Village Level Labor Market Development in Tanzania: Evidence from Spatial Econometrics[1]

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Abstract

While many empirical studies show that participation in rural labor markets is an important household livelihood strategy, data on Tanzania show that the participation in the rural labor markets is still relatively low. This study examines the factors behind the development of village labor markets in Tanzania. Using spatial econometric techniques, the study shows that, despite their incipient development, rural labor markets in Tanzania are significantly interlinked across space. Furthermore, underlying factors for development of rural labor markets, such as access to roads and availability of credit, have varying impact across space. This implies that policy interventions would also have varying effects over space. The study shows that most of the policy interventions for promoting rural labor markets are likely to have greater impact in the northern (eastern) parts of the country than in the southern (western) part of the Tanzania.

1. Introduction

While direct agricultural income is still the backbone of the rural economy in many developing countries, evidence shows that incomes from wage labor and other non-farm activities are important for food security and poverty alleviation in general (Bright *et al.* 2000; Lanjouw and Shariff. 1999; Zucula and Massinga 1992; Ruben and Berger 2001; FAO 1998; Lanjouw 1998). In Tanzania, two consecutive household budget surveys (conducted in1990/01 and 2000/01, respectively), reveal that, participation in rural labor markets has indeed positive bearing on the welfare of the rural population (NBS 2002)[4]. Moreover, the evidence that rural poverty can be reduced by diversifying away from agricultural income has been reflected in many Tanzanian policy documents such as the Rural Development Strategy, the Agricultural Sector Development Strategy, and most recently, the Poverty Reduction Strategy Paper (URT 2000,

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[4] This report, however, does not show that modest reduction in poverty in the 1990s was significantly contributed my increased participation in rural labor markets. What this report shows is: cross-sectionally, in the two survey, households which participated in rural labor markets were less poor that those that did not.

URT 2002). However, participation in the rural labor markets in Tanzania still remains low. The 2000/01 Integrated Labor Force Survey in Tanzania shows that only 11% of the rural population participated in the wage labor markets (NBS 2001).

Given this relatively low rural labor market participation rate, it is important to ask: what determines the flexibility with which the rural households react to the obtaining conditions in the rural labor markets? Indeed, there is a host of theoretical and empirical literature that explains the individual/household participation in the rural labor markets. However, most of the analyses done so far have concentrated on individual level or household level (Isguti 2003; Bright *et al.* 2000), which may overlook the spatial interconnectedness of rural labor market and other geographical aspects such as credit, land, and insurance markets (Rosenzweig 1988)[5]. These aspects are generally spatial in nature in the sense that they are localized in a particular area or their relationships vary from place to place (Anselin 2002).

Moreover, from the policy point of view, most micro-policies for rural poverty alleviation have spatial scale/scope, whereby they first target particular areas/locations and then households located therein (DFID 2002; World Bank 1999; Lanjouw 1998; and World Bank 1993). However, even in this era of renew 'spatial thinking' (Anselin 2002), only few studies such as Isguti (2003), Bright *et al.* (2000), Jeong and Townsend (2003), and Kaboski and Townsend 2002) have analyzed rural labor markets at the village/village level.

This paper argues that, even if the interlocked transactions in rural markets as observed by Rosenzweig (1988) are captured by the analysis at the individual level or household level, that treatment is not satisfactory because it fails to address the spatial variations and the externalities of the development of other market as well as to underline agro-ecological factors (Renkow, forthcoming; Bryceson 2000; Anselin 2002). For example, the analysis at the individual or household level may fail to capture the effect of one household's participation in rural credit market on other households' participation in rural labor markets. The strength of the connection of the two markets in this example is expected to diminish with distance (Hainig 1993). Moreover, accessibility to rural wage employment, credit, land, affects not only single households but tends to have spatial effect – affecting relatively closely located households. Most of these factors are not idiosyncratic (as treated in other studies) because the households in a close neighborhood would be facing similar transaction costs, rationing and entry barriers. Most of these constraints are dictated by the spatial locations as noted by Isguti (2003).

Another example, where the standard analysis at individual level may fail to reveal the constraints to development in rural labor markets is the presence of spatial externalities (Anselin 2002). In the context of rural Tanzania, overstocking is typical example of these spatial externalities (VPO 1999). Overstocking livestock due to ill-defined property rights may cause soil degradation in the village and reduce agricultural productivity. Since most rural activities hinge on the performance of the agricultural sector as discussed in DFID (2002), such market failure would slow down economic activities and halt development of the rural labor

[5] Over decades, researchers in rural economics and agricultural economics have shown that failing markets/market imperfections (or non-existence of certain markets) are wide spread in rural areas (Stiglitz and Weiss 1981).

markets as affirmed in USAID (2004). These effects are, by and large, localized and will tend to affect not only the decisions of households individually, but these effects are likely to have an impact on several households in the vicinity of the affected areas.

Given the increased use of spatial targeting for poverty reduction in which poverty mapping is one of the analytical tools, this paper takes the analysis of the rural labor markets at higher levels of aggregation than household level, namely, at the village level. This approach has been used in Isguti (2003), Bright *et al*. (2000), Jeong and Townsend (2003), and Kaboski and Townsend (2002). Using modified farm household model aggregated at village level, the objective of this paper is to analyze factors that influence rural labor markets in Tanzanian. This paper takes the analysis at the village level because (i) rural labor markets are interconnected with other markets in spatial scale and (ii) rural micro-policies start by targeting particular locations. Thus, this paper attempts answer the question: what are the factors that determine the development of rural labor market in terms of wage and casual employment? The need to understand these factors arise from the accumulating evidence that participation in rural labor markets has been an important strategy for poverty alleviation and food security (Ruben and Berger 2001; FAO 1998; Lanjouw 1998)[6].

The rest of the paper is organized as follows: Section 2 presents the theoretical framework of the agricultural household model and it can be aggregated to a village level. Section 3 describes the econometric models and the estimation procedures. Discussion of the results is provided in Section 4 and the conclusions and outlook of the paper are presented in Section 5.

2. The theoretical framework

Most studies that that take rural labor at village levels base their theoretical framework on the standard farm household framework (Isigut 2003). However, Jeong and Townsend (2003) and Kaboski and Townsend (2002) base their models on wealth-constrained occupation choice frameworks. The major weakness of the occupation choice framework used by Jeong and Townsend (2003) and Joseph Kaboski and Townsend (2002) is on the restrictive assumptions about the production function, which does not allows the comparative static analysis needed in the present study. While this paper borrows the estimation approach from Jeong and Townsend (2003) and Kaboski and Townsend (2002) (the approach that integrates socio-economic data and spatial data), our starting point is the standard farm household model. This is because the farm household models is more versatile to analyzing aspects ranging from purely subsistence household, to where the household is a commercial farmer (Woldahanna 2000) and allows additional features that enrich its comparative static analysis (Taylor and Adelman 2003).

[6] Other studies shows that incomes from wage labor and other non-farm activities have increasingly become importance across space and over time in many developing countries (Bright *et al*. 2000; Lanjouw and Shariff. 1999; Zucula and Massinga 1992).

2.1. The core framework

Let the rural household's preference be presented by a scalar valued utility function U given in equation 1. The arguments of U are the vector of consumption goods (c); leisure (H); and test shifters (a) such as age, education and other household characteristics. The standard assumptions that the function U is quasi-concave, twice continuously differentiable, and non-decreasing in c and H apply.

(1) $U = u(c, H, a)$

The objective of household is to maximize this utility function. However, as in standard farm household model, the representative household faces a number of constraints. As in (Woldahanna 2000), the first one is the farm production technology constraint given by a vector valued implicit function summarized by equation 2.

(2) $Q(q; x, Lh, A, K, Lf; \Omega, Z) \geq 0$

where $Q(.)$ is a closed, bounded convex production possibility set; q is the vector of agricultural outputs; x represent a vector of farm variable inputs such as fertilizers; Lh is vector hired farm labor; Lf is vector of own household farm labor; K is other fixed capital; A is vector of agricultural land under various crops; Z is vector of farm characteristics such as soil type and locational/spatial variables; and Ω is household characteristics.

Other constraints to the households' maximization problems (which are frequently used in both theoretical and empirical literature) are labor constraints, cash constraints, and land constraints. It is also assumed that the household faces both time and cash costs in participating in the rural labor markets. It is further assumed that labor market is not perfect and hired in farm labor is not a perfect substitute for own farm labor. Household that hires in labor pays a wage rate (wh) and incurs supervision cost (sp). The supervision cost is composed of two components, namely, the value of time needed in the supervision (sph) and direct cash need for supervision (spc). The two components of the supervision costs are assumed to be non-decreasing functions of amount of hired in labor (Lh).

From the labor supply side, it is assumed that the household has the option of selling labor for off-farm work at market wage rate (wm); work on the farm, or work on own (non-farm) business. Note, however, that wm is not equal to wh because of market imperfections that cause the wedge between wage paid and effective wage received. For simplicity, the model rules out the case where wage is dependent on hours worked and assumes that the market wage for off-farm labor is determined by standard Mincerian wage equation.

As in Woldehanna (2000), hiring out labor also involves some transaction costs (tc), which can be decomposed into two major components as well. The first component is the commuting/search/time cost (tch), and cash transaction cost (tcc). For simplicity, these components are assumed to be fixed proportion of labor hired out. Furthermore, the household faces rationing in the off-farm labor markets such that the level of labor allocated to off-farm

paid work is truncated from above. In this case, the observed labor in the rural labor market (*Lm*) may fall short of the desired amounts.

2.2. Comparative static analysis and extensions

From the assumptions of the model, the Kuhn-Tucker first order conditions are both necessary and sufficient condition for the household maximization problem. From the Kuhn-Tucker first order conditions, and assuming a non-corner solution, it is possible to derive equation 3 (Mduma 2003)[7].

$$(3) \qquad \omega_m^* = \frac{\lambda.tcc + \gamma(1+tch) + \mu}{\lambda}$$

Equation 3 shows that, the wage that the household is ready to accept is affected by (the sign shows the direction of the effect): marginal value of time (γ, +); the cash constant (λ , -); the rationing in the labor market (μ , +), transaction cash cost (*tcc*, +); and transaction time cost (*tch*, +)[8]. Thus, some components of equation 3 are standard comparative static results of the farm household model. Moreover, equation 3 shows that the participation in rural labor markets also depends on transactions costs, the marginal value of cash constraint, and labor market rationing, which are not from the standard farm household model. These theoretical implications are the one that have been extensively studied at the individual/household levels and the present study extends these implications to the village level[9]. Thus, for estimation purposes (discussed in detail in section 4), the present study relies on the conclusion derived from the farm household model present here. Like in the literature of microeconomic foundation of macroeconomics (Branson 1997), most of the variables at individual/household level are aggregated to village level variables. However, it is important to be aware that, unlike in the traditional labor market participation models, some of the household variables may have neutralizing effects when aggregated at the village level. For example, if we assume a non-corner solution to hire-in labor for some households, then the Kuhn-Tucker condition for optimization can be solved to give the demand for hire labor presented in equation 4.

$$(4) \qquad \omega^*_h = \left(\psi \frac{\partial Q(.)}{\partial L_h} - \lambda * spc - \gamma sph \right) * \lambda^{-1}$$

Equation 4 shows that tightening the cash constraints reduces the demand for labor (which is the opposite of the conclusion arrived in the labor supply given in equation 3). It was shown in

[7] For all derivations involved in this model, the reader is referred to another paper by author, which was presented at the Economics Discussion Series of the Economics Department, University of Dar es Salaam. The paper is available at http://www.pasad.uni-bonn.de

[8] Note that γ, λ, and μ are the respective langrage multipliers of the mentioned constraints.

[9] See Taylor and Adelman (2003) for a recent review of farm household models.

equation 3 that, *ceteris paribus*, tightening the cash constraint will always force the household to look for wage employment. However, at the market level, households, which are not cash constrained are likely to offer opportunities for wage employment to other households (for example to work on their farms or other non-farm business). Unless careful analysis is done at the village level, this kind offsetting effects may send wrong signal to policies that first start by targeting the village and then the individuals. The same problem could arise in the preparation of poverty maps that are intended to represent at small spatial units such as ward or village areas.

3. Methodology

To account for the spatial variations (spatial heterogeneity), many researchers have used Dummy Variable Least Squares (DVLS), by including regional dummies in their regressions (Readon *et al*, 2001; Bright *et al*. 2000). Although this is a move in the right direction in trying to account for spatial variation, it is not adequate if the studied phenomena have a spatial structure (Hainig 1993). For the purpose of this study, the regional dummy approach is clearly not even the 'second best' option in a large country like Tanzania, where rural labor markets are likely to operate in more localized areas than the administrative region boundary.

For case studies that involve few spatial locations, location dummies could be used. Even though location dummies can be used to capture variations in the local labor market (see Woldahanna 2000; Readon *et al*, 2001; Bright *et al*. 2000), this approach may suffer from several problems. First, from the computational point of view, there is a limit in the number of village dummies to be included. For present study, it is practically difficult to include all (over 660) village dummies in analyzing rural labor market participation in Tanzania using 2000/01 Household Budget Survey. Isguti (2003) avoids the problem of adding many village dummies in the regression equation by analyzing a panel data of households observed over sampling clusters. While panel data regression is richer methodologically in terms of usage of sample information than Dummy Variable Least Squares (DVLS), it fails to capture spatial dependence and spatial heterogeneity that may exist. The panel data approach simply eliminates some spatial heterogeneity in the estimation process but does not fully address the problem (Anselin 2002). Thus to avoid all these problems, this paper used spatial econometric estimation technique.

3.1.1. Spatial Econometric Models

Two problems arise when sample data have a location component (spatial structure), because the spatial structure causes violation of the Gauss-Markov assumption of traditional econometrics (Haining 1993; Pace 2000; LeSage 1999). The first component of spatial structure is the spatial dependence among observations in the locations that are near each other. The second one is the spatial heterogeneity of the relationship modeled across space. Spatial dependence or spatial heterogeneity in the rural labor markets are the results of various factors such as differences in geography, history, access to public services and other infrastructures as

well as many other aspects of public policies (Jeong and Townsend 2003; Kaboski and Townsend 2002). Variables such as road density and road quality and differences in access to input and output markets have a significant bearing on the rural labor markets (Davis 2003). Others factors that are likely to introduce spatial structure in the rural labor markets are differences in land tenure system such as the differences in the length of tenure.

This paper tests for the existence of spatial structure in our data using Moran's I test, Wald test, Likelihood ration test, and Langrage multiplier tests. All the tests indicate that there is significant spatial structure in our sample[10]. Spatial regression analysis is therefore called for in order to understand the spatial distribution of factors that are fundamental to development of the rural labor markets. A general regression model with spatial structure is present in equation 5.

$$(5) \qquad y = \rho * W_1 * y + X\beta + u$$
$$u = \lambda * W_2 * u + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I)$$

where y is n-by-1 vector of dependent variable; λ is a parameter of first order spatial moving average-SMA(1) of u; ρ is a parameter of first order spatial autoregressive scheme-SAR(1) of y. u is a spatially auto-correlated error term; ε is white noise spatial error normal process; W_1 and W_2 are n-by-n matrix of spatial weights[11]. In general, W_1 and W_2 should not necessarily be different. However, Pace (1999) and LeSage (199) warn that when the two matrixes are the same, the model could be under-identified. To avoid the problem of model under-identification, LeSage (1999) suggests the construction of one W matrix based on contiguity principles and the other based on distances from a chosen center (e.g. the capital city). However, in the present study distance from the central city (Dar es Salaam, the commercial capital, or respective regional headquarters) represent an important factor in the development of the rural labor markets, which also needs to be modeled. In this case, the present study adopts the strategy of decomposing the general model into two components as suggested in LeSage (1999). These components are (i) Spatial Autoregressive Mixed (SAR) presented in equation 6 and (ii) Spatial Autoregressive Error (SEM) presented in equation 7.

$$(6) \qquad y = \rho * W * y + X\beta + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I)$$

[10] The results of these tests are available from the authors upon request.

[11] The matrix of spatial weights used in this study is produced using Delaunay Triangulation. Given a set of coplanar data points (points that lay on the same plane), Delaunay triangulation is a set of lines connecting each point to its natural neighbors. It is set of triangles such that no data points are contained in any triangle's circumcircle (Haining 1993).

(7) $$y = X\beta + u$$
$$u = \lambda * W * u + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I)$$

To account for spatial heterogeneity, this paper uses Cessetti's spatial expansion method LeSage (1999), where the regression parameters are a function of geographical locations. There are essentially two approaches followed in modeling variation of the relationship over space (Fatheringham *et al* 2004; Anselin 2002; Haining 1993). The first approach is based on the premise that the parameters of the relationship are a function of the latitude and longitude coordinates. In this case, the location in Cartesian space represented by latitude and longitude forms the basis of computing variations (Anselin 2002). The variation in the modeled relationship is normally achieved by imposing the restrictions that nearby observations (in the Cartesian space) take on similar parameter values while distant observations take different parameter values That is, as the location varies, the regression relationship changes to accommodate a linear fit through observations (Haining 1993).

The second spatial expansion approach, which is more relevant for policy purposes than longitude-latitude variations, is the distance expansion (Fotheringham *et al* 2004; Anselin 2002). In this approach, the expansion is done from a common central point (for the present study, Dar es Salaam, the commercial capital). Methodologically, this option has also another advantage over the longitude-latitude expansion in that it allows different weighting schemes (which are not available under longitude-latitude expansion). The most common weighting scheme used, which has policy relevance is that of "hollowing out" from the central city, where there is a gradual decay of influence with distance from the central point (Pace 2000; LeSage 1999). This is particularly important when one wants to analyze the influences of urban centers on the rural labor markets. For comparison purposes, the present study carries out both longitude-latitude expansion and distance expansion, taking Dar es Salaam as the common central reference point.

3.1.2. Estimation Strategy

Spatial exploratory data analysis (section 4.1) shows the presence of outliers, which suggest yet another violation of Gauss-Markov assumption of constant variance the error tem ε. To overcome this problem, the study uses Bayesian estimation strategy. The estimations were carried by taking 1,100 draws using Markov Chain Monte Carlo simulation (Gibbs Sampler). However, the first 100 (burn in) simulation were dropped from the results we present in section 4.2, in order to allow the Markov Chain process to attain a steady state (LeSage 1999). For comparison purpose, the paper use both homoscedastic prior and heteroscedastic prior.

3.2. Variable Definitions and Sources

This paper uses two main sources of data, namely the 2000/01 Tanzania Household Budget Survey (HBS) and International Food Policy Research Institute (IFPRI) GIS database on Tanzania[12]. The study combines the HBS and the GIS data by matching the HBS village names and the names of populated places in Tanzania from the GIS data base. By using this method, the present study was able to match 660 out of 853 HBS village names[13], which is over 77% coverage. The study uses this method (that is, villages instead of regional or district as is usually done in most poverty mapping analysis) because it allows the possibility of conducting similarity analysis of much fine spatial unit such as village level (*i.e.* comparing and contrasting various locations).

After combining the HBS data and the GIS data, GIS data relevant for the development of the rural labor markets as predicted/implied by the theoretical framework was then extracted and joned with the HBS data. The dependent variables for this study come from the HBS data, while the explanatory variables come from the HBS and GIS data base. The following is the description of each variables and its role in the estimation process.

3.2.1. Dependent Variables:

As in Isgut (2003), the present study uses two related indicators of development in the rural labor markets. The first indicator is the proportion of households in the village which reported that the wage labor is the main source of their cash incomes (hereafter referred to as wage labor). The second indicator is the proportion of households in the village which reported that casual labor is the main source of their cash incomes (hereafter referred to as casual labor). The reason for this distinction is that it allows assessment of the differential impact of the explanatory variables on the wage labor, which has some formality and contracts of relative long periods as compared to informal and sport contracts (mainly daily) for the case of casual labor.

3.2.2. Explanatory Variables from HBS

Besides the GIS-based explanatory variables to be discussed shortly, this study uses most of the explanatory variables form the HBS database. This subsection explains the way these explanatory variables were constructed from household or individual level data.

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[12] The original source of the GIS database on Tanzania is Mud Spring Geographer (MSG) Inc. However, most of the data used in this study has already been modified by IFPRI researchers to suit their poverty and malnutrition mapping project in Tanzania. We thank to all IFPRI researchers who provided the data and technical assistance.

[13] To implement this we needed the national, regional, and district boundaries maps because they provide the means for delineating HBS cluster locations. We started to locate the villages sampled in the HBS by comparing their names with those found in the Tanzanian maps of populated areas. When the village was not on the map, then the ward in which it is located (or the nearest village if known), was used as location proxy.

Water and fuel availability: Collection of water has been documented as one of the time consuming activities in the rural communities, which is likely to reduce the participation in the rural labor markets (Loughran and Pritchett 1997). The easiness with which water is available in many rural Tanzania is associated with less time need to fetching water. This then could release some labor resources to engage in other income generating activities. In so doing water availability is expected to increase participation in the rural labor market. To account for the effect of water availability, the study generates two proxies. The first one is the proportions of households whose main sources of drinking water is in-house, outside-house private tape, as well as protected and unprotected private wells (*Pr_water*). The second one is the proportion of the household in the village, whose water sources are in the community, as well as public protected and unprotected wells (*Pu_water*). The rest of water sources are taken as control group.

Another time consuming activities in rural communities is firewood collection. To capture the impact of firewood collection, the study includes the proportions of households in the villages whose main source of fuel is firewood (*Fuel_wood*). As mentioned, time use for the collection of firewood is expected to reduce the participation in the rural labor markets because this activity is labor intensive. The expected sign of the coefficients for this variable is negative.

Rural Business and Commercial Farming: Development in rural labor markets is likely to be associated with the development in other markets, petty business and commercial farming. To capture this relationship, the paper generates a proxy variable (*N_business*) as the proportion of the households in the villages that operated non-farm businesses of any kind. The paper also includes a proxy of commercial farming (*N_comm_farm*), which is the proportion of the households whose main source of cash income is commercial farming. The intension of using these proxies is to find the inter-linkage between self-employment, commercial orientation in farming, and the development of rural labor markets.

Cash Constraint: One aspect that the theoretical framework pointed is that cash constraint has indeterminate effects on the participation in the rural labor markets. To capture the village level cash constraint effect on the rural labor market development, the study creates two indicators of cash constraints. The first one is the proportion of individuals in the village who operate savings and/or current account and/or borrowed from the bank (*Bank_formal*). The second indicator of cash constraints (*Credit_informal*) is a proportion of individuals who participated in informal credit and informal savings groups[14].

Land and Livestock: Land and livestock are among the assets of the rural households that are expected to have bearing on the rural labor market participation. In this study, per capita cultivated land and pasture land (*Land_head*) is used as a proxy of land availability. Other studies of the rural labor markets show that, theoretically, land availability has indeterminate effect on the participation in rural labor markets because land is both a wealth variable and

[14] It has been pointed out that the way the second indicator of cash constraints is generated measures both cash constraints and social capital. If this is the case, then it will reinforce the positive effects of relaxing the cash constraints that come from the demand side of the rural labor markets because it is known that social capital increase participation in the labor market in general.

production factor. First, as wealth variable, land may induce people who have large land to have confidence on their land (and what they can produce from it), which in turn reduce their participation in wage employment. This insurance effect that the land produces reduces the incentives of looking for wage and casual employment (Yao 2001).

But when land is considered as a factor of production, it can be either complimentary to labor or substitute for it (Yao 2001). For the purpose of this study, the complimentary nature of land and labor is more expected to have dominant effect due to poor technology used in small scale farming in rural Tanzania. Most households in Tanzania still depend on hand hoes as their main tool of cultivation. In this case then large land availability in the village makes households with large land to hire wage labor to cultivate the land. The paper also includes the square of the land (*Land_squared)* to capture this non-linearity of the effects of the land holding on the participation in the rural labor markets.

For the case of livestock, we use per capita number of cattle in the village (*Cattle_head*) as the proxy for livestock assets[15]. Per capita ruminant animals was also included in the earlier stages of estimation but was late dropped because it was highly insignificant and rendered the model unstable due to colliniearity with the cattle variable. .

Food Security: The experience shows that some amount of participation in the rural labor markets is a forced participation due to famine/hunger in some households (USAID 2004). To account for the forced participation in rural labor market due to hanger/famine the study includes explanatory variable (*Food_insecurity*), which is the proportion of the households who had difficulty in satisfy food needs in the year of interview. The sign of the coefficient of this explanatory variable is expected to be positive. However, at some point as the famine crisis intensifies, the rural labor markets are expected to shrink (USAID 2004). Thus, the study includes the square of the variable (*Foodp_squared*) and is supposed to have negative sign.

Education, Skills, and Experience: There are several ways of modeling these indicators. For skills, which are normally proxyed by education level, one option which is commonly used in the empirical literature is the percentage of individuals per village who have attained secondary school level or higher (Kaboski and Townsend 2002). In this paper the proxy for skills (*Educ_SEC+*) is modeled as the proportion of individuals with education level above primary school in the population of 15 years old and over. The threshold of 15 years of age was chosen so to make sure that we only deal with those who are not attending the compulsory primary school[16]. The choice of upper limit of 65 year of age is motivated by the retirement age in the form sector in Tanzania.

The study also includes the average age (*Age*) and its square (*Age_squared*) of the population in the village aged between 15 and 65 year. As in individual or household level analysis, age is included as a proxy for experiences (Taylor and Adelman 2003). In our case however, it may not have that direct interpretation because of the averaging factor. Nevertheless, it is included

[15] This proxy is generated from the HBS data, unlike, cattle density, which is generated from the GIS database (see section 3.2.3).

[16] For detailed analysis of the structure of education systems in Tanzania the reader is referred to Seebens and Wobst (2003a 2003b).

in the model because a village where majority of the people are aged may have different participation rates in the labor markets as compared to the villages where majority of the people are young.

Health Aspects and Household Size: Health is undoubtedly one of the important determinants of the participation in the labor markets. Given the increasing spread of HIV/AIDS in Tanzania (Channing and Wobst 2002), it would have been interesting to include some indicators of this problem of HIV/AIDS because it reduces participation in the labor markets of both the sick person and of the family members who take care of the sick. Unfortunately, the HBS did not elicit information on these variables. To control for effects of diseases (in general) on the participation in the rural labor markets, the study includes the proportion of the individuals who fell sick in last four weeks prior to the interviews (*Sickness*). The study also includes average size of the households (*HHSIZE*) as one of the explanatory variables to control for labor endowment. Table 1 summarizes the definition, source, and expected sign of the explanatory variables from the HBS.

Table 1
Summary Definition of Explanatory Variables from
the Household Budget Survey

Name	**Definition**	**Sign**
Hh_size	Average household size in the village	+
Age	Average age of 15-65 age group	+
Age_squared	The square of age1	-
Educ_SEC+	Proportion of those with education level above primary education	+
Sickness	Proportion of individual who fall sick in the past 4 weeks prior to the day of interview	-
Pr_water	Proportion of households with private tap water or well	+
Pu_water	Proportion of households with access to public tap water or well	+
Fuel_wood	Proportion of household using firewood as main fuel sources	-
N_business	Proportion of households operating some petty business	+
N_comm_farm	Proportion of households whose main source of cash is commercial farming	+
Bank_formal	Proportions of individuals who have accounts with banks	+/-
Credit_informal	Proportions of individuals who participated in informal credit/savings groups	-/+
Land_head	Par capita cultivated land in the survey year and the pasture land	+
Land_squared	The square of per capital land	-
Cattle_head	Per capita number of cattle	-
Food_insecurity	Proportion of households who experienced regular food problem in the survey year	+
Foodp_squared	The square of food insecurity	-

3.2.3. GIS Extracted Explanatory Variables

***Location co-coordinates*:** As mentioned earlier, the first important variables in the spatial analysis is the geo-coordinates (location coordinates) of the areas under analysis. The GIS data used in this study employs longitude and latitude co-ordinates as the geo-referencing coordinates. This study uses these coordinates to construct the matrix of spatial weights used in the estimation of spatial dependence model. These coordinates are also used in spatial expansion for estimating spatial heterogeneity (Cassetti) model.

Environmental/natural variables: As implied in the theoretical framework, the development of the rural labor markets is influenced by environmental variables such as climate, hydrograph, topography, and soil quality. Of these natural recourses, soil quality/type have been shown to play significant role in affecting rural labor allocation, such occupation shift out of subsistence farming into other business activities. Felkner and Townsend (2004) argue that households in villages with high soil quality might have a higher opportunity cost for making a shift from agriculture, because their agricultural productivity is relatively high[17]. For the present study, areas with fertile soil have relatively well developed infrastructure, particularly road networks. Therefore, the effect of soil quality on the development of rural labor markets is not modeled directly in this study. Instead, it effects is captured by other variables such as distance to the road and population density. However, the study includes the average annual rainfall (*Av_Rainfall*) as the proxy of the length of the growing period.

Distance and Information costs: As shown in Benson (2002), Felkner and Townsend (2004), and Minot and Baulch (2003), transport costs and information costs are also important in affecting the development of the rural labor markets. The present study uses two measures of information and transport costs that have widely been used in the spatial analysis (Benson 2002). These measures are (i) the distance form each village to its respective regional headquarter (*Distance_reg*); and (ii) the distance from each village to the nearest road (*Distance_road*)[18]. Both distance variables capture a measure of the increasing transport and/or information costs. As distance from roads, urban centers, or markets increases, these costs are also expected to increase. In other studies cited in Wood *et al* (1999), these distance measures have also been used as the proxy for market integration, where it is argued that the regional centers tend to also serve as major market and financial centers. Furthermore, proximity to road facilities could aid economic development, including increased access to financial credit.

***Land degradation Indicator*:** From the GIS database, the study also extracts cattle density as an indicator of land degradation (VPO 1999). Since land is the largest employer, the more it is

[17] Since their main objective was to analyze occupation choices, Felkner and Townsend (2004) conclude that high soil quality could inhibit shifts into entrepreneurial activity (the non-farm activities). But this conclusion overlooks the possibility of using high quality soil to support profitable farming (relative to other poor soil location) and the development of other rural based business. In general therefore, the relationship between high quality soils may not be necessarily linear as portrayed in Felkner and Townsend (2004).

[18] The distance to nearest roads needs to be adjusted to travel speed as discussed in Wood *et al* (1999) in order to reflect the terrain and the nature of the passage. Such adjustment is normally base on the quality of the transport network. However, we are not able to adjust for these aspects because of the lack of the information in the quality of the road

degraded the more it is likely that crop production will fail. Falling agricultural productivity is also likely to be associated with decline in the development in rural labor markets. Thus, the expected sign of coefficient of cattle density (*Cattle_density*) is negative. Since the relationship between cattle density and development in rural labor markets may not be linear, we also attempted to include the square of this variable in the regression. However, the square of this variable was dropped in the process of finding a parsimonious model because it was highly insignificant.

Population Density and Urbanization: This study also includes population density and its square *(Pop_density* and *Popd_squared*, respectively) because development of the rural labor markets is likely to be reflected by the extent a particular location is moving toward urbanization. High population density is likely to be associated with some features of urban areas, which support the development of labor markets. Thus, the expected sign of the population variables is positive. Table 2 summarizes the definition, source, and expected sign of the explanatory variables from GIS database.

Table 2.
List of GIS Extracted Explanatory Variable

Name	Definition	Sign
Distance_reg	Distance from the regional headquarter to the village	-
Distance_road	Distance from the nearest road to the village	-
Cattle_density	Cattle density in the village	-
Av_Rainfall	Average annual rainfall in the village	?
Pop_density	Village population density in the 1990s	+
Popd_squared	The square of the population density	+

4. Estimation Results and Discussions[19]

This section presents the estimation results and discusses their policy implications. The presentation starts with selected spatial exploratory data analysis in subsection 4.1, which forms the supporting base of the discussion of the regression results presented in subsection 4.2.

4.1. Spatial Exploratory Data Analysis (SEDA)

One major advantage of spatial exploratory data analysis (over the standard exploratory data analysis) is its ability to locate where (on the map) a particular phenomenon occurs (Haining 1993). In this paper, the SEDA starts by considering the distribution of the two indicators of the development of the rural labor markets, namely the proportion of households in the village

[19] All the estimation was done using Spatial Econometrics Toolbox for MATLAB developed by Prof. J. LeSage. More information can be found at http://www.spatial-econometrics.com.

whose main source of cash income is (i) wage labor and (ii) casual labor. To explore these dependent variables, the usual exploratory data analysis statistics (for example, using box-plots) are generated and then projected on the map of Tanzania in order to show spatial distributions of the phenomena.

Since development in the rural labor markets has been found to be positive for poverty reduction and food security in particular (Bright *et al.* 2000; Lanjouw and Shariff. 1999; Zucula and Massinga 1992) it is important to see the distributions of the villages that are the best performers and those villages that perform below average. Thus, Map 1 for wage labor and Map 2 for casual labor show the three groups, namely (i) best performers-villages with extreme development in rural labor markets (sample points with values over 1.5 times inter-quintile range); (ii) poor performers-villages below national average (median); and (iii) others villages.

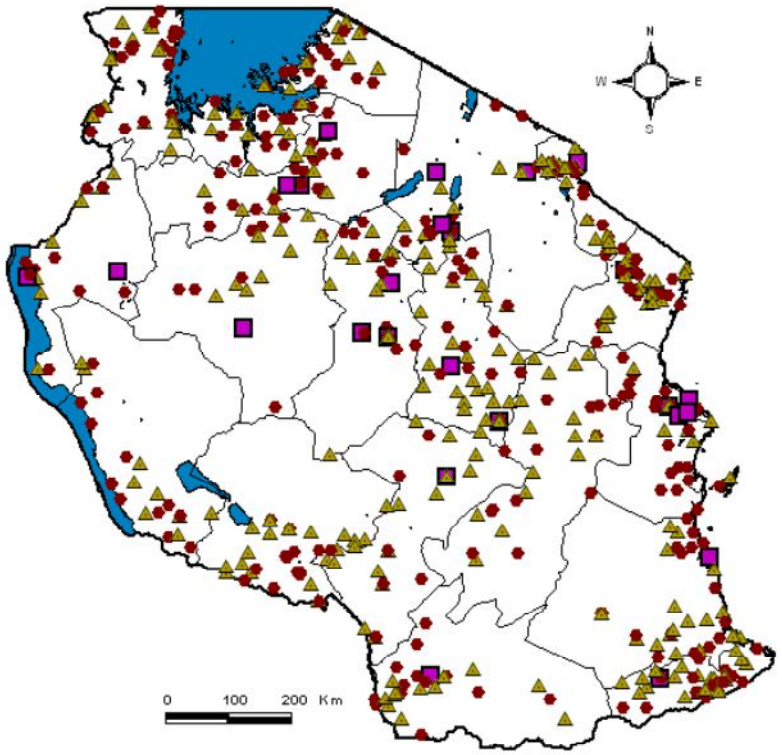
It is apparent from the Map 1 that that villages located close to the towns and near to the major roads constitute majority of the villages classified as best berformers. Indeed, this is as expected since being near to the town and road network tends to increase returns to off-farm activities relative to the on-farm activities though the reduction in the information and transportation costs. But apparent also is that the southern highlands seem to have lower development in the rural labor markets than their counterpart in the north. Generally, the south eastern regions have the least of best performers and they have the largest proportion of those below the national median for the case of wage labor. This could partly be explained by the recently increased youth migration from these regions to other parts of the countries as observed in Diyamett, *et al.* (2001).

However, migration alone cannot explain the low development of rural labor markets in the south-eastern regions. This is because other reports show the northern regions, particularly Kilimanjaro region, also have relatively high net out migration (URT 1998; URT 2002b). Yet still, our analysis shows that they have significant number of villages where rural labor markets are fairly well developed. Thus, other factors should be sought to explain the observed spatial pattern (this is done in the regression analysis).

Apparent also in Map2 is that villages with best performers in terms of proportions of households for which casual wage labor is the main source of cash income are only located in the northern part of the country (particularly, north of the central railway line form Dar es Salaam city to Kigoma region). It can also be seen that the villages with below the national median are largely located in the southern part of the country.

Map 1

DISTRIBUTION OF VILLAGES ACCORDING TO THE DEPENDENCE ON WAGE LABOR AS THE MAIN SOURCE OF CASH INCOME



LEGEND

Village with:

- Above national median but not extreme
- Below national median
- Extreme above national median

- Lake
- Road network
- Regional border
- National border

Moreover, comparing the two maps, there are two contrasts that can be made between the distribution of villages which are the best performers in terms of wage labor and casual labor. First, there is reduction in the number of the best performers in terms of casual labor; and

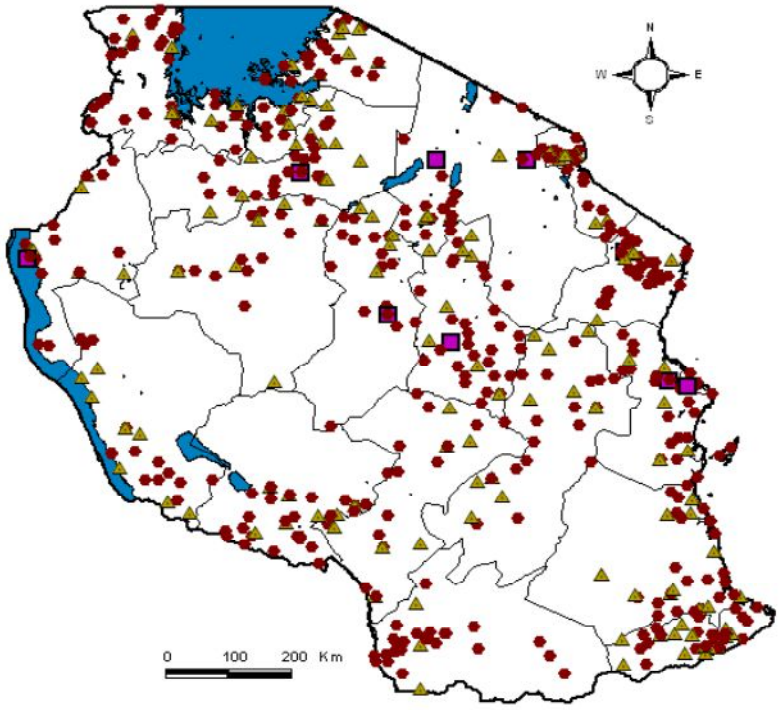
second, is a complete disappearance of best performers in terms of casual labor in the southern part of the country. This first contrast implies that casual labor is more uniformly distributed all over the country than wage labor (in relative terms because there few extremes in casual labor). Indeed, this is what would have been expected because casual labor is more a result of natural rural setting as compared to some deliberate policy intervention for the case of wage labor. The second contrast implies that, since best performers of both wage and casual labor are located in the northern part of the country, then villages with high wage labor also have high casual labor.

The preceding discussion shows that wage labor and casual labor exhibit strong spatial pattern. The spatial pattern in the dependent variables implies that the underline factors for the development of the rural labor markets must also exhibit spatial pattern (Anselin 2002). As noted in other studies, the major underlying factor in the rural economy is the agro-ecological factor (Janvry and Sadoulet 1995, Jeong and Townsend 2003; Kaboski and Townsend 2002). To see how the underline factors exhibit spatial patterns, the study carries out spatial cluster analysis of all explanatory variables. The search for the spatial pattern in the explanatory variables followed the following strategies. First, we run the seven group cluster analysis to try to mimic the seven major agro-ecological zones in Tanzania. The resulting spatial clusters are then matched with the map of agro-ecological zones of Tanzania. However, the results were not able to follow closely the distribution of agro-ecological zones. The explanatory variables could also be spatially clustered according to other spatial factors such as the road density or population density. However, as Kaboski and Townsend (2002) observe, these variables are themselves not independent of the agro-ecological factor. Thus, the study uses another approach where the objective is simply to get as few spatial clusters as possible and characterize their respective locations. This approach gives four spatial clusters, which are presented in Map 3[20].

[20] It is important to note that, having no gouding factor, we gradually reduced the number of clusters from seven to four basically using visual judgment of the distribution of each cluster on the map.

Map 2

DISTRIBUTION OF VILLAGES ACCORDING TO THE DEPENDENCE ON CASUAL LABOR AS THE MAIN SOURCE OF CASH INCOME



LEGEND

Village with:
- Above national median but not extreme
- Below national median
- Extreme above national median

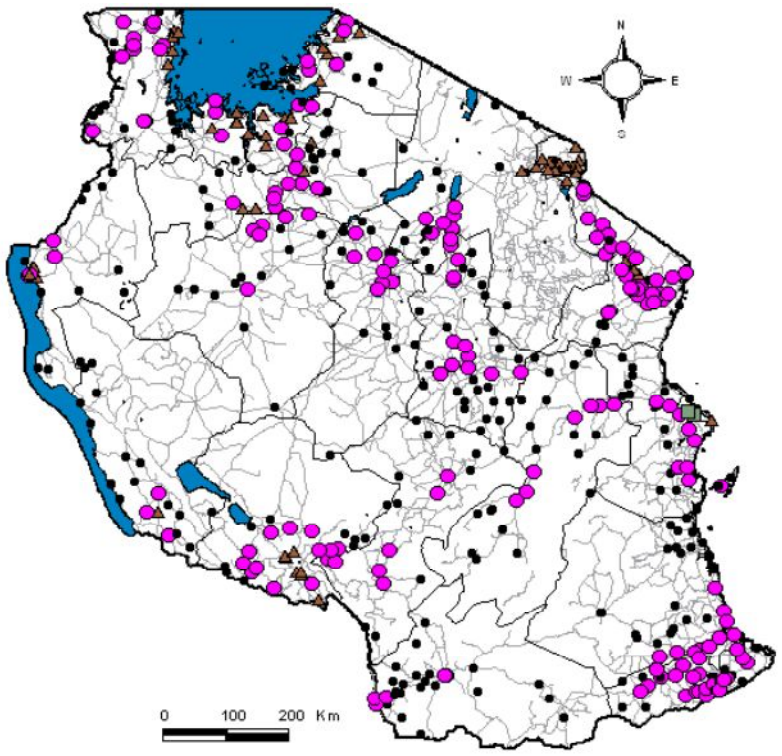
Lake
Road network
Regional border
National border

Two out of the four clusters present on Map 3 have spatial distribution that can readily be explained. The smallest group of villages (symbolized by gray cubes) is entirely comprised of the peri-urban population of the commercial capital Dar es Salaam. It is not surprising that peri-urban population of Dar es Salaam behaves completely different from other rural areas. This finding corroborate well with those of Sparrow *et al.* (2001) and Garrett *et al.* (2001) who shows that this distinction arise because peri-urban population of Dar es Salaam is highly

affected by the development commercial infrastructure in Dar es Salaam city as compared to other rural areas.

Map 3

CLUSTERS OF VILLAGES ACCORDING TO THE DEVELOPMENT OF THE RURAL LABOR MARKETS



LEGEND

Clusters
- Peri-urban Dar es Salam
- Volcanic soil and great lakes
- Highlands, Northern Savanna, and Coast
- Unidentified patterns

Lake

Road network

Regional border

National border

Symbolized by brown triangles on Map 3 is another group of villages which exhibit two spatial patterns. The first pattern is its concentration around the volcanic soils in the northern and southern parts of Tanzania, where coffee used to be the main cash crop. But due to the decline in the coffee prices in the world markets in recent years, these areas are now shifting to the cultivation of other crops. The crops that have mostly been favored in this intra-sectoral shift are mainly labor intensive crops such as vegetables and seasonal fruits (URT 1997; URT 2002b). The second pattern is the concentration of the locations along the major lakes, particularly Lake Victoria and few villages along the Lake Tanganyika. Fishing activities in these areas are also highly labor intensive because of the poor technologies employed. The fishing activities are also likely to stimulate growth of other off-farm activities such as fishing trading[21].

Generally, spatial clustering suggests also spatial non-stationarity in the development of rural labor markets in Tanzania, such that the mean of the variables in our models varies from location to location and according to the direction one takes. For example, we find that the spatial trends of wage and casual labor decline southward. Surprisingly, the west-east trend is not well pronounced. Neither the mean nor the median shows any significant spatial drift in west-east direction. This could partly be explained by the spatial differences in the development transport infrastructure, whereby the north has relatively well developed infrastructure as compared to the south[22]. Most of these spatial aspects need a more rigorous spatial econometric estimation technique discussed in section 3.1, whose results are presented in the subsequent subsections.

4.2. Estimation Results and Discussions

This section presents the results of spatial dependence and spatial heterogeneity models discussed in section 3.1. For the spatial dependence models, the results presentation is mainly in tabular form. However, for spatial heterogeneity models the results presentation is mainly in graphical form because spatial heterogeneity models produce massive outputs, which are not amenable to tabular presentation[23]. We first present and discuss the spatial dependence model results in section 4.2.1; later in section 4.2.2, we present and discuss the results of spatial heterogeneity model.

[21] The other two groups, symbolized by black and pink dots on Map 3 do not have a clear spatial pattern and their description is omitted.

[22] Even though we only discussion east-west and north-south variations, we also measured these variations with respect to other directions by calibrating the rotational angle to 45 degree interval, thus producing eight sets of estimates. All result maps for each direction are available from the authors upon request.

[23] These models produce estimates for each (660) sample location used in this study and it is difficult to see any pattern without the use of graphical aid.

4.2.1. Bayesian Results Spatial Dependence Models

This section presents the estimation results of the spatial autocorrelation model (SAR) and spatial error model (SEM), which are the two components of the spatial dependence models described in Section 3.1.1. The estimations were carried by 1,100 draws using Markov Chain Monte Carlo (MCMC) simulation of the posterior density[24]. Even though the results of the Bayesian estimation with homoscedastic prior are presented alongside those of heteroscedastic prior for comparison purpose, the discussion of the policy implications of these results is mainly based on the results from the robustifying-heteroscedastic prior models.

Model Diagnostic

As convergence of MCMC in SAR and SEM models is not a problem (LeSage 1999), convergence was achieved in both models at relatively low number of interactions (i.e. 1,100 iterations for which the first 100 iterations were burn in). The adjusted R^2 is reasonably high, and all models explains more than 50% of the variation in the wage labor and casual labor (in the classical econometric since).

Bayesian estimations with homoscedastic prior fail to detect spatial dependence in the SAR specification of wage labor and casual labor. However, with heteroscedastic prior, both wage labor and casual labor exhibit significant spatial dependence. But the spatial dependence is much stronger in casual labor than in wage labor. This could be the case because a significant number of those with some wage employment is located by purposeful policy interventions (e.g. teachers, rural medical practitioners, and in plantations) and only a few in wealthy households. Unlike wage labor, casual labor depends mainly on the rural natural environment (e.g. season demand for labor in agriculture due to variation in rainfall).

For the SEM specifications for wage labor and causal labor, errors terms have significant spatial autocorrelation under both assumptions of homoscedasticity and heteroscedasticity. This confirms our earlier claims that Ordinary Least Squares (OLS) estimation would not be appropriated for our models. Figure 1 display some selected model diagnostics for wage labor, where we compare the OLS residuals, standard (non-Bayesian) SAR residuals, and Bayesian SAR residuals.

[24] This study uses the fixed improper prior, first set to reproduce the maximum likelihood estimate (homestcedastic assumption) and secondly, set to reflect our prior that the error terms are hetoroscedastic. If heteroscedasticity and outliers exist, the heteroscedastic prior employed here allows for sufficient divergence from unit of the relative variance terms to accommodate the non-constant variances and robustify against the outliers (LaSage 1999).

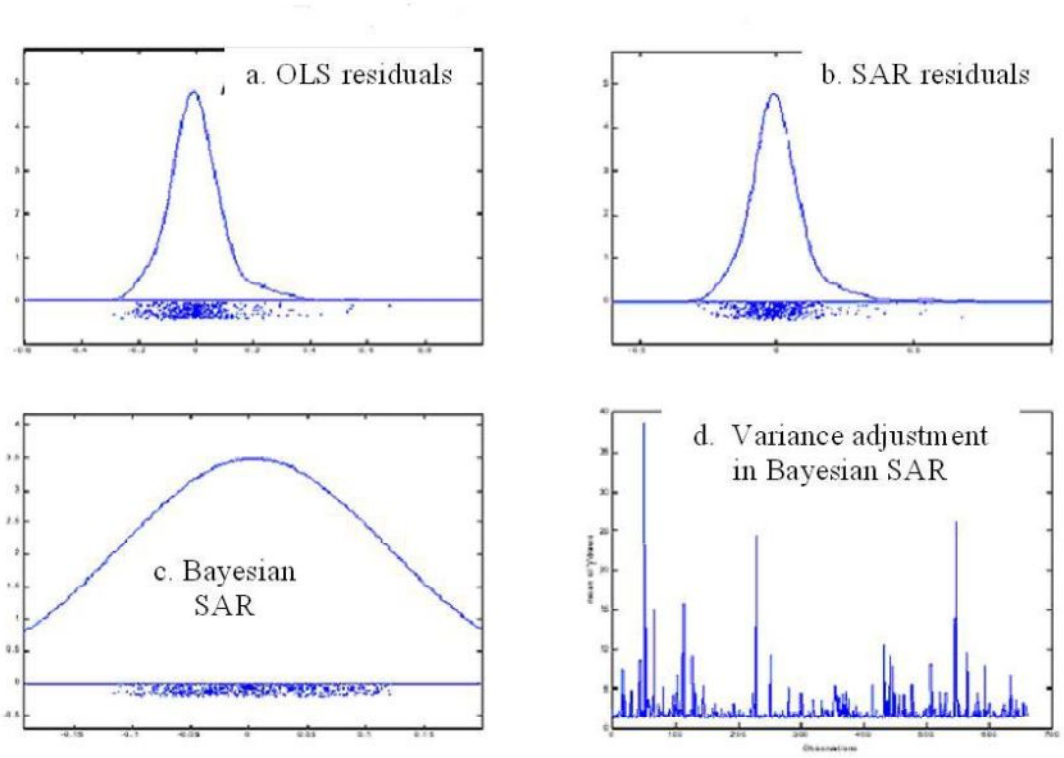


Figure 1.
Selected model diagnostic graphs for comparing performances of various estimation techniques

Panel (a) in Figure 1 shows that ordinary least squares (OLS) residuals suffer seriously form the presence of outliers in the right tail. The problem of outlier is also present in the standard (non-Bayesian) SAR residuals as shown in panel (b). However, the use of heteroscedastic prior in the Bayesian framework is able to adjust to the presence of these outliers. For example, panel (c) in Figure 1 shows that that all outliers are now accommodated and no longer affects the estimates. Likewise, panel (d) shows that the relative variances of the error terms in the Bayesian estimation deviates greatly from unit to correct for the presence of the outliers. Generally, what we observe is the ability of our Bayesian heteroscedastic framework to robustify against the violation of standard (classical) regression assumptions. This makes our results more reliable as compared to those that would have been obtained under standard econometrics estimation techniques. The estimation of the model for casual labor generates similar pattern of diagnostic graphs and their discussion is omitted.

Estimated Parameters and Their Interpretations

Here we present and interpret the coefficients of Bayesian estimation results SAR and SEM models. Table 3 and Table 4 show the results of parameter estimates for spatial autocorrelation model (SAR) and spatial error model (SEM) for wage labor and casual labor, respectively. Note also that the columns labeled homoscedastic and heteroscedastic contain results from homoscedastic and heteroscedastic priors, respectively. In view of the results present in these tables, the followings are the major findings:

1. For wage labor and casual labor, all parameters have the expected signs, with a few exceptions. Nevertheless, the coefficients for population density (and its square) are not statistically significant under both models. The first one is the population density (and its square) which was expected to positive, but turned to be negative. We argued in Section 3 that high population density increases urbanization features such as increased specialization and trade. Thus, population is expected to have positive impact on the development of the labor markets. The other wrong sign is on the participation in informal rural credit, which is arguably capturing social capital as well. Again, this coefficient is not significant. As shown in Mduma (2003), this could possibly reflect the neutralization effects predicted in the farm household theoretical frameworks, where it is shown that that relaxation of the cash constraints has two opposing effects. The effects, which enhance the development of the rural labor markets, come from the demand side while the repressive effects come from the supply side of the rural labor markets. Note however, the relaxation of cash constraints in the village through the participation in formal banking system has positive and significant association with wage and casual labor in the village.

Table 3.
Bayesian Estimation Results of the Determinant of Wage Labor in Tanzanian Villages

	SAR		**SEM**	
	Homoscedastic	**Heteroscedastic**	**Homoscedastic**	**Heteroscedastic**
Variable	Coefficient	Coefficient	Coefficient	Coefficient
constant	-0.219377***	-0.250677***	-0.239024***	-0.24774***
Hh_size	0.016047***	0.012889***	0.016731***	0.014726***
age	0.110174***	0.137297***	0.119272***	0.13341***
Age_squared	-0.0002	-0.0060	-0.0010	-0.0045
Educ_SEC+	0.411356***	0.394935***	0.423061***	0.41536***
Sickness	-0.0280	-0.0192	-0.0257	-0.0230
Pr_water	0.030452*	0.03359**	0.031356*	0.033372*
Pu_water	0.0100	0.0065	0.0117	0.0113
Fuel_wood	-0.15341***	-0.153202***	-0.156984***	-0.157938***
N_business	0.076807***	0.032484**	0.077274***	0.054471***
N_comm_farm	0.0077	-0.0089	0.0064	0.0002
Bank_formal	0.353996***	0.308921***	0.3612***	0.339918***
Credit_informal	-0.0326	-0.0199	-0.0339	-0.0255
Land_head	-0.088458***	-0.05622***	-0.082324***	-0.065531***
Land_squared	0.019283**	0.012696*	0.017133**	0.013497*
Cattle_head	-0.004603**	-0.003394**	-0.005421**	-0.004506**

Table 3.
Bayesian Estimation Results of the Determinant of Wage Labor in Tanzanian Villages

	SAR		SEM	
	Homoscedastic	**Heteroscedastic**	**Homoscedastic**	**Heteroscedastic**
Food_insecurity	0.08473*	0.077925*	0.089319*	0.084341*
Foodp_squared	-0.0858	-0.0835	-0.1013	-0.0948
distance_reg	-0.011851***	-0.006356*	-0.014406***	-0.011705**
distance_road	-0.0013	-0.0022	-0.0010	-0.0013
Cattle_density	-0.0034	-0.006893***	-0.0024	-0.005024*
Av_Rainfall	-0.0010	-0.0020	0.0007	-0.0001
Pop_density	-0.0065	-0.0069	-0.0086	-0.0078
Popd_squared	-0.0002	0.0002	-0.00002	-0.00001
rho	0.0597	0.060934*		
lambda			0.231306***	0.224735***
Adj R^2	0.5734	0.8794	0.5496	0.5431

*** = 1% sign ** = 5% sign * = 10% sign

2. Despite having correct signs, the following variables are not significant predictors of wage labor in the villages: the square of average age in the village, number of sick persons in the village, availability of public water, the square of the food insecurity, and participation in informal rural credit, average annual rainfall, commercial farming, as well as distance to the roads. In estimated model for casual labor, private water availability, which was significant in wage labor estimation, becomes insignificant.

3. As expected the coefficient for food insecurity is positive and significant at 10%. This implies that food insecure household increases their participation in the rural labor markets. This finding corroborates well with the findings of Shariff (1991) and Dessing (2002) in their analysis of distress labor market participation. As the food insecurity becomes critical, participation in the rural labor markets declines. This is reflected in the negative sign of the square of the food insecurity variable, even though it turned out to be not significant.

4. *Asymmetric effect 1*: While the coefficient of sickness is not significant in model for wage labor, it is significant at 10% in the model for causal labor. Since wage labor is comprised largely of contracts which are more permanent in nature as compared to casual labor, this asymmetric effect of sickness shows differences in income insurance. It indicates that the rural wage workers are relatively more insured than the casual laborers in an event of falling sick.

5. *Asymmetric effect II*: Likewise, average annual rainfall has asymmetric effect on these two types of rural labor markets. It affects casual labor negatively but has no effects on wage labor. This could mean that the rural households in areas with relatively high average annual rainfall participates less in casual employment, thus derive most of their cash income from other sources (particularly from selling agricultural produces). But the rainfall variable does not matter for the wage employees, who are more likely to be

located in places by deliberate government policies. They are also found in plantations and in some few relatively reach households, whose incomes are less vulnerable to vagaries of weather.

6. *Asymmetric effect III*: Likewise, distance from the road does not affect wage labor markets but affects casual labor markets. This again is in line with observation 5 above and the explanation could be similar to the one given in observation 5, in that other allocation mechanism such as deliberate government policies account for this phenomenon.

7. As expected, land show its complimentary nature to labor in that large land endowment is associated less labor allocated to the rural labor markets, thus reducing reliance on rural labor markets. But the fact the square of the land is positive and significant; it shows that as per capita land increases, it would reach a point where more hired labor will be demanded. In the rural local market level, this could be possible if there is some inequality in landholdings, where those with large amount of land buying labor from those with small amount of land. Indeed, this is the standard prediction from the farm household models (Singh et al. 19986). However, it is not evident whether such participation in the labor markets is pro-poor or not.

8. Cattle and cattle density have the expected effects and are significant. The effect of par capita number of livestock reduces reliance on labor market because most of the household labor will be allocated to taking care of the household livestock. Also when considering cattle as assets, the wealth effect is likely to reduce involvement in the labor market. Furthermore, land degradation caused by overstocking reduces both wage and casual labor markets in the village. Thus, as villagers pile up their number of cattle, the wealth effect and degradation effect works in the same direction and reinforce each other. By so doing, overstocking reduces the participation in the labor markets of livestock-wealthy households; it also reduces the availability of jobs to the poor households who would have been otherwise employed if crop production was vibrant.

Table 4.
Bayesian Estimation Results of the Determinant of Casual Labor in Tanzanian Villages

	SAR		**SEM**	
	Homoscedastic	**Heteroscedastic**	**Homoscedastic**	**Heteroscedastic**
Variable	Coefficient	Coefficient	Coefficient	Coefficient
constant	-0.179869**	-0.149741**	-0.186895**	-0.16412*
Hh_size	0.019536***	0.020313***	0.020474***	0.021069***
age	0.172246***	0.158634***	0.196693***	0.183032***
Age_squared	-0.00852	-0.00604	-0.01373	-0.01114
Educ_SEC+	0.430104***	0.390246***	0.44172***	0.42057***
Sickness	-0.056042*	-0.071688**	-0.053639*	-0.064991*
Pr_water	0.014959	0.02619	0.01901	0.020898
Pu_water	0.000572	-0.0078	0.00634	-0.00075

Table 4.
Bayesian Estimation Results of the Determinant of Casual Labor in Tanzanian Villages

	SAR		SEM	
	Homoscedastic	**Heteroscedastic**	**Homoscedastic**	**Heteroscedastic**
Variable	Coefficient	Coefficient	Coefficient	Coefficient
Fuel_wood	-0.20679***	-0.217781***	-0.210646***	-0.216081***
N_business	0.057566**	0.031521*	0.052377**	0.041229*
N_comm_farm	-0.02237	-0.02825	-0.03527	-0.03522
Bank_formal	0.340133***	0.345421***	0.333502***	0.340662***
Credit_informal	-0.042242*	-0.02481	-0.04405	-0.03211
Land_head	-0.10025***	-0.073444***	-0.094154***	-0.080937**
Land_squared	0.017471*	0.01139	0.015558*	0.012055
Cattle_head	-0.007044***	-0.006056***	-0.007837***	-0.00701**
Food_insecurity	0.11675*	0.134527**	0.112345*	0.116759*
Foodp_squared	-0.05329	-0.0465	-0.05476	-0.04466
distance_reg	-0.009085*	-0.012579**	-0.012727**	-0.014191**
distance_road	-0.005578*	-0.004313*	-0.00536	-0.0048
Cattle_density	-0.007664**	-0.010046***	-0.007726**	-0.009125**
Av_Rainfall	-0.008778**	-0.008197*	-0.00675	-0.0068
Pop_density	0.002228	0.000209	0.000221	-0.00011
Popd_squared	-0.00036	0.000023	-0.00027	-0.00013
rho	0.083401**	0.068886**		
lambda			0.217087***	0.195859***
Adj R^2	0.5791	0.8507	0.5668	0.5638

*** = 1% sign ** = 5% sign * = 10% sign

9. Other variables can be interpreted in the usual ways as they are commonly interpreted in many empirical studies in this area. Thus, our results imply that villages with relatively educated population, increase access to water, and reduced reliance on firewood are associated with relatively increased participation in the rural labor markets. Moreover, self employment is also associated with high participation in paid labor. This implies that some rural petty businesses provide employment to their proprietors as well as to others, particularly the casual workers.

4.2.2. Bayesian Distance and Longitude-Latitude Expansion

In this section we present the results of the distance expansion and the longitude-latitude expansion. The distance expansion was done with reference to the commercial capital, Dar es Salaam. As mentioned earlier, these models produce a lot of outputs, therefore, only those results that are at least significant to 10% levels are presented and discussed. We first present the results of distance expansion from Dar es Salaam and then later we present longitude-latitude expansion. Moreover, to avoid repetitions, the discussion is only for the expanded coefficients because base coefficients are as discussed under the Bayesian SAR and SEM specifications in section 4.2.1.

For graphical presentation, in the case of the longitude-latitude expansion, the location coordinates are sorted from small to high value of the longitudes and latitudes. As Tanzania is located in the east of the Greenwich, the longitudes increase form west to east, therefore the graphs show coefficient variation from west to east. Also, Tanzania being in the south of the Equator, latitudes increase from south to north, thus the plots show coefficient variations from south to north. For the case of distance expansion estimates, the plots present coefficients sorted by distance from the chosen central point (Dar es Salaam). The central observation is on the left of the graph and the longest distance on the right of the graph.

Distance Expansion from Dar es Salaam

For wage labor model, the coefficient for firewood increases with distance from Dar es Salaam and that of the population decrease with the distances from Dar es Salaam. Note that in the base model the coefficient for firewood (wood) has a negative sign. Therefore, when we observe that effect of time for collecting firewood increases with distance, it means that the magnitude of its impact in reducing rural labor markets declines. Figure 2 shows the variations in the coefficient of time used to collecting firewood and the coefficient for participation in the formal financial institutions.

Figure 2 shows that there would be significant differences in the outcome of the intervention according to the location. For example, in villages near to the city of Dar es Salaam, reduction in the time used to collect firewood may increase participation in rural labor markets more than villages in far remote countryside. This could be due to increased flexibility in job places near the city. But for the case of cash constraints, interventions that increase cash flows near to the city have only modest impact as compared to those faraway. The larger impact in this case if felt far away from Dar es Salaam than nearby.

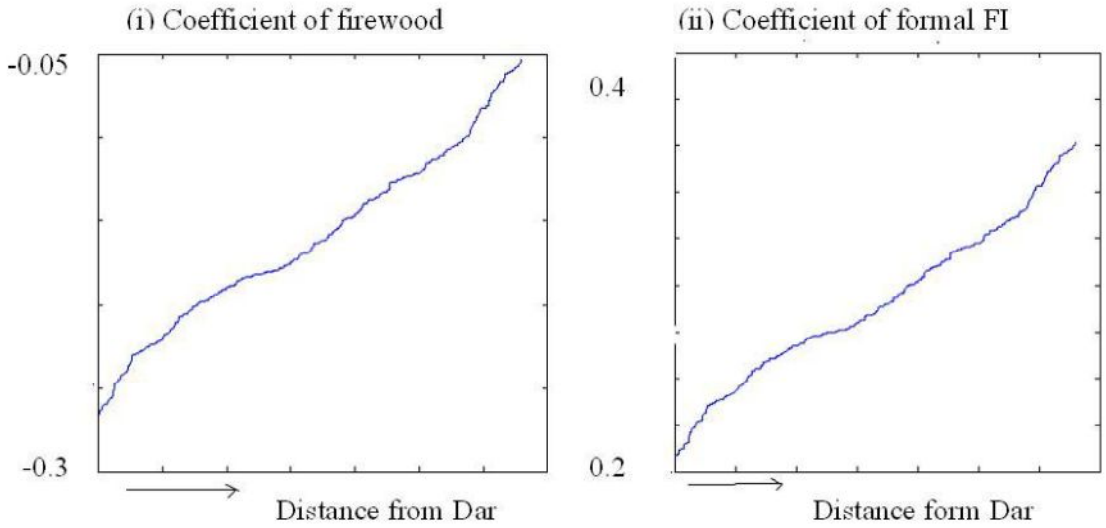


Figure 2.
Spatial variations of the impact of (i) time spent in collecting firewood and (ii) participation in formal financial institutions

For casual labor, the coefficient of average annual rainfall and relaxation of the cash constraint through participation in formal banking systems increases with distance from Dar es Salaam. Like the case for wage labor, interventions that reduce cash constraints in locations far away from Dar are more likely to have greater impacts than close to Dar es Salaam. However, the impact of cattle ownership decreases with distance from Dar es Salaam. The demand for milk in Dar es Salaam city has made diary cattle self-employment projects of their own kind for people of peri-urban of Dar es Salaam (Sparrow et al 2001, Garret et al 2001). These diary cattle projects are generally labor intensive.

Longitude-Latitude Expansion

This sub-section discusses the results of the parameters estimated from models with varying coefficients over longitude or latitude expansions. As stated earlier, we only present the coefficient results whose p-values is less than or equal to 0.1 (that is 10 percent significant level)[25]. Also, emphasis is on those parameters that have more policy relevance than mere model calibration.

[25] The model diagnostics were checked and found to be reasonably well. And since these models emphasize on the prediction across space (the emphasis which is shared with poverty mapping analysis) only the level of

Table 5 shows that for both wage and casual labor, the distance from regional headquarters is negatively associated with the development in the rural labor markets. This association is however not stationary (constant) over space. The coefficient decreases as one moves from west to east, meaning that the adverse effect of the distances is strongly felt in western as compared to eastern parts of the country. Likewise, the time spent in collecting firewood has a varying impacts and decreases as one move westward. Table 5 shows also that the impact of average annual rainfall increases southward. This means that reliable rainfall reduces participation in the rural labor markets for people in south as compared to the people in north.

Table 5.
Longitude (x-) and Latitude (y-) Expansions of
Wage Labor and Casual Labor

Variable	Wage labor	Casual labor
constant	-0.24588***	-0.25319*
distance_reg	-0.1616**	-0.16245**
Av_rainfall		0.146534*
Educ_SEC+	0.920488*	
Bank_formal		1.425089**
Fuel_wood	0.644612***	
x-distance_reg	0.004501**	0.004319*
x-Fuel_wood	-0.02281***	
x-Av_rainfall		-0.00479**
y-Av_rainfal	-0.00454*	
Adj R^2	0.5222	0.5592

Note ***, **, * stand for 1%, 5% and 10% significant level, respectively

Source: Author's estimates from HBS and MSG database

5. Conclusions and implications

This paper has shown that the rural labor markets in Tanzania exhibit significant spatial variations, which is normally not captured in traditional econometric estimation. Using spatial econometric techniques, the paper has demonstrated that: (i) rural labor markets are interlinked across space as well as with other markets; depending on the direction one takes and how far she is from central points such as the city (ii) impacts of policy interventions on the development of rural labor markets are space-dependent; (iii) while some policy interventions may work well in the north but not in the south (and vice versa), other may work well in the east but not in the west (vice versa). For example, interventions that reduce cash constraints are likely to have greater impacts in the western part of the country than in the eastern part.

significance and the adjusted R^2 are reported. The omitted results can be obtained from the authors upon request.

However, interventions that reduce the time used in collecting firewood are likely to have more pronounced impacts in the southern part than in the northern part of the country.

All this implies that: (a) since there seems to be significant interconnectedness between rural labor markets and the development of other markets (particularly credit markets), then a combine intervention in several markets is likely to have more strong impact than separate interventions; (b) policy interventions in relatively close locations are more likely to have strong impacts as compared to interventions fragmented and spread apart across large area. Thus, spatial dependence can be exploited by launching policy interventions in areas that are close to each other.

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