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ANALYSIS

Basic capability effect: Collective management of pastoral resources in southwestern Kenya

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ABSTRACT

Collective action, such as common resource user groups, has gained importance in the management of pastoral natural resources. This study aims at analyzing the effects of basic capabilities, among other factors, on households' decisions to participate in collective management of pastoral resources in Narok County, Kenya. A zero-inflated beta model, in addition to alternative econometric model specifications, is applied on cross-sectional data collected through a household survey. The results confirm the key role of the capability concept in explaining the management of natural resources. Increased basic capabilities, that is, the ability to achieve some minimally acceptable levels of functioning reduce cooperation levels in collective management of pastoral resources. Social capital, neighborhood social influences, resource system characteristics, socioeconomic factors and institutional factors also emerge as key determinants of collective management of pastoral resources. Policy implications drawn by this study encourage strategies to build social capital and facilitate adoption of improved range management technologies where communal management of land is likely to be abandoned for exclusive property rights.

1. Introduction

Co-management of pasture resources under collective ownership systems has gained importance in managing and structuring the use of rangelands in arid and semi-arid areas (Banks, 2003; Hundie and Padmanabhan, 2008; Mwangi and Meinzen-Dick, 2009; Ostrom, 1990). Under these systems of joint provision and exploitation of range resources, pastoralists have access to diverse livelihood options to hedge against risks (Kimani and Pickard, 1998; Mwangi and Meinzen-Dick, 2009). The risks mainly emanate from low and erratic rainfall and variations in pasture productivity characterizing the arid and semi-arid lands (ASALs). With regard to diverse livelihood options, communal ownership of rangeland resources allows users to have access to a larger land area that provides water and pastures in both the dry and wet seasons. This serves as an insurance against individuals incurring losses, especially during dry periods (Mwangi and Meinzen-Dick, 2009). As further illustrated by the authors, collective rights to land and land resources in range areas provide a more equitable way of distributing variable resources and are associated with significant savings on transactions and production costs (Mwangi and Meinzen-Dick, 2009). In addition, collective systems present the necessary scale required to maintain the ecological function of the heterogeneous land surfaces associated with rangelands (Baland and Platteau, 1996; Meinzen-Dick and Mwangi, 2009; Ostrom, 1990). The system provides the scale necessary for mobility that supports more sustainable livestock production in marginal environments (Mwangi, 2009).

On the other hand, redefinition of traditional land use arrangements from communal ownership to exclusive property rights has been observed to result in fragmentation, a key cause of rangeland degradation (Amman and Duraiappah, 2004; Flintan, 2011; Galaty and Ole Munei, 1999; Rutten, 1992). Fragmentation of rangelands results in the loss of flexibility of livestock movements. This disrupts the seasonal movements of livestock necessary to access resources (water and pastures) that are heterogeneous in space and time (Flintan, 2011). Restricted mobility of livestock has been shown to lead to the loss of the opportunistic spread of grazing pressure and ultimately leads to the overuse of resources in the confined areas (Boone and Hobbs, 2004; Hobbs et al., 2008; Meinzen-Dick and Mwangi, 2009). Fragmentation also occurs with the loss of land, especially in well-watered areas, to alternative land uses such as crop farming. Well-watered areas (i.e., dry season grazing areas) provide grazing relief in the marginal areas (wet season grazing areas), particularly during the dry seasons (Wade, 2013). Thus the loss of well-watered areas subjects the marginal areas to serious environmental degradation through depletion of biomass, loss of biodiversity, and soil erosion (Mireri et al., 2008; Mwagore, 2003). This undermines the capacity of pastoral communities to sustainably use the ecosystems as well as deal with risks such as droughts.

While the benefits of collective management of natural resources such as rangelands are clear, what remains unclear are the conducive factors to successful collective actions. Collective management of natural resources does not always emerge, and thus attention by a number

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of studies on factors either facilitating or hindering participation in collective action emerges (Agrawal, 2001; Dayton-Johnson, 2000; Gebremedhin et al., 2004; Meinzen-Dick et al., 2002; Ostrom, 2009; Willy and Holm-Müller, 2013). While there has been some general consensus on the role of certain factors, such as the number of users, importance of the resource system to users, and mobility of the resource system (Agrawal, 2001; Baland and Platteau, 1999; Ostrom, 2009), the role of some factors is debatable. For instance, on one hand, social networks and social participation, which are key elements of social capital, have been identified to enhance individuals' interactions in societies and facilitate participation in collective action (Gebremedhin et al., 2004; Willy and Holm-Müller, 2013). On the other hand, social capital may bring about subjective norms and may affect collective action negatively (Ajzen and Fishbein, 1980). For example, perceived social pressure to opt for subdivision of commonly managed pastures would hinder the collective management of pastoral resources. Market orientation has also been found to affect the capacity of communities to manage resources collectively. It has been found that, in some market-integrated societies, cooperative behavior prevails. In these environments, markets have been found to foster social interactions, leading to the evolution of norms that influence individual values and returns to relationship-specific investments (Bowles, 1998). However, markets may result in competitive environments undermining collective action (Agrawal, 2001; Carpenter and Seki, 2005). The composition of resource users within a group is also likely to affect collective actions in natural resource conservation. While some studies argue that inequalities in wealth within a community facilitate collective action in overcoming social dilemmas (Baland and Platteau, 1999, 2007; Naidu, 2009), others argue that inequalities may lead to low levels of collective action and cooperation (Dayton-Johnson, 2000; Gebremedhin et al., 2004; Janssen et al., 2011; Johnson and Smirnov, 2012).

The seemingly inconsistent results highlight the importance of the context in which collective action occurs (Baland and Platteau, 2007). This paper aims at contributing to the literature on factors affecting the collective management of natural resources. The study provides evidence on the role of basic capabilities as a determinant of collective action in communal grazing land management in a semi-arid setting. Capabilities, as defined by Krishnakumar and Ballon (2008), refer to the ability to achieve and relate not only to the opportunities that individuals access but to also the opportunities that one could potentially have access to (Ballet et al., 2015). Basic capabilities, as defined by the UNDP (1997), refer to the opportunity to achieve some minimally acceptable levels of functioning — the presence of some basic capabilities to function. Functionings, on the other hand, refer to the various valuable things that an individual manages to do or be, that is, the doings and beings of an individual (UNDP, 1997; Krishnakumar and Ballon, 2008).

As illustrated by Sen (2009), the important components of human capabilities relate to the well-being of individuals, the role of individuals in influencing economic production, and the role of individuals in influencing social change. Although these components are not directly observable, they do manifest themselves in observable functionalities (Krishnakumar and Ballon, 2008; Bérenger and Verdier-Chouchane, 2007). Capability constraints curtail the ability of individuals to utilize the opportunities available to them (Ballet et al., 2015; UNDP, 1997). In the context of rangeland resource management, the geographical nature of the ecosystems (arid and semi-arid lands) narrows the range of opportunities that individuals have at their disposal to exploit the ecosystem. However, individuals' basic capabilities further determine individuals' capacity to exploit the pasture resources in more ways than one (grazing), and this leads them to make certain choices. The indigenous people residing in Kenyan rangelands primarily rely on common resource ownership systems of livestock production to sustain their livelihoods. The inhabitants, however, have been observed to react to increased opportunities to promote their economic well-being (Campbell et al., 2003, 2005). With increased opportunities that one can access with the exclusive appropriation of the resource pie and ability to exploit them, an individual cooperating in common resource ownership is likely to exit and opt to exploit the potential higher benefits.

In Kenya, there has been a growing body of research on collective action among smallholder farmers (Andersson and Gabrielsson, 2012; Fischer and Qaim, 2012; Kariuki and Place, 2005; Narrod et al., 2009; Willy and Holm-Müller, 2013). However, only a few studies focus on collective action in pastoral drylands (Mwangi, 2007, 2009), with even fewer empirical studies existing (Nduma et al., 2001) and none illustrating the contribution of basic capabilities, an important factor explaining cooperation (Ballet et al., 2015). The present study fills this important gap in this field of research, not only in terms of identifying the causal relationship between multiple factors and the collective management of pastoral resources but also in showing how basic capabilities impact collective action. The crossing between basic capabilities, among other factors, and participation in collective management of grazing lands is thus the subject of analysis in this paper. The objective is modeled in two separate questions: Which factors affect (1) participation in collective management of pastoral resources and (2) the extent of participation? To achieve the stated objective, the paper applies fractional variate estimation procedures to data collected in a household survey among randomly selected agro-pastoral households in six different divisions in Narok County, in Kenya.

The rest of the study is structured as follows: In Section 2, I present the institutional developments in natural resource management in the study area. Section 3 presents the conceptual and theoretical frameworks in addition to the empirical model. Section 4 describes the location of the study area and data collection methods. Section 5 presents regression results, while Section 6 discusses the results. Lastly, Section 6 draws policy implications and concludes the study.

2. Understanding Institutional Developments in Natural Resource Management in Narok County

2.1. Background

Narok County is located on the southwestern part of the Rift Valley Province of Kenya. The county, a semiarid region, lies between latitudes 34°45′E and 36°00′E and longitudes 0°45′S and 2°00′S, with annual precipitation ranging from 500 to 1800 mm and local variations in topography playing a major role in the distribution patterns (Ojwang et al., 2010). The county has three districts covering an area of about 17,933.1 km^2, with an estimated population of 850,920 according to the 2009 census, and a population density of 47 people/km^2 (Republic of Kenya, 2010). Most of the region, especially the central part of the county, is characterized by harsh ecological conditions, resulting in low productivity. Farming is only suitable along the borders (Jaetzold et al., 2009). Livestock production remains the key component of agricultural production in Narok South and the lower parts of Narok North, with pastures forming the main feed for livestock. In addition to serving as a means of livelihood, livestock production plays a crucial role in the pastoralists' traditional social setting as a sign of wealth (Kaimba et al., 2011). The county supports one of the richest masses of large herbivores worldwide, including migratory wildebeest and a host of associated grazers, browsers, and predators (Ojwang et al., 2010).

In the county, as is the case with the rest of the country, the political economy context is closely linked to the processes of transformations in the institutions governing land ownership and land use (Amman and Duraiappah, 2004; Campbell et al., 2003; Mwangi, 2009). In the pre-colonial era, the area was mainly home to the Maasai pastoralists who practiced nomadic pastoralism characterized by movement of livestock within seasons in search of pastures, water, and incidence of disease (Campbell et al., 2005; Kimani and Pickard, 1998). Livestock production formed the basis of their economic livelihoods (Campbell et al., 2005; Mwangi, 2007; Nyariki et al., 2009). The livestock production system

was defined by individual ownership of livestock with collective use and ownership of pasture and water (Kimani and Pickard, 1998; Mwangi, 2007).

The socio-spatial organizations of the pastoralists comprised the household (the basic unit), the boma (a number of households in the same compound), the neighborhood (a cluster of bomas), and the section (a group of neighborhoods in the same area) (Kimani and Pickard, 1998). The sections were provided enough wet- and dry-season pastures and water and were protected against encroachment by other pastoralists and farmers. Movement of herds out of the section occurred only in cases of extreme drought (Kimani and Pickard, 1998). At the time of the European arrival, the indigenous land use systems were dismantled and replaced with exclusive private land ownership systems (Amman and Duraiappah, 2004). The indigenous populations were deprived of the best lands that served as important dry-season and drought retreat and were restricted to the marginal lands (Amman and Duraiappah, 2004; Campbell et al., 2003, 2005; Kimani and Pickard, 1998).

Land adjudication at independence in many instances followed similar processes as those seen during colonialism. High-potential land was allocated to elites and prominent individuals, while the majority of pastoralists settled on the drier savannah lowlands (Amman and Duraiappah, 2004; Campbell et al., 2005). Even where initial distributions involved high-potential land allocation to the indigenous people, special groups and immigrant farmers from other parts of the country bought out the land from poorer land owners and, in most cases, at very low prices (Amman and Duraiappah, 2004; Kimani and Pickard, 1998). For instance, in Narok County, the relatively fertile land was occupied by Kalenjin and Kikuyu immigrants as well as special groups of wealthy and politically connected commercial farmers (Amman and Duraiappah, 2004).

2.2. Group Ranches and Re-aggregating Individualized Parcels

Group ranches were initiated in 1968 by the government of Kenya (Kimani and Pickard, 1998; Mwangi, 2007, 2009). A group ranch consists of land that is legally jointly owned by a group, such as a tribe, clan, section, family, or other group of persons, and is managed by a committee elected by the members (Kimani and Pickard, 1998; Mwangi, 2009). The elected committee controlled the resource use, that is, it managed the grazing, water, and tillage (Mwangi, 2009). The group ranches were anticipated to encourage the pastoralists to invest in range improvement and reduce the stocking rates, encourage commercialized livestock production, increase the Maasai's contribution to the national economy, and provide the indigenous people with tenure security and guard against landlessness among pastoralists (Kimani and Pickard, 1998; Mwangi, 2009). The communities welcomed the concept of group ranches to secure their land and avoid the risk of losing more land from encroachment by immigrant farmers (Kimani and Pickard, 1998; Mwangi, 2009). Group ranches were created to enclose sufficient wet- and dry-season pasture and resources (Campbell et al., 2005). However, movement in extreme drought years beyond the ranch boundaries remained necessary, and thus the strict boundaries were not feasible (Campbell et al., 2005; Kimani and Pickard, 1998).

There has been a growing trend of group ranch sub-division into individual holdings (Carpenter and Seki, 2005; Kimani and Pickard, 1998; Mwangi, 2007, 2009; Nyariki et al., 2009). Among the identified factors motivating subdivision of group ranches are the difficulties in enforcing collective interests in resource allocation and the need to protecting individuals' land claims against threats of inappropriate allocation of group land to unauthorized individuals by the management committee (Campbell et al., 2005; Kimani and Pickard, 1998; Mwangi, 2007, 2009; Nyariki et al., 2009). While subdivision may initially have been motivated by poor management and difficulties in enforcing collective interests, research indicates that other factors have been important in motivating the transformation (Campbell et al., 2005; Mwangi, 2007). Other than the need to access capital markets and the pressures from the increasing number of individuals entitled to a share in a fixed land resource, subdivision appears to be an expedient strategy to exploit economic opportunities with altered land-holding systems (Campbell et al., 2003, 2005). For instance, individuals are observed to be eager to exploit opportunities arising from market liberalization and crop market development (Campbell et al., 2005).

Land subdivision in the area has resulted in fragmented rangelands and sales to mostly immigrant farmers, a key cause of rangeland degradation (Amman and Duraiappah, 2004; Flintan, 2011; Galaty and Ole Munei, 1999; Kimani and Pickard, 1998; Rutten, 1992). Average parcel sizes have decreased, while the number of fenced parcels and fragments converted to other land uses, such as crop farming, has increased. Fragmented rangelands result in the loss of flexibility and mobility of livestock. In addition, subdivision reduces the grazing capacity of land and spread in opportunistic grazing, leading to the overuse of resources in the confined areas (Boone and Hobbs, 2004; Hobbs et al., 2008; Meinzen-Dick and Mwangi, 2009). Furthermore, due to subdivision, the indigenous people are losing the fertile lands and being pushed into the marginal areas (Amman and Duraiappah, 2004; Kimani and Pickard, 1998). Exclusion further exacerbates the processes of environmental degradation, as marginal lands are used intensively beyond their capacity (Amman and Duraiappah, 2004; Kimani and Pickard, 1998). Ultimately, the combined processes of fragmentation, exclusion, and inhibition lead to increasing levels of poverty, both absolute and relative poverty (Amman and Duraiappah, 2004). It is, however, worth noting that there are some group ranches that have resisted subdivision to date (Mwangi, 2007).

Besides the group ranches that have resisted subdivision, an interesting development in the area has been the regrouping of some individual land owners in the area, with friends, neighbors, or kin to pursue joint herd/pasture management in their re-aggregated parcels (Mwangi, 2007). While each individual title holder retains the right to alienate his resource, the regrouping allows access rights to resources, such as pastures, among single-titled owners who have agreed to pursue shared strategies. Livestock benefit from rotational grazing in the shared space given the radical changes in production systems. Aggregation of the individual parcels indicates attempts to enhance sustainability of the production system given variation in the environmental conditions and pasture productivity characterizing the areas (Mwangi, 2007). Because dynamics in the land-holding systems involves rearrangement of use rights with significant effects on sustainable land management, factors behind these changes are of fundamental concern.

3. Frameworks

3.1. Conceptual Framework

The conceptual framework for this study is based on the theory of collective action (Ostrom, 1990, 2001, 2009), institutional economics (Kirsten et al., 2009a; Meinzen-Dick and Mwangi, 2009), and the capability approach by Sen (1980). In common property resources, rights are held by a defined group. The rights refer to 1) access rights (the right to enter a defined property), 2) withdrawal rights (rights to obtain goods from a resource), 3) management rights (rights to transform the resource and control its use patterns), 4) exclusion rights (rights preventing others to access the resource), and 5) alienation rights (rights to sell or lease or both of the above mentioned rights) (Schlager and Ostrom, 1992; Mwangi and Meinzen-Dick, 2009). These rights can be categorized as use rights and control or decision-making rights (Mwangi and Meinzen-Dick, 2009). The decision whether to cooperate in the joint provision and appropriation of pastoral resources or opt for an exclusive share of the resource pie would alter the rights that an individual can exercise. This would have impacts on the sustenance of the ecosystem.

Studies analyzing individual incentives to cooperate in collective action (Baland and Platteau, 2007; Meinzen-Dick et al., 2002; Ostrom, 2009) show that collective action outcomes depend on the incentive structure available to users. Individuals weigh benefits and costs in specific action situations, which in turn influence their decision. Individuals' incentive structures are on the other hand influenced by a range of factors, such as socio-economic factors, among others (Agrawal, 2001; Dayton-Johnson, 2000; Gebremedhin et al., 2004; Meinzen-Dick et al., 2002; Ostrom, 2009; Willy and Holm-Müller, 2013). Ostrom (2009) illustrates how core subsystems of a social ecological system affect each other as well as link social, economic, and political settings and related ecosystems. The core subsystems – resource systems, resource units, governance systems and resource users – are made up of multiple second-level variables (Ostrom, 2009). The second-level variables interact in processes such as self-organizing activities to produce outcomes. An example of a possible outcome is the ecological performance of a natural resource (Ostrom, 2009). The author further highlights that, in regard to the management of natural resources, when anticipated benefits of managing a resource collectively exceed the perceived costs of organization, users are likely to engage in collective action to manage the resources (Ostrom, 2009). However, second-level variables in a social ecological system have been observed in empirical studies to affect the perceived benefits and costs of users and thus affect the probability of users engaging in collective action (Ostrom, 2009).

As pointed out earlier, the capability concept is associated with the range opportunities that individuals can fully utilize to lead the life they want as well as the constraints that limit individuals to certain choices (Krishnakumar and Ballon, 2008; UNDP, 1997). In other words, capabilities point to an individual's capacity for action or choice. In the context of natural resource management, capabilities determine the capacity for action and subsequently for change in managing land and land resources (Krishnakumar and Ballon, 2008). Capabilities can therefore be interpreted as causal powers that lead not only to different economic outcomes but also to different natural resource management outcomes (Krishnakumar and Ballon, 2008; Martins, 2006; Sen, 2009). There exists ample literature showing that living conditions and knowledge are important components of basic capabilities and form an integral part of human capabilities (Di Tommaso, 2007; Krishnakumar and Ballon, 2008; Psacharopoulos and Yang, 1991; Sen, 2009; Bérenger and Verdier-Chouchane, 2007; UNDP, 1997).

There is ample empirical evidence showing that living conditions influence human development, defined here as the process of expanding people's choices and the level of well-being they can achieve (UNDP, 1997). Living conditions influence the physical health, mental health, and social and emotional development of an individual, which ultimately affects their ability to achieve (Lundberg, 1991; Marmot et al., 2008; Siebens, 2013; Layte et al., 2010; Gove et al., 1979; Rahkonen et al., 1997; Mann et al., 1992; Di Tommaso, 2007; Krishnakumar and Ballon, 2008). For instance, empirical evidence from medical studies shows that household crowding is significantly related to social relationships and the mental and physical health of an individual (Gove et al., 1979). In a different study, living conditions are shown to impact the health of an individual (Rahkonen et al., 1997; Mann et al., 1992). The influences living conditions have on the well-being of individuals also affect the ability of an individual to achieve acceptable levels of functionings. This is illustrated in the empirical findings by Lundberg (1991), and Marmot et al. (2008), in which poor living conditions were observed to affect life chances through skill development, education, and occupational opportunities (Lundberg, 1991; Marmot et al., 2008). Poor living conditions therefore curtail basic capabilities or freedoms that would enable an individual to have the kind of life they want (Bérenger and Verdier-Chouchane, 2007; Krishnakumar and Ballon, 2008; UNDP, 1997). On the other hand, knowledge influences the command that an individual has over resources as well as social factors that in turn affects what the individual can achieve or choose to do (Di Tommaso, 2007; Krishnakumar and Ballon, 2008). The two components are not only able to capture the well-being and role of individuals in influencing economic production (Krishnakumar and Ballon, 2008; Sen, 2009) but are also able to capture basic capabilities in other dimensions such as those in health and social change. For example, better living conditions are observed to impact positively on the health of households (Gove et al., 1979; Ross et al., 1990). In addition, according to the new institutional economic theory, capabilities, in the form of skills and knowledge, are viewed as a factor that brings about social changes such as changes in institutions (North, 1995). Skills and knowledge acquired by individuals change their perceptions about changing/evolving opportunities that may be exploited and may lead to changes in institutions in an effort to pursue the perceived opportunities. The changes in institutions could be, for example, from collective management to exclusive ownership of resources. Based on the above discussion, literature review, and data availability issues, Fig. 1 above illustrates how the identified factors facilitate or hinder collective management of pastoral resources.

3.2. Theoretical Framework

Households' decisions whether to cooperate in the joint provision and exploitation of pastoral resources are illustrated using the economic theory of land. In this theory, landowners are assumed to maximize utility, leading them to choose land uses that yield the highest benefits (Rashford et al., 2011). Following Nelson and Hellerstein (1997) and Chomitz and Gray (1996), land is assumed to be devoted to the highest-rent use such that a parcel at point l will be devoted to land use k if $R_{lkT} > R_{lhT}$, $h \neq k$. The land use decision can be modeled using a multinomial logit model as shown:

$$prob_{hl}(l \text{ devoted to } h) = \frac{e^{X_l B_h}}{\sum_j e^{v_l B_j}} \quad (1)$$

where B = vector of reduced form parameters. Vector X consists of three sets of variables: G = site-specific productivity variables, C = cost-of-access variables, and S = spatial effects of geophysical variables. Eq. (1) can be used to model land use decisions, for instance in arid and semi-arid environments, by integrating additional data such as socio-economic data (see Ellis et al., 2010). In these ecosystems, collective management of pasture resources is highly favorable compared to exclusive land ownership systems. This mainly arises from the wide gap in the availability and access to physical resources, such as pastures, between communal large-scale production systems and exclusive appropriation systems (Kahi et al., 2006). In addition, due to the high heterogeneity associated with semi-arid and arid areas, collective management systems also ensure access to pastures in all seasons. Furthermore, with limited physical resources, exclusive appropriation systems would require high investments in feed, infrastructure, and labor, making the system unattractive to households (Kahi et al., 2006). However, some factors might increase the benefits associated with exclusive appropriation of land compared to collective management of resources. For instance, increased capabilities may be associated with increased land use options under exclusive land ownership. In cases in which the potential net rents from collective action are less than potential benefits with exclusive appropriation of the resource pie, land users would opt out of the common property resource use.

3.3. Empirical Framework

To estimate the effect of capabilities and other factors on decisions regarding whether to participate or not in collective management of pastoral resources, a zero-inflated beta model is employed. The primary motivation for this method lies on the response variable which takes fractional values and has a mass point at 0. First, the zero-inflated beta model allows for the clustering of observations at zero. Second, in

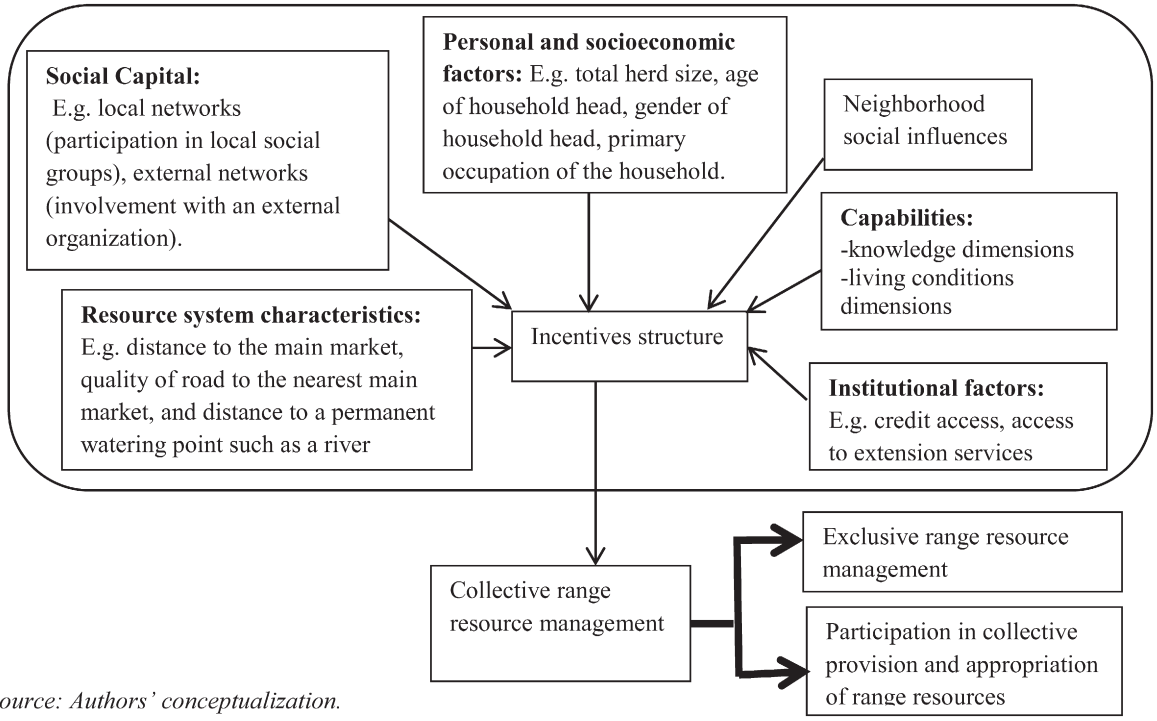

Fig. 1. Conceptual framework.
Source: Authors' conceptualization.

estimations where the response variable takes fractional values, the conditional expectation is only defined on the bounded interval (0, 1) (Papke and Wooldridge, 1996; Cook et al., 2008). This implies that the conditional expectation needs to be a nonlinear function of the regressors (Cook et al., 2008). The use of a linear conditional expectation function estimated by least squares, such as the Tobit model or instrumental variables, would produce biased and inconsistent estimates of coefficients and standard errors (Cook et al., 2008; Papke and Wooldridge, 1996). Third, in fractional responses models, empirical evidence shows that the conditional variance must be a function of the conditional mean (Cook et al., 2008). Zero-inflated beta models are shown to be applicable in this case (Cook et al., 2008).

Other than to issues related to the dependent variable, the zero-inflated beta model enables the study to correct for, if any, self-selection bias. A sample selection issue would occur, for example, if households select themselves into participation or non-participation in collective management of range resources. That is, if different factors generate the observations with zero extent values in participation. The zero-inflated beta model allows for non-participation to be generated by a different process. The zero-inflated beta specification consists of three parts (Buis, 2010):

a. a logistic regression model for whether or not the proportion equals 0,
b. a logistic regression model for whether or not the proportion equals 1,
c. a beta model for the proportions between 0 and 1.

In the sample, there are no households with an extent value of one, but a significant number has zero values; there the study employs the zero-inflate option to model the zeros separately. The zero-inflated beta model is formulated as follows (Cook et al., 2008):

$$f(y_i = 0 : X_i) = 1 - C(\alpha' X_i) \text{ for } y_i = 0, \quad (2)$$

and

$$f(y_i : X_i) = C(\alpha' X_i)\left[\frac{\Gamma(p+q(X_i)}{\Gamma(p)\Gamma(q(X_i))} y^{p-1}(1-y_i)^{q(X_i)-1}\right] \text{for } 0 < y_i < 1 \quad (3)$$

where $q(X_i) = p\exp(-\beta' X_i)$, p is a parameter of the beta distribution and $C(\alpha' X_i)$ represents the probability of a household to participate in collective provision and appropriation of pastoral resources.

4. Data Collection and Analysis Methods

4.1. Data

The data used in this study was collected from a random sample of 360 households in Narok County between November 2013 and February 2014. The area was chosen based on the existing different pastoral systems (pastoral leasing, agro-pastoral, pastoral, pastoral/tourism) forming a good representation of the pastoral systems found in the country. The total number of households selected was based on the formula given by Bartlett et al. (2001). The sample design of the study was based on a multistage stratified random sampling procedure. In the first stage, the study purposively selected 6 divisions based on the presence of pastoral activities to form our sampling strata. In the second stage, with the help of officials from the Kenya National Bureau of Statistics (KNBS) offices in Narok and division administrative officials, two locations were randomly selected with equal probability from each of the divisions. Two sub-locations were then selected randomly with equal probability within each of the locations. Overall, 24 sub-locations were randomly selected within the six divisions. The next step involved selecting a village randomly with equal probability from each of the randomly selected sub-locations. This was done with the help of administrative officials (chiefs). In the last stage, from the shortlisted villages, a sampling frame was prepared for each village with the assistance

of chiefs and village elders. A total sample of 360[1] households was then drawn from the villages selected, with the help of village elders and local chiefs, proportional to the number of households. Questionnaires were administered through personal interviews with household heads and/or their spouses. The survey collected information on participation in collective management of pasture resources, social and financial capital, networking, information and extension, and socio-economic and demographic characteristics, among others.

Principal component analysis (PCA) is employed to generate indices on basic capabilities and material wealth of households. To measure capabilities, the study follows Krishnakumar and Ballon (2008), in which basic capability indicators under two dimensions are considered: knowledge and living conditions dimensions. While other dimensions of capabilities can be considered, we believe that the two dimensions constitute a strong measure of basic capabilities, as they reflect other dimensions of basic capabilities as discussed earlier. The PCA was conducted in three steps. First, following the existing literature, various observed indicators of the two dimensions of basic capabilities are identified (Barrett, 2010; Krishnakumar and Ballon, 2008; OECD, 2015; Psacharopoulos and Yang, 1991; Sen, 2009; UN Habitat, 2003). Among the indicators considered based on the availability of data included knowledge indicators, quality of dwelling conditions, access to and quality of the basic services conditions, and additional capabilities related to well-being. Second, using PCA, the first principal component variable across households was computed on the observed indicators. Given that the data is not expressed in the same units and hence is not standardized, I derived the eigenvectors (weights) using the correlation matrix to ensure that the data had equal weight and none dominated the others (Vyas and Kumaranayake, 2006). The study makes the assumption that the first principal component, with an associated eigenvalue of 5.158 and accounting for 43.0% of the variation in the original data, is a measure of household basic capabilities (Appendix Table A.1). Third, using the factor scores (weights) from the first principal component, a dependent variable with a mean of zero and a variance of λ is constructed for each household (Co′rdova, 2009). The variable, with positive as well as negative values, is regarded as the "relative degrees of basic capabilities" of a household, and the higher the value, the higher the implied capabilities of that household. Kaiser–Meyer–Olkin (KMO) was used to verify the sampling adequacy for the analysis. Following the literature (Berman et al., 2014; Co′rdova, 2009; Vyas and Kumaranayake, 2006), a similar procedure was followed to generate a relative wealth index variable as a measure of material wealth. The first principal component, with an associated eigenvalue of 3.717 and accounting for 31.0% of the variation in the original data, was taken to be a measure of household wealth (Appendix Table A.2).

Following Willy and Holm-Müller (2013), the study formulated a neighborhood social influence indicator (Case, 1992; Hautsch and Klotz, 2003) to represent the social pressure in participation in the collective rangeland management as shown:

$$\mathrm{NEISOCINFL}_i = \frac{\sum X_i}{\sum_{i=1}^{N-1} B_k} \tag{4}$$

where X_i indicates the behaviors performed by household i that are similar to those of other households in the village (that is, participating or not participating in collective provision and appropriation of pastoral resources) in the previous period, and B_k are the behaviors performed by all other households within the village. In the analysis, increased basic capabilities are hypothesized to reduce the probability of a household participating in collective management of pasture resources and also to negatively influence the extent of participation among the participating households.

[1] The sample size is calculated to account for contingencies such as possible missing or failed cases.

4.2. Description of Variables

Table 1 presents the descriptive statistics of the variables used in the estimations. The indicators of participation in the collective management of pastoral resources used in the study include: (1) individual land owners/households who have re-aggregated part of the individual parcels of land to pursue collective herd/pasture management and (2) households in group ranches managing land collectively.

The dependent variable measures the extent of participation by a household. This is given by the proportion of land used collectively to total land one owns or has access to. Whereas the extent of participation in re-aggregated parcel is clear (re-aggregated area/total land owned), in the case of group ranches, the extent of participation by a household is determined by the area within the group pastures not converted to other uses, mainly cropping; that is, the share of non-restricted grazing land per household. As indicated by Hobbs et al. (2008), fragments of land converted to other uses, such as cropping, become unavailable for livestock and other herbivores. As such, the extent of joint provision and exploitation of rangeland resources under group ranches is limited by the spatial conversion of land fragments to other uses. Therefore, the extent of participation of households under group ranches who have converted larger areas of land to other uses is lower compared to those with fewer conversions.

5. Results

Table 2 presents the estimated marginal effects from the zero-inflated beta estimation model. Column one contains the marginal effects of the logit model that seeks to explain the exact 0 s. In this study, the section seeks to explain zero extent that occurs with non-participation. Column two contains the marginal effect estimates of the beta-model for the proportions between 0 and 1; it explains the extent of participation when participation is not zero. As expected, the marginal effects on column 2 are relatively low due to the inclusion of proportions only between 0 and 1. Low changes are predictable due to the narrow range over which changes can be made. Lastly, column three presents the marginal effects when the whole sample is considered. The model specification passes the link test.

The regression results suggest that household basic capabilities are statistically significant in determining participation and the extent of participation in collective management of range resources. In the study area, households with higher basic capabilities are more likely to have zero extent of participation by 22.8 percentage points. When participation is not zero, increased basic capabilities reduce the extent of participation by 1.3 percentage points and by 16.6 percentage points when the whole sample is considered. The elements of social capital together with neighbors' influences included in the analysis are also found to significantly influence participation. In the sample, households with higher neighborhood influences, who participate in social groups or are involved with external organizations are less likely to have zero extent of participation (column 1). These factors are also associated with a higher extent of participation when the whole sample is considered (column 3). However, where participation was not zero, only the involvement with external organizations was found to significantly influence the extent of participation. Households who had networks with external organizations had a higher extent of participation by 4.8 percentage points.

With regard to the role of resource systems characteristics, the model suggests that these variables are statistically significant in determining the probability of households' participation in collective management of range resources. Measures of market access have a significant influence on participation. Access to good roads increases the probability of having zero extent of participation by 89.0 percentage points while increased distance to the market reduces the probability of having zero extent of participation by 7.1 percentage points (column 1). Similarly, when the whole sample is considered, improved road

Table 1
Description of dependent and explanatory variables.

Variable	Description/measurement	Mean/proportion	Std. dev.	Min	Max	Expected sign
Dependent variables						
Pextent	Participation extent measured as a proportion of land used collectively (under joint pasture management) to total land	0.409	0.440	0	.988	
Explanatory variables						
Neisocinfl	Neighborhood social influences index (ratio with range 0–1)	0.228	0.200	0.026	0.875	+/−
Qlrd	Quality of road to the nearest main market (dummy, 1 = graveled or tarmac; 0 = earth)	0.371	0.484	0	1	−
Dmkt	Distance to the main market (km)	8.277	7.153	1	26	+
Dnriver	Distance to the nearest permanent watering point such as a river (km)	16.949	15.620	0.5	46	+
Genderhh	Gender of household head (dummy, 1 = Female)	0.135	0.342	0	1	−/+
Agehh	Age of household head in years (dummy, 1 if age > = 55)	0.200	0.401	0	1	−
Proccup	Primary occupation of the household (dummy, 0 = livestock production; 1 = others)	0.340	0.474	0	1	−
Acescredt	Credit access to the household (dummy, 1 = yes)	0.218	0.413	0	1	+
Herd	Herd size	36.030	23.547	1.999	99.039	+
Wealthindex[a]	Level of household wealth	0	2.177	−1.762	9.628	−
Capbindex[a]	Degree of household basic capabilities	0	2.270	−4.555	5.429	−
Hhsize	Household size	6.233	3.024	1	15	+
Acextn	Access to extension services (dummy 1 = yes)	0.507	0.501			+/−
Pvdtrn	Access to training in agricultural production (dummy 1 = yes)	0.178	0.383	0	1	−
Scegps	Participation in social groups (dummy 1 = yes)	0.478	0.500	0	1	+
Invol	Involvement with an external organization (dummy 1 = yes)	0.301	0.459	0	1	+

Source: *Field Survey, 2013/2014.*
[a] Measured using principal component analysis (PCA).

quality reduces the extent of participation whereas as the distance to market increases, extent of participation increases (column 3). The variables, however, do not have a significant effect on extent for proportions between 0 and 1 (column 2). The distance of a household to a permanent watering point such as a river was found to significantly influence both participation and the extent of participation. Increased distance to a permanent watering point is found to reduce the probability that a household has zero extent of participation and at the same increases the extent of participation when the whole sample is considered (columns 1 and 3). Additionally, an additional kilometer away from a permanent watering point is found to increase the extent of participation by 0.004 percentage points when participation is not zero (column 2).

Table 2
Factors influencing households' decisions to participate in collective provision and appropriation of rangeland resources (pastures).

Variables	Zero/one inflated beta — marg. effects		
	Probability of having value 0 (1)	Conditional on not having value 0 or 1 (2)	Proportion (3)
Neighborhood social influences	−1.708**	−0.053	1.167**
	0.698	0.069	(0.477)
Quality of road	0.890***	0.004	−0.621***
	0.089	0.062	(0.069)
Distance to the market	−0.071*	−0.003	0.048*
	0.038	0.002	(0.027)
Distance to the river	−0.140***	0.004***	0.100***
	0.030	0.001	(0.021)
Gender of hh head	−0.336	−0.010	0.228
	0.239	0.025	(0.166)
Age of hh head	0.097	0.005	−0.066
	0.291	0.019	(0.204)
Primary occupation of the hh	0.384	−0.036	−0.283
	0.293	0.038	(0.199)
Level of hh wealth	−0.062	−0.004	0.041
	0.048	0.006	(0.034)
Degree of hh capability	0.228***	−0.013***	−0.166***
	0.061	0.005	(0.044)
Involvement with an external organization	−0.877***	0.048*	0.644***
	0.079	0.028	(0.058)
Herd size	−0.008**	0.005	0.006**
	0.004	0.009	(0.003)
Household size	−0.037	0.001	0.026
	0.048	0.003	(0.033)
Credit access	0.301	0.003	−0.209
	0.293	0.022	(0.204)
Participation in social groups	−0.484**	0.005	0.338**
	0.199	0.018	(0.138)
Contact with extension service providers	0.496*	0.028	−0.333*
	0.267	0.029	(0.192)
Access to agricultural production training	0.121	0.038	−0.068
	0.348	0.030	(0.251)
Model summary	Wald chi^2 (16) = 81.83***		
	Standard errors in parentheses, no. of observations 352, ***p < 0.01, **p < 0.05, *p < 0.1		

Access to extension agents is the only institutional factor found to significantly influence participation in the study. Contact with extension service providers increases the probability of households' having zero extent of participation (column 1). Contact with extension agents also reduces the overall extent of participation by 33.3 percentage points (column 3). The factor, however, does not significantly influence the extent for the households participating in collective management (column 2). The regression results also demonstrate that socioeconomic factors play a significant role in the collective management of pastoral resources. The herd size of a household is found to significantly influence participation. Increased herd sizes are observed to reduce the probability of households having zero extent of participation (column 1). In addition, an additional unit of livestock increases the overall extent of participation by 0.06 percentage points (columns 3). Herd sizes, however, do not significantly influence the extent of the households' participation in collective management (column 2).

The study employs various other specification techniques, such as the fractional GLM specification advocated by Papke and Wooldridge (1996) for handling proportional regressions for robustness checks (Appendix B). Similar results to the zero-inflated beta model are found.

6. Discussion

The regression results from the zero-inflated beta model indicate differences in the influence of variables on boundary observations (zero participation) from non-boundary observations (non-zero participation). Similar to the findings by Cook et al. (2008), the regression results show existing differences in the factors influencing participation in collective management of range resources from factors influencing the extent of the participation. The probability of a household participating in collective management of range resources is found to be influenced by various variables: neighborhood influences, degree of household

basic capabilities, distance to the main market, distance to a permanent watering point, quality of the roads, involvement with external organizations, and participation in social groups. However, distance to the nearest permanent watering point, household basic capabilities, and involvement with external organizations are the only variables found to significantly influence the extent of participation for households participating in the collective management of range resources.

The regression results demonstrate that household basic capabilities play a significant role in the collective management of pastoral resources. As highlighted by Ballet et al. (2015), capability changes can present an obstacle to the collective management of natural resources. Increased basic capabilities reflect the strategic power of an individual or individuals and are essential to transform one form of capital into another form. In this case, greater capabilities increase opportunities for alternative uses of rangeland resources. These findings are in line with the new institutional economic theory according to which capabilities, in the form of skills and knowledge, shape individuals' perceptions about opportunities that may be exploited (North, 1995). This increases the options/choices that an individual has and ultimately leads to changes in institutions, such as property rights, to facilitate their exploitation (North, 1995). Greater capabilities, therefore, provide exit options for households from managing range resources collectively and generate opportunities for different rangeland uses. In contrast, limited capabilities restrict individuals' capacity to explore various options, ensuring that collective use of pasture resources is maintained. The effect of increased basic capabilities could be viewed positively as it reduces collective action problems of interdependency among individuals (Kirsten et al., 2009b). As observed, increased capabilities liberate participants to pursue their interests, so that their efforts influence the individual benefits with no wider benefits to all. Increased capabilities are also associated with less transaction costs of monitoring and enforcing participants' adherence to rules (Kirsten et al., 2009b). On the other side, increased basic capabilities are likely to weaken social cohesion, cultural values, and customs, which are social capital components associated with collective management of pastoral resources. These unquantified social costs are likely to affect cooperation of communities in other areas for joint well-being.

Components of social capital included in the model significantly influence participation in collective management of pastoral resources. The degree of promotion that a household receives from neighboring households is likely to affect their actions along a particular path, such as that of participating in collective management of pastoral resources or adoption of a technology (Case, 1992; Willy and Holm-Müller, 2013). As indicated by Willy and Holm-Müller (2013), the degree of promotion (neighborhood influences) could either be positive or negative, depending on which of the two is stronger. In this study, the positive effect is stronger, as neighborhood social influence is found to have a positive effect on collective management of pasture resources. Participation in social groups is also found to facilitate collective management of pastoral resources. Social participation enables households to establish social networks and also involves repeated interactions, leading to higher social capital (Willy and Holm-Müller, 2013). Cooperative efforts are thus likely to be higher in households with higher social capital. This provides fertile ground for collective action (Gebremedhin et al., 2004; McCarthy et al., 2004; Willy and Holm-Müller, 2013). External social networks, measured by a household's involvement with external organizations, also play a significant role in prompting the collective management of pastoral resources. Involvement with external organizations in the management of pasture resources is likely to increase the benefits associated with the ecosystems. External organizations have been shown to provide external support as well develop the capacity of households to utilize the full potential of rangelands, such as with wildlife tourism (Bell and Prammer, 2012; Osano et al., 2013). This enables pastoral communities to exploit rangelands in more beneficial ways, leading to increased economic benefits and thus the value of the ecosystems to rural communities. Increased economic value associated with rangelands in turn could serve as an incentive to increase cooperation levels in the management of the resources to ensure their sustenance and also continued flow of benefits. The above confirms the findings of Dayton-Johnson (2000) and Narloch et al. (2012), which indicate that higher individual benefits associated with cooperation are likely to lead to higher levels of cooperation.

The role of resource system characteristics in collective management of pastoral resources suggests a von Thünen-like model (Fujita and Thisse, 2013; Serneels and Lambin, 2001). In von Thünen's model, land use is determined by land rent–locational rent. In the study, in addition to distance to the market, land rent is determined by additional variables, namely proximity to a permanent water source and quality of roads, as an additional proxy for transportation costs. This is in line with the work by Serneels and Lambin (2001). Quality of the road network and distance to the market have a significant influence on participation in collective action. In line with the empirical work by Gebremedhin et al. (2004) and Carpenter and Seki (2005), increased market access may result in competitive environments undermining collective management of the pastoral resources. Competition, as indicated by the new institutional economic theory (North, 1995), is a key driver for institutional changes, such as redefinition of land use arrangements from collective management to exclusive property rights. On the other hand, larger distances to the market are relevant in reducing the opportunity cost of land and providing fewer exit options to manage the land collectively (Gebremedhin et al., 2004). In addition, as indicated by Rashford et al. (2011), characteristics of a parcel of land, such as closeness to water bodies, are also likely to affect collective management of pastoral resources. Parcels of land near water bodies such as rivers are more responsive to changes in the economic returns, increasing exit options of managing pastoral resources collectively.

Access to extension agents is found to have a negative influence on collective management of pasture resources. As explained in Onemolease and Alakpa (2009), contact with extension agents is likely to lead to the adoption of more agricultural innovations, such as fodder conservation and pasture establishment and thus likely to reduce the need of collective management of pastoral resources. The socioeconomic factors are also shown to play a significant role in collective management of pastoral resources. Households with larger herd stocks are more likely to participate in the collective management of pastoral resources. With large numbers of livestock, collective management of pastoral resources mitigates the consequences of environmental variability characterizing the ecosystems (Mwangi and Meinzen-Dick, 2009).

7. Conclusions and Policy Implications

Collective ownership of range resources is a fundamental pillar in structuring the use of pastoral rangelands. These systems allow for joint provision and exploitation of rangeland resources, providing a more equitable way of distributing pasture resources that are highly variable over time and space. In addition, collective management of range resources, unlike exclusive property rights, provides significant returns to scale. Under these systems, pastoralists have access to larger areas capable of providing water and good pastures in both dry and wet seasons, reducing the risks emanating from low and erratic rainfall and variations in pasture productivity characterizing rangelands. Furthermore, exclusive property rights undermine the capacity of pastoral communities to sustainably use the ecosystems as well as deal with risks such as droughts.

However, collective management of natural resources does not always emerge and is affected by various factors. This study used

econometric approaches to assess the influence of basic capabilities, among other factors, on the participation and extent of participation in the collective management of pasture resources in southwestern Kenya. Regression results indicate differences in the factors influencing participation in the collective management of range resources from factors influencing the extent of the participation. From the findings, increasing neighborhood influences, participation in social groups, involvement with external organizations, large distances to the main market and to a permanent watering point, and large herd sizes are associated with lower probabilities of zero extent of participation. On the other hand, households who have access to better roads and higher basic capability levels are more likely to have zero extent of participation. With regard to non-boundary observations (non-zero participation), distance to the river, household capabilities, and involvement with external organizations are the only variables with significant influence on the extent of participation.

While increased basic capabilities reduce cooperation levels in collective management of pastoral resources, it has the advantage of liberating participants to pursue their interests and reducing collective action problems of interdependency among individuals. Increased capabilities are also associated with less transaction costs of monitoring and enforcing the adherence to rules associated with collective action. However, increased capabilities may result to unquantified social costs. Less association of communities is likely to weaken or destroy social cohesion, cultural values, and customs of pastoral communities and may affect their cooperation in other areas for joint well-being.

Important policy implications can be drawn from these findings. Identifying the factors that facilitate or hinder collective management of pastoral resources can make a valuable contribution in identifying efforts needed to mitigate risks likely to be experienced with exclusive property rights. In addition, the results could facilitate the design of more effective pastoral resource conservation programs. The findings suggest that building social capital may have significant benefits for collective management of natural pasture resources. Possible approaches to achieve this are through policies that enhance the presence of external supporting actors at the grassroots in addition to recognizing and facilitating capacity building of local groups. These policies are likely to expand communities' social networks and social participation. In addition, the policies are likely to enable participants to exploit the opportunities available with collective management of range resources, for instance, pastoral tourism and organic livestock production. Furthermore, policies that present short-term rewards for cooperation in management of range resources could increase individuals' benefits associated with cooperation and thus encourage collective management of natural resources. These policies could be either in the form of increased service delivery such as access to livestock markets and information on livestock market prices beyond Narok County.

The effect of other forms of capital such as increased capabilities (ability to achieve) and resource system characteristics indicate that collective action in natural resource management may not always be viable for improved rangeland management. The results highlight the need for policies that encourage the adoption of improved range management technologies in areas where the law of nature (communal management of land) is being abandoned for the capitalist structure (privatization of communal resources). The policies may include conservation agriculture and the production of good quality forages adapted to grazing and drought stress.

The main limitation of the analysis in this study lies in the failure to integrate risks facing rangeland users in the analysis of participation in the collective management of pastures. As highlighted earlier, there are inherent risks associated with the stochasticity of rainfall and variations in pasture productivity in rangelands found in arid and semi-arid areas (Domptail and Nuppenau, 2010; Kimani and Pickard, 1998). The level of these risks depends on the severity of drought, the level of overgrazing, and the fragility/resilience of particular land/parcel. The risk measurement thus provides a sizeable challenge because the risks associated are stochastic (stochastic events) and the related dynamics are not linear but determined by thresholds (Domptail and Nuppenau, 2010; Domptail, 2011). Bio-economic models, however, allow representation of non-liner and threshold dynamics such as those observed in rangelands (Domptail, 2011). In addition, bio-economic models allow for the depiction of land user strategies related to risks, as shown by Janssen and van Ittersum (2007) and employed by Domptail and Nuppenau (2010). Further work using bio-economic models may address this limitation to understand how risks affect pastoral and agro-pastoral farmers' decisions on collective management.

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Appendix A

Table A.1
Principal component analysis on degree of capabilities.

Variable description	Mean	Std. dev.	Factor scores/weights for each variable
Years of schooling	5.600	4.845	0.4028
Literate	0.481	0.500	0.3613
Level of education achieved	0.713	0.878	0.4008
Main walling material	0.153	0.361	0.2083
Main roofing material	0.572	0.495	0.2951
Toilet facility	0.298	0.458	0.2878
Lighting	0.100	0.301	0.1762
No. of people living in one house (measure of living in crowded conditions)	6.233	3.024	−0.0092
Access to the health center	4.786	4.160	−0.2649
Access to drinking water	2.332	1.592	−0.2815
Source of drinking water(protected and covered)	0.489	0.500	0.2829
Sufficiency of household food consumption (food access)	2.916	0.817	0.2696
KMO	0.864		
Largest eigenvalue, λ	5.158		
Proportion of variance explained	0.430		

Table A.2
Principal component analysis on relative wealth index (material wealth index).

Variable description	Mean	Std. dev.	Factor scores/weights for each variable
Plow	0.067	0.250	0.201
Donkey/ox cart	0.019	0.138	0.150
Wheel barrow	0.180	0.385	0.319
Tractor	0.012	0.109	0.219
Cattleshed	0.387	0.488	0.352
Bicycle	0.043	0.204	0.184
Radio	0.385	0.487	0.390
Television	0.070	0.255	0.310
Car	0.031	0.174	0.282
Mobile phone	0.447	0.498	0.406
Water tank	0.091	0.288	0.315
Motorcycle	0.053	0.224	0.199
KMO	0.764		
Largest eigenvalue, λ	3.717		
Proportion of variance explained	0.310		

Appendix B. Robustness checks — factors influencing households' decisions to participate in collective provision and appropriation of rangelands resources

	Fracglm		Heckman		Tobit	
Variables	Participation extent coeff. (1)	Marg. effects (2)	Selection eq. coeff.[a] (3)	Outcome eq. coeff. (4)	Participation extent coeff. (5)	Marg. effects (6)
Neighborhood social influences	1.370**	0.321**	4.088**	−0.003	0.357***	0.245***
	(0.646)	(0.153)	(1.669)	(0.074)	(0.136)	(0.093)
Quality of road	−0.990**	−0.232***	−3.563***	0.011	−0.268***	−0.184***
	(0.400)	(0.090)	(0.996)	(0.107)	(0.088)	(0.059)
Distance to the market	0.030	0.007	0.218***	−0.004	0.008	0.006
	(0.026)	(0.006)	(0.063)	(0.005)	(0.005)	(0.004)
Distance to the river	0.124***	0.029***	0.309***	0.006***	0.027***	0.019***
	(0.011)	(0.003)	(0.060)	(0.002)	(0.003)	(0.002)
Gender of hh head	−0.008	−0.002	0.241	0.041	−0.055	−0.038
	(0.359)	(0.084)	(0.854)	(0.048)	(0.078)	(0.053)
Age of hh head	−0.357	−0.084	−1.016	0.038	−0.086	−0.059
	(0.256)	(0.060)	(0.740)	(0.038)	(0.065)	(0.045)
Primary occupation of the hh	−1.007***	−0.236***	−1.139**	−0.007	−0.296***	−0.203***
	(0.303)	(0.067)	(0.510)	(0.048)	(0.065)	(0.044)
Level of hh wealth	−0.028	−0.007	0.044	−0.005	−0.004	−0.002
	(0.068)	(0.016)	(0.161)	(0.012)	(0.018)	(0.012)
Degree of hh capability	−0.343***	−0.080***	−0.582***	−0.025**	−0.088***	−0.060***
	(0.085)	(0.019)	(0.196)	(0.010)	(0.017)	(0.011)
Involvement with an external organization	2.415***	0.566***	4.524***	0.151**	0.610***	0.418***
	(0.482)	(0.104)	(1.233)	(0.065)	(0.093)	(0.062)
Herd size	0.005	0.001	0.022**	−0.000	0.001	0.001
	(0.003)	(0.001)	(0.010)	(0.000)	(0.001)	(0.004)
Household size	0.008	0.002	−0.014	0.004	0.000	0.002
	(0.037)	(0.009)	(0.080)	(0.005)	(0.009)	(0.006)
Credit access	0.418	0.098	−0.096	0.028	0.107	0.073
	(0.380)	(0.090)	(0.718)	(0.045)	(0.077)	(0.053)
Participation in social groups	0.698**	0.164**	1.469**	0.021	0.159**	0.109**
	(0.283)	(0.066)	(0.643)	(0.040)	(0.065)	(0.044)
Contact with extension service providers	−0.341	−0.080	−1.175*	0.037	−0.057	−0.039
	(0.235)	(0.055)	(0.615)	(0.041)	(0.062)	(0.042)
Access to agricultural production training	−0.293	−0.069	−0.234	−0.046	−0.074	−0.051
	(0.380)	(0.089)	(0.635)	(0.053)	(0.087)	(0.060)
Constant	−3.527***		−7.523***	0.593***	−0.467***	
	(0.479)		(1.617)	(0.091)	(0.119)	
Mills lambda				0.016		
				(0.076)		
Sigma					0.388***	
					(0.022)	
Model summary[1]	Deviance = 119.0293093 Pearson = 190.0767306		Wald chi^2 (16) = 28.46**		LR chi^2 (16) = 387.03*** Pseudo R^2 = 0.559	

[a] Whether the household participates in collective management of pastoral resources.
[1] Standard errors in parentheses, no. of observations 352.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

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