

GIS FOR APPLIED ECONOMICS

INTRODUCTION TO NETWORK ANALYSIS AND GEOREFERENCING

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ROADMAP

1. Network Analysis
2. Networks Analysis in economic research (an example)
3. Georeferencing (Making your own map)
4. Georeferencing in action
5. Final Practice



NETWORK ANALYSIS



WHY IMPORTANT FOR APPLIED ECONOMICS?

- Real measure of distance, neighborhood,...
- Spill-Over effect (diffusion)
- Social Network



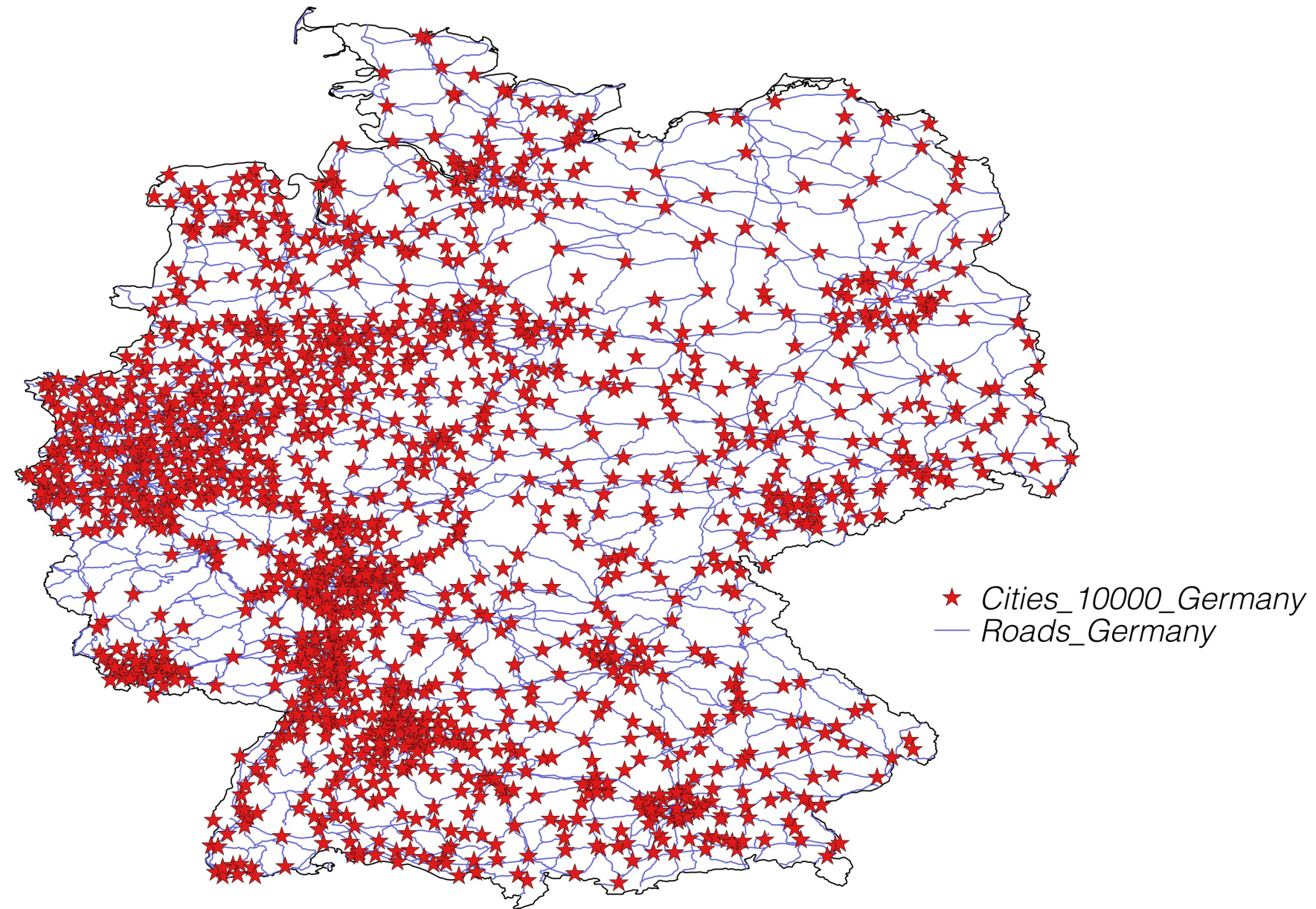
BASIC CONCEPTS (I)

A network is a collection of elements and their inter-relations (Kolaczyk, R, 2009)

Definition 1. A **network** is a collection of “ n ” items (also known as vertices or nodes) connected through “ g ” edges (also known as connections or links), which can be represented by a graph $G = (V, E)$ consisting of a set V of vertices and a $n \times n$ matrix E of edges (also known as the adjacency matrix), where $e = [e_{ij}]_{i,j \in V}$ and $e_{ij} \in (0, 1)$. Where each e_{ij} expresses the edge or link between a pair vertices $\{i, j\}$, $\forall i, j = 1, \dots, N$.



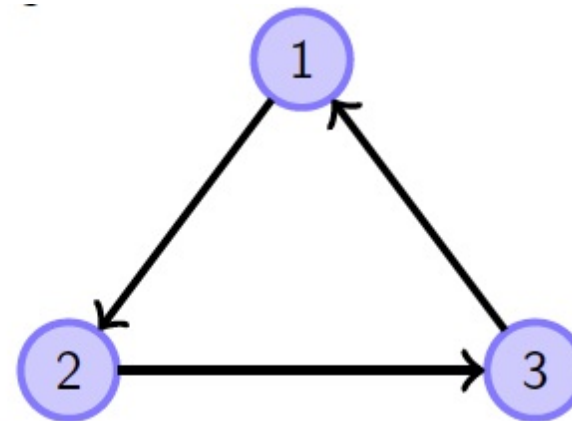
German Road Network and Large Cities (i.e. $> 10,000$ people)



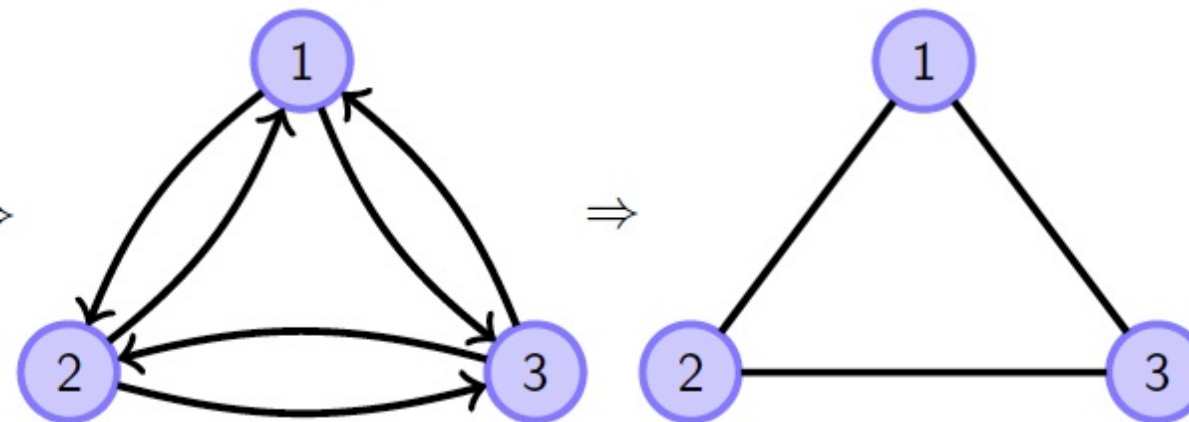
BASIC CONCEPTS (II)

- Type of networks: directed graph, undirected graph

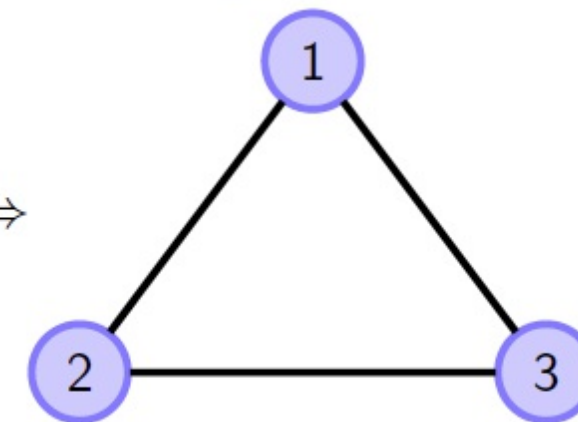
Example 1: $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix} \Rightarrow$



Example 2: $\begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} \Rightarrow$



$\Rightarrow$



BASIC CONCEPTS (III)

- Neighborhood: set of nodes which node (i) has link
- Degree: Number of set where they are directly connected to
- Walk: A sequence of nodes in which two nodes have a link between them.
- Shortest Path (geodesic distance): is the length of the shortest path between two nodes

Other important concepts (clustering, centrality,...)



NETWORK ANALYSIS IN APPLIED ECONOMICS



TRAFFICKING NETWORKS AND THE MEXICAN DRUG WAR

American Economic Review. 2015;105 (6) :1738-1779.



This study examines the direct and spillover effects of Mexican policy led by conservative party (PAN) towards the drug trade.

EMPIRICAL STRATEGY

Regression Discontinuity Design

- Different between PAN losses by a wide margin
- PAN wins by a large margin

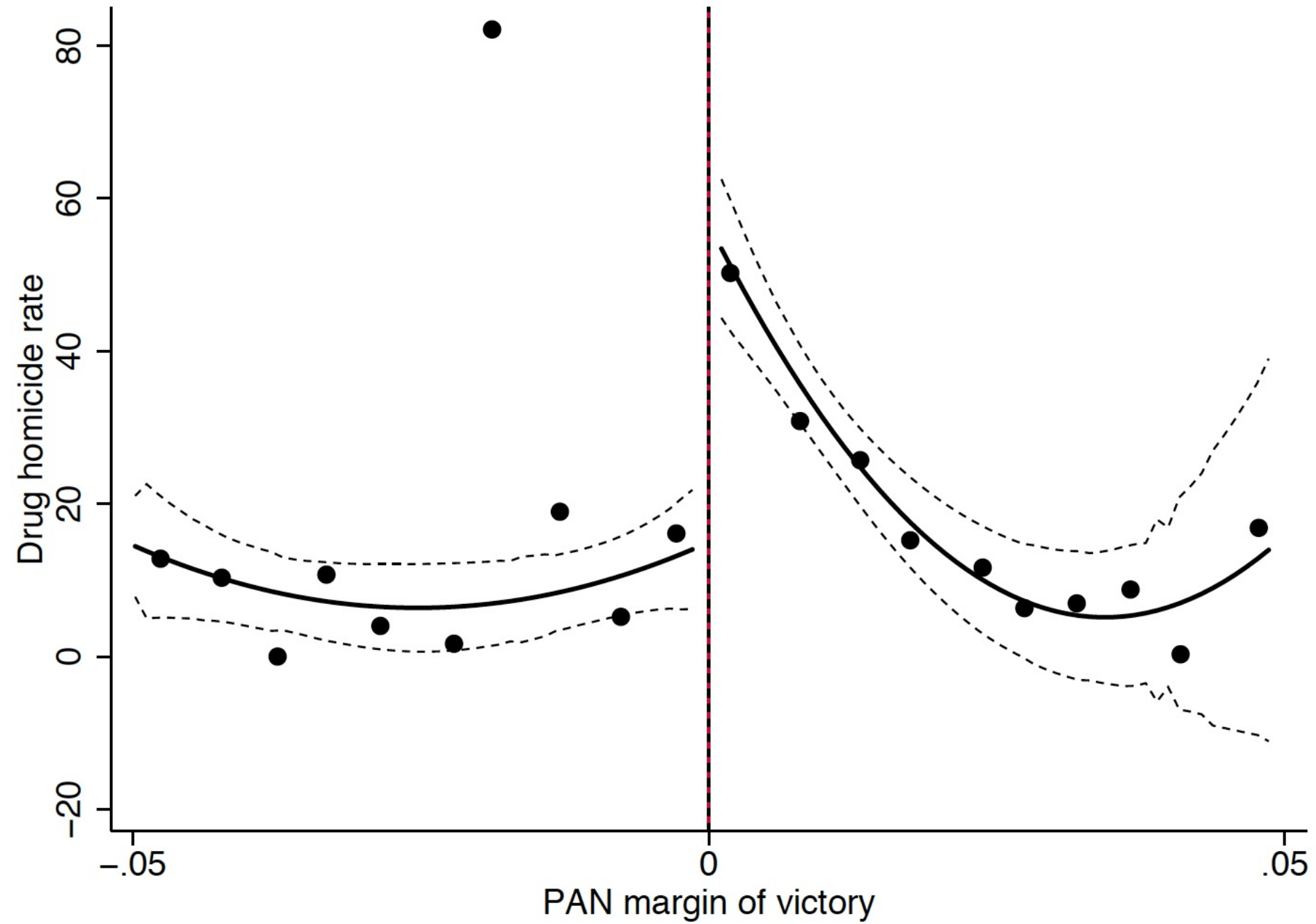
RESULTS

Drug-related violence increases substantially after close elections of conservative party mayors.

→ drug traffickers violence (re-allocation)



Drug-related homicides RD figures



Road network and Predicted Trafficking Routes

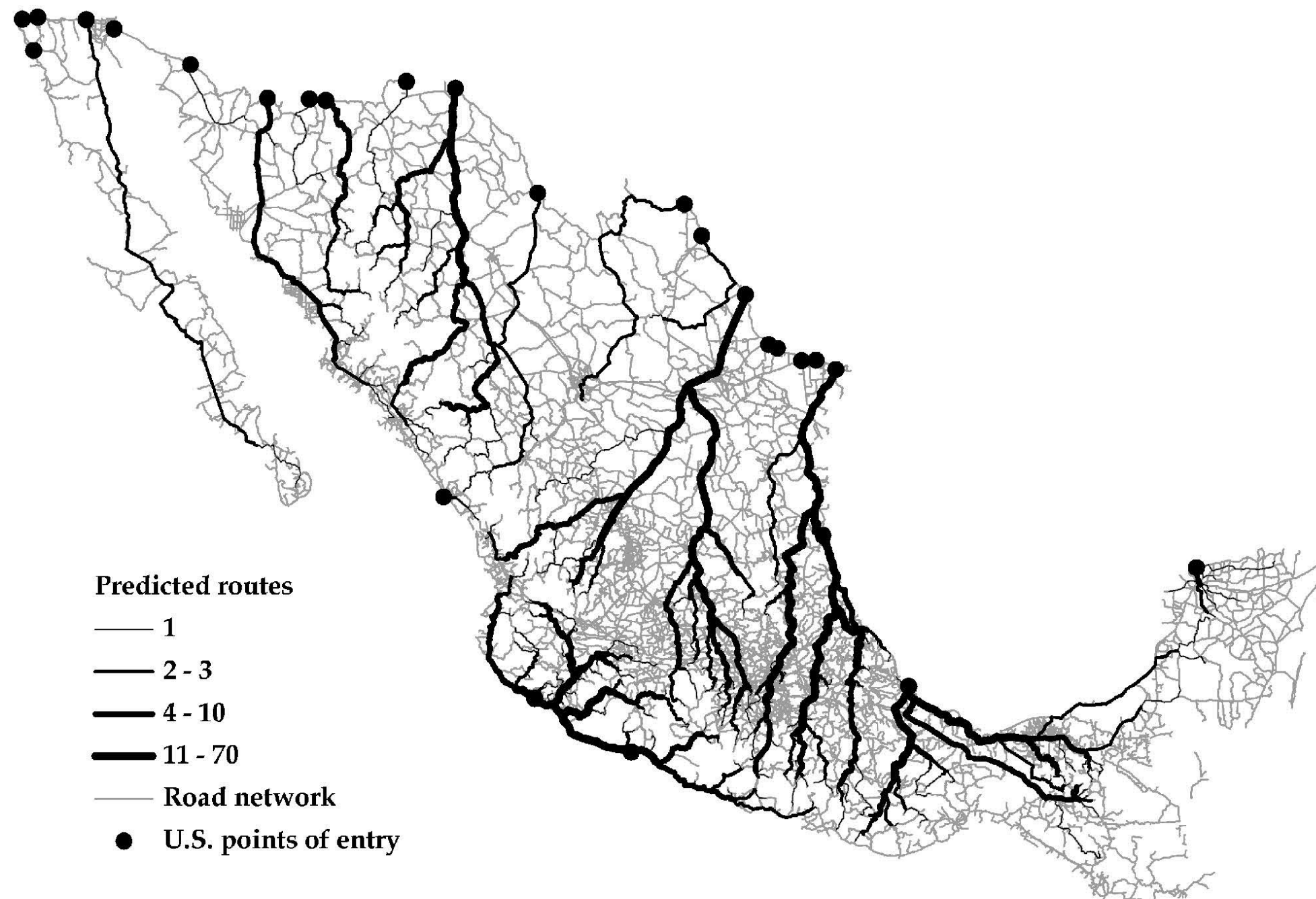
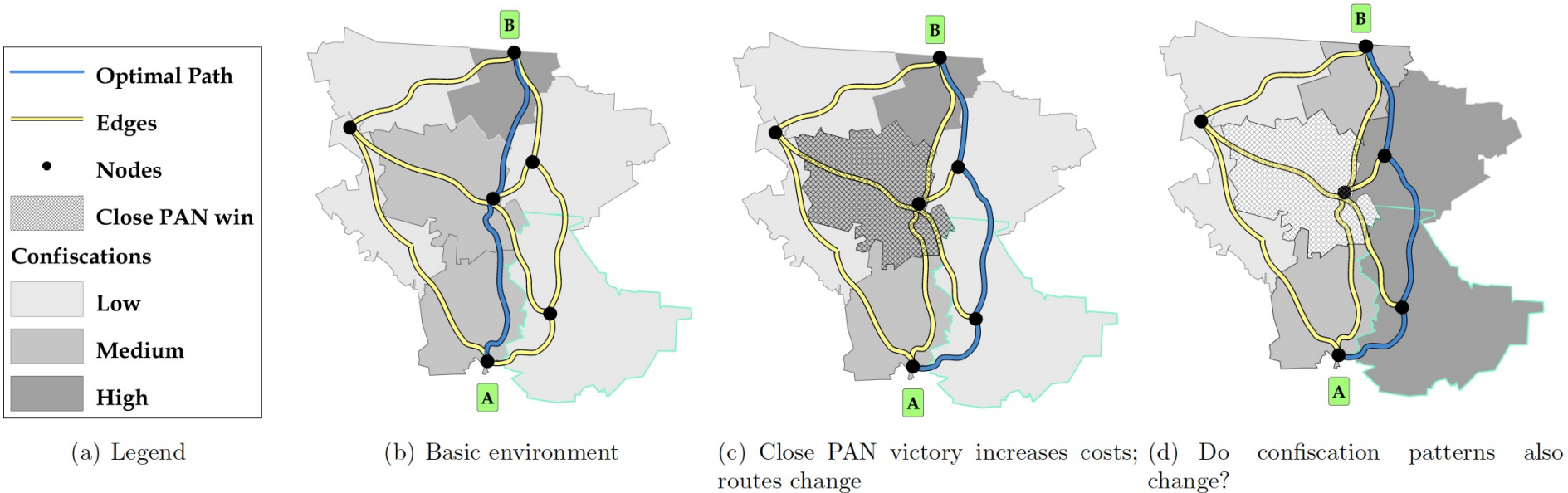


Illustration of Spillovers Methodology



GEO-REFERENCING

Crating your own maps



ARCHIVE MAPS

Spanish Kingdoms 1030



BE CAREFUL!



Source: [The Economists](#)



AERIAL PICTURES

Warsaw Before, During and After WWII



Source: [The Economists](#)



OWN COLLECTION



Source: [LSMS-ISA](#)



GEOREFERENCING DESKTOP SOLUTION (RECOMMENDED!)

BASIC DEFINITION

- Geo-located an image
 - Using parallels
 - Reference Points
 - Other information
 - Output?
- Once geo-referenced
 - Create polygons, points (output?)
 - Machine Learning Techniques - Classification (output?)
 - Visualization



STEP 1: GEOREFERENCING IN QGIS

- Plug-in: Georeferencer-GDAL(!)

Basic Steps:

- Image
- Set CRS
- Insert Reference Points
- Transformation



STEP 2: GENERATING A VECTOR

(editing)

Import!

- Check geometries
 - Geometry Checker (plug-in)
- Optimize polygons
 - PolygonSimplifier (plug-in)

Have a look to the [geo-referencing tools in ArcGIS](#) as well



CAN WE DO IT DIRECTLY IN PYTHON?

Yes, yet different solutions

Some nice packages for doing this

- pystretch: manipulate images larger than your RAM
- gdal

When can I consider this solution?

- Several pictures with the same source and location
- Automate geo-referencing



GEO-REFERENCING IN ACTION



THE LONG-TERM EFFECTS OF AFRICA'S SLAVE TRADES

Nathan Nunn

The Quarterly Journal of Economics (2008) 123 (1): 139-176.

(GIS strategy replication)



THE PAPER

Can part of Africa's current underdevelopment be explained by its slave trades?

DATA

Slaves exported from each country

- from each port of Africa
- Ethnicity of a sample of 100,00+ slaves
- Ethnic homeland in Africa



REDUCED FORM

$$y_i = \alpha + \beta \ln\left(\frac{export_i}{area_i}\right) + X_i' + \varepsilon_i$$

y_i	GDP per capita in country i in 2000
$exports_i$	# of slaves exported 1400-1900 from country i
$area_i$	Land surface area of country i
X_i'	Controls

THE VALUE OF DEMOCRACY: EVIDENCE FROM ROAD BUILDING IN KENYA

Robin Burgess, Remi Jedwab, Edward Miguel, Ameet
Morjaria, Gerard Padró i Miquel

The Quarterly Journal of Economics (2012) 127 (4): 1707-
1754



Ethnic favoritism using data on road building in Kenyan districts across the 1963–2011 period

EMPIRICAL REQUIREMENTS

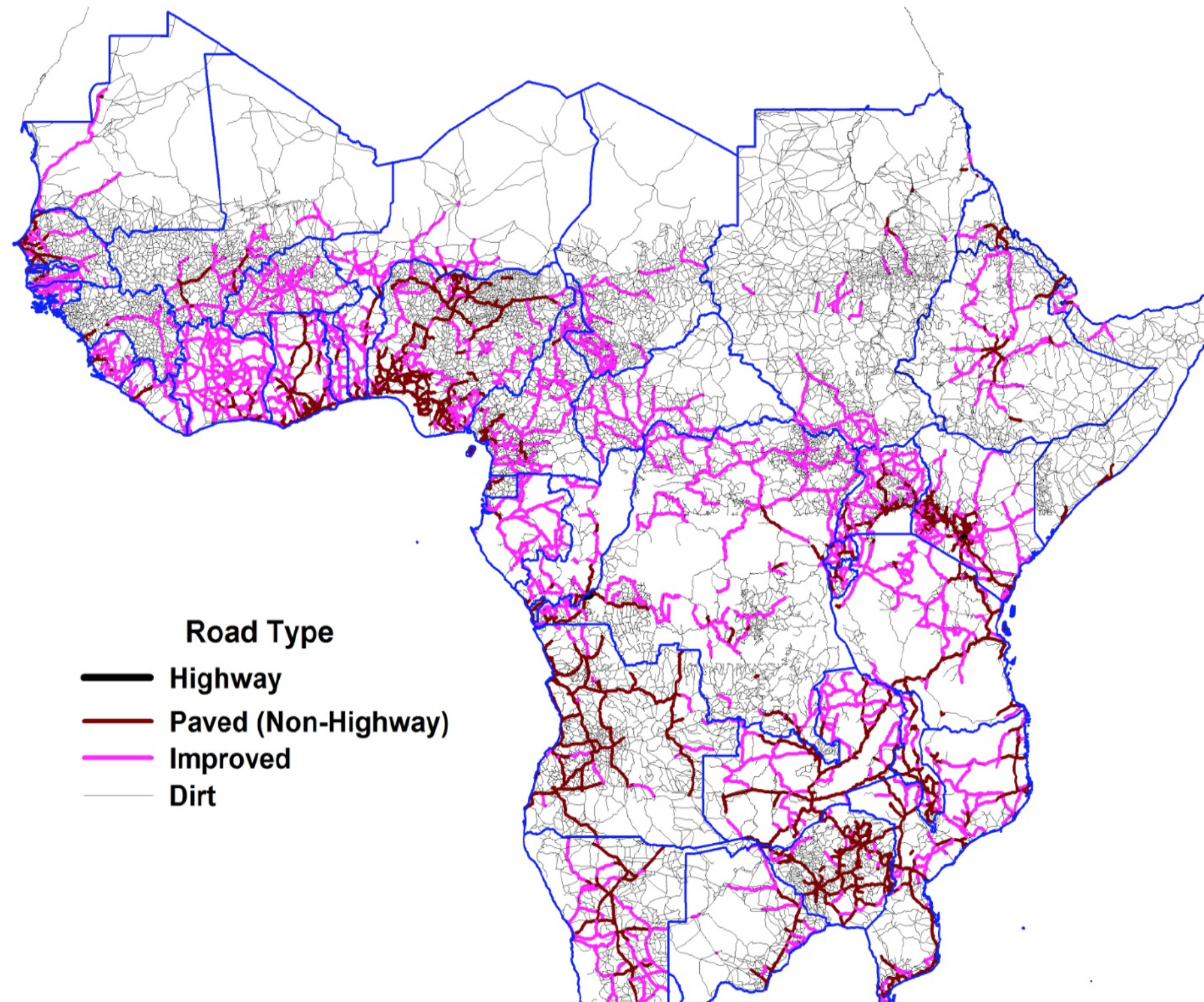
- Track road network expansion over time
- Baseline information on road maps
 - Digitize Michelin maps for Kenya since 1961



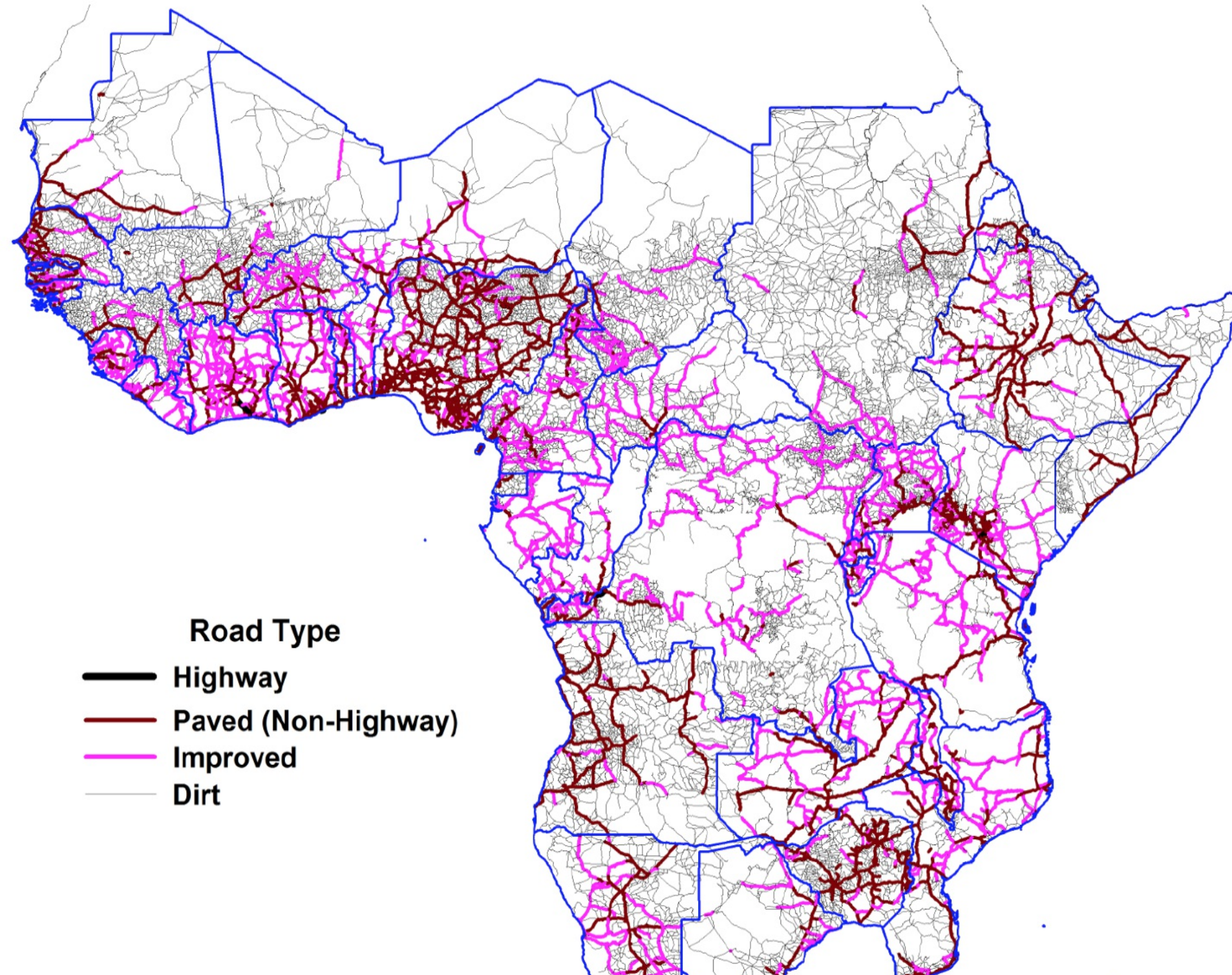
Michelin Road Map for Liberia in 1965 (example)



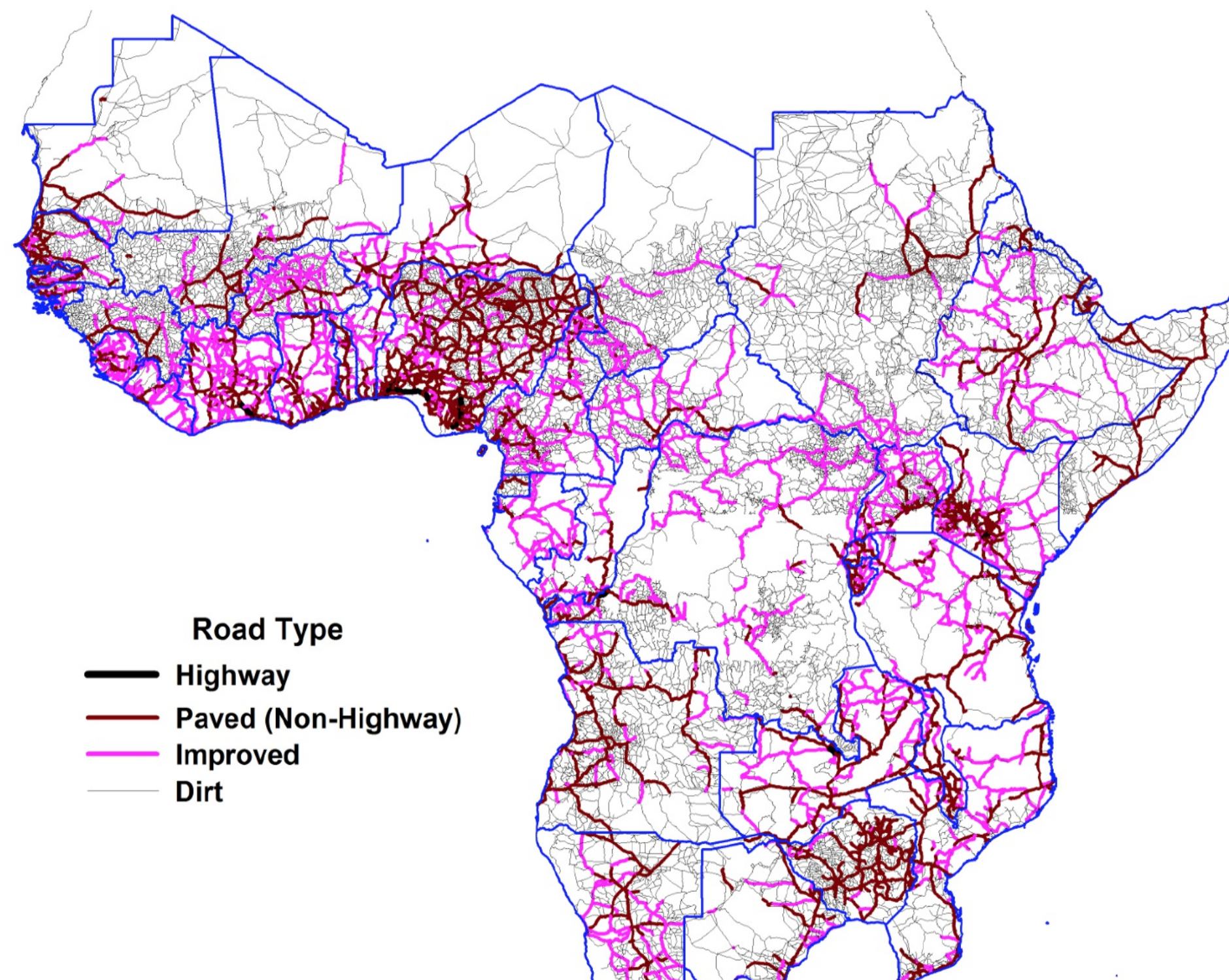
Michelin Road Map for Africa - 1960



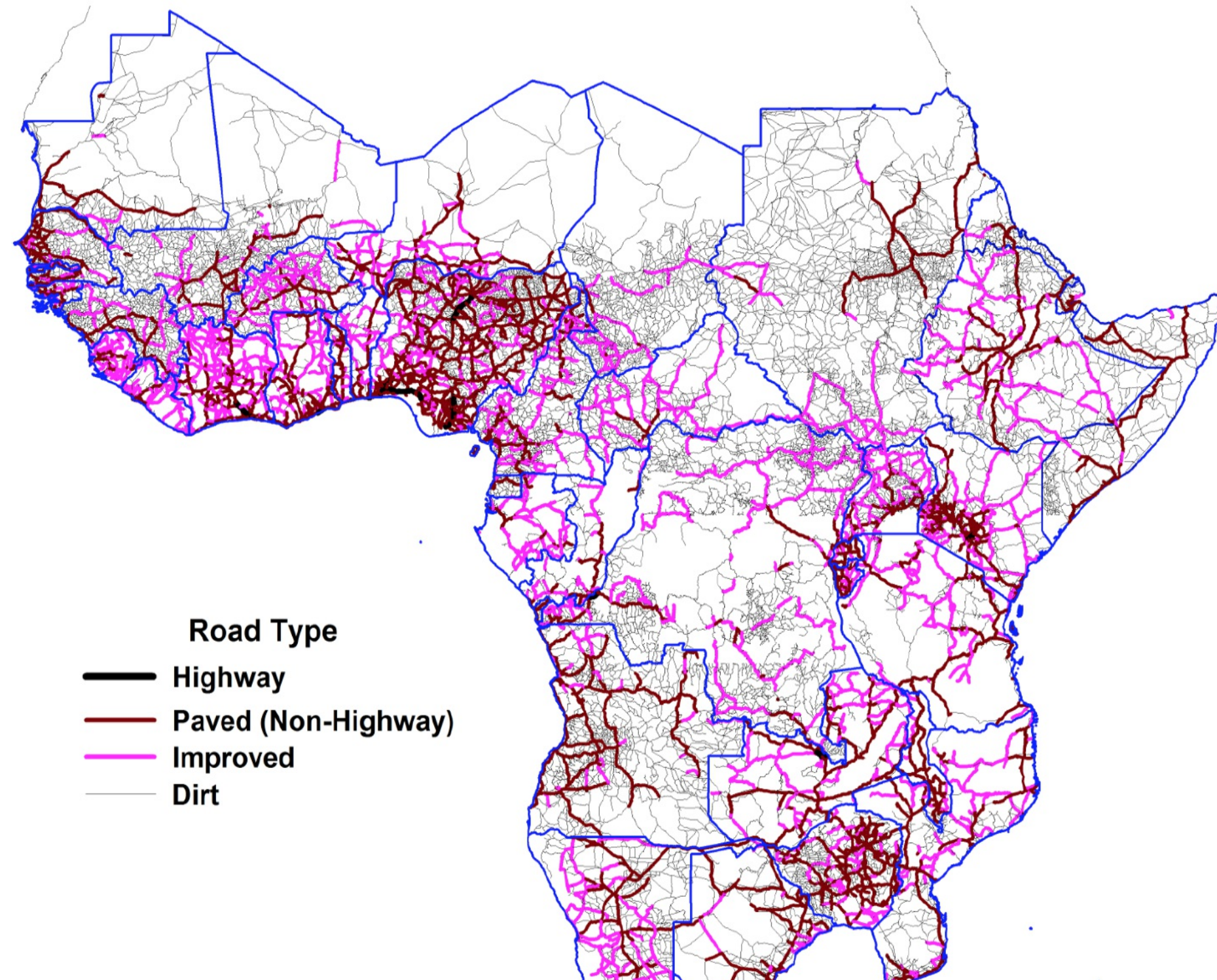
Michelin Road Map for Africa - 1980



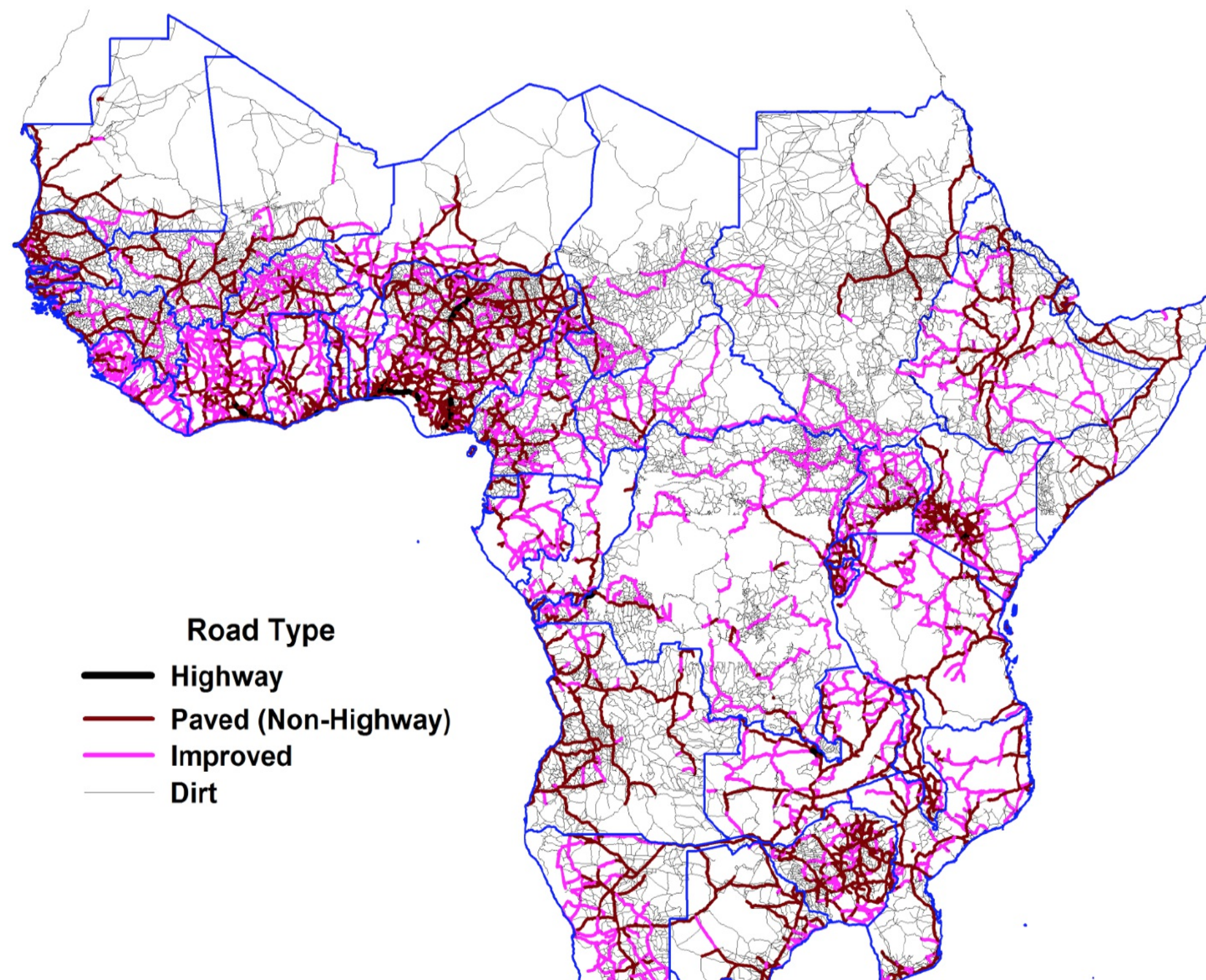
Michelin Road Map for Africa - 1990



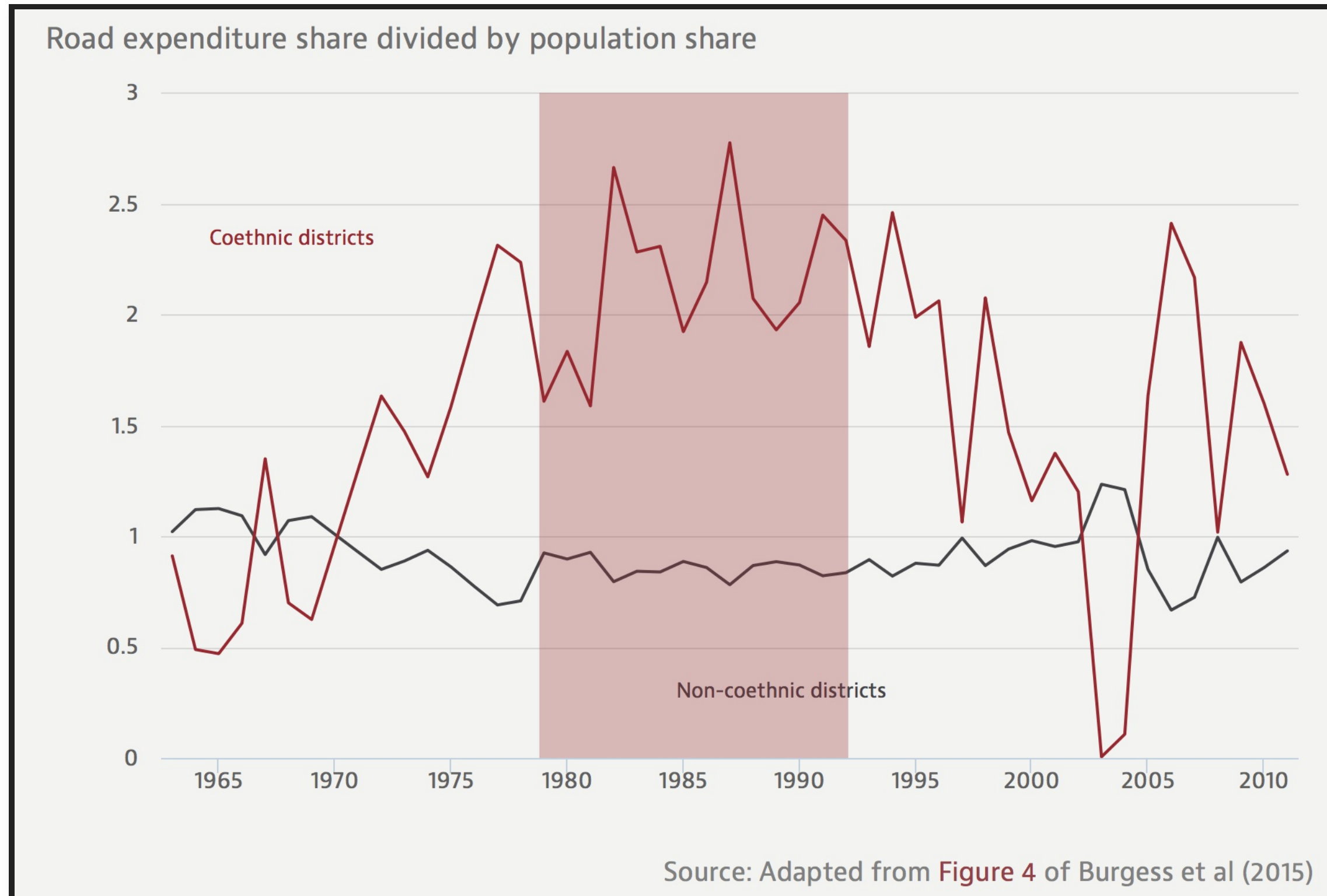
Michelin Road Map for Africa - 2000



Michelin Road Map for Africa - 2010



MAIN RESULTS



RAILROADS AND AMERICAN ECONOMIC GROWTH: A “MARKET ACCESS” APPROACH

Dave Donaldson and Richard Hornbeck.

Quarterly Journal of Economics, 131(2):799-858, 2016.

(please have a look!)



FINAL PRACTICE



GENERAL QUESTION

Is the current development (luminosity 2013) in current Spanish communities correlated with the former political division from Spanish Kingdoms 1210



SPANISH KINGDOMS 1210



THE PRACTICE (ROAD MAP)

1. Geo-reference the archived map
2. Create a new vector with this polygons
3. Get only Spanish territory
4. Attached to the current communities their correspondent Spanish Kingdoms
5. Get the sum of the total Nightlight
6. Present results visually
7. Get the mean test by Spanish Kingdoms
8. Present the results in a map

