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LIVESTOCK AS INSURANCE AND SOCIAL STATUS. EVIDENCE FROM REINDEER HERDING IN NORWAY

Anne Borge Johannesen
Anders Skonhoft

Department of Economics

Norwegian University of Science and Technology
N-7491 Trondheim, Norway
www.svt.ntnu.no/iso/wp/wp.htm

Livestock as insurance and social status.

Evidence from reindeer herding in Norway

By

Anne Borge Johannesen* and Anders Skonhoft

Department of Economics

Norwegian University of Science and Technology

NO-7491 Trondheim

Norway

Abstract

The theory of livestock as a buffer stock predicts that agropastoralists facing substantial risks typically will use liquid assets, such as livestock, for self-insurance to smooth consumption. This paper examines this hypothesis for reindeer herders in Norway where the herders, in contrast to pastoralists in, say, Sub-Saharan Africa, face well functioning credit markets. Using survey data including slaughtering responses to a hypothetical meat price increase, we test whether keeping reindeer as insurance against risks affects the slaughter response. Furthermore, we study whether status motives for keeping large herds affect the harvest response to a changing slaughter price. As a background for the empirical analysis, a stochastic bioeconomic model describing Saami reindeer herding is formulated.

Key words: insurance, pastoralism, social status, uncertainty

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* Corresponding author e-mail: anne.borge@svt.ntnu.no

1. Introduction

In many semiarid low productive areas, like the Sahel zone in Sub-Saharian Africa, livestock raising is the dominant type of agricultural production (e.g., Barfiled 1997 and Fafchamps 1998). This is also so in many cold alpine areas in Northern Europe and elsewhere (e.g., Austrheim et al. 2008). Because of low vegetation productivity and strong seasonable growth variations, the utilization of such areas often takes place through a system of nomadic pastoralism where the livestock are moved around to different locations to match spatial and seasonal vegetation growth variations (see e.g., Binswanger and McIntire 1987 for studies of semiarid tropics; Chang and Tourtellotte 1993 for examples from Balkan and Southern Europe; and Johannesen and Skonhoft 2009 and the references therein for evidence from Scandinavia). Hence, migration of livestock and people in such environmental surroundings may be seen as a direct response to vegetation shortages. Furthermore, because pastoralists in such settings are subject to frequent environmental shocks, migration may also provide an effective insurance mechanism against spatial vegetation shortages. Nomadic behaviour is, however, not the only way of coping with such risk. As possible vegetation scarcity involves the prospect of a sudden dramatic decrease in livestock holdings, pastoralists may also manage risk through livestock accumulation, especially were credit and insurance markets are weak, or even nonexistent (e.g., Doran et al. 1979; Binswanger and McIntire 1987; Perrings 1994; Fafchamps 1998; McPeak 2004).

The *size* of the livestock herd may therefore be an important insurance asset. In many nomadic societies, as well as in pastoral and agropastoral communities with less mobile herds, the herd size can also provide other important non-marketed benefits. For instance, in traditional pastoral societies the herd size is often of importance for cultural reasons, as well as an asset signalling social status (Walker 1993; Perrings 1994; Dasgupta and Mäler 1995;

Fafchamps 1998; Fraser and Chisholm 2000). The benefit pastoralists derive from such non-marketed, or non-consumptive, values may clearly lower the marginal utility of the livestock offtake relatively to livestock inventory and hence, result in larger herds and higher grazing pressure compared to situations when such non-marketed values are absent (e.g., Perrings and Walker 1995). Furthermore, in presence of non-marketed benefits, higher meat price may lead to lower harvest and hence, increased rather than reduced grazing pressure. This was demonstrated by Skonhoft and Johannesen (2000), who modelled the role of non-marketed benefits related to Saami reindeer herding in Norway and found a possible negative relationship between livestock slaughtering and meat price. They considered herdsmen as maximizing a weighted average of slaughtering profit and herd size while at the same time facing an income constraint. In case of a binding income constraint, a price increase allows the herdsmen to slaughter fewer animals and still obtain the same slaughtering income. In this way, increased meat price may stimulate herdsmen to reduce the number of slaughtered animals. This was also hypothesized by Doran et al. (1979) who found a *negative* relationship between livestock slaughtering and meat price in Swaziland. Bostedt (2005) demonstrated a similar result for Saami reindeer herding in Sweden.

Negative supply responses to a price increase can, however, also simply result from slow biological reproduction in the livestock dynamics. Jarvis (1974) presented evidence from cattle beef production in Argentina and found that a higher beef price may motivate the farmers to delay the timing of the slaughtering temporarily to gain weight increase, inducing a negative short-run supply response. Eventually as the biomass increases, allowing for higher meat offtake in the long run, the slaughter-price response becomes positive. That is, following this logic, farmers respond to a *permanent* price increase by keeping animals away from the market in the short run to increase the animal weight gain and future slaughtering. On the other hand, when facing a *temporary* price increase herdsmen may have incentives to increase the slaughter supply in the short run, and subsequently reduce future supplies to correct for the stock shortfall (Rosen 1987).

Still, non-marketed benefits seem to be important in many economies based on nomadic pastoralism. Even in presence of well functioning capital markets, Skonhoft (1999) and Skonhoft and Johannesen (2000) argued that the insurance and status motives are important determinants of herd size in Saami societies practicing nomadic pastoral reindeer herding in Norway. See also section three below. Bostedt (2005) argued that cultural values, such as the intrinsic value of being active in reindeer herding, motivates the Saamis to keep large herds in Sweden. Using cross section survey data, he regressed the slaughtering response to a changing meat price on herd size and demonstrated that large herds (presumably caused by cultural non-marketed values) imply a negative slaughtering response. However, in this paper no attempt was made to explicitly control for non-marketed livestock benefits.

The present paper presents evidence on herdsmen perception of non-marketed values using survey data from Saami reindeer herding in northernmost Norway (Finnmark county). A large fraction of the herdsmen emphasize that the size of the reindeer herd is important to provide insurance against unfavourable environmental conditions and social status within the herding community. A stochastic bioeconomic model is formulated to analyze how such values may affect herdsmen's behaviour in presence of environmental shocks and changing economic conditions. The model is formulated in section two. The paper proceeds by presenting descriptive data from the survey area in section three, while an empirical analysis of how the slaughtering responses to a changing meat price is found in section four. Section five finally summaries our main findings.

2. A model of reindeer as a source of insurance and social status

In what follows a model of an individual livestock herder facing environmental shocks is formulated, and where the stock size as a measure of social status, as well as a possible insurance motive, is included. It is assumed that each herdsman at time t derives utility from the social status gained by keeping a large herd size in number of animals, y_t, relative to the average stock size $\bar{y}_t$ in the community. Notice that this stock effect also readily can be interpreted as an insurance motive (see, e.g., Fafchamps 1998). All the time the herding community is assumed to be 'large' in the sense that the individual effect on the average stock size is negligible (see also Brekke and Howarth 2002). It is assumed that all animals slaughtered h_t are sold at a fixed and certain price P, and that meat production is the only (endogenous) source of income. When further assuming that slaughtering costs are stock independent so that P may be interpreted as a 'net' price, and neglecting any costs related to livestock maintenance, the current herding profit reads $\pi_t = Ph_t$. The individual herdsman is assumed to maximize expected present value utility over slaughtering income and relative herd size given as:

(1) $$EPV = E_0 \sum_{t=0}^{\infty} \frac{1}{(1+\delta)^t} \left[U(\pi_t) + W(y_t / \bar{y}_t) \right].$$

The utility is strictly increasing in income, $U' > 0$, and herdsmen are assumed to be risk averse, i.e., $U'' < 0$. Furthermore, the utility is strictly increasing in social status, $W' > 0$, but at a decreasing degree, i.e., $W'' < 0$. E_0 is the expectation operator where the expectation is formed at the at very beginning of the planning horizon, $t = 0$, and δ is the discount rate.

The individual livestock herd grows according to:

(2) $$y_{t+1} = z_t \left[y_t + F(y_t) - h_t \right]$$

where $F(y_t)$ represents natural growth, assumed to be density dependent and described by a one-peaked concave function. All the time, we will think of this as a standard logistic function. In the present exposition any effects from the herd size to the vegetation quantity is neglected, meaning that we are ignoring any possible ecological interactions among the flock sizes of the herders. Therefore, the individual herd size growth depends only on own stock size. z_t is a stochastic variable reflecting shifting environmental conditions; that is, climatic variations affecting vegetation growth, fluctuations in the snow cover, changing predation pressure from carnivores, and so forth. Environmental shocks are assumed to be independent and identically distributed (i.i.d.) over time with unit mean, $E[z_t]=1$ and finite support, $0 < z_{low} < z_t < z_{high} < \infty$. Notice that the above formulation implies that harvest at time t is based on the actual stock while the surplus stock is prudent to shifting environmental conditions. Therefore, the stock in year $(t+1)$, after slaughtering and natural growth, is uncertain. This is the same set up as in the seminal Reed (1979) 'escapement fishery' paper.

When current and future slaughtering levels are chosen so as to maximize the present-value expected utility, the value function is defined as

$V_t(y_t) = \max_{h_t} \left\{ E_t \sum_{s=t}^{\infty} \left[U(\pi_s) + W(y_s / \bar{y}_s) \right] / (1+\delta)^{s-t} \right\}$. Because slaughtering and stock size are non-stochastic within the present period, the corresponding Bellman equation writes:

(3) $$V_t(y_t) = \max_{h_t} \left\{ U(\pi_t) + W(y_t / \bar{y}_t) + \frac{1}{1+\delta} E_t \left[V_{t+1}(y_{t+1}) \right] \right\},$$

and where the animal growth equation (2) is the constraint. In addition, the initial size of the herd y_0 is known.

The first order condition of this problem for an internal solution reads

$U'(\pi_t)P + \frac{1}{1+\delta}E_t[V'_{t+1}(y_{t+1})(\partial y_{t+1}/\partial h_t)] = 0$, or $U'(\pi_t)P = \frac{1}{1+\delta}E_t[V'_{t+1}(y_{t+1})z_t]$ when taking the animal growth equation (2) into account. When using the envelope theorem and again the animal growth equation and evaluating this expression at $(t+1)$, we next find $V'_{t+1}(y_{t+1}) = W'(y_{t+1}/\bar{y}_{t+1})(1/\bar{y}_{t+1}) + \left[1+F'(y_{t+1})\right]U'(\pi_{t+1})P$ (more details in the Appendix). When further inserting into the first order condition (3), this condition may be rewritten as:

$$(4) \qquad U'(\pi_t)P = \frac{1}{1+\delta}E_t\left\{\left[W'(y_{t+1}/\bar{y}_{t+1})(1/\bar{y}_{t+1}) + \left[1+F'(y_{t+1})\right]U'(\pi_{t+1})P\right]z_t\right\}.$$

Equation (4) states that optimal slaughtering at time t is determined by the equality between the marginal utility of current slaughtering and next years expected marginal utility of livestock savings, and where the latter includes the marginal utility of social status, as well as other possible stock motives, and slaughtering. Condition (4) and the population growth equation (2) describe the solution of the present optimization problem through two interconnected first order difference equations in harvest h_t and number of animals y_t. With the initial stock value y_0 given, the optimal paths can in principle be calculated.

In absence of the status effect it is seen the price plays no role in the harvesting decision as (4) then simply reduces to $U'(\pi_t) = \frac{1}{1+\delta}E_t\left\{\left[1+F'(y_{t+1})\right]U'(\pi_{t+1})z_t\right\}$ when P, as here, is assumed to be known for sure. This result is obvious, as the value of the income no longer play any role in the trade-off. What matters then is the size of the harvest only. In absence of environmental uncertainty, i.e., z_t is non-stochastic and hence equals one, this condition reduces further to $U'(\pi_t) = \frac{1}{1+\delta}[1+F'(y_{t+1})]U'(\pi_{t+1})$. With, say, $F'(y_{t+1}) > \delta$, we find

$U'(\pi_t)/U'(\pi_{t+1}) > 1$ and therefore $h_{t+1} > h_t$, and increased harvest over time. In steady state, $h_{t+1} = h_t = h^*$, the stock growth equalizes the discount rate, $F'(y^*) = \delta$. This is a well known result from standard bioeconomic theory when there are no stock dependent harvesting costs (see, e.g., Clark 1990). However, whether this steady state is stable and reachable from y_0, depends on the parameterization of the model[1].

With the status effect present, but still in absence of environmental uncertainty, equation (4) reads $U'(\pi_t)P = \frac{1}{1+\delta}\left[W'(y_{t+1}/\bar{y}_{t+1})(1/\bar{y}_{t+1}) + \left[1+F'(y_{t+1})\right]U'(\pi_{t+1})P\right]$. This expression indicates that the social status motive, as well as the insurance motive, for livestock holding partially works in the direction of higher present marginal income utility and hence a lower year t slaughtering level. Therefore, not surprisingly, we may expect herdsmen with preferences for social status to keep more animals than other herdsmen. On the other hand, the price stock effect, as well as the price harvest effect, is ambiguous. The intuition here is that the dynamics may be complex and even include cycles (e.g., Fafchamps 1998) (cf. also footnote 1).

In steady state with no uncertainty, we have $F'(y^*) = \delta - \frac{W'(y^*/\bar{y})(1/\bar{y})}{PU'(Ph^*)}$ together with $F(y^*) = h^*$ and where the status effect is clear and evident. However, also now the meat price effect is unambiguous, and we find that a higher price increases the marginal harvesting utility of the harvest and reduces the relative marginal status effect. Therefore, a higher slaughtering price motivates herdsmen to *temporarily* increase the offtake and leave a smaller stock size for the future. The slaughtering response is weaker for herdsmen with strong preferences for social status. The *permanent* price effect on harvest is, however, generally ambiguous as the effect then depends on whether the steady state is located to the left hand or right hand side of y^{msy} (*msy*= maximum sustainable yield). If the preferences for social status, or insurance, is strong and the steady state initially is located to the right hand side of y^{msy}, a higher slaughter price will increase the steady state harvest while a further price increase next will slow down the steady state slaughtering. These effects are nothing else than the well-known upward bending supply curve from the fishery economics literature which occurs when the natural growth function, as here, is assumed to be of the density dependent one-peaked type.

We then look more closely how the presence of uncertainty in condition (4) may affect the above reasoning. Shifting environmental conditions through z_t occur between periods. That is, after harvest year t the left hand side of (4) has a given value. Then a negative environmental shock will *ceteris paribus* increase the expected future marginal utility of livestock (right hand side of equation 4). Because this value is equated with the current and given marginal utility of slaughtering, the harvesting level in period t reduces (e.g., also McPeak 2004). This implies that the risk of poor future environmental conditions stimulates herdsmen to keep more animals than in absence of risk (see also the Appendix).

The notion of steady state has no obvious meaning when uncertainty is present. However, the expected steady state $E[y_{t+1} - y_t] = 0$, or $E[y_{t+1}] = E[y_t] = \tilde{y}$ yields the herd size the stock in the long term will fluctuate around. In the same manner, $E[h_{t+1}] = E[h_t] = \tilde{h}$ represents the expected steady state harvest. Inserted into condition (4), we find

$$U'(P\tilde{h})P = \frac{1}{1+\delta} E\left\{\left[W'(\tilde{y}/\bar{y})(1/\bar{y}) + \left[1 + F'(\tilde{y})\right]U'(P\tilde{h})P\right]z_t\right\}, \text{ or}$$

$U'(P\tilde{h})P = \frac{1}{1+\delta}\left[W'(\tilde{y}/\bar{y})(1/\bar{y}) + \left[1 + F'(\tilde{y})\right]U'(P\tilde{h})P\right]$ which hence is exactly the same expression as without uncertainty. Expected steady state is therefore identical with steady state when environmental uncertainty is neglected, $\tilde{y} = y^*$, and the price effects on herd size and harvest are identical.

Having conceptually analysed the role of environmental uncertainty and non-marketed values, we now turn to analyse if insurance and social status motives for livestock keeping play a role in reindeer herding in northernmost Norway. In doing so, we distinguish between the two non-marketed values of reindeer, social status and insurance, and test whether they affect the slaughtering responds due to a changing meat price. However, before doing so, a closer description of reindeer herding and our data are given.

3. Reindeer herding in northernmost Norway

3.1. The reindeer herding area

We analyse how the slaughter responses to a price change using cross-section survey data from interviews with Saami reindeer herdsmen in western Finnmark in northern Norway conducted in July 2007. The reindeer herding region of western Finnmark covers a total area of some 24.000 km^2 and counts in total 216 reindeer management units with an aggregated reindeer population of 94 000 animals (NRHA 2007). The survey covers 15 of the 25 reindeer herding districts in this region, and 44 reindeer management units. One management unit typically counts several reindeer owners where all usually are relatives of the unit manager. The owners include both active and non-active herdsmen but in order to restrict the sample to active herdsmen only, the managers of the units were interviewed. The average number of owners per unit in the survey sample is 6.2 persons, while the western Finnmark average is 6.1 (NRHA 2007).

The northernmost parts of Norway constitute the main area of reindeer herding in the country. Saami reindeer herding in this area can be traced to the hunting of wild reindeer since time immemorial. During the 15th century, entire reindeer herds were domesticated and part of the Saami people became herding nomads. This tradition has preserved until today (Johansen and Karlsen 2005). Reindeer follow a seasonal migration pattern across a huge area during the year due to food scarcity and shifting vegetation conditions (cf. also the introductory section). During the summer reindeer graze on grass, herbs and sedges on the islands and peninsulas near the coast, while the winter ranges are found in the interior continental parts characterized by vegetation types rich in lichens (Johansen and Karlsen 2005). See Figure 1. The Reindeer Farming Act gives the Saamis in northern Norway the right to graze their herds in practically all non-private land areas in the county (Austenå and Sandvik 1998) to secure the migration between coast and inland. This migration route has been important to secure an appropriate balance between winter and summer ranges (Johansen and Karlsen 2005).

Figure 1 about here

On a national scale, reindeer herding in Norway is a small industry. The total industry comprises 556 management units keeping in total 240.000 reindeer (NRHA 2007). There is a restriction on entering the industry because reindeer herding can be performed by Saami people only (NRHA 2007), and a unit leader (i.e. the owner and manager of a management unit) must have herding as his main occupation (Austenå and Sandvik 1998). Even though this industry is small on a national scale, reindeer herding is of great importance to the Saami people both economically and culturally. The Norwegian government, both in official statements and through different types of subsidies, has also emphasized reindeer herding being of the greatest importance to sustain the Saami culture.

Saami reindeer herders relay on reindeer as the only source of agricultural production. Reindeer meat is the main product produced and sold on the market, but some herders supplement with fur and handicrafts. A negative environmental shock (e.g., very packed snow cover) will therefore cause both an income and an asset shock due to reduced slaughtering weight and livestock loss. Other negative shocks include loss to predators and traffic accidents. In contrast to most pastoral societies in developing countries, however, Saami reindeer herders are faced with well functioning credit market. Furthermore, reindeer losses caused by predators or traffic accidents are compensated by the government with the slaughtering and grant value of the animal (Labba et al. 2006)[2]. Still, a number of herdsmen perceive large herds as an insurance against adverse herding conditions. Having a large herd seems also to be crucial for the prestige and social status it confers (see below). A large herd reflects a successful and competent herdsman and enter as a mean in the competition for grazing land. It has been argued that the status motive has been replaced by increased focus on productivity in the southern parts of Norway, whereas it is still intact in Finnmark (Riseth and Vatn 2009). For policy reasons it is critically important to understand the objectives which motivates the size of a reindeer herd. First of all, such motives tend partially to result in larger herds and a more intensive grazing pressure (cf. also the introductory section and section two). Second, a slaughtering subsidy, which was implemented with the intention to increase the offtake and reduce the grazing pressure in northern Norway, may give unexpected results when motives of self-insurance and social status are present (cf. also introductory section). Such possible effects were confirmed in the above theoretical model.

3.2. Descriptive data

Table 1 shows the sample herd size distribution according to the response alternatives described in the survey. About 23 per cent of the management units have a flock size between 301 and 400 animals. The average number of owners in management units keeping 301-400 animals is below that in units keeping more animals. See Table 2. Although the survey does not distinguish between active and non active owners, this result may certainly reflect that more labour (i.e., active owners) is required to manage larger herds. About 39 per cent of the sample keeps 501-600 animals. This may not be surprising as the maximum herd size to qualify for production grants and slaughtering subsidies is 600 animals (NRHA 2007). The sample average counts 401-500 animals, which corresponds well with the western Finnmark average of 435 animals per management unit.

Table 1 about here

Table 2 about here

The management unit leaders were asked a number of questions concerning the importance of being an active herdsman. First, about 70 per cent of the sample agreed, or strongly agreed, that being an active herdsman is vital to sustain the Saami culture. Second, more than 85 per cent of the sample seems reluctant to quit reindeer herding, even if given better income opportunities. See Table 3. This result indicates that herdsmen earn some intrinsic utility of being an active herdsman, and fits well with the findings from reindeer herding in Sweden (again, see Bostedt 2005). Those who also emphasize the importance of future generations, have on average larger flock sizes than others (except for the single respondent in answer alternative 1). This may indeed reflect that larger herds are perceived as crucial in order to secure the possibilities for future generations to stay in reindeer herding.[3] As opposed to

Bostedt (2005), the unit leaders were also specifically asked whether they perceive their animals as valuable in other respects besides the slaughtering value. They were faced with two different non-marketed values, insurance value and social status, and were asked to indicate whether, and to what degree, these are detrimental for the herd size. See Table 4. 50 per cent of the sample agree, or strongly agree, that the herd size is important in providing insurance against adverse herding conditions. The fraction perceiving the herd size as important to gain social status is lower, but still 25 per cent agreed, or strongly agreed, on this assertion. Those management units who agree/strongly agree with the insurance motive, keep on average more animals than the others.[4] On the other hand, the herd size of respondents who agree/strongly agree with the status motive is, however, not significantly different from others.

Table 3 about here

Table 4 about here

In order to analyse how herdsmen respond to changes in the slaughtering price, each herdsman was asked whether the number of slaughtered animals per year would change when faced with a hypothetical 100 percent increase in the per kilo slaughtering price. See Table 5. In contrast to the findings in Sweden (Bostedt 2005), none of the respondents in our survey would choose to reduce the slaughter. Therefore, it is no sign of any negative supply responses in this sample. Second, while just 8 per cent of the Swedish reindeer herdsmen report a positive supply response, 50 percent indicates such behaviour in the present survey. Third, although not significantly different, herdsmen with a positive supply response keep on average more animals than others in the present sample. The Swedish findings, on the other hand, predict the opposite relationship. See also section 4 below.

Table 5 about here

4. Empirical specification and estimation results

As already indicated, Saami reindeer herding is much more multifaceted than optimizing the meat production only. The herding provides benefit to its owners through cultural identity, and a large herd size may gain social status within the Saami community (Tables 3 and 4). We now analyze how non-marketed values influence how herdsmen respond to a hypothetical slaughter price increase, and where the focus is on values related to insurance and social status. In contrast to the literature on livestock as a buffer stock (e.g., Fafchamps et al. 1998), actual livestock transactions and shocks are hence, not included in our data set. Nonetheless, the data cover information on different non-marketed livestock values as perceived by herdsmen themselves. The data set is therefore in the present case well-suited to separate the role of any insurance value from that of social status. Therefore, instead of investigating how actual environmental shocks affect slaughtering, we treat insurance motives as a non-marketed value of livestock and test whether such preferences affect the slaughtering response.

The response to a hypothetical 100 per cent increase in the price per kilo slaughtered meat (Table 5 above) is used to model the supply response. The logit specification of the empirical model is given as:

(5) $$\partial h^i / \partial P = \begin{cases} 1 & \text{if } \partial h^i / \partial P > 0 \\ 0 & \text{otherwise} \end{cases}$$

where $\partial h^i / \partial P = a + \boldsymbol{b}\boldsymbol{X}^i + u^i$, and $\boldsymbol{X}^i$ and $\boldsymbol{b}$ are vectors of explanatory variables and coefficients, respectively. u^i is the error term and $i = 1, ..., N$.[5] $\partial h^i / \partial P = 1$ if herdsman i chooses to increase the slaughter, $\partial h^i / \partial P = 0$ if herdsman i chooses to keep the slaughtering level unchanged. The herdsmen were posed with the following question: "Given the current size of your herd, how would you change your slaughtering level if you were faced with a *long lasting* doubling in the per kilo meat price?" That is, they were confronted with a permanent price increase, and they were asked to consider the herd size as exogenous when responding to the question. In light of the theoretical reasoning (section two above), we hence test whether non-marketed values affect the temporarily slaughter response. Different specifications of the supply response are presented in Table 6.

HERD is a dummy for individual herd size with value one for herd sizes above 400 animals, and zero otherwise. *INSUR* is a dummy with value one for herdsmen who agree, or strongly agree, that the herd size is important in providing insurance against adverse herding conditions, and zero otherwise. The dummy *STATUS* equals one for herdsmen who agree, or strongly agree, that the herd size is important to obtain social status, or else zero. From the theoretical model we expect herdsmen with non-marketed values to temporarily be less likely to possess a positive supply response when compared to herdsmen who impose lower non-marketing values to their herds. The latter two variables are also included in interaction terms with the herd size as *INSUR*HERD* and *STATUS*HERD*, respectively, to determine whether herdsmen with non-marketed values are less likely to have a positive supply response if they actually keep large herds. *AGE* reflects the age of the respondent and is included to capture possible differences across generations. Summary statistics of the variables are reported in table A1 in the Appendix.

Table 6 reports the logit estimates. The coefficient of the herd size *HERD* in regression (a) is positive, but not significantly different from zero. However, when controlling for non-marketed values in models (b)-(d) the coefficient turns out positive and significant. This indicates that owners of large herds are more likely to increase the slaughtering when confronted with a permanent price increase, and contrasts the negative relationship between herd size and supply response as demonstrated by Bostedt (2005) in Swedish reindeer herding. He presumes a positive relationship between herd size and non-market values, and interprets the negative coefficient as a result of high non-marketed values. Instead, we control for the insurance motive for keeping a large herd in model (b). The coefficient of *INSUR* is positive, but not significantly different from zero. However, the interaction term has a negative impact on the supply response, indicating that owners of large herds who value the herd as insurance are less likely to increase their slaughter than owners with no insurance motive. In contrast, whether herdsmen see the herd size as important to gain social status or not, seems to have no significant impact on the supply response in models (c) and (d).

Models (e) and (f) give a further analysis of the impact of social status on the slaughter response by controlling for relative herd size. These models include two distinct variables for relative herd size to reflect different patterns of interaction across grazing seasons. During the summer grazing period, where the animals graze in the coastal areas (cf. the above Figure 1), the pastures are divided into 25 well defined grazing districts; that is, the herdsmen interact only with herdsmen residing within the same district. The number of reindeer units in a summer district ranges from 1 to 20 with an average of 8.6 units (NRHA 2007). In the winter season, on the other hand, the animals graze on inland common pastures shared by a larger number of reindeer units (cf. also Figure 1). To capture any status motive relatively to other herdsmen residing in the same summer district, model (e) introduces the dummy variable

$A\_\bar{y}_S$ with value one if the herd size of the individual herdsman is above the average herd size in his summer district, and zero otherwise. A similar dummy variable $A\_\bar{y}_W$ is introduced in model (f) to capture any relative status motive compared to the average of all herdsmen on the common winter pasture. The coefficient of $A\_\bar{y}_S$ is positive and significantly different from zero, which suggests that owners of herds above the summer district average are more likely to respond to a price increase by increasing the slaughter. However, the interaction term *STATUS** $A\_\bar{y}_S$ is negative, but just weakly significant. Notice that the coefficient of *AGE* turns out as negative and significantly different from zero in this model. The reason is that the oldest herdsmen in the sample tends to keep herds above the summer district average and when controlling for $A\_\bar{y}_S$ we see that these herdsmen are less likely to increase the slaughtering as the meat price increases. Social status as dependent on herd size relatively to (the large number of) other units on the common winter pasture (model (f)), has no significant impact on the slaughtering response.

6. Concluding remarks

The theory of livestock as a buffer stock predicts that (agro)pastoralists facing substantial risks while at the same time being restricted by weak credit and insurance markets, will use liquid assets such as livestock for self-insurance in order to smooth consumption. This paper examines this hypothesis related to reindeer herding in Northern Norway where the herders, in contrast to pastoralists in Sub-Saharan Africa, are facing well functioning credit markets and compensation schemes. This is done using survey data which include slaughtering responses to a hypothetical increase in the meat price. The survey reveals to what extent the herdsmen themselves see large reindeer herds as a source of insurance against adverse conditions, and we test whether this affects the slaughter response to a price increase. Furthermore, the data demonstrate that a rather large fraction of the herdsmen see the herd size as important to gain social status. Based on the theoretical model, it is hypothesised that preferences for such non-marketed values of the reindeer result in a weaker slaughter response. We are able to verify that preferences for reindeer as an insurance asset tend to reduce the slaughter response for owners of large herds. Although quite a large fraction of herdsmen report prevailing preferences for social status, we find no strong evidence that such preferences change the slaughter and harvesting decisions.

The General Agreement between the reindeer herder organization and the Norwegian government includes a number of grants and subsidies, some of which directly enhance the reindeer slaughtering price. Although the analysis presented here does not explicitly incorporate policy instruments, it nevertheless suggests that the slaughter response to subsidies aimed at increasing the producer price is more likely to be weaker for large herdsmen with non-marketed motives than for herdsmen with no such motives. Even though we can not quantity the overall supply response based on this analysis, policy makers should be aware of possible “adverse” effects of slaughtering subsidies. When keeping in mind the past decades problems of overgrazing in Finnmark, existing analyses have recommended to make subsidy to some extent conditional on a slaughter requirement (see Riseth and Vatn 2009).

Appendix

The bioeconomic model

To derive condition (4), an expression for $V'_{t+1}(y_{t+1})$ is needed. Because the derivate of the value function is independent of time, we seek an expression for $V'_t(y_t)$. When differentiating (3) with respect to y_t and using the envelope theorem and equation (2) (cf. also the main text), we find $V'_t(y_t) = W'(y_t/\overline{y}_t)\frac{1}{\overline{y}_t} + \frac{1}{1+\delta}E_t\left[V'_{t+1}(y_{t+1})(1+F'(y_t))z_t\right]$.

Inserting $\frac{1}{1+\delta}E_t\left\{V'_{t+1}(y_t)z_t\right\} = U'(\pi_t)P$ from the first order condition next yields

$V'_t(y_t) = W'(y_t/\overline{y}_t)\frac{1}{\overline{y}_t} + (1+f'(y_t))U'(\pi_t)P$. When evaluating this expression at $(t+1)$ and inserting into the first order condition we end up with equation (4).

In the main text section 4 empirical model, the individual herd size is specified as exogenous. Therefore, the following derives the relationship between slaughtering and meat price when the herd size is considered as exogenous. The utility of income function is specified as $U_t(\pi_t) = (Ph_t)^{\alpha}$ with $0 < \alpha < 1$. We first look at the situation where no uncertainty is included. With this specification of the utility function and $z_t = 1$, differentiation of the first order condition (4) with respect to h_t and P yields

$$\left\{\begin{matrix} \alpha(\alpha-1)(\pi_t)^{\alpha-2}P^2 + \left[1/(1+\delta)\right]W''(y_{t+1}/\overline{y}_{t+1})(1/\overline{y}_{t+1})^2 \\ +\left[1/(1+\delta)\right]F''(y_{t+1})\alpha(\pi_{t+1})^{\alpha-1}P \end{matrix}\right\}dh_t$$
$$=$$
$$\left\{-\alpha^2(\pi_t)^{\alpha-1} + \left[1/(1+\delta)\right]\left[1+F'(y_{t+1})\right]\alpha^2(\pi_{t+1})^{\alpha-1}\right\}dP$$

The bracket term on the left hand side is negative. When inserting from the first order condition, the bracket term on the right hand side equalizes

$\left\{-\left[z_t/(1+\delta)\right]W'(y_{t+1}/\overline{y}_{t+1})(1/\overline{y}_{t+1})/P\right\} < 0$. The slaughter response dh_t/dP is hence positive.

However, due to the bracket term on the left hand side it is seen that preferences for social status indicates a weaker slaughter response.

Next, we look at the situation when uncertainty is included. Differentiation now yields

$$\left\{ \begin{array}{l} P^2\alpha(\alpha-1)(\pi_t)^{\alpha-2} + [1/(1+\delta)]E_t\left[W''(y_{t+1}/\bar{y}_{t+1})(1/\bar{y}_{t+1})^2 z_t^2\right] \\ +[1/(1+\delta)]E_t\left[F''(y_{t+1})\alpha(\pi_{t+1})^{\alpha-1}Pz_t^2\right] \end{array} \right\} dh_t$$

$$=$$

$$\left\{-\alpha^2(\pi_t)^{\alpha-1} + [1/(1+\delta)]E_t\left[(1+F'(y_{t+1}))\alpha^2(\pi_{t+1})^{\alpha-1}z_t\right]\right\}dP$$

When inserting from the first order condition (4), the bracket term on the right hand side may also be written as $\left\{-E_t\left[W'(y_{t+1}/\bar{y}_{t+1})(1/\bar{y}_{t+1})z_t\right]\alpha/P\right\}$. This term equals zero for herdsmen with no preferences for social status, meaning that a permanent change in the slaughter price will not affect their slaughtering decision under the assumption of given herd size.

Assume now that the herdsman has preferences for social status and that all herdsmen are equally affected by an environmental shock in the sense that the $y_{t+1}/\bar{y}_{t+1}$ remains unchanged. Then $E_t\left[W'(y_{t+1}/\bar{y}_{t+1})(1/\bar{y}_{t+1})z_t\right] = W'(y_{t+1}/\bar{y}_{t+1})\left\{E_t\left[(1/\bar{y}_{t+1})\right]E_t\left[z_t\right] + \text{cov}\left[1/\bar{y}_{t+1}, z_t\right]\right\}$. The first bracket term $E_t\left[(1/\bar{y}_{t+1})\right]E_t\left[z_t\right]$ is positive and hence, works as in the deterministic model above in the direction of a positive slaughtering response. The covariance term is, however, negative and works in the opposite direction. This means that environmental uncertainty implies a smaller, or even a possible negative, slaughter response compared to the deterministic model.

The data

Table A1 describes the data used in the regressions.

Table A1 about here

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Tables and figures

Table 1. Herd size distribution in the survey.

Variable	Description	N	Per cent
Herd size per management unit	0-100 reindeer	1	2.3 %
	101-200 reindeer	2	4.5 %
	201-300 reindeer	1	2.3 %
	301-400 reindeer	10	22.7 %
	401-500 reindeer	4	9.1 %
	501-600 reindeer	17	38.6 %
	601-700 reindeer	2	4.5 %
	>700 reindeer	4	9.1 %
Total respondents		41[1)]	

1) Three observations are missing.

Table 2. Number of owners and income per management unit according to herd size.

Herd size	Mean number of owners	Mean income (1000 NOK)
0-100	5.0	0-99
101-200	4.5	0-99
201-300	7.0	150-199
301-400	4.2	200-249
401-500	6.8	250-299
501-600	5.3	300-399
601-700	11.5	400-499
>700	14.0	300-399

Table 3. Responses to: "How important is it for you to be a reindeer herder?"

Response alternative	N	Per cent	Mean herd size
1. "I will quit as a reindeer herder if I get an occupation that will provide the same income"	1	2.3 %	>700
2. "I will quit as a reindeer herder if I get an occupation that will provide a better income"	5	11.4 %	301-400
3. "I will not quit as a reindeer herder"	7	15.9 %	401-500
4. "I will not quit as a reindeer herder and it is important to me that the next generation takes over"	31	70.5 %	501-600
Total respondents	44		

Table 4: Responses to assertions on non-use values. Mean herd size in parenthesis.

"A large herd is important…	N	Strongly disagree	Disagree	Agree	Strongly agree
…as an insurance in times of adverse conditions"	43	18.2 % (401-500)	29.5 % (301-400)	15.9 % (501-600)	34.1 % (501-600)
…to gain social status"	42	36.4 % (401-500)	34.1 % (501-600)	6.8 % (601-700)	18.2 % (401-500)

Table 5: Responses to a 100 % price increase.

Response alternative	N	Mean stock
Reduce slaughter	0 (0.0 %)	
No change in slaughter	20 (45.5 %)	401-500

Increase slaughter	22 (50.0 %)	501-600
Don’t know	2 (4.5 %)	401-500

Table 6: Logit estimation results (t-values in parentheses)

	(a)	(b)	(c)	(d)	(e)	(f)
CONSTANT	0.096	1.117	-0.296	0.510	3.315	0.533
	(0.06)	(0.58)	(-0.16)	(0.23)	(1.30)	(0.24)
HERD	1.051	2.960	1.795	3.599	1.895	3.118
	(1.44)	(2.53)***	(1.96)**	(2.63)***	(1.30)	(1.96)**
INSUR		2.321		2.556	3.103	2.560
		(1.54)		(1.49)	(1.76)*	(1.49)
INSUR HERD*		-4.625		-4.685	-5.382	-4.779
		(-2.41)**		(-2.25)**	(-2.35)**	(-2.27)**
STATUS			1.911	1.876	1.090	1.874
			(1.29)	(1.11)	(0.83)	(1.11)
*STATUS*HERD*			-3.018	-2.780		
			(-1.69)*	(-1.35)		
$A\_\bar{y}_S$					2.947	
					(2.14)**	
$A\_\bar{y}_W$						0.711
						(0.59)
$STATUS*A\_\bar{y}_S$					-4.184	
					(-1.74)*	
$STATUS*A\_\bar{y}_W$						-2.937
						(-1.41)
AGE	-0.019	-0.053	-0.022	-0.052	-0.108	-0.053
	(-0.61)	(-1.40)	(-0.65)	(-1.32)	(-2.06)**	(-1.32)
Log-likelihood	-25.551	-20.941	-24.023	-19.959	-17.773	-19.782
N	39	38	39	38	38	38
R^2_{adj}	0.054	0.203	0.111	0.241	0.324	0.247

Notes: ***, **, and * significant at 1, 5, 10% level, respectively. Table A1(Appendix) reports variable definitions.

Table A1: Description of variables and descriptive statistics

Variable	*Description*	*N*	*Mean (st. dev.)*	*Min*	*Max*
HERD	=1 if herd size above 400 animals, =0 otherwise	41	0.66 (0.480)	0	1
INSUR	=1 if herdsman agree or strongly agree that the herd size is important as insurance, =0 otherwise	43	0.51 (0.506)	0	1
INSUR HERD*	Interaction term	40	0.40 (0.496)	0	1
STATUS	=1 if herdsman agree or strongly agree that the herd size is important for social status, =0 otherwise	42	0.26 (0.445)	0	1
*STATUS*HERD*	Interaction term	41	0.15 (0.358)	0	1
$A\_\bar{y}_S$	=1 if herd size is above the summer district average, =0 otherwise	41	0.44 (0.502)	0	1
$A\_\bar{y}_W$	=1 if herd size is above the total area average, =0 otherwise	41	(0.56) (0.502)	0	1
$STATUS * A\_\bar{y}_S$	Interaction term	41	0.12 (0.33)	0	1
$STATUS * A\_\bar{y}_W$	Interaction term	41	0.15 (0.358)	0	1
AGE	Age of the respondent	44	47.14 (11.276)	22	68

Source: Own survey (see main text section 3)

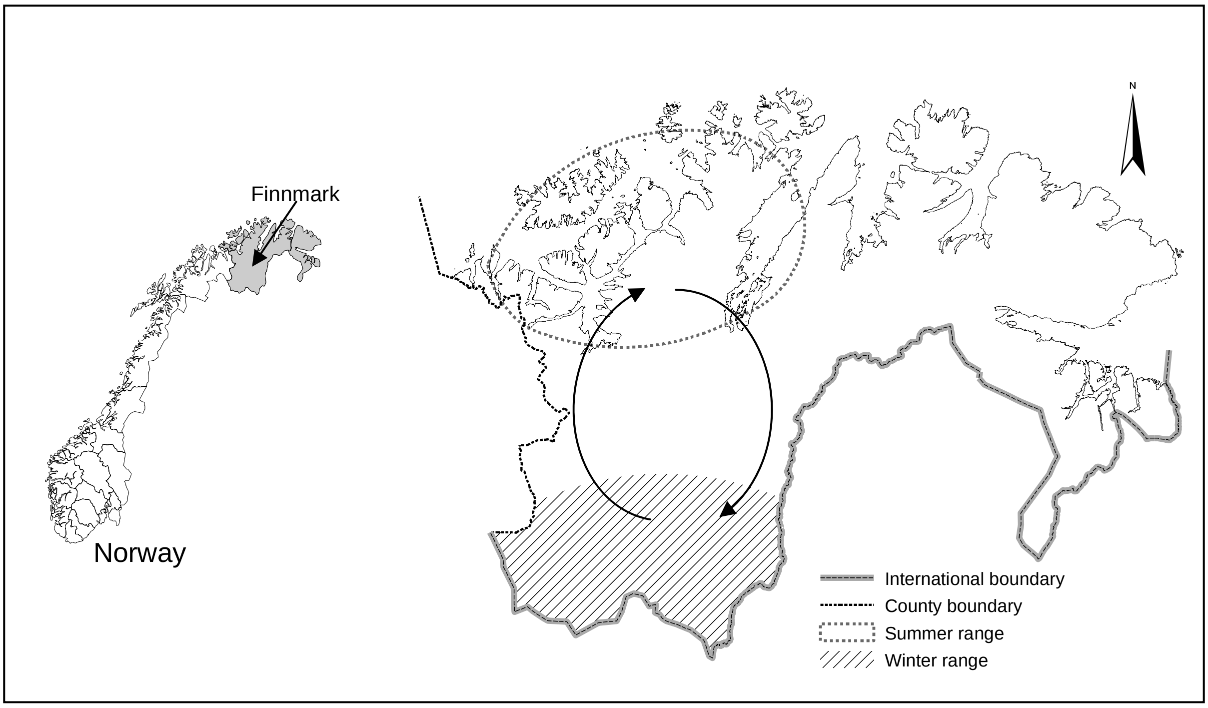

Figure 1: Map of Finnmark reindeer herding area indicating the migration route in West Finnmark.

[1] This last proposition contrasts the standard bioeconomic model formulated in *continuous* time where the transitional dynamics is of the saddle path type with two stable arms leading to steady state.

[2] Losses to traffic accidents to cars are compensated by the insurance company of the motorist, while accidents to trains are compensated by the government (Labba et al. 2006).

[3] More frequently than for others, herdsmen in this group keep more than 400 animals. The null hypothesis of equal means across groups is rejected at 5 percent level of significance.

[4] Herdsmen who agree/strongly agree on the insurance motive keep more often than others more than 400 animals. The null hypothesis of equal means across the groups is rejected at 5 percent level of significance.

[5] See Johnston and Dinardo (1997), chapter 13.