Are poor, remote areas left behind in agricultural development: The case of Tanzania

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Abstract

In Tanzania, as in many other developing countries, the conventional wisdom is that economic reforms may have stimulated economic growth, but the benefits of this growth have been uneven, favoring urban households and farmers with good market access. This idea, although quite plausible, has rarely been tested empirically. In this paper, we develop a new approach to measuring trends in poverty and inequality and apply it to Tanzania in order to explore the distributional aspects of economic growth and the relationship between rural poverty and market access. We find that, over the 1990s when significant economic reforms were implemented, the overall rate of poverty fell. Poverty fell the least in Dar es Salaam and the most in small urban areas. The degree of poverty reduction was similar between rural and urban areas, across educational categories, and across income groups, though female-headed households seem to have lost relative to male-headed households. We find that rural poverty is associated with remoteness, but the relationship is surprisingly weak and it varies depending on the definition used. Rural poverty is more closely related to access to regional urban centers than distance to roads or to Dar es Salaam. We find little evidence that remote rural areas are being "left behind", either in relative or in absolute terms.

Key words: Tanzania, poverty, market access

JEL classification: I32, O18, O55, Q13, R11

Introduction

In the late 1980s, Tanzania embarked on a series of wide-ranging reforms to allow markets to play a larger role in the economy. The government removed extensive controls on prices, liberalized agricultural markets, devalued the exchange rate and eventually allowed it to float, removed import controls and lowered tariffs, and closed or privatized a large majority of the state enterprises, which had been established in almost every sector of the economy. In macroeconomic terms, the reforms have been relatively successful. After stagnation in the 1980s, the Tanzanian economy grew at 4-5 percent per year in the second half of the 1990s and 5-6 percent over the past few years. Budget deficits have been brought under control, and inflation has been reduced to less than 5 percent. The impact of the economic reforms on rural areas, however, has been widely debated. Some argue that market liberalization has created new opportunities for farmers, particularly in high-value agriculture for sale to the cities or for export. Others claim that the reforms have increased unemployment, widened the gap between the poor and the rich, and disadvantaged farmers by removing input subsidies. An intermediate position is that the reforms have benefited well-endowed households, but left behind others, particularly those in remote areas. These issues are important because they affect the design and implementation of the Poverty Reduction Strategy Programme (PRSP), as well as the rural development strategy more generally.

This debate has suffered from a lack of comparable information regarding the trends and spatial patterns in poverty and inequality. Better information on trends in poverty and inequality would help government agencies and international organizations understand and guide the impact of policy reforms. More accurate data on the spatial patterns in poverty would help efforts to target assistance to the poorest areas.

The objective of this study is to examine the trends in poverty and inequality over the 1990s. In particular, we address the following questions:

- Has poverty increased or decreased during the 1990s, a period of extensive market liberalization?
- What types of households have gained or lost as a result of these changes?
- Have households in poor, remote areas been "left behind" other rural areas in terms of growth?

This study develops a new approach for measuring medium-term trends in poverty and inequality, drawing from both the small-area estimation method (Hentschel et al, 2000 and Elbers et al, 2003) and the asset index method (Filmer and Pritchet, 1998). We use the 1991 Tanzanian Household Budget Survey (HBS) to estimate the relationship between per capita expenditure and various household characteristics. This relationship is then applied to the same household characteristics in the Tanzanian Demographic and Health Surveys, carried out in 1991-92, 1996, and 1999, to estimate the incidence of poverty and level of inequality in each of those years[1]. We then use GIS analysis to compare levels and trends in poverty and inequality between urban areas, rural areas with good market access, and remote rural areas.

The results of the analysis indicate that the incidence of poverty has declined modestly over the 1990s, from 46.8 percent in 1991-92 to 42.6 percent in 1999. The decline in poverty was greatest in small urban areas, but, contrary to conventional wisdom, the poverty rate declined more in rural areas than in Dar es Salaam. Poor and less educated household seem to have benefited proportionally from economic growth.

Using six definitions of market access, we find that the relationship between rural poverty and lack of market access is weaker than generally supposed, though this relationship varies widely depending on the definition of market access used. In terms of poverty, the distance from a rural household to a regional urban center matters more than the distance to a road or to Dar es Salaam. Furthermore, we find little evidence that remote, rural areas have lost more or gained less from economic growth than other areas.

[1] The 1999 survey was called the Reproductive and Child Health Survey, but it is similar to the other two surveys and includes all the variables we needed. For convenience, we refer to all three as DHS surveys.

Background

At least four approaches have been used for measuring trends in poverty in developing countries. One approach is to combine information on per capita gross domestic product, a measure of inequality (usually the Gini coefficient), and an assumed functional form for the distribution of income (usually log normal). This method is not very precise, but, being the least data-intensive, it has been used for large-scale cross-country analyses (see Chotikanapich et al., 1997).

Another approach is to compare the results of household budget surveys carried out in different years. Typically, this involves a comparison of some welfare measure, such as income or expenditure, adjusted for household size and changes in the cost of living between the two surveys. But survey results are often difficult to compare in developing countries due to changes in the questionnaire and sampling method, as well as problems adjusting for inflation. Using data from two surveys in Tanzania, Sarris and Tinios (1994) show that such comparisons are very sensitive to seemingly-arbitrary decisions regarding how to adjust for inflation.

A third approach is to construct an asset index based on household surveys that do not collect income or expenditure data. The asset index combines information about housing characteristics, source of water, sanitation, and ownership of consumer durables into an index using weights that are generated from principal component analysis (Filmer and Pritchit, 1998) or cluster analysis (Stifel et al, 2003).
The asset index approach is typically based on data from the Demographic and Health Surveys (DHS), that have been carried out 2-3 times in many developing countries. Although the results are robust to alternative specifications, it is difficult to evaluate the accuracy of the asset index as a measure of income or expenditure.

A fourth approach is to develop an index based on available measures of health, education, and nutrition. Sometimes called basic needs indicators, these measures often give equal weight to each indicator or attach subjective weights based on the perceived importance of each indicator. The Human Development Indicator, developed and monitored by the United Nations Development Programme, falls into this category.

Methods

In the last five years, a new approach has been developed to estimate poverty for small areas (such as districts) by combining data from a household expenditure survey and a census (Hentschel et al, 2000; Elbers et al, 2003). The idea is to use the household survey to estimate the relationship between poverty and a set of household characteristics, and then apply this relationship to the same household characteristics in the census data. This method has been applied in a growing number of countries (Henninger and Snel, 2003). However, census data are typically available only every ten years, making it difficult to use this approach to describe medium-term trends. Although often called "poverty mapping", this approach can be used to generate small-area estimates for any variable that can be predicted using household characteristics.

This study uses a new method for estimating trends in poverty in the medium term that draws from both the asset index approach and small-area estimation methods. To implement this method, we select household characteristics that are available in both a household budget survey and the Demographic and Health Surveys for that country. Typically, these variables include the size and age-sex composition of the household, the education of household members, the sex and ethnicity of the head of household, housing characteristics (type of roof, floor, and walls), source of water, type of toilet, whether or not the house has electricity, and ownership of consumer durables such as radios, bicycles, and motor vehicles.

The next step (called "Stage 1" in the small-area estimation literature) is to use the household budget survey to estimate per capita expenditure (y_i) as a function of these household characteristics (X_i). In order to reduce heteroskedasticity and ensure that the residuals in the regression approximate a normal distribution, we follow the convention of using a semi-log functional form:

$$\ln(y_i) = X_i\beta + e_i \qquad (1)$$

In Stage 2 of the standard small-area estimation method, the regression coefficients from Stage 1 would be applied to the same household characteristics from census data to generate spatially disaggregated estimates of poverty. In this study, we apply the regression coefficients to the same household characteristics from Demographic and Health Surveys (DHS). Hentschel et al. (2000) show that the expected value of the probability that household i is poor (P_i) can be described as follows:

$$E\left(P_i \mid X_i^C, \beta, \sigma\right) = \Phi\left[\frac{\ln(z) - X_i^{DHS}\beta}{\sigma}\right] \qquad (2)$$

and that a consistent estimate of the incidence of poverty for a set of households is simply the average of these household probabilities[2]. Although we lose the spatial resolution available from the census data, we gain a temporal dimensions from the fact that DHS surveys have been carried out two or three times in many developing countries. The similarity of the questionnaires and sampling method, as well as the generally high quality of the data generated, make the DHS surveys a useful tool in measuring trends over time.

An important assumption of this approach is that the model for predicting income based on household characteristics is valid over the range of years covered by the DHS surveys. In other words, we assume that the regression coefficients (β) are constant over the 1990s and that any changes in poverty are

[2] Typically, the poverty rate is calculated as a weighted average, taking into account the sampling weights of the census (if any) and the size of the households. This results in an estimate of the proportion of people below the poverty line rather than the percentage of households below the line.

reflected in changes in the household characteristics (X_i). Although this assumption is standard in the asset index literature, we report on the results of sensitivity analysis to test this assumption.

We apply this method in Tanzania by using the 1991 Household Budget Survey (HBS) for the regression analysis in Stage 1. The HBS covered 4750 households in mainland Tanzania, using a stratified random cluster sample[3]. The survey collected data on income, expenditure, the characteristics of household members, ownership of assets, and housing characteristics. Stage 2 of the analysis uses three Demographic and Health Surveys carried out in Tanzania in 1991-92, 1996, and 1999. The three surveys used almost identical questionnaires and sampling methods. The 1991-92 and 1996 surveys had samples of 8327 and 7969 households, respectively, selected from the same 357 clusters (see Figure 1). The 1999 survey was smaller, using a sample of 3615 households selected from 176 clusters that were a subset of the original clusters. The DHS surveys collect information on characteristics of household members, ownership of a few assets, and housing characteristics, as well as a wide range of health and nutrition variables.

In what could be called Stage 3 of the analysis, the results from Stage 2 are then combined with geographic information system (GIS) data to explore the relationship between rural poverty and market access in Tanzania and whether this relationship changed over the 1990s. We use six definitions of market access: straight-line distance to the nearest road, straight-line distance to the nearest regional center[4], and travel time to cities and towns in four size-categories. To link the DHS poverty data and the GIS market access data, we first identified the geographic coordinates of the DHS clusters. This was possible for 329 of the 357 clusters in the first two DHS surveys[5]. Second, the straight-line distance from

[3] Asset data are missing for 14 households in the HBS, so the sample that we used for the regression analysis included 4736 households.

[4] During the 1990s, mainland Tanzania wasis divided into twenty administrative regions, each with an administrative center. Recently an additional region was created.

[5] Twenty-eight clusters in the 1996 and 1998 DHS surveys could not be found in GIS databases of places in Tanzania, nor on paper maps of the country.

these clusters to the nearest roads and regional centers was calculated using the software ArcView. The four travel-time measures were generated with a raster analysis that measured the distance along the road network, with weights for each type of road to convert distance into travel time. This analysis, carried out with ArcInfo, created a country-wide "surface" for each of the four travel-time market access variables, from which the values corresponding to each DHS cluster were selected (Figure 1 shows the values of travel time to a secondary town on a map of Tanzania). The final result is a database with poverty estimates at the household level and GIS variables at the cluster level[6].

Results

The results of the analysis are divided into three sections. First, we describe the regression analysis used to predict per capita expenditure as a function of household characteristics, using household survey data from Tanzania. Then, we present estimates of Tanzanian poverty and inequality over the 1990s derived from applying the regression models to the household characteristics in three Demographic and Health Surveys. Finally, these poverty estimates are used to analyze econometrically the relationship between poverty, on the one hand, and various definitions of market access. .

Predictors of household welfare

In this section, data from the 1991 Household Budget Survey (HBS) are used to estimate the logarithm of per capita expenditure as a function of household characteristics, as shown in equation (1). Although the HBS collected information on many more variables that could be used to "predict" per capita expenditure, we are limited to those that are also available in the three Demographic and Health Surveys (DHS) carried out in Tanzania in 1991-92, 1996, and 1999. In many cases, categorical variables such as water source had to be grouped into a small number of categories to ensure compatibility between the HBS and the three DHS surveys.

[6] Macro International, the research firm that conducts the Demographic and Health Surveys, kindly provided the geo-coordinates for the 176 clusters in the 1999 survey. Todd Benson geo-coded another 156 clusters, compiled GIS variables, and calculated some of the market access indicators. Jordan Chamberlin calculated the travel-time measures of market access. .

The sample of the 1991 HBS is divided into four strata: Dar es Salaam, large towns, small towns, and rural areas. A Chow test indicates that the coefficients in the four strata are significantly different from each other, so separate regressions were run for each stratum. Ordinary least squares (OLS) models were used to carry out some diagnostic tests. The Breusch-Pagan test indicates the presence of multiplicative heteroskedasticity in two of the four models (Dar es Salaam and large towns). We address this problem by using the Huber/White/sandwich estimator of the standard errors, which is consistent under heteroskedasticity. The Ramsey RESET test, using powers of the predicted values, suggests the omission of variables in the same two models. In spite of adding squared terms and additional variables, we were not able to address this problem. The variance inflation factors (VIF) were calculated to test for multicollinearity. Two variables in the Dar es Salaam model had VIF values over 20, the conventional limit, are were removed.

Next, the four models were run using the *svyregress* command in Stata which takes into account the stratification and clustering of the HBS sample and, as mentioned above, calculates Huber/White/ sandwich standard errors. Individual variables and sets of dummy variables were removed if they were not statistically significant at the p=0.20 level. Note that we are not concerned about likely endogeneity of some of the explanatory variables (e.g. ownership of consumer goods) in the models because we are only interested in generating a model to predict per capita expenditure.

Table 1 gives the results of the final models. Some coefficients were statistically significant in all four models: household size, household size squared, and ownership of a radio, refrigerator, and car. The sets of dummy variables representing the age-sex composition of the household, the education of the head of household, and the region are each jointly significant, based on the F-test. Somewhat surprisingly, the poverty rate does not vary significantly between male- and female-headed households. The coefficients representing the education of the spouse were jointly significant only in the rural model. The signs of the

coefficients are broadly consistent with expectations: the coefficients on ownership of consumer goods and electricity are uniformly positive, while the coefficient on earth floors is negative.

The overall fit of the four models is relatively good, with the value of R^2 ranging from 0.42 to 0.53. This is toward the upper range of similar prediction models carried out as part of poverty mapping analyses in other countries (see Henninger and Snel, 2003).

Estimates of poverty and inequality

The regression equations described in the previous section are then applied to the same household characteristics in the Tanzanian Demographic and Health Surveys (DHS) of 1991-92, 1996, and 1999. The result is an estimate of the per capita expenditure for each household in the three DHS surveys. This estimate is transformed into the probability that the household is poor using equation (2) and averaged over groups of households to obtain estimates of the incidence of poverty. Table 2 presents the poverty estimates for each year of the DHS and for different household groups. Using this procedure, the overall poverty rate for mainland Tanzania is estimated to be 46.8 percent in 1991-92. This is very close to the poverty rate of 47.1 estimated directly from the expenditure data in the 1991 Household Budget Survey. The 1991-92 poverty rate for Dar es Salaam Table 2 is 3.6 percent, close to the HBS estimate of 3.1 percent, while the 1991-92 rural poverty rate is 52.9 percent, somewhat lower than the HBS estimate of 56.3 percent. In general, these results provide some confidence that the poverty estimates derived from the household characteristics in the DHS are reasonable close to the poverty estimates from the original budget survey.

Looking at the trends over time, the figures in Table 2 suggest that the poverty rate has fallen about 4 percentage points between 1991-92 and 1999, with most of the decline occurring between 1991-92 and 1996. Between 1991-92 and 1999, rural poverty declined 3.5 percentage points, while urban poverty fell by 4.9 percent. This would seem to suggest a widening gap between rural and urban households, though

the difference is not large. Interestingly, the poverty reduction in urban areas does not come from gains in Dar es Salaam, by far the largest city and commercial center. Rather the urban poverty reduction is due to substantial declines in poverty in large towns and, to a lesser degree, small towns. One hypothesis is that during the 1990s, economic reforms resulted in a more geographically decentralized pattern of growth, now that the public sector and state enterprises (most of which were based in Dar es Salaam) play a smaller role in economic decisions.

The poverty trends by geographic zone in Table 2 suggest that poverty reduction over the 1990s has been uneven, with some zones showing substantial poverty reduction but the Central Zone shows no improvement. It is interesting to note that the poorest zone in 1991-92, the Southern Highlands, showed the greatest poverty reduction over the 1990s, a decline of 8 percentage points. This is somewhat surprising because the Southern Highlands, as the main maize-surplus zone in Tanzania, is said to have been hurt more than other regions by market reforms that eliminated fertilizer subsidies and removed maize price supports. On the other hand, as the region with perhaps the best agricultural potential, perhaps it has gained from market reforms and, in particular, from the gradual opening of cross-border trade with Zambia.

The poverty rate among female-headed households was roughly equal to that of male-headed households in 1991-92. During the 1990s, however, poverty among male-headed household appears to have declined substantially (about 5 percentage points), while that of female-headed households has remained roughly constant. One hypothesis is that female-headed households have been less able to take advantage of new market opportunities provided by the economic reforms due to cultural norms, the demands of child care, or other factors. Alternatively, the growing problem of HIV/AIDS may mean that many of these female-headed households are AIDS widows, who would have faced costs associated with the illness and incapacity of their husbands. The DHS data indicate that the proportion of female-headed households has increased from 19 percent in 1991-92 to 23 percent in 1999.

Table 2 also shows the poverty trends by the educational level of the head of household. The table shows the strong negative relationship between education and poverty. It also suggests that the gains from economic growth in the 1990s have not been limited to the educated elite of the country. In fact, the largest decline in poverty was among households whose head had only some primary education.

The last section of Table 2 presents the trends in poverty by expenditure quintile. The quintiles are defined separately for each year so that the table compares, for example, the poverty rate of the bottom 20 percent in 1991-92 with the bottom 20 percent in 1999[7]. The estimated poverty rate declined in all five expenditure quintiles. In terms of the absolute change in the incidence of poverty, the richest quintile gained the least, but in terms of the percentage reduction in poverty, they gained the most. Thus, the assessment of which income group gained the most over the 1990s depends in large measure on how one measures the gain – in absolute or in relative terms.

Relationship between market access and poverty

As described earlier, the poverty estimates from the DHS data were combined with GIS variables to explore the relationship between rural poverty and market access over time. The focus is on *rural* poverty because urban areas have, almost by definition, good market access, and we do not want the large urban-rural income differences to affect our results. In this analysis, we use six measures of market access:

1) Straight-line distance to a primary or secondary road
2) Straight-line distance to a regional center
3) Travel time to Dar es Salaam
4) Travel time to the closest of eight large towns[8],
5) Travel time to the closest of 11 secondary towns[9],

[7] Recall that these figures are calculated as the average of the probabilities that each household is poor, where all households have some positive probability (see equation 2). This explains the positive poverty rates even among the highest quintile.

[8] Large towns are those given the status of "municipality" in Tanzania and comprise Arusha, Dodoma, Iringa, Mbeya, Morogoro, Moshi, Mwanza, and Tabora.

6) Travel time to the closest of 22 tertiary towns[10].

Somewhat surprisingly, the different measures of market access are not very closely correlated with each other. Of the 15 combinations of market access indicators, most pairs have correlation coefficients (r) between 0.4 and 0.6, and only one is above 0.65.

Table 3 presents the estimates of rural poverty by year and by degree of market access using the six definitions given above. The average poverty rate for rural areas, in the first row, is almost identical to the rural poverty rates reported in Table 2, the slight differences being due to the omission of clusters that could not be geo-coded. The relationship between poverty and market access varies across different measures of market access. Rural poverty is most closely related to distance to a regional center and, to a lesser degree, travel time to primary, secondary, and tertiary towns. On the other hand, distance to a road and travel time to Dar es Salaam do not seem to be related to the incidence of poverty at all. The latter result is partly explained by the fact that the coastal area near Dar es Salaam is dry and has a low agricultural potential.

In order to get a more detailed picture of the bivariate relationship between poverty and market access, we use non-parametric regression analysis[11]. Figures 2-7 give the results of regressing rural poverty (or more precisely, the household-level probability of poverty) as a function of each of the six measures of market access at the cluster level. In each case, the first panel (a) gives the result for 1991-92 and the second (b) for 1999. Figure 2 shows an unexpected, possibly U-shaped, relationship between rural poverty and distance from a road, particularly beyond 75 kilometers. It should be noted that fewer than 10 percent of

[9] Bagamoyo, Bukoba, Chake Chake, Kigoma, Lindi, Mtwara, Musoma, Shinyanga, Singida, and Songea.

[10] Babati, Ifakara, Kahama, Kibaha, Kilosa,, Kondoa, Korogwe, Makambako, Manyoni, Masasi, Mpanda, Mpwapwa, Newala, Njombe, Nzga, Same, Sengerama, Sumbawanga, Tukuyu, Tunduru, Urambo, and Wete.

[11] To implement the non-parametric regression analysis, we use the *kernreg* command in Stata and adopt a half-bandwidth of 40 percent of the range of the independent variable, an Epanechnikov kernel, and 30 points where the regression analysis is carried out. The confidence intervals are estimating by bootstrapping with 100 replications.

the households live this far from the road[12], so the result is being driven by a relatively small number of observations. Figure 3 shows a positive relationship between rural poverty and distance to a regional center in 1991-92, but the relationship appears weaker in 1999. A similar pattern occurs in Figure 4 with travel time to Dar es Salaam. In Figures 6-7, the shapes are similar in 1991-92 and 1999. All six graphs reveal a downward shift in the graph, reflecting the overall reduction in rural poverty, but none of the graphs show an increase in the slope, which would indicate that remote rural areas have lost more (or gained less) than rural areas with better market access.

These bivariate relationships can also be examined with traditional parametric regression analysis. We run separate models for 1991-92 and 1999 in the context of seemingly unrelated regression (SUR) analysis, which allows us to test the statistical significance of any changes in the market access coefficient between 1991-92 and 1999[13]. In particular, the conventional wisdom that remote rural areas have lost more (or gained less) than rural areas with better market access would be indicated by a statistically significant *increase* in the market access coefficient. The results, shown in Table 4, reveal that the market access coefficient are statistically significant at least at the 10 percent level in most cases[14], but they explain a very small proportion (1-2 percent) of the variation in rural poverty. The measure that perform best is travel time to a secondary town. But the difference between the 1991-92 coefficient and the 1999 coefficient is not statistically significant at the 5 percent level for any of the six measures of market access (in one case, it is significant at the 10 percent level but the coeffient *decreased* over the period).

[12] In 1992, 424 households in 17 clusters lived more than 75 km from a road, while in 1999, 153 households in eight clusters lived this far.

[13] This procedure is implemented with the *suest* command in Stata, which calculates Huber/White/sandwich estimates of the standard errors, which are heteroskedasticity consistent and take into account the stratification and clustering in the data.

[14] Of the twelve coefficients, six are significant at the 5 percent level and two more at the 10 percent level.

A similar analysis (not shown) comparing the 1991-92 and 1996 data produced very similar results. Seven of the twelve coefficients are statistically significant at the 5 percent level, but none of the coefficients changes significantly between 1991-92 and 1996..

The market access results presented thus far have been based on bivariate relationships. It is worth asking whether the findings would differ if we controlled for other geographic variables such as land use category, elevation, and climate. Table 5 shows the results of a model estimating rural poverty as a function of five of the six market access indicators[15] and other geographic factors. Again, we use SUR model to test for changes in the poverty-market access relationship between 1991-92 and 1999. A significant increase in the market access coefficient would confirm the conventional wisdom that remote rural areas have lost (or gained less) more than other rural areas. As shown in Table 5, two of the market access measures show no significant change between 1991-92 and 1999, while two others reveal a significant *decrease* in the coefficient. Only one market access indicator, travel time to a primary town, has a coefficient that increases significantly over the period. A separate SUR model (not shown) comparing 1991-92 and 1996 showed no changes significant at the 5 percent level.

Discussion

In Tanzania, as in many other developing countries, the conventional wisdom is that economic reforms may have stimulated economic growth, but the benefits of this growth have been uneven, favoring urban households and farmers with good market access. This idea, although quite plausible, has rarely been tested. In this paper, we develop a new approach to measuring trends in poverty and inequality and apply it to Tanzania in order to explore the distributional aspects of economic growth and the relationship between rural poverty and market access. We find that, over the 1990s when significant economic reforms were implemented, the overall rate of poverty fell about 4 percentage points. Poverty fell the

[15] One market access indicator, travel time to tertiary towns, is dropped because it is not significant and it is closely correlated with travel time to secondary towns

least in Dar es Salaam and the most in small urban areas. The degree of poverty reduction was similar between rural and urban areas, across educational categories, and across income groups, though female-headed households seem to have lost relative to male-headed households.

We find that rural poverty is associated with remoteness, but the relationship is surprisingly weak and it varies depending on the definition used. Rural poverty is more closely related to access to regional urban centers than distance to roads or to Dar es Salaam. Although poverty is somewhat higher in more remote rural areas, we find no evidence that remote areas are being "left behind", either in relative or in absolute terms.

Is it possible to reconcile these results with the conventional wisdom that remote rural areas are much poorer than other rural areas and "left out" of economic progress occurring elsewhere in the country? It may be that other measures of market access, such as ones that take purchasing power into account, would support the conventional wisdom. Alternatively, it is possible that the pattern holds in general, but that Tanzania is an exception. Finally, it may be that our assumption that the coefficients in the expenditure prediction equation are stable is not valid. More research is needed to address these issues, but this paper raises the question whether the benefits of economic growth are as spatially concentrated as is commonly supposed.

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Table 1. Regression models of per capita expenditure

	Dar es Salaam		Large towns		Small towns		Rural areas	
	N = 1107		N = 794		N = 664		N = 2171	
	R^2 = 0.5034		R^2 = 0.4279		R^2 = 0.5268		R^2 = 0.4178	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Household size	-0.25492	-8.91***	-0.224030	-2.79***	-0.252674	-5.74***	-0.159395	-10.27***
Households size squared	0.00972	4.54***	0.011910	2.20**	0.011629	4.38***	0.004886	6.59***
% males under 5 yrs share of total	0.00539	3.30***	0.001294	0.32	0.002042	0.64	0.003574	1.91*
% females under 5 yrs as % share of	0.00555	3.02***	0.000240	0.07	0.001382	0.33	0.001045	0.75
% males 5-15 yrs	-0.00012	-0.09	-0.012338	-1.73*	-0.002905	-0.93	-0.001735	-1.23
% females 5-15 yrs	0.00028	0.25	-0.003835	-1.1	-0.005580	-2.38**	-0.001598	-1.03
% males 16-30 yrs	-0.00059	-0.66	-0.002234	-1.18	-0.000363	-0.17	0.000734	0.71
% females 16-30 yrs	0.00092	1.26	-0.003077	-1.54	-0.002251	-1.14	0.000172	0.12
% females 31-55 yrs	-0.00030	-0.22	-0.002818	-2.67***	-0.002908	-1.23	-0.000399	-0.25
% males over 55 yrs	0.00243	1.15	-0.001686	-0.44	-0.005041	-2.15**	0.003162	2.48**
% females over 55 yrs	0.00233	1.24	-0.001034	-0.42	-0.001228	-0.36	0.000748	0.54
Female head								
Age of head	-0.00357	-2.61**	-0.001256	-0.53				
Head has some primary schooling	0.01550	0.24	0.279551	2.34**	0.243244	2.69***	0.086257	2.39**
Head finished primary school	-0.10593	-1.32	0.527486	3.57***	0.391461	3.04***	-0.012855	-0.18
Head has some second. schooling	0.04493	0.57	0.237551	1.48	0.386034	3.87***	0.230773	1.93*
Head finished upper sec school	0.19154	2.51**	0.321873	2.24**	0.401873	3.32***	0.042039	0.65
Spouse has some primary schooling							0.052134	1.52
Spouse finished primary school							0.358541	2.64***
Spouse has some second. schooling							0.177469	1.11
Spouse finished upper sec school							-0.019249	-0.33
Floor of house made of earth	-0.17159	-3.99***	-0.288577	-2.67***			-0.205615	-3.76***
Water from indoor pipe	0.28188	4.82***			0.193219	1.05		
Water from outdoor pipe					0.148876	1.44		
Water from well					-0.154783	-1.19		
Flush toilet					0.246282	1.44		
Latrine					0.240432	2.24**		
House has electricity							0.121323	1.51
Radio ownership	0.08130	1.87	0.127064	1.49	0.304930	2.90**	0.293940	7.62***
Television ownership	0.23464	2.02**	0.345648	1.22				
Refrigerator ownership	0.30908	5.88***	0.191551	1.80*	0.368204	2.57**	0.426404	1.48
Motorbike ownership							0.149271	1.50
Car ownership	0.33038	2.75***	0.434943	2.45**	0.263515	1.66	0.240083	1.97**
Constant	10.99431	85.61***	10.56714	38.72***	9.823588	29.81***	-0.34683	-1.81*

Source: 1991 Tanzanian Household Budget Survey

* = significant at the 10 percent level, ** = significant at the 5 percent level, *** = significant at the 1 percent level

Note: Dependent variable is log of per capita expenditure. Coefficients of regional dummy variables omitted to save space.

Table 2. Incidence of poverty by year and by household category[1]

	Year			Change from
	1991-2	1996	1999	1991-2 to 1999
Tanzania mainland	0.468	0.429	0.426	-0.042
Urban category				
Urban	0.247	0.199	0.198	-0.049
Rural	0.529	0.484	0.492	-0.037
Stratum				
Dar es Salaam	0.036	0.041	0.033	-0.003
Large towns	0.184	0.165	0.118	-0.066
Small towns	0.345	0.305	0.315	-0.030
Rural areas	0.529	0.484	0.492	-0.037
Geographic zone				
Coast	0.385	0.346	0.370	-0.015
Northern Highlands	0.284	0.304	0.270	-0.014
Lake Zone	0.498	0.440	0.477	-0.021
Central Zone	0.520	0.550	0.527	-0.007
Southern Highlands	0.590	0.528	0.510	-0.080
Southern Zone	0.513	0.460	0.444	-0.069
Sex of head of household				
Male	0.469	0.422	0.418	-0.051
Female	0.465	0.460	0.463	-0.002
Education of head of household				
No schooling	0.576	0.547	0.556	-0.020
Some primary school	0.490	0.459	0.413	-0.077
Completed primary school	0.343	0.345	0.357	0.014
Some secondary school	0.138	0.137	0.111	-0.027
Completed secondary school	0.135	0.098	0.073	-0.062
Expenditure quintile[2]				
Poorest	0.835	0.802	0.797	-0.038
2	0.654	0.601	0.600	-0.054
3	0.482	0.428	0.425	-0.057
4	0.294	0.247	0.246	-0.048
Richest	0.078	0.065	0.066	-0.012

Source: Based on analysis of the 1991 Household Budget Survey and the Demographic and Health Surveys of 1991-92, 1996 and 1999.
(1) Incidence of poverty refers to the proportion of the population living in households with per capita consumption expenditure below the poverty line.
(2) Quintiles of per capita consumption expenditure defined separately for each year.

Table 3. Incidence of rural poverty by year and by measures of market access[1]

	Year			Change from
	1991-2	1996	1999	1991-2 to 1999
Tanzania rural areas	0.531	0.484	0.491	-0.040
Distance to road				
On road	0.595	0.536	0.565	-0.030
Less than 2 km	0.468	0.467	0.461	-0.007
2-5 km	0.503	0.439	0.49	-0.013
More than 5 km	0.546	0.487	0.482	-0.064
Distance to regional center				
Less than 10 km	0.335	0.292	0.364	0.029
10-50 km	0.515	0.485	0.457	-0.058
50-100 km	0.54	0.481	0.503	-0.037
More than 100 km	0.561	0.517	0.523	-0.038
Quartile of travel time to Dar es Salaam				
Closest	0.534	0.499	0.534	0.000
2	0.499	0.457	0.419	-0.080
3	0.544	0.478	0.488	-0.056
Farthest	0.543	0.500	0.519	-0.024
Quartile of travel time to a primary town				
Closest	0.480	0.448	0.448	-0.032
2	0.550	0.484	0.505	-0.045
3	0.570	0.504	0.545	-0.025
Farthest	0.515	0.498	0.469	-0.046
Quartile of travel time to a secondary town				
Closest	0.486	0.456	0.450	-0.036
2	0.540	0.472	0.504	-0.036
3	0.531	0.494	0.490	-0.041
Farthest	0.565	0.509	0.522	-0.043
Quartile of travel time to a tertiary town				
Closest	0.515	0.469	0.495	-0.020
2	0.536	0.507	0.482	-0.054
3	0.552	0.478	0.472	-0.080
Farthest	0.523	0.482	0.517	-0.006

Source: Based on analysis of the 1991 Household Budget Survey, the Demographic and Health Surveys of 1991-92, 1996 and 1999, and GIS analysis.
(1) Incidence of poverty refers to the proportion of the population living in households with per capita consumption expenditure below the poverty line.

Table 4. Relationship between rural poverty and each measure of market access

	Year	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	1991-92	N = 5668	N = 5668	N = 5668	N = 5668	N = 5668	N = 5668
		R^2 = 0.002	R^2 =0.023	R^2 = 0.008	R^2 = 0.017	R^2 = 0.023	R^2 = 0.002
	1999	N = 1813	N = 1813	N = 1813	N = 1813	N = 1813	N = 1813
		R^2 = 0.012	R^2 =0.018	R^2 =0.007	R^2 =0.014	R^2 =0.023	R^2 =0.008
Constant	1991-92	.47347***	.40451***	.41783***	.42057***	.41822***	.45270***
	1999	.43104***	.35920***	.36697***	.37534***	.36543***	.38554***
Distance to nearest	1991-92	-.00033					
road	1999	-.00089**					
Distance to nearest	1991-92		.00080***				
regional center	1999		.00070*				
Travel time to Dar es	1991-92			.00004**			
Salaam	1999			.00004			
Travel time to	1991-92				.00009***		
primary town	1999				.00001*		
Travel time to	1991-92					.00016***	
secondary town	1999					.00015***	
Travel time to	1991-92						.00006
tertiary town	1999						.00012
Test of hypothesis	F-statistic	F = 3.05	F = 0.08	F=0.01	F=0.07	F=0.00	F=0.61
that $\beta_{1991\text{-}92} = \beta_{1996}$	Prob	p = .0819	p = .7795	p=.9185	p= 0.7852	p=0.9745	p=0.4340

Source: Seemingly unrelated regression analysis of poverty rates as a function of indicators of market access.

Table 5. Relationship between rural poverty and all measures of market access controlling for agro-climatic characteristics

	1991-92 N = 5668 R^2 = 0.1195		1999 N = 1813 R^2 = 0.1128	
Variable name	Coefficient		Coefficient	
% of land in cropland	-0.0059		-0.0307	
% of land in deciduous forest	-0.01202		0.018389	
% of land in dry	0.002491		-0.00553	
% of land in coniferous forest	-0.11951	*	(dropped)	
% of land in grassland	0.021981		-0.00204	
% of land in mixed forest	0.047575		-0.12655	
% of land in savanna	0.001542		-0.01489	
% of land in shrub land	-0.04326		0.021543	
Mean elevation	3.13E-05		9.71E-05	
Rainfall in growing season	8.99E-05		0.000204	
Evapotranspiration rate	-0.00141	***	0.000506	**
Average max daily temperature	0.029348	**	0.014917	
Distance to road	-0.00183	***	-0.0031	*
Distance to regional center	0.000928	***	0.000788	***
Travel time to Dar es Salaam	2.95E-05		-5.7E-05	
Travel time to primary town	4.79E-05		0.000173	
Travel time to secondary town	5.96E-05		0.000123	***
Constant	0.276426		-0.59789	*
Test of hypothesis that coefficients for distance to road are equal for 1991-92 and 1999	F=4.94		Prob =0.0273	$\beta_{1991\text{-}92} > \beta_{1999}$
Test of hypothesis that coefficients for distance to regional center are equal for 1991-92 and 1999	F=0.13		Prob =0.7191	
Test of hypothesis that coefficients for travel time to Dar are equal for 1991-92 and 1999	F=4.64		Prob =0.0322	$\beta_{1991\text{-}92} > \beta_{1999}$
Test of hypothesis that coefficients for travel time to primary town are equal for 1991-92 and 1999	F=4.51		Prob =0.0348	$\beta_{1991\text{-}92} < \beta_{1999}$
Test of hypothesis that coefficients for travel time to secondary town are equal for 1991-92 and 1999	F=0.86		Prob =0.3549	
Test of hypothesis that all coefficients are equal for 1991-92 and 1999	F=1.72		Prob =0.0308	

Source: Seemingly unrelated regression analysis of rural poverty rates as a function of cluster-level GIS variables including six measures of market

Figure 1. Map of Tanzania with travel time to secondary towns

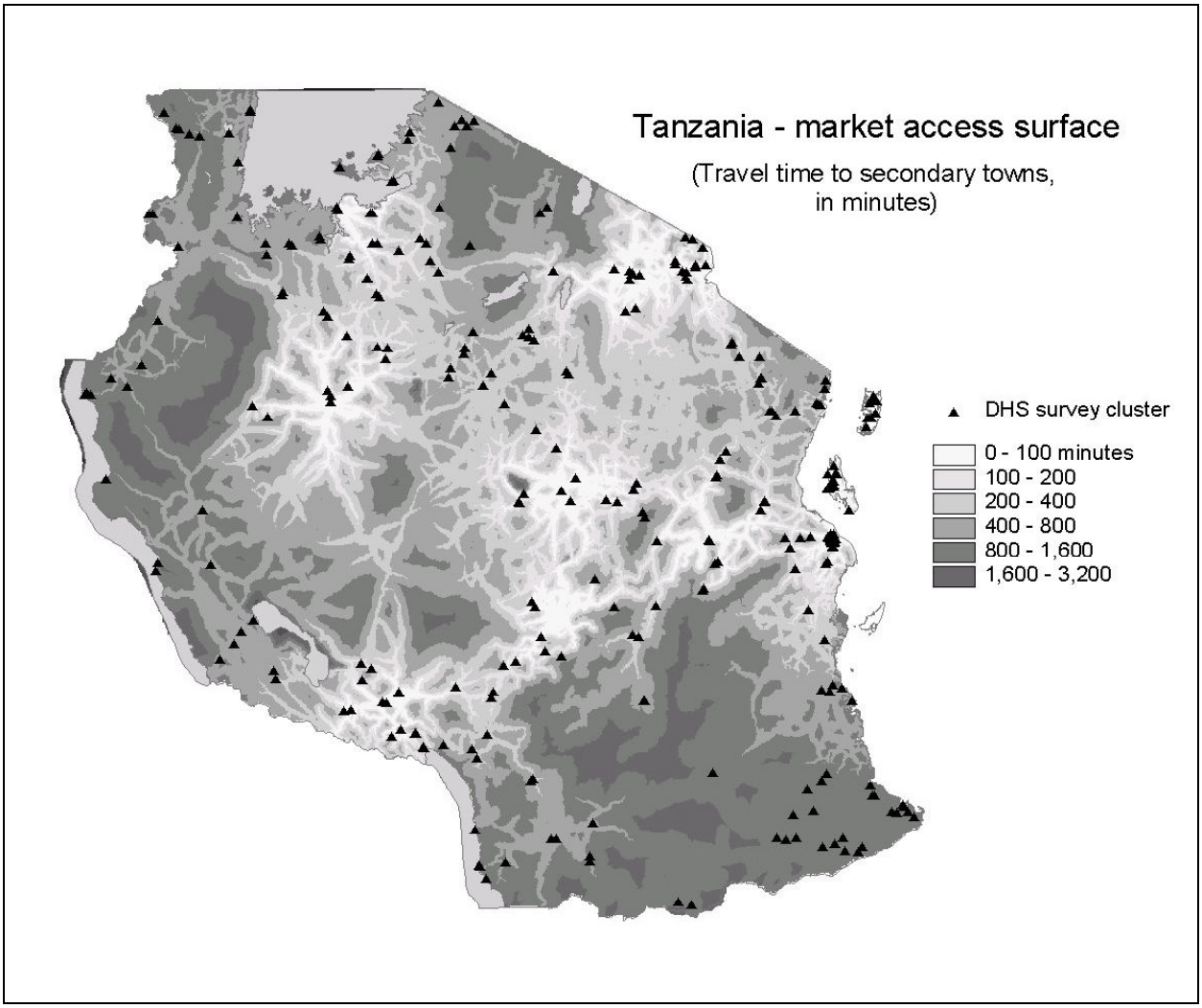

Figure 2. Non-parametric regression of rural poverty as a function of distance to road

a. 1991-92 **b. 1999**

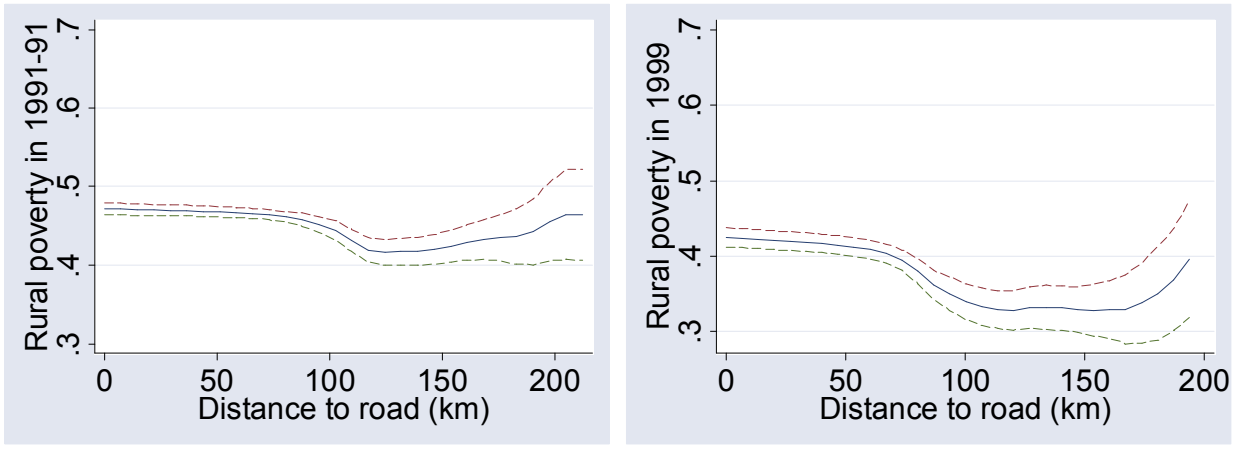

Figure 3. Non-parametric regression of rural poverty as a function of distance to regional center

a. 1991-92 **b. 1999**

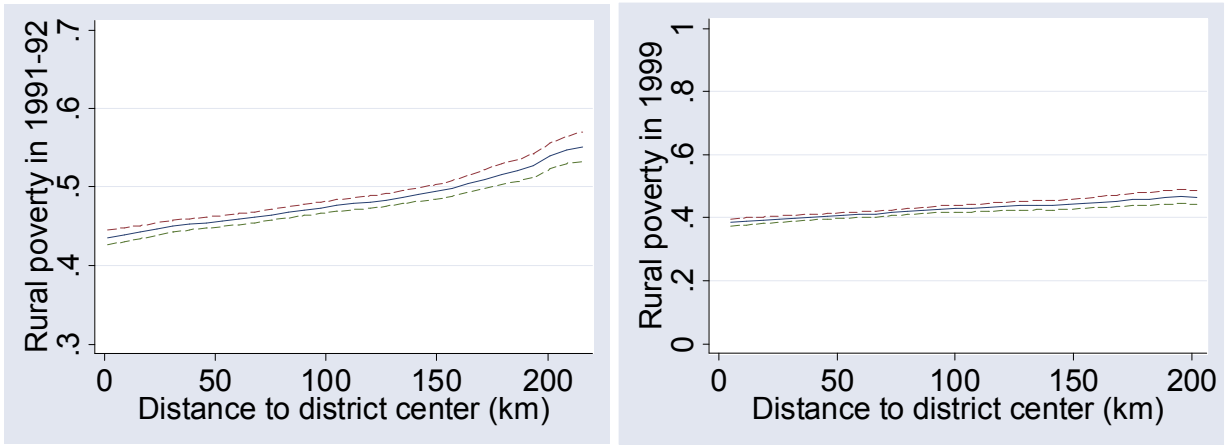

Figure 4. Non-parametric regression of rural poverty as a function of travel time to Dar es Salaam

a. 1991-92 **b. 1999**

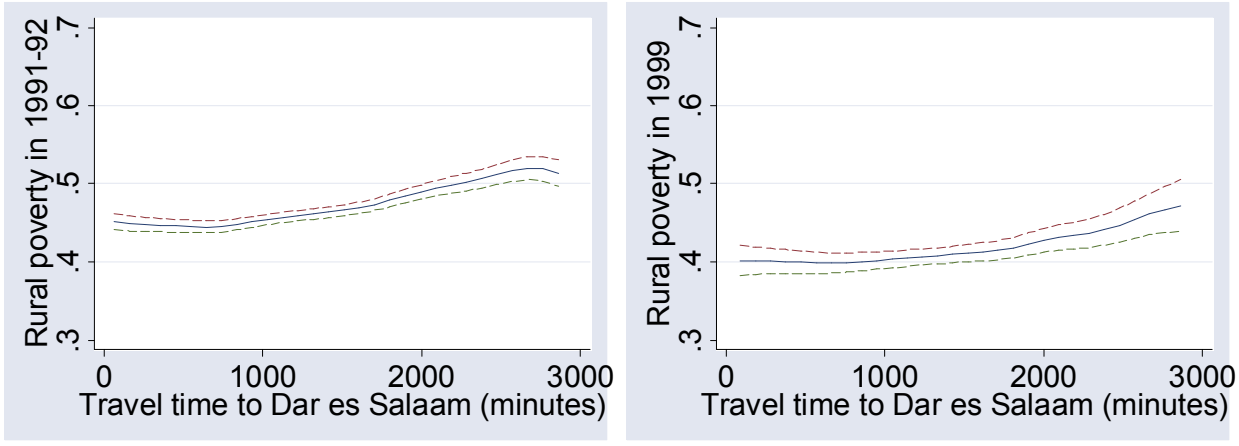

Figure 5. Non-parametric regression of rural poverty as a function of travel time to primary town

a. 1991-92 **b. 1999**

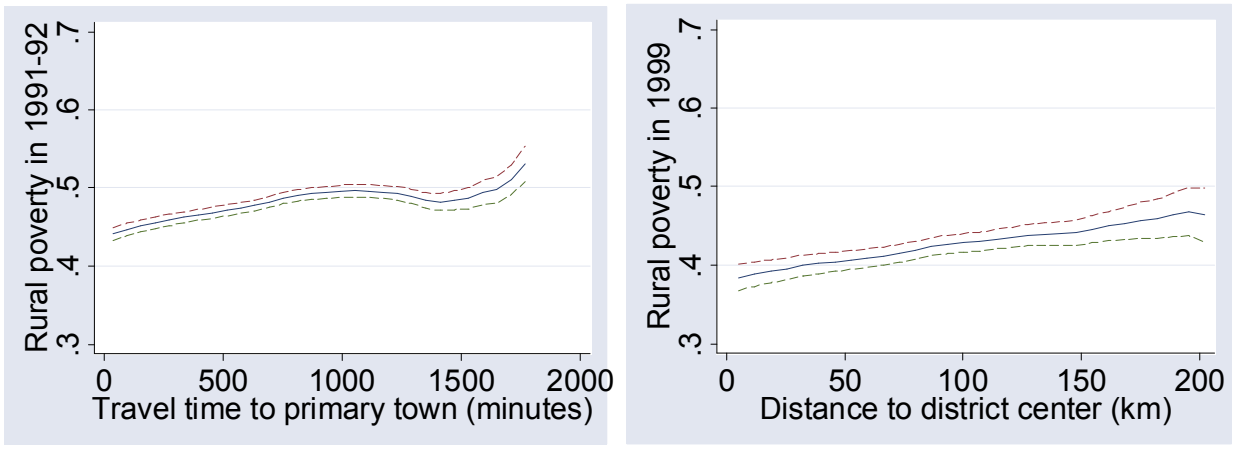

Figure 6. Non-parametric regression of rural poverty as a function of travel time to secondary town

a. 1991-92 **b. 1999**

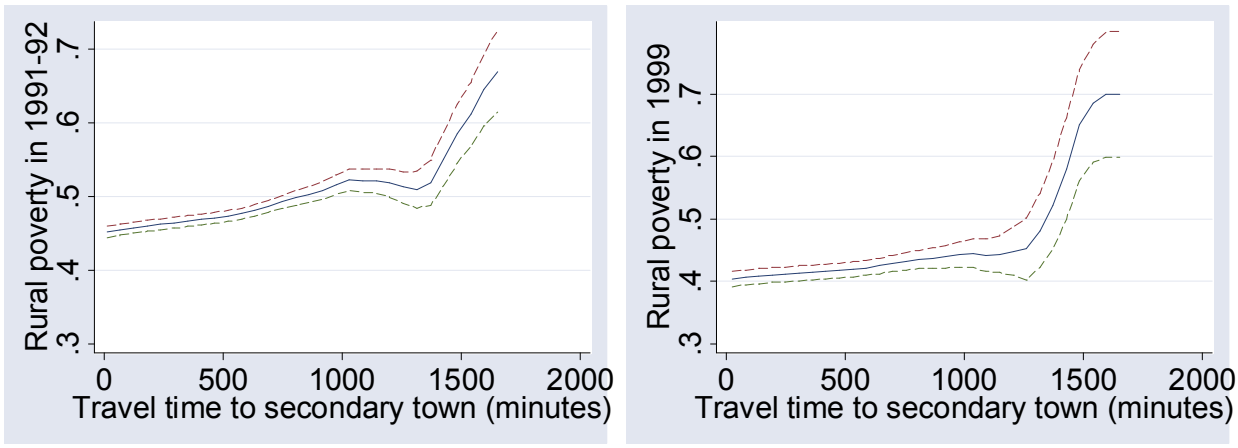

Figure 7. Non-parametric regression of rural poverty as a function of travel time to tertiary town

a. 1991-92 **b. 1999**