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Influence of Road Infrastructure on Agricultural Transformation and Equity in Tanzania

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Abstract

Transforming agriculture from subsistence to commercial farms is at the bottom of rural development strategies. The influence of physical market access in terms of road network in the transformation process deserves attention. To demonstrate this, data were collected from 240 farmers in 12 villages at varying distance from a tarmac road in Tanzania. Partial analysis showed that productivity, income, market orientation and other variables vary significantly with distance from the road. There was a significant difference between men and women headed households. A three stage least squares method showed clearly specialisation and intensification effects of road accessibility on agricultural productivity.

Introduction

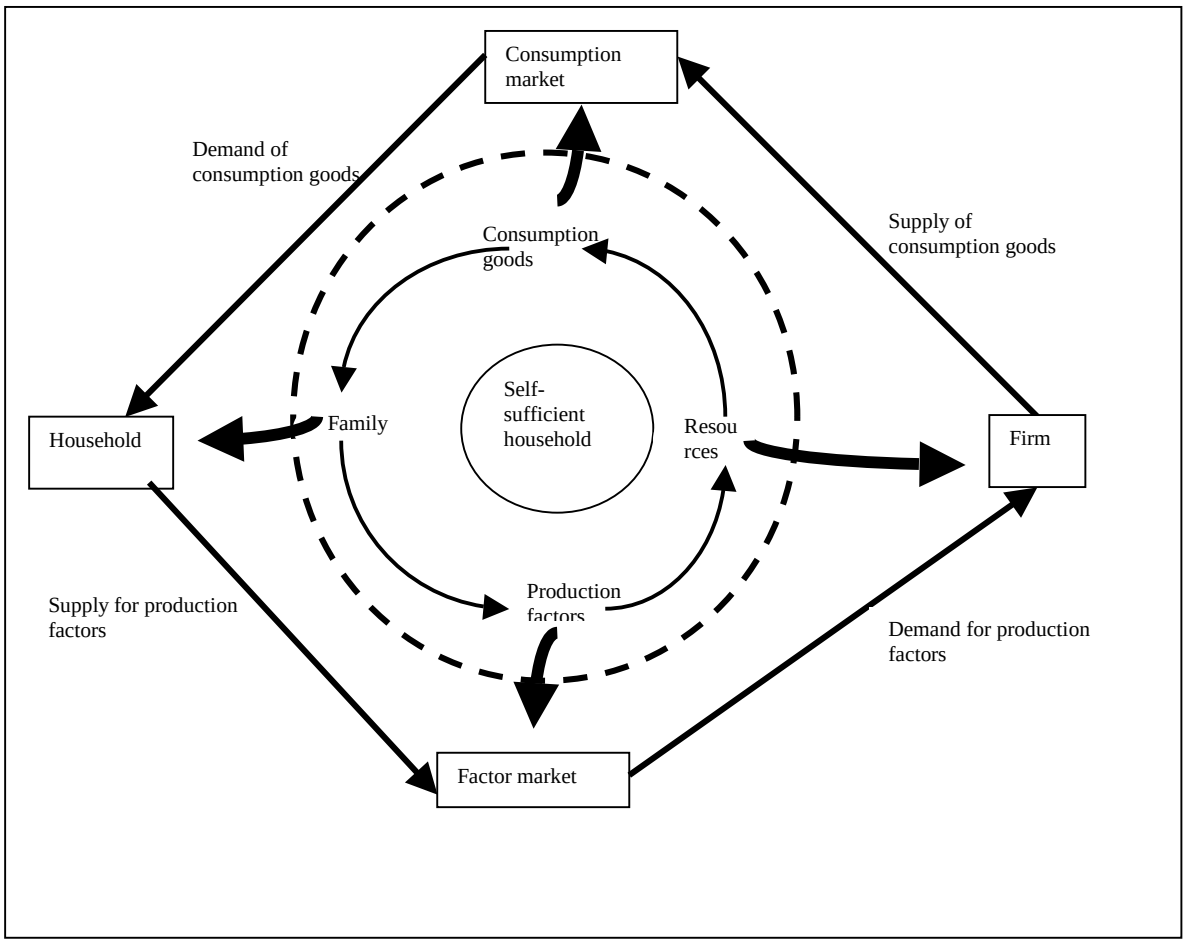
Most of the agricultural output in Tanzania is produced by small farmers scattered in small rural communities. On the other hand the major markets and processing centres for crops as well as input sources and ports are located in urban centres at a considerable distance. Because of this structure of human settlements a reliable road network is important for agricultural and industrial growth. Poor road network effectively inhibits market integration and promotes subsistence oriented farming practice. This reality does not seem to be unveiled for many decision-makers who pay little attention to developing roads. This is probably hindered by lack of empirical justification for investment in road infrastructure. This study is set to measure empirically the influence of road access on agricultural productivity in Tanzania. The unequal distribution of gains from improved road access between economically strong and weak actors in the system is also examined. To this effect men and women are used to represent the strong and the weak respectively. Apart from enabling policy makers to make informed decisions quantitative measurement of this type would shed light on the returns to investment on expensive public expenditure such as road construction.

Theoretical Perspectives

This study is based on the market induced development theory. The basic paradigm of this theory holds that efficient marketing system generates prices that induce economic development through influencing resource allocation. For this to happen a household should

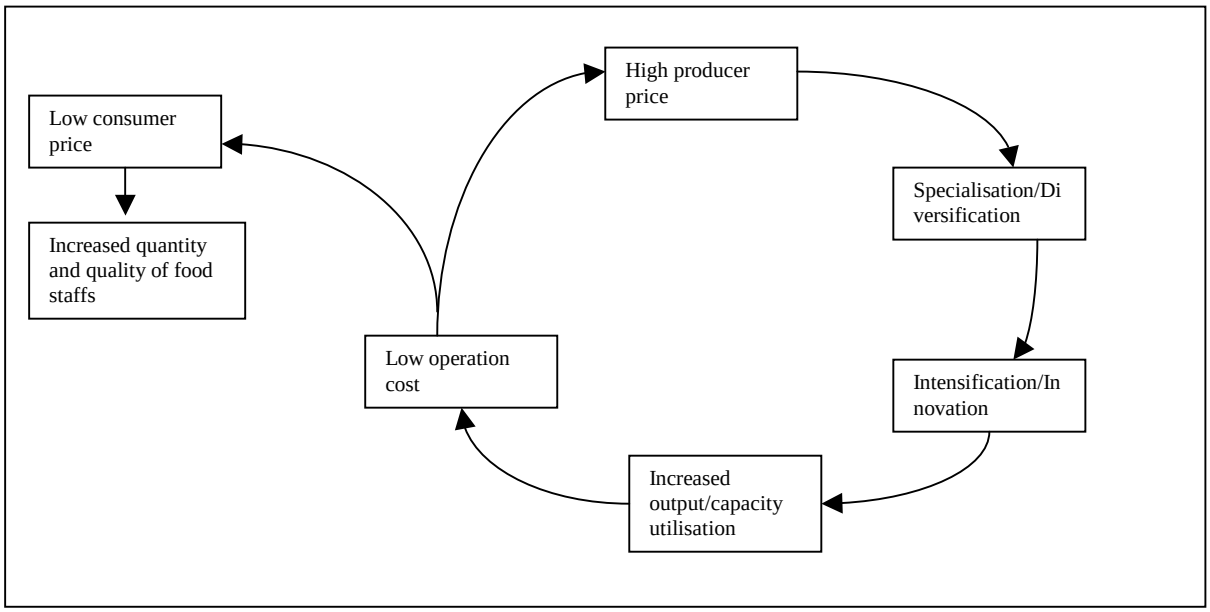
be integrated to the main stream of the economy, that is, stop being self-sufficient agricultural unit. A self-sufficient agricultural unit is a home – consumption oriented farm, which internally decides on production and consumption but without relating to any external market. Demand and supply forces are adjusted internally. All needs of the family are satisfied out of own production; whatever is not produced may not be needed. If it is needed it may be produced even though at high costs because the family may be having a comparative disadvantage in producing it. Figure 1 shows a transition process when a self-sufficient family is integrating to the commercial marketing system.

Figure 1: Self-sufficient Household integrating into the marketing system



When the household is connected to the commercial marketing system, price signals indicate the direction into which an enterprise or farm should change its activities. This implies specialisation or diversification as indicated by comparative advantage. The intensity, by which an activity is pursued, is decided such that to maximise returns. The extent, to which an activity is followed, depends on the economies of scale inherent in an operation. Thus, decisions about direction, intensity and extent of activities are implicitly reflecting decisions on resource allocation. A causal relationship exists between these decisions, and sometimes they reinforce one another and generate circular effects of self-acceleration involving different actors (Figure 2).

Figure 2: Circular effects of a marketing system



A number of authors have used aggregate farm productivity to measure the relationship between productivity and market access, which is in a way determined by road network. Authors such as Hau (1999), Odhiambo (1998), and Njehia (1994) used travelling time in minutes from households to central markets whereas Munyemana and von Oppen (2000) used distance in km from households to the market place to measure the same. This study uses both time and distance to measure agricultural productivity.

Methodology

Four centres along a tarmac road, the Tanzania-Zambia Highway (TANZAM) were chosen for survey. The centres were namely Chalinze, Mikumi, Ilula and Chimala. At each centre three villages based on the relative proximity to the road were selected. Based on the distance from the road the villages were classified as easy access (<6 km), medium access (6-13 km), and difficult access (>13 km). In each village 10 men and 10 women were interviewed to collect information on crops produced by the majority of farmers and normally sold to traders. The selection of farmers in a particular village was based on proximity to the feeder road. The reference period was 1998/1999 production season.

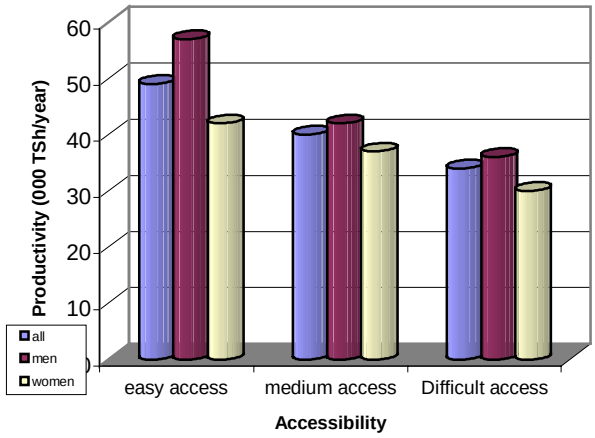
Data Analysis

Aggregate productivity was computed by multiplying the quantity of a crop by its average nominal price, adding up over all crops and dividing the total by the area under the crops. Market orientation was calculated as a ratio of output sold to total output and expressed as a percentage. Then partial analysis was performed using Excel 5.0 and SPSS 9.0. Comprehensive analysis using a three stage least square method on a simultaneous model was carried out for men and for women using LIMDEP 7.0. From the variable coefficients, elasticities were derived as suggested by Gujarati (1995). The impact of a 10% improvement in road accessibility on productivity was then examined.

Results and Discussion

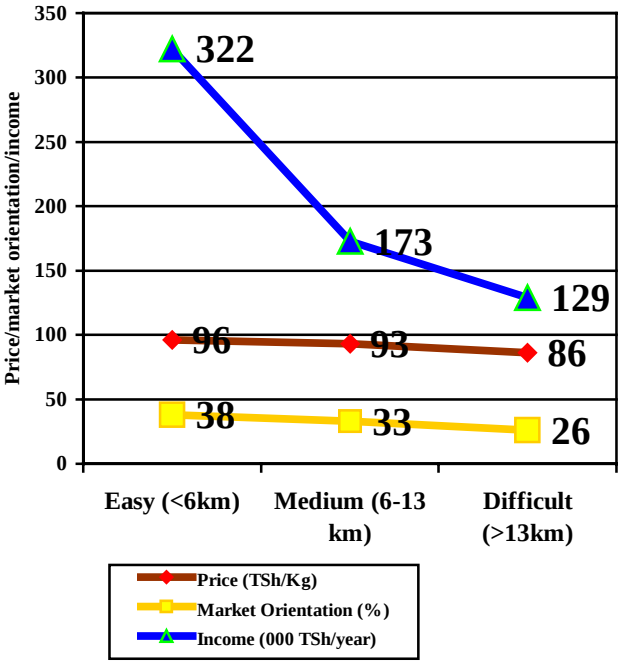
Partial analysis showed a significant inverse relationship between variables and distance. As the distance from the household to the tarmac road decreased productivity increased (Fig 3). While the overall productivity for easy access villages was TZS 48,497 that for medium and difficult access were TZS 39,883 and 33,856 respectively. A significant difference between the productivity of men and for women headed households was noted. For example in the easy access villages the productivity for men was 25% higher than for women. The same trend was manifested for medium and difficult access villages.

Figure 3: Road Acessibility Vs Aggreagate Productivity



Other variables such as producer price, market orientation and income followed the same trend as productivity (Fig 4). For instance maize producer price for easy access villages was 3% higher than for medium access villages, and the price for medium access villages was higher than for difficulty access villages by 8%. A similar behaviour was revealed by household annual income. Reduced to daily income a household in an easy access village gets TZS 881 whereas in a difficult access village it gets only TZS 354. This is equivalent to U$ 1.34 and 0.53 per day. A similar trend could be observed for market orientation.

Figure 4: Influence of road on procer price, market orientation and household income



However some variables for example labour and area cultivated were positively related to the distance. The trend in labour can be explained by the fact that near the highway a farmer has access to labour substitutes such as tractors and oxen.

Detailed results of comprehensive analysis are presented in table 1 to 3 below. Most variable coefficients carried expected signs and were statistically significant (table 1). Road access variables indicated that if time to the feeder road were reduced by 1 hour (example by increased use of intermediary transport means) productivity for men headed households would increase by TZS 2,800 (about U$ 4) whereas that for women would increase by TZS 621 (U$ 0.94). On the other hand if distance to the tarmac road were reduced by 1 Km (by construction more roads) productivity would increase by TZS 4,755 (U$ 7) for men and TZS 650 (U$ 0.98) for women. A much clearer

picture is given in table 2, which reduces all measurements to percentage changes (elasticity).

Table 1: Variable Coefficients from 3SLS Analysis

Variable[a]	Men N=120 Equations						Women n=120 Equations					
	PVITY	FERT	CHEM	HYV	LABOR	INCOM	PVITY	FERT	CHEM	HYV	LABOR	INCOM
PVITY	DEP			0.001*** (13.070)			DEPENDENT			0.002*** (12.006)		
FERT	989.37*** (36.825)	DEPENDENT		0.642*** (36.665)			134.92*** (11.367)	DEPENDENT		0.316*** (12.411)		
CHEM	29.756 (0.370)		DEPENDENT				55.55 (0.444)		DEPENDENT			
HYV	153.42*** (19.717)			DEPENDENT			45.79*** (6.010)			DEPENDENT		
LABOR	15.358 (0.808)				DEPENDENT		-46.382 (-0.156)				DEPENDENT	
INCOM		0.00007*** (4.162)	0.0001*** (3.867)	-0.000002 (-1.209)		DEPENDENT		0.0001*** (4.498)	0.0001*** (4.539)	0.0002*** (3.555)		DEPENDENT
MANU		-0.192 (-0.015)						-0.013 (-0.006)				
EDUC		0.156 (0.308)				2287.98*** (4.270)		0.387 (0.183)				1092.96*** (2.281)
CREDT			244.14*** (2.418)						446.99*** (4.605)			
AGE			-0.968*** (-4.496)			3694.73*** (3.987)			-0.981*** (-5.697)			1804.21*** (2.589)
HSIZE					2.555*** (2.459)						4.030 (0.772)	
TRACT					-0.0166*** (-2.006)						-0.051 (-0.169)	
HLVAL					-0.014*** (-2.719)						-0.041** (-1.938)	
FROAD	-2799.84*** (-2.483)	0.289*** (-2.497)	-0.154 (-1.023)	-1.817*** (-2.482)	0.230** (1.901)	-190.05*** (-3.578)	-620.56*** (-4.331)	-0.490*** (-4.530)	-0.279*** (-2.822)	-1.461*** (-4.346)	0.276 (0.604)	-388.56 (-0.905)
TANZ	-4754.98*** (-8165)	-0.489*** (-8.171)	-2.493*** (-3.920)	-3.086*** (-8.165)	3.541*** (4.885)	-4629.05*** (-2.622)	-650.08*** (-9.108)	-0.506*** (-9.422)	-2.788*** (-5.640)	-1.529*** (-9.133)	6.526*** (2.590)	-5077.45*** (-2.298)
DDSM	-27.71** (-1.991	-0.0290*** (-2.026)	0.663 (0.400)	0.180** (1.991)	0.108*** (6.511)	-44.91 (-0.577)	-6.216*** (-3.752)	-0.048** (-3.865)	-0.020* (-1.550)	-0.146*** (3.761)	0.066 (1.089)	-69.676 (-1.203)

From this table it was possible to deduce the specialisation (direct) and intensification (indirect) effects of road access on aggregate agricultural productivity and other variables as summarised in table 3. It can be noted that if for instance distance from the household to the tarmac road was improved by 10% aggregate productivity would increase by 10.8% for men, that is 8.80% from specialisation and 1.98% from intensification effect. For women the increase would be 4.26%; 1.50% from specialisation and 1.38% from intensification effect. Assuming that these results give a true reflection for Tanzania whose GDP is U$ 6.5 billion, 49% of which from agriculture (Bank of Tanzania, 1998), a 10% increase in tarmac road would increase GDP and income per capita by 4% each.

Table 2: Derived Variable Elasticity

Variable[a]	Men n=120						Women n=120					
	PVITY	FERT	CHEM	HYV	LABOR	INCOM	PVITY	FERT	CHEM	HYV	LABOR	INCOM
PVITY				0.89***						1.86***		
FERT	0.80***			0.71***			0.10***			0.18***		
CHEM	0.03						0.06					
HYV	0.11***						0.05***					
LABOR	0.03						0.16					
INCOM		0.489***	0.62***	0.016				0.54***	0.80***	0.70***		
MANU		Na[a]						Na[a]				
EDUC		-0.02				0.03***		0.03				0.02***
CREDT			Na[a]						Na[a]			
AGE			0.90***			0.67***			1.22***			0.29***
HSIZE					0.24***						0.19	
TRACT					0.01***						-0.03	
HLVAL					0.73***						-0.12***	
FROAD	-0.82***	-0.11***	-0.04	-0.73***	0.04**	-0.01***	-0.23***	-0.27***	-0.10***	-0.47***	0.03	-0.03
TANZ	-0.88***	-0.11***	-0.41***	-0.78***	0.40***	-0.15***	-0.15***	-0.17***	-0.61***	-0.29***	0.43***	-0.24***
DDSM	-0.25**	-0.32***	-0.54	2.22**	0.60	-0.07	-0.07***	-0.79***	-0.21*	1.40***	0.22	-0.16
MKORI						0.31***						0.70***

Note: *** = Significant at 1%, ** = Significant at 5%, * = Significant at 10%

[a] Na=not applicable, PVITY= aggregate productivity (TZS /acre), FERT=fertilizer (Kg/acre), CHEM= chemicals (%), HYV=high yielding variety (%), LABOR=labour (man-days/acre), INCOM=household income (TZS /year), MANU=manure (dummy), EDUC=education (years), CREDT=credit (dummy), AGE=respondent's age (years), HSIZE=household size (number),

TRACT=area under tractor (%), HLVAL=hired labour value (TZS /man-day), FROAD=time to feeder road (hours), TANZ=distance to TANZAM (Km), DDSM=distance to Dar es Salaam (Km), MKTORIE=market orientation (%)

Table 3: A 10% Effect of Improvement in Road network

	Men		Women	
	Feeder Road	**Distance to the tarmac road**	**Feeder Road**	**Distance to the tarmac road**
Specialisation Effect	8.20	8.80	2.30	1.5
Intensification Effect	1.69	1.98	0.39	1.38
Fertiliser	0.88	0.88	0.04	0.17
Pesticides	Ns	0.12	0.06	0.37
HYV seed	0.80	0.86	0.24	0.15
Labour	0.01	0.12	0.05	0.69
Total Effect	9.89	10.8	2.69	4.26

Conclusion and Policy Issues

It has been revealed that access to road in terms of time and distance has a significant influence on aggregate productivity and other variables. The influence is partitioned into direct (specialisation) and indirect (intensification) effect. We have noted that improvement in road access does not benefit all the actors equally in the system because of varied ability to take advantage of improved situation in the system. The economically strong participants are likely to benefit more than the weak. This has been confirmed by the results that the effect of improvement in roads access was more pronounced in men than in women. We conclude that an investment priority in road infrastructure is imperative for agricultural and rural development strategies. The strategies should be gender sensitive in order not to accentuate the economic gap between men and women.

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