Title: Cross-scale relationships between social capital and women's participation in decision-making on the farm: a multilevel study in semi-arid Kenya

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Highlights

- Social capital dimensions have positive and negative associations with women's participation in farm decision-making.
- Divisional poverty levels mediate associations between social capital and women's decision-making across scales.
- Divisional education attainment is more strongly associated with women's decision-making than individual attainment.

Abstract

Social capital develops through relations between people and groups within community social networks. Women in smallholder agrarian communities often draw on social capital to influence their intra-household bargaining positions, with significant implications for their resource access. However, the extent to which women use different types of social capital to increase their participation in agricultural decision-making remain understudied. This research examines the relationships between women's participation in agricultural decision-making and bonding, bridging, and linking social capital and how broader contextual factors can interact with the pathways through which social capital functions in rural semi-arid Kenya. In 2014, we collected and analyzed quantitative and qualitative data: household (N = 206) and community (n = 127) surveys, key informant interviews (n = 77), twelve focus group discussions, and eight community meetings. Results indicate that women draw on bridging social capital to increase the diversity of their information and training sources. We found that women's participation in decision-making has a positive association with bonding social capital and a negative association with linking social capital. Multilevel analysis reveals cross-scale interactions between poverty prevalence and social capital on women's decision-making participation. Findings suggest that advances in regional development have the potential to amplify the stock and usage of social capital for women's empowerment in smallholder agrarian systems.

Keywords: Food and nutrition security; Gender; Intra-household dynamics; Multilevel analysis; Social ties; Social networks

1 Introduction

Gender relations are critical in affecting sustainable development in smallholder agrarian systems (Agarwal, 1997; De Haan and Zoomers, 2005; Doss, 2011; Yngstrom, 2002). In Africa, many nations have enacted legislation and public policies designed to promote gender equity (Cotula, 2007; FAO, 2010), yet access to resources at the local level remains largely governed by traditional gender norms and patrilineal systems of resource allocation (Koopman, 2009; Po and Hickey, 2018). In many cases, women face more constraints in formal access to agricultural and land resources than men (Agarwal, 1997; Doss et al., 2015; Kevane, 2012; Meinzen-Dick et al., 1997a; 1997b), often with significant implications for household food and nutritional security (Evers and Walters, 2000; Koopman, 2009; Sraboni et al., 2014; van den Bold et al., 2015). Previous research has found that women in smallholder agrarian systems depend more readily on informal social networks than men, in order to enable and sustain access to resources (Po and Bukania, 2016; Ribot and Peluso, 2003), given their fewer exit options and lower representation in community leadership positions (Agarwal, 2000; Gotschi et al., 2010; Molyneux et al., 2002; Moore, 1990; Westermann et al., 2005). In the context of rural livelihoods and poverty alleviation (Chambers and Conway, 1991; Ellis, 2000; Scoones, 1993), such relational access strategies essentially transform a stock of social capital into a bundle of rights and benefits.

Social capital has been defined as "networks, norms of reciprocity and trustworthiness" (Putnam et al., 1993, p. 167), and is generally built upon shared beliefs and values or a collective identity (Adler and Kwon, 2002; Putnam, 2000; Woolcock and Narayan, 2000). Previous research on social capital has identified three common structural (network) dimensions: bonding, bridging, and linking (Andriani and Christoforou, 2016; Coleman, 1988; Granovetter, 1973; Woolcock,

2001), that "contribute to cooperation and, more specifically, to mutually beneficial collective actions" (Andriani and Christoforou, 2016, p. 11).

Bonding social capital is known to foster the development of "strong ties" (Granovetter, 1973), characterized by norms of trust and reciprocity in groups of people with similar cultural, religious, or ethnic backgrounds and socio-economic status. Bonding social capital tends to accumulate through frequent interpersonal and sometimes emotional interactions (Putnam, 1993; Woolcock, 2001). However, high levels of bonding social capital can also exert social pressure on members to conform to expected group norms, potentially leading to the rejection of alternative ideas, reinforcement of exclusive identities (Portes and Landolt, 1996), and perpetuation of traditional gender roles (Narayan, 1999). For example, previous research has found that high levels of bonding social capital in women's groups has the potential to lead to higher social seclusion, lower access to new information, technologies, and outside opportunities, and higher dependence on male relatives for various needs (Gotschi et al., 2010; Meinzen-Dick et al., 2014; Padmaja et al., 2006). Bonding social capital is considered essential in helping tight-knit networks of individuals to subsist or "get by", whereas two other types, bridging and linking social capital, are more important for "getting ahead" (Putnam, 2000).

Bridging social capital develops through horizontal linkages across groups of people from different social backgrounds (Granovetter, 1973; Putnam, 1993). It often accumulates through civic engagement, such as when engaging in voluntary associations or public meetings (Putnam, 1993). It therefore relies less on interpersonal relations, and more on shared values and generalized trust within a broader community. Bridging social capital can facilitate an individual's access to the resources available from different groups (Andriani and Christoforou, 2016), particularly novel information (Schuller et al., 2000).

Linking social capital is an extension of bridging social capital. It accumulates from relationships between actors from different social and economic hierarchies, representing vertical network linkages (Andriani and Christoforou, 2016; Sabatini, 2009; Woolcock, 2001). These types of social ties can facilitate an actor's ability to engage with external (potentially non-local) actors holding different positions of power and authority in order to access additional resources (Meinzen-Dick et al., 2014; Woolcock, 2001), or to influence local rules in resource allocation.

While each of these structural dimensions of social capital have been identified as playing a potentially important role in women's empowerment and the success of collective action in different rural settings, the empirical evidence that connects social capital to gendered household food and nutrition outcomes remains limited. More specifically, despite evidence that social capital in community-based group settings can increase women's collective access to information and resources (Bodin and Crona, 2009), little is known about how social capital affects intra-household decision-making on family farms. This is an important policy question because when women have enhanced access to household resources and greater autonomy to make household-, child-, reproductive- and health-related decisions, children in their households generally exhibit improved nutritional growth and health outcomes (Carlson et al., 2015; Cunningham et al., 2015; Richards et al., 2013; Ziaei et al., 2015). As food providers, caregivers, and cultivators, women have been found more likely to align their preferences with nutrition-sensitive agricultural practices (Malapit et al., 2015; Meinzen-Dick et al., 1997b; Pinstrup-Andersen, 2013). Recent research has indicated positive relationships between women's participation in agriculture-related decision-making and improvements in household crop and dietary diversity, adoption of agricultural innovations, productivity (Alkire et al., 2013; Carletto et al., 2015; FAO, 2011;

Malapit et al., 2015), and maternal and child nutrition outcomes (Bryce et al., 2008; Po et al., 2019).

The relationships between different forms of social capital and women's decision-making in the domain of smallholder agricultural production therefore emerge as an area that requires further empirical research. In this paper, we present a multilevel study on how bonding, bridging, and linking social capital relate to women's participation in agricultural decision-making in rural eastern Kenya and how such relationships interact with variations in the broader contexts.

In what follows, we introduce the study area comprising Kamba smallholder farming systems and describe the study's mixed-method research approach. We discuss the results and interpretations regarding the dimensions of social capital, and cross-scale relationships with women's participation in agricultural decision-making. Finally, we propose insights that can further our understanding of social capital and gender relations within smallholder agricultural systems.

2 Study area: Kambaland, rural eastern Kenya

To understand how different dimensions of social capital contribute to women's participation in agricultural decision-making, we conducted our research in Kambaland, eastern Kenya. This is an arid and semi-arid agro-ecological landscape, experiencing highly variable rainfall and declines in soil fertility that often lead to low agricultural yields (Jaetzold et al., 2006; Kaplan, 1984). The Kamba ethnic group predominately resides in this region, as one of the five largest ethnic groups in Kenya (KNBS, 2009). The majority of Kamba people practice rain-fed agriculture with limited agricultural inputs, on land sizes averaging approximately two hectares (Odhiambo et al., 2004). Agricultural livelihoods are often supplemented with income from casual labor, beekeeping, and small-scale trading of artisanal crafts (Juma and Ojwang, 1996). Although most members of

Kamba households engage in agricultural activities, there are traditional, but not exclusive, gender roles. For example, men may be responsible for clearing fields and soil tilling before each planting season, while women may be more involved in weeding, transporting harvest from fields, and post-harvest food processing (Fig. 1), which can include selecting and saving seeds for the next season (Mucioki et al., 2016). Managing weeds and pests, harvesting crops, and building terraces may be shared or divided between men and women, depending on the household. In the more arid regions of Kambaland where the risk of crop failure is relatively high, household livelihoods rely on a mixture of agriculture and pastoralism. Here, the division in gender roles tends to be more defined, with men generally accepted as owners of larger livestock, such as cattle and goats, and women as managers of smaller livestock, primarily poultry (Brownhill et al., 2016).

Household food and nutrition security is a major issue in rural Kambaland. In the three Ukambani counties, 25 to 46 percent of children under five are classified as malnourished (KNBS, 2015). Although smallholder households in the region are generally constrained in their natural resource-dependent livelihoods, the Kamba people have long utilized existing circles of social relations to enhance their resource base and livelihood strategies (Brownhill and Njuguna, 2016). Kamba people have historically organized based on clan and kinship linkages. The Harambee (self-help) movement following the independence of Kenya increased grass-roots group activities with the support of the Kenyan government (Ngau, 1987). Families participate in community committees through the provision of financial and in-kind support on issues such as schooling, water and sanitation, health, and youth capacity-building (Schafer, 2005). For example, see James and Po (2016) on rural finance among Kamba smallholder women in Makueni County.

Fig 1. Two women are dehulling pigeon peas (*Cajanus cajan*). (Photograph by June Po)

3 Methods

To assess the role of structural social capital in women's participation in decision-making on the farm, we used a mixed-method research design drawing on qualitative and quantitative data collected from Machakos and Makueni Counties, two of the three counties that constitute Kambaland in the arid and semi-arid eastern region of Kenya (Fig. 2).

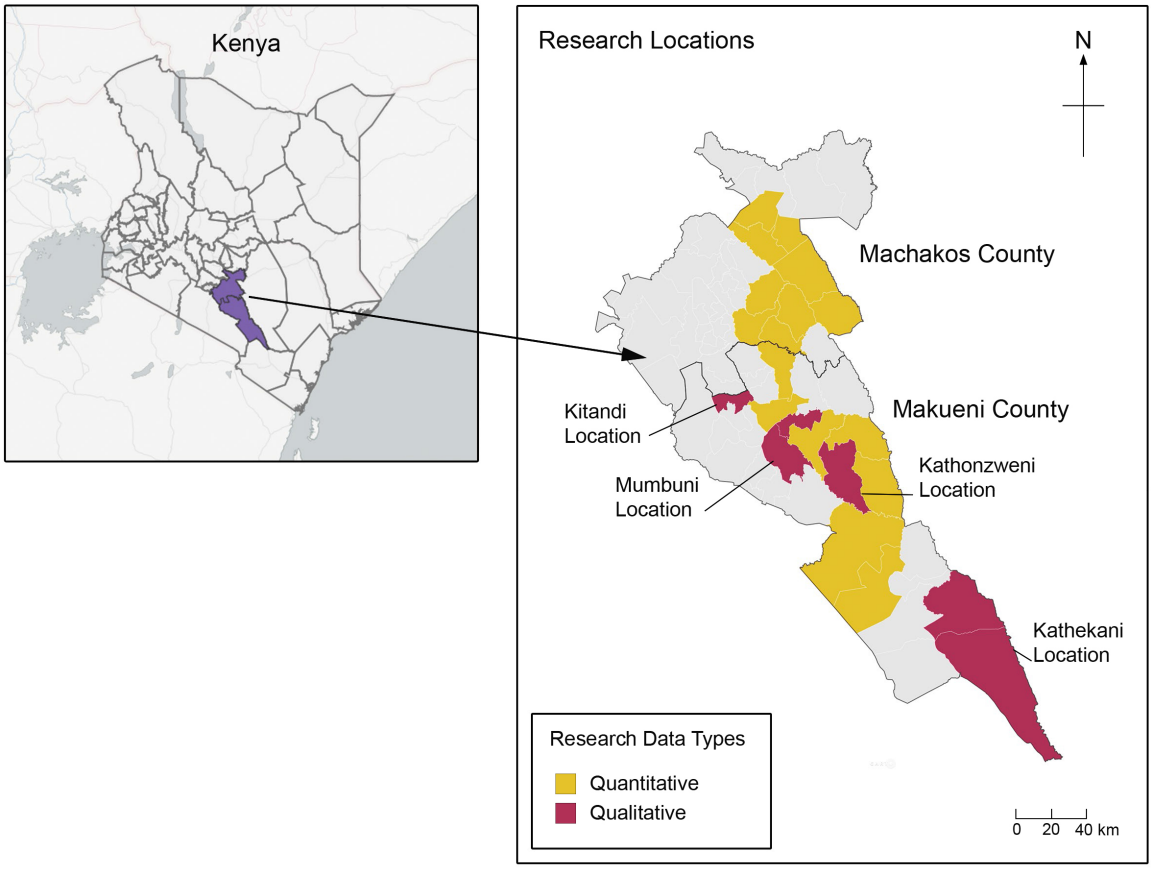

Fig. 2. Research location map.

3.1 Qualitative data collection and analysis

From 2013 to 2014, the lead author conducted eight community meetings [four women-only (n = 280), four men-only (n = 83)], twelve focus group discussions [four women-only (n= 45), four

men-only (n = 19), and four mixed-gender (total n = 70)], and 77 in-depth key informant interviews in Makueni County, specifically within four administrative locations: Mumbuni, Kitandi, Kathonzweni, Kathekani (Fig. 2). Interviews with women and men farmers were held at the homestead and continued while traversing a home garden or farm whenever feasible. This process provided opportunities for respondents to have more control of the interview environment, showing features of the farm, fruit trees, cash and food crops, points of water source, farm boundaries between family members and neighbours, etc. The process also helped minimize interjections by other household members, for example, during an interview with a woman in the presence of a more senior male member of the household. Multiple questions on the same topic were asked from different angles over the course of an in-depth interview in order to triangulate respondents' answers and improve data reliability. These data also served to inform the subsequent design of survey questions and measures designed to evaluate different relationships and facilitate interpretation of findings. Focus group discussions followed a semi-structured interview guide. Discussions were audio recorded with verbal consent and transcribed in the local Kikamba dialect or English and then translated into English. Transcripts were thematically analyzed using the inductive process of semi-open coding (Berg, 2004).

3.2 Quantitative data collection and analysis

In 2014, the lead author administered a household survey using a multi-stage sampling strategy in both counties as a part of a larger agriculture and food security project (Hickey et al., 2012; Muhammad et al. 2016). The first stage of the sampling strategy involved clustering by county. Households were then selected from district lists that contained 72 registered and active farmer groups. Three hundred and twenty-four households met the project inclusion criteria of having a non-pregnant woman of at least 15 years old with at least one of her children aged 6 to 36 months.

Pregnant women were excluded from the larger project sample to minimize confounding factors such as gestational weight gain and dietary changes, in order to focus on the relationships between agricultural interventions, food security, and maternal and child health. After randomized sampling selection, recruitment, and data cleaning, 206 women were included in the final data analysis. The survey covered topics concerning participants' time-use, agricultural decision-making, access to land resources, community assistance, household asset ownership, agricultural productivity, and indicators of social capital adapted from the Indian Human Development Survey (Desai et al., 2005). Household and community surveys were informed by previous focus group discussions, piloted, and revised before use in training sessions with local enumerators. The household surveys were administered at the homes of respondents in the local dialect, Kikamba, and lasted approximately 50 minutes. All respondents provided written consent at the time of data collection. Three attempts were made to administer the survey with each pre-selected respondent in the event the respondent was not available at prior visits. Community surveys were also administered to village-elders or sub-county chiefs located in the 127 different villages where respondents resided. Each community survey included questions on village characteristics, such as access to markets, credit, political administration, available community organizations, and government programs.

3.2.1 Outcome variable: Agricultural decision-making

Table 1 provides the variable definitions used in our quantitative analysis. The primary outcome variable for our analysis was women's level of participation in agricultural decision-making. This variable was constructed using a battery of eight questions concerning farm activities commonly reported by respondents from focus group discussions and key informant interviews. These were: "In the past season, who decided to: 'buy specific seeds', 'prepare the lands', 'start weeding',

'spray chemicals', 'apply manure', 'plant trees', 'build terraces'", and "Can you alone decide to sell the harvest from this land". A positive response was counted if a respondent reported herself as being one of the household members who made the decision. For example, if the "husband", "father-in-law", and "respondent" were reported as the people who decided on applying manure, the response "1" would indicate the woman respondent participated in decisions regarding application of manure. If "respondent" was not reported among the people who made the decision, the response "0" would indicate the woman respondent did not participate in decisions regarding manure application in the past season. Eight responses were then summed to create an agricultural decision index score out of eight.

We additionally asked respondents whether they or their family received information as a form of assistance (Yes or No) from a list of twelve types of community group: "neighbours", "extended family", "relatives in Kenya", "clan", "women's groups", "men's groups", "farmers' groups", "church members", "community health workers", "non-governmental organizations", "agricultural extension officers", and "family outside Kenya" in the past twelve months. The twelve responses were summed and used as a proxy of information source diversity, a second outcome variable with values from 0 to 12. Similarly, responses on whether they or their family received training as a form of assistance from the twelve types of community groups were collected for the third outcome variable.

3.2.2 Explanatory variables

Our explanatory variables were divided into three levels: individual, village, and division.

3.2.2.1 Level 1 Covariates: Individual-level social capital

We categorized social capital into bonding, bridging, and linking. Recognizing that measures of social capital is diverse and often ambiguous (Durlauf, 1999), we selected indicators that are

supported by theoretical understanding and contextual realities. Two indicators were used for bonding social capital. First, whether or not respondents contributed money at a local fundraiser in the past year. This is a proxy indicator measuring trust and adherence to norms and collective action (Grootaert and van Bastelaer, 2001). Adherence to social norms does not preclude the presence of social pressure and obligation. However, monetary contribution and participation in local fundraisers reflect respondents' expectations and experiences with community members based on norms of trust, reciprocity, as well as social obligation (Stern and Coleman, 2015). Second, the total number of memberships in groups that generally share similar social backgrounds, such as self-help groups, revolving savings groups, youth groups, religious committees, clan or family committees, funeral or wedding committees and food assistance groups (e.g. Food for Work) sponsored by NGOs. In these voluntary and associative groups, most members self-select and share similar customary or religious values. A Bible scripture reading group, for example, has members who share the same Christian faith (Nyangena and Sterner, 2008). Through frequent interactions and the high intensity of cultural and emotional exchanges, such groups primarily foster bonding social capital. At the same time, low levels of bridging or linking social capital exist among these groups when members engage in welfare development activities, which depend on broader community participation. For example, members in a labour-intensive Food for Work assistance program generally come from a similar socio-economic status with vulnerabilities to food insecurity, and meet certain poverty-level eligibility requirements for food assistance. The process of labour-sharing on each other's farms at regular intervals also likely fosters bonding social capital.

We used three indicators to capture bridging social capital: (1) whether the respondent attended public community meetings; (2) the total number of memberships in groups with

members from diverse social backgrounds; and (3) whether the respondent voted in the last election. Attending public community meetings and casting a ballot in a major election are examples of civic participation, a critical indicator of social capital (Putnam, 1993). The gathering of large groups of people from diverse backgrounds, while waiting for the meeting to start or standing in line to cast a ballot, foster informal exchanges of information, characteristic of bridging social capital interactions. Memberships in professional and community development groups, such as farmer groups, agricultural or milk co-operatives, women welfare groups, formal microfinance groups (e.g. Rafiki, Kenya Women Microfinance Bank), community health program groups, water harvesting or dam committees, and non-food assistance NGO project groups can capture interactions that promote broader goals in the community. These characteristics are similar to the group distinctions used by Story (2014) for measuring bonding and bridging social capital. The subset of community groups selected as a proxy measure of bonding social capital was based on the theoretically homogenous background of members and the exclusiveness that limited the set of community members eligible to be involved in these community groups. Similarly, the subset of community groups selected as a proxy measure of bridging social capital was based on the theoretically heterogeneous background of membership and their aims of the groups.

We used two indicators to proxy linking social capital: (1) whether the respondent participated in any political campaigns, such as organizing meetings and volunteering for rallies with the representative they support; and (2) whether any household member belonged to the local administration, such as a village or ward council or government office. These indicators proxy the building of linking social capital rather than the usage of linking social capital. Respondents who answered "yes" were considered more likely to have exposure to political representatives,

campaign organizers, and local administrators, and have more opportunities to create linking social capital than respondents who answered "no".

Although the dimensions of social capital are measured as distinct variables, they are theoretically not mutually exclusive. For example, women who actively participate in training activities in farmer groups (hosted by agricultural extension services or NGO-sponsored programs) can foster less bonding social capital, but more bridging social capital, and linking social capital with NGO personnel. Moreover, these women are more likely exposed to new agricultural methods or nutrition-sensitive information that will influence their preferences and be reflected in their decisions on the farm. While we acknowledge that community associative groups can foster multiple types of social capital, we measured bonding and bridging social capital by memberships in community groups that primarily foster strong ties or weak ties. We recognize that this is one of the limitations in measuring social capital dimensions from group and association memberships without additional measures of inclusivity, frequency, or engagement of members.

3.2.2.2 Level 2 Covariates: Village characteristics

Village-level indicators were: (1) whether or not a village had a chief or an assistant chief's office; (2) had a market; (3) had a location in public to purchase alcohol or other addictive substance; and (4) the combined total number of available community groups and government programs out of a list of 37 groups and programs. These were used as contextual variables to capture the development-related characteristics of the village. A chief or assistant chief's office provides multiple services to the community. A chief's office is often where large groups of people gather for community announcements, where official documents, such as identification cards, application forms and recommendation letters are prepared as prerequisites for official group formation. It is also the gateway for outsiders with new programs or information to gain formal permission to

operate in the community. Theoretically, its presence can foster multiple dimensions of social capital and in general, community development. Marketplaces are centres of informal exchange of information and trade, with restaurants, salons, and cyber-cafes that facilitate social gatherings. In rural Machakos and Makueni Counties, and in many counties across the country, "market day" is a bustling day held usually once a week, at a centralized village or town location. These markets are often near the main tarmac road where farmers and vendors arrive on buses to sell their products and where herders bring large herds of cattle and goats for auctioning (Field observations 2014). During market days, women are generally at the markets, purchasing food and domestic items and selling or marketing farm produce. These market days provide weekly opportunities for information exchange. Women establish their informal networks at places, such as produce stands, salons, or teashops. When women relay new information they gain from the market to their family members, they may further engage in related household or farm decision-making.

3.2.2.3 Level 3 Covariates: Division-level aggregate characteristics

Contextual factors represent the characteristics of the geographical region, such as the presence of a public market in the village, that are not dependent on micro-level household data. In contrast, compositional factors, as described, are composed of micro-level data. For example, a compositional social capital variable can be the percentage of households in the division that have more than five community group memberships. The variable describes a division-level characteristic that varies between divisions, and is calculated from household-level data. Another example of compositional factors is the division prevalence of families below the poverty line. These contextual and compositional variables likely influence who people interact with, how they interact, and what types of information they transmit, and in turn, can have significant impacts on resource access and management, especially for female farmers (Healy et al., 2007).

In the current study, administrative divisions within Machakos and Makueni County were used to form aggregate indicators at a greater spatial scale (Grootaert and van Bastelaer, 2001). Household survey data were aggregated following methods outlined by Kawachi et al. (1997), Kim et al. (2006), and Subramanian et al. (2002), which estimated social capital at the neighborhood or administrative level. Administrative divisions were chosen as the level of aggregation such that there was sufficient variability between 18 divisions and variability of micro-level data within divisions. There was a range from five to 26 households sampled per division. The compositional bonding social capital variable was calculated by taking the average of: (1) the proportion of respondents who attended or contributed to a local fundraiser; and (2) the proportion of respondents who had above median number of memberships in groups that foster bonding social capital (Kim et al., 2006). Similarly, the compositional bridging social capital variable was calculated by taking the average of: (1) the proportions of respondents who attended public community meetings; (2) voted in the last election; and (3) had above the median number of memberships in groups that fostered bridging social capital. The compositional linking social capital variable was the proportion of respondents that participated in a political campaign activity in each division. We calculated the proportion of women who completed primary education as a proxy for population education level in each division and the proportion of households living in the lowest asset tertile as a proxy for population socio-economic development in each division.

3.2.2.4 Socio-demographic covariates: Individual and household characteristics

We adjusted for potential individual and household-level variables for women's participation in agricultural decision-making. Women's highest level of education was categorized into "above primary", "completed primary", and "below primary school", which in Kenya's educational system is eight years of primary education. Women's age in years, household asset index were

inputted as continuous variables. The household asset index was calculated by summing ownership of household consumer products (such as clock, radio, television, solar panel, animal cart, motor vehicle, boat), and improved dwelling structures, such as "corrugated iron" versus "grass/thatch/tin cans/other" as roof materials, "cement or ceramic tiles" versus "earth, sand, or dung" as floor materials, and "latrine with slab or ventilated improved pit latrine" versus "no facility, open pit, field, or latrine without slab" for latrine type. Regional-level variables were counties and agro-ecological zones (Table 1).

[Insert Table 1]

3.2.3 Multilevel analysis

A multilevel analysis was used to test the overall associations between individual-level, village-level, and division-level social capital, women's participation in agricultural decision-making, and the variation between divisions. Multilevel models on 206 individuals (level 1) were nested within 127 villages, that were in turn nested within 18 divisions (level 2).

Villages were not included as an analytical level in the multilevel model because there was insufficient variation within villages, with most villages having less than six respondents. This method enabled us to estimate the associations of division, village, and individual-level indicators on women's agricultural decision-making participation. The linear regression analyses follow a two-level random-intercept model, that is fitted using the maximum likelihood estimation to estimate model parameters. The model is defined as:

$$Y_{ij} = \beta_1 + \beta_2 X_{ij} + \beta_3 Z_j + u_j + \varepsilon_{ij} ,$$

where Y_{ij} is the dependent variable representing participation in agricultural decision-making by woman in the household (i), and in the division (j). X is a vector of individual level variables, Z is

a vector of division level explanatory variables. u_j is the random intercept for division j; ε_{ij} is the residual.

Four sets of models were used in the study (Appendix 1). The first set of models (1-7) examine the cross-sectional associations between women's agricultural decision-making, different dimensions of social capital, village characteristics, and division-level indicators separately. The second set of models (8-10) examine cross-scale interactions between dimensions of social capital (household level) and village characteristics. The third set of models (11-16) examine how village characteristics mediate the associations between bridging social capital indicators and the diversity of i) information sources or ii) training sources received by women. The range of groups in the community (e.g. associative groups, family, or relatives) is measured in two ordinal variables. The fourth set of models (17-22) examine cross-scale interactions between dimensions of social capital (household level) and division-level indicators.

We tested for multicollinearity, and selected the explanatory variables for the regression models by assessing Akaike Information Criterion (AIC), and theoretical considerations to balance between minimizing omitted variable bias and an over-specification of models. No significant correlation was found at the 1 percent significance level between social capital indicators at the household level (Appendix 2). Therefore, we used separate indicators: two indicators to measure bonding social capital, three for bridging social capital, and two for linking social capital, rather than constructing summary indicators, to measure the three social capital dimensions at the household-level (Kim et al., 2006). There was multicollinearity at the 1 percent significance level between division-level compositional social capital variables and household-level social capital variables (Appendix 3). Division-level compositional variables of social capital, literacy

prevalence, and poverty prevalence were centered to minimize the effects of multicollinearity in subsequent regression analyses.

3.3 Limitations

While this paper aims to provide a broader and more nuanced picture of how social capital dimensions associate with women's decision-making participation on the farm, the study has a number of limitations. We lacked data on women's leadership within the community to better capture the potential benefits and ramifications of women's individual linking social capital compared to household linking social capital. Our data did not have additional information on the frequency or level of engagement within community groups to help differentiate groups that fostered bonding from bridging social capital. The results from a cross-sectional analysis can only infer associative relations rather than causality between the measures of social capital dimensions and women's participation in agricultural decision-making. Despite these limitations, the study provides rigorous evidence and corroborations that furthered our understanding of social capital dimensions and their relations to gender power dynamics within nuanced smallholder farming contexts.

4 Results and discussion

Our results reveal that different dimensions of social capital have varying degrees of influence on Kamba women's participation in agricultural decision-making. The findings indicate that not only does household-level social capital matter, but compositional factors also have critical influences on women's participation in decision-making on agricultural production. The descriptive results of our social capital indicators are presented in Table 2. Table 3 presents the results from the multilevel linear regressions Models 1 to 7. Tables 4, 5, 6, and 7 report the results of the cross-scale interactions with village and division characteristics, revealing how contextual and

compositional variables can influence the associations between social capital and women's decision-making. Table 8 summarizes the findings from all statistical models 1 to 22. Table 9 summarizes results concerning the role of bonding, bridging, and linking social capital, and cross-scale relationships.

4.1 Descriptive results

Descriptive results show that, on average, respondents reported participating in two to three agricultural decisions in the past season (mean = 2.81 SD = 2.61). Over 95 percent of the respondents reported that they had attended or contributed to a local fundraiser and 92 percent had attended a community public meeting in the past 12 months (Table 2). Approximately 70 percent of the respondents reported voting in the most recent national election and 20 percent participated in political campaign activities. More than half of the women in the sample reported being a member of at least four community groups with members from similar backgrounds, and at least one community group with members from different backgrounds. In the following section, we discuss the various relationships between the different dimensions of social capital and women's participation in decision-making in the context of Kamba smallholder agriculture.

[Insert Table 2]

4.2 Bonding social capital and women's decision-making

Our findings showed that bonding social capital has a positive association with women's participation in agricultural decision-making (Table 3 Model 2). Qualitative findings reveal a number of mechanisms. First, respondents described informal arrangements and co-dependence between neighbours had facilitated greater access to natural capital. Shared activities reported include keeping livestock, monitoring crop growth, and providing security on farm plots that are far from the homestead. Second, respondents reported that their participation in community groups

expanded their access to collective knowledge and experience, with a spill-over transfer of effective technologies to non-group members. Kiptot et al. (2006) reported that farmers received peer-to-peer (non-group) dissemination of soil conservation knowledge and technology primarily from relatives, group members, friends, and neighbours in western Kenya. This transfer of knowledge and resources was also reported by Mucioki et al. (2016) in the transfer of indigenous pearl millet seed varieties from elder women to younger women in Tharaka-Nithi, Kenya. Such exchanges embedded within traditional social relations can reduce the risks of poor harvests when planting new crops in resource-scarce settings. Third, our findings showed that bonding social capital enhances women's access to psychological support. Respondents reported mutual motivation and accountability among labour-sharing group members through discussions of ongoing concerns while working. Fourth, similar to other capital assets, we found that previously accrued bonding social capital can contribute to future social safety nets for marginalized groups, such as the infirmed, the sick, and the widowed who are often constrained physically from labour-sharing and from participating in most social group networks. For example, one of our respondents was an HIV positive woman who lived in Kathamboni village for more than forty years. Although she could no longer dig terraces with her labour-sharing group, her previous group members registered her as a member in subsequent years in order to maintain her eligibility for food assistance.

[Insert Table 3]

As some women in patrilocal communities leave their natal family upon marriage, they are faced with the task of establishing new bonding social capital with their husband's family, new neighbours, associative groups, and leaders in the community (Larance, 2001). One of the respondents explained her process of meeting new neighbours:

> You know when you go to Malili, there is a new farmer or a new person in that place. The first thing you can do: you can relax, and be through with [visit] the neighbour you have found there. Just, you just go to a place, start speaking to him. And in Malili, we are not so squeezed, you find the neighbour is 200 metres from your place. You start joining, speaking with him, because you don't know him, he doesn't know you, we start a relationship. Sometimes you find you are friends. You are neighbours (Female participant, 2013).

Our findings align with Bruegel's theory of social capital that solidaristic social networks can also enhance "a degree of power that enables them to challenge the status quo" (Franklin, 2005, p. 2), seen among group members who bend rules to help the most vulnerable members access food assistance. The transformative potential of bonding social capital, especially for women, can help sustain their basic needs for survival and livelihood outcomes (Bates, 1990; Bourdieu, 1989; Bruegel, 2005; Ostrom, 2000a; 2000b).

4.3 Village contextual factors facilitate bridging and linking social capital

We expected that social capital among heterogeneous individuals was more likely to result in the exchange of information, knowledge, and adoption of innovations. In turn, women who are better informed are also more likely to participate in decision-making. Women's social capital is particularly important in acquiring information as it serves in part to compensate for lower levels of natural capital (e.g. land), physical capital (e.g. agricultural equipment), or financial capital compared to men. We found that bridging social capital has a positive association with women's participation in agricultural decision-making when women also lived in a village with a market place or a chief's office (Table 4, Model 9).

[Insert Table 4]

Are women with high bridging social capital making more decisions because they have better access to diverse information to inform their decisions? Table 5 shows the percentage of respondents who reported receiving information or training from a range of community groups in the previous twelve months, namely, "neighbours", "extended family", "relatives in Kenya", "clan", "women's groups", "men's groups", "farmers' groups", "church members", "community health workers", "non-governmental organizations", "agricultural extension officers", and "family outside Kenya". Women reported receiving information primarily from neighbours, extended family, and church members and training primarily from farmer groups, agricultural extension officers, and women's groups (Table 5).

[Insert Table 5]

In the study context, women who lived in a village with a market place and reported to have attended public meetings, were more likely to receive information (Table 6, Model 13) and training (Table 6, Model 16) from a wider range of community members. Receiving training and information through women's informal social networks may help to circumvent a number of constraints women face in order to attend formal training workshops. Women's attendance in NGOs or government extension training may depend on participation eligibility, financial means for transportation, time availability outside child care and domestic responsibilities, or permission from a household head.

Similarly, a chief's office provides a physical and legitimate gathering place for formal informational exchange. Village members with better access to a chief or local village administration may receive resources from higher strata of social, economic, or institutional status, such as from a governmental extension office or an international NGO. They may also provide training and resources that were not readily available to members in the same strata. We expected

that greater access to a chief's office would enhance women's access to training through the potential formation of social capital. Indeed, our analysis indicated that women who had a high number of associative memberships in villages that had a chief's office were also associated with receiving training from a greater diversity of community members (Table 6, Model 16). When women had access to such training opportunities, qualitative evidence points to how bridging and linking social capital with the support from local administration and NGOs can facilitate knowledge dissemination and livelihood improvements. For example, Kamba women expressed how training in poultry-keeping, immunization, and management had diversified their livelihood strategies. The NGO also legitimized these women's skills with the presentation of training certificates. The finding highlights the important roles of both formal donor organizations and informal community grass-root networks, and their cooperation in fostering linking social capital.

Beyond access to training, research findings indicate that living in a village with a functioning local administrative body can bring women more opportunities to diversify their livelihood strategies. One committee member explained how the relationships built from her participation in a water-dam committee had led to connections with the village administration who, later, granted her group permission to establish a tree nursery in a small region near the dam. However, having a chief's office in the village is only a proxy for a well-functioning village administration composed of chiefs, village elders, and other local administrators. Information and news can spread quickly if leaders utilise existing spatial-social networks in the village, such as providing store-keepers with information to disseminate at a highly frequented corner store. In contrast, when local leaders are not adequately serving the villagers due to favouritism, low competence, or elite capture, community members who are well-connected might not experience benefits from bridging and linking social capital. While the analysis on village contextual factors support "the

significant contribution of geographical location on individuals' perceptions of and participation in, social capital creation" (Healy et al., 2007, p. 112) the findings also indicate that women who have lower access to formal knowledge networks (Kiptot et al., 2006) are actively seeking and engaging in knowledge flows via their informal social networks.

[Insert Table 6]

4.4 Linking social capital and compositional factors at division level

In contrast to bonding and bridging social capital, we found negative associations between household linking social capital and women's participation in agricultural decision-making (Table 3, Model 4; Table 4, Model 10). In particular, when households reported having one of its members working in the local village administration or government agency, women in these households had a lower, but non-significant, likelihood of participating in agricultural decision-making. In households where a member other than the female respondent held a leadership position within the community, their status might result in greater control over other household members' preferences and decisions. As Andriani and Christoforou (2016, p. 7) explained, the theory of social interactions by Becker (1974) posits that, "the head of the family voluntarily internalizes his external actions for the benefit of the family, which also represents his own benefits". However, such a "benevolent dictator" may deem alternative voices in resource allocation unfavourable and suppress these voices (Becker, 1981; Kabeer, 2010). Previous research on linking social capital among community associations in Uganda similarly suggests that toleration of behaviours that discourage member participation or fears of challenging the "gatekeeper" are often due to the material benefits brought by the gatekeepers with high linking social capital (Titeca and Vervisch, 2008). This negative potential supports our finding that women participate less in decision-making

when they are in a household where a member works in the village administration or governmental setting.

As Kabeer (1997) pointed out, other theories of intra-household dynamics co-exist. For example, how increases in women's education and entry into non-farm labour market influence their bargaining position (Agarwal, 1997; Mammen and Paxson, 2000). Alternatively, Sen (1990) offered a "co-operative-conflict" model that hypothesizes a mixture of satisfaction is gained from achieving self-preferences and from devoting resources to the preferences of others, in our case, to members in the household who hold leadership positions within the community. Our interviews with men and women highlighted that traditional and religious norms served to reinforce traditional values of male headship in households. A common analogy spoken among Kamba women explains:

> Women, men say that they are weak assets and the man is the head. But now, they [women] are the neck, and there's no way the neck can speak unless the head has spoken. So the men have authority to tell and give permission (July 24th, 2013).

One of the key findings in this study is that variations in the broader context influence linking social capital functions within family relations. Similar to Holvoet (2005, p. 86), that "in general, households that are better off and have a higher position within the society tend to apply gender norms more strictly", we found that the negative association between being in households with a member in a local administrative position and women's participation in agricultural decision-making was mediated by division-level poverty ($\beta = 0.077$ SE = 0.038 $p < 0.05$) (Table 7 Model 22).

[Insert Table 7]

Figure 3A shows that when households do not have members that belong to a local administration or government office, a proxy for low linking social capital, women's level of predicted participation in decision-making is not influenced by division-level poverty. However, when households have a relatively high linking social capital, the likelihood of women's participation in decision-making changes as the compositional indicator of division-level poverty changes. Households with lower linking social capital may have more relaxed expectations of gender roles where all household members struggle to contribute to livelihoods in poorer divisions. In contrast, households with higher linking social capital may have higher inequality of resource access, and stricter expectations of gender norms. We observed an exchange between a husband, who is a community leader, and his wife, who is also a chairwoman in her church, in front of the interviewers:

> Husband asked wife: Have you got that she has told me?
>
> Wife: No.
>
> Husband asked the wife and daughter in-law: You went to school for no reason?
>
> Wife: We forgot the one [English] she is speaking, we understand the other one [Kiswahili] but her, we don't understand.
>
> Research Assistant: How much do you sell? How much do you get at the end of harvest?
>
> Wife: We get like ten thousands [Shillings].
>
> Husband: Let me answer for her, when they get this tomatoes the yield can be very big and when they have so much, the price can go very low... which mean what they do not have … a correct record for this year. … not exactly as what she has said. More than twenty thousand. (Interview July 10th, 2013)

Beyond wealth indicators, we used the proportion of women who have completed primary school in the division as a proxy of division-level literacy prevalence. Fig. 3B demonstrates that women in households that have high linking social capital have a lower predicted probability of participating in agricultural decision-making than those in households with low linking social capital. Moreover, this probability has a positive association with the aggregate division-level education attainment. When a division's women's education level is higher, educational homogamy assumes that men's education level will be at similar levels, within the same household (Nielsen and Svarer, 2009). Higher education level could also support more egalitarian, inclusive participation in intra-household decision-making. Taken together, this result supports the strength of position proposition (Lin 2001), which posits that a household's stock of linking social capital can enable it to benefit even more from increased societal human capital, such as division-level education attainment. We posit that the household heads' view of gender roles, and their openness for gender equity, depends in large part on the prevailing societal views, adding complexities to the influence of linking social capital on women's empowerment.

[Insert Fig. 3]

[Insert Fig. 4]

4.5 Compositional social capital and interaction with education

Our findings also provide insights to the importance of compositional social capital when considering gradual and long-term changes to women's intra-household decision-making. Previous research has explored how contextual and compositional social capital can affect health outcomes, such as self-rated health, health-seeking behaviour, and mortality (Dean et al., 2014; Kawachi et al., 1997; Kim et al., 2006; Story, 2014; Subramanian et al., 2002). Our study extends

this work to livelihood processes in agrarian contexts, such as women's agricultural decision-making that impacts household food and nutrition security (Malapit et al., 2015).

We tested whether the variation observed in women's participation is attributed to the division-level random effects in the multilevel regression models, but did not find significant difference between divisions. This could be due to homogeneity in the ethnic Kamba culture and similar livelihood activities across the divisions. However, from the fixed effects analysis, we found that aggregate bridging social capital at the division-level, was significantly and positively associated with women's participation in agricultural decision-making (Table 3, Models 6 & 7). This suggests that there are cross-scale relationships with bridging social capital beyond what was observed at the individual, household, and community levels.

In contrast, aggregate bonding social capital did not significantly associate with women's participation in decision-making. This could be due to the influence attributed to bonding social capital being predominantly captured at the household level, with little additional impact observed from aggregate bonding social capital at the division level. This finding is in line with research on social capital and utilization of health care services by Story (2014), where he posited that communities with higher levels of bonding ties do not provide additional help to individuals who already have strong individual bonding social capital. Although we did not observe a significant association with the division-level bonding social capital in our study, this does not necessarily imply an absence of broader bonding social capital effects.

Although girls' educational attainment is an important factor for women's empowerment, our findings suggest that educational empowerment does not readily translate to Kamba women's bargaining power within the household. Our results found no significant association between women's participation in decision-making and their formal schooling (Table 3, Models 1 to 7).

Surprisingly, we found that the division's aggregated indicator of education had significant positive associations with women's participation in decision-making ($\beta = 0.040$ SE = 0.017 $p < 0.05$) (Table 3, Model 6 & 7). This finding supported the hypothesis that distal factors measured at the division level correlate significantly with women's agricultural decision-making. It is also very unlikely for reverse causation to occur in this case: that is, for women's level of participation in farm decision-making in the last season to result in their formal education attainment. Higher education attainment of the general public at the division-level can be conducive to an exchange of new ideas, non-traditional attitudes, and broader discussions on male and female preferences on the farm. In contrast, women's education at the individual level may not be sufficient to encourage decision-making without a broader supportive context as indicated in our findings (Table 3). When validating these results with Kamba farmers, women farmers explained the Kamba proverb, "A thought in the head does not influence the outcome of a case unless it is spoken out". It conveys the common frustrations Kamba women experienced when they acquired new farm knowledge but were unable to share their knowledge in a household where power relations discouraged such discussions.

To build on this result, we again found women's bonding social capital came into play. Unlike "model" farms where new agricultural technologies, such as tree grafting and a water retention pit system, can be seen by passersby, changing attitudes towards gender roles and shifts in intra-household bargaining and decision-making are gradual, iterative processes, often kept behind closed doors. If expressed, these dynamics are more likely conveyed through private exchanges among friends and neighbours who have existing norms of trust and reciprocity, both considered strong characteristics of bonding social capital (Putnam, 1993). In our case study, we found that increased division-level educational attainment significantly augmented the already positive

association between bonding social capital and the predicted likelihood of women's participation in agricultural decision-making (Table 7, Model 17). One interpretation suggests that in a division where men's and women's education levels are higher, people would also be more open to norms of equitable gender dynamics. Women who have higher bonding social capital are more likely exposed to accounts of intra-household negotiation processes from their friends and neighbours, which our analysis indicates, contributes to greater participation in agricultural decision-making. Fig. 4 indicates that women with higher bonding social capital, measured in the number of memberships in community groups that foster bonding social capital, have greater likelihood of participating in farm decision-making in divisions with higher aggregate education levels. Our quantitative findings are summarized in Table 8. Findings suggest that there was a status quo bias (Cordaro and Desdoigts, 2016) towards hierarchical gender power dynamics, which factored into women's low participation in decision-making in domestic and agricultural domains (Davis and Negash, 2007; Samuelson and Zeckhauser, 1988). A Beckarian model of intra-household decision-making suggests that women's share of contribution to agricultural labour in semi-arid smallholder systems should reflect women's share of participation and autonomy in agricultural decision-making. However, changes in intra-household power relations and processes of decision-making are gradual and complex (Molyneux et al., 2002). We propose that bonding social capital that builds trust relations can help facilitate diffusions of gender-transformative attitudes and behaviours and improve women's involvement in resource allocation decisions.

[Insert Table 8]

[Insert Table 9]

5 Conclusion

This study builds on our understanding of social capital dimensions, particularly bonding, bridging, linking social capital and highlights the diverse ways Kamba women use social capital dimensions to enhance their intra-household bargaining positions. It illustrates that Kamba women actively use their formal and informal community networks to gain access to information and training. Shifts in culturally established gender norms can be better supported when there is broader social and economic development, as shown in the division-level analysis. This study demonstrates how gaining linking social capital in the household may come at a cost, constraining women's bargaining positions with regard to agricultural and livelihood resources. Moreover, findings underscore the multilevel interactions between division indicators, aggregate bridging social capital, and bonding social capital on women's participation in decision-making. Additional research is needed to further understand the social conditions in which linking social capital can support and empower women. Future mapping of social capital accumulation within informal and community associative networks can help identify loci of change in social and gender norms.

The separation between the state and the domestic spheres poses barriers for gender-transformative resource policy implementation. Recognizing that current formal forums in agrarian societies may not be widely used for culturally sensitive debates related to gender power dynamics, this paper provides insights into the informal networks women use in diffusing information. Our findings imply that greater policy attention to enhance the capacities of village administrators, building infrastructure for well-organized market places, and promoting greater access to and quality of higher education could have cross-scale impacts on women's role in agricultural development. Together, the different dimensions of social capital have the potential to shift broader societal views towards gender equality and support women's engagement in leadership roles within agricultural livelihoods.

CRediT authorship contribution statement

June Y.T. Po: Funding acquisition, Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, reviewing and editing, Visualization. Gordon M. Hickey: Funding acquisition, Resources, Conceptualization, Investigation, Supervision, Writing – reviewing and editing.

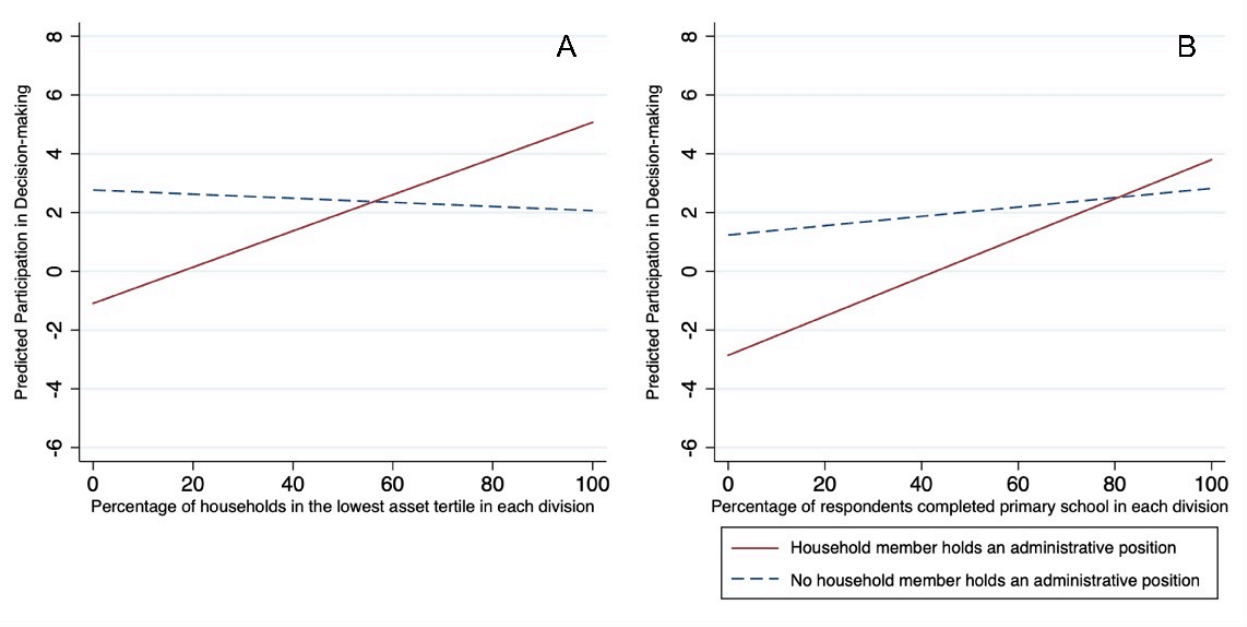

Fig. 3
A. An interaction between division-level poverty prevalence and linking social capital on women's predicted participation in agricultural decision-making. In households with high linking social capital, women are more likely to participate in agricultural decision-making in poorer divisions than in richer divisions.
B. An interaction between division-level education prevalence and linking social capital on women's predicted participation in agricultural decision-making. In households with high linking social capital, women participate less in agricultural decision-making than those in households with low linking social capital. However, predicted probability increases at a greater rate as division-level education attainment increases.

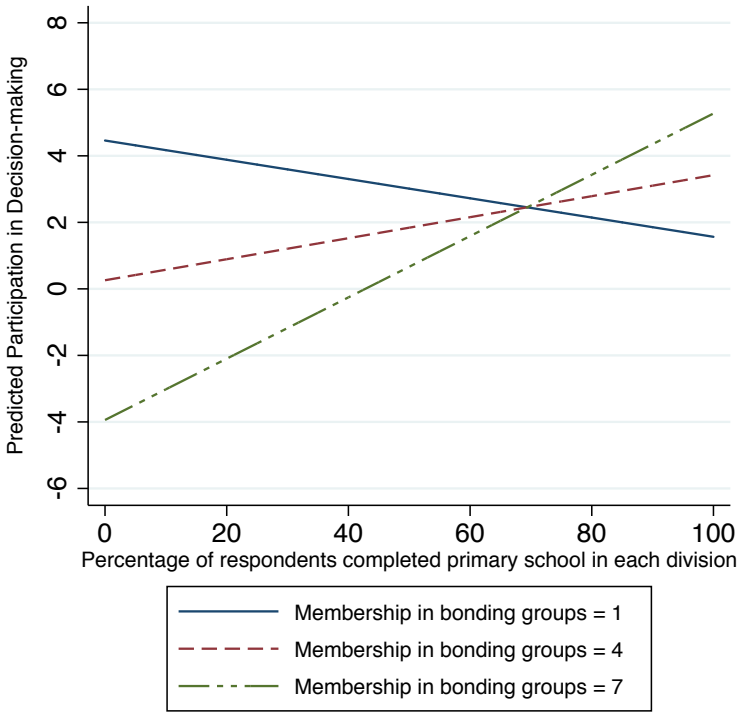

Fig. 4
An interaction between division-level education prevalence and bonding social capital on women's predicted participation in agricultural decision-making.

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Table 1

Variable descriptions.

Outcome variables	Description
▪ Women's agricultural decision-making	Discrete variable (0 to 8)
▪ The range of community groups from which information was received	Discrete variable (0 to 12)
▪ The range of community groups from which training was received	Discrete variable (0 to 12)
Independent variables	
Individual-level	
Bonding social capital	
▪ Attended and/or contributed to local fundraisers	(0) No or (1) Yes
▪ Total number of bonding group memberships	Discrete variable (0 to 7)
Bridging social capital	
▪ Attended public community meetings	(0) No or (1) Yes
▪ Total number of bridging group memberships	Discrete variable (0 to 5)
▪ Voted in the last election	(0) No or (1) Yes
Linking social capital	
▪ Participated in political campaigns	(0) No or (1) Yes
▪ Household member in local administration or government position [a]	(0) No or (1) Yes
Social-demographic variables	
▪ Women's highest level of education	(1) Higher than primary school (2) Completed primary school (Standard Grade 8) (3) Lower than primary school
▪ Women's age in years	Continuous variable (15 to 99)
▪ Household asset index [a]	(1) Highest asset tertile (2) Middle asset tertile (3) Lowest asset tertile
▪ Gender of household head [a]	(0) Male or (1) Female
Village-level	
▪ Vehicle-accessible roads in rain seasons	(0) No or (1) Yes

▪ Presence of a chief or assistant chief's office	(0) No or (1) Yes
▪ Presence of a market place	(0) No or (1) Yes
▪ Presence of alcohol or mirra retail	(0) No or (1) Yes
▪ Total number of available community groups and government programs	Discrete variable (0 to 37)
Division-level	
▪ Compositional bonding social capital	Mean proportion of respondents with (1) High number of memberships in bonding groups and (2) Attended or contributed to local fundraisers (Median value serves as the reference for the high and low groups)
▪ Compositional bridging social capital	Mean proportion of respondents with (1) High number of memberships in bridging groups, (2) Attended public meetings, and (3) Voted (Median value serves as the reference for the high and low groups)
▪ Compositional linking social capital	Proportion of respondents involved in political campaign activities
▪ Poverty prevalence	Proportion of households living in the lowest asset tertile
▪ Literacy prevalence	Proportion of respondents completed primary education (Standard Grade 8)
Regional-level	
▪ County	(0) Machakos County or (1) Makueni County
▪ Agro-ecological zone	(0) Lower Midland 4 or (1) Lower Midland 5

[a] Household-level variables.

Table 2

Descriptive results for three levels of variables.

Individual-level	N = 206	%	Village-level	N = 127	%	Division-level N = 18	%	SD
Memberships in bonding groups			Road access during rain seasons			Mean percentage of households with:		
Low	119	57.80	No	46	36.51	High bonding social capital	73	9.3
High (above median >4)	87	42.20	Yes	81	63.49	High bridging social capital	70	5.2
Attended or contributed to fundraisers			Chief or assistant chief's office			High linking social capital	20	9.5
No	9	4.40	No	86	67.72	Primary education or above	82	14
Yes	197	95.60	Yes	41	32.28	Lowest asset tertile	51	14
Memberships in bridging groups			Alcohol and mirra retail					
Low	113	54.90	No	93	73.23			
High (above median >1)	93	45.10	Yes	34	26.77			
Attended public meetings			General market place					
No	17	8.30	No	56	44.09			
Yes	189	91.70	Yes	71	55.91			
Voted in the recent national election			Community groups and programs available					
No	61	29.60	0 to 9	17	13.39			
Yes	145	70.40	10 to 19	93	73.23			
Participated in campaign activities			20 to 29	16	12.60			
No	164	79.61	30 and above	1	0.79			
Yes	42	20.39						
Household member in local administration or governmental position								
No	162	78.64						
Yes	44	21.36						

Table 3

Multilevel linear regressions of women's participation in agricultural decision-making and social capital indicators.

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	β	β	β	β	β	β	β
Bonding social capital							
Memberships in bonding groups		0.229*					0.245*
		(0.121)					(0.135)
Contributed to local fundraisers		2.113**					2.022**
		(0.870)					(0.853)
Bridging social capital							
Memberships in bridging groups			-0.055				-0.147
			(0.145)				(0.161)
Attended public meetings			0.902				0.574
			(0.649)				(0.618)
Voted in the recent national election			0.429				0.156
			(0.436)				(0.422)
Linking social capital							
Participated in political campaigns				-0.228			-0.405
				(0.439)			(0.422)
Household member in local administration or governmental position				-0.296			-0.288
				(0.443)			(0.443)
Village characteristics							
Chief or assistant chief's office present					0.312		-0.005
					(0.427)		(0.425)
Alcohol and mirra retail present					-1.026**		-0.974**
					(0.459)		(0.438)
General market place present					-0.084		-0.012
					(0.426)		(0.428)
Number of community groups and government programs					-0.008		0.011

					(0.051)		(0.052)
Division-level variables							
High bonding social capital [a]						0.015	-0.014
						(0.020)	(0.022)
High bridging social capital						0.129***	0.130***
						(0.045)	(0.046)
High linking social capital						0.047*	0.050*
						(0.026)	(0.026)
Proportion of respondents completed primary education						0.040**	0.041**
						(0.017)	(0.017)
Proportion of households in lowest asset tertile						-0.002	0.002
						(0.014)	(0.015)
Socio-demographic variables							
Higher than primary education (ref.)							
Completed primary (Standard Grade 8)	-0.393	-0.470	-0.353	-0.364	-0.462	-0.420	-0.513
	(0.391)	(0.386)	(0.391)	(0.394)	(0.387)	(0.379)	(0.371)
Lower than primary	-0.329	-0.457	-0.363	-0.327	-0.533	-0.028	-0.307
	(0.514)	(0.498)	(0.522)	(0.513)	(0.517)	(0.521)	(0.533)
Women's age (years)	0.086***	0.071***	0.070**	0.087***	0.087***	0.092***	0.077***
	(0.027)	(0.027)	(0.030)	(0.027)	(0.027)	(0.026)	(0.029)
Highest asset tertile (ref.)							
Middle asset tertile	-0.278	-0.264	-0.210	-0.274	-0.118	-0.167	0.135
	(0.420)	(0.408)	(0.423)	(0.420)	(0.425)	(0.414)	(0.422)
Lowest asset tertile	-0.208	-0.137	-0.113	-0.245	-0.014	-0.183	0.048
	(0.466)	(0.454)	(0.476)	(0.467)	(0.472)	(0.469)	(0.475)
Male-headed household (ref.)							
Female-headed household	0.458	0.518	0.478	0.409	0.449	0.372	0.344
	(0.434)	(0.433)	(0.432)	(0.437)	(0.431)	(0.422)	(0.424)
Machakos County (ref.)							
Makueni County	-0.176	-0.068	-0.166	-0.147	-0.247	-1.215**	-1.152**

	(0.407)	(0.353)	(0.397)	(0.400)	(0.403)	(0.536)	(0.538)
Agro-ecological zone Lower Midland 3 (ref.)							
Agro-ecological zone Lower Midland 4	0.718*	0.815**	0.753**	0.780*	0.518	1.163***	1.207***
	(0.402)	(0.347)	(0.383)	(0.399)	(0.406)	(0.383)	(0.402)
Constant	0.067	-2.511**	-0.563	0.102	0.524	0.133	-2.570*
	(1.004)	(1.252)	(1.099)	(1.001)	(1.237)	(0.975)	(1.447)
Level 2 Random Intercept							
Constant	-1.135	-17.833***	-1.381	-1.259	-1.196	-23.384***	-23.340
	(1.135)	(6.552)	(1.710)	(1.436)	(1.412)	(6.135)	(2244.555)
Level 1 Residual							
Constant	0.908***	0.890***	0.903***	0.908***	0.892***	0.876***	0.831***
	(0.051)	(0.049)	(0.052)	(0.052)	(0.052)	(0.049)	(0.049)
Observations	206	206	206	206	206	206	206
AIC [b]	983.80	977.13	986.72	987.08	984.86	977.44	981.02

Significant levels at $p < 0.10$ *, $p < 0.05$ **, $p < 0.01$ ***.
Robust standard error described in parenthesis.
[a] Mean proportion of respondents with high bonding social capital.
[b] Akaike Information Criterion.

Table 4
Summary of associations between household-level social capital dimensions and women's participation in decision-making, mediated by village characteristics.

Model	(8)		(9)		(10)
	β		β		β
Bonding social capital		**Bridging social capital**		**Linking social capital**	
Memberships in bonding groups	0.021	Memberships in bridging groups	-0.242	Participated in political campaigns	-1.267**
	(0.179)		(0.306)		(0.577)
Contributed to fundraisers	1.563	Attended public meetings	2.079**	Household member holds an administrative position	-0.279
	(0.843)		(1.010)		(0.750)
		Voted	-0.304		
			(0.735)		
Village characteristics		**Village characteristics**		**Village characteristics**	
Chief or assistant chief's office	-0.150	Chief or assistant chief's office	0.181	Chief or assistant chief's office	-0.542
	(1.056)		(1.732)		(0.514)
Market place	-2.062	Market place	-0.014	Market place	-0.361
	(1.224)		(1.529)		(0.521)
Mediation by village variables		**Mediation by village variables**		**Mediation by village variables**	
Memberships (bonding SC) X chief's office	0.472	Memberships (bridging SC) X chief's office	0.353	Participated in campaign X chief's office	1.219
	(0.265)		(0.341)		(0.994)
Memberships (bonding SC) X market place	0.094	Memberships (bridging SC) X market place	0.132	Participated in campaign X market place	1.179
	(0.271)		(0.365)		(0.826)
Contributed to fundraisers X chief's office	-1.794	Attended meeting X chief's office	-0.481	Household member holds an administrative position X chief's office	1.818
	(0.956)		(1.560)		(1.301)
Contributed to fundraisers X market place	1.471	Attended meeting X market place	-1.257	Household member holds an administrative position X market place	-0.506
	(0.988)		(1.327)		(0.941)
		Voted X chief's office	-0.325		
			(0.952)		

All regression models adjusted for lower-order indicators of interactions, women's education, women's age, household asset tertile, gender of household head, county, and agro-ecological zone.
Significant levels at $p < 0.05$ **, $p < 0.01$ ***.
Robust standard error described in parenthesis.

Table 5
Percentage of women reported receiving information and training assistance from diverse groups.

	Percentage of women received	
	Information	Training
	%	%
Neighbours	84	46
Extended family	74	42
Relatives in Kenya	49	19
Clan	34	14
Women's Groups	68	47
Men's Groups	23	16
Farmers' Groups	62	53
Church members	75	48
Community health workers	52	31
Non-governmental organizations	35	31
Agricultural extension officers	58	50
Family outside Kenya	9	4

Table 6

Associations between bridging social capital and information or training received, mediated by village characteristics.

Model	(11)	(12)	(13)	(14)	(15)	(16)
Outcome variable	Information	Information	Information	Training	Training	Training
	β	β	β	β	β	β
Chief's office	-0.115		1.342	-0.273		0.071
	(0.434)		(1.164)	(0.452)		(1.217)
General market place	-0.025		-3.580***	-0.384		-4.898***
	(0.424)		(1.289)	(0.431)		(1.389)
Attended public meetings		0.512	-1.100		-0.020	-3.160***
		(0.674)	(0.756)		(0.733)	(1.081)
Membership (Bridging groups)		0.405***	0.133		0.561***	0.389
		(0.143)	(0.271)		(0.153)	(0.275)
Interactions						
Chief's office X attended meetings			-1.784			-1.330
			(1.098)			(1.180)
Chief's office X memberships			0.313			0.839**
			(0.339)			(0.355)
Market place X attended meetings			3.065**			4.612***
			(1.249)			(1.384)
Market place X memberships			0.323			-0.063
			(0.329)			(0.336)
Constant	6.321***	5.159***	7.183***	4.320***	3.123***	6.806***
	(0.320)	(0.554)	(0.687)	(0.349)	(0.763)	(1.026)
Observations	206	206	206	206	206	206

Robust standard error described in brackets.
p-value <0.05 **, *p*<0.01 ***.

Table 7

Associations between household-level social capital dimensions and women's participation in decision-making and interactions with division-level variables.

Model	(17)	(18)		(19)	(20)		(21)	(22)
N = 206	β	β		β	β		β	β
Bonding social capital			**Bridging social capital**			**Linking social capital**		
Memberships in bonding groups	0.209	0.222 **	Memberships in bridging groups	0.045	-0.050	Participated in political campaigns	-0.159	-0.148
	(0.111)	(0.112)		(0.144)	(0.145)		(0.441)	(0.447)
Contributed to fundraisers	2.340 ***	2.209 ***	Attended public meetings	0.933	1.045	Household member in local administration	-0.043	-0.178
	(0.477)	(0.449)		(0.615)	(0.571)		(0.443)	(0.467)
			Voted	0.478	0.536			
				(0.407)	(0.413)			
Education [a]	-0.082		Education	-0.016		Education	0.019	
	(0.045)			(0.039)			(0.020)	
Poverty [b]		-0.031	Poverty		0.057	Poverty		0.004
		(0.042)			(0.050)			(0.016)
Interactions			**Interactions**			**Interactions**		
Memberships in bonding groups X education	0.020**		Memberships in bridging groups X education	0.015		Participated in political campaigns X education	-0.013	
	(0.009)			(0.010)			(0.030)	
Contributed to fundraisers X education	0.035		Attended public meetings X education	0.032		Household member in local administration X education	0.051	
	(0.040)			(0.036)			(0.028)	
Memberships in bonding groups X poverty		0.006	Voted X education	-0.002		Participated in political campaigns X poverty		-0.063
		(0.008)		(0.028)				(0.033)

Contributed to fundraisers X poverty	0.006 (0.031)	Memberships in bridging groups X poverty	-0.007 (0.012)	Household member in local administration X poverty	0.077 ** (0.038)
		Attended public meetings X poverty	-0.018 (0.050)		
		Voted X poverty	-0.031 (0.030)		

Robust standard error described in brackets.
p-value < 0.05 **, *p* < 0.01 ***.
[a] Division-level proportion of respondents completed primary education or above.
[b] Division-level proportion of households in the poorest asset tertile.

Table 8
Summary of model results.

Table 3 **Purpose: Find associations between women's participation and variables of interest separately**

DV [a]: women's participation in agricultural decision-making

EVs [b]:

(M1)	Socio-demographic variables only
(M2)	Bonding social capital indicators + M1
(M3)	Bridging social capital indicators + M1
(M4)	Linking social capital indicators + M1
(M5)	Village variables + M1
(M6)	Division variables + M1
(M7)	All variables

Key Findings:

(M2)	We found a significant, positive association between women's bonding social capital and women's participation in agricultural decision-making
(M4)	We found a negative, but not significant, association between household linking social capital and women's participation in agricultural decision-making
(M6)	We found significant, positive associations between i) mean proportion of respondents with high bridging social capital ii) proportion of respondents completed primary education in each division and women's participation in agricultural decision-making
(M7)	The above associations were rigorous when we adjusted for other social capital and higher-level variables in the model

Table 4 **Purpose: Examine whether village characteristics mediate the associations of social capital and women's participation**

DV: women's participation in agricultural decision-making

EVs: incorporate interaction terms between social capital indicators and village variables

(M8)	Village variables X Bonding social capital
(M9)	Village variables X Bridging social capital
(M10)	Village variables X Linking social capital

Key Findings:

(M9)	We found a significant, positive association between women's bridging social capital and participation in agricultural decision-making when adjusted with village variables
(M10)	We found a significant, negative association between household linking social capital and women's participation in agricultural decision-making when adjusted with village variables

Table 6 **Purpose: Tease out why bridging social capital is positively associated with women's participation through flow of information and training**

DV: Diversity in sources of information (M11 to M13)

	DV: Diversity in sources of training (M14 to M16)	
	EVs:	
	(M11, M14)	Village variables only
	(M12, M15)	Bridging social capital variables only
	(M13, M16)	Village and bridging social capital variables and their interactions terms
	Key Findings:	
	(M12, M15)	We found significant positive associations between diversity in sources of information (M12) and training (M15) and membership in groups (bridging social capital)
	(M13, M16)	We found that in villages with a market place, women's attendance in public meetings have a positive association with the range of information (M13) and training (M16) women received in the community
	(M16)	(M16) We found that in villages with a chief's office, women's membership in community groups have a positive association with the range of training sources they receive
Table 7	**Purpose: Examine cross-scale interactions between social capital indicators and division-level indicators**	
	DV: women's participation in agricultural decision-making	
	EVs:	
	(M17)	Bonding social capital X literacy prevalence
	(M18)	Bonding social capital X poverty prevalence
	(M19)	Bridging social capital X literacy prevalence
	(M20)	Bridging social capital X poverty prevalence
	(M21)	Linking social capital X literacy prevalence
	(M22)	Linking social capital X poverty prevalence
	Key Findings:	
	(M17)	We found that compositional indicator of education at the division-level significantly augments the already positive association between bonding social capital and women's participation in agricultural decision-making
	(M22)	We found that compositional indicator of poverty at the division-level significantly attenuates the negative association between household linking social capital and women's participation in agricultural decision-making

[a] Dependent variable.
[b] Explanatory variable.

Table 9

Summary of findings on three types of social capital and cross-scale interactions.

Bonding social capital
▪ Bonding social capital has a positive association with women's participation in agricultural decision-making at the household-level ▪ There is a high percentage (>95%) of respondents participate in local fundraisers, which reinforces norms of reciprocity ▪ Values of collective action are widely accepted by Kamba respondents and supported in Kamba customary and Christian religious beliefs ▪ Sharing of emotional support, such as mutual motivation during arduous agricultural labour and stressful events, is reported to take place in labour-sharing groups ▪ Bonding social capital forms a social safety net for marginalized groups, such as the infirmed, the sick, the widowed, who may not be able to participate in regular community groups ▪ Participation in community groups increases one's access to collective knowledge, experience, and farm labour ▪ Strong bonding social capital within the family may suppress alternative views that differ from the status quo ▪ Women reported to have forgone their entitlement to productive resources, such as land tenure, in order to maintain harmony within the nuclear and extended family
Bridging social capital
▪ Bridging social capital has a positive association with women's participation in agricultural decision-making, especially in villages that have supportive infrastructures, such as a chief's office or a market place ▪ Information and announcements can spread quickly when leaders identify focal points in the village and take advantage of spatial-social networking (e.g. a highly frequented corner shop) ▪ Women face significant time costs to maintain bridging social capital ▪ Transportation (e.g. on foot, or by motor vehicles) costs time and cash that majority of women respondents cannot spare ▪ Attending regular meetings, controlling loans from rotational savings groups can create tension or build norms of reciprocity in their relationship with the household head
Linking social capital

- Membership in NGO sponsored development groups leads to increased opportunities in agricultural training (e.g. poultry keeping) and legitimacy (e.g. certificate), that contributes to building capacity and confidence in women's livestock management
- Participation in community development committees (e.g. a water dam building committee) can lead to an ongoing working relationship with village administrators. In turn, linking social capital can lead to trust and better access to other natural or communal resources
- Households with members that hold local authoritative positions might maintain a stricter dynamics in gender roles and expectations, potentially reducing gender-equitable participation in productive decision-making
- Linking social capital is negatively associated with women's participation in agricultural decision-making

Cross-scale interactions

- There is presence of cross-scale associations and interactions found between the division-level variables and women's participation in agricultural decision-making
- Education attainment at the division-level is positively associated with women's participation in agricultural decision-making
- When aggregate level of women's education attainment or the aggregate poverty level within divisions are high, the negative associations between linking social capital and women's participation in agricultural decision-making are attenuated
- Traditional gender relations are perceived to be threatened by women's growing financial independence, higher educational attainment, and leadership roles in society

Appendix

Appendix 1

First set: Models 1 to 7

Model 1	A null model, has no social capital indicators. It has socio-demographic variables, which are women's education, women's age in years, household asset index tertile, gender of household head, fixed effects for two agro-ecological zones, and two counties.
Model 2	Model 1 plus bonding social capital indicators.
Model 3	Model 1 plus bridging social capital indicators.
Model 4	Model 1 plus linking social capital indicators.
Model 5	Model 1 plus village-level indicators.
Model 6	Model 1 plus division-level indicators.
Model 7	Includes all indicators in the multilevel linear regression: Model 1 in addition to bonding social capital, bridging social capital, linking social capital, village-level, and division-level indicators.

Second set: Models 8 to 10 examine interactions with village characteristics

Model 8	Model 1 plus two bonding social capital indicators, two village indicators, and their four interaction terms (between the two bonding social indicators and the two village indicators).
Model 9	Model 1 plus three bridging social capital indicators, two village indicators, and their six interaction terms.
Model 10	Model 1 plus two linking social capital indicators, two village indicators, and their four interaction terms.

Third set: Models 11 to 16 associate diversity of information or training sources that respondent received and bridging social capital; and their interactions with village characteristics

Model 11	Predicts the association between the diversity of information sources and the presence of village characteristics.
Model 12	Predicts the association between the diversity of information sources and bridging social capital indicators.
Model 13	Predicts the association between the diversity of information sources and bridging social capital indicators, adjusted for village characteristics and their interaction terms.
Model 14	Same as Model 11 except training is received instead of information.
Model 15	Same as Model 12 except training is received instead of information.
Model 16	Same as Model 13 except training is received instead of information.
Fourth set: Models 17 to 22 examine cross-scale interactions with division characteristics	
Model 17	Model 1 plus two bonding social capital indicators and one division indicator (the proportion of respondents completed at least primary education in each division) and their two interaction terms.
Model 18	Model 1 plus two bonding social capital indicators and another division indicator (the proportion of households in the lowest tertile asset index in each division) and their two interaction terms.
Model 19	Model 1 plus three bridging social capital indicators and one division indicator (education) and their three interaction terms.
Model 20	Model 1 plus three bridging social capital indicators and another division indicator (asset index) and their three interaction terms.
Model 21	Model 1 plus two linking social capital indicators and one division indicator (education) and their two interaction terms.
Model 22	Model 1 plus two linking social capital indicators and another division indicator (asset index) and their two interaction terms.

Appendix 2 Correlation coefficients between indicators of bonding, bridging and linking social capitals

	Correlation coefficients			
Bonding social capital indicators	Membership in bonding groups	Attended public meetings	Membership in bridging groups	Participated in campaign activities
Attended or contributed to fundraisers	0.145			
Membership in bonding groups				
Bridging social capital indicators				
Voted in the recent national election		0.076	0.158	
Attended public meetings			0.052	
Membership in bridging groups				
Linking social capital indicators				
Household member in local administration				0.030
Participated in campaign activities				

Appendix 3

Correlation coefficients between division-level compositional social capital and household social capital indicators.

Bonding social capital indicators	
	Proportion of respondents with high bonding social capital in division
Membership in bonding groups	0.256 ***
Attended or contributed to fundraisers	0.245 ***
Bridging social capital indicators	
	Proportion of respondents with high bridging social capital in division
Membership in bridging groups	0.218 ***
Attended public meetings	0.167
Voted in the recent national election	0.002
Linking social capital indicators	
	Proportion of respondents with high linking social capital in division
Participated in campaign activities	0.219 ***
Household member in local administration	-0.115