Impacts of Marketing Costs on Supply Chains in Tanzania

Mark Musumba
Agriculture and Food Security Center
Earth Institute at Columbia University
Lamont-Doherty Earth Observatory, Palisades, NY 10964
mmusumba@ei.columbia.edu
and

Rafael F. Costa
Researcher at Blue Consultoria Financeira e Estatística
rafaelfcosta@gmail.com


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Introduction and Background
Promotion of market participation has been recognized as a key to agricultural transformation (Alene et al., 2008). Markets allow farmers to increase their incomes by producing what provides the highest returns to land and labor; and can then use that cash to buy what the households need to consume (Timmer, 1997). Boughton et al. (2007) and Timmer (1998) argue that the process of agrarian household transformation involves transition from subsistence mode to market engagement where inputs and products are increasingly purchased and sold off the farm. In Tanzania, there is a renewed policy to increase food security by increasing production in surplus areas (Benson et al. 2012) which imply a need to connect surplus regions to deficit regions if the goal on ensuring national food security in staples is to be achieved. The agricultural transition of smallholders to commercialization in Tanzania’s surplus regions has been affected by high marketing costs that are mainly tied to transportation costs to the market. The most productive regions, mainly in the Southern Highlands of Tanzania, face very high transportation costs to move products to deficit regions in Dar es Salaam, Shinyanga, and Dodoma regions (Minot, 2009). These regions are located in remote areas making the transportation costs high.

Efficient transportation systems are very indicative on the movement of produce from surplus to deficit regions and on farmers’ decision on which crops to plant. Poor road systems and infrastructure reduce market access for farmers and increase prices of net food buyers in deficient areas. For example the density of paved roads in Tanzania is 47.1 kilometers (KM) per 1000 KM$^2$ of arable land$^1$ which is lower than the average for low income countries of 86.1 km and 507km for middle income countries (AICD, 2010). Transportation costs have a welfare effect in that high costs are translated into high prices for the consumers and low farmgate prices for growers in Tanzania (Mkenda and Campenhout 2011). Improving infrastructure or reducing transportation costs, may increase social welfare of both consumers and producers in Tanzania.

In this study, we use comprehensive national regional data to model the distribution system of maize in Tanzania. Data on regional production and consumption for maize was obtained from the Tanzanian Ministry of Agriculture Food Security and Cooperatives (MAFC 2013) while data on transaction costs, market and farm-gate prices plus consumption patterns are calculated from survey data collected by the national bureau of statistics (NBS) of Tanzania (NBS 2013). A spatial equilibrium model (Samuelson 1952; Takayama and Judge 1971) is developed with the goal of emulating the distribution system of these staples to 21 major markets in Tanzania. Our objective is to simulate the effect of marketing costs and regional market prices on the maize supply chain in Tanzania. We simulate these effects assuming that the production in Tanzania is for domestic production calibrating the model for the year 2010. This

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$^1$ Only around 24% of rural populations are within 2 km from an all season road in Tanzania. (http://www.mca-t.go.tz/en/document/doc_view/357-mca-t-gender-policy.html)

Maize was chosen as a product for study because it is the main staple crop of Tanzania and has the highest contribution of any staple crop to per capita caloric intake and household case income (Minot, 2009; USAID, 2010). In addition, 45 percent of arable land in Tanzania is allocated to maize and was cultivated by at least 60 percent of the households in 2008 (USAID 2010; NBS 2012). Tanzania has invested over (U.S.) 300 million dollars in agricultural input subsidies with a focus on maize from 2008 – 2013 (NAIVS) with a goal of ensuring food security. This initiative is constrained by access to output and inputs market due to high marketing costs. At the same time, farmers are uncertain of the extent of their market because the Tanzania government has a history of instituting export bans on maize depending on the maize harvest and expected level of prices to protect consumers. This policy has a negative impact on producers in that they cannot export maize grain to take advantage of the high world prices and may also lose money on their investment if the ban stays in place for a long duration of time and coincide with bumper harvest (Minot 2013). This may affect the farmer’s production in that they focus on production for the domestic market.

A number of studies have focused on transaction costs and price transmissions in food commodity markets in Tanzania (Baffe et al. 2015). Winter-Nelson and Temu (2002) examine coffee market in the post liberalization period and recommend the need to reduce marketing costs if farmers were to access output markets. Van Compenhout (2007) studies the market in Tanzania using the threshold autoregressive model to analyze the transaction costs and the spreads of adjustment of market prices in spatial maize markets. His finds that the cost of transaction are higher between Iringa and eastern markets and interesting also observes that even with deterioration in road conditions in the Dodoma-Iringa route, market integration still improves. Baffe et al. (2015) also studies the maize market in Tanzania but with a goal of examining the external influences on maize market prices in Tanzania. Their finding indicate that domestic factor have a greater influence on prices than external factors. In this study, we also focus our analysis on maize but explore marketing costs effect on the supply chain using a spatial equilibrium model. Using extensive and recent data, our goal is to examine the impact of marketing cost and prices on new initiatives or investments in agricultural production.

Data
Data used for the study was obtained from multiple sources. Production data for maize was obtained from Ministry of Agriculture Food and Cooperatives (MAFSC 2013). This data covered 5 years from 2006 to 2010 to ensure that we account for annual variability in production. Data indicated that production is highest in Mbeya and Iringa while the lowest production is in Dar es Salaam and Pwani (Figure 1). Data of population for the regions was obtained from National Bureau of Statistics (NBS, 2013). These data were projections of population of each region that covered the years 2008-2010. This data was used to estimate the demand by region for maize staple. By population, Dar es Salaam is the main deficit area (Figure 2). Iringa, Mbeya and Rukwa have the largest surpluses which is consistent with literature (Baffe et al. 2015).
Figure 1. Average annual maize production by region from 2008-2010.

Figure 2. Maize surplus per region calculated from average population size.
Methodology
To examine the impact of marketing cost on the supply chain in Tanzania, a spatial equilibrium model that focuses on maize was developed. This model is based on seminal work by Samuelson (1952) and Takayama and Judge (1971). Spatial equilibrium models have been used to examine transportation costs and studies like Fellin (1993) Fuller et al. (2001) and Costa and Rosson (2007) have contributed to this work.

Spatial equilibrium model developed for this application is a quadratic programming model that maximizes producer and consumer surplus minus transportation costs to produce inter-regional flow of prices. The model allows for movement of produce from 4 major supply regions; Iringa, Mbeya, Rukwa, Ruvuma and the 4 major deficit regions of Dar es Salaam, Mtwara, Dodoma, and Singida (Minot 2009); accounting for historical production and demand trends. The model is specified to represent maize trade in 2010 using interior road network. The model also takes into consideration the potential of maize movement to “minor deficit” regions whose production fluctuates through scenario analysis. Given that this is an ex-ante analysis of the supply chain, the model solution is the baseline for 2010. Using this solution, effects of improvement in infrastructure that reduce transportation costs and market prices are modelled to examine the impact on national welfare.

Preliminary Results and Discussion
After calibrating and validating the model, we examined the impacts of reducing the transportation costs between surplus and demand locations by examining changes in prices and consumer and producer welfares. These reductions in transportation costs are assessed by different scenarios where proposed transportation improvement projects are analyzed. The World Bank in 2014 approved transportation infrastructure improvements to a tune of $300 million to reduce transportation costs along the Dar es Salaam-Isaka corridor (World Bank, 2014) but we argue that there is need to increase such invests to agricultural bread baskets. Our preliminary results indicate that high transportation costs in the Tanzanian maize producing regions affect considerably the supply chain efficiency of the local farmers. By evaluating different reduction in transportation costs scenarios, gains in prices and producer and consumer welfares are observed throughout the producing regions. This study is a first in the aspect of analyzing the maize supply chains in Tanzania and shedding a light to different stakeholders in the development economics area. We hope that this study will drive the discussion on the importance of reduction in transportation costs in the supply chain and provide insight on the most efficient routes in food product distribution for developing countries such as Tanzania.
References:
Ministry of Agriculture, Food Security and Cooperatives (MAFSC) 2013b. Agricultural Statistics