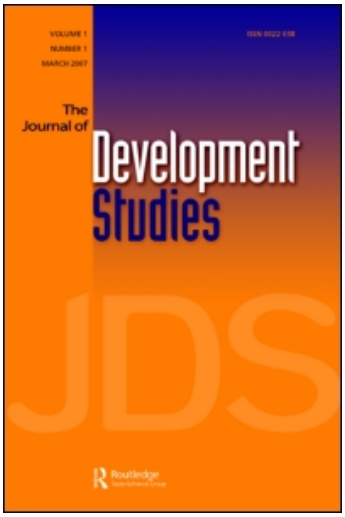

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The Balance of Power in Rural Marketing Networks: A Case Study of Snake Trading in Cambodia

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ABSTRACT *Producers in small-scale rural markets often receive unfavourable prices for their goods as a result of more powerful market participants. This study uses a combination of price analysis and interview data to assess the position of snake hunters in the aquatic snake market from Tonle Sap Lake in Cambodia. Despite the hunters' dependence on intermediary traders for market access and credit, the evidence implies that they are not powerless participants. Intermediary traders operate under high competition as a result of the increasing scarcity of snakes and therefore, despite interlocked credit and snake markets, offer relatively high prices to hunters.*

I. Introduction

Trade in developing countries is typified by an elaborate market network in which numerous actors are involved in the transfer of goods from producers to final consumers. Market structures in developing countries, particularly in rural areas, are often characterised by high levels of imperfection whereby numerous small-scale producers hold weak bargaining power and are vulnerable to exploitation by small numbers of intermediaries or final users (Ellis, 1992). Such a view has been used as justification for interventions aimed at improving the terms on which the poor participate in markets and protecting them from parasitic traders (IFAD, 2001; Pokhrel and Thapa, 2007). One characteristic of small-scale rural market systems is that prices are not publicly announced and contracts are oral and informal, with no means of legal enforcement, thus allowing assertion of power through dishonesty

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over market prices (Gabre-Madhin, 2001). Within both the fisheries and agricultural sectors, access to formal credit by the rural population is limited. Poor producers are therefore often compelled to obtain credit informally from traders, which can incur hidden costs through unfavourable prices for their goods (Smith et al., 1999; Sahu et al., 2004; Neilson, 2007). It is, however, becoming increasingly recognised that intermediary traders play an important role in facilitating and financing trade, and that they themselves operate under uncertain and risky market conditions (Belcher and Schreckenberg, 2007; Biles et al., 2007; Pokhrel and Thapa, 2007).

Analysis of market structure can be used to improve market efficiency and distributional outcomes, and also to determine the scope for conservation action based on market regulation. Interventions to improve the efficiency of markets for environmental goods and services can equally address both poverty reduction and natural resource conservation. Among the market-based development initiatives in poverty reduction programmes related to natural resources, are those that certify environmental and social characteristics of a production process (Matursbaugh, 2005; Klooster, 2006). Fairtrade is one such initiative, aimed at regulating the terms of exchange between actors in the global market chain, of which coffee production is the most famous (Linton et al., 2004; Leigh Taylor et al., 2005). The ability of such market-based certification schemes to work in favour of the producers is often undermined by powerful actors, such as retailers. In order to direct appropriate market-based instruments for sustainable and ethical production in many market systems, an understanding of market structure, the power relationships and nature of informal agreements between the actors in the market chain is needed.

The ability of countries to trade environmental goods and services is strongly linked with economic development and poverty reduction (Doney and Wroe, 2005). Of growing recognition is the trade in wild species, with an increasing number of articles highlighting their importance to the livelihoods of the rural poor. While capture fisheries for food is the most significant (Allison and Ellis, 2001; Béné, 2003), many niche products from wildlife can make locally significant contributions to development. These benefits are often localised and difficult to estimate, but there is a growing literature on the value of non-timber forest products (NTFP's) (Belcher et al., 2005; Burgener, 2007) and the importance of a well-managed wildlife trade for supporting livelihoods (Roe, 2008). The small-scale commercialisation of bushmeat and wild foods, for example, was shown to provide a vital source of income for rural households living in extreme poverty in West Africa (De Merode et al., 2004; Cowlishaw et al., 2005a); while the trade in live reef fish for both food and marine ornamentals has been shown to support large fishing populations in the Indopacific (Pomeroy et al., 2004; Vincent et al., 2007) as well as in Amazonia where it was estimated that around 10,000 people earn income from the trade (Moreau and Coomes, 2007, 2008).

Within many Southeast Asian countries, the levels of domestic and international trade of natural resources is, however, contributing to a loss in the abundance and diversity of species, therefore negatively impacting the rural poor who depend on them (Donavan, 1999; Lee et al., 2004; Rigg, 2006). Therefore, there is a need to understand how markets for these resources operate and how they are, or could be, benefiting the poor. Cambodia is one of the poorest countries in Southeast Asia and one that, following more than two decades of conflict, has recently emphasised a

market-based economy, with revenue derived from exports increasing dramatically. With such a large natural resource-dependent population, there are concerns that the benefits of trade to those extracting the resources may be small.

On Tonle Sap (the Great Lake), Cambodia, there has been a massive expansion in the trade of fish and other resources. Domestic markets for fish are well-established and there is a growing export industry (Rab et al., 2005). These export markets have diversified and include not only fresh and processed fish from capture fisheries, but also farmed crocodiles and wild-caught snakes. The development of the aquaculture and crocodile export industry has also increased the level of domestic trade of low-value aquatic resources for use as food for farmed fish and crocodiles (So et al., 2005). The use of water snakes as crocodile food has given rise to the 'world's largest snake hunt' with an estimated seven million snakes being caught each year (Brooks et al., 2007). There are growing fears that this activity is unsustainable, with severe declines in catch sizes now being reported (Brooks et al., 2007). Previous work has also demonstrated the high importance of snake hunting to the poorer households in floating communities on Tonle Sap, for whom it represents a significant source of income at a time of year when few alternatives exist (Brooks et al., 2008).

Recent studies of the market infrastructure for the fishery resources from Tonle Sap Lake have highlighted the inefficiency and inequity of the supply chain that results from high transaction costs, power imbalances and a lack of accessibility of market information (Foran, 2005; Rab et al., 2005). Both studies commented that Tonle Sap fishers are often in a weakened position whereby they have no choice but to sell their catches at unfavourable prices to intermediary traders who possess the market power. As it is the same fishers who also hunt snakes and the same fish traders who also trade snakes, it might be expected that such power relations also exist in the snake marketing chain.

In this paper, we examine the structure of snake markets in Cambodia with a particular focus on the position of the small producers: the snake hunters, relative to intermediary traders that transport the snakes to landing sites. Using information from interviews with market actors, we describe the structure of the snake market. Price data collected at different nodes of the market is used to explore first, the magnitude of seasonal and yearly variations in price; second, the effect of distance from markets on price; and, finally, marketing margins and the relative market power of producers and intermediary traders. The paper then discusses the information on non-price aspects of the snake market, including the effect of resource scarcity and the role of interlocked credit and snake markets. Understanding the balance of power between snake hunters and traders allows us to test the prediction that hunters are weak participants who are subject to exploitation by more powerful actors. This information can aid in the development of market-based intervention for the management of Cambodia's snake fishery, while broadening our understanding of power relations in small-scale market networks.

II. Fieldwork and Data Collection

Tonle Sap Lake, located in central western Cambodia, is the largest lake in Southeast Asia. It is connected to Phnom Penh and the Mekong River by the Tonle Sap River.

Each year during the southwest (SW) monsoons, as a result of the rising waters in the Mekong, the Tonle Sap River reverses direction and floods an expanse of forest, grassland and agricultural land surrounding the lake. The production and availability of fish and other aquatic resources are driven by this annual flood pulse and are therefore highly seasonal.

Four distinct markets for Tonle Sap snakes were identified: crocodile food, human snack food, skins as leather, and live export. The crocodile farm industry generates the biggest demand, consuming around 90 per cent of the total number of snakes traded (Brooks et al., 2007). A small but growing trade exists for human food, in which they are predominantly used as snack food. The international trade in snakeskins and live snakes, although small in comparison to the crocodile food trade, is of potentially equal or higher value as they supply luxury markets. Most are exported to Thailand, Vietnam and China, and in the case of skins, they are eventually traded worldwide as part of the exotic leather trade (Zhou and Jiang, 2004). During times of low fish abundance on Tonle Sap, snakes contribute to household food consumption for people living on the Lake, but they are not considered a significant part of the diet. The four trades do not operate entirely independently. Although driven by different markets with differing patterns of demand, many of the same actors are involved in the various chains, particularly at the producer end.

This study focused on the north of the lake in Siem Reap and Battambong provinces, where we collected information on snake markets through various methods outlined in the following paragraphs. Given its dominance, we have focused on the crocodile food trade. Prices were recorded at different actor levels. Hunter price refers to the price paid to hunters and these data were primarily collected as part of the catch monitoring programme carried out in Battambong province, where the majority of traded snakes originate. Details of this survey can be found in Brooks et al. (2007). The prices received for 1236 transactions for snakes sold as crocodile food between August 2004 and February 2007 were recorded. These data were collected at regular intervals of two weeks of data collection per month. As a result of the changing flood regime of the lake, hunting locations change throughout the year. The exact location of each transaction site was also recorded, using a handheld satellite Global Positioning System (GPS) device. The same method was used close to Chong Khneas port in Siem Reap province, to compare prices received by hunters who could access markets more directly, yielding 226 transactions for snakes sold between August 2004 and January 2006.

Trader price refers to the price paid to lake-based traders by land-based traders and was gathered at Chong Khneas, the main landing site in Siem Reap province where the majority of the lake's snakes are traded. The survey was conducted from June 2004 until March 2007 and was based on 24-hour monitoring on 124 survey days, providing a total of 912 transactions for snakes sold as crocodile food. These data were collected at regular intervals of one day per week. Further details of the survey methods are given in Brooks et al. (2007). Crocodile farm price refers to the price paid by crocodile farms and was taken from copies of feeding records that included the price of snakes, which we obtained from nine crocodile farmers in Siem Reap province between January 2005 and March 2006. This provided a total of 85 separate snake transactions.

Interviews with hunters were carried out both at the hunting ground, during the catch monitoring, as well as in the villages of Prek Toal, Anlong Taour and Kbal Taol in Battambong province where the majority of hunters and traders operating within this area live (see Figure 1). The latter formed part of the household surveys carried out in these villages between August–September 2005, and further details of these can be found in Brooks et al. (2009). These interviews were based on structured questionnaires and included information on whom they sold to and agreements and contracts with buyers.

The authors interviewed 37 traders at various stages in the snake market chains between June 2004 and December 2005: 20 in Battambong, six in Siem Reap, five

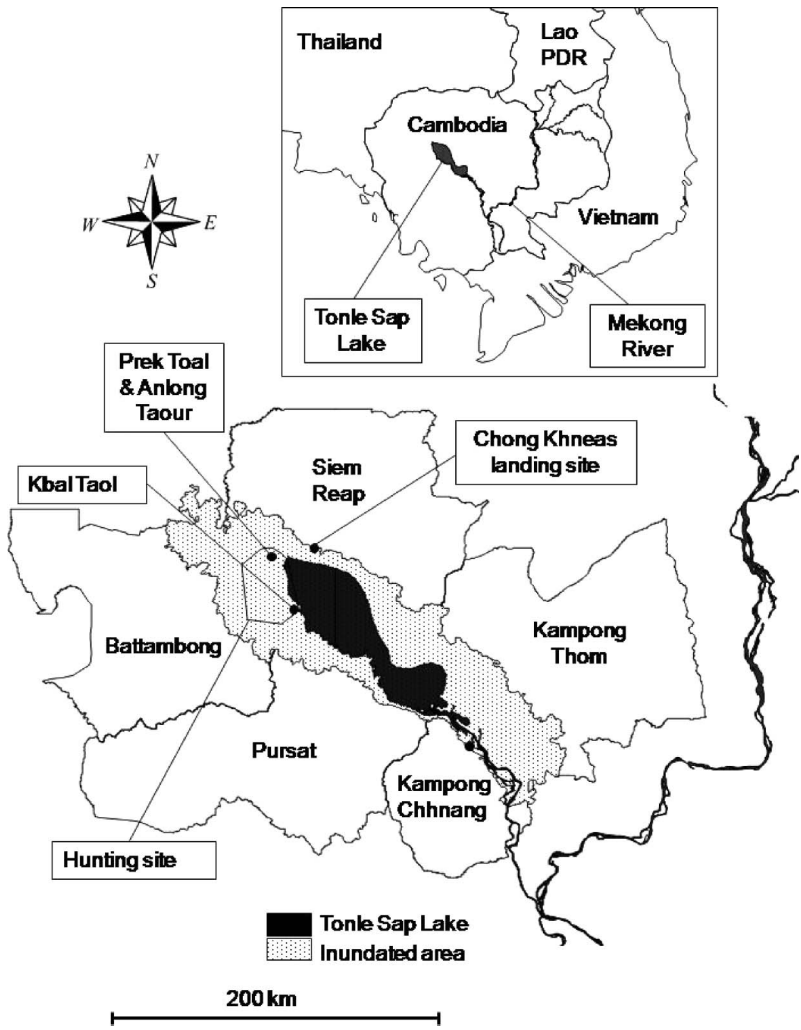

Figure 1. Map of Tonle Sap Lake, the inundated area and the boundaries of five of the provinces surrounding the lake. *Note*: The locations of Prek Toal, Anlong Taour and Kbal Taol floating villages, and Chong Khneas landing site are shown.

in Kampong Thom, three in Kampong Chhnang and three in Pursat province. These interviews were semi-structured and their content varied depending on how comfortable the traders were to talk to us and how much time they could spare. Interviews typically covered issues of who they buy from and sell to, the nature of agreements and contracts between buyers and sellers, quantities traded, changes in supply, competition between traders for supply and per unit mark-up prices.

Snakes are captured using a variety of techniques. Stationary gill nets, designed to catch fish by their gills as they attempt to swim through, typically catch smaller-sized snakes whereas baited hooks are used to target the larger-bodied snakes. Traps and hand capture are used to capture snakes alive. Only surface swimming snakes such as cobras and pythons are normally captured by hand. All of these activities are carried out primarily by hunters living on the lake, who typically own small canoes without an engine. Hunters, therefore, have limited access to land markets due to their distance across potentially rough water. Although snakes are sometimes consumed in poorer households when the price of fish is high, they are more often a source of income.

III. The Snake Market Network

The number of actors in the market chain ranges from two, where a hunter sells directly to a household for consumption, to up to seven actors with six transactions taking place. The former does not occur often, and is not covered in our analysis. The latter may be the case with the use of snakes as human food where the snakes may be sold on to market sellers and food stall owners before reaching the final consumer (see Figure 2). On the lake-based part of the chain the same actors are typically involved in all trade types. Some hunters may specialise in the species and size of snakes they hunt, depending on the fishing gear they own, but many will hunt all species and sizes. The lake-based traders will trade all species and sizes of snakes, along with many other aquatic products due to the high cost of transport around the lake. At the point where snakes are brought to land, there is a greater degree of specialisation among those trading the various kinds of fish, snakes and other aquatic resources.

Whether a hunter sells to itinerant traders based in the flooded forest, to traders in one of the floating villages on the lake or to a land-based trader, depends on where they live. Due to their limited mobility they typically sell to whichever is closest. Of the trade that arrives in Chong Khneas, less than one per cent comes directly from hunters. The majority of trade passes through one or two intermediary traders prior to reaching the landing site. Interviews with hunters in Prek Toal, Anlong Taour and Kbal Taol and the relative proportion of hunters at the hunting site from these villages, indicate that a relatively equal proportion of hunters sell to traders in the forest, and traders in the floating villages (see Figure 2). However, there was great variation between villages and times of year. For example, all hunters from Prek Toal and Anlong Taour will sell to forest-based traders during the high flood season due to the distance of the hunting ground from the villages at this time, whereas in Kbal Taol, the majority of traders can return home to sell to village traders for most of the year.

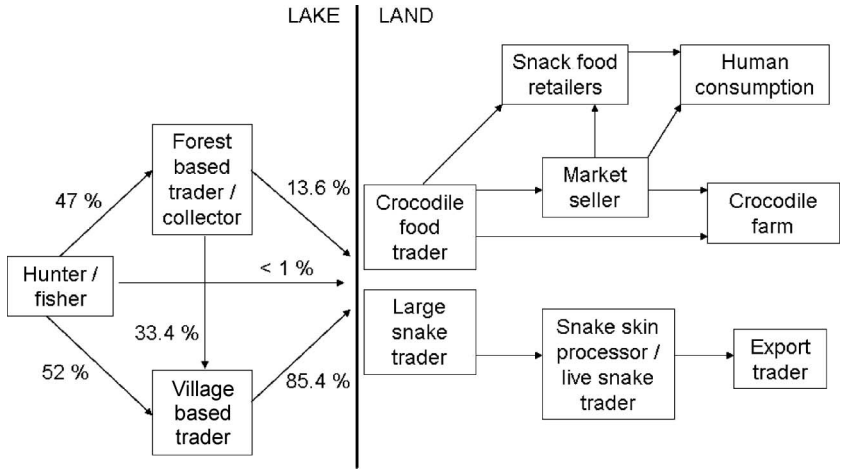

Figure 2. Snake market network based on trade passing through Chong Khneas, Siem Reap province. *Notes*: Percentages on the left hand-side of the diagram (the lake-side) represent the proportion of trade occuring in each direction based on interviews with various actors. At the lake-land interface, traders specialise in export markets for large-bodied snakes or domestic markets for crocodile or human food.

Of the five forest-based traders whom we interviewed, three sold to traders in the village, one transported the snakes directly to the landing sites, and one did both depending on the quantity of snakes. Both in villages and at landing sites, there are some traders who do not transport the snakes but provide holding facilities. However, 80 per cent ($n = 10$) of the village-based traders sold their supply to traders in landing sites and, within these landing sites, 89 per cent ($n = 9$) transported the snakes either directly to crocodile farms or to traders in other areas for separate trades such as supplying local markets, food stalls or skins processors and export.

The market is concentrated at the landing sites when snakes are sold to large-scale land-based traders. Of the trade that is routed through Chong Khneas port, 82 per cent is sold to just five individuals. The remaining amount is split between a large but unknown number of smaller-scale traders. The large-scale land-based traders supply the large crocodile farms directly but also sell to smaller traders or market sellers, depending on the quantity they receive and the demand from crocodile farms. The large-scale traders, therefore, control a large share of the market. While there are over 500 crocodile farms in Siem Reap Province being supplied by the trade in Chong Khneas, there is considerable variation in the size of farms with a few large farms (>200 crocodiles) containing a large proportion of the total number of captive crocodiles. These large farms therefore also control a large share of the snake market. The concentration of power in the snake market is most dispersed at the production end where there are estimated to be over 1000 hunters supplying the trade at Chong Khneas, with relatively little variation in catch size between hunters. Hunters therefore control a relatively small share of the market. The market chain for skins differs at the consumer end, such that the number of actors and, therefore, share of the market declines from hunter to trader to exporter. It is likely that this

market chain is even more concentrated at production facilities in other countries that may be buying from several exporters in various countries.

IV. Price Analysis

The price data were gathered from fieldwork carried out between July 2004 and March 2007 at different dates and at different nodes of the market network for snakes sold as crocodile food (lake, landing and crocodile farms). While, in some instances, only one price was obtained, on many days many prices for the same product were collected. Our main focus will be on the lower part of the market network, from the hunters to the landing site, as price information on the upper end (landing site to crocodile farms) is sparse. Figure 3 presents the mean monthly prices during the four years of the study.[1]

Price differences for the same product at the same time can be used to examine whether there are significant quality variations, or if the market is fragmented. If prices collected at the same time for the same product are very different from each other, the price data cannot be analysed as that of a single commodity. Alternatively, if markets are fragmented, the same product can have different prices in different segments of the market (Ray, 1998; Bardhan and Udry, 1999).

To examine the extent of variation in snake prices collected on the same day, the coefficient of variation of daily prices were calculated (excluding days where only one price was collected). The percentile distribution of the ratios is given in Table 1. The figures indicate that the dispersion of prices is quite small, particularly for hunters, but also for landing prices. In more than 70 per cent of the cases, for example, only a

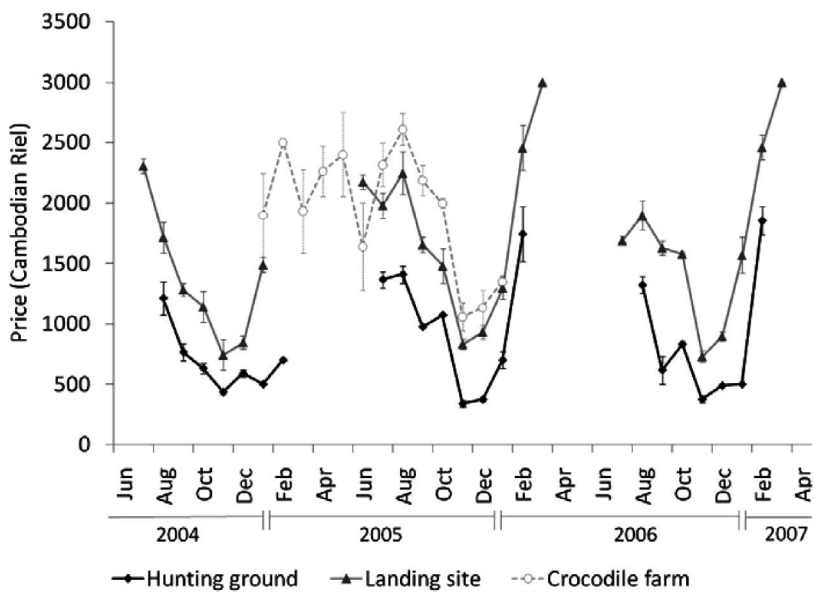

Figure 3. Mean monthly prices of snakes ± standard error at three transaction sites (hunting ground, landing site and crocodile farms).

Table 1. The coefficients of variation for snake price within a day at the three different market stages for each decile of the distribution

Percentiles	Hunters' price (%)	Landing price (%)	Crocodile farms (%)
10	0.0	0.0	3.9
20	0.0	2.1	11.0
30	0.0	5.0	17.8
40	0.0	7.5	23.1
50	0.0	10.5	28.3
60	0.0	13.2	32.6
70	0.0	22.7	34.7
80	8.9	59.3	38.4
90	15.1	87.1	44.7
100	51.2	139.8	51.4
No. of days with more than one price recorded	188	117	9
Total no. of days prices recorded	208	143	76

single hunter's price was observed in many transactions within a day. These results indicate that the price data are for the same quality of snakes, and that there is no or only a small degree of market fragmentation, particularly at hunting grounds and the landing site. Since the number of observations is small and their variation large, we do not depend heavily on crocodile farm prices in further analyses.

Annual and Seasonal Price Effect

The price data shown in Figure 3 indicate that there are significant variations. To analyse seasonal and yearly variation, regressions of snake prices (in logarithms) at hunting sites, landing site and crocodile farms with month and year indicator variables were carried out (Table 2). For the regression of the hunters' price, distance from the main landing site in kilometres (km) is also included as an indicator variable. There was significant seasonal variation in both prices at all three transaction sites, particularly for hunters' and landing prices. Using January as the reference month, both hunters' and landing prices are higher between February and October while dropping below the January levels in November and December. Interestingly, when prices are higher compared to January they increase at higher rates for hunters' than landing prices. However, when prices are lower in November and December, the rate at which they decrease is smaller for hunters' than landing prices (based on a comparison of the monthly coefficients for hunters' and landing prices). Even though detailed information on seasonal fluctuation of margins is needed to address the issue properly, these results imply that seasonal variations probably favour the hunters as compared to traders who receive the landing price. Nonetheless, landing prices exhibit an increasing annual trend, as indicated by the positive and significant coefficients for all years, which is only apparent in the year 2005 for hunters' prices. Interestingly, when monthly hunters' and landing prices decline, crocodile farm prices also decline, but in most of the other months when the two prices rise, with the exception of February and August, crocodile farm prices do

Table 2. Hunters', landing and crocodile farm snake prices regressed on distance, month and year indicator variables

Coefficient	Hunters price	Landing price	Crocodile farm price
(log) distance in km	−0.11* (0.06)		
February	0.99*** (0.14)	0.55*** (0.07)	0.33* (0.18)
March		0.75*** (0.05)	−0.006 (0.25)
April			0.20 (0.21)
May			0.25 (0.23)
June		0.41*** (0.05)	−0.18 (0.26)
July	0.66*** (0.10)	0.40*** (0.08)	0.20 (0.20)
August	0.95*** (0.09)	0.37*** (0.07)	0.36* (0.19)
September	0.39*** (0.10)	0.10* (0.05)	0.18 (0.19)
October	0.42*** (0.10)	0.013 (0.07)	0.10 (0.18)
November	−0.38*** (0.11)	−0.57*** (0.07)	−0.56*** (0.21)
December	−0.05 (0.10)	−0.42*** (0.06)	−0.48** (0.21)
2005	0.25*** (0.07)	0.19*** (0.05)	0.29 (0.18)
2006	0.083 (0.08)	0.13*** (0.05)	
2007	0.079 (0.12)	0.20*** (0.07)	
Constant	6.51*** (0.20)	7.08*** (0.06)	7.21*** (0.03)
Observations	140	143	76
R-squared	0.89	0.82	0.51

Notes: Robust standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1; snake prices are in logarithms; distance in km is from the main landing site; January and 2004 are the reference month and year, respectively.

not increase. This may imply that crocodile farms manage to protect themselves from seasonal price rises while enjoying the lower prices in November and December. There is also no annual trend in crocodile farm prices. Due to the relatively small number of observations at crocodile farms, these results must be treated with caution. Prices have not been controlled for inflation, as it is not the trends themselves we wish to highlight but the existence of annual and seasonal effects that we control for in further analysis.

Spatial Effects on Price

Location tends to have a significant impact on returns of economic activities. Producers near main markets have the location advantage of selling their products without incurring as much transport and transaction costs as those far away. In other words, they have the opportunity to enjoy location rent (McCann and Sheppard, 2003). This is particularly pertinent for perishable commodities. Hunters that live and hunt close to Chong Khneas landing site can sell their snakes directly to market sellers. Snakes traded in this way were detected by trade occurring from boats with no engine. These snakes were sold at a significantly higher price (1948 ± 70 Riels) than those sold by the lake-based traders in Chong Khneas (1624 ± 43 Riels), based on a paired t-test of monthly average prices received by each ($t_{10} = -3.2$, $P < 0.01$). This is possibly because the snakes would be fresher and could be sold for human rather than crocodile food at a higher price. These hunters are therefore able to enjoy the advantages of selling snakes on a higher value

commodity market. These snakes comprise less than 1 per cent of the snakes that arrive at Chong Khneas landing site (see Figure 2), and due to the fact that they are considered a different commodity are not included in the analysis presented in this paper.

Due to the remote location of the major hunting grounds, the majority of hunters rely on a lengthy market chain to transport their snakes to the markets and crocodile farms. Throughout the year, hunting locations change and vary in distance to the landing site and, therefore, the costs of transportation will also vary. As the cost of living and hunting at different sites is unlikely to change, the effect of location on prices received by hunters can illuminate their position relative to the intermediary traders. If traders hold more of the market power, they would be expected to extract all the location rent from hunting sites that are nearer to the landing site, Chong Khneas. Therefore, if this were the case, we would not expect hunters' prices to vary with distance to the main landing site. There was, however, a significant decrease in price with an increase in the distance of the hunting site from the landing site (see Figure 4). As prices have been shown to not vary considerably within a day (see Table 1), the effect of distance is occurring over time. Therefore, in order to explore this further, the distance of hunters from the main landing site, Chong Khneas, in km (transformed into logarithms) was included in the regression as reported in Table 2 to control for monthly and yearly effects. The coefficient indicates that a one percentage increase in distance results in a 0.11 per cent decrease in hunters' price. Although this relationship is not very strong,[2] this result indicates that snake hunters near the main landing site are benefiting from their location, rather than the traders extracting all the location rent. Information on transportation and transaction costs,

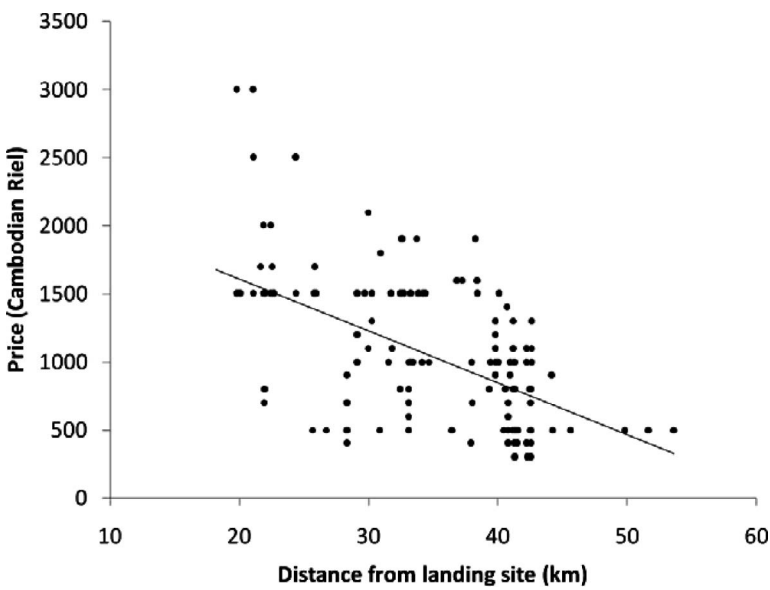

Figure 4. The effect of distance between hunting site and Chong Khneas landing site on the price of snakes (per kg) received by hunters. ($y = 0.038x + 2370.0$, $R^2 = 0.31$, $P < 0.0001$).

which was not available, would be needed to know if hunters capture the whole location rent, or just part of it.

Price Margins

The price margins of snake hunters and traders can also be used to indicate their relative strength in the marketing network. Ideally, information on the production and marketing costs at each level should be compared to the price margins to see if they reflect costs or market power. We do not have data on production and marketing costs but, if hunters were weak participants in the market network, we would still expect a low price margin for hunter price, relative to traders. Although price data have been collected between July 2004 and March 2007, all three prices (hunters', landing and crocodile farms) are only available for eight months since the collections were at different times (see Figure 3). Table 3 reports the average price margins, as a percentage of the final price paid by consumers, for hunters', lake-based and land-based traders for those eight months. Even though it is difficult to generalise from this small number of observations, there is no indication of consistently low or declining price margins for hunters. The price margins for hunters range from 26–60 per cent; the corresponding ranges for lake- and land-based traders are 19–52 per cent and 3–25 per cent.

While we do not know the actual marketing costs, based on interviews with lake-based traders boat fuel is the largest variable cost incurred. As the snakes are perishable and traders need to transport them to landing sites regularly, the cost per kilogram (kg) of snakes will depend on supply. Based on this premise, we would expect the marketing margin of lake-based traders to increase with a decrease in supply. As our data on final prices are sparse, we have calculated this margin as the difference between hunter and landing site prices. Based on monthly average prices, this marketing difference that represents the net profit of lake-based traders was positively correlated with the price paid at landing sites (Pearson correlation coefficient $R = 0.53$, $n = 21$, $P < 0.05$). This may be partly explained by the negative relationship between price and supply that was obtained by using weekly average snake price and quantity landed per day (Brooks et al., unpublished data). This

Table 3. Price margin of hunters and traders in the final (crocodile farm) price of snakes (%), calculated from the mean monthly averages shown in Table 1

Year	Month	Hunters' margin	Lake-based traders' margin	Land-based traders' margin
2005	January	26.32	52.15	21.54
2005	July	58.97	26.54	14.48
2005	August	59.63	26.53	13.84
2005	September	44.61	31.25	24.15
2005	October	55.00	19.06	25.94
2005	November	32.13	46.61	21.26
2005	December	33.03	49.53	17.44
2006	January	51.85	44.34	3.81

implies that when supply is low and price is high, the marketing margin increases to accommodate the increased cost per kg. However, these relationships between cost and quantity are likely to be confounded by the other commodities traded simultaneously by lake-based traders (such as fish). Nonetheless, this further supports the notion that marketing margins are not exploitative of powerless producers but driven, at least partly, by the costs of trading.

Timing of Price Changes and Market Power

The prices received by hunters correlate significantly with the prices received by traders, based on monthly averages ($R = 0.91$, $n = 21$, $P < 0.0001$), and the timing of these price changes can indicate market power held by each actor. If, in most cases, landing prices change first and then hunter's price follows, it would indicate that the land traders are leading price changes. To examine who is leading price changes at the lower end of the snake market network, we estimated a vector autoregressive model (VAR) using hunting ground and landing site snake prices. This is a linear model in which the dependent variable is regressed against its own lagged values, as well as the past and lagged values of another variable, and is widely used to analyse multiple time-series data (Stock and Watson, 2001). The idea here is to examine whether hunters' prices are changing after landing prices have changed in the past, or vice versa. The Granger causality test provides a formal procedure to examine which price change is leading. Since we do not have complete information on hunters' and landing snake prices for the 33 months between July 2004 and March 2007, the missing values were imputed.[3] For imputing the missing values, the regression of prices on monthly and yearly indicator (dummy) variables were used. Due to the high fit[4] of the regressions and the relatively low proportion of inputted values, the prediction errors of the missing values are expected to be low.

To avoid the possibility of basing our results on spurious regressions, first we tested if the hunters' and landing prices are non-stationary processes (random walk) using the Augmented Dickey-Fuller (DF) unit root tests. Three types of random walk were considered: random walk without drift, random walk with a drift and random walk with time trend. The DF statistics for the three respective cases, when the prices are taken as they are in levels (without differencing them), are provided in the Appendix. Even though the null hypothesis of non-stationarity is rejected in the two cases – with a drift and time trend – it is accepted in the case of 'without a drift' at a 5 per cent level of significance. Hence, there is sufficient reason to be suspicious that using the prices in levels will lead us to spurious regressions.

The next set of DF statistics tested if the price differences – monthly price changes – are stationary. These statistics can be found in the Appendix and show that the null hypothesis of non-stationarity is strongly rejected in all cases. Hence, the VAR is based on the monthly price changes rather than the price levels.

The vector autoregressive model estimated here is of the following form:

$$\Delta P_t^h = a + \sum b_j \Delta P_{t-j}^h + \sum c_j \Delta P_{t-j}^l + u_{1t}$$

$$\Delta P_t^l = d + \sum e_j \Delta P_{t-j}^h + \sum g_j \Delta P_{t-j}^l + u_{2t}$$

where ΔP_t^h and ΔP_t^l are hunters and landing price changes at month t respectively, ΔP_{t-j}^h and ΔP_{t-j}^l are the same price changes but with j months lag, a, b, c, d, e and g are constants to be estimated and u_{1t} and u_{2t} are error terms in the two regressions. The estimated coefficients for the vector autoregressive model (VAR) with two, three, four or five month lags can be found in the Appendix.

Diagnostic tests for the estimated vector autoregressive models support the validity of the estimates and all the test statistics for autocorrelation, normality, skewness and kurtosis indicate that the assumptions have not been violated. Five months is the optimal lag selected according to all the statistics: log likelihood, likelihood ratio statistics, final prediction error, Akaike information criterion, Hannnan Quinn information criterion, and Schwarz's Bayesian information criterion. The eigenvalues also indicate that the stability condition is satisfied. In addition, the chi- and r-squared values for each regression – with the exception of only one chi-square – show the existence of significant correlations between the prices.

After the estimation of the vector autoregressive models, Granger causality tests were conducted to see which prices are leading the changes; the results for two, three, four and five lags are given in Table 4. If the lagged values of price x can statistically significantly predict price y, price x is said to 'Granger cause' price y. The results in Table 4 indicate that, in all cases, the hypothesis that changes in the hunters' prices does not Granger-cause changes in landing price is decisively rejected. On the other hand, the hypothesis that changes in landing prices do not Granger-cause hunters' prices is accepted in one out of four cases (with two lags). The results imply that general changes in hunters' and landing prices are co-determined, meaning that sometimes changes in hunters' prices and at other times changes in landing prices lead. The price received by the hunters is not only responding to changes in the price at the main landing site, but at times it is leading these price changes.

V. Supply and Institutional Issues

Out of 17 traders who reported temporal trends in the number of traders in their area, 12 reported an increase. Of the four that reported a decrease, three were from

Table 4. The effect of monthly lagged price changes on hunters' and landing price changes based on Granger causality Wald tests for vector autoregressive models with different lags

Lags	Dependent	Independent	Chi-sq	df	Prob > Chi-sq
2	Hunters' price	Landing price	1.70	2	0.428
	Landing price	Hunters' price	15.20	2	0.000***
3	Hunters' price	Landing price	21.35	3	0.000***
	Landing price	Hunters' price	16.07	3	0.001***
4	Hunters' price	Landing price	16.82	4	0.002***
	Landing price	Hunters' price	15.88	4	0.003***
5	Hunters' price	Landing price	52.52	5	0.000***
	Landing price	Hunters' price	42.33	5	0.000***

Note: ***p < 0.01, **p < 0.05, *p < 0.1.

different geographical areas to where increases were reported, where we were told there were no longer enough snakes to trade. These reports indicate that competitive pressures are likely to be high among traders in the study area. The competition between traders for supply may be further exacerbated by the increasing scarcity of the resource. There were consistent reports that the amount of snakes available to trade is declining. Of the 19 traders who mentioned temporal trends, 95 per cent stated they now trade less than in previous years. These declines were apparently not due to an increase in the number of traders but due to fewer snakes caught per hunter. One trader we spoke to who stopped trading in 2005, told us:

> I could no longer afford to trade snakes as the hunters could not collect as many. Most of the original traders have also stopped due to the decline in their numbers. They all gave loans to the hunters but the hunters could not find many snakes and could not pay them back, so they gave up. (Interview ID: MM4)

The decline in snakes reported here by traders is supported by hunters who perceived a decline of around 80 per cent over a five year period (Brooks et al., 2007). Forest and village-based traders are often hunters themselves who have managed to get into an only slightly better position in order to trade. Therefore, they are vulnerable to becoming hunters once again if unsuccessful in making a profit through trade.

Out of 50 hunters interviewed, 68 per cent were in debt to a trader to whom they had to sell their catch. Of the 14 traders who buy directly from hunters, 71 per cent have an agreement with hunters to whom they have loaned money or provided a gill net in return for securing a supply of snakes. Of the hunters that had taken out loans for fishing gear alone, 77.3 per cent had such an agreement, whereas 22.7 per cent paid interest at a mean ($\pm$SE) rate of 5.4 $\pm$ 1.5 per cent per month, compared to a significantly higher interest rate of 15.8 $\pm$ 3.1 per cent per month paid on loans given to hunters for other purposes (t-test: $t_{23} = 3.04$, $P = 0.006$). Of traders that buy from other traders, 57 per cent have some form of agreement, which is, in some cases, also in the form of a loan. The interest rates of these loans are unknown. Credit markets are therefore interlocked with snake markets such that the interest on credit loans, or part of it, is negated in turn for selling their snakes exclusively to the provider of the loan. Out of 29 hunters who had such an agreement, eight informed us that they had to sell their catch at a low price. The interlocking of product and credit markets often strengthens the position of traders within the market network (Bardhan and Udry, 1999).

Four traders also referred to the use of territories which were either entire villages or areas of hunting ground within which traders would operate. If other traders arrive within their area, these other traders would not be able to purchase fish or snakes. As one trader told us: 'There are closer places that have snakes but I cannot buy them as in these places there are other traders who buy all the resources' (Interview ID: MM10). In some circumstances, traders will tow hunters to hunting grounds as part of this agreement. Another form of agreement involves trading with relatives. We spoke to two forest-based traders who were related to a number of the hunters who sold to them, and they were confident they would secure a supply due to these relationships.

There were, however, reports of agreements between different actors being broken. One trader who collects snakes from hunters in the forest told us: 'I loaned money to

hunters, but they broke their contract. When I go to the forest to buy snakes, the hunters change their location so I can't find them' (Interview ID: MM30). Such allegations are reported throughout the market chain. One of the main traders in Chong Khneas (Interview ID: MM17), who buys from smaller lake-based traders, claimed that traders who are under an agreement to sell to her, now sell to other traders who come from other areas and buy from them at a slightly higher price before they arrive at the landing site.

While carrying out catch monitoring we observed a stand-off in the forest, where hunters collectively refused to sell their catch to the trader until a fair price was offered. This is an indication that collective action by hunters probably plays an important role in the balance of power in the snake marketing network.

While interlocking of credit and snake markets and the practice of territorial division of villages by traders decrease competition and probably strengthen the power of traders, the increase in the number of traders over time, the scarcity of snakes, problems of contract enforcement and collective action by hunters probably have the opposite effect.

VI. Rural Development Through Market-Strengthening

Our findings indicate that a balance of power exists between the snake hunters and the intermediary traders that they sell to. Far from being exploitative, these traders are playing an important role in the marketing of snakes from Tonle Sap Lake, financing trade for hunters that would otherwise be unable to participate. Our analyses of price trends have shown that, despite the interlocking of snake and credit markets, changes in the final price of snakes and costs of trading are reflected in the price received by hunters, and that prices are co-determined by both hunters at hunting grounds and traders at landing sites.

Although snake catches are perishable, which has been linked to the low bargaining power of producers in other systems (Perry, 1986; Jaleta and Gardebroek, 2007), traders are equally dependent on a sale, to at least cover their costs of travelling to the forest. Additionally, if they do not offer fair prices, hunters can break agreements and sell to other traders, perhaps not on the current but on future transactions. Due to the increasing scarcity of the resource and the threat of terminating future trade through a bad reputation, it becomes beneficial to traders to be honest about market prices – the importance of reputation being a solution to what would otherwise be a prisoner's dilemma (Grabowski, 1998). Although hunters depend heavily upon traders for credit to purchase fishing gear, as well as market access, traders are unable to assert complete control over the hunters and experience high transaction costs due to these non-binding agreements. While it is possible that a less equitable share of market power exists further up the market chain where wealthier and more powerful actors are involved, our interview data suggest that traders are competing for a supply throughout the market network, and thus have weakened bargaining power.

This is contrary to what is often observed within the agricultural sector, where competition between producers for buyers is prominent, resulting in the small-scale producers being unable to sell their produce at a profitable price and integrate into the market (Ellis, 1992). It is also often thought that fishers operating in many

traditional fisheries are in an equally weak position, whereby traders acquire control through the establishment of credit relationships and fishers are therefore only able to access the market on unfavourable terms (Ahmed and Capistrano, 1997; Hapke, 2001; Gine and Klonner, 2002). This situation has been widely referred to in Cambodia, where financial dependency is often used to secure a supply for traders (CFDO, 2005). Along with a lack of transparency and information transfer through the market chain, this has been highlighted as a major reason why markets are failing the poor (Chea and McKenney, 2003, 2004). However, our study indicates that the existence of interlocked credit and commodity markets does not allow traders to exert control, but is more often a necessary arrangement to finance and secure a supply for traders that operate within risky and uncertain conditions.

This crucial, non-exploitative and often risky role of intermediary traders has been highlighted in other studies of rural market networks. In the Lower Mekong Basin, it has been highlighted that fishers, farmers and traders are all equally dependent on their ability to secure a supply, and it is often the traders that absorb a considerable amount of the financial risk existing in the market (Bush and Minh, 2005). In the bushmeat trade in Ghana, traders were shown to receive the smallest share of the final sales price of all actors involved and hunters the greatest (Cowlishaw et al., 2005b), and the 'fish for sex' transactions that occur between petty fish traders and fishers in Zambia highlights the significantly weakened position of traders that results, in part, from competition for supply (Merten and Haller, 2007; Béné and Merten, 2008).

A common perception within rural market systems is that of asymmetric flow of knowledge of the market, whereby producers know far less of demand than consumers know of supply (Aleem, 1990; Gorton et al., 2006). Such incomplete information has been shown to lead to bargaining inefficiency and to those with more knowledge (the buyers) receiving a greater share of the marketing margin (Cramton, 1984). Although this is likely to exist to some extent in the Tonle Sap snake trade, we found that information transfer on market prices for snakes was accelerated by an extensive mobile phone network, the diversity and abundance of intermediary traders, some of whom were related to hunters, and the cooperation and sharing of knowledge between hunters at the point of sale. While in agricultural systems it has been shown that buyers will set relatively low initial price offers when sellers have no information on central market prices (Jaleta and Gardebroek, 2007), we found that because of the fierce competition for supply between traders on Tonle Sap, there was little room for dishonesty over market prices.

Market interventions often work to restructure market chains and to redistribute marketing margin to the benefit of the poor and marginalised producers, by reducing trading inefficiencies and loss of revenue (Ellis, 1992). It has been documented that trading fisheries resources in Cambodia are subject to high costs. Work by Chea and McKenney (2003, 2004) showed that, of gross profit, 33 per cent was lost in the form of fees (landing, transport and export) and 53 per cent to expenses such as transport and storage. It has, therefore, been acknowledged that there is a need to reduce these costs through improved trade infrastructure to improve efficiency of the supply chain for the benefit of all (Rab et al., 2005). Our work has shown that, due to the numerous and competing traders and the balances of power described above, these interventions are likely to filter down to the hunters themselves, resulting in raised incomes.

Other forms of intervention aim to increase the revenue derived by producers, by strengthening their position in the market network. They include the provision of credit with competitive interest rates, increasing the flow of information over market prices and setting up cooperatives, thus allowing producers to have more control over price (Ellis, 1992; Rab et al., 2005). The intervention that may be of relevance to Tonle Sap is the provision of credit, which could theoretically weaken the power of traders that occurs through the interlocking of credit and commodity markets. However, due to the competition already existing in the market network, the impact of such initiatives to increase the power of hunters within the market and increase the prices they receive is unlikely to be as substantial as assumed. Nonetheless, such strategies are likely to increase the flexibility of hunters' livelihood strategies and help to prevent their decline into negative debt cycles that often result from loans with non-competitive interest rates.

In the context of widespread decline in a number of wildlife and fisheries resources, the notion that the increase in scarcity of a resource strengthens the position of small-scale producers in rural market systems has wide applicability. This situation is to be expected in a range of circumstances where global trade is dependent on small-scale producers in remote rural locations, like the non-timber forest products trade (Neumann and Hirsch, 2000), fisheries (Kurien, 2005), and aquarium fish (Moreau and Coomes, 2006), as well as in domestic markets such as that for bushmeat (Cowlishaw et al., 2005b). These markets are known to be fairly substantial and represent a significant source of income for many marginal and poor people (Beck and Nesmith, 2001; Béné, 2003; De Merode et al., 2004; Rigg, 2006).

VII. A Snake-Eye's View of Rural Marketing Chains

Trade is largely unregulated in many markets for wildlife products, and there are strong concerns that many natural resources are being extracted at unsustainable rates. There is currently no effective legislation or enforcement governing the use of Tonle Sap snakes. Given the apparent increase in scarcity of this resource, some form of intervention may be required to reduce the extent of exploitation and/or protect the resource (and revenues gained from it) through other means, such as habitat protection. While increasing the revenue of hunters may provide a means for people to move into other livelihood activities, resulting in a reduction in pressure, this could also give rise to what is known as the 'honeypot effect', where in the absence of some kind of limited entry scheme or other form of exclusive access or property rights, more people may be attracted to the trade. Interventions to increase the profitability of hunting, for example through increased per unit profits, may therefore need to be coupled with those to limit the extent of exploitation.

Market structure information can be used to identify the best entry point for interventions to reduce supply or demand of wild species considered at risk from over-exploitation. The most efficient way of intervening in the trade of snakes, whether through seasonally restricting their use, or restricting the use of certain sizes or species, is to target the small actor groups with the largest *per capita* share of the market power and those that are easy to access (Cowlishaw et al., 2005b). For the crocodile food trade, this would be the large-scale traders that are based at landing sites, and for the export trades, the exporters or potentially the production facilities in the import countries.

VIII. Conclusion

Despite being interlocked with credit markets, the market for snakes from Tonle Sap Lake in Cambodia appears to be relatively competitive, at least at the lower end between the hunters and the intermediary traders. This is likely to be the result of increasing scarcity of snakes such that traders are competing for a diminishing supply and are therefore unable to obtain control of the market. Market interventions at the consumer end of the chain, such as increasing the value of the product or decreasing the costs of trade are therefore likely to filter down and result in a higher price being paid to the hunters. The snake trade provides an important source of income for a large number of poor households and increasing this revenue, through reducing the costs of trade, may make a significant contribution to poverty reduction in the area. Such intervention, however, needs to be coupled with efforts to address the decreasing availability of the resource that is itself driving the competition in the market network. Otherwise, efforts to reduce poverty through market interventions are likely to further deplete the resource base and compromise the livelihoods of future generations of people living on Tonle Sap.

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Notes

1. The average exchange rate for the duration of the study was 4152 Cambodian Riel/USD.
2. The coefficient is significant at 10 per cent level of significance.
3. The number of missing prices replaced with imputed values is 11 and 7 for fishers' and landing prices, respectively.
4. The corresponding r-squared for fishers' and landing prices were 0.73 and 0.81, respectively.

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Appendix

Table A1. Augmented Dickey-Fuller tests for stationarity of hunter's and landing prices (for levels and differences)

	In levels			In differences		
	Without drift	With drift	With time trend	Without drift	With drift	With time trend
Hunters' prices	−1.795*	−4.953***	−4.879***	−7.976***	−7.850***	−7.715***
Landing prices	−1.225	−3.622***	−3.577**	−5.061***	−4.969***	−4.866***

Note: The null hypothesis is the processes are I(1), that is, non-stationary. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A2. The effect of monthly lagged price changes on current price changes of hunters' and landing prices based on a vector autoregressive model (VAR) with two to five lags

	Two lags		Three lags		Four lags		Five lags	
Coefficient (SE)	Hunters' price	Landing price	Hunters' price	Landing price	Hunters' price	Landing price	Hunters' price	Landing price
Hunters' price								
Lag 1	−0.469**	0.609***	−0.393***	0.656***	−0.288	0.589**	−0.272**	0.746***
	(0.18)	(0.20)	(0.15)	(0.21)	(0.19)	(0.25)	(0.13)	(0.20)
Lag 2	−0.383*	−0.167	−0.209	−0.0595	−0.261	−0.219	−0.376**	−0.616***
	(0.20)	(0.22)	(0.19)	(0.27)	(0.20)	(0.27)	(0.15)	(0.23)
Lag 3			−0.266	−0.137	−0.385*	−0.367	−0.582***	−0.485**
			(0.17)	(0.23)	(0.20)	(0.26)	(0.14)	(0.22)
Lag 4					−0.130	−0.446**	−0.309**	−0.486**
					(0.17)	(0.23)	(0.14)	(0.22)
Lag 5							−0.670***	−0.523***
							(0.12)	(0.19)
Landing price								
Lag 1	0.194	0.0276	−0.0994	−0.138	−0.0960	−0.142	−0.261***	−0.282*
	(0.15)	(0.17)	(0.14)	(0.19)	(0.14)	(0.18)	(0.097)	(0.15)
Lag 2	0.0524	−0.377**	0.145	−0.330**	0.244*	−0.283	0.205**	−0.301**
	(0.14)	(0.15)	(0.12)	(0.16)	(0.14)	(0.19)	(0.094)	(0.14)
Lag 3			−0.501***	−0.273*	−0.458***	−0.119	−0.600***	−0.445***
			(0.12)	(0.17)	(0.13)	(0.18)	(0.11)	(0.16)
Lag 4					0.205	0.0936	0.398***	0.333**
					(0.15)	(0.20)	(0.11)	(0.17)
Lag 5							−0.0338	−0.531***
							(0.11)	(0.16)
Constant	−11.54	16.58	−6.169	21.02	−5.993	22.26	24.20	39.10
	(86.8)	(94.0)	(66.9)	(91.5)	(66.8)	(89.2)	(46.1)	(70.7)
Chi-square	7.30	23.92***	35.77***	29.14***	39.81***	35.95***	123.47***	79.26***
R-squared	0.19	0.43	0.54	0.49	0.57	0.55	0.81	0.73
Observations	32	32	31	31	30	30	29	29

Note: Standard errors are shown in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.