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**EXPLORING THE RELATIONSHIP BETWEEN FORMAL
EMPLOYMENT AND HOUSEHOLD WELFARE**

Evidence from Rural Tanzania

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Keywords— employment, welfare, infrastructure, tanzania, instrumental variables, LATE

Abstract

This study investigates the impact of formal employment on household welfare in rural Tanzania using data from the 2012/13 Tanzania National Panel. Distance to major roads is employed as an instrumental variable to estimate the local area treatment effect (LATE) of formal employment participation on household consumption levels. Results from the first stage show that as distance from major roads increases the likelihood of participating in formal employment also declines. The second stage results reveal that households that are engaged in formal employment have significantly higher consumption levels compared to non-participating households. The findings highlight the crucial role that improving road infrastructure can play in promoting access to formal employment opportunities and improving living standards in rural areas.

1. Introduction

In recent years, global poverty and inequality have remained pressing issues, with a significant share of the world's population still living in extreme poverty. Economic growth has been uneven across regions and countries as reflected by wide disparities in cross-country income levels. Moreover, a significant proportion of the global workforce, particularly in developing countries, is employed in the informal sector, resulting in even greater in-country income inequality. This global trend is evident in Tanzania, one of the fastest-growing economies in East Africa, which recorded an impressive output growth of 4.5 percent in 2012, maintaining an average of 6.3 percent since 2000.¹ However, despite this remarkable economic growth, the 2011/12 Household Budget Survey revealed that poverty reduction has been limited during this period. The poverty headcount only decreased from 33.6 percent in 2007 to 28.2 percent in 2012. Strikingly, 84.1 percent of individuals living in poverty resided in rural areas, while 14.4 percent lived in other urban areas, and a mere 1.5 percent in Dar es Salaam (National Bureau of Statistics 2014a).²

This disparity raises a crucial question: what factors contribute to the persistence of economic inequality, despite the country's impressive economic growth? One possible explanation may lie in the scarcity of formal employment opportunities, particularly in rural areas where economies are largely dependent on subsistence agriculture and other farm employment, which tend to be irregular due to seasonality. Noteworthy, Tanzania boasts an extensive road network, however accessibility varies significantly across geographical locations, with rural areas having the poorest connectivity to major roads. This lack of adequate road infrastructure in rural areas may limit access to formal employment opportunities, education, and healthcare, thereby contributing to relatively lower levels of household welfare compared to urban areas.

¹National Bureau of Statistics 2024

²Dar es Salaam is one of the smallest regions in the country, but it is the main urban commercial hub.

Given this context, we examine the relationship between road accessibility, formal employment, and household consumption to better understand the factors perpetuating economic inequality in Tanzania and to inform policies aimed at promoting inclusive growth and poverty reduction. Specifically, this paper examines how formal employment increases household consumption in rural areas and how distance to major roads influences access to formal employment opportunities. We hypothesize that formal employment leads to higher and more stable incomes, enabling households to increase their consumption and improve their well-being. Furthermore, we posit that proximity to major roads is a key determinant of access to formal employment opportunities, as it facilitates access to goods markets, education, health services, and labor markets that may otherwise be inaccessible in poor road conditions.

In this study we utilize nationally representative data from the 2012/13 Tanzania National Panel Survey. To test our hypotheses, we employ an instrumental variable approach, using distance to major roads as an instrument for formal employment. The strategy allows us to address potential endogeneity issues in the association between formal employment and household consumption. This allows us to estimate the local average treatment effect (LATE) of formal employment on household consumption for the subpopulation of households whose employment status is determined by their proximity to roads.

The first stage regression reveals positive and statistically significant relationship between distance to major roads and formal employment participation, in line with our initial assumption that proximity to major roads is associated with better access to formal employment. The second-stage IV regression yields a striking result, participation in formal employment leads to positive and significant difference in household consumption compared to non-participating households. The magnitude of this relationship is quite large, albeit plausible, given that average monthly household consumption in the sample and the average formal sector wage for Tanzania in 2012. These results provide reasonable evidence for causal impact of formal employment on household welfare in rural Tanzania.

This study makes several important contributions to literature. First, it provides causal evidence on the impact of formal employment on household welfare in rural Tanzania, highlighting the critical role of employment in poverty reduction and improving living standards consistent with Tesgera et al. (2024) and Hoang et al. (2014). Second, it underscores the importance of road infrastructure in promoting access to formal employment opportunities, particularly in rural areas where connectivity is limited in line with the findings from Fan et al. (2002) and Van De Walle and Cratty (2002). Third, the study's findings have significant policy implications, suggesting that investments in road infrastructure and policies aimed at increasing formal employment opportunities in rural areas can be effective strategies for reducing poverty and promoting inclusive economic growth.

The remainder of this paper is structured as follows: Section 2 provides a background on employment trends, and Tanzania's road network. Section 3 discusses the literature review conducted for the study. Section 4 describes the data used in the analysis, variables of interest and presents the descriptive statistics. Section 5 outlines the empirical strategy, discussing the identification strategy and assumptions, as well as model specifications. Section 6 presents the main results of the instrumental variable regressions along with robustness checks. Finally, Section 7 concludes the paper by discussing the policy implications of the findings, limitations of the study, and suggestions for future research.

2. Background on Tanzania's Employment and Road Infrastructure

Out of the 44 million people that were counted in the 2012 population census, only around 1.6 million were employed in the formal sector, with 35.8 percent employed in the public sector and the remainder (64.2 percent) working in the private sector. The formal labor market also heavily favors men, with 62.4 percent of the workers in the formal sector being male, while the remainder were female. There were also significant geographical disparities in formal employment. Specifically, out of the 26 regions in the country, Dar es Salaam held the largest share of workers in the formal sector at 33 percent followed by Morogoro at 9.1 percent, reflecting the large regional gap in formal employment (National Bureau of Statistics 2013). In this context, understanding the impact of formal employment on household welfare is crucial for informing policies aimed at poverty reduction and improving living standards.

Tanzania's geographical diversity and infrastructure development also makes it an interesting location to explore the relationship between formal employment and household consumption. As of December 2012, the country's network of trunk and regional roads had reached 31,193 km, with 37.3 percent being in good condition, while 47.4 percent and 15.3 percent being in fair and poor conditions, respectively (National Bureau of Statistics 2015).³ The quality and accessibility of roads vary across the country, with rural areas having the poorest connectivity to major road networks. This variation in road access provides a unique opportunity to use distance from major roads as an instrument to estimate formal employment participation, as proximity to major roads may influence access to more economic opportunities such as formal employment.

³Trunk and regional roads are the main long-distance roads that connect regions, cities, ports, and airports.

Tanzania has undergone some road upgrading programs that have improved economic outcomes to the recipient areas. As part of the Tanzania Compact project, MCC implemented funded a USD 405 million between 2008 and 2013, to upgrade trunk roads in Tanzania. The project was able to complete 190km of roads and there was an observed increase in output growth rates measured by increased intensity of nighttime lights particularly in urban areas that received the intervention (Millennium Challenge Corporation 2020).

3. Literature Review

This paper builds upon some studies that have investigated the impact of road accessibility on access to formal employment. In summary, the studies find a positive and significant impact of improved road accessibility on participation in formal employment. Specifically, Fan et al. (2002) use simultaneous equation models to investigate the impact of public investments in rural China by using provincial-level data over the period 1970-1997 on poverty reduction. They find that government spending on infrastructure resulted in growth of nonfarm employment and increase in wages in rural areas, which resulted to poverty reduction in the villages. In particular, one yuan that was invested in roads resulted in a 6.71 yuan return to output growth in the nonfarm economy and 8.83 yuan in the overall GDP. Furthermore, investment of 10,000 yuan was found to lift 3.2 people above the poverty line.

Van De Walle and Cratty (2002) also evaluate the impact of the 1997 Rural Transport Project I (RTPI) on economic activity and the standard of livings in Vietnam. The project rehabilitated 5,000 kilometers of roads that covered 18 provinces with high poverty levels over 3 to 5 years. They estimated the impact using difference-in-differences estimation combined with propensity score matching. They find that a 3.3 percentage points increase of in the share of community households that engage in non-farm businesses was due to road rehabilitation. The project also had higher positive welfare outcomes to the treat-

ment group particularly significant reduction in time to get to the hospital, pharmacies, and banks. However, some studies found some negative outcomes associated with road rehabilitation, at least in the short term. Dumas and Jativa (2019) use households fixed effects and propensity score matching investigate the short-term effects of 2,500 km road rehabilitation program in Tanzania. They find that the farm activities are adversely affected due to reduction in crop prices and reallocation of labor to more non-farm work, along with increase in worker wages however, the earnings fail to compensate for the losses in agricultural income.

Using a comprehensive household and firm census micro-data in India, Asher and Novosad (2020) examine the impact of rural roads construction on employment outcomes. They utilize a fuzzy regression discontinuity design with the program eligibility threshold being population at the village level. They find that construction of rural paved roads reduced share of workers in agriculture, while wage labor increases. However, there were no significant impacts on consumption. To examine the impact of rural road rehabilitation on employment, Blimpo et al. (2013) use data from randomized controlled trial in a community development project in Liberia that had road rehabilitation as one of its components. They employ a difference in difference approach to compare the outcomes in the treatment and control groups before and after the intervention. Their results show a significant increase in wage employment after road rehabilitation particularly in young workers. In the treatment communities they find evidence of increased market activity as well as improved access to social services such as health and education.

Similarly, Aggarwal (2018) also employs a natural experiment to isolate the impact of improved roads on economic outcomes of Indian districts in rural areas. Distribution of the treatment among villages was based on whether villages had a population of at least 500 people thus they were to be connected to nearest market via an all-weather road. The study compares outcomes across 500 districts, and they find that areas that had greater road construction experienced lower prices for goods as well as increased variety in the

consumption basket. In addition, districts that had more paved roads had increased use of fertilizer as well as higher school enrollment for kids.

Similarly, Huang et al. (2022) examined the role of rural transportation infrastructure in shaping non-farm employment opportunities for rural laborers in China by using the China Labor-Dynamics Survey (CLDS) micro data and employing the entropy method along with the ordered Logit model, the authors demonstrate a positive correlation between accessible transportation infrastructure and increased non-agricultural employment. The study highlighted that improved infrastructure not only facilitates the movement of rural laborers but also influences their decisions to seek employment closer to home, due to better local economic opportunities. The study further identifies key socio-demographic factors that affect labor employment choices, such as gender, family dependency ratios, and geographical features in rural areas.

Mottaleb and Rahut (2019) investigated the transformative impact of improved infrastructure in economically lagging regions of Bangladesh, particularly following the construction of the Jamuna Multipurpose Bridge (JMB) in 1998. By analyzing data from the Household Income and Expenditure Surveys (HIES) of 2000 and 2010, the authors explore how the bridge's establishment of direct road and rail links between the economically lagging northwest and the advanced eastern part of Bangladesh has influenced labor allocation, input use, and livelihood diversification. Using a difference-in-difference estimation approach, the study found that the improved transportation infrastructure led to a rise in labor out-migration, with day laborers transitioning to better-paying jobs. Additionally, wage rates and cropping intensity increased in the affected regions of Rajshahi and Rangpur. The study concluded that infrastructure investment, such as the JMB, can significantly contribute to economic growth and poverty alleviation.

In developed countries the outcomes are found to be somewhat different compared to developing and low-income countries. Jiwattanakupaisarn et al. (2010) studied the causal links between highway infrastructure and employment across sectors in the U.S.

using data from 1984 to 1997. Their results show that expanding highway capacity boosts employment in the services sector while reducing it in manufacturing. The study also found a bidirectional effect, where growth in services employment and declines in manufacturing prompted changes in roadway capacity. Additionally, the research identified both positive and negative spillover effects from highway improvements where the increases in non-interstate roads in neighboring states benefited manufacturing, but interstate highway gains within a state could negatively impact employment in nearby states.

Some studies also examine the impact of formal employment on household consumption and welfare. Tesgera et al. (2024) examine the impact of non-farm employment on household consumption in rural areas of western Ethiopia. They use the Heckman's two-step procedure with first stage used to estimate the probability of non-farm activity participation and using the predicted outcomes from the first stage to estimate household consumption, similar to instrumental variable approach. Households engaged in non-farm employment had higher levels of consumption compared to those participating in farm related employment. Another study by Ma et al. (2022) investigates the extent of consumption diversification driven by non-farm employment in rural China using a two-stage endogenous treatment regression (ETR). Their analysis reveals that participation in non-farm employment significantly increases household consumption diversification, with higher effects when women are engaged in nonfarm activities.

Furthermore, Hoang et al. (2014) assess the effect of non-farm employment on poverty reduction and household expenditure using village non-farm networks as an instrument to estimate non-farm employment participation. They find that non-farm employment participation by a household member increases likelihood of a household escaping poverty by 7 to 12 percent and increases household expenditure by 14 percent. Using nationally representative panel data, Adjognon et al. (2017) examine how participation in non-farm wage and self-employment influences welfare outcomes, particularly per capita consumption expenditure in Malawi. They employ fixed effects regression and correlated random effects

and find that non-farm employment improves household welfare and reduces poverty, although wealthier households benefit more compared to poorer ones. The analysis also shows that non-farm income facilitates the use of agricultural inputs, suggesting an indirect channel through which rural households improve their livelihoods.

Stifel (2010) studied the relationship between rural non-farm employment and household welfare in Madagascar employing multinomial logit models to analyze barriers hindering households from adopting more advantageous strategies. The study found that high-return non-farm activities are crucial for poverty alleviation; however, barriers such as limited education, lack of formal credit, and inadequate access to telecommunications hinder participation. Katega and Lifuliro (2014) employ a cross-sectional survey of 341 households in two villages in Dodoma Region in Tanzania to assess the role of rural non-farm activities in poverty alleviation. The study finds that the high household income earned from non-farm activities enabled higher to access food, health services, education, and farm inputs, thus alleviating both income and non-income poverty.

4. Data description

4.1. Original data

We use the third Wave of the Tanzania National Panel Survey (NPS) that was conducted between October 2012 and November 2013.⁴ The NPS is a Living Standards Measurement Survey that tracks the evolution of living conditions of Tanzanian population overtime. The survey collects data on consumption, agricultural production, formal income generating activities and other socioeconomic characteristics.⁵ The choice of the NPS 2012/2013 is justified by the availability of all required information for the study, which is not the case for the more recent surveys.

⁴World Bank 2015

⁵National Bureau of Statistics 2014b

It is worth noting that the first round of NPS was held in 2008/2009, the second round in 2010/2011. The survey is based on a “stratified, multi-stage cluster sample design” and uses the 2002 National Master Sample Frame as a sampling frame, which contains the list of all populated enumeration areas in Tanzania. As for stratification, it was based on geographic areas, which resulted into four strata: Dar es Salaam, other urban areas in Mainland, rural areas in Mainland, and Zanzibar. While for clusters within a stratum, they are randomly selected with a probability of selection proportional to their population size. These clusters correspond to census enumeration areas (in urban areas) and villages (in rural areas). On the other hand, tracking is done at the household level. If at least one person is identified as a household member in the previous wave of survey and a household member in the current wave too, this household can be considered as tracked.

As a result, low attrition was reported in the second and third waves of NPS (3 and 3.9 percent, respectively). The lowest rates were found in other urban areas in Mainland and in rural areas (2 percent) (National Bureau of Statistics 2014b). The NPS 2012/2013 includes household-level data with 4,883 observations, and individual-level data on household members’ characteristics with 25,412 observations.

4.2. Data for the study

The unit of analysis for the IV is the individual household member. However, for some variables like the annual consumption per adult-equivalent, information is only available at household level (see table 1 for more details). Merging household-level data and individual-level data into one dataset was required. Unmatched observations were dropped (only 3.8 percent of the initial sample). The sample size was reduced to 24,814 individuals.

Since the study focuses on formal employment and consumption in rural areas, only individuals belonging to the working-age population between 15 and 60 years old were selected. We restrict the age to 60 because it is the age of retirement in Tanzania. We did

not consider age below 15 because primary education is compulsory in Tanzania, and it lasts to around 15 years. In addition, Tanzania employment laws set the minimum age for child employment at 14 years old and 18 years if the work environment can be harmful to the child's health and development.⁶ Additionally, we assume that youth under 15 are too young and older people aged 60+ are too old to be influenced by our IV instrument, which is the distance from home to major roads. All households in our sample live within 75 km of the nearest major road. In consequence, the sample size becomes 8,149 individuals.

4.3. Key variables of interest

In NPS 2012/13, the indicator that is used to measure living standards in poverty analysis is consumption and it is more appropriate than income because of the following reasons. Income is more volatile for household working in agriculture sector because of seasonality; its measurement is less precise for self-employed and people working in informal and agriculture sectors; and respondents to survey find consumption as an easier concept to grasp and they are more willing to share information on consumption than income to avoid questions on taxes (National Bureau of Statistics 2014b).

Therefore, our outcome variable is real per adult equivalent consumption. This variable is derived from household annual consumption that covers the total value of food and non-food goods and services consumed within a year (nominal consumption). The NBS calculated household real consumption by adjusting each round of the NPS for temporal and spatial price differences. We divide it by household adult equivalent size to obtain real per adult equivalent consumption.

We seek to determine formal employment at individual level. A dummy variable named employed is created. It takes the value of 1 if the individual has formal employment and 0 otherwise. In this paper, formal employment refers to paid employment. In the questionnaire of the survey, the individual was asked if he/she spent most of his/her

⁶The Government Printer 2004

time in the last 12 months on formal employment that earns a salary. Another variable of interest is Distance to the nearest major road. The survey provides information on localization of the household. One of the indicators is “Distance from the household to the nearest major road” measured in kilometers.

Other variables such as father education, male, age, asset index, remittances and shocks will be used in the empirical analysis. Table in appendix 1 presents their description.

4.4. Describing employment rates

The average formal employment rate in rural areas was quite low at 8.9 percent. In rural areas, there are minimal formal job opportunities because the economy is more dependent on agriculture for subsistence. Meanwhile, farm employment tends to be irregular or temporary because of seasonality. In addition, educational attainment is low, making it difficult for rural dwellers to find formal employment. In the female population, only 5.6 percent were employed, while 12.3 percent of male population were employed. Consumption is expected to increase if the individual is employed. In general, formal sector jobs are associated with contracts that offer more security to employees. They are more likely to receive regular salaries and social security coverage like healthcare or retirement plans. These benefits incentivize individuals to increase consumption and living standards.

4.5. Descriptive Statistics

Figure 1 shows summary statistics of key variables in the analysis. Data from NPS is used without any weightings or adjustments for representativeness purposes.

Figure 1. Summary statistics of key variables

Variable	Mean	Std. Dev.	Min	Max
Real consumption per adult-equivalent	803014.5	622502.5	43480.6	9803580.0
Employed	0.09	0.29	0.0	1.0
Distance to nearest major road	19.69	19.33	0.0	74.9
Father education	0.28	0.45	0.0	1.0
Age	30.36	12.50	15.0	60.0
Male	0.49	0.50	0.0	1.0
Asset index	-0.01	0.01	0.0	0.2
Remittances	0.17	0.38	0.0	1.0
Shocks	0.78	0.42	0.0	1.0

In the sample, on average, real consumption per adult equivalent is TZS 803,014.54 per year or TZS 66,917 per month (approximately USD 43).⁷ The average distance from home to the nearest major road is 19.69 km, which means many households are located in remote areas. Accordingly, distance from the road is expected to be associated with lower household consumption. On average, 27.6 percent of individuals have a father who completed primary school. According to human capital theory, students acquire knowledge and skills through education. They become more productive and then have a higher chance to be hired and get higher wages. In the absence of information on the level of education of each member of the household, we assume that an individual in a household that has an educated father is likely to be exposed to higher education. The father may share knowledge directly with family members or he is more motivated to send children to school because he knows the importance of education. Therefore, having an educated father is expected to increase the chance of getting a job and increase consumption.

⁷1 USD= TZS 1517.7 World Bank 2024

In the sample, 17 percent of the individuals received remittances, which are expected to increase consumption. This additional income mainly comes from family members living in urban areas and it can help a household to spend more on consumption of goods and services. Meanwhile, 77.8 percent have experienced shocks over the past five years. The shocks include events such as droughts, death of a member of the family, loss of land, dwelling damaged, etc. that affected income. Accordingly, shocks are expected to reduce consumption. Lastly, the proportion of gender in the sample is almost the same with 49 percent being male.

5. Empirical Strategy

5.1. Identification Strategy

To identify the causal impact of formal employment on household consumption in rural Tanzania, we employ an instrumental variable approach. Specifically, we exploit the variation in access to roads as an instrument for formal employment. In this setting, the instrumental variable approach is more appropriate for estimating causal effects compared to other methods, such as ordinary least squares (OLS), because it addresses the potential endogeneity arising from reverse causality. Reverse causality may be present if household consumption itself affects the likelihood of engaging in formal employment, creating a bidirectional relationship between the two variables. By using distance to main roads as an instrument, we isolate the variation in formal employment that is solely due to the household's location relative to these roads. This allows us to estimate the local average treatment effect (LATE) of formal employment on household consumption for the subpopulation of households whose employment status is affected by their proximity to roads.

5.2. Identification Assumptions

The following are the assumptions that we make to obtain consistent and unbiased estimates of the causal effect of formal employment on household consumption. Our instrument must satisfy relevance assumption. In our study, we assume that the distance to main roads (instrument) significantly affects formal employment participation (endogenous explanatory variable). Households located closer to main roads are assumed to have better access to formal employment opportunities compared to those located farther away. This assumption will be tested by examining the strength of the first-stage relationship between distance to main roads and formal employment.

The assumptions are also supported by the Appraisal Document for the Tanzania Roads to Inclusion and Socioeconomic Opportunities (Rise) Project by the World Bank. The report argues that improved road accessibility can lead to better economic outcomes through increased formal employment opportunities, by connecting rural communities to markets, education, health, and financial services, as well as labor markets and economic opportunities that are inaccessible in poor road conditions. This increased connectivity enables rural populations to access more formal employment opportunities.⁸ Additionally, improved road infrastructure benefits farmers and regional value chains by providing access to markets, distribution centers, and agricultural inputs, which can lead to reduced post-harvest losses, lower transaction costs, and strengthened value chains. These improvements further create more formal employment opportunities in the agricultural sector, such as processing, packaging, and distribution (World Bank 2021).

The instrument must also be able to satisfy the exclusion restriction. The assumption being that distance to main roads affects household consumption only through its impact on formal employment, after controlling for relevant factors. Given the significant spatial disparities in informal employment with lower rates being in rural areas, this assumption may be plausible. Distance to main roads may be a key channel which determines access to formal employment opportunities through which the level of household consumption is affected. Nevertheless, we acknowledge that proximity to main roads may be associated with other observable factors that could affect household consumption, such as fathers' education, gender, asset ownership, remittances, and shocks; therefore, we control for these variables accordingly.

⁸World Bank 2021

5.3. Model Specification

All regressions are estimated using OLS with district fixed effects. Standard errors are clustered at the household level. The unit of observation is the household member living in the district .

In the first stage least squares (FSLs) regression, we estimate the relationship between distance to the nearest major road and formal employment:

$$employed_{di} = \beta_0 + \beta_1 distance_{di} + \beta_2 X_{di} + \gamma_d + \epsilon_{di}$$

Where:

$employed_{di}$ represents the binary variable Employed.

$distance_{di}$ is the instrumental variable representing distance from home to major roads, measured in kilometer.

X_{di} is a vector of control variables representing individual characteristics (gender and age) and household characteristics (asset, remittances, shocks, and father education).

γ_d are district fixed effects that account for other unobservable characteristics that differ across districts and can affect household consumption patterns such as geographic or climate factors, differences in land productivity, availability of natural resources, as well as district policies on employment and land use.

ϵ_{di} is a conditionally mean-zero error term, clustered at the district level.

The second stage least squares (2SLS) regression is estimated as:

$$\ln consumption_{di} = \alpha_0 + \alpha_1 employed_{di} + \alpha_2 X_{di} + \gamma_d + \mu_{di}$$

Where:

$\ln consumption_{di}$ is the dependent variable: the logarithm of per adult equivalent real consumption.

$employed_{di}$ is the predicted value of given by the First Stage Least Squares regression.

X_{di} is a vector of control variables representing individual characteristics (gender and age) and household characteristics (asset, remittances, shocks, and father education).

γ_d are district fixed effects.

μ_{di} is a conditionally mean-zero error term, clustered at the district level.

The reduced form equation is specified as follows,

$$\ln consumption_{di} = \delta_0 + \delta_1 distance_{di} + \delta_2 X_{di} + \gamma_d + \xi_{di}$$

ξ_{di} is a conditionally mean-zero error term, clustered at the district level.

6. Results

6.1. First Stage Regression

The first stage regression is used to isolate the changes in formal employment participation that are driven by a household's distance from major roads, controlling for other relevant factors that may be correlated to the two variables.

Figure 2. First Stage Least Squares Regression Results

Dependent Variable: Employed

VARIABLES	(1) Full sample	(2) Male only	(3) Female only
Distance	-0.005*** (0.001)	-0.007*** (0.001)	-0.003*** (0.001)
Distance squared	0.00007*** (0.0000)	0.000104*** (0.000)	0.0000411*** (0.0000)
Father education	0.044*** (0.008)	0.051*** (0.013)	0.034*** (0.010)
Age	0.013*** (0.002)	0.019*** (0.003)	0.007*** (0.002)
Age squared	-0.00016*** (0.000)	-0.000237*** (0.000)	-0.0000904*** (0.000)
Male	0.072*** (0.006)		
Shocks	-0.020** (0.009)	-0.023* (0.014)	-0.015 (0.010)
Asset index	0.91 (0.648)	0.32 (0.934)	1.230*** (0.466)
Remittances	0.036*** (0.011)	0.035** (0.016)	0.043*** (0.012)
Constant	-0.110*** (0.026)	-0.148*** (0.040)	 (0.01) (0.027)
Observations	8,077	3,935	4,142
R-squared	0.049	0.052	0.026
F-stat	35.31	29.37	11.93

Robust Standard Errors in Parentheses

*** p<0.01, ** p<0.05, * p<0.1

Based on the full sample (column 1 of figure 2), the coefficient for distance from major roads is negative and statistically significant at the 1 percent level. This indicates that for every additional kilometer away from major roads, the probability of a household participating in formal employment decreases by approximately 0.5 percentage points, holding all other variables constant. Since we included the variable distance squared in the regression, and it is statistically significant with an opposite sign, this shows us the

relationship between distance to major roads and formal employment participation is quadratic, with a turning point of approximately 35km. Intuitively, households closer to major roads have better access to formal employment opportunities. As distance increases the costs and time of commuting increases, and information on formal employment opportunities becomes limited. Beyond a certain point (35km), the probability of formal employment participation starts to increase again, possibly due to the presence of other roads and other sub-centers. The results support the assumption that greater access to major roads leads to higher formal employment participation, consistent with the findings from Fan et al. (2002) and Van De Walle and Cratty (2002).

The regression model includes some control variables that capture various household characteristics. The results show that household head education, age, and gender are positively associated with formal employment participation, while age squared which reflect the decreasing rate of chances of formal employment as one ages and shocks have a negative relationship. Additionally, a household that receives remittances has a higher chance of participating in formal employment, with the relationship being statistically significant. On the other hand, the household's asset index did not have a statistically significant association with formal employment participation, at the 5 percent level.

6.2. Second Stage Regression

From the second stage regression, we examine main results of the changes in household consumption that are due to the exogenous participation in formal employment that is driven by the household's distance from major roads, controlling for various household characteristics.

The results (figure 3 – column 1) show a positive and significant relationship between formal employment participation and household consumption, similar to the findings by Tesgera et al. (2024) and Katega and Lifuliro (2014). The coefficient for estimated formal employment is 2.44 which is statistically significant at the 1 percent level.

This indicates that participation in formal employment due to distance from major roads leads to a 244 percent points higher household consumption, compared to the non-participating households, holding other factors constant. The magnitude of the coefficient is plausible since the monthly average household consumption for the household in this sample is TZS 66,000 per month (USD 43), meanwhile in 2012 the average cash earnings of employees in Tanzania was TZS 356,666 (USD 227). It is therefore plausible that a household that starts participating in formal employment can on average increase its consumption by more than two times or 200 percent (National Bureau of Statistics 2013).

Households with male heads are associated with 15.4 percentage points lower consumption levels compared to those with female heads, under *ceteris paribus*. The relationship is statistically significant at the 1 percent level. The result might seem counter intuitive because in the results of the first stage regression being male was associated with a higher likelihood of participating in formal employment. However, this may reflect the nature of gender roles in Tanzania where women are the main the household managers. Controlling for formal employment participation and other factors women might have a higher propensity to spend on the household compared to men. Holding everything constant, a unit increase in the household asset index leads to a 7.9 percent increase in household consumption. The household asset index mirrors the household's economic wellbeing. A higher value is likely correlated to higher purchasing power, access to credit and income generation abilities, hence this would be reflected in the household consumption levels. The results for the above control variables were all economically and statistically significant at the 1 percent level (Table 4 – Column 1). The rest of the control variables did not have a significant effect on the growth of household consumption. These suggest that in

this context, age of household head and its squared, shocks and access to social welfare assistance did not play a crucial role in determining household consumption levels.

Figure 3. Second Stage Least Squares results
Dependent Variable: Inconsumption

VARIABLES	(1) Full sample	(2) Male only	(3) Female only
Employed	2.444*** (0.440)	1.702*** (0.343)	4.043*** (0.992)
Father education	0.085** (0.033)	0.111*** (0.037)	0.05 (0.054)
age	-0.007 (0.007)	0.004 (0.009)	-0.015 (0.010)
age squared	0.00006 (0.0001)	0.00007 (0.0001)	0.00017 (0.000)
male	-0.154*** (0.034)		
shocks	-0.028 (0.035)	-0.041 (0.038)	-0.011 (0.049)
asset index	7.853*** (2.573)	10.768*** (3.120)	4.33 (2.651)
remittances	-0.008 (0.042)	-0.004 (0.046)	-0.059 (0.068)
Constant	13.457*** (0.107)	13.257*** (0.129)	13.443*** (0.131)
Observations	8,077	3,935	4,142
R-squared	-0.837	-0.405	-1.876
F-stat	10.96	12.20	4.77

Robust Standard Errors in Parentheses

*** p<0.01, ** p<0.05, * p<0.1

6.3. Robustness Checks

We estimate the impact of distance on employment by dis-aggregating the sample by gender in the first stage regression (columns 2 and 3 of figure 2). When the sub sample is composed by male only, every additional kilometer away from major roads is associated with a decrease the probability of a household participating in formal employment by approximately 0.7 percentage points, holding all other variables constant. This effect is smaller for female sub sample (0.3 percentage points) because women are likely to face more constraints in commuting and getting a formal job due to societal and cultural factors as well as having more responsibilities in the household such as domestic work and childcare. Additionally, a large number of women do not have access to higher education compared to men in rural areas. Moreover, existing gender discrimination in labor markets especially in rural areas might favor men, regardless of the distance factor.

The second stage regression results (columns 2 and 3 of figure 3) show that the effect of being employed in formal employment on consumption is less pronounced (170.2 percent) for male and more pronounced (404.3 percent) for female, compared to the full sample. These results might reflect the tendency of women to prioritize household consumption compared to men. This leads to higher welfare improvement in the household once they are engaged in formal employment, consistent with Ma et al. (2022). However, this can also be a result of the small number of women in the sample who participate in formal employment, causing the instrument to overestimate the impact on household consumption.

7. Conclusion and Policy Recommendations

This study examines the causal impact of formal employment on household consumption in rural Tanzania, using distance to major roads as instrumental variable. The results from the first stage revealed a negative relationship between distance to major roads and formal employment participation, supporting the hypothesis that proximity to major roads is associated with better access to formal employment. The second stage IV regression found that participation in formal employment leads to a substantial increase in household consumption compared to non-participating households, *ceteris paribus*. To check the robustness of the findings we separately analyzed the male and females led households. The signs remained consistent reflecting stability of the model, however magnitudes were not the same, reflecting heterogenous outcomes as a result of gender roles and socio-cultural factors. Specifically, proximity had a smaller influence on women's likelihood of participating in formal employment and households with women that were formally employed had higher consumption levels compared to their counterparts. The IV approach was able to address potential endogeneity issues, however the estimates are a local average treatment effect (LATE) thus have limited external validity to the general population. Noteworthy, there might also be some omitted variables that may be causing bias to our results, which were not addressed due to data limitations.

To tackle unemployment and poverty in rural areas, the government should enhance public investment in road infrastructure, to ensure increased connectivity among districts, towns, and villages so as to maximize economic opportunities. Involving local communities and stakeholders in planning and implementing road projects is crucial to ensure that the specific needs and priorities of the poorest population are addressed. Furthermore, providing incentives that encourage the creation of industrial and commercial businesses in rural areas can lead to increased formal employment opportunities.

The government should focus on enhancing safety, offering skills training, developing agricultural extensions, and promoting microcredit programs. These policies should target both agriculture and non-agriculture sectors to help promote inclusive growth and development in rural Tanzania. In addition, gender targeted programs can help improve households' welfare, this includes reforms in labor markets and education to ensure more women participation in formal employment. As well as eradicating of cultural norms that prevent women from accessing economic opportunities such as household chore distribution.

Future studies can build upon this analysis and assess the long-term impacts of infrastructure development on output, education, health, and labor market outcomes. In the presence of data from different time periods other studies could also compare the changes in outcomes to entities or areas that receive infrastructure development projects to those that do not.

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A. APPENDICES

A.1. List of key variables

Variable	Unit	Description
Real consumption per adult equivalent	Tanzanian Shillings (TZS)	Household annual consumption covers the total value of food and non-food goods and services consumed within a year (nominal consumption). Real consumption is calculated by adjusting each round of the NPS for temporal and spatial price differences (household level)
Employed	Dummy variable	It takes the value of 1 if the individual has formal employment and zero otherwise. In this paper, formal employment refers to paid employment. The individual was asked if he/she spent most of his/her time in the last 12 months on formal employment that earns a salary.
Distance to the nearest major road	Kilometer (km)	Distance from home to the nearest major road (household level)
Father education	Dummy variable	It takes the value of 1 if the father in the household completed primary school, zero otherwise
male	Dummy variable	It takes the value of 1 if the individual is male, zero otherwise
age	Years	Age of each individual member of the household
asset index		The individual is asked to give value to a list of assets in the household, if she were to sell them (household level). Ex: TV, radio, car, phones, etc. Then, we created the index based on these values.
remittances	Dummy variable	It takes the value of 1 if anyone in the household received any remittances or financial assistance in the form of cash or in-kind during the last 12 months, zero otherwise (household level).
Shocks	Dummy variable	It takes the value of 1 if over the past five years, the household was severely affected negatively by any of events like droughts, death of a member of the family, loss of land, dwelling damaged, etc. that affected income, zero otherwise (household level).

A.2. Reduced form regression results

Figure 4. Dependent variable: Inconsumption

VARIABLES	(1) Full sample	(2) Male only	(3) Female only
Distance	-0.012*** (0.002)	-0.012*** (0.002)	-0.013*** (0.002)
Distance squared	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Father education	0.192*** (0.020)	0.198*** (0.027)	0.183*** (0.022)
age	0.024*** (0.004)	0.037*** (0.005)	0.013*** (0.005)
age squared	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
male	0.022** (0.010)		
shocks	-0.076** (0.030)	-0.080** (0.033)	-0.071** (0.030)
asset index	10.091*** (1.557)	11.325*** (2.348)	9.344*** (1.182)
remittances	0.081** (0.033)	0.055 (0.039)	0.113*** (0.034)
Constant	13.184*** (0.073)	13.004*** (0.098)	13.384*** (0.083)
Observations	8,077	3,935	4,142
R-squared	0.074	0.085	0.072
F-stat	17.29	15.42	15.11

Robust Standard Errors in Parentheses

*** p<0.01, ** p<0.05, * p<0.1