How do Roads Spread AIDS in Africa?
A Critique of the Received Policy Wisdom

Elodie Djemai

Toulouse School of Economics
A branch of the literature on AIDS suggests that mobility is a vector of HIV propagation

- truck drivers (e.g. Oruboloye et al, 1993; Huygens, 2001; Gouws and Ramjee, 2002)
- migrant workers (Meekers, 2000; Adaji Nwokoji and Ajuwon, 2004)
- regional prevalence level depends on trade openness (Oster, 2009)

Road infrastructure might be a transmitter of the epidemic from region to region
Road infrastructure and AIDS

Road infrastructure might

- reduce the cost of self-protection (information flows)
- increase the set of sexual partners (population flows)

Outside option:

- Infectious v.s. communicable disease
- Simple contact not sufficient to increase the risk of infection

Agenda:

- Explore the empirical link between road infrastructure and the risk of infection
Research questions

- Test if/ how/ how much proximity to road increases the likelihood of HIV-infection

- Mechanism: Test if the observed relationship is
  - an access issue: lower knowledge, lower access to condoms
  - or a behavioral issue: lower condom use, more casual sexual partners or a mixture of the two
Our approach

- Study the general population at the individual level
- Combine survey data with geographical data on road infrastructure - for six African countries
- Exploit variations in the individuals’ location, i.e. the distance to the nearest road
Outline

1 Motivation
2 Data description
   - Survey Data
   - Geographical data
3 Distance to road and HIV-infection
   - Primary results
   - Identification
   - Sensitivity analysis
4 Supply of and demand for self-protection
   - The supply of protection
   - The demand for self-protection
5 Conclusion
Outline:

1. Motivation
2. Data description
   - Survey Data
   - Geographical data
3. Distance to road and HIV-infection
   - Primary results
   - Identification
   - Sensitivity analysis
4. Supply of and demand for self-protection
   - The supply of protection
   - The demand for self-protection
5. Conclusion
DHS are standardized nationally representative household surveys in developing countries.

We are using data from: Cameroon (2004), Ethiopia (2005), Ghana (2003), Kenya (2003), Malawi (2004) and Zimbabwe (2005/06)

- Homogeneous set of questions
- Blood sample collection to test for HIV
- GIS data on the sampled clusters
## Survey Data

### Geographical data

### Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>All</th>
<th>CMR</th>
<th>ETH</th>
<th>GHA</th>
<th>KEN</th>
<th>MWI</th>
<th>ZWE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV+</td>
<td>0.0787</td>
<td>0.0539</td>
<td>0.0184</td>
<td>0.0213</td>
<td>0.0650</td>
<td>0.1244</td>
<td>0.1788</td>
</tr>
<tr>
<td>HIV testing</td>
<td>0.1536</td>
<td>0.1907</td>
<td>0.0743</td>
<td>0.0921</td>
<td>0.1563</td>
<td>0.1488</td>
<td>0.2204</td>
</tr>
<tr>
<td>women</td>
<td>0.6606</td>
<td>0.6659</td>
<td>0.7005</td>
<td>0.5305</td>
<td>0.6946</td>
<td>0.7836</td>
<td>0.5535</td>
</tr>
<tr>
<td>age</td>
<td>28.60</td>
<td>28.56</td>
<td>28.77</td>
<td>30.26</td>
<td>28.53</td>
<td>28.15</td>
<td>27.81</td>
</tr>
<tr>
<td>urban</td>
<td>0.3332</td>
<td>0.4993</td>
<td>0.2994</td>
<td>0.3988</td>
<td>0.3312</td>
<td>0.1422</td>
<td>0.3530</td>
</tr>
<tr>
<td>no educ</td>
<td>0.2462</td>
<td>0.1755</td>
<td>0.5440</td>
<td>0.2851</td>
<td>0.1370</td>
<td>0.2087</td>
<td>0.0316</td>
</tr>
<tr>
<td>prim educ</td>
<td>0.3795</td>
<td>0.3997</td>
<td>0.2439</td>
<td>0.1848</td>
<td>0.5313</td>
<td>0.6271</td>
<td>0.3181</td>
</tr>
<tr>
<td>sec educ</td>
<td>0.3378</td>
<td>0.3935</td>
<td>0.1815</td>
<td>0.4898</td>
<td>0.2501</td>
<td>0.1561</td>
<td>0.6101</td>
</tr>
<tr>
<td>higher educ</td>
<td>0.0365</td>
<td>0.0313</td>
<td>0.0305</td>
<td>0.0404</td>
<td>0.0816</td>
<td>0.0081</td>
<td>0.0401</td>
</tr>
<tr>
<td>catholic</td>
<td>0.1753</td>
<td>0.3892</td>
<td>0.0099</td>
<td>0.1587</td>
<td>0.2383</td>
<td>0.2182</td>
<td>0.1029</td>
</tr>
<tr>
<td>protestant</td>
<td>0.4670</td>
<td>0.3539</td>
<td>0.1533</td>
<td>0.5353</td>
<td>0.6044</td>
<td>0.6158</td>
<td>0.6790</td>
</tr>
<tr>
<td>muslim</td>
<td>0.1696</td>
<td>0.1720</td>
<td>0.3269</td>
<td>0.1941</td>
<td>0.1209</td>
<td>0.1518</td>
<td>0.0075</td>
</tr>
</tbody>
</table>
Geographical data on road infrastructure

- Double source: *Digital Chart of the World* from ESRI and from Harvard Geospatial Library

- Use ArcGis to locate the sampled clusters and the road network on a country map and compute our variable of interest, i.e. the distance "as the crow flies"

- Restrict to the network of paved or "primary" roads
Geographical data on road infrastructure

Figure: Road infrastructure and sampled clusters, Zimbabwe DHS (2005/06)
Individuals’ distribution

- Respondents live on average 24 km (15 miles) away from the nearest paved road.
- Median = 11 km (6.8 miles).
- Maximum value ranges from 95 km (Malawi) to 288 km (Kenya).
1 Motivation

2 Data description
   • Survey Data
   • Geographical data

3 Distance to road and HIV-infection
   • Primary results
   • Identification
   • Sensitivity analysis

4 Supply of and demand for self-protection
   • The supply of protection
   • The demand for self-protection

5 Conclusion
Random effects probit estimation

\[ \text{Prob}(HIV_{ij} = 1) = \Phi(c + \beta D_j \log(\text{distroad}_j) + X'_i \delta + \gamma_c + u_{ij}) \] (1)

where from Battese and Tessema (1993):

\[ D_j = \begin{cases} 
0 & \text{if distroad}_j = 0 \\
1 & \text{if distroad}_j > 0 
\end{cases} \]

and to capture the unobserved heterogeneity at the cluster level:

\[ u_{ij} = \alpha_j + \varepsilon_{ij} \] (2)
### Estimated effect of road distance on HIV-infection

**RE probit estimates (marginal effects)**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dldistroad</td>
<td>-0.0818***</td>
<td>-0.0548***</td>
</tr>
<tr>
<td>Controls</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Country FE</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Cluster RE</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Observations</td>
<td>53,405</td>
<td>50,830</td>
</tr>
<tr>
<td>Nb clusters</td>
<td>2,704</td>
<td>2,702</td>
</tr>
<tr>
<td>Mean dpt</td>
<td>0.0789</td>
<td>0.0808</td>
</tr>
</tbody>
</table>

**Note:** Standard errors in parentheses. *** $p < 0.01$

Controls: gender, marital status, age, urban, education, wealth, religion, HIV/AIDS-knowledge
Probit results show a strong negative effect of road distance on the risk of HIV-infection.

*Size:* When increasing the distance to a road by 10 km, the risk of infection

- drops from 7.35% to 6.74%
- is reduced by 8.26%
Non-random placement

- There might be observable or unobservable variables driving both the choice of residence location and the risk of infection.

- Possible determinants of individual placement:
  - household size
  - job occupation

- The estimated IV coefficient remains negative and statistically significant when using either household size, job occupation or both as instrumental variables.
Sensitivity

- The size of the coefficient is sensitive to
  - gender
  - urban \(v.s.\) rural residence
  - the use of the road (using traffic flows as proxy)

→ suggesting that the effect of road goes through the increase in the set of potential sexual partners
Outline:

1 Motivation

2 Data description
   - Survey Data
   - Geographical data

3 Distance to road and HIV-infection
   - Primary results
   - Identification
   - Sensitivity analysis

4 Supply of and demand for self-protection
   - The supply of protection
   - The demand for self-protection

5 Conclusion
Idea

- Goal: Study whether the increase in the individual risk of infection is due to deficiencies in the supply or in the demand for self-protection

- Approach: Estimate the effect of road distance on
  - Knowledge of HIV-transmission
  - Access to condoms
  - Choice of condom use and sexual partner
HIV/AIDS-Knowledge

- Respondents are asked about the validity of six statements about HIV-transmission, e.g.
  
  - "Can people reduce their chance of getting the AIDS virus by not having sex at all?"
  - "Is it possible for a healthy-looking person to have the AIDS virus?"

- We generate a score to capture the quality of their knowledge
**Effect on HIV/AIDS-knowledge**

<table>
<thead>
<tr>
<th>Dependent variable: score</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dldistroad</td>
<td>-0.0972***</td>
<td>-0.0905***</td>
<td>-0.0471***</td>
</tr>
<tr>
<td>knows $s^{one}$ HIV+</td>
<td></td>
<td>0.2676***</td>
<td>0.1974***</td>
</tr>
<tr>
<td>ever tested for aids</td>
<td></td>
<td>0.2846***</td>
<td>0.1755***</td>
</tr>
<tr>
<td>read sometimes magazine</td>
<td></td>
<td></td>
<td>0.4639***</td>
</tr>
<tr>
<td>radio &lt;once a week</td>
<td></td>
<td></td>
<td>0.2552***</td>
</tr>
<tr>
<td>radio &gt;once a week</td>
<td></td>
<td></td>
<td>0.3309***</td>
</tr>
<tr>
<td>radio almost every day</td>
<td></td>
<td></td>
<td>0.4512***</td>
</tr>
<tr>
<td>tv &lt;once a week</td>
<td></td>
<td>0.2070***</td>
<td></td>
</tr>
<tr>
<td>tv &gt;once a week</td>
<td></td>
<td>0.1222***</td>
<td></td>
</tr>
<tr>
<td>tv almost every day</td>
<td></td>
<td></td>
<td>0.3488***</td>
</tr>
<tr>
<td>Mean dpt</td>
<td>3.5678</td>
<td>3.6188</td>
<td>3.6190</td>
</tr>
</tbody>
</table>

- Same qualitative results when using different measures of HIV/AIDS knowledge
Access to condoms

Respondents are asked

- whether they know a place where a person can get condoms and to cite the places they know
- about their ability to buy a condom
  - "If you wanted to, could you yourself get a condom?"
### Effect on the access to condoms

#### RE probit estimates (marginal effects)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>place</td>
<td>any</td>
<td>public</td>
<td>private</td>
<td>private</td>
<td>ability</td>
</tr>
<tr>
<td>medical sector</td>
<td>place</td>
<td>medical</td>
<td>sector</td>
<td>medical</td>
<td>sector</td>
</tr>
<tr>
<td></td>
<td>place</td>
<td>sector</td>
<td>place</td>
<td>sector</td>
<td>place</td>
</tr>
<tr>
<td>Dldistroad</td>
<td>-0.031***</td>
<td>0.037***</td>
<td>-0.057***</td>
<td>-0.057***</td>
<td>-0.051***</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.008)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Obs.</td>
<td>76,030</td>
<td>76,030</td>
<td>76,030</td>
<td>76,030</td>
<td>42,688</td>
</tr>
<tr>
<td>Clusters</td>
<td>2,713</td>
<td>2,713</td>
<td>2,713</td>
<td>2,713</td>
<td>2,652</td>
</tr>
<tr>
<td>Mean dpt</td>
<td>0.6704</td>
<td>0.3328</td>
<td>0.2727</td>
<td>0.3576</td>
<td>0.8103</td>
</tr>
</tbody>
</table>

\[
\text{Predictedprob}(1) = \begin{cases} 
68.5\% & \text{if distroad} < 5 \\
58\% & \text{if } 5 < \text{distroad} < 10 \\
52\% & \text{if } 10 < \text{distroad} < 15 \\
38\% & \text{if distroad} > 100 
\end{cases}
\]
Empirical results provide no support to the story of ignorance and misfortune

Road infrastructure improves the HIV/AIDS-knowledge and access to condoms

Access is necessary but not sufficient to prevent people from being infected
Results: competing effects

Estimate the choice of condom use and the choice of partner (usual v.s. casual) during the last intercourse in a bivariate probit model.

- Two competing effects: Proximity to a road
  - increases the likelihood of using a condom and
  - increases the likelihood of having sex with a casual partner

- Agents seem to choose the preventive measure that hurts the less their utility

  → Preferences for having more sexual partners even with a condom
Summary

This empirical analysis of the relationship between proximity to road and HIV-infection reaches the following conclusions:

- Living close to a paved road increases the risk of HIV-infection
- despite the increased access to condom and knowledge about HIV transmission
- because the demand for casual sex increases there and offsets the increase in condom use
Policy implications

In terms of public policies to fight AIDS:

- Draw specific programs for accessible v.s remote areas
- Persistent spatial disparities in access to information and protective devices
- Knowledge and condom availability are necessary but not sufficient to prevent from being infected
- Need to provide people more incentives to self-protect

In terms of road investment:

- Road infrastructure has costs and benefits on the HIV/AIDS epidemic