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Food security in developing countries: Gender and spatial interactions

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Abstract

This brief summarizes findings of a project entitled “Food Security in Developing Countries: Gender and Spatial Interactions’” undertaken by researchers from the University of Alberta. The project uses a large cross-sectional dataset from the Integrated Modelling Platform for Mixed Animal Crop systems (IMPACT) Lite collected by Climate Change, Agriculture, and Food Security (CCAFS) from 2010 to late 2012. This dataset surveyed 1,500 households located across seven countries in Africa and Asia. The project focused on estimating three spatial effects on food security: i) a spatial autoregressive effect that measures how neighbors’ food security influences a farmer’s food security; ii) how these spatial effects differ for male and female-headed households; and iii) how the food security of neighbors of the same gender affect their own food security.

Keywords

Agriculture; climate change; food security; gender.

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Contents

Introduction

This brief summarizes findings of a project entitled “Food Security in Developing Countries: Gender and Spatial Interactions’” undertaken by researchers from the University of Alberta. The project uses a large cross-sectional dataset from the Integrated Modelling Platform for Mixed Animal Crop systems (IMPACT) Lite collected by Climate Change, Agriculture, and Food Security (CCAFS) from 2010 to late 2012. This dataset surveyed 1,500 households located across seven countries in Africa and Asia. The project focused on estimating three spatial effects on food security: i) a spatial autoregressive effect that measures how neighbors’ food security influences a farmer’s food security; ii) how these spatial effects differ for male and female-headed households; and iii) how the food security of neighbors of the same gender affect their own food security.

Gender and food security

Generally, female-headed households are more vulnerable and less food secure than their male counterparts (Babatunde et al. 2008). One of the major reasons is that women often face a wide range of constraints that affect their households in numerous ways. Substantial differences between women and men include access to land, credit, labor, and ownership of assets. Additionally, it is common for women living in rural areas of developing countries to be constrained by an array of socio-cultural factors such as gender migration and education beliefs.

Women’s access to land is one important factor that can affect food security. Individuals who own land can control vital household decisions such as what crop to grow and what to consume and sell. However, women tend to either own smaller pieces of land than men or are landless. In addition to providing food and income, land and its associated tenure represents a valuable resource because it can serve as collateral to access credit (Doss 2001). Particularly, women’s access to credit is known to increase household and child food security.

The ability of women to generate income in the agricultural sector may also be constrained by their limited access to human capital (Quisumbing and Maluccio 2003), which may come from household members or hired help. Typically, labor constraints in a household are shaped by the gendered division of labor and household size and composition. Women who are poor and at higher risk of being food insecure are also more likely to work as wage laborers (Sraboni et al. 2014) or their households tend to be smaller than their male's counterparts (Doss 2001).

The ability of women to acquire wealth or assets is frequently attributed to whether institutions allow them to own and be in charge of their own property or take part in contracts. For example, in some cultural contexts property rights are determined by marital and inheritance systems (Deere et al. 2013). Hallman (2003) suggests that females who have greater control over resources, including assets, have improved food security.

Women that head a household are often divorced, widowed, or separated, and their social context, choices, and outcomes can be much different from those of women living in male-headed households (Drèze and Srinivasan 1997). The roots of such a social context depend on demographic and social factors that have fostered the increase of female-headed households. Women without spouses who have children typically drop out of school or college, reducing their probabilities of working (Duflo 2012). Likewise, socio-cultural beliefs can contribute to the perception that women have less education than men (Kassie, Ndiritu and Stage 2014).

The discussion above suggests that gender can be an important aspect of food security. Gender differences manifest themselves in the allocation of resources and in decisions among and within households. Understanding gender and its interactions with other socioeconomic factors is crucial in understanding food security.

Gender, social networks and spatial interactions

Individuals interact and their behavior is often influenced by networks of relationships. Individuals' characteristics like gender, and their varying behaviors, affect the formation and structure of social networks (Bramoulle, Galeotti and Rogers 2016). Numerous factors are

identified in the literature that influence interactions and activities of individuals. Such factors include social learning, diffusion of innovation, homophily, and social capital.

Social learning is a process in which individuals have the ability to gather information from, and observe behavior of, others, thereby enhancing their knowledge (Foster and Rosenzweig 1995). Learning processes may change over time; individuals may draw signals of different quality and might be selective in their conversations.

Diffusion of innovation refers to the spreading of information, over a wide range of topics, due to the interactions between individuals in gathering information and observing others (Foster and Rosenzweig 1995). Part of the diffusion of information from social learning may be caused by imitation. For example, women may tend to join groups that can mobilize fewer resources than men as they are resource constrained (Maluccio, Haddad and May 2003). As a result, the spreading of information through men's and women's networks may be quite different.

Social capital is another important element of social networks. Social capital refers to the resources (i.e., information, influence, and status) that are embedded in social networks (McDonald 2011). Podolny (2010) finds that being connected to another person can bring status benefits. Social capital also influences women's relationships in numerous ways. The difference of resources endowments that female-headed households have, relative to male-headed households, may impact their social capital formation and exchange of information (Katungi et al. 2008).

As social networks are able to influence many socioeconomic characteristics of households, it is important to develop insights on how they are formed, and how their structure can generate heterogenous social impacts. An important factor in social network formation is homophily – the preference of individuals to interact with peers they consider to be alike, e.g., people of the same gender (Stehlé et al. 2013). For instance, an individual with many smoker friends might be influenced to become a smoker. Similarly, women imitate women, and men imitate men, which can result in powerful motivation (Gittinger 1990).

Spatial interactions also play an important role in establishing social links. Social networks exist and operate within geographical spaces. Nolin (2010) suggests that spatial interactions

are more likely to occur within spatially closer households or neighbors for three reasons. First, transaction costs of time and resources for travel increase with distance. Second, it is easier to assess information from closer individuals like neighbors than from those further away. Third, closer neighbors interact more frequently, which may increase the probability of future interactions.

Spatial interactions can take a wide variety of forms that include travel for shopping, commuting to work, and on-farm interactions. The possibility remains that spatial interactions affect women differently than men. For example, women may have a higher opportunity cost of time than men (e.g. from a high domestic workload), which reduces their participation in organizations or other social interactions (Meinzen-Dick and Zwarteveen 1998). This constraint may motivate women to engage in relationships that are spatially closer, and perhaps develop fewer but more meaningful relationships.

The discussion above shows that there are numerous factors that may interact with gender dimensions to influence behavior. Moreover, these interactions may produce spillover effects within the system where information and other externalities are transferred to others (refer to Anselin, 2003 for a discussion).

The potentially central role that spatial relationships play within the complexities of social networks suggest that we may use the spatial distribution of households as a proxy for more complex relationships. In our dataset, we characterize spatial position using GPS coordinates for every household. We proceed to test the hypothesis that these spatial coordinates are meaningful in helping to explain the food security of households.

Methodology

Measuring gender

A common approach in the literature is to capture gender differences with dummy variables based on whether the gender of the head of the household is male or female (Fekadu and Muche Mequanent 2010). Although the use of dummy variables may be practical, the limitations of using a simple gender dummy can be numerous, given that men and women in agricultural societies face many different inequalities in their farming activities (see

discussion above). Given that the info note will interact gender with spatial effects, we believe our best option is to capture the influence of gender by using a binary gender variable (i.e. female- vs. male-headed household), which is well established in the literature (e.g. Babatunde et al. 2008). Such an approach is necessary to investigate extensively across wide regions, rather than intensively at a single study site.

Measuring food security

To assess the status of food security, we use a calorie gap measure that reflects the "food access" dimension of food security. We adopt this approach because the IMPACT Lite survey contains detailed information about food consumption over different seasons of a year, which also provides us with seasonality data that will help address the "stability" dimension. The calorie gap metric is defined as the difference between the actual daily calorie intake and the recommended daily calorie intake by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). The FAO/WHO recommended daily calorie intake measures account for differences in individual's energy requirement by gender and sex (Ncube et al. 2016). A positive calorie gap implies the household is food or calorie-rich; conversely, a negative gap indicates that a household is food or calorie-poor.

Modelling spatial interactions

To model gender and spatial interactions, we implemented a Spatial Autoregressive (SAR) model. To estimate a SAR model, observations are characterized by their location (i.e. GPS coordinates). Our survey instrument collected GPS coordinates of the location of each household. This information allows us to construct the spatial weights matrix W, which is required to estimate a SAR model. The spatial weight matrix W indicates, for each location in the system, which of the other sites affect food security at that location (Anselin 2001). The matrix W assigns weights for the influences of each neighbor on a household's food security.

There are two fundamental assumptions regarding spatial weights in the spatial econometrics' literature. First, the literature assumes a decline in influence among agents as the distance between two observations increases. We adopt a truncated version of W, where an element wij=0 if households at locations i and j are further than 20 kilometers apart. The second assumption is row-normalization, with the convention that the diagonal of W is zero. We row-normalize our matrix W so that a row i represents a convex combination

of weights that household i places on the influence of neighbors within 20km, i.e., every element wij element is between 0 and 1.

In the SAR model, the main term of interest is WY. WY is a weighted average of neighbors' food security, where weights increase with spatial proximity. Therefore, the spatial autoregressive parameter ρ, often referred to as the spatial effect, captures the marginal effect of neighbors' food security on own food security. That is, when neighbors' food security increases by x calories, own food security increases by ρx calories.

Given the potential effect that spatial interactions may have on food security, we are interested in estimating the following SAR model:

$$Y_{id} = \rho \sum_{j} W_{ij} Y_{jd} + X'_{id}\beta + C'_{c}\theta + D'_{d}\delta + T'_{t}\alpha + \varepsilon_{id}$$

In order to integrate gender into our baseline model, we construct two types of models: Ego-Gender and Gender-Homophily. We will refer to "ego" as a household of reference; the focal position concerning which household's food security is being affected in the model. We assume that each ego household can be either female- or male-headed. All other households located within 20km from the ego are defined as comprising the ego's "neighborhood".

Using an ego-centric perspective, where a household i of gender $g \in \{M,F\}$ is influenced by other households i's neighborhood, the gender spatial model in scalar notation is:

$$Y_{id}^{g} = \rho^{g}\tilde{Y}_{id}^{g} + X_{id}^{g\prime}\beta^{g} + C_{id}^{g\prime}\theta^{g} + D_{id}^{g\prime}\delta^{g} + \varepsilon_{id}^{g}$$

where the superscript g indicates that only observations of ego-centric gender g are included in the regression. We estimate a regression model for each gender. This procedure delivers a set of parameters for males and another set for females. The parameter ρM is estimated when the model has gender g=M and therefore uses 1298 male ego-centric observations, while ρF uses 198 female ego-centric observations.

Learning about homophily interactions is essential to a better understanding of food security as it captures a reduced-form arrangement of how social ties grow into complex structures to generate opportunities for sharing and distributing food resources at the community level

(Mertens et al. 2015). In homophily models, we are interested in estimating the effect of the food security of neighbors of gender g on the ego household of same gender g. Therefore, not all neighbors are considered when calculating the weighted average of neighbors' food security.

To calculate the weights, we construct a new spatial matrix WG that collects the influences of column individuals on a row individual, where all individuals have the same gender g. Therefore, in the female homophily model, this matrix is a 198×198 square matrix, and a 1298×1298 matrix in the male homophily model. The Gender homophily model in scalar notation is:

$$Y_{id}^{g} = \rho_{H}^{g} \sum_{j} W_{\{i,j\}\in G}\, \tilde{Y}_{id}^{g} + X_{id}^{g\prime}\beta^{g} + C_{id}^{g\prime}\theta^{g} + D_{id}^{g\prime}\delta^{g} + \varepsilon_{id}^{g}$$

A comparison between the parameters of model 2 ρHg and model 3 ρg reveals, how much marginal spatial effects depend on all neighbors, as opposed to how much depends on spatial interactions with gender-homophily interactions.

Equation (1) reveals that the spatial lag term of the SAR model is correlated with the error term. The outcomes of neighbors affect the egos' outcomes, and vice-versa, which leads to reverse causality. We address the endogeneity of the spatial lag by implementing a GMM/IV strategy, which was first proposed by Kelejian & Prucha (1998; 1999) and is currently well-established in the literature.

Results

Our findings suggest that the food security of neighbors has a positive influence on own food security. Specifically, a household's food security increases by approximately 17 calories in response to an increase of 100 calories in neighbors' food security.

The results of the Ego-Gender Models indicate that female farmers' food security increases by 49 calories when neighbors' food security increases by 100 calories. The effect goes down from 49 to only 14 calories for male-headed households. This finding suggests that gendered

spatial effects influence food security and may therefore provide valuable information for policy-makers when designing policy interventions.

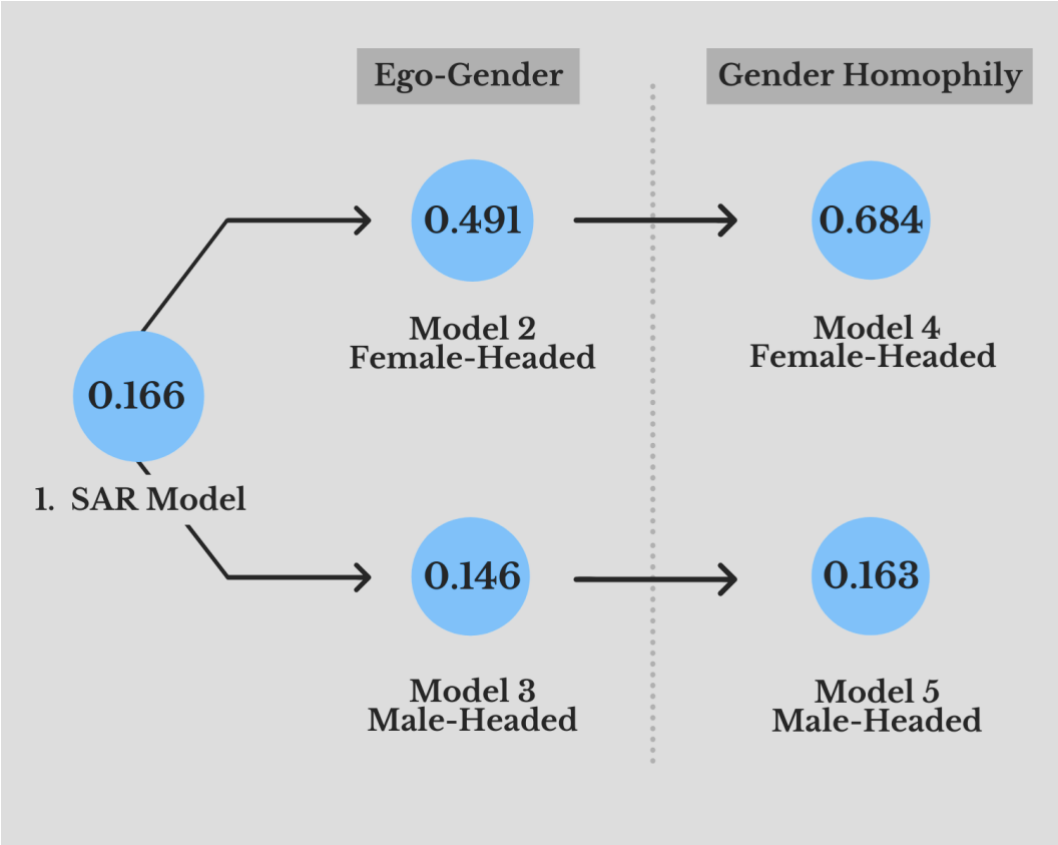

Figure 1. Decomposition of Spatial Effects on Food Security for Women and Men. The numbers in blue circles indicate the spatial effects on food security for female-headed households and male headed households. The numbers are interpreted as the increase of calories for the group of gender-ego when the calories of gender edge (neighbors) increase by 1 calorie

The results of the Gender Homophily Models are shown in Figure 1. The spatial effects parameters ρ=0.68 ($p<0.01$) and ρ=0.16 ($p<0.01$) for females and males, respectively. Note that the spatial effect for male households is similar to that of the Ego-Gender and SAR models. In contrast, women benefit more than men from all neighbors. Moreover, results from the Gender Homophily Model show that women receive a large boost on food security from the spatial interaction with female neighbors. The spatial effect suggests that female-headed household's food security increases by 68 calories in response to an increase of 100 calories in female neighbors' food security. This result supports the idea that homophily may be a factor that influences smallholder farms' food security, but only for women. In situations where developments projects are budget constrained and seeking to target

resources, this spatial effect for women could induce policy-makers seeking to improve food security to design gender-clustered policies, i.e. redirecting their efforts towards female-headed households, surrounded by female-headed neighbors.

Conclusions and policy implications

Our results show that improving food security has spatial multipliers that help all households, but that these spatial multipliers help female-headed households more; especially if the spillover is between two female-headed households (i.e. homophily). This is encouraging news for development, because policies that aim to target aid can have the largest positive spillover effects where they are needed most.

While targeted policy efforts towards promoting women's access to a wide range of resources seems critical for promoting food security and development, complementary efforts within spatial effects on food security could play an important role. For example, development programs that have tried to build social capital among women (e.g. women self-help groups, or support for women's cooperatives) appear to be working and helping to create large spillover effects. Along these lines, new programs to promote food security may be more effective if they include means of strengthening social capital as an amplifying mechanism for pursuing food security.

In summary, food insecurity is a development problem that would benefit from having policy-makers be aware of gendered-spatial impacts. Our investigation demonstrates that spatial effects can have positive consequences for women's food security. Therefore, it is germane to understand the complexities that involve interactions among women and their influence on food security concerns. Based on these findings, potential policy solutions include the strengthening of social capital of female-headed households, which could facilitate spatial spillover effects that boost their food security, and that potentially could ensure significant progress in important development dimensions for women.

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