THE IMPACT OF URBAN GROWTH ON AGRICULTURAL AND NON-FARM INCOME IN KENYA

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Motivation

In structural transformation the impacts of urban growth on rural areas via increases in urban demand for food and labor.

Productivity growth in agriculture provides the increased supply of food and labor for urban growth.

Have any other urban drivers of rural growth emerged?
The importance of non-farm income has increased rapidly everywhere.

Can this still be explained just by the impact of agricultural growth on non-farm growth?

Or have spillovers emerged from urban growth onto nonfarm growth?
Where could spillovers come from?

- From commuting to nearby cities from temporary migration to cities, and from remittances of migrants
- Technology spill-overs to the non-farm sector
- From increasing demand for rural amenities and non-farm goods
- From firm location in rural areas to escape rising wages
Specific questions

- How large is the impacts of urban growth on agricultural income growth?
- Is there also a direct impact of urban growth on rural non-farm growth?
- Or is the non-farm growth still driven by agricultural growth alone?
Technical Approach
How to measure urban growth for cities:

Proxy for urban growth: Light intensities from the National Geophysical Data Center (USDD DMSP) transformed into:

To account for the distance, the urban income proxies measures are transformed to urban gravities using a negative exponential function.

- Local urban gravity is the urban gravity of the nearest city of more than 50’000 inhabitants.
- National urban gravity is the sum of urban gravities across all other cities excluding the nearest city to the village.
- Each village therefore has its own local and national urban gravity

The growth in these variables are termed local urban growth (LUG) and national urban growth (NUG)
Distance Decay of Urban Gravity

We chose $b = 2$

We chose $a =$
The cities, their night light intensity and the sample villages
How to relate these urban growth variables to agricultural and non-farm growth?

Geo-referenced household-level data spanning a long time period are necessary.

Tegemeo Institute of Agricultural Policy and Development
Econometric issues

Fixed household effects:
They are taken care of via differencing the growth rates

A simultaneity issues arises because agricultural income growth is expected to cause non-farm income growth

- We therefore estimate the nonfarm income equation using 2SLS.
- Instruments to predict agricultural income are agricultural variable such as tractor density, and HYVs.
- These clearly have an impact on agriculture income but not on nonfarm income, and are therefore valid instruments.
Findings
Table 1: The gross impacts of urban growth on rural incomes

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Income</td>
<td>Agriculture Income</td>
<td>Nonfarm Income</td>
</tr>
<tr>
<td>Local urban gravity</td>
<td>0.275**</td>
<td>0.491***</td>
<td>-0.659</td>
</tr>
<tr>
<td>National urban gravity</td>
<td>0.728***</td>
<td>0.994***</td>
<td>-0.844</td>
</tr>
<tr>
<td>Urban gravity interaction</td>
<td>-0.150**</td>
<td>-0.318***</td>
<td>0.332</td>
</tr>
<tr>
<td>Agricultural income per capita</td>
<td>.</td>
<td>.</td>
<td>1.367</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.128***</td>
<td>-0.251***</td>
<td>0.295*</td>
</tr>
<tr>
<td>Observations</td>
<td>3,558</td>
<td>3,558</td>
<td>3,558</td>
</tr>
<tr>
<td>Adj. R-squared</td>
<td>0.0079</td>
<td>0.0080</td>
<td>0.0268</td>
</tr>
<tr>
<td>Number of households</td>
<td>1,186</td>
<td>1,186</td>
<td>1,186</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1
The impact of urban growth on agricultural income is large.

Elasticities are fairly large elasticities at 0.49 and 0.99 respectively.

For rural incomes, national urban growth is more important than local urban growth.

The impact of equal growth of LUG and NUF is the sum of the local and national UGs, net of their interaction term.

- The interaction term is negative, indicating that local and national urban growth are substitutes.

The resulting elasticity of equal urban growth is >>>>>>.
Agricultural growth has a high impact on non-farm growth, but the impact is not significant. The estimated elasticity is 1.36. To confirm this large impact, further work is required.
Key Conclusions
The income impacts of urban growth on agricultural income growth in Kenya are large. This is consistent with the structural change literature on the impact of growing urban demand for food, agricultural raw materials and labor.

The impact of national urban growth on agricultural incomes is larger than the impact of local urban growth.

- But local city growth also contributes significantly to agricultural growth.
The impact of agricultural growth on nonfarm growth is high but not significant.

This is consistent with the literature on farm to non-farm linkages.

Further work is required to estimate the impact more precisely.
Prospects for direct interventions to foster non-farm growth

Urban spillovers to the non-farm sector are not yet present in Kenya.

There is therefore no driver to non-farm income growth other than agriculture.

It remains difficult to foster non-farm growth via non-agricultural policies and programs.
Conclusions of the structural transformation literature remain unchanged.

If in Kenya agricultural income growth remains widely shared...

...urban growth will contribute significantly to rural poverty reduction.

...via the impact of urban growth on demand for food and rural labor.
Thank you
Measuring Economic Growth of Kenyan Cities
Measuring economic growth of cities by night-light intensity from space - overview

Night-light intensity from space has been measured at the pixel level on earth from 1992-2013.

- It varies on a scale from 0 to 63.

Economic growth will increase the emission of light, and therefore the two measures are closely correlated.

The light intensity of a city is the sum of the light intensities of each pixel around the city center for which light intensity exceeds the value of 6 for Kenya.

With economic growth a city’s light intensity will grow:

- Via the growth of light intensity in any given urban pixel
- By adding pixels to the cities that have come to exceed a threshold light intensity of 6
DMSP/OLS nighttime lights time series background

The Defense Meteorological Satellite Program Operational Line Scanner (DMSP/OLS)

- 1 $Km^2$ spatial resolution annual dataset originally used to map distribution of cloud temperatures using thermal infrared sensors.
- Most applications involve viewing city light emission at night and manmade/natural fires

Version 4 - 1 $Km^2$ spatial resolution annual dataset from 1992-2013

Shows the lights from cities, towns, and other sites with persistent lighting, removing background noises associated with the data

Became free to download in 2010
Nighttime light calibration

6 different sensors were used from 1992-2013, the onboard sensors were not calibrated so the values need to be calibrated to be comparable.

We calibrated by assuming growth from 1992-2013, since cities in Kenya mostly expanded during this period.

Pixels were sequentially adjusted from 1992-2013 to either be the same value or greater from one year to the next. Full calibration of data can be read from Zhao et al. (2015).
Determining Development of Each City

Population and pixel threshold

- A population threshold of cities greater than 50,000 was used to reflect markets in Kenya.
- A pixel threshold was also set to separate urban and rural development.
  - GRUMP (Global Rural-Urban Mapping Project) urban area data, from CIESIN, from 1995, was used to compare with the 1995 calibrated nightlight data to get the approximate proper cut-off (CIESIN-Urban Extents Grid, 2011).
- Values below 6 were discarded for all years from 1992-2013 after calibration.
Determining Development of Each City

- An adjacent neighborhood pixel level analysis was used to determine nightlight data associated with each city.
- Starting at city center and expanding outward pixels were chosen that immediately neighbor center pixel.
City growth across years

The adjacent neighborhood approach was used for each year, resulting in the following for each city over 50,000.

For some cities, such as Nairobi and Thika, development became connected at a certain year. In this case, they were viewed as one metropolis from the beginning.

The map shows urban area change of cities, but does not show change in development intensity, an important aspect of urban gravity.
For each city, the trend of urban development intensity from 1992-2013 can be analyzed using the sum of nighttime light pixels.

Development generally increased by 45% across cities in Kenya from 1992-1996, and an even greater increase occurred from 2009-2013 of 75%.

While the Nairobi/Thika metropolis had the greatest level of development. The greatest increase occurred in Garissa at 362%, compared to just 175% in Nairobi/Thika from 1992-2013.
## Urban gravity and urban growth

Urban gravity of a city to any sample village is its light intensity weighted by its distance between the two.

- using the negative exponential function of distance as the weight.

The growth in urban gravity is a proxy for urban growth (UG).

Local urban growth (LUG) is the change in the urban gravity of the nearest city of more than 50’000 inhabitants.

National urban growth (NUG) is the growth of the sum of urban gravities of all the other cities in the country (NUG).

- Each enumeration area therefore has its own LUG and NGU
\[ UG_i = \sum_j CityNight_j \times e^{-d_{ij}^b/2a^2} \]

\( UG_i \) = Urban gravity (accessibility) calculated for village i

\( CityNight_j \) = the sum of all city nights within the urban extent of city j

\( d_{ij} \) = distance between village i and city j.

\( a, b \) are two parameters which are affecting the shape and speed of the distance decay function. We choose \( b = 2 \), and various \( a \) values (\( a = 50, 100, 150, 200 \)).
References
