Transportation Costs, Food Markets and Structural Transformation:

The Case of Tanzania*

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Abstract

This paper describes the development of an applied general equilibrium model to explore in an analytical setting the effects of high domestic transaction costs on the spatial patterns of economic activity in Tanzania. We consider to what extent the high transaction cost environment is causally related to the size of the quasi-subsistence agricultural sector, and conduct a series of stylized experiments to ask how the economy would respond to policy changes and to exogenous shocks such as changes in world food prices.

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1 Introduction

In Tanzania, as in many of the other countries of sub-Saharan Africa, large fractions of the population live in rural areas (76%) and work in agriculture (82%). Most households depend for their livelihoods on farming small plots of land, where they primarily produce food for home consumption. Small amounts of food (and non-food agricultural goods) are sold to market. Productivity in the agricultural sector is generally very low. Agriculture's share of GDP is estimated at 45%, which implies – if the numbers are taken at face value – that output per worker in agriculture is only about one fourth as high as in the rest of the economy.[1]

Transportation costs between farm and market are extremely high, due in part to poor road infrastructure and perhaps also to non-competitive behavior in the marketing and transportation sectors. Food prices in urban centers are often double the prices received by farmers, and they appear to be considerably higher than the prices at which similar commodities might be imported from North American or European markets. In this environment, food imports might offer an attractive alternative to domestic food production – if only to feed coastal cities. However, the data show that surprisingly small fractions of staple foods are imported. For example, Tanzania imports less than two percent of its maize and is almost entirely self-sufficient in all agricultural commodities other than wheat, sugar, and palm oil; it exports some cashew nuts but relatively few other agricultural commodities.

Why is agricultural trade so low in a country that is almost entirely agricultural? Would food imports improve the welfare of the country by making food less expensive in urban areas? Or would they worsen welfare by undercutting domestic production and threatening the livelihoods of the rural poor? What would rural people produce if they lost access to urban markets? Why does the agricultural sector generate so few exports, relative to the numbers of people who work in the sector?

This paper examines the role of domestic transportation costs and other transaction costs in shaping the Tanzanian economy. We are particularly focused on the food marketing

[1] As pointed out in Gollin, Lagakos, and Waugh (2012), measurement issues here are acute; neither labour in agriculture nor value added in agriculture is measured with great precision. But there are other reasons to believe that standards of living in rural areas are low, relative to those in urban areas. For example, 80% of urban residents have access to improved water sources, compared with 46% of rural residents. Measures of health and nutritional status are also generally higher in cities than in rural areas.

system and its impact on the spatial distribution of agriculture, industry, and other economic activities. Using an applied dynamic general equilibrium model of the Tanzanian economy, we explore the relationship between high transaction costs and the quasi-autarkic nature of Tanzanian agriculture.

The paper is organized as follows. The next section of the paper offers a review of some recent relevant literature and also examines some of the background data on transport costs in Tanzania. From this, we move on to describe the computational model that we use in analyzing the effects of transport costs on the macroeconomy. After briefly reviewing the benchmark model calibration, the paper reports on the results of several experiments in which we change key parameters in the model and discuss the responsiveness of the model economy to these changes. In this way, we can simulate the effects of various policies on the model economy. At this stage we limit our attention to a set of highly stylized experiments designed to identify the principal channels through which changes in transport costs will influence the macro dynamics of the economy. The final section offers some conclusions and reflects on the potential external validity of the model – and its limitations.

2 Background

By any measures, Tanzania is a country that faces high transportation costs of all kinds. Its ports on the Indian Ocean are far removed from the world's major shipping arteries, and the country deals in relatively low volumes, making ocean freight expensive and making shipping times lengthy. In the port of Dar es Salaam, a variety of managerial issues and other constraints combine to make unloading costly and time-consuming. The domestic transport network is also riddled with problems. Almost all goods move by road. (The only operational rail line in the country, the Tazara Railway connecting Tanzania to Zambia, carries very small fractions of the country's domestic freight.) Although major trunk roads are adequate, minor roads and rural roads can be poorly maintained and even impassible at certain times of the year. As a result, many of the country's rural areas are substantially remote from markets. Only 24 percent of the country's rural population lives within 2 km of a paved road (AICD 2010). This affects the opportunities that farmers have to sell their products, and it also influences the prices that rural households pay for goods purchased from other parts of the country. Even Tanzania's secondary cities can face substantial transport costs, creating large price wedges in comparison to markets in Dar es Salaam.

This paper focuses on transport cost wedges arising between Dar es Salaam, which serves as the main port of entry and exit for Tanzania's international trade in goods, and the country's secondary cities, and the transportation cost wedges applying to the movement of goods between the secondary cities and Tanzania's rural areas. These costs have been fairly well documented in previous studies on marketing margins, value chains, and price differentials across locations. It is useful to review what is known about the magnitude and nature of these costs.

Tanzania's transport sector

Although Tanzania's roads and transport system are arguably better than those found elsewhere in sub-Saharan Africa, there is abundant evidence that large fractions of the country's area and population are poorly served by the road network. Aggregate data show that the density of paved roads was well below the norm for low-income countries, with 47.1 km of paved roads per 1000 km^2 of arable land. This lags far behind the average for low-income countries, which was 86.6, and for middle-income countries, which was 507.4 (Africa Infrastructure Country Diagnostic 2010, p. 14). As a result, transport costs are very high. Derksen-Schrock et al. (2011) cite data showing that nearly two thirds of Tanzanian farmers sell their produce from the farm gate rather than carrying it to a nearby market, largely because of the high transaction and transportation costs. Since many farmers have very small marketable quantities, the returns from carrying these quantities to market are limited, and the travel time and expense are effectively fixed costs. Moreover, historically, large numbers of farmers have found themselves with "stranded" crops that they were unable to market because of transportation failures at key moments. Anecdotally, this problem remains today; during the rainy season, farmers in some parts of the country may be effectively cut off from markets. This affects crop choices (reducing the attractiveness of perishable fruits and vegetables, for example) and input use, as well as the profitability of harvested commodities.

Mkenda and Van Campenhout (2011) summarize data showing that the average distance to market in rural Tanzania was 3.3 km in 2007, with other facilities even farther away; the nearest public transport was over 5 km distant, and the nearest bank was 38 km away. These authors also review and assess a number of recent studies of transport costs in Tanzania. Several of these, including Eskola (2005) and Kweka (2006), have attempted to measure transport costs directly either from value chain analyses or from direct surveys of traders and truckers. There are no straightforward ways of measuring transport and transaction costs. Traders and those involved in the physical movement of goods may have strong incentives to under-report the prices and margins that they charge. Cross-location price differences are not easy to interpret. In a perfect competition setting, these price differences and a no-arbitrage condition should imply that the price wedges correspond to transaction costs; but in reality, there may be differences in location-specific demand or supply, and the no-arbitrage condition may not apply to markets that are relatively thin.

Mkenda and Van Campenhout (2011) review the available surveys and independent estimates of transport costs. They conclude that for transport between major markets, a transaction cost of about $15 per ton per 100 km is a reasonable estimate. This compares with a national average in the United States in 2011 of about $5.78 per 100 km (USDA 2011). The biggest costs in Tanzania, however, are between the farmgate and the market. Mkenda and Van Campenhout estimate these costs at $13-15.5 per ton, over relatively short distances, implying that half the total transaction costs occur between the farm and the market. Taken together, these data suggest that the costs of shipping grain to market are about six times higher in Tanzania than in the United States, although the comparison is difficult to make.One problem is that it is difficult to distinguish in the data between transport costs and other transaction costs; another concern is that the data in the U.S. are those associated only with the transport, rather than any costs of loading the truck at the farm. Their estimates of trucking costs are consistent with other recent estimates for shipping non-agricultural goods from urban areas to rural areas.

Thus, we take it as a starting point for our research that Tanzania's agricultural transport is costly. We will return to measurement issues in the calibration section below. We recognize that transport costs reflect rents, fuel costs, and vehicle operation costs. We also assume that some fraction of the transport cost can be represented by an iceberg cost, consistent with much previous literature on international and domestic trade. The iceberg cost implies that when goods move from one location to another, a fraction of the initial quantity simply "melts" en route to the destination. In keeping with a large literature on agricultural marketing, we prefer to think of this as physical waste and spoilage, or damage, rather than as pilferage or loading and unloading charges. For instance, a recent study for the UN Food and Agriculture Organization suggests that 13.5% of grain production in sub-Saharan Africa is lost in postharvest processing, handling, and distribution, on average; this compares to about 4.5 percent in North America (Gustavsson et al. 2011).Additional amounts are lost in North America in packaging and at the consumer level; the report suggests that losses in Africa at the consumer level are very low, while in rich countries they can be quite high.

3 Previous literature

The paper contributes to a recent and growing literature that has revisited the relationship between transportation costs and development patterns. In effect, this literature can be seen as incorporating elements of spatial economics and urban/regional economics into the development literature. The spatial overlay of remote areas and impoverished areas is too striking to ignore (as shown in Stifel and Minten 2008), but the causal direction is highly unclear.

The relationship between transport costs and development is difficult to examine for several reasons. One reason is that general equilibrium effects may dominate partial equilibrium effects, at least in the long run. For example, a new road may induce many changes in economic activity patterns, including changes in prices, wages, movements of labor and capital, and the prevalence of different economic activities. Thus, a simple comparison of incomes or production before and after an infrastructure project may give misleading results.

A second difficulty in understanding the relationship is that dynamic effects may matter more than short-run effects. Adjustments to transportation improvements may have long lags. A new road will not necessarily induce changes in economic activity overnight; or, more precisely, the short-run responses will not be the same as the longer-run responses.

Finally, a third challenge in evaluating public investments in transportation infrastructure is that causal identification is extremely difficult. The source of this problem is that the placement of roads, railroads, and infrastructure projects is intrinsically non-random. Policy makers seldom build “roads to nowhere.” instead, transportation infrastructure projects normally link areas of economic activity. This certainly makes cross-sectional comparisons (of areas with different levels of transport infrastructure) nearly useless in evaluating the impact of infrastructure investments. Even difference-in-difference approaches will be problematic. This makes it difficult to know whether infrastructure improvements lead to economic growth or whether they follow it (or whether, in some instances, they occur as the outcome of concerted planning exercises in which infrastructure investments are made in parallel with other public investments

Several empirical approaches seek to get around these difficulties. Some studies seek to use an experimental approach to evaluate the impact of roads. For example, several studies have tried to take advantage of randomized roll-outs of road improvements, using the differences in timing of infrastructure projects as a way to identify the causal relationships (e.g., Gonzalez-Navarro and Quintana-Domeque 2011). There are certainly some impacts that should be visible almost instantly: e.g., travel times, transport costs, and price wedges or marketing margins between locations. But many of the effects of infrastructure improvements are likely to take shape over relatively long time periods – years, rather than months – as firms and individuals respond to reduced transportation costs through changes in investment patterns, location decisions, and other choices that may be characterized by adjustment costs. The randomized roll-outs of road improvements will seldom provide clarity in the causal mechanisms over a period of time long enough to shed light on these impacts. If the roll-out of infrastructure projects is phased in over a matter of one or two years, the differential impact between early and late project recipients may no longer be clear after eight or ten years have passed – even though that may be a relevant time period for the dynamic impacts of investments to be realized.

Because of the difficulty of solving this identification problem, a number of researchers have relied on creative approaches to estimate the impact of roads and transportation. One novel approach, from Jacoby (2000), uses a quasi-Ricardian approach in evaluating roads by looking at the value of farmland at different distances from a road. Jacoby and Minten (2009) use a cross-section approach that looks at distance from roads as an explanatory factor in accounting for household income and farm productivity among households in an otherwise homogeneous area characterized by high idiosyncratic variation in road access, due to local topographical features. Another approach, from Renkow et al. (2004) estimates supply and demand schedules and tries to infer the transaction cost wedge that would implicitly clear the market.

Another approach to assessing the impact of transportation costs on development patterns is to rely on an instrumental variable approach. Banerjee et al. (2012) show that locations that fall on a straight line between two historical cities (and excluding the endpoint cities) are more likely to be on a major road or railroad than locations that are (literally) offline. Based on that first-stage result, they use the straight-line property as an instrument for transport connectivity, controlling for other potentially conflating variables. A different instrumental variable approach is followed by Storeygard (2012), who uses world oil price changes to instrument for changes in transport costs over time; he links this to a data set based on the observation of light from space to estimate the effect of changes in transport costs on changes in economic activity for nearly 300 cities in sub-Saharan Africa.

Relatively few studies find plausible instruments to look at the long-run impact of transportation infrastructure. Banerjee et al. (2012) capture some long-run effects, but much of the present-day infrastructure that they find was build during comparatively recent times, and China is perhaps an unusual case in that spatial patterns of development have until quite recently been managed very directly by the national government.

One particularly interesting analysis of long-run effects is provided by Donaldson (2010), who uses historical data from the development of India's railroads to look at the impact of transportation infrastructure on internal trade and growth. Using data that identifies the dates when each segment of the rail network was developed, he is able to find support in the data for the proposition that railroad construction led to decreases in transport costs, increases in the flows of goods, increases in income levels, and reductions in the degree of autarky in locations where railroads were constructed. Strikingly, in a kind of placebo test, Donaldson does not find evidence of these effects for a set of railroad lines that were planned but never built. A similar exercise forms the core of Jedwab and Moradi (2011), who focus on railroads in Ghana.

In addition to these empirical papers, a number of recent studies look at the impacts of transportation improvements in the context of applied general equilibrium models. Herrendorf et al. (2012) consider the benefits of transportation improvements on the United States economy in the 19th century.

Gollin and Rogerson (2011) examine the transport cost environment in Uganda, a landlocked economy with very high domestic transport costs for food. They find that in an economy with high internal transportation costs for food, the price of food in urban areas will be quite high. As a result, in equilibrium, large fractions of the population will remain in remote areas producing food for their own consumption. This paper starts to ask to what extent the same results would hold in a relatively open economy like that of Tanzania, where food can be readily imported to Dar es Salaam. Although it is customary to think of a country like Tanzania as an open economy, we note that portions of the economy are open and yet other portions are effectively closed. The articulation of the open and closed portions of the economy are precisely what we wish to focus on.

Transport and infrastructure policy questions

The difficulty of carrying out empirical studies on the impact of transportation infrastructure has led to considerable confusion in the related policy literature that focuses on project evaluation. A large literature on African transport infrastructure documents the problems, failures, and high costs of transport. At the same time, a number of project evaluations have cast doubt on the likely returns to infrastructure investments.

One key question is whether the problems of transportation in sub-Saharan Africa are due to inadequate physical infrastructure or whether they are better understood as problems related to lack of competition in the transport sector (as in Teravaninthorn and Raballand 2009). Another question is whether agricultural productivity is sufficiently high to respond to improvements in rural transportation infrastructure. Still another question is whether Tanzania's agricultural sector can compete effectively with food imports. Our work seeks to address a number of questions along these lines.

Our paper follows a different approach from many earlier studies of transportation improvements. We use a computable general equilibrium model in which explicitly modeled transportation costs affect the movement of goods within and between locations. In this framework, we can conduct quantitative experiments in which we can examine the effects on the entire economy of changes in transport costs. One of the advantages offered by our approach is that we can fully identify and account for causation; econometric studies often struggle with the problem of identifying the causal effects of transportation improvements on development.

In this sense, our paper offers an alternative methodological approach to the existing attempts to estimate the impact of transportation infrastructure based on cross-sectional, time series, or panel data. These studies inevitably confront identification problems of one kind or another.

4 Model

To address our questions, we use an applied general equilibrium model that embeds the basic insights from Gollin and Rogerson (2011) into the model framework developed by Adam and Bevan (2006). Our model is thus a variant of the conventional trade-focused small open economy model popularized by Devarajan *et al* (1994) augmented with three particular design features. First, we allow both production and consumption to be spatially distributed across three stylized geographic locations. One is a rural region, which produces only staple food, which is essentially non-tradable, and and exportable cash crop. A second is the commercial capital, Dar es Salaam, which is assumed to do no agricultural production, but which serves as a production centre for manufacturing and services, and which also is the entrepot for all international trade. This is, of course, an abstraction from the actual Tanzanian economy, which trades significant quantities of goods overland with neighboring African countries. The essential issue, however, is that much of this is in effect cross-border transit traffic from Dar es Salaam itself. Between these two regions lies a third region, which we think of as representing all the secondary cities and urban peripheries of Tanzania: we refer to these secondary cities collectively as *Mwanza* (which is just one of the major towns in Tanzania). We do not view any of these regions as literal representations of any cartographic spaces; our Dar es Salaam effectively includes the mining and tourism sectors, which are physically located at some distance from Dar. Likewise, our secondary cities do not correspond to any contiguous set of locations in Tanzania. Hence our Mwanza is not a point and 'within-Mwanza' trade is conducted across space. We do, however, assume that, in some sense, transport connections are better between the towns that make up our model Mwanza than between each and the rural economy. But the essential analytical point is that goods and services move across this geography: imports move between the (single) port and the location at which they are consumed, exports move from the farm / factory gate to the port, while domestically produced goods and services may be consumed in locations other than where they are produced. Second, movement is costly so that variations in transport costs will play a central role in determining the equilibrium allocation of resources. Moreover, transport costs are assumed to consist of a number of elements allowing us to distinguish, for example, between interventions that reduce the degree of monopoly in the transport and distribution sector – and hence will have distributional as well as efficiency effects – from those that reduce the rate of "melt" by improving the quality and lower the cost of the road transport. Further, we assume that transport costs depend both on distance and on the nature of the goods themselves: for example, perishable goods such as food may be more vulnerable to physical deterioration whilst being transported than are manufactured goods. This means that we overlay the spatial model with a highly nuanced structure of endogenous transport costs. Third, consistent with the key themes from the economic geography literature survey in Section 3 above, the model allows for dynamic growth externalities operating through the possibility of agglomeration economies in the secondary cities.

A listing of the principal equations of the model is provide in the Appendix. In what follows we restrict our attention to the new features of the model.

The structure of production and trade

The economy consists of a total of 11 private activities and commodities spanning four consumption goods (staple food, processed food, manufactures and services), and two pure export goods (cash crops and mining). Different varieties of each good, excluding mining, are produced in different locations which differ in their endowments of the fixed factor, agricultural land, and in the production activities that are available at each location (see Table 1). In addition, we treat the natural resource sector as based in Dar. In practice, this sector will represent the mining and tourism sectors, which we view as producing goods purely for export. Sectors operating in the urban location may purchase intermediate goods from other locations, with different transportation and transaction costs depending on the origin and type of the intermediates. The secondary cities are engaged in all activities except for mining and the production of government services. Sectors operating in this location can sell final goods to Dar es Salaam and to rural areas, and they may purchase intermediates from these locations, with corresponding transportation and transaction costs. The rural location can only produce food and cash crops. These can be consumed directly by the rural household, or they can be sold onward to other markets, at the appropriate costs.

The production of staple food and cash crop production requires land and labour only; all urban production – processed food, other manufacturing and services – requires capital and labour. There is also a fuel importing sector. Fuel is a direct import, it has no domestic substitutes but contributes to transport costs along all nodes in the economy. Fuel requires no domestic resources to distribute (essentially its own distribution costs are embedded in transport costs).

Table 1. Structure of Production and Trade

		Location			*Sectoral Trade*	
Commodity	*Factors*	*Rural*	*Mwanza*	*Dar*	*Imports*	*Exports*
Staple Food	Land, Labour	x	x		Mwanza only	
Cash Crops	Land, Labour	x	x		Mwanza only	Rural, Mwanza
Processed Food	Cap, Labour		x	x	Mwanza, Dar	Mwanza, Dar
Manufactures	Cap, Labour		x	x	Mwanza, Dar	Mwanza, Dar
Services	Cap, Labour		x	x		
Mining	Cap, Labour			x		Dar only
Public Services	Cap, Labour			x		
Fuel					All	

The government sector generates revenue from a variety of taxes and tariffs, some of which is used to finance public consumption, some is returned to households in the form of transfers, and the remainder is used for public investments. Each sector corresponds to a distinct production technology, characterized as Cobb-Douglas in land (S) and labour (L) (in the rural sectors) or capital (K) and labour (in the urban sectors). Land is fixed in perpetuity while private capital stocks are fixed in each period, but evolve over time through depreciation and gross investment. The markets in skilled (L_S) and unskilled (L_U) labour are competitive, so that in equilibrium labour of each skill type is fully employed and paid its marginal product (around a set of fixed wage differentials across sectors). The initial skill mix is sector specific. Production in each sector exhibits constant returns to private factors while the overall productivity of private factors is a function of public infrastructure capital. Production functions therefore take the following form:

$$X_i^{rural} = A_i S^{\alpha s_i} L_{Ui}^{\alpha U_i} L_{Si}^{(1-\alpha S_i - \alpha U_i)} K^{\alpha g} \tag{4.1}$$

$$X_i^{urban} = A_i K^{\alpha K_i} L_{Ui}^{\alpha U_i} L_{Si}^{(1-\alpha S_i - \alpha U_i)} K^{\alpha g} \tag{4.2}$$

Households and preferences

The model economy consists of four representative households which are endowed with different quantities of the factors. Rural households hold rural land (S_R), unskilled labor (L_R^u) , and skilled labor(L_R^s) . In the secondary cities households hold some agricultural land (S_M) , unskilled labor(L_M^u) , and skilled labor(L_M^s). Urban households in Dar es Salaam can be divided into workers and capitalists. The workers hold unskilled labor (L_D^u) , and skilled labor (L_D^s) . Capitalists hold all the economy's capital, K. Households consist of large numbers of individual members who can move between households depending on where they sell their (skill-specific labour). Hence the Rural, Mwanza and Dar households will change size as labour moves between sectors. By contrast, the capitalist household is fixed in size. In principle, there may be costs associated with individual movements between locations/households although in the current version of model we assume labour movement is frictionless. More generally, we abstract from many details at the household level by assuming that while labour allocations are determined according to the demand for specific skills and that the returns to skills differ, all income is pooled within the household: land is jointly owned and land rents in each location are allocated uniformly across all members of the household regardless of their skill level or other characteristics including their length of association with the household. Thus labour that is newly arrived shares equally in the assets and income of the group with established household members. In addition arriving individuals adopt 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. Households, indexed j, consume a vector of composite goods $q_i = (F,\ P,\ M,\ S)$ where F is staple (un-processed) food, P processed food, M manufactured goods, and S services. Preferences can be represented by a CES-LES utility function of the form

$$\mathrm{U_j} = \left[\sum_i \beta_{i,j} \left(q_{i,j} - \bar{q}_{i,j} \right)^{\frac{\sigma_{j-1}}{\sigma_j}} \right]^{\frac{\sigma_j}{\sigma_{j-1}}} \tag{4.3}$$

where $\bar{q}_{ij}$denotes the household-specific subsistence level of consumption of composite good i (where$\bar{q}_{ij} = 0\ i \neq F$) , σ_j is the household specific constant elasticity of substitution and each composite is an Armington aggregate of domestically produced and imported varieties of the good

$$q_i = \left[\delta_i m_i^{\frac{\varepsilon_i - 1}{\varepsilon_i}} + (1 - \delta_i) d_i^{\frac{\varepsilon_i - 1}{\varepsilon_i}}\right]^{\frac{\varepsilon_i}{\varepsilon_i - 1}} \tag{4.4}$$

where $0 < \varepsilon_i < \infty$ is the elasticity of substitution between domestic and imported varieties in consumption. To reflect the spatial dimension of the model, we assume that the composite is assembled at the factory gate so that the relative price of the composite good will be a function of the transport cost associated with bringing the import to the production location. The composite good enters both final and intermediate demand vectors; in both cases demand will be a function of the cost of transporting the good to the demand location, either the household (for final consumption), to the port of Dar es Salaam (for exports), or the domestic factory gate (intermediate consumption and investment).

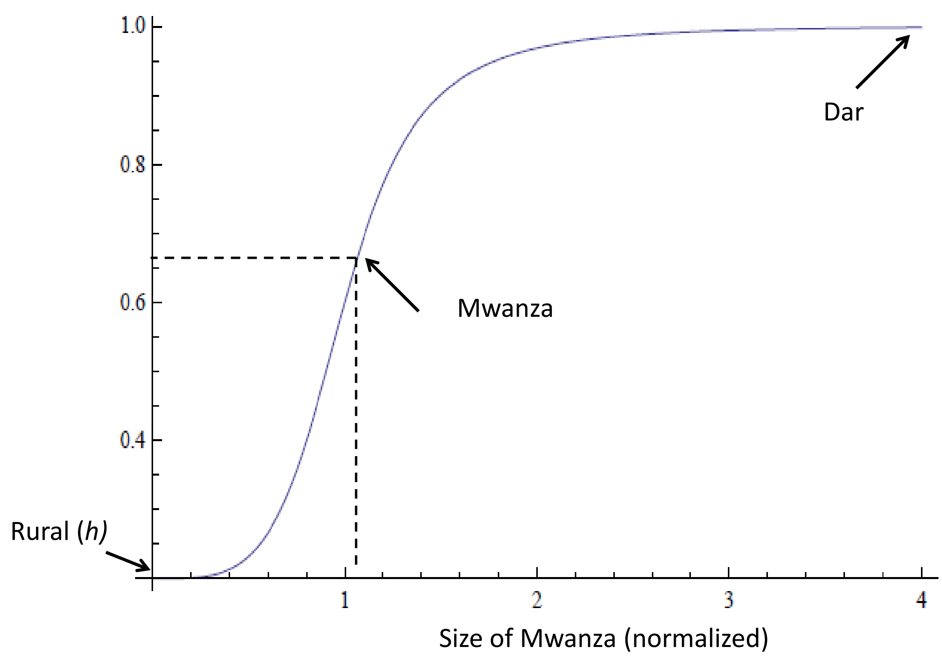
Transport

There are costs associated with moving goods from one location to another and these consist of several different 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 (which are conventionally defined intermediates produced in the service sector); and a certain amount of "melt" that we model as an iceberg cost so that when goods are moved, a specified proportion of the initial quantity is lost *en route* from origin to destination. We treat these quantities as though they were consumed, in effect, by a non-human sector (e.g., bacteria): as such the melt is 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 while the pure rent component may be amenable to regulatory reform.

Agglomeration effects in the secondary cities

Much of the recent literature in urban and regional economics emphasizes the agglomeration externalities that result from urbanization. In the model we focus on the possibility that the concentration of economic activity in the secondary cities leads to higher productivity levels in some or all sectors operating in Mwanza. To represent this process we adopt a smooth function relating productivity to some measure of the size of the secondary cities. Our chosen functional form is from the inverse-tangent class summarized in Figure 1.

Figure 1: Size and relative sectoral productivity of Mwanza



Mwanza is the only location in the model economy at which both rural and urban production takes place and we treat it as the only location where agglomeration economies are in play, treating the rural economy and Dar as anchor locations. For rural production, productivity is fixed at the intercept (denoted h) while for urban activities we assume that Dar is Salaam is sufficiently large that it operates at maximal (unit) relative productivity. Since it is the consequence of endogenous movements of economic activity to Mwanza that is of interest in this paper, nothing of analytic interest is lost by this simplification.[2] Of course,

[2]We assume that the rural economy is populated by a large number of very small production units operating at a fixed level of productivity. Locating Dar es Salaam at the maximal productivity implies all

variations in the size of Mwanza will actually involve population movements affecting the population / scale in both areas but this has no consequence for productivity.[3]

The functions defining the dynamics of productivity of Mwanza-based activities in Figure 1 is defined as

$$Q_R(Mwa) = \left\{1 - (1-h)Arctan\left[\left(\frac{\mu}{Mwa}\right)^{\kappa}\right]/(\frac{\pi}{2})\right\} \tag{4.5}$$

and

$$Q_U(Mwa) = \left\{1 - Arctan\left[\left(\frac{\mu}{Mwa}\right)^{\kappa}\right]/(\frac{\pi}{2})\right\} \tag{4.6}$$

for rural and urban sectors respectively where Mwa is the normalized scale of Mwanza-based activities and $\mu$and κ are parameters of the Arctan function. To calibrate these functions we proceed as follows. First, we set $\mu = 1$ and choose k to control the curvature of the function. For rural activities we set the normalized size of Mwanza equal to unity ($Mwa = 1 = \mu$) so that we can solving for h to match the calibrated productivity ratios (by sector) between Mwanza and Rural variants of the same commodity, as revealed by the SAM. For urban activities, given that we have located Dar at the maximal productivity, we solve for the calibration value of Mwa, given κ (and $\mu = 1$), to match the calibrated productivity differentials between Mwanza and Dar activities.[4]

Macroeconomic closure and dynamics

We adopt, as our default, a neoclassical closure in which total private investment is constrained by total savings net of exogenous public investment, where household savings propensities are exogenous. This rule, broadly consistent with conditions in the poorest countries where unrationed access to world capital markets is virtually zero and domestic

agglomeration economies there are exhausted. Moreover, since the functional form implies a positive gradient throughout we have closed off the possibility of dis-economies scale in Dar es Salaam, an issue possibly worth developing in subsequent versions of this paper.

[3] Our short-hand term 'Mwanza' needs to be interpreted as a *set* of secondary towns. The total population resident in secondary towns exceeds the population of Dar es Salaam but each town is substantially smaller than Dar. To reflect this we assume that the model 'Mwanza' consists of a fixed set of identically sized secondary towns denoted N. This gives us a degree of freedom to locate the scale of the representative second city relative to Dar es Salaam.

[4] Choosing $\mu = 1$ is innocuous but setting $Mwa = \mu = 1$ for agriculture effectively places Mwanza near the point of steepest slope; setting $Mwa = 2\mu$ would locate Mwanza closer to optimum size so that growth in the scale of Mwanza would trigger a weaker agglomeration externality, and *vice versa* for lower initial values for Mwa.

private saving is relatively interest inelastic, means that the shortfall (excess) of government savings relative to the cost of government capital formation, net of exogenous foreign savings, directly crowds-out (crowds-in) private investment. There is a risk, however, that this closure rule exaggerates the private investment response to public investment (either positively or negatively). Thus capitalists will fully invest the predetermined volume of savings even if this drives the return on capital below some notional world interest rate and there will be no endogenous response, either of domestic or foreign investment, if domestic rates exceed the world or long run rate of return. To overcome this problem, we also run the simulation experiments under a simple expedient of allowing for an exogenous private capital inflow. In subsequent versions of the model we shall allow for an endogenous private capital account.

The model has a simple recursively dynamic structure. Each solution run tracks the economy over 10 periods from the initial policy change, and each period may be thought of as a fiscal year. Within-year public and private capital stocks are fixed and the model is solved given the parameters of the experiment (e.g. the change in transport costs or productivity parameters). This solution defines a new vector of prices and quantities for the economy, including the level of public and private sector investment, which feed into the equations of motion for sectoral capital stocks of the form

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

where $d_i$denotes the sector-specific rate of depreciation, $K_{it}$the start-of-period capital stock and $I_{it}$the within-period level of investment by destination. To focus exclusively on the impact of stationary changes in the vector of transport costs on the economy we calibrate the model to an initial static steady-state equilibrium in which net public and private investment is zero (i.e. gross investment exactly matches depreciation) and there is no growth in the labour supply. We calibrate the model to a fixed nominal exchange rate so that the numeraire can be thought of as the world price of importables.

5 Calibration and Baseline Parameterization

The model is calibrated to a stylized Social Accounting Matrix (SAM) loosely based on the 2001 Social Accounting Matrix (SAM) for Tanzania produced by the *International Food*

Policy Research Institute, IFPRI (see Thurlow and Wobst, 2003).[5] The basic *IFPRI* SAM consists of 43 productive activities producing 43 sectors (of which almost half are agricultural activities). Factor market data are disaggregated by age, gender and human capital, and households by income, location and human capital.

We take this SAM as our starting point for calibrating our model.[6] Our first step is to subject the SAM to a aggressive aggregation: we initially collapse the 43 production sectors to seven basic commodities (food, cash crops, natural resources, processed food, manufactured goods, private services and public services) and then immediately dis-aggregate all but natural resources and public services to allow for different spatial variants of each commodity to be produced. Thus, for example, staple food is produced by rural households and under a different (more efficient) technology in Mwanza. Likewise for cash crops, processed food, manufactures and private services. We assume for convenience that natural resources and government services are produced 'at the port'. There exist no comprehensive data on the spatial distribution of economic activity in Tanzania and hence we have been forced to rely on data from a variety of independent sources, combined with our own (informed) judgment, to generate our quasi-spatial SAM. In particular, the *Integrated Labour Force Survey (2001)* provides a detailed geographic breakdown of employment, by skill and activity, between Dar es Salaam, Other Urban areas and Rural. Similarly, the *Tanzania Agricultural Sample Census (2003)* provides a basis for allocating land between staple and cash crop activities and between subsistence (our rural production technology) and commercial (our 'Mwanza') technologies. As is common across low income countries, there are no estimates of the size of the capital stock, either in aggregate or across sectors/locations for both the public and private sector. We impute these on the basis of the recorded values of gross profits in the SAM and an assumed (common) rate of depreciation across sectors.

[5]This SAM itself is a mechanical update which combines data from the 2000/01 Tanzania Household Budget Survey and the 2000/01 Tanzania Labour Force Survey with the 1992 input-output matrix (the most recent available). An exercise is currently underway by the National Bureau of Statistics to re-calibrate the SAM on the basis of the 2007 Household Budget Survey. This is not yet complete: we plan to update the SAM as and when the new SAM is released.

[6]The fully modified SAM is available on request from the corresponding author.

Transport Costs

The *IFPRI* SAM provides direct estimates of the transport and distribution wedge between producer and consumer prices. The transport wedge in that SAM is treated entirely as payments to the producers of transport services. Retaining their estimate in order to calibrate the total cost mark we decompose the wedge into the various components (pure rents, fuel costs and a pure melt). The economy-wide transport cost mark up is equivalent to approximately 20% of household final consumption. We assume approximately 50% of this is represented by rents that accrue to the capitalist household, around 20% is a directly fuel cost and the remaining 30% we attribute to a pure melt component. We assume that all three components are more or less proportional to distance and/or time but can 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. These are summarized in Table 2.[7]

Table 2: Transport cost wedge by location and component

	Location				
	Rural	Mwanza	Dar	TOTAL	Share of total
Component					
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	9.9%	28.8%	20.7%	19.4%	

Modifications to the SAM for calibration.

We subject the SAM to a final round of modifications to ensure that it provides a satisfactory basis for modeling. Specifically, we adjust elements of the inter-sectoral allocation of factors

[7] Table 2 suppresses a huge amount of detail. For example, the transport cost per unit of consumption at any given location will reflect not just the distance between the consumer and domestic producer but also, the import content of the composite good (recognizing that imports need to be transported to the location at which their are combined with the domestic variant) and intermediate goods intensity of production (since the transport costs associated with moving intermediates between spatially differentiated producers will also feed into the final transport costs borne by consumers).

so as to generate a stationary steady state for the model which displays broadly plausible factor shares, factor returns and consumption vectors. This entails imposing on the model, *inter alia,* zero growth in population and zero net investment (i.e. gross investment is set equal to depreciation). This final round of adjustments has been made entirely on the basis of judgment. Table 3 summarizes the principal settings for the model.

Table 3: Calibration Parameters

Parameter	*Name*	*Baseline value*	*Notes / Variations*
Elasticity of substitution in consumption	σ_j	1.5	
Armington elasticity	ε_i	0.75	2.5 [A4]
Elasticity of transformation	ϵ_i	0.75	2.5 [A4]
Agglomeration parameter	κ	4	
Subsistence share (% total consumption)	$\bar{q}_{ij}$	0.95	food only
Investment sensitivity parameter	η	0	25 [A4]

6 Experiment Design

To examine the core properties of this model we consider three basic experiments. These are highly stylized simulations designed to help ascertain the quantitatively important channels through which variations in transport costs influence the micro and macroeconomic structure of the model economy. At this stage, therefore, we are not concerned with specific policy interventions. Experiment set A involves a reduction in the cost of moving staple food within the domestic economy, both as a result of the reduction in the pure melt component of the transport wedge and through the elimination of monopoly rents earned from transport and distribution services. In Experiment B we explore the consequences for the a transport-cost ridden economy of changes in the land endowment in Mwanza, and in Experiment C we examine the consequences of a permanent increase in world food prices. In all three cases we abstract from consideration of the private or public policy measures and the associated resource cost required to bring about the changes we treat as exogenous: in other words, for example, we treat these experiments as tracing only the 'benefit' side of a reduction in transport costs, suppressing the cost of doing so.

6.1 Reducing transport costs

Table 4 reports the results from Experiment set A and is constructed as follows. The top panel displays the impact of the reduction in the transport cost wedge on the mark up between farm-gate and consumer prices for food across different consumption locations. The initial mark-up and the consequent reduction is lower the closer consumption is to production. The remainder of the table reports, in a highly condensed form, the impact of the experiment and its variants on production and trade, income and welfare and on factor markets. In each case we report only the 'comparative static' outcome comparing changes over 10 periods (years) with the initial situation. Parameter settings are as shown in Table 3.

In experiment *A1* the melt component in all food-related transport costs is eliminated, covering the movement of domestically produced food and for food that is traded across international borders.[8] In Experiment *A2* and subsequently we narrow the focus to domestic transport costs and assume that imported food does not benefit from the reduction in the melt rate. Experiment *A3* introduces the possibility of agglomeration economies in Mwanza and in *A4* the agglomeration is combined with a parameterization that allows for greater flexibility in both production and consumption in the domestic economy. Specifically, we set the Armington elasticity and the elasticity of transformation in production (i.e. between domestic and export markets) to 2.50 across all sectors and allow for the intersectoral allocation of investment to be highly responsive to inter-sectoral differentials in the return to capital (conditional on the aggregate investment level determined by the neo-classical closure). Finally, *A5* allows for the latent growth in simulation *A4* to be accompanied by an increase in private capital inflows.

We complete this run of experiments in *A2a* and *A5a* by comparing the results in *A2* and *A5* to the case where instead of reducing the melt component of the transport cost wedge we consider an approximately equivalent-impact reduction in the pure rent component of the mark-up: in other words, we replace the elimination of a pure cost with the elimination of a domestic distortion. In the case of *A5a* we maintain the capital inflow at its value in experiment *A5*.

The first two columns of Table 4 reports the basic 'transport cost reduction' experiment. In *A1* the melt component of the transport cost wedge is eliminated on the movement of all

[8]Food produced in the rural areas is strictly non-traded but imports account for approximately 12% of the 'Mwanza' staple food composite.

'food' commodities across the economy, on imports and domestically-produced food and in *A2* it is assumed that some proportion of imports still melt as before: in effect, experiment *A1* combines a reduction in domestic barriers to movement with a *de facto* trade liberalization in food. As expected, the trade-creating effect of this liberalization results in lower domestic food production and higher food imports in *A1* relative to *A2* (food production increases by around 0.65% in *A1* compared to 1.00% in *A2* but imports of the 'Mwanza food' rise by almost 8% in *A1* compared to 1% in *A2*). More importantly, though, the biggest impact on the trade balance between the two scenarios is that non-traditional *exports* in *A2*, principally of processed food and manufactures from Mwanza and Dar, rise sharply (by almost 5% compared to 2.7% in *A2*). The non-traditional export growth is driven in part by the reduced cost of intermediate inputs – especially food into food processing – and in part by the incipient real exchange rate depreciation arising from the *de facto* trade liberalization which imparts an additional incentive to the export sector. The overall difference in outcome between these two experiments is relatively small. This reflects the relatively low share of food in total imports and the limited substitutability in consumption between commodities in consumption: under a more flexible setting for the model economy (not shown here), this trade creation effect is stronger and the gap in output growth between the two experiments is correspondingly larger.

The factor market and spatial consequences of the reduction in transactions costs are modest but consistent with our priors. Skilled and unskilled labour is drawn from non-food activities in Mwanza and Dar into food production in both the rural economy and in Mwanza, but importantly given differential labour productivity between the two locations, the growth of output in Mwanza rises faster than for the economy as a whole.

These movements set up a rather more complex set of outcomes for real income, which is here defined as disposable income deflated by household-specific price indices, and our per-capita welfare measure.[9] For the economy as a whole, real disposable income rises sharply by around 4.5% in A1, and slightly less when we suppress the trade liberalizing effects of the reduced melt on imports. As a result the spatial distribution of income shifts away from the rural economy and towards the secondary cities. All labour-supplying households gain in income terms while the capitalist household experience a fall in its per capita income. This

[9] Welfare is measured directly from the consumption function as aggregate supernumerary consumption by household type normalized on the (employment) size of the household.

reflects a number of factors.Recall that in this model, gross household incomes are pooled across all sources of factor and non-factor income and is distributed uniformly across all end-of-period household members. First, since the fall in the transport wedge is highest for consumers located far from where food is produced, the consumption gains are enormously skewed in favour of those Mwanza and Dar-based households consuming rural-produced food. Second, however, there are weak offsetting gains to net producers. Given the high subsistence share in food consumption, food demand is relatively inelastic with respect to the fall in price but weak positive demand effects are nonetheless present, driving up real product wages and returns to land, the gains from which are captured by households in the Rural and Mwanza areas. Third, as labour moves out of urban into rural sectors, capital, which is used exclusively in urban activities become relatively abundant, driving down its average return.[10] Hence the decline in the absolute per capita incomes of the capitalist household. From a welfare perspective, however, all household benefit from the pure cost-reducing effects of eliminating the melt component of the transport cost wedge. The difference in the distribution of income compared to welfare reflects the variation in consumption shares and the fact that different household face different cost premia; hence, by dint of the very large share of staple food in their consumption basket, the biggest welfare gains accrue to the rural household, even though the reduction in their own cost mark up is relatively small.

Experiments *A3* to *A5* progressively introduce additional dynamic features into the experiment staring from A3 where we allow for economies of agglomeration in Mwanza of the form described above where under the chosen parameterization the elasticity of TFP with respect to the concentration of Mwanza is relatively high, at around 0.8.[11] As expected, agglomeration effects magnify and reinforce the patterns noted in the static case, accelerating the distribution of output from rural and, to a lesser extent, the capital city towards the secondary cities. The labour market dynamics underlying this transformation appear initially to be counter-intuitive, however. In all the cases from *A3* to *A5* labour

[10] This decline the return on capital is to some extent an artifact of the model's neoclassical macroeconomic closure which assumes a closed private capital account. Aggregate investment is determined by fixed savings rates out of private income net of government dis-saving. With an effectively neutral fiscal position there is no vent to allow private households to export capital in response to diminishing domestic returns to capital.

[11] We do not have accurate estimates of this elasticity; however the qualitative estimates are broadly invariant to alternative estimates.

exits Mwanza and is absorbed into the rural area! This apparently perverse movement is, however, the outcome of the interaction of the flexibility of the economy, the distribution of patterns of consumption, and the capital adjustment dynamics of the model economy. To illustrate, let us consider the case of manufactured good produced in Mwanza. What is happening is this: agglomeration economies increase the productivity of all factors shifting the aggregate supply curve outwards for given inputs. However, the bulk of the output of Mwanza manufactures is consumed domestically and predominantly by the capitalist households in Dar, in other words those that share least in the real income gain from reducing the melt rate on food. This imbalance between domestic supply and demand means that the relative price of manufactured goods falls: and unless the sector specific wage falls by the same amount (it doesn't) firms will seek to shed labour. This labour-shedding will be lower the stronger is aggregate demand and/or the greater the capacity of firms to switch output between the domestic and export markets (see the comparison of *A3* and *A4*). Though not shown in the table, the one Mwanza sector to draw labour in as a result of the agglomeration effect is the pure export cash crop sector which is able to sell its output at a constant (world price): we explore this effect further in the next section.

Experiment *A5* completes the basic sequence by assuming that the growth of Mwanza is accompanied by a sustained increase in private capital inflows. As noted, the neo-classical closure version of the model treats private capital inflow as exogenous and invariant to the average return on capital (although inter-sectoral patterns of investment are return sensitive). To finesse this, we calibrate this experiment by choosing the level of capital inflows to satisfy some arbitrary cost-of-capital constraint. Specifically, we assume private capital flows in to the economy up to the point where the average return is 15%, one percentage point lower than the initial equilibrium. This equates to a capital inflow of approximately 2% of baseline GDP. Scaling up the growth in this manner clearly alters the distribution of income and welfare, reflecting the increased income from gross profits accruing to capitalist households, but the main contribution from this experiment is that it underscores the simple point that any significant change in the aggregate structure of production will require significant physical capital accumulation.

So far we have considered the elimination of the pure melt component of the transport cost wedge. In our final two experiments in this section, labeled *A2a* and *A5a*, we run the corresponding experiments for the case where an approximately equivalent reduction in transport cost premium on food is achieved through the elimination of monopoly rents. As the top panel indicates, the correspondence is not exact, in particular in the rural economy, where rents account for a smaller share of the overall cost wedge than pure melt. In both cases, the main difference is the impact on the capitalist household whose real incomes and welfare drop sharply relative to the previous case; the consequences for aggregate demand – especially towards food – tend to exacerbate the labour movements noted above, particularly when exacerbated by the agglomeration effects.

6.2 Increasing commercial land supply

In our second main experiment, reported in Table 5, we consider the effect of increasing the supply of productive land in the secondary cities. This land could be thought of as being brought into production from a land bank, as the result of some private improvement (land clearance) or other public policy action that endows otherwise idle land with value (for example, the provision of some public goods such as access roads or land reclamation).[12] At this stage we ignore how the increased land came about and simply assume that the new land is identical in its characteristics to the infra-marginal land currently employed in production in Mwanza. As with the previous experiment we start from the parameter settings reported in Table 3 and limit attention to the 10-year comparative static results. We explore two main variants of the land-bank experiment by considering in turn increasing the availability of land in the production of food crops and cash crops where the former is essentially non-tradable and the latter is an exportable good. In either case we consider a 50% increase in land. All available land is fully employed in production.

Experiments *B1* and *B2* report the benchmark results for increased land for food and cash crops respectively. In this case we assume there are no agglomeration effects at work, that elasticities of substitution and transformation between domestic and traded goods are low, and that there is a high subsistence requirement in food consumption (95% of baseline food consumption is deemed to be 'subsistence consumption'). Experiments *B3* and *B4* repeat the same pair of experiments under high values for these elasticities. Experiments *B5* and *B6* then introduce agglomeration effects and, as with Table 4, the final pair of

[12] An alternative way of presenting this experiment would be to assume there is a fixed supply of land with some proportion of land in the rural are being 'moved' to Mwanza. This 'movement' can be thought of as bringing land under commercial modes of operation rather than an explicitly physical movement of labour.

experiments, *B7* and *B8* allow for increased foreign private capital inflows to respond to the increased growth in the economy.

Bringing additional land into cultivation at zero opportunity costs must necessarily increase output and aggregate welfare. The ultimate consequences for growth and distribution in this economy, however, is fundamentally determined by the nature of the output that additional land produces (along with labour) and whether this response triggers any latent productivity effects. To illustrate this point we consider two polar cases that correspond almost exactly to the cases examined in a different setting by Matsuyama (1992).[13] In the first instance (experiments *B1*, *B3*, *B5* and *B7*) we assume the land brought under cultivation is used to produce staple food for the local market. There is no international export market for staple food and hence its price is determined entirely by the balance of demand and supply in the domestic economy. In this case the increase in output in the face of an inelastic demand drives down the incipient relative price of food, releasing labour to other sectors. In the even-numbered experiments ($B2$, $B4$, *B6* and *B8*) the new land is used to produce cash crops, a sizable proportion of which is exported, at fixed world prices: the basic dynamics are thus reversed as labour is drawn into the cash crop sector. As Matsuyama (1992) and Gollin and Rogerson (2011) stress, the growth dynamics of the economy will depend crucially on the whereabouts of the relevant growth externalities. In Matsuyama, productivity shocks in a trade-protected agricultural sector releases labour to a modern sector characterized by learning-by -doing thereby stimulating a growth take off. With free trade in agriculture labour moves in the opposite direction. (Matsuyama offers this as a parable of why the industrial revolution occurred first in Britain rather than France, despite the free market in technological know-how)

The basic dynamics can be seen in the comparison between *B1* and *B2*. In the latter case, increased land for cash-crop production draws labour, principally unskilled labour, out of both the rural economy and Dar into the now-booming Mwanza economy. This region's share of output thus rises on the back of a major export boom leading to real per capita income gains for all households. These are concentrated, however, in Mwanza and Dar (in the case of Mwanza the gains reflect rising real wages driven by the growth of cash crop production; in the case of Dar a significant part of the increase is due to out-migration of labour to Mwanza, thereby reducing the denominator for per capita income). In both cases,

[13]Matsuyama (1992) examined the effect of trade policy on the dynamics of growth.

the direct income gains are reinforced by the appreciation of the real exchange rate operating on the relatively high share of imports in the consumption basket of these households.

The contrast with *B1*, where additional land supports staple food production, could hardly be greater. Since staple food has a low price elasticity of demand in the domestic economy and no export market there is virtually no effective demand response to the increase in food supply: the price of Mwanza food falls, and unskilled labour leaves Mwanza for the rural economy and for Dar with the result that there is little change in the structure of production eventuates. The rural economy is particularly badly hit in this scenario. The fall in the price of Mwanza food puts downward pressure on rural food prices while labour migration from Mwanza places more pressure on the land and hence on per capita incomes. Moreover, as net sellers of food, the fall in relative food prices contributes the fall in overall welfare for rural households. In this scenario, as labour moves into non-agricultural activities in Mwanza and into Dar the return to capital increases and with it income inequality: the capitalist household benefits most on both income and welfare measures in this case. Again, of course, the effect is somewhat exaggerated by the savings-investment closure.

The remaining scenarios follow the pattern established in Table 4. When the economy is more flexible – as represented by higher Armington elasticities and higher elasticities of transformation in production across all sectors, the impetus driving the growth of Mwanza is marginally strengthened. In the case where new land contributes to cash crop production, greater flexibility generates a stronger the export boom and greater labour movement towards Mwanza (*B4* compared to *B2).* When land augments the supply potential for non-traded food, the higher substitutability in consumption means the additional Mwanza food substitutes for imported food at the margin so that domestic output rises marginally relative to the low substitutability case and less labour is shed from Mwanza into the rural economy. In both cases, aggregate welfare increases; in the food-supply case, however, greater flexibility compresses the distribution, with the welfare losses to the rural and Dar households reducing and the gains to Mwanza and capitalist households rising by less in *B3* compared to *B1.*

We can now bring agglomeration effects back into the picture. In this case – and given our specification of the agglomeration mechanism – economic density and the export boom are mutually reinforcing as productivity in cash crop production attracts more labour into Mwanza, fueling increased agglomeration effects for all Mwanza activities and accelerating the structural transformation of the economy (Experiments *B6* versus *B4*). Not surprisingly, this virtuous complementarity is even stronger if private capital supports the transformation (Experiment *B8*).

6.3 Global fuel price increases

For our final experiment we return to the question of transport costs to explore the impact of a rise in world fuel prices on growth and distribution in the economy, a question of considerable importance nowadays. This experiment, shown in Table 6, is intentionally simple. Experiment *C1* in Table 6 traces the impact of a 50% increase in world fuel prices (which are assumed to pass through completely to domestic prices) when the economy is assumed to have a low Armington elasticity and a correspondingly low elasticity of transformation in production, while *C2* considers the case when these elasticities are high. Finally, *C3* returns to the low-elasticity case and examines the case where the fuel price increase is accompanied by a reduction in the melt rate associated with the movement of exports from farm/factory gate to the port[14].

The principal insight from this experiment is how the presence of transport costs affect the macroeconomic adjustment to the fuel price shock. The dynamics of this shock are somewhat different from what would conventionally be predicted by this class of model when faced with an adverse terms of trade shock arising from an increase in world fuel prices.

In experiments *C1* and *C2* real output falls in aggregate and more so in locations where transport costs are higher (Mwanza and Dar, see *Table 2* above) while labour of both skill types move 'closer to the port' in Dar. Real incomes are hit by more than the fall in output so that once labour has moved, labour-supplying households in Dar suffer the largest loss in real incomes on a per capita basis. By contrast, as more labour moves into the urban areas, particularly Dar, the return on capital rises to partially offset the increase in real consumption prices facing capitalist households.

But the important aspect of these results, which provides important insights on how transport costs function in this model economy, is the external adjustment to the fuel price increase. The direct balance of payments effect of the fuel price shock is large – equivalent to almost 2% of GDP – and since we assume that there are no direct substitutes for fuel

[14] It may be more natural to think of a reduction in the costs of exporting arising from the elimination of rents, for example, as a result of improved customs procedures, but in this instance we choose to work with the simplest characterization of the transport costs, the melt.

(its use is directly proportional to the movement of goods across and within the borders of the state) and no external borrowing capacity, this requires an offsetting adjustment to the non-fuel current account. In our firs two experiments the increase in net non-fuel exports occurs almost entirely through a reduction in imports rather than an increase in exports. Cash crop exports increase to some degree but this is more than offset by a contraction in non-traditional exports. This follows directly from what is happening to relative prices. In the standard small open economy it is commonplace to treat fuel imports as a component of final demand so that a rise in the fuel price raises the relative price of imports with respect to domestic goods. If the elasticity of substitution in consumption is low this will tend to require a depreciation in the export real exchange rate rate and an increase in exports. Net non-fuel exports would therefore rise to meet the higher level of fuel imports. In the case studied here, however, the terms of trade shock also directly impacts exports through the increased cost of getting them to the world market, handing back proportionally more of the burden of external adjustment onto the compression of imports. In both *C1* and *C2* total gross exports actually decline implying a more than proportional decline in non-fuel imports.

The importance of this dimension of external adjustment is illustrated in *C3* in which we accompany the *C1* experiment with an exogenous elimination of the 'melt' component of transport costs on exports. The change in the external adjustment is dramatic, with the increased fuel import demand (which is now higher than before because the overall level of economic activity has risen relative to the case analyzed in *C1*) being more than full financed by increased net exports.

7 Discussion, conclusions and extensions

It is in the nature of high dimension simulation models that the results are extremely detailed and sensitive to small changes in calibration and the specification of experiments. This is particularly so in this paper where we have restricted ourselves to a set of highly stylized experiments designed to identify the principal channels through which transport costs shape economic adjustment. When the model is used to run specific and fully-costed public policy interventions a greater degree of 'discipline-in-calibration' can be imposed on the model to ensure a closer coherence between the model economy and the country-specific empirical evidence.

Nevertheless, the simulations presented in this paper provide some key insights into how changes in level and form of transport costs impact on the scale and structure of production and welfare in Tanzania. First, even though our analysis focuses on changes in the transport costs (and land endowments) only to the extent they impact directly on agriculture, which accounts for just under half of GDP, the aggregate effects of these changes are sizeable, both in terms of the scale and composition of output and their likely impacts on labour movement. Aggregate output rises by between 1% and 2% over the decade relative to counterfactual and growth is consistently concentrated in the secondary cities and, within them, in non-agricultural sectors. This is particularly marked when the initial transport cost reduction is accompanied by additional private capital inflows: in experiment $A5$, for example, the change in transport costs lead to an almost 4% shift in the composition of production in favour of Mwanza over a decade, principally as a result of the relative decline in quasi-agricultural output (and employment). Second, whilst from a production perspective these effects are broadly similar whether the reduction in transport costs emerges from the elimination of pure costs (the melt) or of rents, the consumption and welfare effects of changes in transport costs on food do depend on the nature of the cost-reduction. Reducing rents leads to a very substantial welfare shift from capitalists to labour-dependent households, in particular rural households. Third, consistent with the existing literature, the dynamics of adjustment and transformation depend crucially on the openness to trade of favoured sectors. In our 'land bank' experiments we show how inter-sectoral and spatial shifts in production and employment depend on whether productivity gains accrue to traded or non-traded sectors; similar results occur when the impetus comes from a reduction in transport costs. Finally, our fuel price experiment shows how an explicit treatment of the impact of fuel costs on exportables significantly changes the way in which the economy adjusts to global oil price shocks.

As we have stressed, although these experiments provide valuable qualitative insights into the general equilibrium effects of changes in transport costs, they remain partial and tentative and, by design, suppress the resource cost implications of the policy interventions required to implement the experiments. Three major steps remain to be completed before we can bring this framework to bear on specific policy measures. First, further sensitivity analysis, combined with further development of the baseline calibration is required to align the quantitative magnitudes of the simulations with the empirical reality of the Tanzanian economy. Second, quantitative estimates of the resource costs and financing options for the implementation of specific policy interventions need to be integrated with the model. And finally, the analysis to date has highlighted a number of areas where modifications to the core model design may be required. We close by noting just four.

- Whilst the current neoclassical macroeconomic closure may be appropriate for undertaking relatively short-horizon comparative static analysis, it is probably a poor closure rule when considering the medium to long-term horizons over which we seek to analyze structural transformation. It seems appropriate to examine the properties of the model when we relax the assumption of fixed household savings propensities and allow for endogenous private remittances and/or capital inflows following the approach adopted by Adam and Bevan (2008).

- The Adam and Bevan (2008) model also provides a basis for a dynamic disequilibrium calibration arguably more suited to circumstances in Tanzania (and other economies) in which there is rapid growth of the labour supply and the configuration of the physical capital stock is far from the steady state assumed in the social accounting matrix underpinning the current model.

- Third, our model is currently built around a simplified characterization of household behaviour and an even simpler representation of the labour market. At present labour of both skill types can move costlessly between sectors and locations, joining the receiving household, pooling their income with existing household members and adopting the consumption and saving behaviour of the receiving household. This is reasonable given the immediate focus on how changes in transport costs shape the supply side of the model economy, but further refinement of the household and labour market structures is probably required as we seek to apply the model to policy experiments calibrated over shorter horizons. This refinement is likely to entail introducing labour market frictions and allowing for labour to be temporary migrants so that their claims on land and their consumption preferences are anchored in the 'sending' rather than the 'absorbing' household. Within households, it may be appropriate to replace the current consumption function with a nested consumption function which allows the elasticities of substitution in consumption across spatial varieties of commodities to differ from those governing substitution between major commodity groups.

- Finally, further work is required to refine the characterization of agglomeration effects. In the current version, the 'size' of secondary cities is determined very simply by the growth of aggregate production located in Mwanza. As a result, agglomeration effects can be triggered to the same degree by growth in any or all Mwanza-based sector. Empirical evidence would suggest that agglomeration effects depend as much on the nature of economic concentration than than its simple scale: further work is required to examine the role of the concentration of skills, of infrastructure and of local market demand rather than the current simple measures of scale in driving agglomeration effects.

8 References

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Appendix 1: Model equations

The following are the principal equations of the model. Except where required, sectoral indices are suppressed; a number of model identities and definitions have been excluded.

Prices

$$p_M = Rp_M^w(1 + t_M)(1 + \tau_M) \tag{8.1}$$

$$p_E = Rp_E^w(1 + t_E)(1 + \tau_E) \tag{8.2}$$

$$p_X = \frac{p_D XD + p_E E}{X} \tag{8.3}$$

$$p_Q = \frac{p_D XD + p_M M}{Q} \tag{8.4}$$

$$p_{VA} = p_X - \sum_j \tau_{Nj}\phi_j p_Q \tag{8.5}$$

$$p_C^h = (1 + \tau_D^h)(1 + t_D)p_Q \tag{8.6}$$

$$p_K = \sum_j \phi_j^K p_Q \tag{8.7}$$

Production

$$X^{rural} = AS^{\alpha S} L_U^{\alpha U} L_S^{(1-\alpha S-\alpha U)} K^{\alpha g} \tag{8.8}$$

$$X^{urban} = AK^{\alpha K} L_U^{\alpha U} L_S^{(1-\alpha S-\alpha U)} K^{\alpha g} \tag{8.9}$$

$$L_i^{sk} = \frac{\alpha^{sk} p_{VA} X}{W_i^{sk}} \qquad sk = (U, S) \tag{8.10}$$

$$\sum_i L_i^{sk} = \overline{L}_{sk} \tag{8.11}$$

$$X = A_T \left[\gamma E^{\frac{\epsilon+1}{\epsilon}} + (1-\gamma) XD^{\frac{\epsilon+1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon+1}} \tag{8.12}$$

$$\frac{E}{XD} = \left[\left(\frac{p_E}{p_D} \right) \left(\frac{1-\gamma}{\gamma} \right) \right]^{\epsilon} \tag{8.13}$$

$$Q = A_C \left[\delta M^{\frac{\varepsilon-1}{\varepsilon}} + (1-\gamma) XD^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{8.14}$$

$$\frac{M}{XD} = \left[\left(\frac{p_D}{p_M} \right) \left(\frac{\delta}{1-\delta} \right) \right]^{\varepsilon} \tag{8.15}$$

$$N = \sum_j (1+\tau_N)\phi_j X \tag{8.16}$$

Income and Consumption

$$Y^{rur} = \sum_{rur} p_{VA}^{rur} X_{rur} \tag{8.17}$$

$$Y^{Mwa} = \sum_{Mwa} (rs_{Mwa} S_{Mwa} + \sum_{sk} w_{sk} L_{Mwa}^{sk}) \tag{8.18}$$

$$Y^{Dar} = \sum_{Dar} \sum_{sk} w_{sk} L_{Dar}^{sk}) \tag{8.19}$$

$$Y^{Cap} = \sum_{Cap} (r_{Cap} K_{Cap} + \sum_i \sum_l rent_l) \qquad l = (M, E, D) \tag{8.20}$$

$$YD^h = Y^h (1 - t_Y^h) \tag{8.21}$$

$$H^h = s^h YD^h + R * pkap^h \tag{8.22}$$

$$p_C^h C^h = p_C^h \overline{C^h} + \left(\frac{p_C^{h1-\sigma} \beta^{h\sigma}}{\sum_i p_C^{h1-\sigma} \beta^{h\sigma}} \right) \left[YD^h (1 - s^h) - p_C^h \overline{C^h} \right] \tag{8.23}$$

Fiscal

$$GR = R\left[\sum t_M p_M^w.M + \sum t_E p_E^w.E\right] + \sum_h \sum t_D(1+\tau_D^h)p_Q C^h + \sum_h t_Y^h Y^h \tag{8.24}$$

$$H_{gov} = GR - (p_{VA} + \sum_j (1+\tau_N)\phi_j)G + R.aid \tag{8.25}$$

Transport Costs

$$\tau_M = \phi_M^{fuel}\left(Rp_w^{fuel}Fuel_M\right) + \phi_M^{rent}rent_M + \phi_M^{melt}melt_M \tag{8.26}$$

$$\tau_E = \phi_E^{fuel}\left(Rp_w^{fuel}Fuel_M\right) + \phi_E^{rent}rent_E + \phi_E^{melt}melt_E \tag{8.27}$$

$$\tau_D^h = \phi_D^{h,fuel}\left(Rp_w^{fuel}Fuel_D^h\right) + \phi_D^{h,rent}rent_M^h + \phi_D^{h,melt}melt_M^h \tag{8.28}$$

Saving, Investment and Macroeconomic Balance

$$p_K DK = \theta(1 - \mu(r - \overline{r}))(Saving - p_K DK^{pub}) \tag{8.29}$$

$$I = \sum_j \phi_j^K DK_j \tag{8.30}$$

$$Saving = \sum_h H^h + H_{gov} \tag{8.31}$$

$$Q = \sum_h C^h + N + I + G + \sum_l melt_l \tag{8.32}$$

$$\sum p_M^w.M + p_{fuel}^w.\sum_l Fuel_l = \sum p_E^w.E + aid + \sum_h pkap^h \tag{8.33}$$

Variables and parameters

R	Nominal exchange rate
p_M, p_M^w	Domestic (world) import price
p_E,p_E^w	Domestic (world) export price
p_D	Domestic goods price
p_Q	Composite goods price (factory gate)
p_X	Output price
p_{VA}	Value added price
p_C	Consumption price
p_K	Capital goods price
X	Domestic output
XD	Domestic sales
Q	Composite commodity
E	Exports
M	Imports
S	Land
L_U, L_S	Unskilled, Skilled labour
K	Capital
W	Nominal Wages
N	Intermediate inputs
Y	Gross factor income
YD	Disposable income
C	Consumption
s, H, H_{gov}	Savings rate, household savings, government savings
$rent$	Rents on transport
$melt$	'Melt'
$Fuel$	Direct fuel imports
$pkap$	Private capital inflows
$\tau_{M,E,D,N}$	Transport mark-up (imports, exports, domestic, intermediates)
$t_{M,E,D,Y}$	Import tariffs, export duties, indirect taxes, income taxes
DK, I	Investment by destination, origin
GR, G	Government revenue, government expenditure
aid	Foreign aid

Table 4: Reduction in transport mark-up on food

				Experiment						
			Baseline	A1	A2	A2a	A3	A4	A5	A5a
				Cumulative 10 year Change over baseline (except where indicated)						
EXPERIMENT										
Change in transport mark-up										
	Rural Food	**Rural**	1.01	-1.1%	-1.0%	-0.1%	-1.0%	-1.0%	-1.0%	-0.1%
		Mwanza	1.51	-15.2%	-15.0%	-13.0%	-15.0%	-15.0%	-15.0%	-13.0%
		Dar	1.50	-15.1%	-15.0%	-14.0%	-15.0%	-15.0%	-15.0%	-14.0%
	Commercial Food	**Rural**	1.52	-16.5%	-16.0%	-13.0%	-16.0%	-16.0%	-16.0%	-13.0%
		Mwanza	1.23	-9.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%
		Dar	1.28	-11.0%	-10.0%	-10.0%	-10.0%	-10.0%	-10.0%	-10.0%
SETTINGS		**Component**		Melt Domestic and International	Melt Domestic	Rents Domestic	Melt Domestic	Melt Domestic	Melt Domestic	Rents Domestic
		Agglomeration		No	No	No	Yes	Yes	Yes	Yes
		Flexibility		Low	Low	Low	Low	High	High	High
		Private Capital Flows (% initial GDP)		No	No	No	No	No	2.0%	2.0%
				PRODUCTION AND TRADE						
Growth of Real GDP			-	1.52%	0.89%	1.27%	1.62%	1.78%	7.67%	7.73%
Increase in gross output in Mwanza			-	1.83%	1.17%	1.58%	2.56%	2.93%	12.80%	12.18%
o/w growth in non-agricultural output				2.44%	1.40%	1.64%	2.63%	3.22%	14.25%	12.35%
Change in output share (percentage points)		**Rural**	21.5%	-0.3%	-0.1%	0.0%	-0.3%	-0.3%	-1.7%	-1.4%
		Mwanza	36.3%	0.1%	0.1%	0.2%	0.4%	0.5%	2.0%	1.9%
		Dar	42.2%	0.2%	0.0%	-0.3%	-0.1%	-0.2%	-0.3%	-0.5%
Exports		**Cash Crops**	394	0.59%	-0.01%	-1.60%	2.61%	1.71%	7.14%	4.76%
		Other	781	4.95%	2.71%	3.68%	3.76%	4.65%	12.37%	13.31%
		Total	1175	3.49%	1.80%	1.91%	3.37%	3.66%	10.61%	10.44%
Mundell-Flemming Real Exchange Rate			1.00	1.05	1.03	1.01	1.03	1.03	0.99	0.97
				INCOME DISTRIBUTION AND WELFARE						
Growth of Aggregate Real Private Income (measured at household-specific prices)			6299	6.0%	4.3%	0.6%	5.2%	5.3%	11.7%	7.2%
Change in sectoral share of real income		**Rural**	31.0%	0.3%	0.1%	1.2%	0.3%	0.1%	-1.5%	0.1%
		Mwanza	16.7%	1.2%	1.3%	1.1%	1.1%	1.2%	0.5%	0.5%
		Dar	10.8%	0.5%	0.5%	0.1%	0.6%	0.6%	0.3%	0.3%
		Cap	41.5%	-2.0%	-1.9%	-2.4%	-1.9%	-1.9%	0.7%	-0.9%
Change in per capita incomes		**Rural**	-	6.9%	4.6%	3.6%	6.0%	5.5%	5.9%	6.6%
		Mwanza	-	13.1%	12.1%	8.5%	12.6%	13.3%	15.8%	14.3%
		Dar	-	13.0%	11.1%	10.0%	12.6%	12.0%	16.8%	15.9%
		Cap	-	0.9%	-0.4%	-5.2%	0.4%	0.5%	13.7%	4.9%
			-							
Change in social welfare		**Aggregate**	-	4.50%	2.26%	6.79%	3.41%	3.42%	11.43%	15.59%
		Rural	-	4.92%	2.72%	8.04%	3.87%	3.84%	11.81%	16.85%
		Mwanza	-	3.56%	1.14%	5.75%	2.50%	2.67%	11.75%	15.86%
		Dar	-	3.38%	1.41%	6.59%	2.27%	2.27%	10.87%	14.74%
		Cap	-	2.76%	0.37%	-6.03%	1.02%	1.18%	6.73%	0.22%
				FACTOR MARKETS						
Employment growth										
	Unskilled	**Rural**	11600	0.07%	0.08%	0.7%	0.21%	0.16%	0.32%	0.94%
		Mwanza	1680	0.12%	0.08%	-1.9%	-0.88%	-0.78%	-1.66%	-4.53%
		Dar	340	-3.04%	-3.13%	-13.2%	-2.77%	-1.72%	-2.83%	-9.57%
	Skilled	**Rural**	690	1.01%	1.01%	5.3%	1.17%	0.67%	0.22%	4.01%
		Mwanza	720	0.41%	0.21%	-0.3%	-0.23%	-0.20%	0.29%	-1.32%
		Dar	680	-1.46%	-1.24%	-5.1%	-0.94%	-0.47%	-0.54%	-2.67%
Real Wage Growth										
	Unskilled		0.071	6.35%	4.59%	7.3%	5.74%	5.47%	10.13%	12.44%
	Skilled		0.826	5.55%	3.65%	2.1%	4.80%	4.69%	9.30%	7.63%
Average return on capital			16.00%	15.51%	15.43%	14.52%	15.53%	15.70%	15.00%	14.53%
Change in land rental (per hectare)										
	Rural	**Food**	-	1.10%	1.20%	7.40%	2.40%	3.10%	11.90%	18.00%
		Cash Crop	-	3.10%	1.50%	1.50%	3.10%	0.40%	1.10%	-0.30%
	Mwanza	**Food**	-	1.60%	1.90%	8.10%	0.80%	1.60%	5.70%	10.40%
		Cash Crop	-	-0.30%	1.20%	0.70%	3.50%	4.30%	15.40%	13.40%

Table 5: Land Development in Secondary Cities

				Experiment							
			Baseline	B1	B2	B3	B4	B5	B6	B7	B8
				Cummulative 10 year Change over baseline (except where indicated)							
EXPERIMENT											
Increase in fertile land in Mwanza											
		Staple Food	150.00	225.00	150.00	225.00	150.00	225.00	150.00	225.00	150.00
		Cash Crop	100.00	100.00	150.00	100.00	150.00	100.00	150.00	100.00	150.00
SETTINGS											
		Agglomeration		No	No	No	No	Yes	Yes	Yes	Yes
		Flexibility		Low	Low	High	High	High	High	High	High
		Private Capital Flows (% initial GDP)		No	No	No	No	No	No	3.8%	2.3%
				PRODUCTION AND TRADE							
Growth of Real GDP			-	0.89%	2.67%	0.93%	2.97%	3.68%	7.73%	11.16%	12.22%
Increase in gross output in Mwanza			-	1.89%	5.12%	2.10%	5.67%	7.06%	15.94%	19.81%	23.24%
o/w growth in non-agricultural output				0.23%	2.84%	0.17%	2.96%	3.71%	9.73%	16.53%	17.33%
Change in output share (percentage points)		**Rural**	21.5%	-0.1%	-0.7%	-0.2%	-0.7%	-0.6%	-1.7%	-2.3%	-2.6%
		Mwanza	36.3%	0.3%	0.9%	0.4%	1.0%	1.4%	2.9%	2.9%	3.7%
		Dar	42.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.7%	-1.3%	-0.5%	-1.1%
Exports		**Cash Crops**	394.00	0.12%	25.78%	-0.31%	30.42%	6.12%	51.96%	11.06%	60.09%
		Other	781.00	0.47%	0.86%	0.18%	0.26%	3.52%	5.66%	12.90%	6.18%
		TOTAL	1175.00	0.35%	9.21%	0.01%	10.37%	4.39%	21.19%	12.28%	24.26%
Mundell-Flemming Real Exchange Rate			1.00	1.01	0.95	1.01	0.97	0.99	0.93	0.95	0.92
				INCOME DISTRIBUTION AND WELFARE							
Growth of Aggregate Real Private Income			6299	1.1%	1.8%	1.0%	2.2%	2.7%	5.6%	11.5%	10.6%
Change in share of Real Income		**Rural**	31.0%	-0.1%	-0.3%	-0.3%	-0.7%	-0.2%	-0.5%	-1.1%	-1.2%
		Mwanza	16.7%	-0.4%	0.7%	-0.3%	1.0%	-0.3%	1.1%	-0.7%	0.9%
		Dar	10.8%	0.2%	0.1%	0.1%	0.0%	0.3%	0.2%	0.1%	0.1%
		Cap	41.5%	0.3%	-0.4%	0.4%	-0.7%	0.3%	-0.7%	1.8%	0.2%
Change in per capita incomes		**Rural**	-	0.5%	1.3%	-0.2%	0.6%	1.5%	4.1%	6.5%	6.7%
		Mwanza	-	1.5%	3.0%	1.3%	4.0%	4.6%	10.7%	11.3%	14.1%
		Dar	-	1.2%	3.9%	0.4%	4.8%	3.9%	9.0%	12.4%	13.8%
		Cap	-	1.9%	0.9%	2.0%	0.5%	3.5%	3.8%	16.2%	11.2%
Change in Social Welfare		**Aggregate**	-	0.05%	3.32%	0.13%	3.49%	3.37%	10.27%	14.42%	16.19%
		Rural	-	-0.2%	3.0%	-0.1%	3.03%	3.14%	9.60%	14.09%	15.54%
		Mwanza	-	0.8%	5.0%	0.7%	5.84%	4.98%	15.10%	17.45%	21.67%
		Dar	-	-0.2%	4.9%	0.0%	4.77%	3.01%	11.31%	15.43%	17.52%
		Cap	-	1.2%	1.9%	1.1%	1.93%	2.99%	5.77%	10.49%	9.61%
				FACTOR MARKETS							
Employment growth											
	Unskilled	**Rural**	11600	0.47%	-0.39%	0.3%	-0.58%	0.6%	-0.09%	0.89%	-0.12%
		Mwanza	1680	-3.75%	3.10%	-2.9%	4.46%	-4.8%	1.19%	-5.91%	1.51%
		Dar	340	2.65%	-1.76%	2.4%	-5.29%	2.1%	-2.65%	-1.24%	-3.45%
	Skilled	**Rural**	690	-1.45%	-1.16%	-0.1%	-1.59%	0.1%	-1.30%	0.00%	-1.58%
		Mwanza	720	-1.11%	2.08%	-0.8%	2.64%	-1.3%	2.08%	-0.32%	2.53%
		Dar	680	1.18%	-0.88%	1.0%	-1.18%	1.2%	-0.88%	0.34%	-1.08%
Real Wage Growth											
	Unskilled		0.071	1.41%	2.82%	1.4%	2.82%	2.8%	5.90%	8.29%	8.72%
	Skilled		0.826	0.85%	2.06%	1.2%	2.54%	2.9%	5.92%	8.03%	8.83%
Average return on capital			16.00%	16.27%	15.83%	16.27%	15.61%	16.40%	15.86%	15.00%	15.00%
Change in land rental (per hectare)											
	Rural	**Food**	-	0.10%	6.50%	0.30%	5.30%	4.40%	14.20%	16.20%	18.40%
		Cash Crop	-	0.20%	1.60%	-0.20%	-2.70%	0.10%	-1.40%	1.40%	0.00%
	Mwanza	**Food**	-	-38.80%	8.00%	-37.30%	5.90%	-38.60%	2.90%	-35.10%	5.20%
		Cash Crop	-	0.40%	-19.40%	-0.10%	-10.10%	9.20%	7.30%	22.20%	16.00%

Table 6: Permanent increase in real fuel price

			Baseline	C1	C2	C3
				Experiment		
			Cummulative 10 year Change over baseline			
EXPERIMENT **Increased World Fuel Price** **(full pass-through to domestic fuel price)**		**PwFuel**	1.00	1.50	1.50	1.50
SETTINGS						
	Agglomeration			No	No	No
	Flexibility			Low	High	Low
	Transport cost reduction			No	No	Yes
				PRODUCTION AND TRADE		
Growth of Real GDP			-	-1.71%	-1.73%	-0.60%
Increase in gross output in Mwanza			-	-2.34%	-2.27%	-0.54%
Change in output share (percentage points)		**Rural**	21.5%	0.5%	0.5%	0.2%
		Mwanza	36.3%	-0.3%	-0.2%	0.0%
		Dar	42.2%	-0.2%	-0.2%	-0.2%
Exports		**Cash Crops**	394	3.91%	3.70%	12.65%
		Other	781	-2.31%	-3.79%	1.84%
		Total	1175	-0.22%	-1.28%	5.47%
Mundell-Flemming Real Exchange Rate			1.00	1.00	1.02	0.98
				INCOME DISTRIBUTION AND WELFARE		
Growth of Aggregate Real Private Income **(measured at household-specific prices)**			6299	-2.99%	-2.77%	-1.56%
Change in sectoral share of real income		**Rural**	31.8%	-0.8%	-0.7%	-0.9%
		Mwanza	17.2%	-0.7%	-0.7%	-0.3%
		Dar	11.1%	-0.3%	-0.3%	-0.4%
		Cap	39.9%	1.8%	1.7%	1.5%
Change in per capita incomes		**Rural**	-	-3.0%	-2.3%	-1.6%
		Mwanza	-	-3.7%	-3.7%	-1.4%
		Dar	-	-5.3%	-4.8%	-2.9%
		Cap	-	-2.4%	-2.5%	-1.8%
			-			
Change in social welfare		**Aggregate**	-	-6.22%	-6.00%	-3.17%
		Rural	-	-6.57%	-6.36%	-3.70%
		Mwanza	-	-5.54%	-5.24%	-1.27%
		Dar	-	-6.69%	-6.01%	-2.52%
		Cap	-	-3.18%	-3.46%	-1.99%
				FACTOR MARKETS		
Employment growth						
	Unskilled	**Rural**	11600	-0.08%	-0.08%	-0.2%
		Mwanza	1680	-0.25%	-0.10%	1.2%
		Dar	340	3.87%	3.21%	0.9%
	Skilled	**Rural**	690	-0.22%	-0.14%	-0.1%
		Mwanza	720	-1.26%	-1.19%	0.1%
		Dar	680	1.56%	1.41%	0.0%
Real Wage Growth						
	Unskilled		0.071	-4.21%	-3.53%	-2.5%
	Skilled		0.826	-3.67%	-2.93%	-1.9%
Average return on capital			16.00%	16.27%	16.35%	16.15%
Change in land rental (per hectare)						
	Rural	**Food**	-	-6.85%	-5.50%	-1.46%
		Cash Crop	-	-2.37%	0.60%	6.65%
	Mwanza	**Food**	-	-7.46%	-5.30%	-1.71%
		Cash Crop	-	-0.05%	0.10%	14.33%