Agglomeration, Migration and Agricultural Growth:
A Regional CGE Analysis for Uganda

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Summary – Uganda experienced rapid growth and poverty reduction over the last decade, but failed to significantly improve incomes in its northern regions where prolonged conflict has, until recently, hindered growth. Three broad strategies are proposed to close the regional divide: (i) a north-south transport corridor to encourage regional trade; (ii) accelerated growth in the southern capital city and encourage north-south migration; and (iii) improve agricultural productivity in rural areas. These strategies are examined using a regionalized economywide model, accounting for internal migration and productivity gains from urban agglomeration. Simulation results indicate that a north-south corridor benefits northern households but its national benefits are limited by the small size of northern urban centers and the low productivity of northern producers. Investing in the capital city accelerates economic growth but has little effect on other regions' welfare because of the city's weak linkages with other regions and small migration effects. Improving agricultural productivity, however, though less effective at stimulating national economic growth, generates broad-based welfare improvements in both rural and urban areas. We therefore conclude that without significant gains in agricultural productivity in the next decade, out-migration and urban-led growth centered in Kampala will be insufficient to significantly reduce poverty in northern Uganda.

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1. Introduction

Uganda's economy, led by rapid growth in the urbanized south primarily around the capital, Kampala, has expanded rapidly over the last decade and national poverty has declined (Okidi et al., 2005). However, agricultural GDP per capita has actually fallen over this period, rural household income growth has been slow, and rural poverty remains high. Moreover, Uganda's northern region, where a quarter the population lives, has not participated in the growth process, in large measure because of internal conflict that until recently undermined development efforts in the region, leaving many inhabitants displaced. Thus, while poverty declined in the south, where Uganda's coffee exports originate, the high levels of poverty in the north have remained virtually unchanged.

In this paper, we explore three alternative strategies to address persistent rural poverty and the north-south divide, each with unique spatial and development implications in terms of economic density (urbanization and agglomeration effects), economic distance (transport costs) and spatial distribution of welfare (see World Bank, 2008). The first option we analyze is development of a road corridor that reduces transport costs between major urban centers in the northern and southern regions, as well as transport costs between northern and international markets. The second option is to reinforce the growth process in Kampala, thereby harnessing agglomeration economies and creating employment opportunities for migrants. The third option is investment for increased agricultural productivity to directly raise rural incomes in both the north and the south.

To analyze these investment options, we use a regional computable general equilibrium model that captures the economic linkages between the northern/southern regions and rural/urban areas. Section 2 describes Uganda's economic structure and the regional model. Section 3 presents the model results and Section 4 concludes.

2. Regional and rural-urban linkages in Uganda

Despite agriculture's poor performance over the last decade, it still accounts for one-third of national GDP and four-fifths of total employment in Uganda. Agricultural exports generate two-thirds of export earnings, mainly from coffee, tea and tobacco. Manufacturing has grown rapidly, but still generates only ten percent of GDP, half of which is agro-processing. Strong linkages thus exist between rural-based agriculture and urban-based manufacturing. Accordingly, the dynamic regional economywide and microsimulation (DREM) model developed for this study disaggregates the economy into sub-national regions to capture regional rural-urban linkages and the spatial impacts of alternative growth strategies.

North-south regions and major urban centers

In our analysis, we first divide Uganda into North and South. The population census is then used to identify major urban centers with populations above 50,000 people, which includes Kampala (1.7 million people out of a total of 27 million). Since Kampala is the core of Uganda's industrial economy, it is a separate region in the model. The two major cities in the north are Gulu and Lira with a combined population of 200,000 people; the southern major urban centers have a total population of 524,000 people. Thus, the five regions in the model are (i) northern rural; (ii) northern urban; (iii) southern rural; (iv) southern urban; and (v) Kampala metropolitan area. A major transport route connects the southern urban centers with Kampala and foreign markets, while a less developed corridor currently connects northern and southern regions.

Production is disaggregated across the five regions using household survey and industrial census data. The northern regions contain 23 percent of the population but account for 11 percent of

national GDP (see Table 1). Northern per capita GDP is thus only US$150 per year, compared to a national average of US$310. The northern region, predominantly rural and dominated by agriculture, is a net exporter of agricultural goods (e.g., cotton and forestry), mining and electricity. The southern region is much larger, and unlike in the north, there is a sharp rural-urban divide. Southern per capita GDP is closer to the national average at US$271. However, average per capita GDP in southern urban centers is US$1074, reflecting the south's higher-earning sectors, such as formal manufacturing and private services. The south is also a net exporter of agricultural goods (e.g., maize, horticulture, coffee and livestock). Most agricultural outputs are supplied to urban centers for processing and traded with other regions. Finally, Kampala, the fifth region in the model, forms the economic core of Uganda's economy. The capital contains only 6.1 percent of the population, but generates 21.6 percent of national GDP, and has an average per capita GDP of US$1098 per year, more than seven times that of northern rural areas.

Modeling regional growth and investments

The recursive dynamic regional CGE model used in this analysis is run over the period 2005-2015. With adaptive expectations, the model can be separated into a (i) within-period component, where producers and consumers maximize profits and utility, and (ii) between-period component, when the model is updated to reflect population and labor supply growth, capital and technology accumulation, and agglomeration effects on total factor productivity.

The model contains 47 sectors in each of the five regions. Production technologies are calibrated to a 2005 social accounting matrix (SAM) which stipulates producers' initial use of factor and intermediate inputs. The model classifies labor into occupation-based skill categories. Skilled and semi-skilled workers are assumed fully-employed with flexible wages. Rural unskilled labor has an upward sloping supply curve reflecting their underemployment. Within each period workers in the

model migrate across sectors within regions and between periods they migrate across regions in response to wage differentials. Capital also moves across sectors within regions, but formal and informal capital markets are segmented. Between-period capital accumulation depends on past investment financed by domestic and foreign savings. New stocks are allocated towards regions and formal/informal sectors according to profit rate differentials. Finally, agricultural land is immobile across regions but endogenously allocated across crops.

The model captures production linkages using nested constant elasticity of substitution (CES) production functions allowing producers in each region to generate demand for both factors and intermediates. For most commodities it is assumed that regional producers supply to a national market and prices equate demand/supply at the national level. Some non-traded commodities (e.g., construction and trade) have regional markets where prices equate regional demand/supply. Region-specific transaction costs are incurred when supplying goods to the national market, the size of which is determined by regions' net trading position. Finally, the decision to supply national domestic or foreign markets is governed by a constant elasticity of transformation (CET) function, while substitution possibilities exist between imports and domestic goods under a CES Armington specification.

Incomes from production and trade accrue to households according to employment and wage data from the survey. Households in the model are disaggregated across regions and farm/non-farm and poor/non-poor groups. Southern rural farm households are further separated into coffee/non-coffee producers. Differences in income/expenditure patterns are important for distributional change, since sectoral incomes will accrue to different households depending on location and factor endowments. Households in the model receive factor incomes and then pay taxes and save. Remaining income is used for consumption spending using a linear expenditure system of demand.

Closure rules balance macroeconomic accounts. For the current account, a flexible exchange rate maintains a fixed level of foreign savings, implying that foreign debt can be raised to pay for investments and that export earnings must cover additional imports. For the government account, tax rates are fixed and recurrent spending grows at a fixed rate. The fiscal deficit therefore adjusts so public expenditures equal receipts. Finally, investment and private consumption are fixed shares of absorption, with private savings adjusting to ensure that savings equals investment in equilibrium.

Finally, two factors determine each region's TFP growth rate. In the first component, an exogenous rate is selected so that the model tracks recent growth trends. The second component is agglomeration effects in urban areas that are an increasing function of the area's population density (see Henderson and Wang, 2005). Combined with the model's treatment of internal migration, this specification implies that a region's TFP growth accelerates if it is net recipient of migrant workers.

3. Comparing alternative investment scenarios

Three investment scenarios are modeled: (i) a transport corridor connecting major northern and southern urban centers; (ii) accelerated growth in Kampala; and (iii) improved rural agricultural productivity. A baseline scenario is also constructed to provide a counterfactual against which these investment scenarios can be compared.

Baseline scenario

In the baseline scenario, growth in population and labor supply, migration, and total factor productivity are based on trends for 1992-2005. Uganda's total population and labor supplies grow at three percent per year, implying that the national dependency ratio remains constant. We initially assign the same labor supply growth rates in all regions, but these diverge over time as workers

migrate between regions. Thus, while national population and workforce growth rate is fixed, the model endogenously reallocates labor and populations between regions.

The model initially tracks observed migration flows from the population census. Kampala has an initial net annual inflow of 26,000 migrants (i.e., 2.9 percent of its workforce), with most migrants coming from rural areas (i.e., 62 and 23 percent from south and north respectively). Over time migration rates respond to changes in relative regional wages. Net in-migration causes population growth in Kampala to accelerate, leading to positive agglomeration effects and higher TFP growth. Exogenous TFP growth is also higher in Kampala and southern urban centers, while agricultural productivity declines. This reflects stagnant incomes and poverty reduction in rural areas and in the northern region over the last decade.

Under these baseline assumptions Uganda's economy grows at 6.1 percent per year, driven mainly by industry and services (see Table 2). Declining productivity means agriculture grows at only 3.4 percent. Slow agricultural and rural nonfarm growth raises food prices and lowers real consumption growth for rural households.

Growth is unevenly distributed, with the north growing only a third as fast as Kampala (see Table 3). Strong industrial growth in Kampala widens regional wage gaps, causing more workers to migrate to the capital. Kampala's labor supply grows at an average 6.5 percent per year under the baseline. Rural labor supply also grows above 3 percent due to the assumption of unemployed unskilled labor. This offsets the migration of skilled northern workers to southern urban centers. Outmigration does not, however, outweigh population growth and northern urban population densities still rise, causing positive agglomeration effects and faster TFP growth. However, agglomeration effects are small compared to exogenous TFP growth, even in Kampala where there is large inward migration and where agglomeration effects account for only 12 percent of overall productivity growth.

The baseline scenario is consistent with current growth trends. The economy becomes increasingly concentrated within the southern urban centers, especially within Kampala. Although rural households benefit from economic growth, agriculture's poor performance causes below-average real consumption growth. There is thus rising rural-urban and north-south inequality in the baseline.

Scenario 1: Connecting northern urban centers with Kampala

The first investment scenario simulates an improved transport corridor connecting northern and southern urban centers. This is captured through two adjustments to the baseline scenario. First, northern trade margins capture the cost of supplying goods to southern markets and generate demand for regionally produced trade services. The scenario assumes that the corridor increases northern traders' productivity. TFP growth in the northern urban trade sector is increased substantially, thus lowering the price of northern trade services and reducing interregional transaction costs. Traders in northern rural areas also benefit from the transport corridor, albeit to a lesser extent. Secondly, it is assumed that overall productivity rises because of the corridor, with nonagricultural TFP growth increased by two percentage points each year in the northern urban centers.

Increasing trade sector productivity causes substantial growth in the northern urban trade sector. A smaller acceleration takes place in northern rural areas. Consequently, the price of trade services falls by between a quarter and a half in the northern regions. This benefits northern manufacturing, whose products are already traded with the south, but whose market opportunities improve dramatically. Rural nonfarm activities also benefit from lower transaction costs. Overall, the GDP growth rate for northern urban region doubles under the Corridor scenario. Agricultural growth increases only slightly in northern rural areas because demand-linkages are constrained by low productivity. Consequently, the northern rural growth acceleration remains small.

The corridor increases northern wages, causing a reversal in migration flows from northern regions to southern regions (excluding Kampala), but does not reverse net migration to Kampala, which has a work force ten times that of the two northern urban centers. Rising northern urban population densities generate positive agglomeration effects, but these are small compared to exogenous TFP increases (see Table 2). Thus, household welfare changes are significant only in the north, where average household welfare (as measured using per capita 'equivalent variations') rises by an additional 0.8 percentage points per year, from 2.4 percent per year under the baseline scenario to 3.2 percent under the Corridor scenario (Table 4). These welfare changes are also reflected in poverty outcomes (Table 5). Poverty declined under the baseline scenario from 31 to 25 percent during 2005-2015. Under the Corridor scenario, poverty declines further to 24 percent, due to increased participation of the northern poorer population in the national growth process.

Scenario 2: Investing in metropolitan Kampala

The second scenario allocates investment to Kampala, with the intention of generating enough growth at the national level that other regions also benefit (possibly by increasing employment opportunities for migrant workers). Government spending is increased by 1.5 percentage points each year during 2005-2015 (i.e., about 0.25 percent of GDP). To calculate, the direct impact of this spending on TFP, we apply a simple spending-to-TFP elasticity. Under the baseline scenario, the ratio of annual TFP growth (1.6 percent) to annual government spending growth (6.0 percent) was 0.2. We apply this elasticity to the new government spending to arrive at an *exogenous* TFP increase for Kampala's nonagricultural sectors of 1.5 percentage points each year (weighted by Kampala's contribution to national GDP). We assume that Uganda's government borrows domestically, thus increasing the fiscal deficit and crowding-out private investment (see Table 2).

Faster TFP growth raises Kampala's GDP growth rate from 10.4 to 12.7 percent per year. Since Kampala is a quarter of Uganda's economy, its expansion raises national GDP growth by 0.7 percentage points each year. Labor demand rises in the capital city, thus widening the regional wage gap and encouraging greater migration to Kampala. These new migrants mainly come from rural areas in northern and southern regions. Additional in-migration is considerable with new migrants accounting for 8 percent of Kampala's workforce by 2015. This contributes to the rising population density of Kampala, which has positive agglomeration gains.

Faster economic growth in Kampala also reduces growth in GDP in other regions, however, due to increased migration, regional trade competition, and, to a lesser extent, through negative agglomeration effects. Nonetheless, slower GDP growth does not reduce welfare outside of Kampala because it is offset by outmigration of workers and their families, which raises per capita expenditures for remaining households (see Table 4). More importantly, however, faster growth in Kampala raises

demand for goods produced in other regions, such as food and agriculture, whose prices rise relative to the baseline scenario. Demand linkages cause agricultural growth to accelerate and rural incomes to rise. Increased production in Kampala also lowers prices of manufactures, which benefits consumers in other regions, especially urban households which spend a larger share of their incomes on manufactured goods. Ultimately, most benefits accrue to Kampala households, but only a small share of these fall below the poverty line. Thus, while per capita EV amongst poor households rises by 0.65 percentage points each year, it rises by 1.04 percentage points for non-poor households. This means that concentrating growth in Kampala worsens national inequality. It does, however, reduce national poverty by more than the Corridor scenario (see Table 5).

Scenario 3: Improving agricultural productivity in rural areas

Uganda's agricultural sector lags behind the rest of the economy, and northern crop yields for most major crops are especially low. Improving farm technologies is thus a key policy objective. In the third investment scenario we increase agricultural TFP growth in both the north and south. As with the Kampala scenario, government recurrent spending increases by 1.5 percentage points per year. Using the spending-to-TFP elasticity of 0.2 and weighting for agriculture's contribution to national GDP, agriculture's TFP growth rate rises by 1.5 percentage points. As before, additional government spending widens the fiscal deficit and crowds-out private investment. The Kampala and Agriculture scenarios are thus directly comparable.

Raising agricultural productivity causes raises agricultural growth by 1.3 percentage points each year (see Table 2). Export crops grow most rapidly, because food crops face more stringent market constraints, which cause their prices to decline substantially when production expands. Export crops rely on foreign markets, where demand constraints are usually less severe. Agriculture is a large part of the economy, causing national GDP growth to rise by 0.6 percentage points per year.

Not surprisingly, most growth occurs in rural regions where agriculture is most important. Urban regions also benefit from agricultural growth, which provides inputs into the agro-processing sectors. Demand-linkages from higher rural incomes raise demand for manufactured goods, benefiting urban sectors and causing rural households to diversify into nonfarm activities. Since rural households spend more of their incomes on locally produced goods, import demand is less than in the Kampala scenario (see Table 2). Ultimately, however, the Agriculture scenario generates slightly less economic growth at the national-level than the Kampala scenario because rural growth does not crowd-in as much private investment as urban industrial growth. Nor does agricultural growth increase exports as much.

However, rural welfare improves more in this scenario (Table 4) because the dominant share of the returns to agricultural growth accrues to poorer and rural households. Urban households also benefit from lower food prices and more nonagricultural employment opportunities in agro-processing, especially in the north. There is also large decline in national poverty, despite the Agricultural scenario's smaller effect on national growth (Table 5), because most poor households reside in rural areas and are reliant on agricultural incomes. Note though, that under this scenario there are broad-based welfare improvements across all regions, including Kampala.

4. Conclusions

The three scenarios analyzed in this paper (north-south corridor, Kampala-based growth, and investments in agricultural productivity) suggest that the sector and location of investments will be a major determinant of growth, poverty and regional outcomes in Uganda. Reducing north-south transaction costs has only modest effects on regional growth and poverty reduction. Northern households benefit, but national outcomes are limited by the small size of northern urban centers. The

benefits of the transport corridor are further constrained by low agricultural productivity, which limits northern farmers' ability to take advantage of new market opportunities.

Investments to accelerate growth in Kampala beyond its high growth rates over the last decade produce substantial urban growth, but do not generate sufficient economy-wide growth linkages to substantially improve conditions in rural areas and the northern region. Too few jobs are created for rural-urban migration to have a discernable impact on national poverty reduction, even with increases in total factor productivity driven by positive agglomeration effects. A Kampala-driven growth strategy thus widens the north-south divide and the northern region remains isolated from the national growth process.

The third alternative, improving agricultural productivity, does have a positive impact on growth and poverty reduction in northern Uganda, but is less effective than urban development in generating national growth. Yet, agricultural growth leads to significant and broad-based welfare improvements, especially for poorer and rural households.

Overall, the results indicate that if Uganda continues on its current growth path of Kampala-centered growth, regional inequality will worsen and poverty rates will remain very high in the northern region. This adverse outcome results in spite of an assumption that increased urbanization leads to major gains in total factor productivity gains from agglomeration effects. Only with rapid productivity growth in agriculture, however, is the income gap between north and south substantially narrowed and overall poverty rates in the north reduced. Of course, agricultural productivity growth alone, without substantial urban income growth, would encounter major demand constraints. Thus, increasing agricultural productivity, combined with continued urban investments, should be a major component of any growth strategy aimed at substantially reducing poverty in northern Uganda and regional income inequalities.

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Table 1. Regional economic structure in 2005

	Northern region Rural	Northern region Urban	Southern region Rural	Southern region Urban	Kampala metro	Uganda
Population (%)	22.0	0.7	69.2	1.9	6.1	100.0
Total GDP (%)	10.5	0.5	60.7	6.7	21.6	100.0
Agriculture	16.1	0.1	83.4	0.4	0.1	100.0
Export crops	21.8	0.0	78.2	0.0	0.0	100.0
Manufacturing	3.2	0.8	24.6	12.7	58.7	100.0
Agro-processing	3.8	1.0	27.9	15.4	51.9	100.0
Other industry	12.5	0.6	58.8	7.8	20.3	100.0
Private services	6.8	0.7	46.0	7.9	38.7	100.0
Public services	8.5	1.0	66.6	13.2	10.7	100.0

Source: 2005 Uganda social accounting matrix

Table 2. Macroeconomic results

	Initial share	Baseline scenario	Corridor scenario	Kampala scenario	Agriculture scenario
		Average annual growth rate, 2005-2015 (%)			
			Point deviation from baseline		
National GDP	100.0	6.11	0.06	0.67	0.60
Agriculture	31.1	3.44	0.05	0.13	1.25
Export crops	3.0	2.09	0.02	-0.19	1.85
Manufacturing	8.5	7.90	0.12	0.93	0.34
Other industry	15.5	7.11	0.01	0.27	-0.16
Private services	30.8	7.45	0.04	0.91	0.27
Public services	14.1	5.93	0.13	1.26	1.28
Consumption	75.3	5.53	0.07	0.63	0.86
Rural	53.0	4.69	0.09	0.36	0.91
Urban	22.3	7.30	0.03	1.14	0.77
		Final year value, 2015			
Consumer price index	1.000	1.035	1.037	1.029	1.017
Food price index	1.000	1.157	1.160	1.161	1.084
Real exchange rate	1.000	0.984	0.986	0.953	1.000

Source: Results from the Uganda DREM model
Note: Exchange rate index is foreign currency units per local currency unit (i.e., a decline is an appreciation).

Table 3. Migration and agglomeration effects in the Baseline scenario

	Uganda	Northern (rural)	Northern (urban)	Southern (rural)	Southern (urban)	Kampala (metro)
Regional GDP growth rate (%)	6.11	3.29	3.74	4.64	5.82	10.44
Labor employment growth rate	4.09	4.11	1.22	3.90	1.92	6.54
Skilled	3.00	1.87	1.27	2.38	2.51	6.12
Semi-skilled	3.00	1.89	0.30	2.03	1.62	6.73
Unskilled	4.48	4.66	2.10	4.38	2.13	6.26
TFP growth rate	1.64	-0.16	1.96	0.83	1.92	4.27
Due to agglomeration effects	-	-	0.10	-	0.16	0.52
Annual migration inflows (workers)	0	-5,916	-892	-15,963	-2,006	24,776
Migrant share of labor force (%)	0	-0.28	-1.87	-0.24	-1.08	2.90

Source: Results from the DREM model

Table 4. Per capita welfare (equivalent variation) results

	Initial p.c. consumption, 2005 (USh1000)	Average annual EV growth rate, 2005-2015 (%)			
		Baseline scenario	Point deviation from baseline		
			Corridor scenario	Kampala scenario	Agriculture scenario
All households	452	4.03	0.11	1.01	1.49
Poor	163	2.15	0.32	0.65	2.06
Non-poor	646	4.26	0.07	1.04	1.38
Northern	226	2.41	0.83	0.58	1.50
Rural	211	2.10	0.68	0.50	1.48
Urban	669	6.39	0.59	1.77	1.72
Southern	424	3.26	0.04	0.62	1.49
Rural	393	3.11	0.04	0.59	1.48
Urban	1,531	5.33	0.05	1.27	1.52
Kampala	1,638	4.57	0.06	1.79	1.36

Source: Results from the Uganda DREM model

Table 5. Poverty results

	Initial value, 2005 (%)	Baseline scenario	Deviation from baseline		
			Corridor scenario	Kampala scenario	Agriculture scenario
		Final year poverty headcount, 2015 (%)			
National poverty headcount (%)	31.01	24.55	-1.36	-2.24	-6.02
Rural	34.29	27.34	-1.38	-2.54	-6.66
North	64.10	57.61	-4.65	-2.98	-9.05
South	26.84	19.78	-0.56	-2.43	-6.06
Urban	12.96	9.17	-1.27	-0.58	-2.47
North	38.81	30.77	-6.31	-1.75	-6.57
South	7.14	4.31	-0.14	-0.32	-1.55
		Final year number, 2015 (millions of people)			
Population (millions of people)	27.16	36.50	0.00	0.00	0.00
Poor population (millions of people)	8.42	8.96	-0.50	-0.82	-2.20

Source: Results from the Uganda DREM model.