-1})}}\right] \times \left[\frac{1}{1-(1+\alpha\lambda_i v)^{-\alpha^{-1}}}\right] \quad (9a)$$

$$Pr(r_{ik}^s = n | r_{ik} > 0) = \frac{n_i\Gamma(n_i+\alpha_i^{-1})}{\Gamma(\alpha_i^{-1})\Gamma(n_i+1)} \left[\frac{\alpha_i^{n_i}(\lambda_i v)^{(n_i-1)}}{(1+\alpha_i\lambda_i v)^{(n_i+\alpha_i^{-1})}}\right] \quad (9b)$$

[3] E[v]=1 and Var[v]=α (Martínez-Espiñeira and Amoako-Tuffour 2008).

where α_i, the dispersion parameter, is heterogeneous, based on individual characteristics (Englin and Shonkwiler 1995; Martínez-Espiñeira and Amoako-Tuffour 2008). These two variants were run to ascertain the effect of heterogeneity on the assumption of endogenous stratification.

For all the models, the consumer surplus and marginal effects functions given in (4) and (5) remain constant (Creel and Loomis 1990). The models are then run with the split samples and best model for a particular sample selected based on presence of overdispersion and model Akaike Information Criterion (AIC).

3. Data

The survey was conducted in the midst of the bleaching event from 29th June and 13th August 2010. A total of 578 divers were interviewed across 11 dive sites in the three countries of which, 423[4] were used in the analysis. Data were collected that reflect both travel decisions and demographic characteristics; these include data on the travel preferences to the sites, travel costs, dive experience, importance of the dive to the trip and various socio-demographic attributes such as gender, income, education level and origin (local or international). Around 84% of this reduced sample were international divers, with about 90% from Thailand and Indonesia and 68% from Malaysia being international.

Similar to a previous dive-related study (Du Preez *et al.* 2012), it was found that most divers undertook multiple dives per trip. Assigning a demand based on number of trips such as commonly used in studies of recreational fishing (Shrestha *et al.* 2002; Rolfe and Prayaga 2007; Prayaga *et al.* 2010) or hunting (Creel and Loomis 1990; Whitten and Bennett 2002)

[4] Respondents were dropped based on incomplete information and exclusion of outliers that were attributed to misreporting

would therefore be inaccurate. Hence, the dependent variable for this analysis was taken as an annual dive rate to the site. This was obtained by multiplying the non-integer visit rate (total visits to the site over years diving) with the number of dives undertaken in the current trip. This was then converted to an integer value and truncated at 1.

The total travel cost for this analysis was inclusive of dive packages, accommodation and transport costs. In this analysis, both travel cost and on-site costs were assumed to determine the 'price' for diving. This includes diving costs, accommodation and meals and travel costs from home to the dive sites, including flights for international tourists[5]. Using the information on the number of dives included in the current trip, a 'cost per dive' variable was derived. All costs were converted to US Dollars using average exchange rates for that time period (between the end of July and mid-August)[6].

Time costs (travel and on-site time) are often included as an opportunity cost of time based on some proportion of wage; a quarter (Du Preez *et al.* 2012), a third (Chen *et al.* 2004; Martínez-Espiñeira and Amoako-Tuffour 2008; Rolfe and Dyack 2010) or full-wage rate (Whitehead *et al.* 2000). In this analysis, time costs are assumed to be zero, drawing from the definition of travel and on-site time by Prayaga, Rolfe and Sinden (2006), that most individuals do not lose income from leisure and travel and following methodologies by other coral and dive studies (Park *et al.* 2002; Farr *et al.* 2011).

Multi-purpose/destination visitors were also accounted for with the travel costs. Since it was not known which of the respondents were multi-purpose visitors and having auxiliary purposes may not diminish the importance of diving for the respondent (Beal 1995), a

[5] A number of divers purchased all inclusive dive packages that included all of these components, while others organised the different components separately.
[6] Average exchange rates obtained from X-rates.com (http://www.x-rates.com/average/)

proportion was assigned to scale the costs according to the relative importance of diving to the entire trip. This was based on the stated perceived importance of the dive to the overall trip similar to previous TCM studies (Bennett *et al.* 1996; Kuosmanen *et al.* 2004). Bennett (as cited in Kuosmanen *et al.* 2004) notes that this measure can be more accurate than a time proportion given that the time spent on an activity would not determine its importance to the trip.

However, imposition of the proportion scalar would result in some costs being below the marginal cost per dive (i.e. the minimum price actually paid per dive) for some divers. Hence, the values for scaled travel costs were truncated at a country-specific minimum cost, the lowest price paid by a domestic visitor. The distribution of the travel cost per dive against dive demand is given in Figure 1.

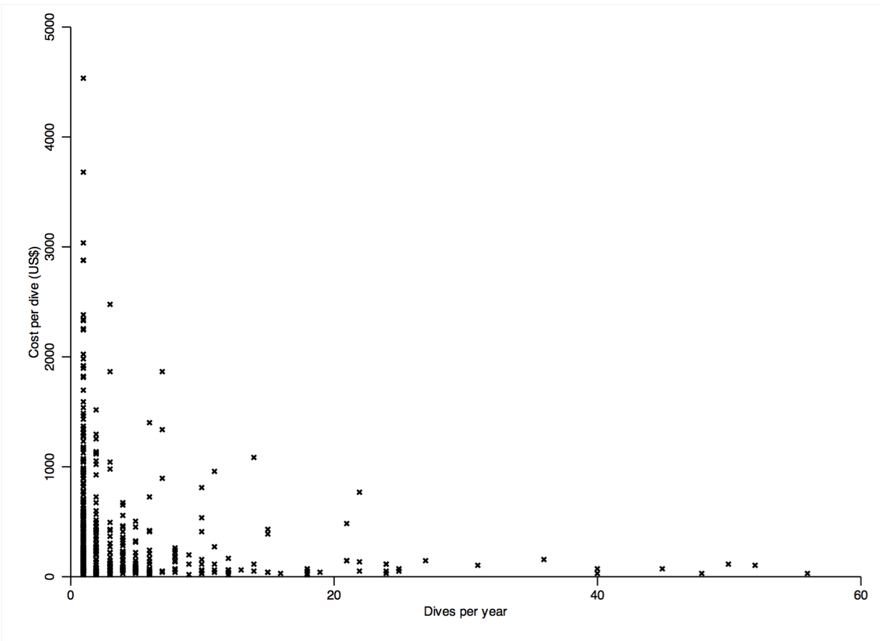

Figure 1: Distribution of cost per dive against dives per year.

Aside from the abovementioned information, demographic attributes such as income[7], age, gender (dummy), education level (dummy if had a university education), if the respondent was a local (dummy) and the country that the respondent was diving (Thailand, Malaysia or Indonesia) were also collected. A variable to account for the respondents' experience of diving was taken as the total number of dives per year of experience. These include dives sites outside of those included in the study. Since this variable was to be a general measure of dive experience, it was left as a continuous variable (non-integer). A summary of the key data is given in Table 1.

Table 1: Descriptive statistics for regression variables (n=423).

Variable	Mean	Std. Dev.	Min	Max
Dives at site per year of diving experience	4.77	7.69	1.00	56.00
Travel cost per dive (US$)	443.90	587.95	10.80	4525.69
Total number of dives per year of experience	47.43	356.31	0.14	7100.00
Gender (Female=0, Male=1)	0.59	0.49	0.00	1.00
Age	31.13	9.68	15.00	66.00
University education (No=0, Yes=1)	0.79	0.41	0.00	1.00
Estimated income (US$ '000)	35.88	16.36	3.23	85.38
Importance of dive to trip	0.79	0.26	0.05	1.00
Dive site in Malaysia (No=0, Yes=1)	0.29	0.45	0.00	1.00
Dive site in Indonesia (No=0, Yes=1)	0.33	0.47	0.00	1.00
Diver origin (International=0, Local=1)	0.16	0.36	0.00	1.00

[7] This was derived from a perceived scaling of respondents income from the averages (GDP per capita) in year 2010 or as close to, collected from the World Bank database (http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2).

4. Results

4.1 Pooled estimation

Three specifications were run with the pooled sample: a truncated Poisson, truncated negative binomial and a truncated negative binomial model corrected for endogenous stratification. All three models included all covariates as listed in Table 1 except for the importance of dive trip, which was factored into the travel cost variable.

From the results of the pooled model (Table 2), the overdispersion parameter, α, was found to be highly significant at 1% for both negative binomial variants; hence, overdispersion is inherent in the sample and the truncated Poisson model would be invalid. Based on the AIC, the negative binomial model that did not correct for endogenous stratification performed marginally better.

As expected, the travel cost variables were highly significant at 1% for all models and similar in absolute magnitudes. The dive experience was also similarly highly significant for the negative binomial models. Another important variable to note is the diver origin (local or international) was significant at 10% and positive for the negative binomial models, suggesting that a local visitor is willing undertake more dives at a given cost, and hence has a higher benefit from dive trips. The positive coefficient for diver origin was not as expected given international divers were assumed to garner a greater benefit for diving in the region.

Based on the consumer surplus function (4), the consumer surplus of the truncated negative binomial model with the lower AIC was US$590 per dive, which was much lower than that of the model that corrected for endogenous stratification at US$680. Most importantly, the marginal effects of the diver origin suggested that a local diver had between US$278 (corrected for endogenous stratification) and US$422 greater benefit from diving in the region, which was not as expected. In addition, the comparison of the AICs suggested that correction of endogenous stratification would result in a less satisfactory model. This is also not as expected given the sample was assumed to suffer from the common TCM issue of endogenous stratification.

Table 2: Pooled regression results with truncated models.

Variable	Truncated Poisson			Truncated negative binomial			Truncated negative binomial with endogenous stratification		
	Coeff	Std. Error		Coeff	Std. Error		Coeff	Std. Error	
Constant	1.7542	0.1045	***	-13.854	914.28		-15.499	386.01	
Travel cost/dive	-0.0016	0.0001	***	-0.0017	0.0002	***	-0.0015	0.0002	***
Dive experience	0.0002	0.0000	***	0.0073	0.0021	***	0.0022	0.0005	***
Gender	-0.1278	0.0485	***	-0.0226	0.2202		-0.0815	0.1199	
Age	0.0033	0.0026		-0.0261	0.0132	**	-0.0091	0.0072	
Uni education	-0.2118	0.0568	***	-0.3913	0.2686		-0.2454	0.1454	*
Est income	0.0046	0.0019	**	-0.0017	0.0079		0.0012	0.0047	
Malaysia	0.3140	0.0600	***	-0.2898	0.3147		0.0992	0.1632	
Indonesia	0.1274	0.0611	**	-0.1671	0.2583		-0.0200	0.1443	
Diver origin	0.2412	0.0783	***	0.7161	0.4223	*	0.4095	0.2183	*
α[8]				4.72E+07	2.08E+05	***	3.79E+07	1.21E+05	***
Sample size	423			423			423		
AIC	8.328			4.274			4.533		
Log Likelihood	-1751.5			-892.88			-948.78		
Prob > χ^2	0.000			0.000			0.000		

Note: * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.
α represents the overdispersion parameter.

4.2 Diver origin-based split-sample model

The first set of split-sample models were based on the diver origin. That is, separate regressions were run for international and local divers. Both negative binomial variants were

[8] The large estimates and standard errors from both dependent variable specifications do not affect the significance of overdispersion, which was derived as a comparison of the resulting likelihoods. Hilbe (2011) suggests that such large estimates are possibly the result of the significantly large proportion of low frequency dives (60% of *diverate1* participating in 1-2 dives a year).

Table 1: Split-sample models based on diver origin.

Variable	Truncated negative binomial						Truncated negative binomial with endogenous stratification					
	International Visitors			Domestic Visitors			International Visitors			Domestic Visitors		
	Coeff	Std. Error		Coeff	Std. Error		Coeff	Std. Error		Coeff	Std. Error	
Constant	-15.119	428.64		2.9102	0.8787	***	-16.329	553.20		-2.4644	47.475	
Travel cost/dive	-0.0017	0.0002	***	-0.0076	0.0037	**	-0.0015	0.0002	***	-0.0076	0.0038	**
Dive experience	0.0074	0.0021	***	0.0120	0.0074		0.0022	0.0005	***	0.0124	0.0074	*
Gender	-0.0409	0.2379		-0.1415	0.3065		-0.0857	0.1324		-0.1445	0.3149	
Age	-0.0245	0.0141	*	-0.0126	0.0206		-0.0059	0.0078		-0.0123	0.0211	
Uni education	-0.2970	0.2856		-0.7990	0.3949	**	-0.1437	0.1593		-0.8092	0.4042	**
Est income	-0.0020	0.0078		-0.0370	0.0406		0.0002	0.0047		-0.0377	0.0416	
Malaysia	-0.5451	0.3237	*	1.0518	0.4457	**	-0.1008	0.1797		1.0672	0.4523	**
Indonesia	-0.1600	0.2716		0.0083	0.6443		0.0041	0.1525		0.0194	0.6614	
α	1.62E+08	2.63E+05	***	0.9276	0.5703	***	7.94E+07	2.10E+05	***	2.09E+02	9.95E+01	***
Sample size	357			66			357			66		
AIC	3.945			5.914			4.279			5.884		
Log Likelihood	-694.14			-185.15			-754.84			-185.17		
Prob > χ^2	0.000			0.008			0.000			0.002		

Note: * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.
α represents the overdispersion parameter.

run with the split-samples to ascertain if the effects of endogenous stratification were apparent in either sub-sample. Given that overdispersion was found to be inherent in the combined sample, a Poisson variant was excluded.

Travel cost remained significant for international divers (at 1%) for both models but at a lower significance level (5%) for local visitors. The coefficients for each sub-sample were similar across the models respectively and remained negative as expected.

More covariates were found significant for international visitors for the model that did not correct for endogenous stratification. In addition, the AIC suggested that not correcting for endogenous stratification produced a more satisfactory model for the international sub-sample. Given that international visitors represented a large proportion of the sample, this would account for the similar effects of the correction for endogenous stratification in the pooled model. Conversely, the model that accounted for endogenous stratification produced a marginally better model for the domestic sub-sample with dive experience being significant (at 10%) and a lower AIC. Hence, it could be inferred that correction for endogenous stratification was required for the domestic sub-sample but would produce a less satisfactory estimate for the internationals.

Dive experience was found to be consistently highly significant (at 1%) for international divers but only at 10% for locals, inferring that experienced international divers had more marginal value per dive than local highly experienced divers (who were most likely dive instructors there).

The consumer surplus for international visitors was US$576 per dive (not corrected for endogenous stratification) and US$131 for domestic divers (after correction). It can be inferred that the consumer surplus estimate from the pooled model was biased towards the much larger international visitor sub-sample. Additionally, divers in Malaysia had significant differences in the economic value of their dive, with international divers having a benefit of up to US$314 lower than other regions, and locals having a higher benefit of around US$140 compared to the other countries.

4.3 Dive country-based split-sample model

The split-sampling was also applied to a country specific model. Both negative binomial models were run for all three countries. The non-correcting model (for endogenous stratification) had produced better AIC values for the Thailand sample but could not fit concave models with the given covariates for the Malaysia and Indonesia sub-samples, despite regressing different estimation algorithms by excluding variables that were found not significant the alternative regression (corrected for endogenous stratification). In the interest of consistency, the final split-sample models by country in Table 4 only outline the truncated negative binomial models that corrected for endogenous stratification with the full covariate list.

The travel cost variable remained significant (at 1%) and negative as expected across the three countries. The coefficient for travel cost in Thailand was the lowest followed by Indonesia and then, Malaysia as the highest. Dive experience was found to be highly significant for the Malaysia and Indonesia sub-samples but not for Thailand. In addition, the coefficients for the former two countries were found to be expectedly positive. Diver origin was highly significant for the Malaysian sub-sample and unexpectedly positive (local divers in Malaysia gained a higher benefit).

The consumer surplus for Thailand was found to be highest at US$1213 per dive, twice that of Indonesia (US$595) and six times that of Malaysia (US$262). This was much higher than the marginal benefit for a diver in Thailand from the pooled regression of US$170 per dive (over a diver in Malaysia). The estimates from Indonesia were most similar to those of the pooled model at just under US$600[9]. The marginal benefits for dive experience were only slightly higher for respondents from Malaysia than Indonesia. Local Malaysian divers had a marginal benefit of US$275 per dive over an international, in comparison with the previous split-sample model, which indicated a US$454 higher benefit for domestic divers in Malaysia.

Table 4: Split-sample model based on dive country

Variable	Thailand			Malaysia			Indonesia		
	Coeff	Std. Error		Coeff	Std. Error		Coeff	Std. Error	
Constant	-14.998	1253.9		-11.654	576.30		-13.681	388.99	
Travel cost/dive	-0.0008	0.0002	***	-0.0038	0.0006	***	-0.0017	0.0003	***
Dive experience	-0.0001	0.0002	***	0.0091	0.0016	***	0.0033	0.0009	***
Gender	-0.1011	0.2004		-0.0935	0.2394		-0.2162	0.2250	
Age	-0.0373	0.0130	**	-0.0306	0.0149	**	-0.0022	0.0126	
Uni education	0.1531	0.2447	**	-0.6156	0.2483	**	-0.3604	0.3114	
Est income	-0.0046	0.0077		0.0141	0.0092		-0.0059	0.0093	
Diver origin	0.2524	0.4141	***	1.0517	0.3461	***	-0.6099	0.4880	
α	3.80E+07	2.18E+05	***	1.21E+06	2.64E+04	***	2.79E+06	2.95E+04	***
Sample size	161			121			141		
AIC	4.342			4.625			4.158		
Log Likelihood	-341.57			-27.798			-285.12		
Prob > χ^2	0.000			0.000			0.000		

Note: * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level. α represents the overdispersion parameter.

[9] The country specific covariates were insignificant in the pooled models.

4.4 Comparison of implied consumer surplus values

The distributions of the imputed consumer surplus values from the different models are given in Figure 2. Although median estimates varied, in most cases these were not significantly different to each other for a given country/origin group (although each country had notable exceptions). The results for international visitors were generally most consistent between different model types. The high variability around the domestic diver values may reflect the smaller sample from this group, particularly in Thailand where international visitors made up a substantial proportion of the sample.

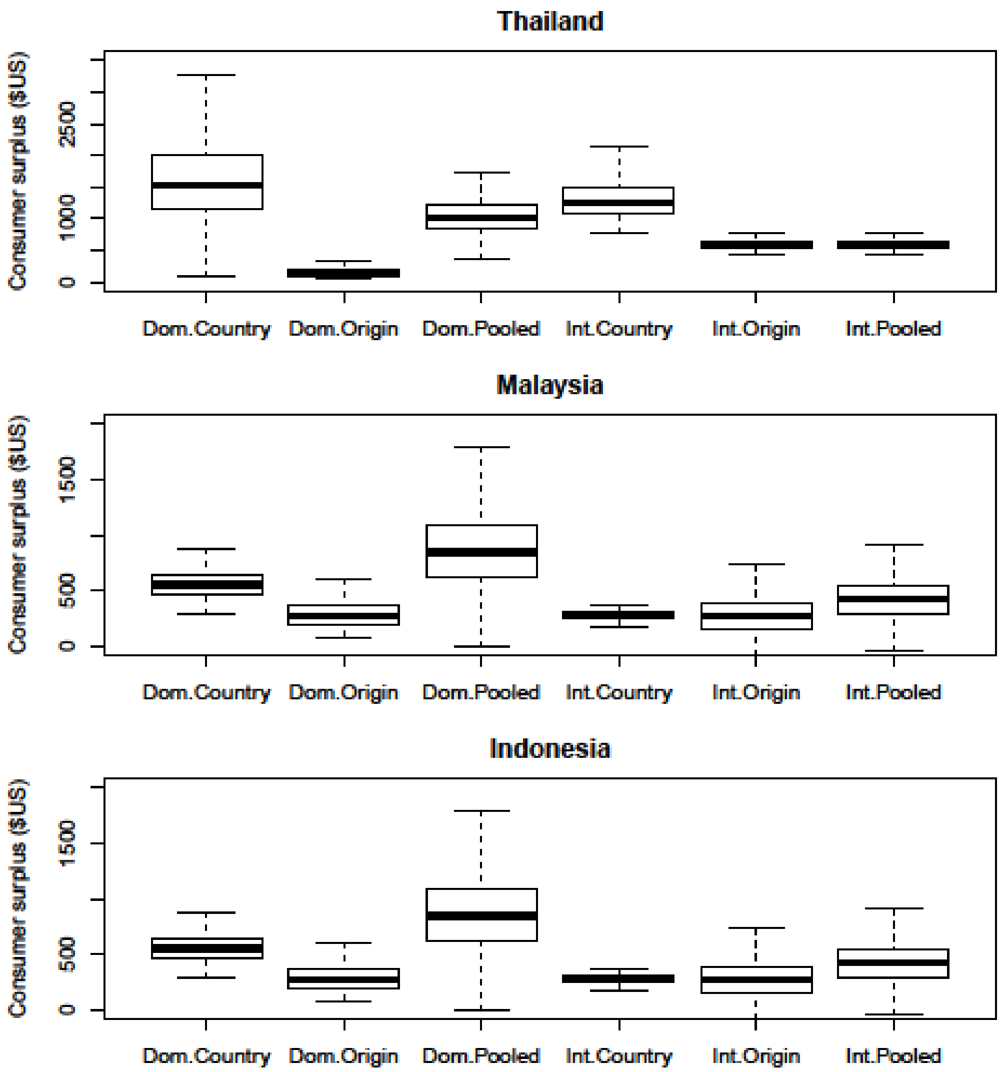

Figure 2. Distribution of derived consumer surplus estimates. "Dom" refers to domestic divers, "Int" refers to international visitors, "Country" refers to individual country split sample, "Origin" refers to domestic or international split sample, and "Pooled" refers to the pooled model.

5. Discussion

The pooled estimates for CS were in between higher estimates from Tapsuwan and Asafu-Adjaye (2008) and lower estimates of Pham and Tran (2003) and Ahmed *et al.* (2007) for coral valuations in the region. It is also significantly higher than estimates from the choice experiment for the sample (Doshi *et al.* 2012). The positive diver origin covariate from the pooled model does suggest some potential bias caused by the large international sub-sample.

The difference in consumer surpluses from the first split-sample model is relative conservative; Seenprachawong (2001; 2003) estimated that internationals have a consumer surplus of US$1000 more than local divers. However, this split-sample model suggested some shortcomings if the TCM was estimated as a pooled model. Firstly, the correction for endogenous stratification produced inferior estimation for the international sub-sample. This most likely reflects the large proportion of single visits in the data set. Its effects marginally improved the estimation for domestic visitors where a greater proportion of divers had multiple visits. Its true effects would probably be more apparent with a larger domestic sample size. Also, the large international sub-sample had skewed the estimates for the pooled regression resulting in inadequate representation of domestic dive demand.

The country-based split-sample models echo previous findings of heterogeneity based on the destinations despite engaging in the same recreational activity (Arin and Kramer 2002). The differences in consumer surplus between countries were inadequately captured in the pooled model. The dummy variables for dive origin have also proven to be inconclusive with both country specific models and pooled models suggesting domestic visitors having higher marginal benefits, contrary to the first split-sample models based on diver origin.

The results of the above analyses have suggested that many assumptions associated with TCM methodology can become invalidated with the presence of heterogeneity. There is sufficient evidence to infer that assuming homogeneity in a sample that consists of international and domestic respondents and across different destinations can induce bias in the resulting estimates of economic values. In addition, the use of dummy variables to capture these heterogeneous agents may not be sufficient. The ideal improvement of such analysis is to assign multiple split-samples based on potential sources of heterogeneity but this bears an additional cost of data collection to ensure sufficient sub-sample sizes. The resulting samples may also not be reflective of the aggregate visitation.

Such findings can prove consequential on estimates of economic values that are used to justify user fees. Firstly, assigning a uniform user fee based on pooled estimates may result in an over-charge or under-charge of particular sub-samples, depending on the proportion of each sub-sample in the pooled estimation. In this instant, a uniform user fee would wrongly interpret the effect on domestic dive demand given the bias towards the international sub-sample illustrated in Table 5.

Table 5: Semi-elasticities[10], percentage change in dives per year with US$1 increase in cost per dive[11]

Pooled sample	-0.170%
International sub-sample	-0.173%
Domestic sub-sample	-0.757%

Similarly, a uniform user fee across the three countries would mostly be a reflection of the Indonesian dive demand, which has a consumer surplus most identical to the pooled estimate.

[10] Semi-elasticities were used rather than elasticities because user fees are assumed to be introduced as a dollar value rather than a percentage value. Hence, semi-elasticities would help illustrate the percentage change in dive demand per dollar increase in travel costs induced by a potential user fee.

[11] These semi-elasticities were based on results of the TNBREG models for all three variants and estimated with gender=1 (males) and university education=1 to capture the majority proportion of the samples. For the pooled sample, the dummy variables for diver origin and dive country we maintained at proportional values (non-integer).

A uniform user fee would cause the largest decrease in dive demand for Malaysia, followed by Indonesia and the least effects on Thailand. Implementing a user fee that fits these estimated consumer surplus values accordingly can ensure that a sufficient user fee is implemented without affecting tourism revenue. In addition, the effects of the user fee in each country could further exacerbate the decrease of visits from domestic divers since a user fee would represent a larger proportion of their travel costs compared to international visitors. This is especially detrimental for diving in Malaysia where almost 40% of divers are locals.

Hence, the implementation of a user fee for conservation efforts would require further analysis into the appropriate balance of sufficient management levy and its potential impacts on dive demand and tourism revenue for the various heterogeneous groups.

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