Rural-Urban Linkages, Transaction Costs, and Poverty Alleviation: The Case of Tanzania

Christopher Adam
Oxford University

David Bevan
Oxford University

Douglas Gollin
Oxford University

IMF Workshop on Macroeconomic Policy and Income Inequality
October 22-23, 2015

Rural-Urban Linkages, Transaction Costs, and Poverty Alleviation

Outline

Background: Agriculture and Non-Agriculture

- Across sub-Saharan Africa, large fractions of the labor force work in agriculture.
  - 75% for Tanzania
- Agricultural sector appears to have low productivity, relative to non-agriculture, typical of other countries in Africa.
  - Agriculture share of value added is 45% in Tanzania.
- Implies raw "agricultural productivity gap" $\frac{VA_N/L_N}{VA_A/L_A}$ is large: 3.5

Background: Poverty

- Poverty is relatively concentrated in rural areas.
  - Headcount poverty rate in Dar es Salaam is one-third as high as in more remote districts.
  - Under-5 mortality rates four times higher in rural districts compared to urban districts.
  - Only 3% of rural households have electricity compared to 45% of mainland urban households.
- But there are also significant numbers of poor people in urban areas.
  - Concentrated in informal services and low-skill labor.

Background: Transport Costs

- Tanzania is a country with poor roads and transport infrastructure.
- Correspondingly large costs of moving goods across space.
  - Not all costs are transport costs; poor infrastructure and low population density also lead to low levels of competition.
- Markets across Tanzania are reasonably well integrated, but with large price differences across locations at a moment in time.

Price Dispersion across Markets

Table 1: Cross-location price spreads, selected commodities:
(Max - Min)/Average across 20 locations in Tanzania (CPI data).

	Dec. 2001 - Dec. 2003	Jan. 2004 - Dec. 2006	Jan. 2007 - Dec. 2009	Dec. 2001 - Dec. 2009
Food items				
Beans	0.647	0.641	0.579	0.619
Dried Fish	1.161	1.435	1.309	1.318
Rice	0.620	0.469	0.491	0.516
Maize Flour	0.877	0.841	0.710	0.802
Non-food items				
Men's Trousers	1.050	1.092	1.032	1.059
Toothpaste	1.231	1.439	1.674	1.473
Torch Battery	0.225	0.423	0.833	0.524
Car Battery	0.342	0.546	0.810	0.591

Investment for Poverty Alleviation

- Against this background, how should the public sector invest to achieve poverty alleviation?
- Will investments in rural areas reduce poverty?
- Or are rural areas intrinsically poor?
  - Farm size is very small and skill levels are low.
  - Earnings of the rural poor are essentially determined by unskilled wage plus some land rents... Is it plausible to increase land rents sufficiently to reduce poverty among households that farm 2 ha of land?

Approach and Methodology

- To address these questions, need a model in which we can think about labor markets and skill types (differentiated labor).
- Also need a model that can represent the spatial disparities in well-being that we observe in the data.
  - A model with different locations
  - Explicit frictions in moving goods across space
- Government policy will consist of allocations of public capital.
  - Must be financed in some way within the model.
- General equilbrium approach: benefits from investments may not accrue to sectors where we invest.

Antecedents

- We draw on the more stylized model of Gollin and Rogerson (2012), which has three locations: urban, "close," and "remote."
  - Related to growing literature on remoteness; e.g., Minten and Stifel (2008).
- Also related to previous CGE approaches for Tanzania; e.g., Pauw and Thurlow (2010), Thurlow and Wobst (2003).
- Pays explicit attention to financing of investment, as in Adam and Bevan (2006) or Devarajan et al. (1994).

Model

- Open economy model with three "locations": Dar, Rural, and a composite region of secondary cities and commercial agriculture, which we call "Mwanza."
- The economy has fixed endowments of unskilled and skilled labor, allocated endogenously across the three locations.
  - Proxy for poverty.
- The Rural and Mwanza locations are endowed with land that can be used in the production of staple foods or cash crops.
- Cash crops are not consumed domestically.
- We treat the mining sector as though it is located in Dar. (When we take the model to data, this sector also includes the tourism sector.)

Structure of Production

Table 2. Structure of Production and Exchange

		Location		
Commodity	*Factors*	*Rural*	*Mwanza*	*Dar*
Staple Food	Land, Labor	x	x	
Cash Crops	Land, Labor	x	x	
Processed Food	Capital, Labor		x	x
Manufactures	Capital, Labor		x	x
Services	Capital, Labor		x	x
Mining	Capital, Labor			x
Public Services	Capital, Labor			x
Fuel				

Production Technologies

- Production is Cobb-Douglas in the factors available in each location.
- Rural technologies use land, skilled labor, and unskilled labor.
- Urban technologies use capital and both types of labor.

$$X_i^{rural} = A_i S^{\alpha s_i} L_{Ui}^{\alpha U_i} L_{Si}^{(1-\alpha S_i-\alpha U_i)} K_g^{\alpha g_i}$$

$$X_i^{urban} = A_i K^{\alpha K_i} L_{Ui}^{\alpha U_i} L_{Si}^{(1-\alpha S_i-\alpha U_i)} K_g^{\alpha g_i}$$

- All technologies can use government capital, which is non-rivalrous across sectors but has an impact that may vary across sectors.

Government Sector

- The government generates revenue from a variety of taxes and tariffs.
- Revenue is used to finance:
  - Public consumption
  - Government transfers
  - Public investment.
- Government has access to external sources of finance

Household Types

- There are seven household types, each of which can be characterized as having a representative member.
- Six of the household types correspond to the skill types and locations:
  - Dar Unskilled and Skilled (DARU and DARS)
  - Mwanza Unskilled and Skilled (MWAU and MWAS)
  - Rural Unskilled and Skilled (RURU and RURS)
- These households earn wage income and (for Mwanza and Rural) share in the land rental income, plus a share of remittances from overseas.
- The seventh type is the Capitalist household: this household has gross income consisting of the the net before-tax profits from all domestically owned capital in the economy.
  - The Capitalist household consumes in Dar.

Household Size and Mobility

- The initial size of each household type is calibrated from the data.
- Subsequently, household size is endogenous, except for the Capitalist household, which is treated as fixed in size.
- We assume that migration across locations is costless.
- In equilibrium, the marginal value product of labor for each skill type is equalized across location and activity.
- Utility is not equalized across locations, however, since prices differ across locations.

Preferences

- All members of each household (including new arrivals) share a common set of household-specific preferences, which are non-homothetic.
- In particular, there is a subsistence requirement for food that will induce an income elasticity of demand for food below unity.
- The representative member of of household j consumes a vector of composite goods: (F_k, P_k, M_k, S_k), where F_k is staple (un-processed) food, P_k processed food, M_k manufactured goods, and S_k services, each of which could be produced in different locations denoted k.
- Let q_i denote the composite consumption of good $i \in \{F, P, M, S\}$.

Preferences, cont.

- Preferences can be represented by a CES-LES utility function of the form

$$U_j = \left[\sum_i \beta_{i,j} \left(q_{i,j} - \bar{q}_{i,j} \right)^{\frac{\sigma_{j-1}}{\sigma_j}} \right]^{\frac{\sigma_j}{\sigma_{j-1}}}$$

  where $\bar{q}_{ij}$is the household-specific subsistence level of consumption of composite good i by the representative household member.

- In practice, we set subsistence terms to zero except for staple food.

- σ_j is the household specific constant elasticity of substitution.

- Each composite good is itself an Armington aggregate of domestically produced and imported varieties of the good

$$q_i = \left[\delta_i m_i^{\frac{\varepsilon_i - 1}{\varepsilon_i}} + (1 - \delta_i) d_i^{\frac{\varepsilon_i - 1}{\varepsilon_i}} \right]^{\frac{\varepsilon_i}{\varepsilon_i - 1}}$$

Transport Costs

- The model includes unit costs of moving goods from one location to another.

- These consist of several components:

  - pure monopoly rents (which accrue to the capitalist household);
  - fuel costs (which are linked to imports of fuel) which have a direct impact on the balance of payments;
  - transport services (conventionally defined intermediates produced in the service sector);
  - iceberg costs, treated in the model as consumed, in effect, by a non-human sector (e.g., bacteria) and thus a pure loss to the economy.

- All the components of the transport costs are amenable, in principle, to change through public investments in infrastructure.

- In addition, the fuel cost component will respond to changes in the world price of fuel.

Agglomeration Externalities

- The model has agglomeration effects incorporated into its structure.
- However, our current analysis switches off all these effects.

Macro Closure

- Neoclassical closure: total private investment is constrained by total savings net of exogenous public investment.
  - Domestic household savings propensities are exogenous.
  - Private capital account is closed but endogenous.
  - Foreign investors have some demand for domestic capital and can acquire assets if domestic interest rates rise sufficiently high.

Macro Dynamics

- Simple recursive dynamic structure.
- Each solution run tracks the economy over 10 periods, each of which may be thought of as a fiscal year.
- Within-year public and private capital stocks are fixed. The model is essentially static and solves for a new vector of prices and quantities for the economy, including the level of public and private sector investment.
- Investment allocations are embedded in laws of motion for public and private capital:

$$K_{it+1} = (1 - d_i)K_{it} + I_t$$

Calibration and Parameterization

- We begin our calibration with the 2001 IFPRI SAM, but then aggregate sectors and disaggregate into locations.
- Tanzania's *Integrated labor Force Survey (2001)* gives geographic breakdown of employment, by skill and activity, between Dar es Salaam, Other Urban areas and Rural.
- *Tanzania Agricultural Sample Census (2003)* allows for allocation of land between staple foods and cash crops and between subsistence sector (our "Rural" location) and commercial sector (our "Mwanza").

Key Parameters

Table 3: Calibration Parameters

Parameter	*Name*	*Baseline value*
Elasticity of substitution in consumption	σ_j	1.5
Armington elasticity (between domestic and import varieties)	ε_i	0.75
Elasticity of transformation in production	ε_i	0.75
Agglomeration parameter (switched off in this analysis)	κ	1
Subsistence share (% initial total consumption)	$\bar{q}_{ij}$	0.90
Investment sensitivity parameter	η	0

Calibrating Transport Costs

- The IFPRI SAM provides direct estimates of the transport and distribution wedge between producer and consumer prices but treats this entirely as payments to producers of intermediate transport services.
- We keep the wedge but decompose into components (pure rents, fuel costs, and iceberg melt).
  - 50% rents that accrue to the capitalist household
  - 20% fuel cost
  - 30% iceberg melt
- We treat all three components as more or less proportional to distance and/or time but allow them to vary across commodities.
- Applying a set of distance-based estimates to these shares we arrive at a complete matrix of transport costs across commodity composites and household locations.

Transport Costs

Table 2: Transport cost wedges by location and component

	Location				
Component	Rural	Mwanza	Dar	Total	Share of Total
Rent	5.3%	13.1%	10.8%		51%
Melt	2.3%	10.2%	6.2%		31%
Fuel	2.4%	4.5%	3.7%		18%
Total Mark-up	10.0%	27.8%	20.7%	19.4%	

Quantitative Experiments

- 3 basic policy interventions interacted with 5 different financing arrangements
- Policy interventions:
  - Increase in public investment targeting agriculture
  - Increase in public investment targeting non-agriculture
  - Fuel subsidy
- Financing alternatives:
  - No financing $\Rightarrow$Deficit financed by private savings (i.e., crowding out private investment)
  - Aid financing$\Rightarrow$Exchange rate effects and relative price effects.
  - Indirect tax imposed on manufactured goods and services, collected only from skilled households in Dar and Mwanza
  - Direct tax on income of capitalist households and skilled households in Dar and Mwanza
  - Tariff on imported manufactures.

Comments on Experiments

- Consider a 10-year horizon – long enough to allow the economy to equilibrate to changes.
- The fuel subsidy is set at a level that corresponds to a permanent 50% reduction in domestic fuel costs.
- The public investments are set to match the fuel subsidy in total size; i.e., to be finance-neutral with respect to the fuel subsidy.
  - Corresponds to a magnitude of approximately 3.1% of GDP or 2.1% increment in the stock of public capital.
- Thus, our policy experiments are highly comparable in magnitude.
- Observe effects on key outcome measures.

Baseline Economy

Table 3: Summary Baseline Economic Structure

Share	Rural	Mwanza	Dar
Output	21.5%	36.3%	42.2%
Employment	70.7%	19.4%	9.9%
Consumption	36.0%	15.6%	48.4%
Value Added	32.9%	33.8%	33.3%

More Baseline Numbers

Aggregate Indicators	Percent of GDP
Absorption	111.6%
Consumption	78.9%
Private Investment	16.2%
Public Investment	8.9%
Govt. Spending	7.5%
Fiscal balance	-2.3%
Exports	19.9%
Imports	37.2%
Current Account	-10.8%

Key Results: Some Points to Note

- Little effect on aggregate variables whether investments target agriculture or non-agriculture.
- Aggregate effects are small.
- Model structure does not give big impacts from interventions of this scale.
  - Is this a feature of the model, or of the economy?

Key Results, Agricultural Investments

	Changes from Baseline				
Macro aggregates	Deficit Finance	Indirect Tax	Direct Taxes	Tariff	Aid
Real GDP	-2.8%	0.7%	0.0%	-1.3%	1.2%
Real Exchange Rate	2.0%	1.0%	2.0%	-2.0%	-3.0%
Private Investment	-3.9%	-0.1%	-0.9%	-2.1%	0.7%
Fiscal Balance	-3.8%	0.2%	-0.2%	-1.0%	-2.8%
Current Account	-0.5%	-0.1%	-0.3%	0.0%	-2.4%

Key Results, Non-Agricultural Investments

	Changes from Baseline				
Macro aggregates	Deficit Finance	Indirect Tax	Direct Taxes	Tariff	Aid
Real GDP	-2.8%	0.6%	-0.1%	-1.4%	1.1%
Real Exchange Rate	2.0%	-1.0%	2.0%	-3.0%	-5.0%
Private Investment	-3.9%	-0.1%	-0.8%	-2.1%	0.7%
Fiscal Balance	-3.7%	0.2%	-0.1%	-1.0%	-2.7%
Current Account	-0.4%	-0.1%	-0.2%	0.1%	-2.3%

Key Results, Agricultural Investments

	Changes from Baseline				
Δ in Output Share	Deficit Finance	Indirect Tax	Direct Taxes	Tariff	Aid
Rural	0.50%	0.01%	0.04%	0.20%	-0.30%
Mwanza	-0.84%	-0.11%	-0.33%	-0.68%	-0.34%
Dar	0.34%	0.10%	0.29%	0.48%	0.64%

Key Results, Non-Agricultural Investments

	Changes from Baseline				
Δ in Employment	Deficit Finance	Indirect Tax	Direct Taxes	Tariff	Aid
Rural	0.40%	-0.07%	-0.05%	0.10%	-0.39%
Mwanza	-0.81%	-0.08%	-0.29%	-0.65%	-0.31%
Dar	0.41%	0.15%	0.34%	0.55%	0.70%

Key Results, Agricultural Investments

	Changes from Baseline				
Δ in Employment	Deficit Finance	Indirect Tax	Direct Taxes	Tariff	Aid
Rural	-2.30%	-0.71%	-1.33%	-1.80%	-1.19%
Mwanza	0.17%	0.88%	0.74%	-0.14%	0.70%
Dar	16.13%	3.35%	8.07%	13.16%	7.12%

Key Results, Non-Agricultural Investments

	Changes from Baseline				
Δ in Employment	Deficit Finance	Indirect Tax	Direct Taxes	Tariff	Aid
Rural	-1.24%	0.31%	-0.29%	-0.74%	-0.16%
Mwanza	-1.64%	-0.87%	-1.01%	-1.97%	-1.10%
Dar	12.10%	-0.49%	4.03%	9.15%	3.28%

Key Results on Wages and "Poverty"

Table 4:

K public (agric.)	RGDP	Real Consumption Wage Growth					
		Unskilled			Skilled		
		RUR	MWA	DAR	RUR	MWA	DAR
No financing	-2.77%	-5.56%	-6.10%	-8.34%	0.70%	0.92%	-0.23%
Aid financing	1.17%	0.50%	0.11%	-0.76%	3.55%	4.06%	3.85%
Indirect tax	0.69%	0.00%	-1.18%	-2.09%	0.99%	-2.95%	-4.49%
Direct tax	-1.03%	1.16%	-0.17%	0.73%	1.48%	1.73%	2.55%
Tariff	-1.31%	-4.77%	-6.13%	-7.69%	0.21%	-0.37%	-0.77%

Key Results on Wages and "Poverty"

Table 5:

K public (non-agric.)	RGDP	Real Consumption Wage Growth					
		Unskilled			Skilled		
		RUR	MWA	DAR	RUR	MWA	DAR
No financing	-2.81%	-4.02%	-5.04%	-6.42%	-0.42%	0.05%	-1.49%
Aid financing	1.10%	2.30%	1.42%	1.43%	2.58%	2.63%	3.32%
Indirect tax	0.59%	0.81%	0.70%	-0.03%	-0.08%	-4.34%	-5.55%
Direct tax	-0.08%	0.09%	-0.98%	-1.16%	0.65%	0.39%	0.19%
Tariff	-1.36%	-3.13%	-4.96%	-5.69%	-0.82%	-1.15%	-1.93%

Key Results on Wages and "Poverty"

Table 6:

		Real Consumption Wage Growth					
		Unskilled			Skilled		
Fuel subsidy	RGDP	RUR	MWA	DAR	RUR	MWA	DAR
No financing	-2.46%	0.23%	-0.22%	0.06%	1.82%	2.93%	3.71%
Aid financing	1.17%	5.42%	5.98%	7.77%	4.77%	6.14%	7.85%
Indirect tax	0.70%	5.04%	5.59%	6.67%	1.49%	-0.78%	-1.18%
Direct tax	0.10%	3.48%	3.91%	4.88%	2.17%	3.40%	4.96%
Tariff	-1.03%	1.16%	-0.17%	0.73%	1.48%	1.73%	2.55%

Key Findings: Public Interventions

- Fuel subsidies appear to have the strongest impact on the well-being of the unskilled.
  - Almost across-the-board benefits.
- Increases in public capital targeted to the non-agriculture sector appear to do a somewhat better job of reducing poverty – including rural poverty – than investments targeted to the agricultural sector.
- Skilled rural workers benefit consistently from public investments in agriculture, but unskilled workers do not.

Key Findings: Financing

- Sources of financing matter – and interact with the interventions.
- Tariffs are generally bad, and "no financing" creates strong crowding out effects on private investment.
- For investments in agriculture, direct taxes create the strongest positive effects on RURU.
- For investments in non-agriculture and for fuel subsidies, aid financing is best for RURU.
- The relative benefits of direct and indirect taxes depend on the intervention.

Conclusions

- Overall effects are relatively modest. Poverty reduction is not easy without invoking magical mechanisms.
- Finance matters: we cannot judge the relative benefits of different interventions without also considering the sources of financing.
- Non-agriculture investments may yield strong benefits in terms of rural poverty reduction.
- Reductions in real transport costs – modelled here as fuel subsidies – generate larger benefits than increments in public capital.
- The productivity of public capital investments would need to be extremely high to match the benefits of fuel subsidies.

Caveats and Further Agenda

- Lots of things missing from the model...
- We should not take the "fuel subsidy" idea literally: in the model, this is the only reduction in transport costs that we can model with a clearly defined cost.
  - Any reduction in transport cost will have a large impact in this framework.
  - An actual fuel subsidy would be liable to all kinds of leakages and administrative problems.
- The impact of different financing arrangements also depends critically on tax incidence.
  - Need more research on tax incidence and administrative costs.

Acknowledgments

- We gratefully acknowledge the work of Beatrice Mkenda and Tamma Carleton, whose research on transport costs has shaped our thinking about development in Tanzania.

- Early research on related topics was supported in part by the International Growth Centre.

- In Tanzania, we received support from numerous individuals, including particularly Dr. Benno Ndulu, Pantaleo Kessy, and John Page.