

Krantz, Sebastian

**Working Paper**

## Optimal investments in Africa's road network

Kiel Working Paper, No. 2272

**Provided in Cooperation with:**

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

*Suggested Citation:* Krantz, Sebastian (2024) : Optimal investments in Africa's road network, Kiel Working Paper, No. 2272, Kiel Institute for the World Economy (IfW Kiel), Kiel

This Version is available at:

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# Appendix

Figure A1: Average Network Speed and WorldPop Population Estimate

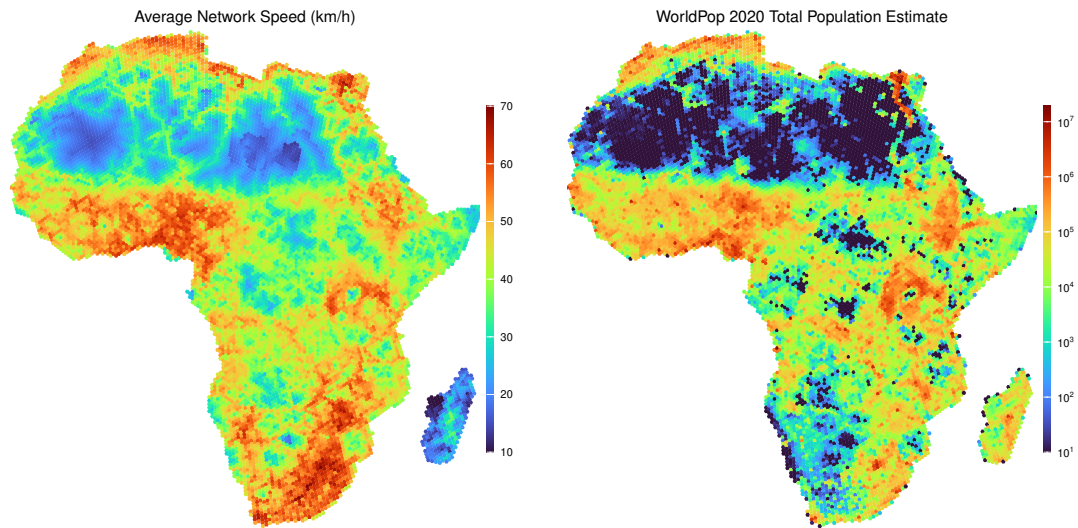


Figure A2: Gridded GDP and International Wealth Index

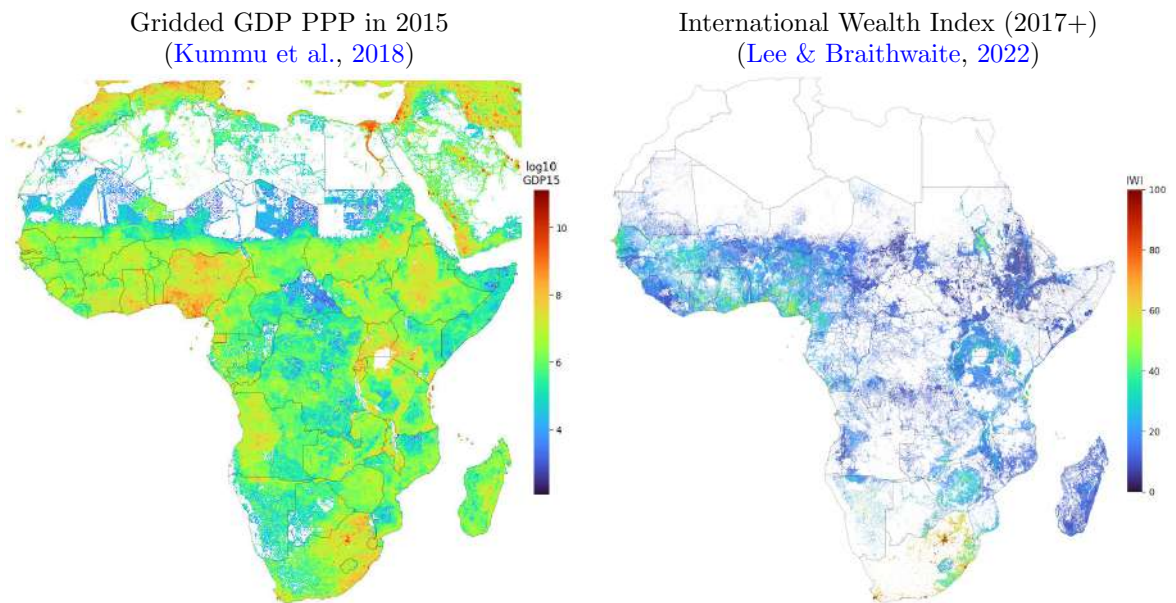
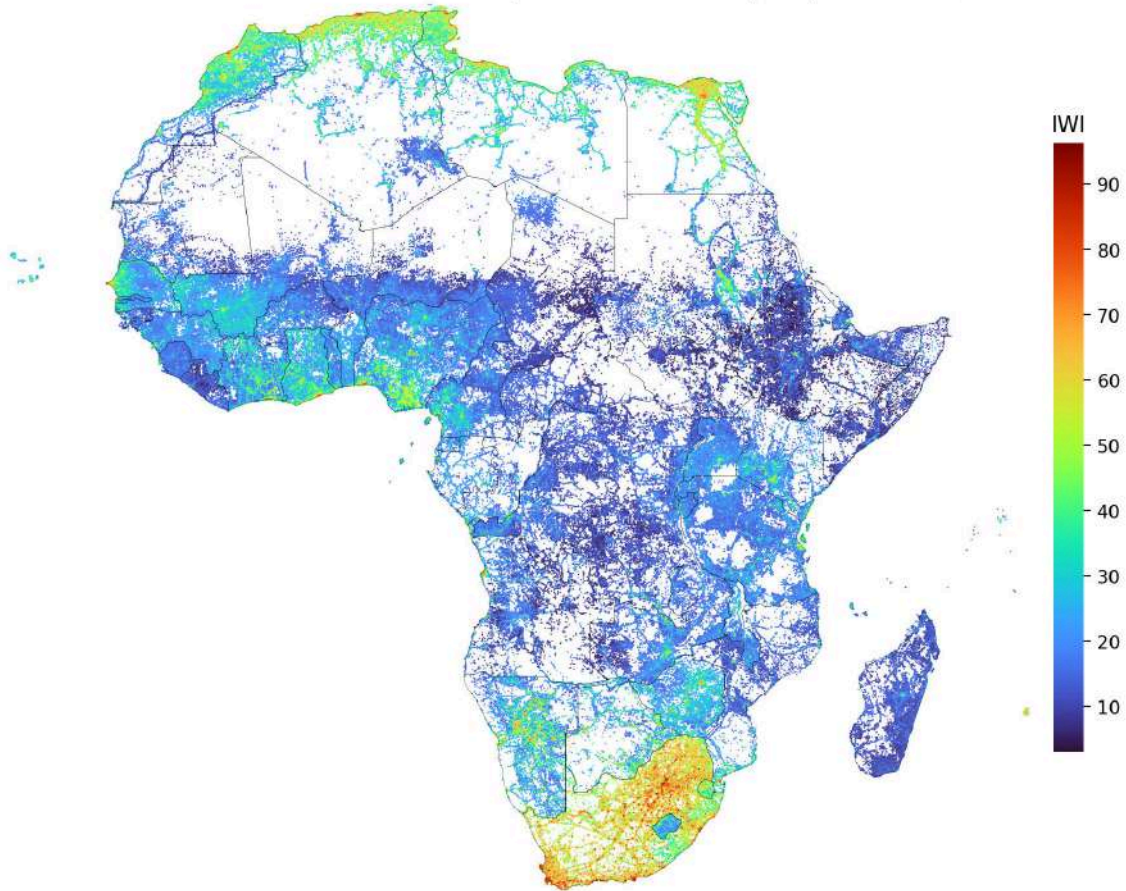


Figure A3: Imputed International Wealth Index using Database of [Krantz \(2023\)](#)

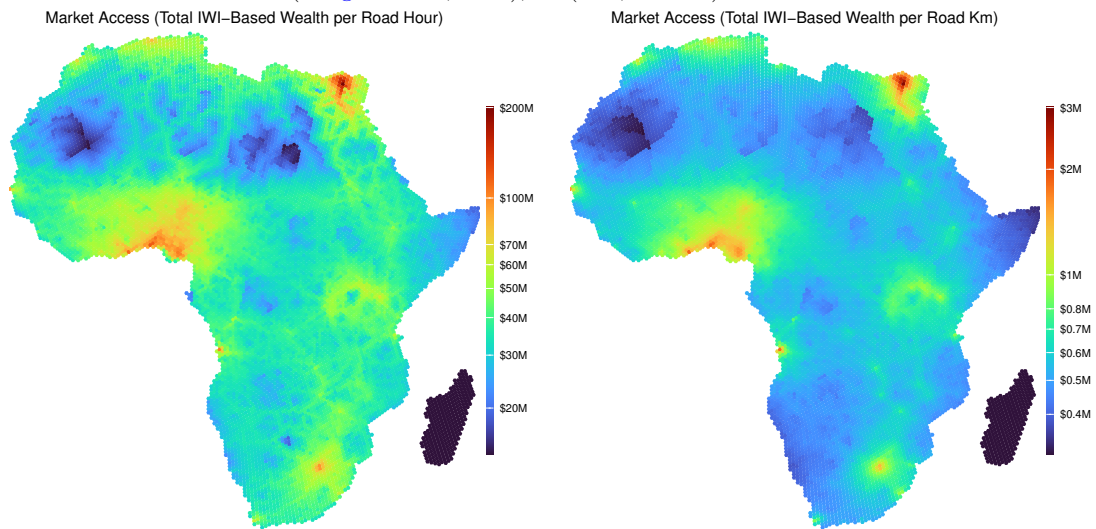
Predicted International Wealth Index: Imputed With MissForest, R-Squared = 0.970



**Notes:** The high  $R^2$  is not surprising as the estimates of [Lee & Braithwaite \(2022\)](#) also utilize many features from OSM in their methodology and Random Forests is very flexible. A concern with the imputation is that the relationship between infrastructure and wealth may be different south of the Sahara. [Lee & Braithwaite \(2022\)](#) mention the absence of (recent) DHS surveys in North Africa as an obstacle to extending their methodology to them. Their success in estimating cross-country models for all of SSA, including South Africa, however suggests that these models - approximated by *MissForest* - should also provide acceptable predictions in North Africa.

Figure A4: Market Access Maps using Total IWI-Based Wealth

$\theta = 1$  (Peng & Chen, 2021),  $\text{cor}(\text{MA}, \text{Wealth}) = 0.389\text{-}0.406$



$\theta = 3.8$  (Jedwab & Storeygard, 2022),  $\text{cor}(\text{MA}, \text{Wealth}) = 0.876\text{-}0.966$

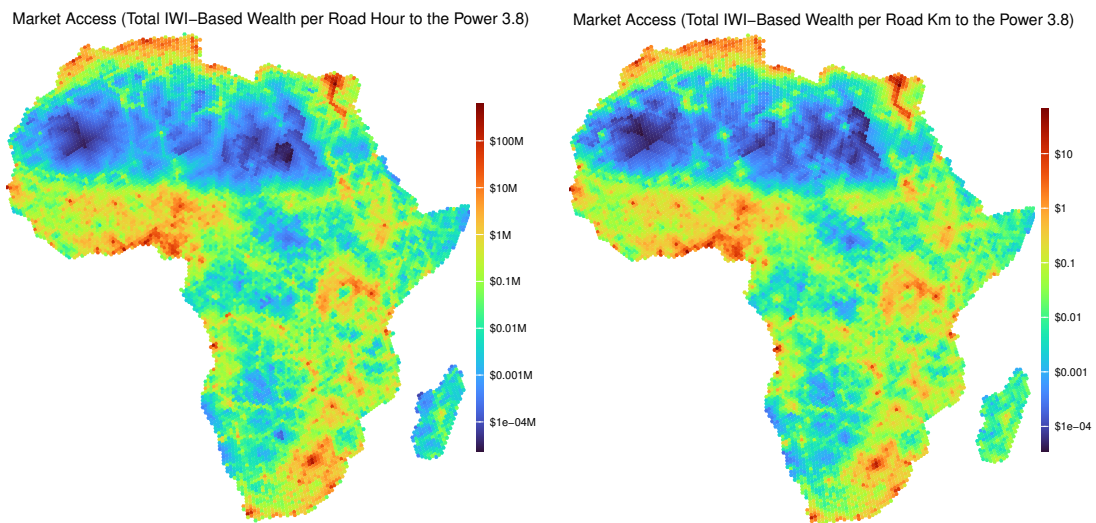
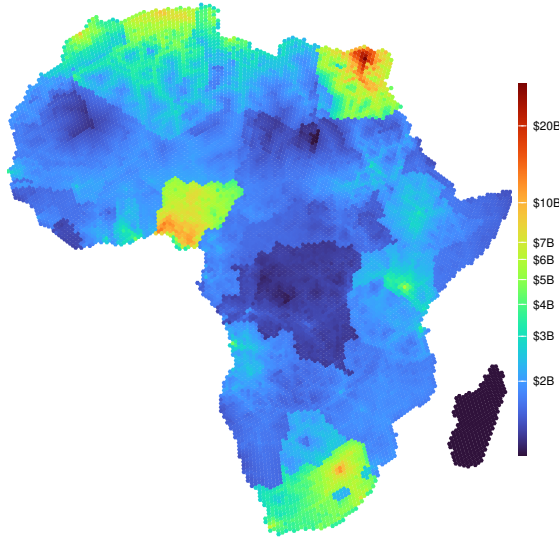




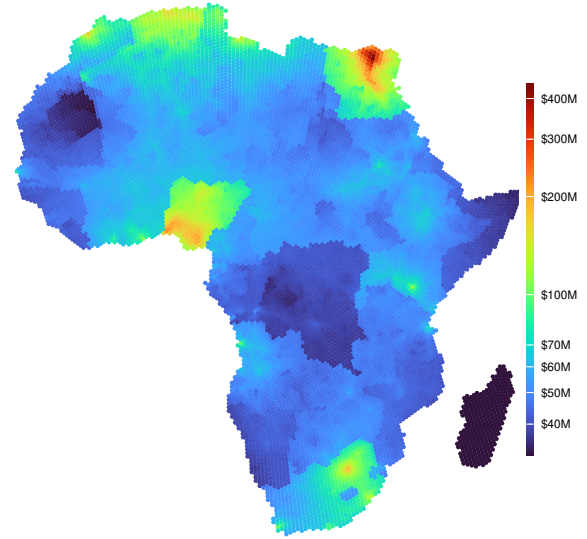
Figure A5: Market Access Maps using GDP in 2015 USD PPP: With Frictions

$\theta = 1$  (Peng & Chen, 2021),  $\text{cor}(\text{MA}, \text{GDP}) = 0.519-0.530$

Market Access (Total 2015 GDP PPP per Road Hour)

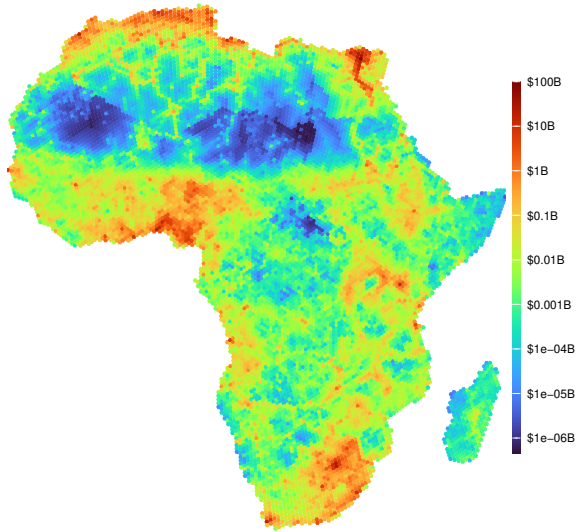


Market Access (Total 2015 GDP PPP per Road Km)



$\theta = 3.8$  (Jedwab & Storeygard, 2022),  $\text{cor}(\text{MA}, \text{GDP}) = 0.894-0.962$

Market Access (Total 2015 GDP PPP per Road Hour to the Power 3.8)



Market Access (Total 2015 GDP PPP per Road Km to the Power 3.8)

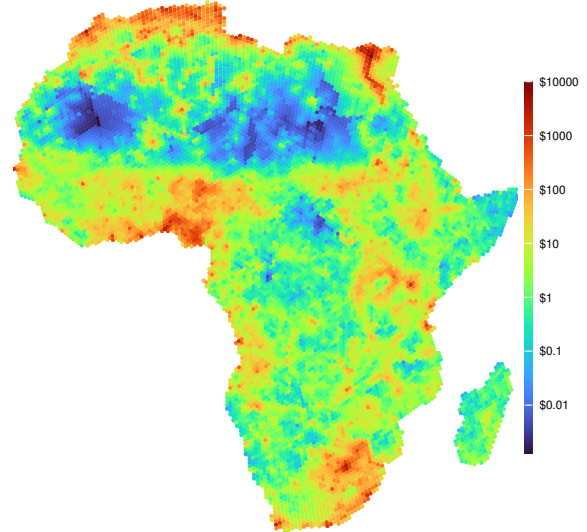
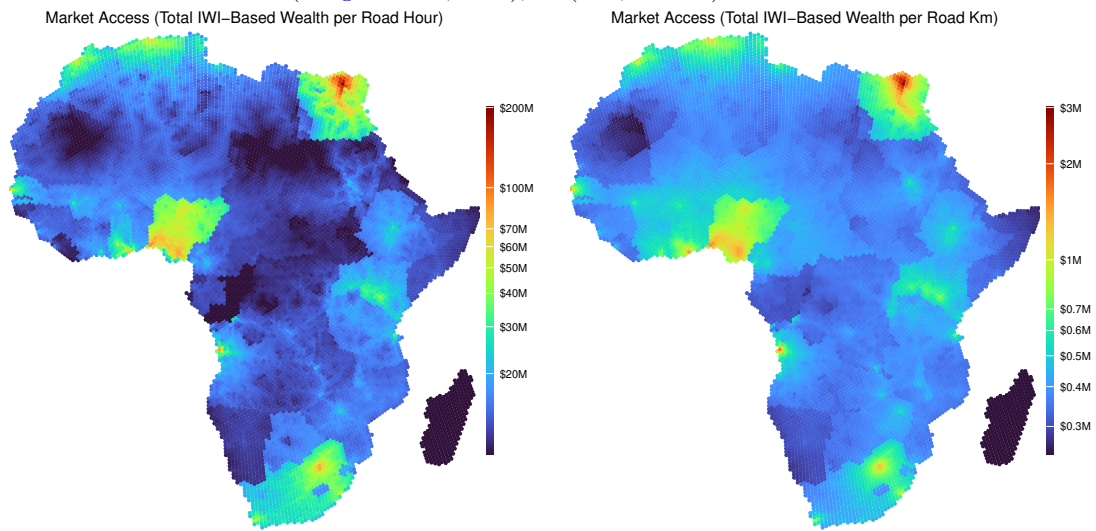


Figure A6: Market Access Maps using Total IWI-Based Wealth: With Frictions

$\theta = 1$  (Peng & Chen, 2021),  $\text{cor}(\text{MA}, \text{Wealth}) = 0.449\text{-}0.451$



$\theta = 3.8$  (Jedwab & Storeygard, 2022),  $\text{cor}(\text{MA}, \text{Wealth}) = 0.875\text{-}0.966$

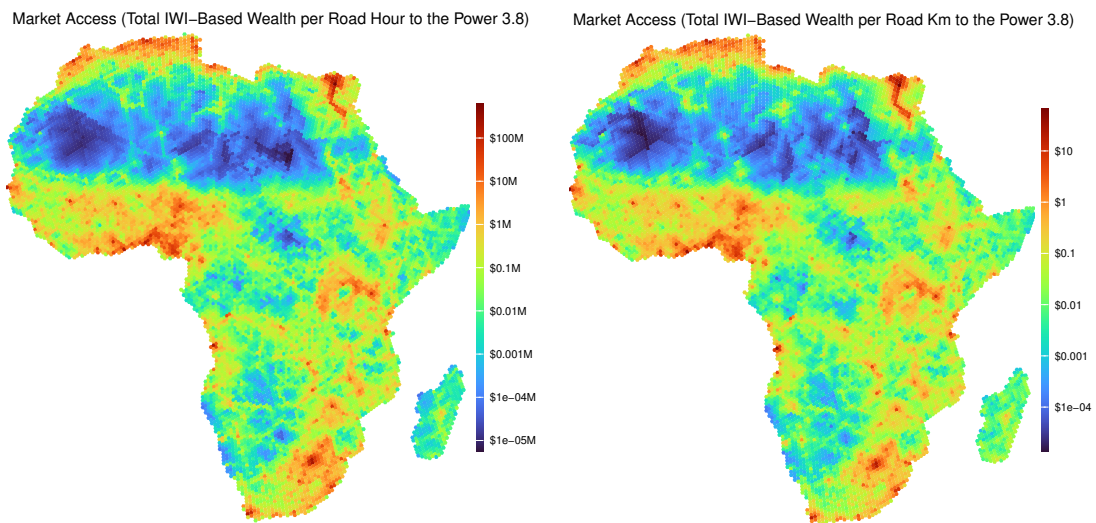
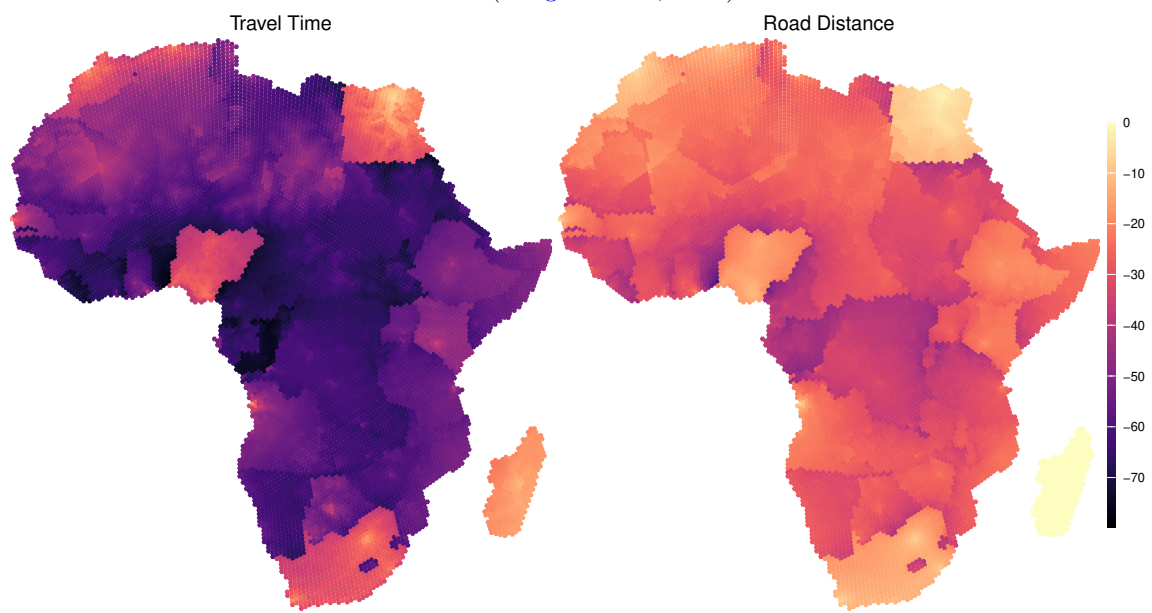


Figure A7: Market Access Loss (%) from Border Frictions using Total IWI-Based Wealth

$\theta = 1$  (Peng & Chen, 2021)



$\theta = 3.8$  (Jedwab & Storeygard, 2022)

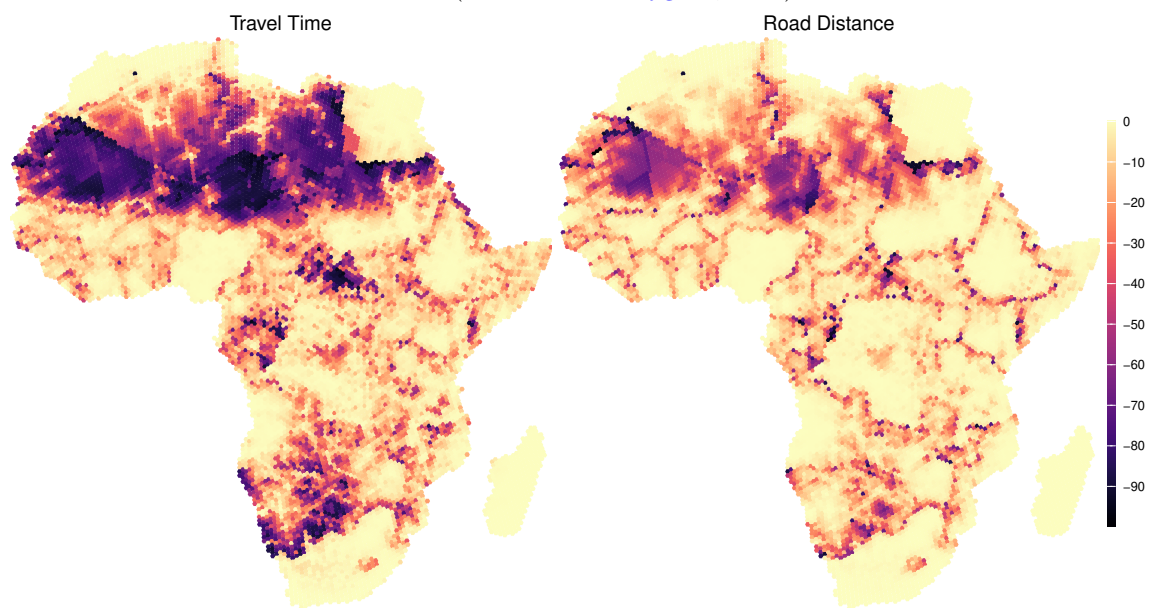




Figure A8: Optimized Full Network Graph: Duration Weighted Edges

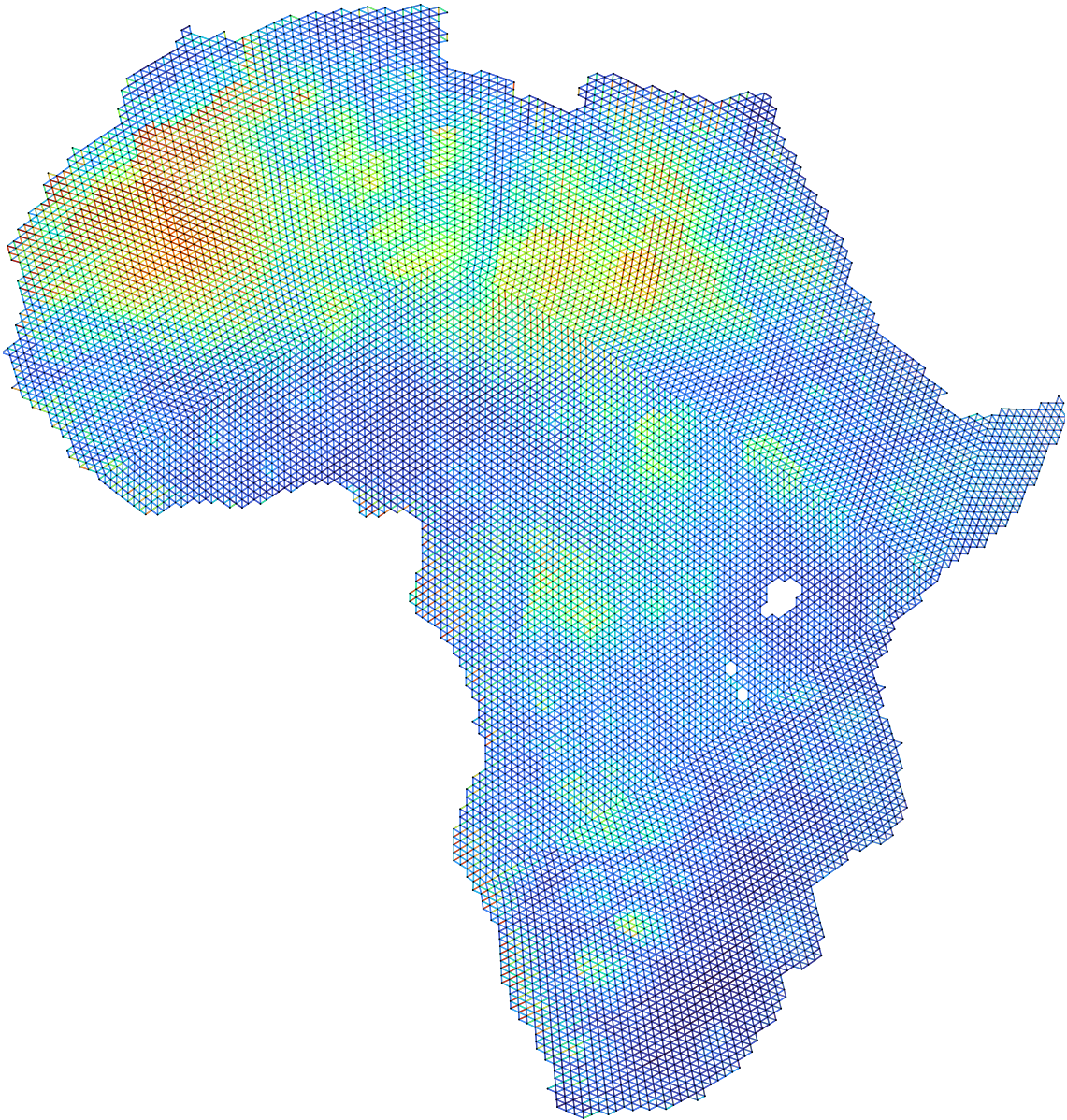




Figure A9: Discretized Trans-African Network Plus Original Routes

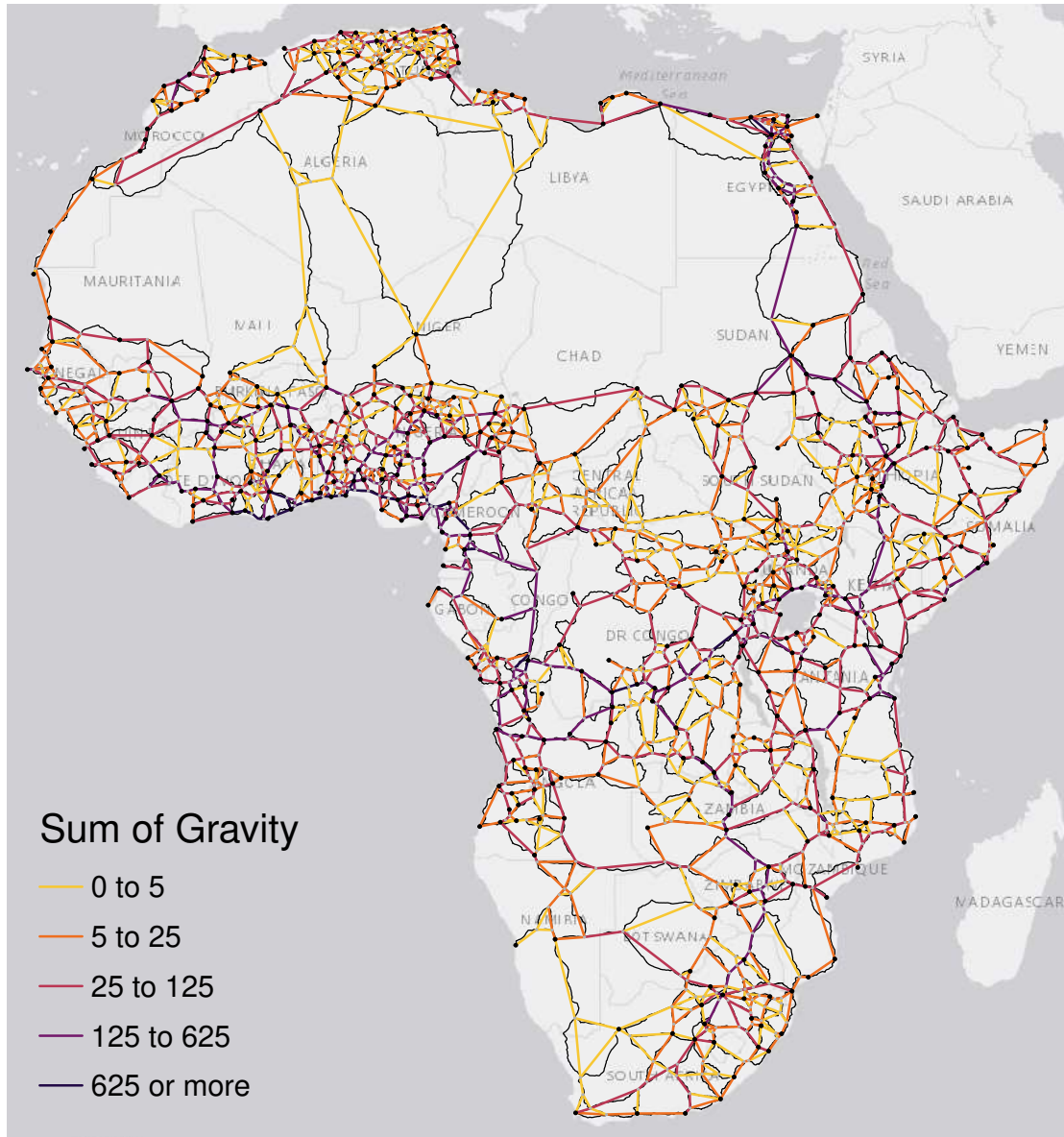


Figure A10: Discretized Trans-African Network and New Links for US Route Efficiency

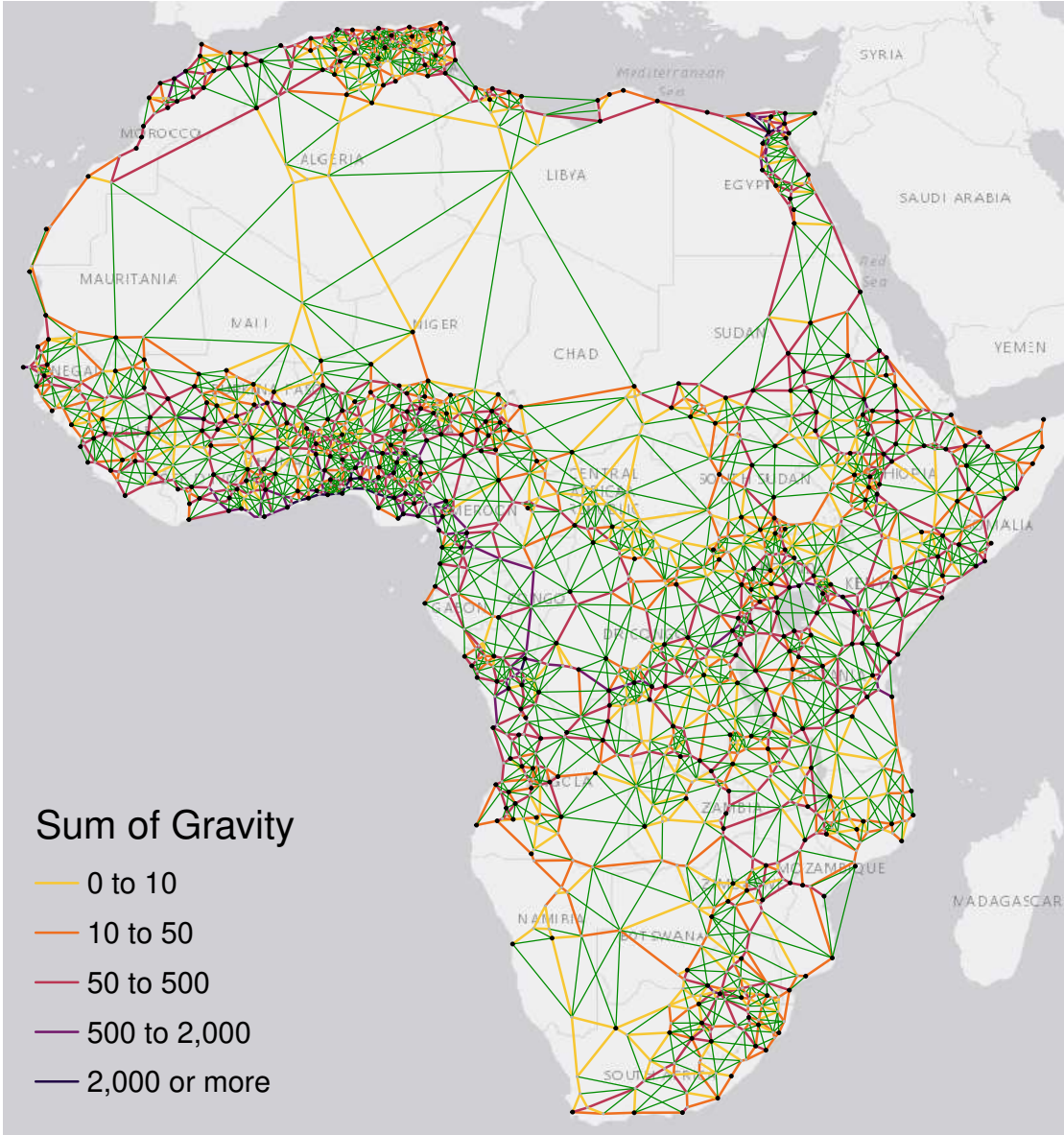


Figure A11: Local Road Distance Reduction:  $\min(\kappa_{ik}^r) = 0.85$

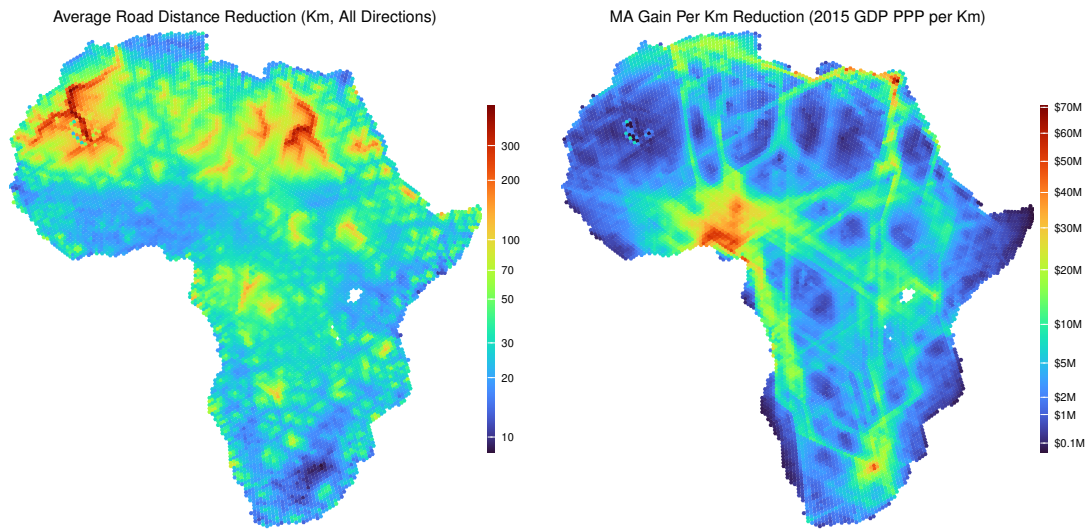


Figure A12: Estimated Network Building Cost per Kilometer

Total Network Building Cost Estimate      New Links + Algeria-Morocco 3× Cheaper

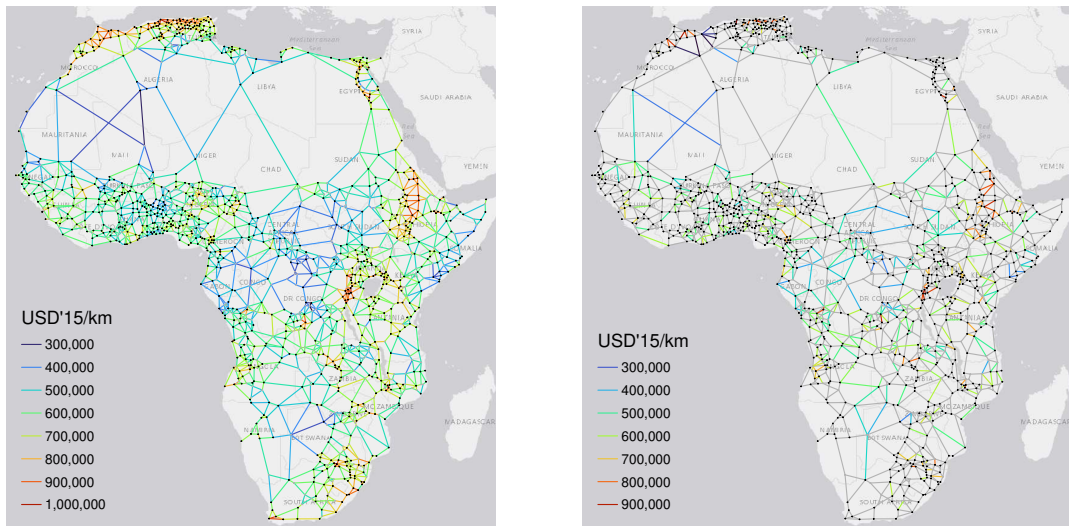


Figure A13: Nightlights vs. IWI to Measure City Productivity

Nightlights/Capita (20km Buffer)      IWI by Lee & Braithwaite (2022)

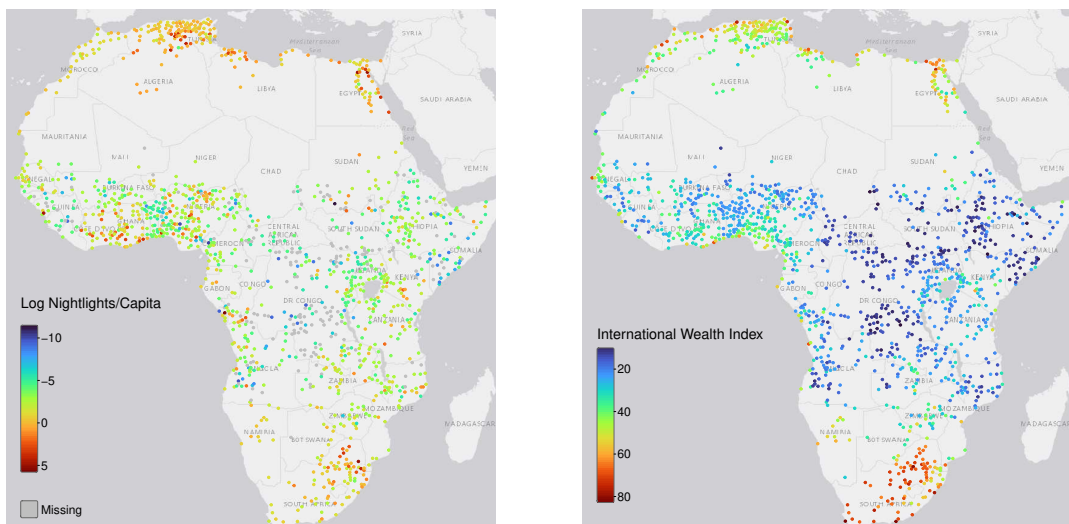




Figure A14: Optimal \$50B Investments, Trade, and Welfare by  $\sigma$

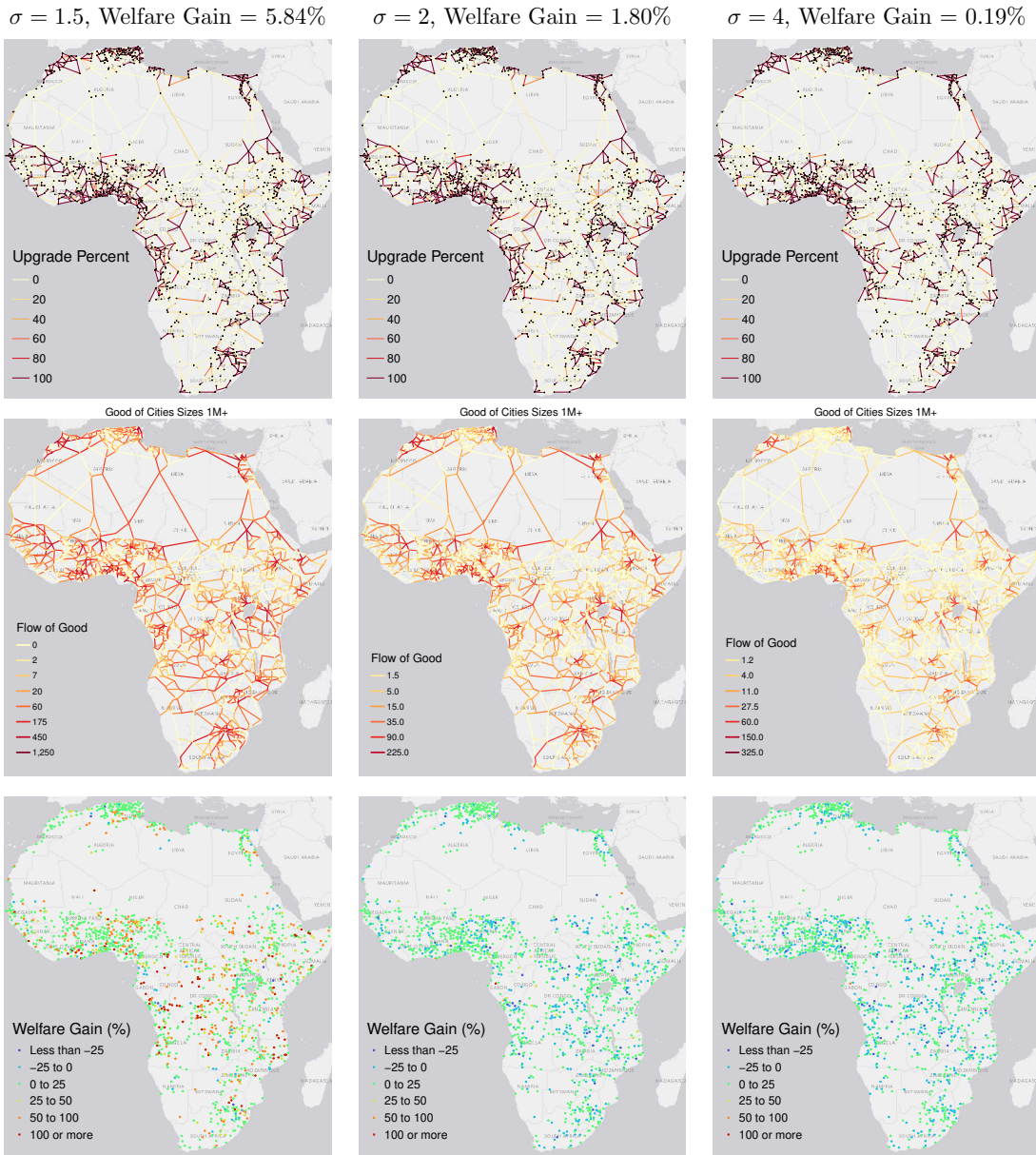


Figure A15: Optimal Infrastructure Allocation Without Imported Goods

Without Imported Goods

Difference to Allocation with Imports

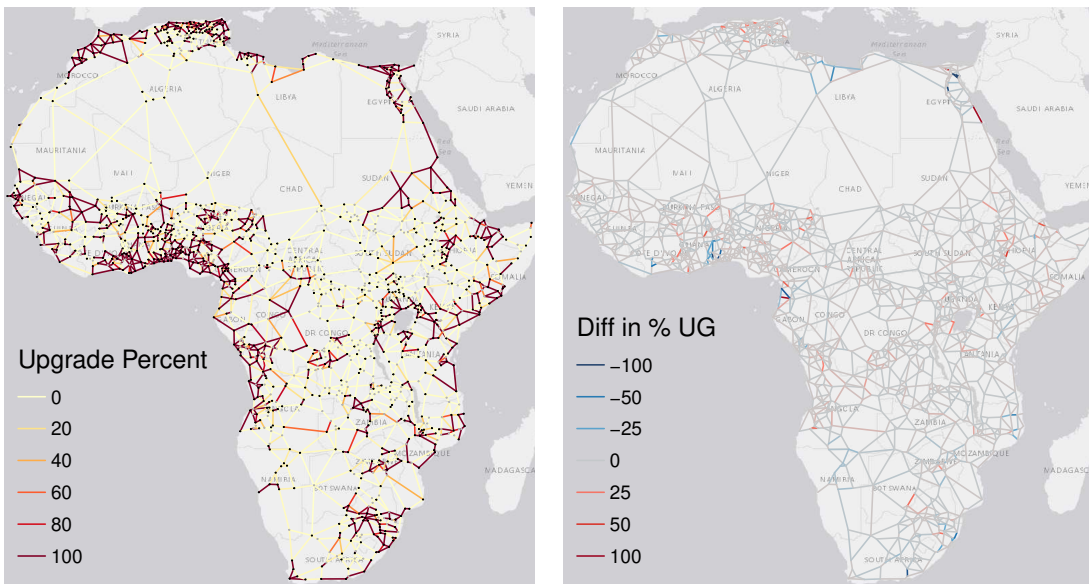




Figure A16: Ratio of Goods Flows under Border Frictions to Frictionless Flows

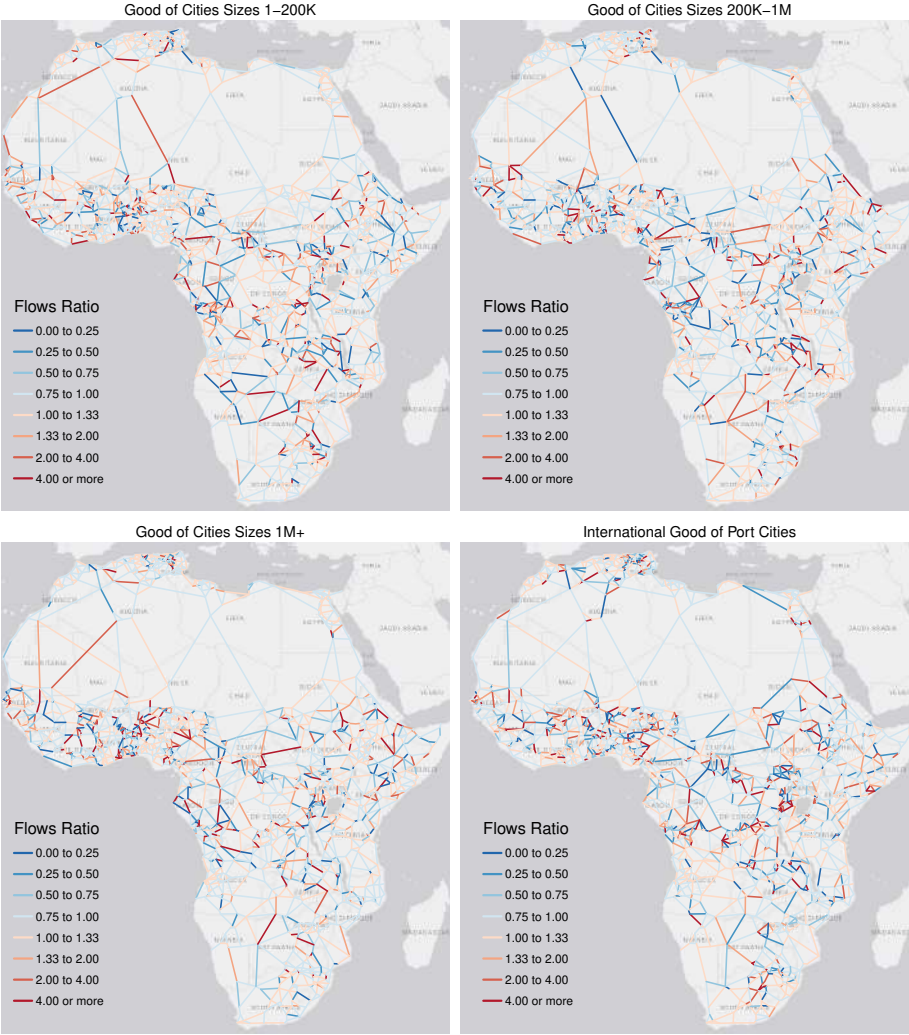


Figure A17: Flow of Goods and Local Consumption under IRS

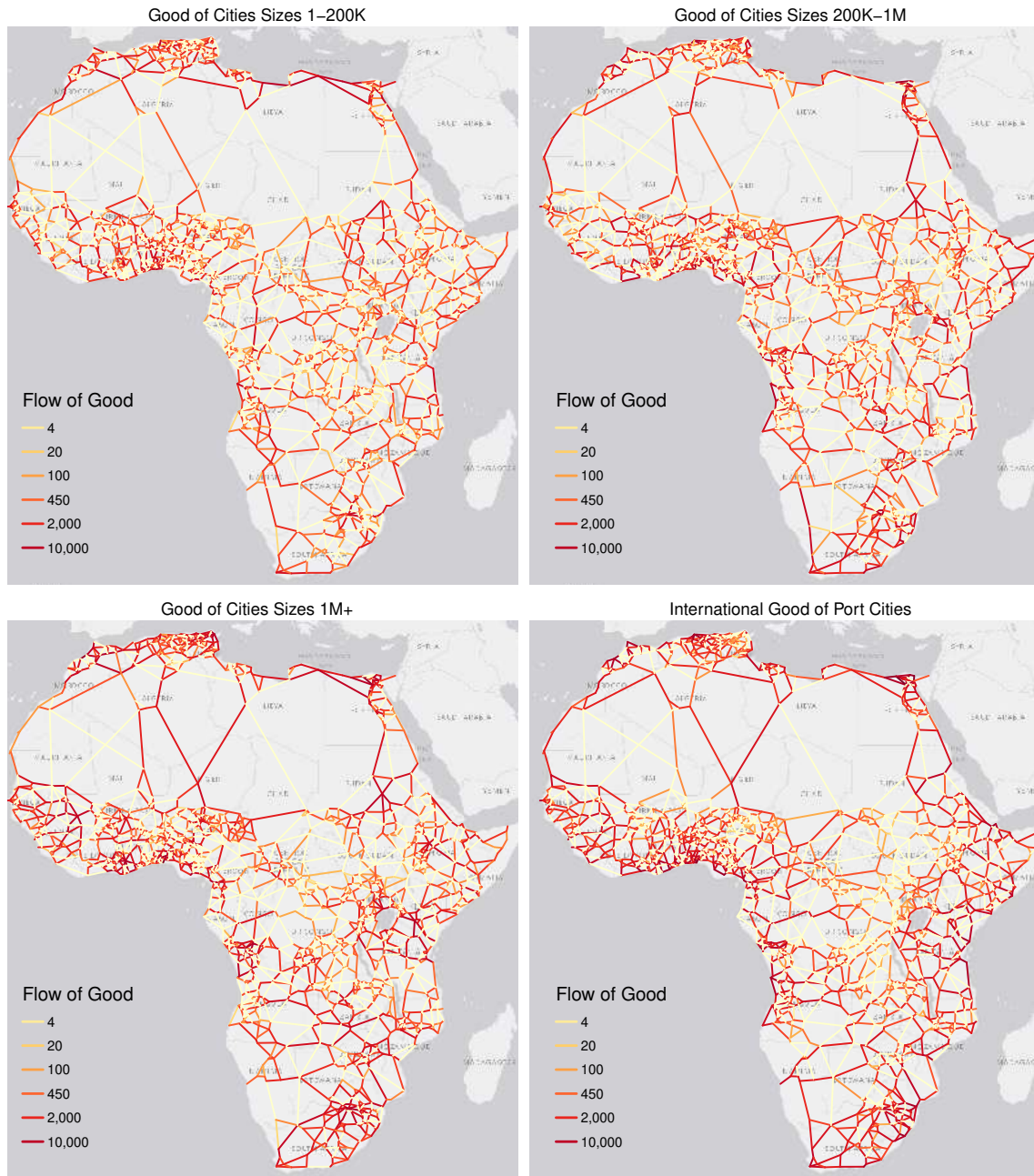


Figure A18: Optimal \$50B Investments, Trade, and Welfare under IRS by  $\sigma$

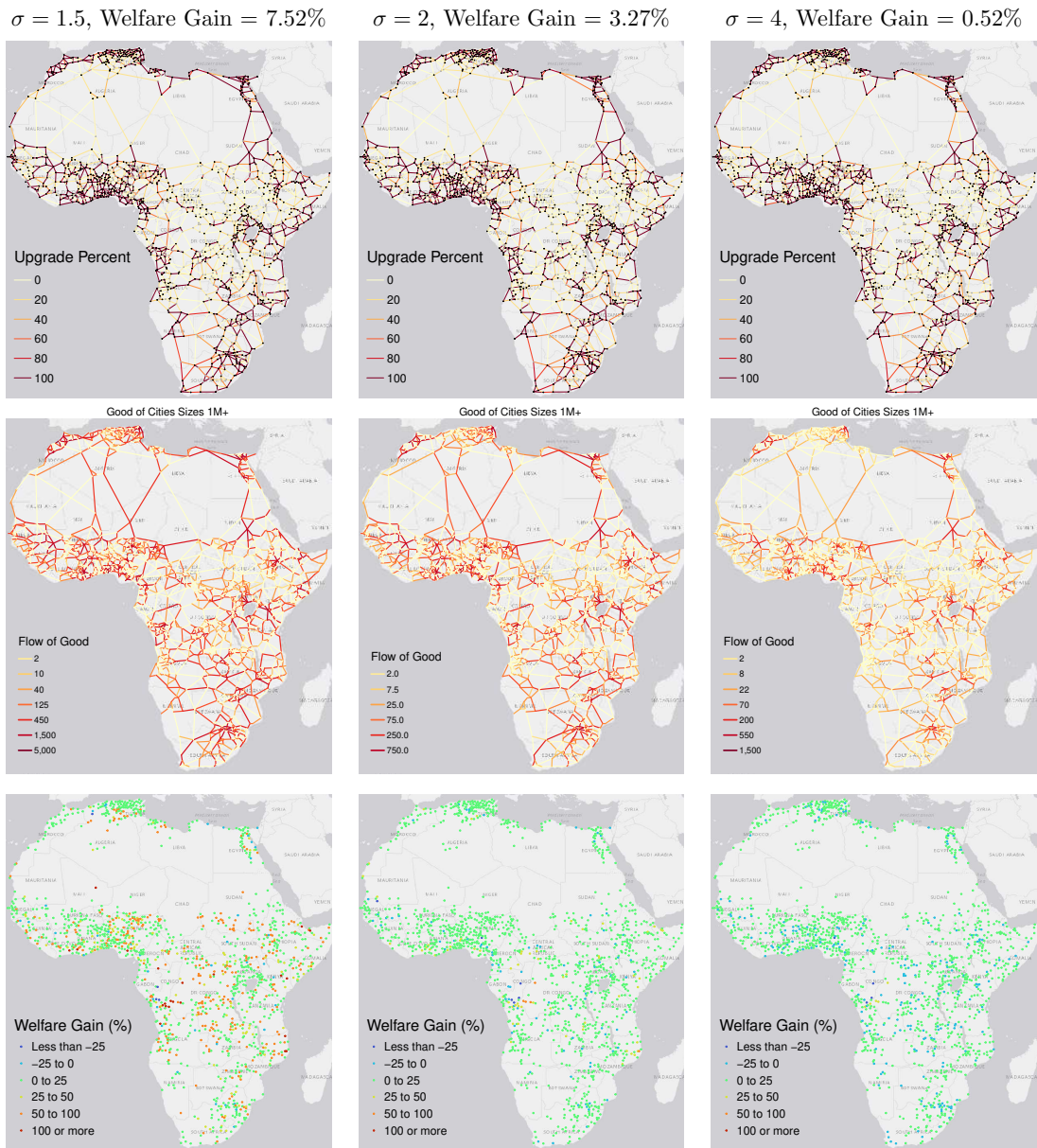


Figure A19: Optimal Infrastructure Allocation Without Imported Goods: IRS Case

Without Imported Goods

Difference to Allocation with Imports

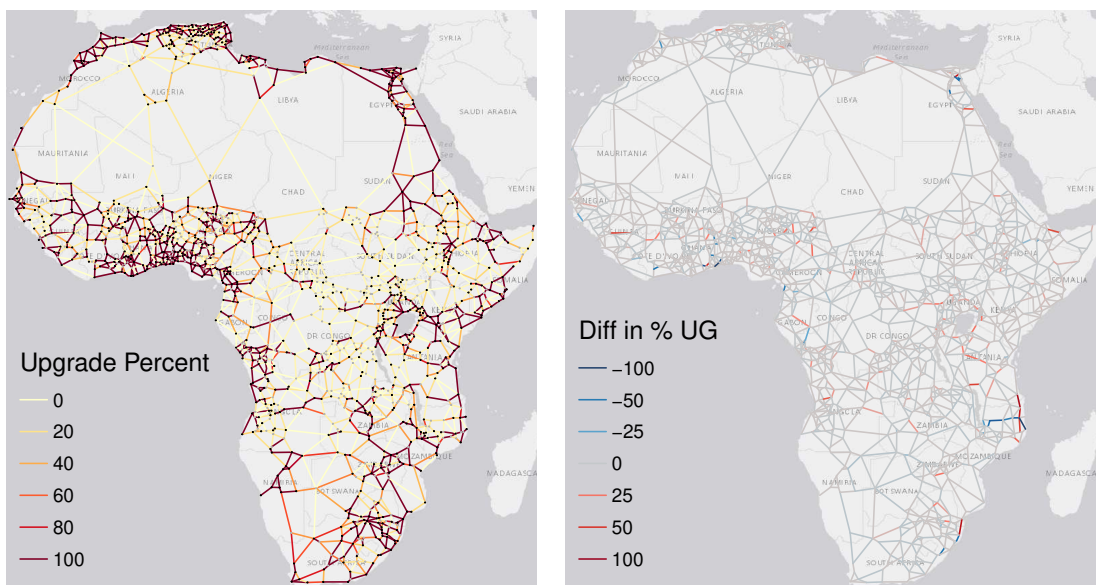


Figure A20: Ratio of Goods Flows under Border Frictions to Frictionless Flows: IRS Case

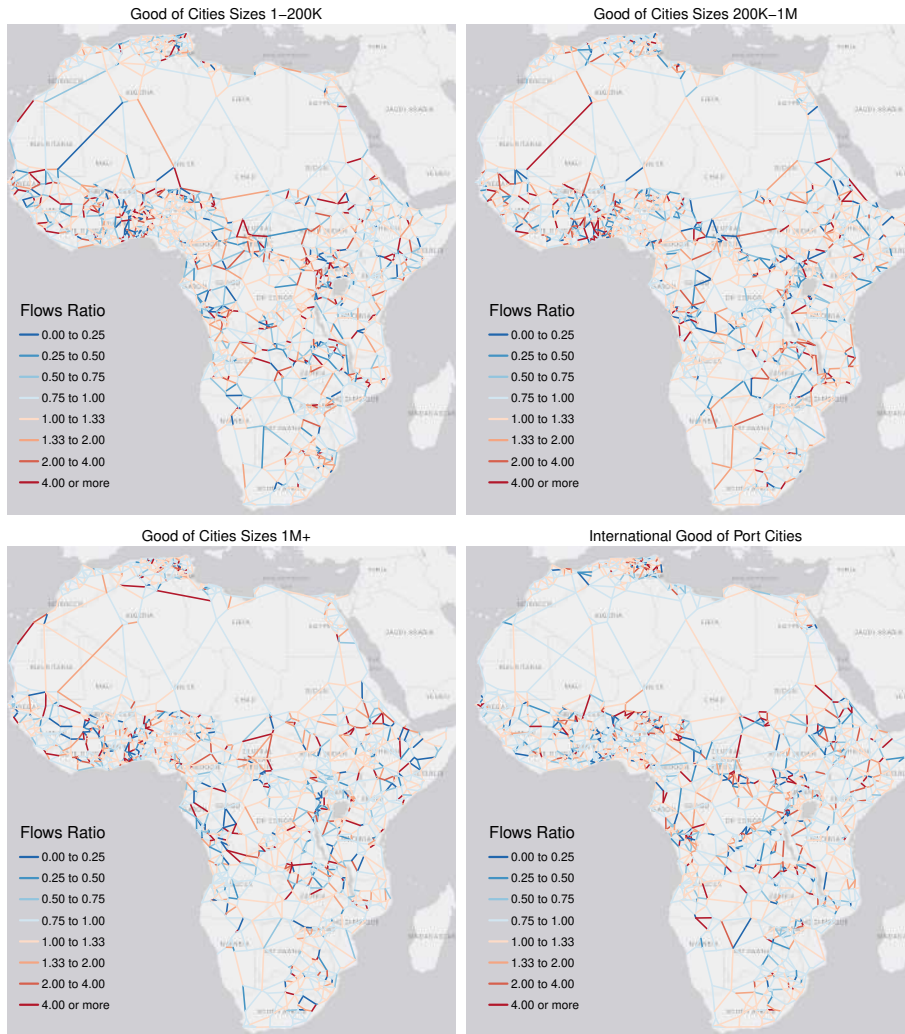




Figure A21: Trans-African Network Connecting Large Cities: Parameterization with Real Roads

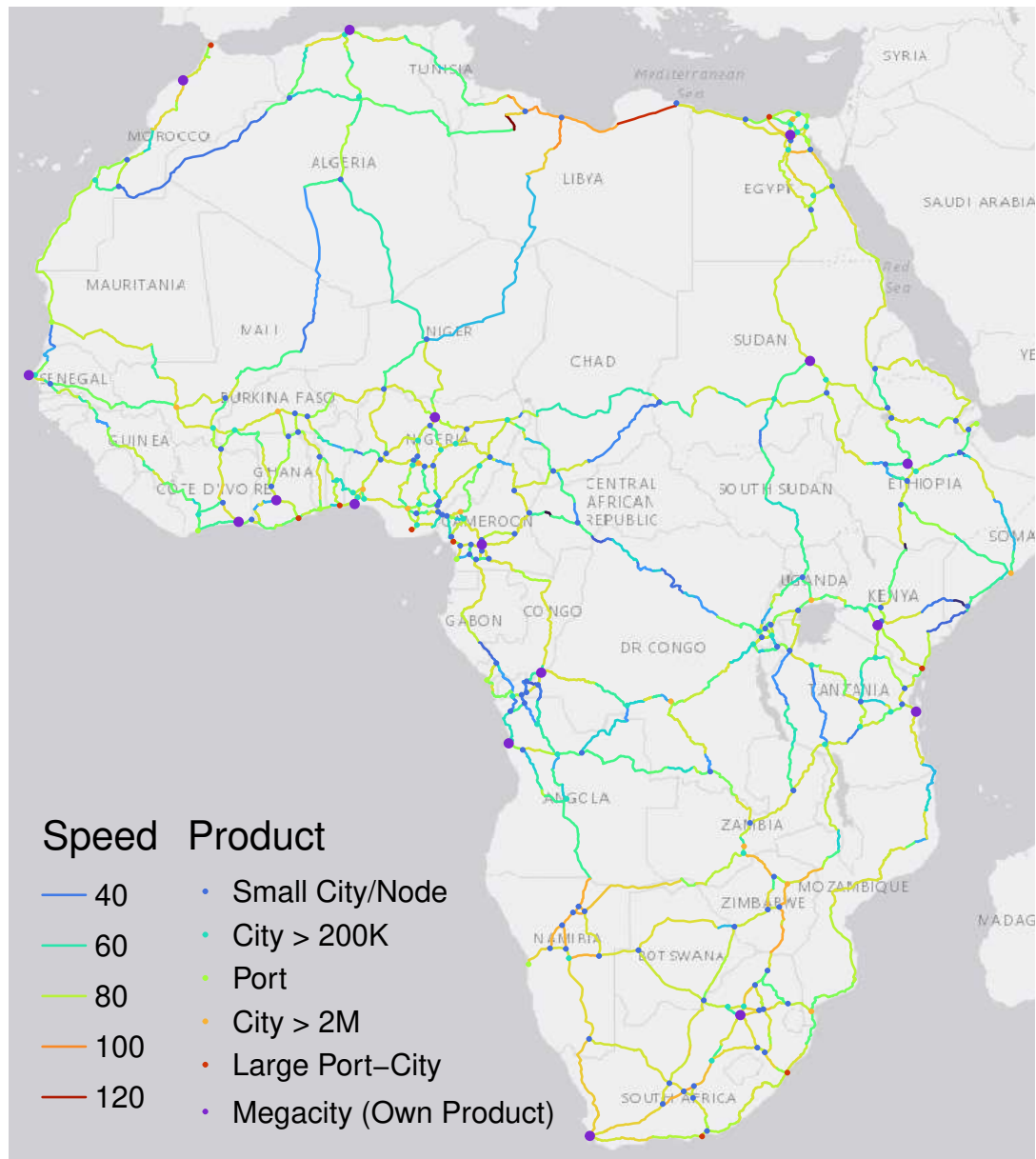


Figure A22: Flow of Goods Through Trans-African Network Connecting Large Cities

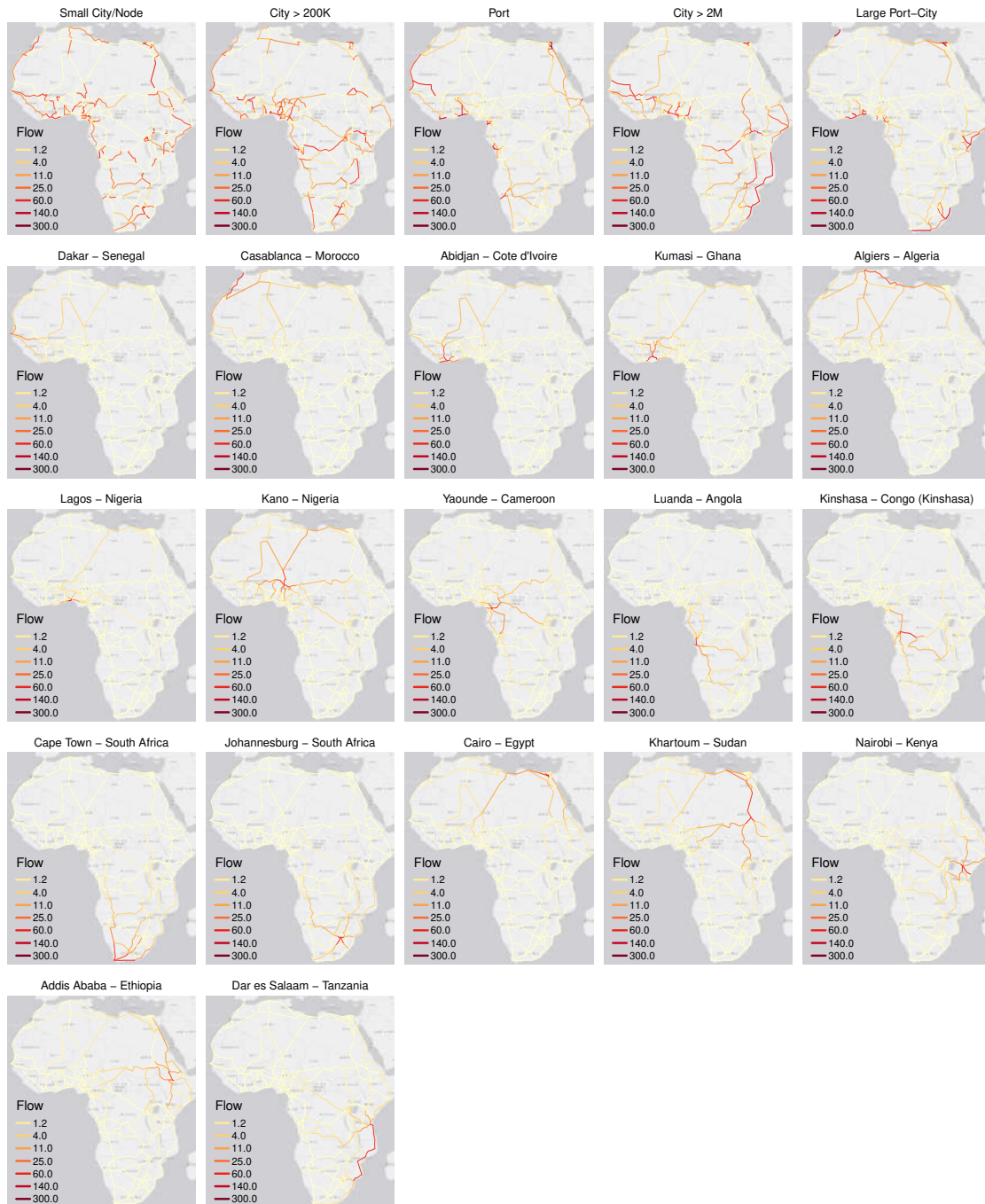
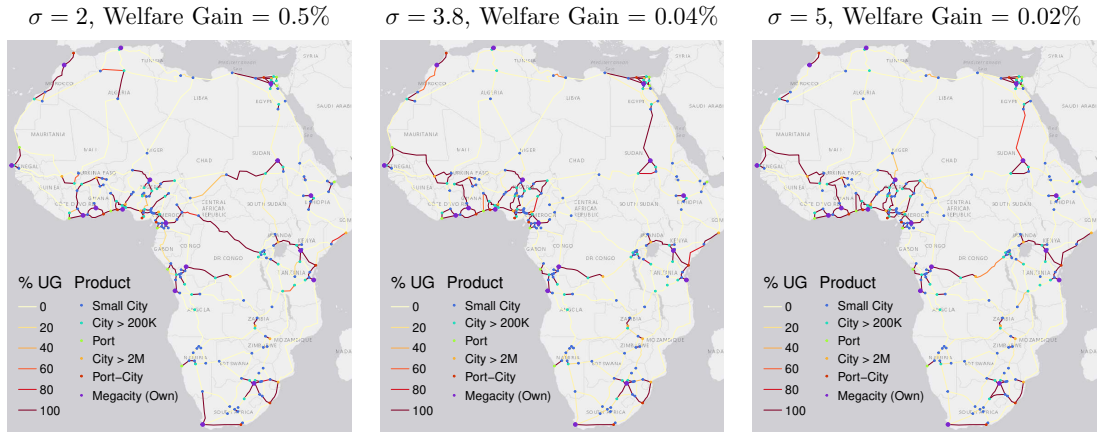
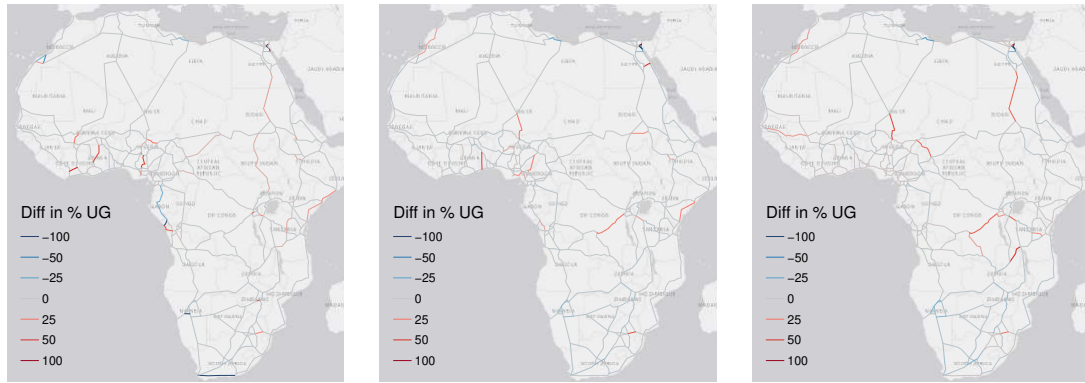


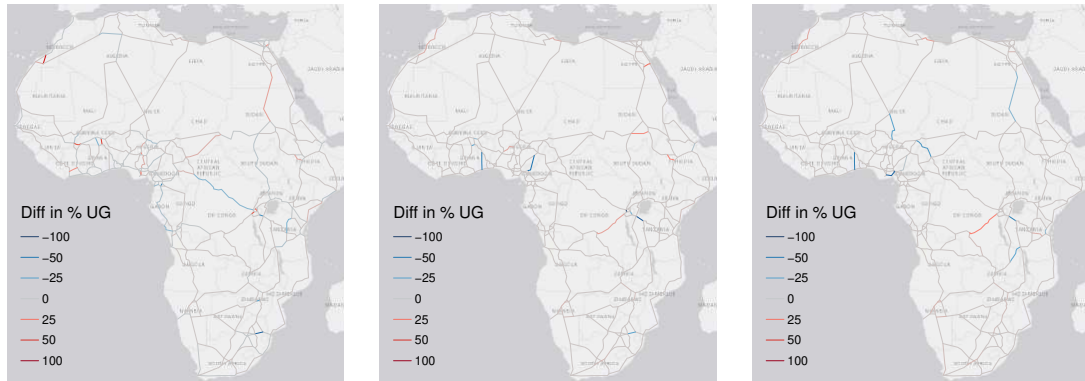
Figure A23: Optimal \$10B Trans-African Investments and Trade by  $\sigma$



No Imported Goods (Difference)



With Border Frictions (Difference)



Flow of Goods (With Imported Goods, No Frictions) - Selected Megacities

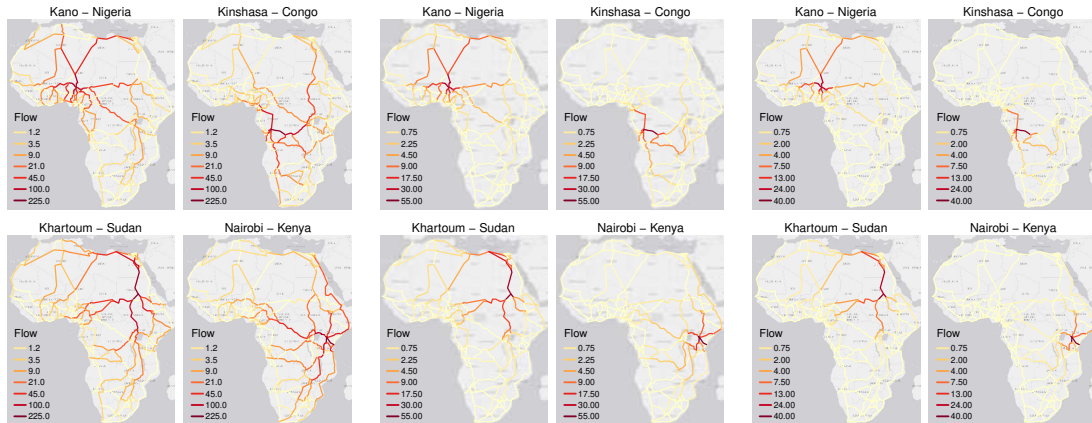




Figure A24: Optimal \$10B Trans-African Investments by  $\sigma$  with Inequality Aversion ( $\rho = 2$ )

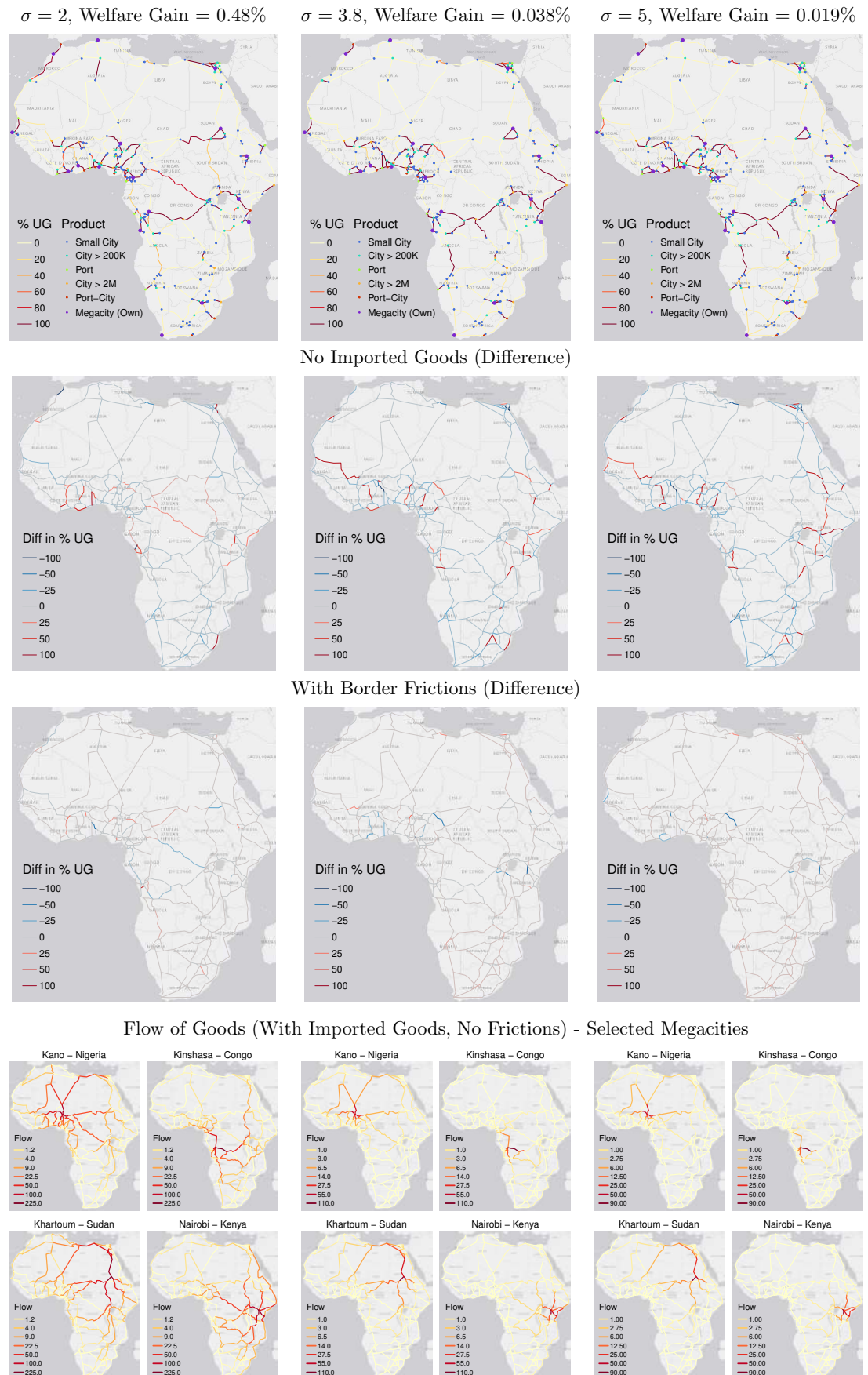


Figure A25: Flow of Goods Through Trans-African Network Connecting Large Cities: IRS Case

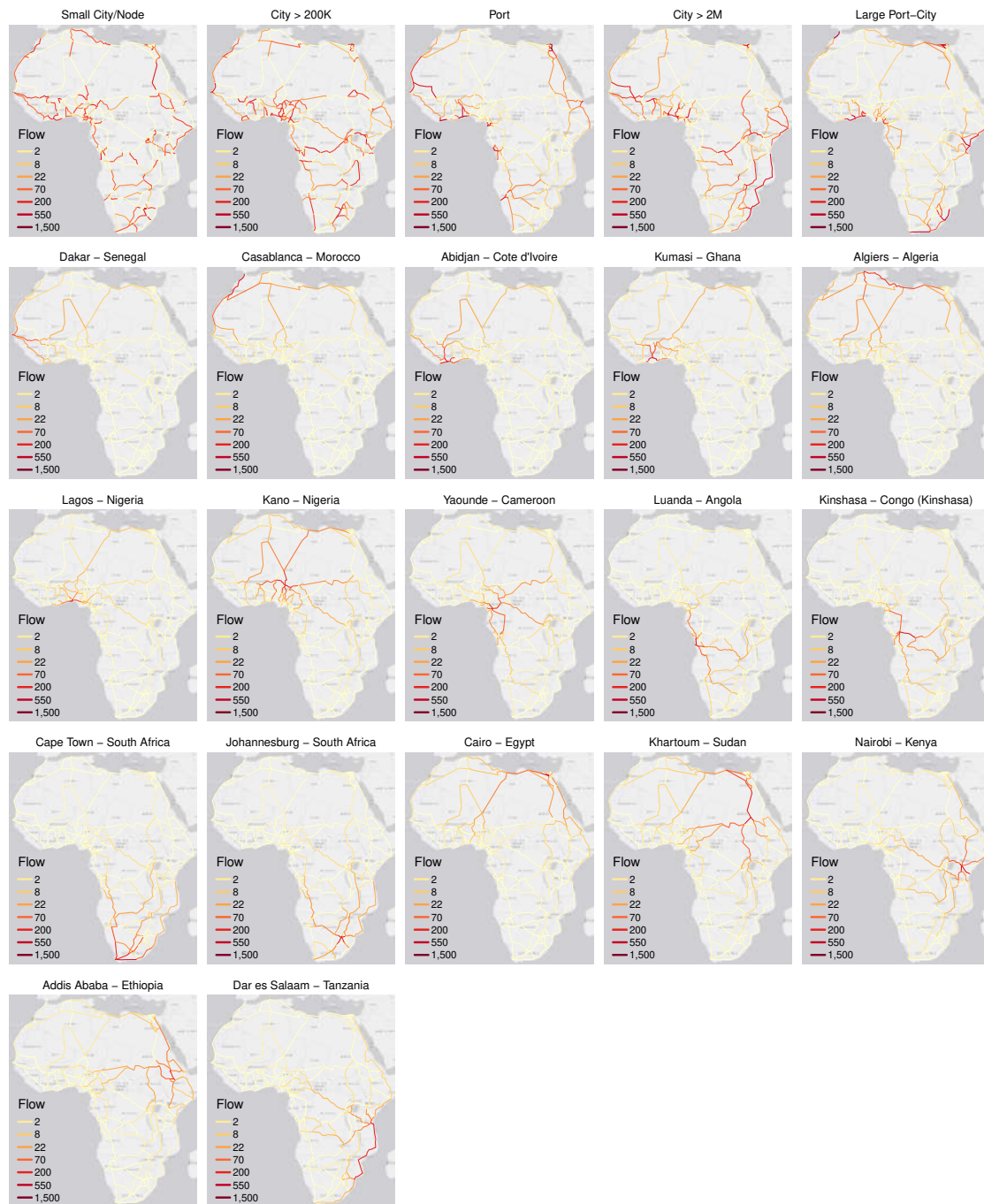


Figure A26: Optimal Trans-African Network Investments under Increasing Returns

Final Network Speed

Investments in km/h

Investments in % Completed

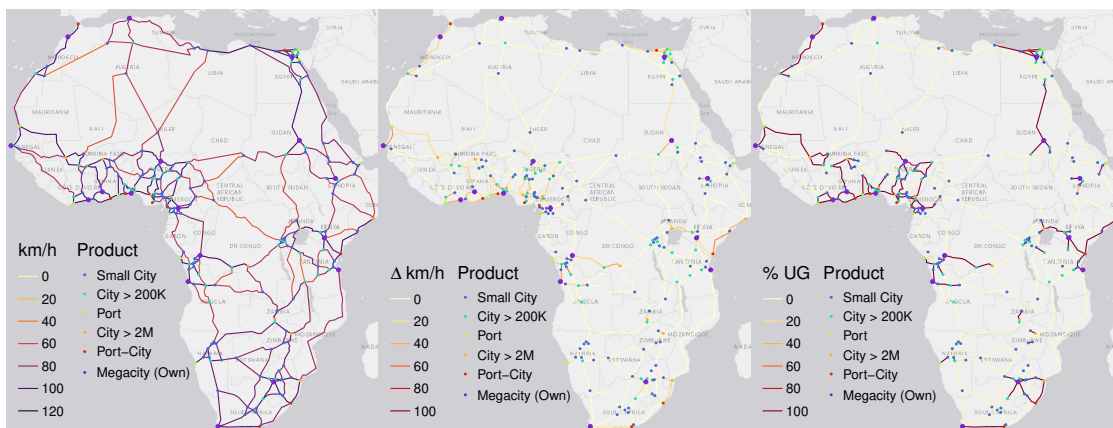
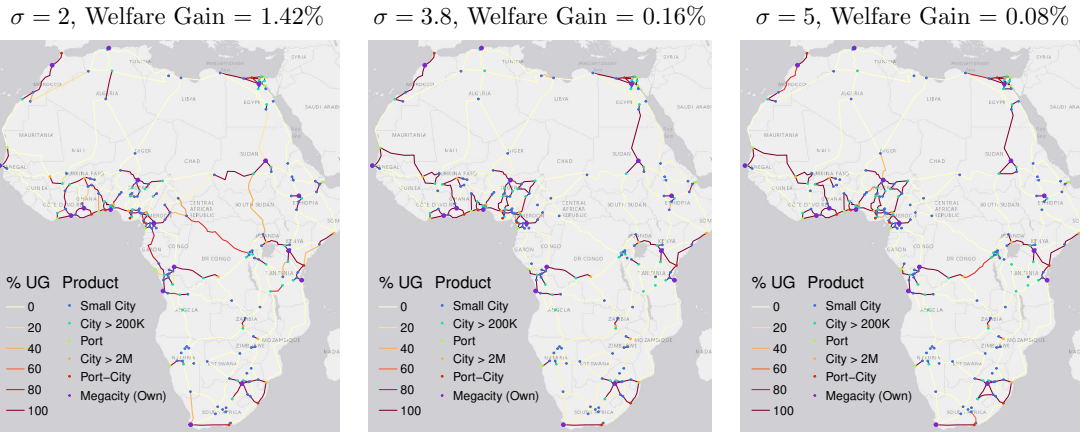
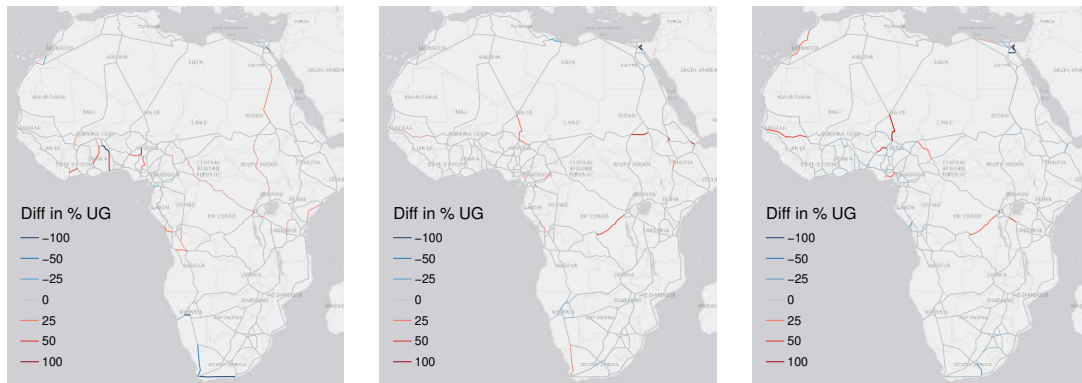


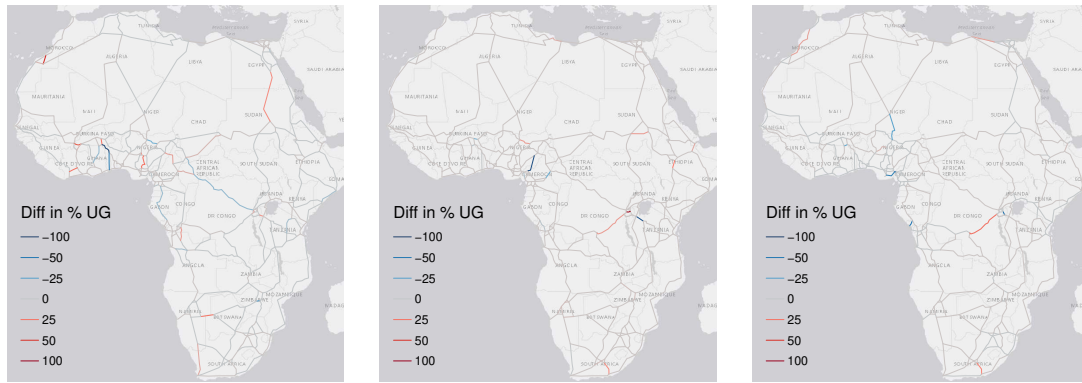
Figure A27: Optimal \$10B Trans-African Investments and Trade by  $\sigma$ : IRS Case



No Imported Goods (Difference)



With Border Frictions (Difference)



Flow of Goods (With Imported Goods, No Frictions) - Selected Megacities

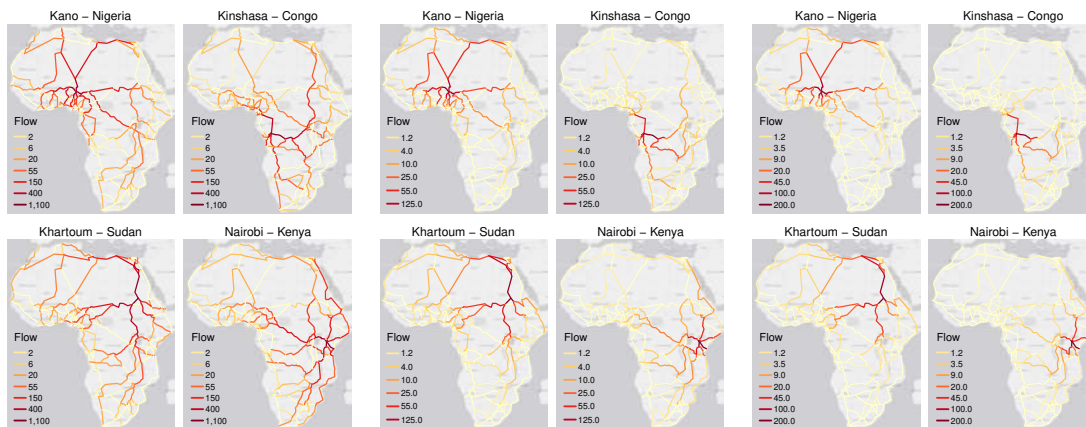
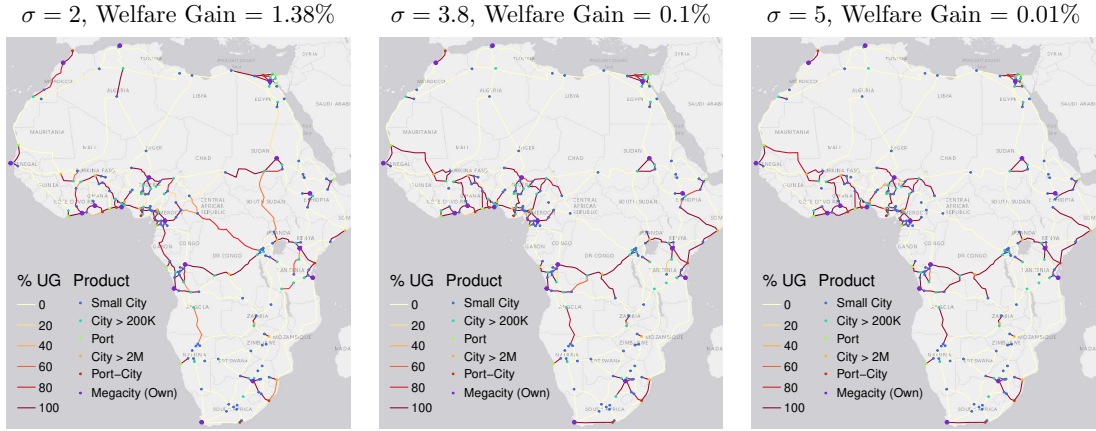
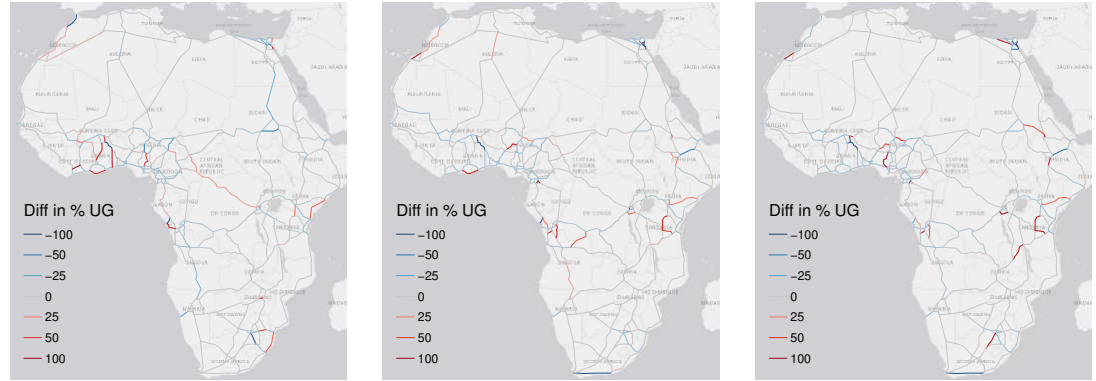




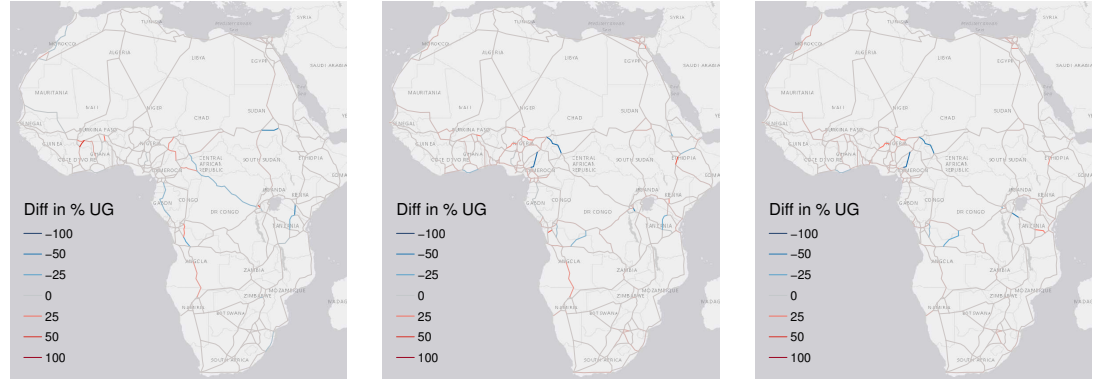
Figure A28: Optimal \$10B Trans-African Investments by  $\sigma$  with Inequality Aversion ( $\rho = 2$ ): IRS Case



No Imported Goods (Difference)



With Border Frictions (Difference)



Flow of Goods (With Imported Goods, No Frictions) - Selected Megacities

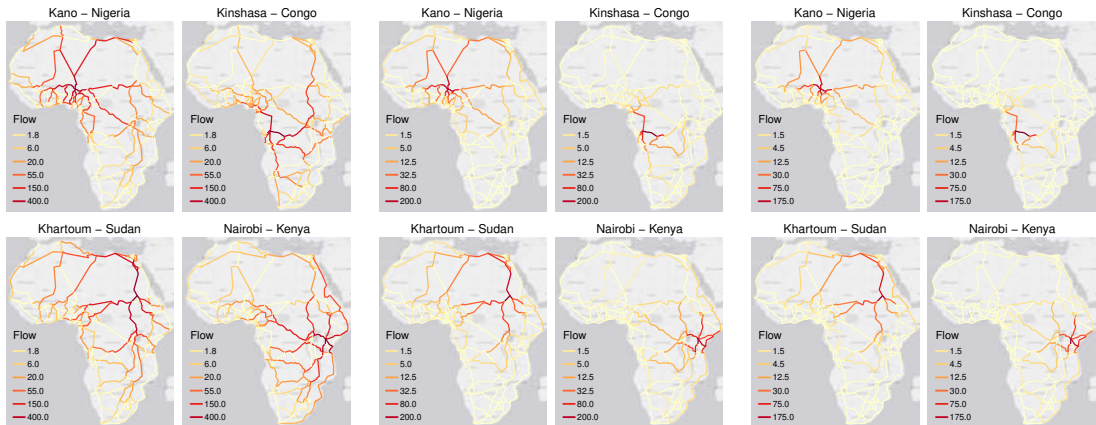


Figure A29: Flow of Goods Through Trans-African Network: Fastest and Shortest Routes

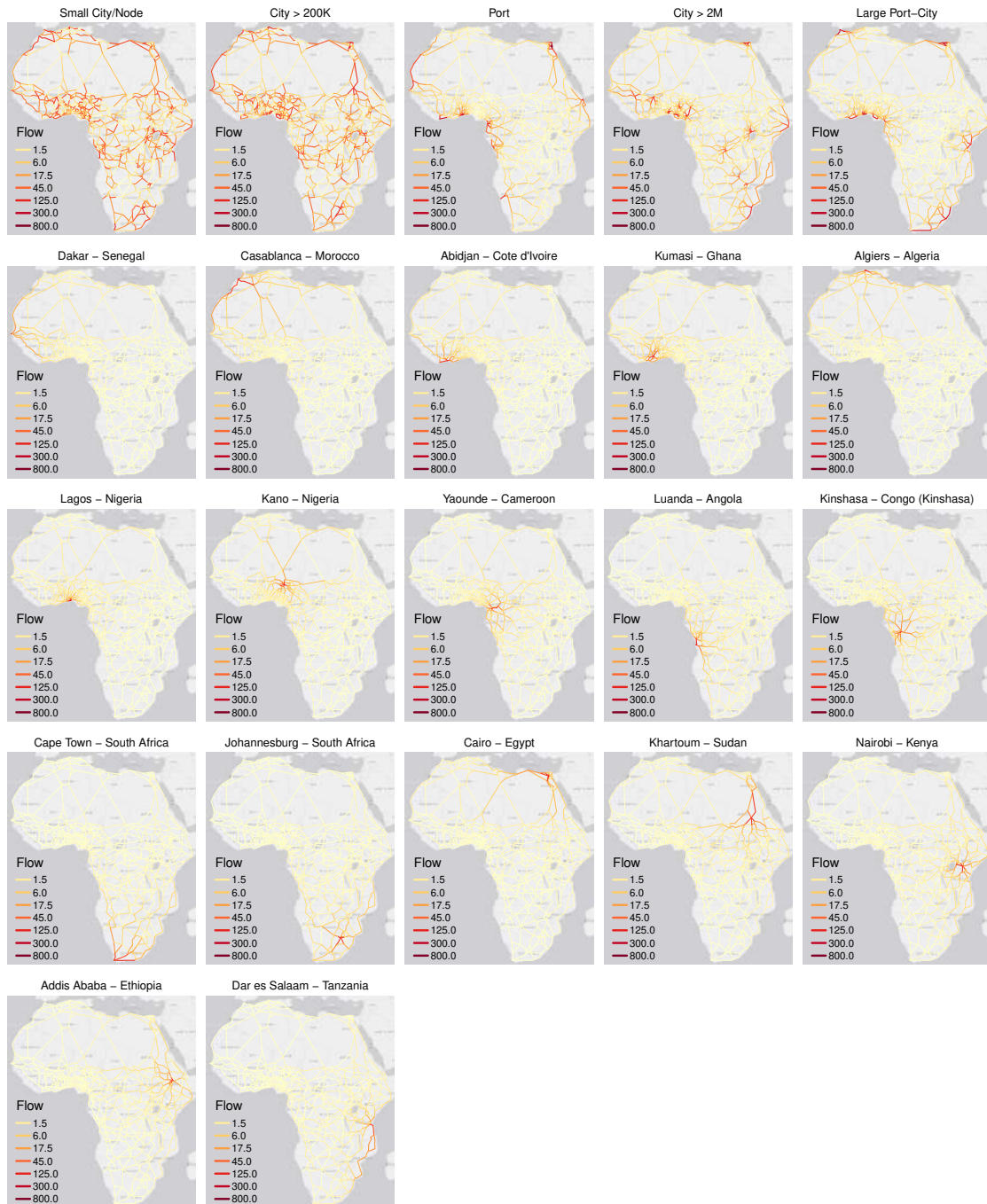
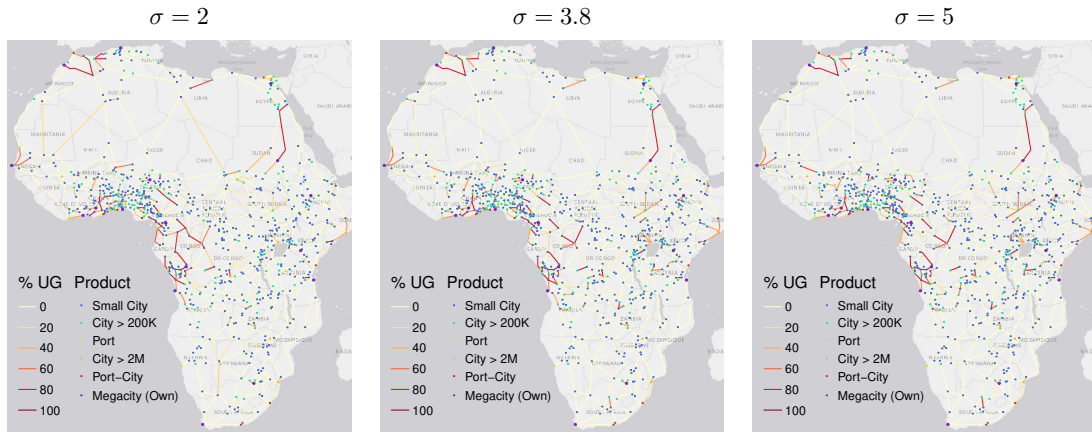
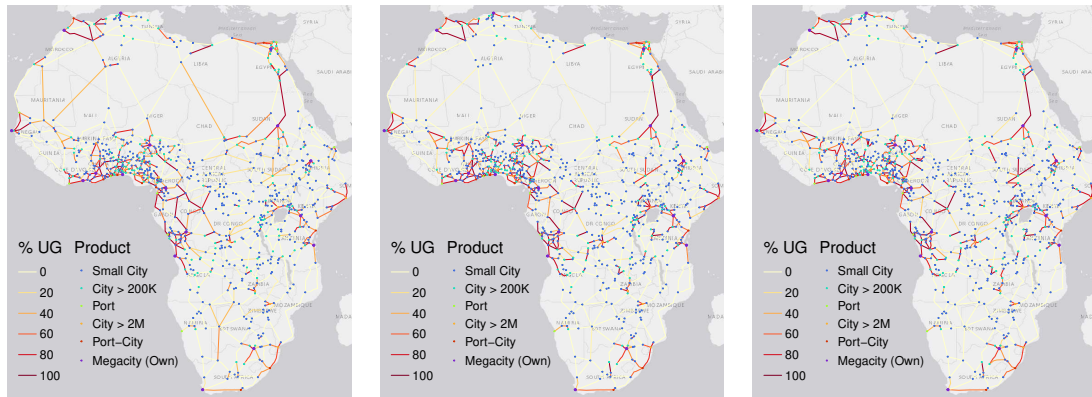


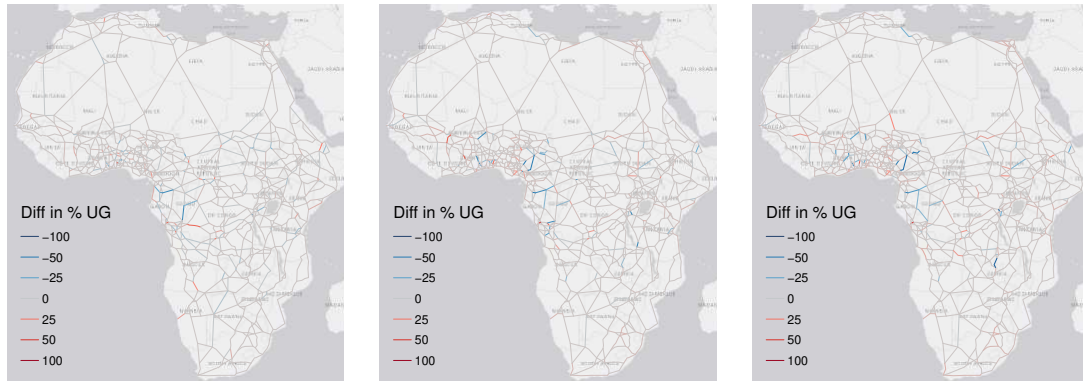
Figure A30: Optimal \$10B and \$20B Trans-African Investments by  $\sigma$  - Infrastructure



↑ \$10B Budget      |      ↓ \$20B Budget



Difference under Border Frictions (\$20B Planner)



Flow of Goods (No Frictions, \$20B Planner)

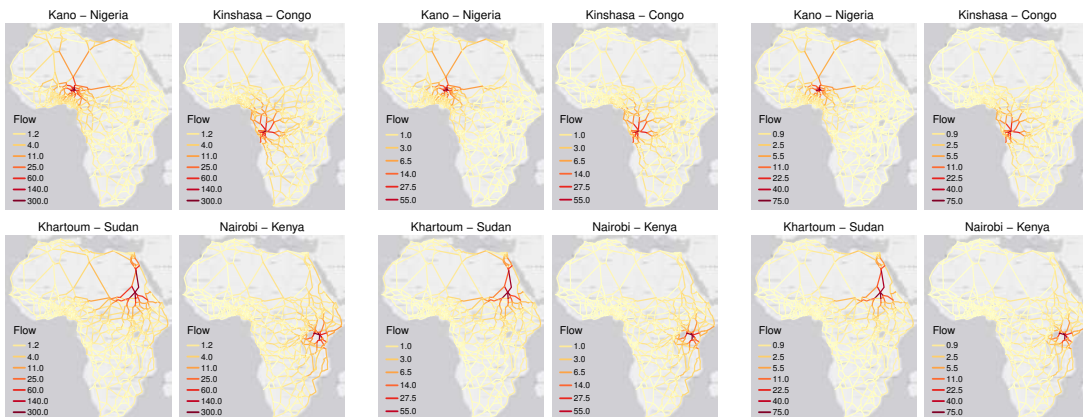




Figure A31: Welfare gains by  $\sigma$ : Standard and Frictions Scenarios

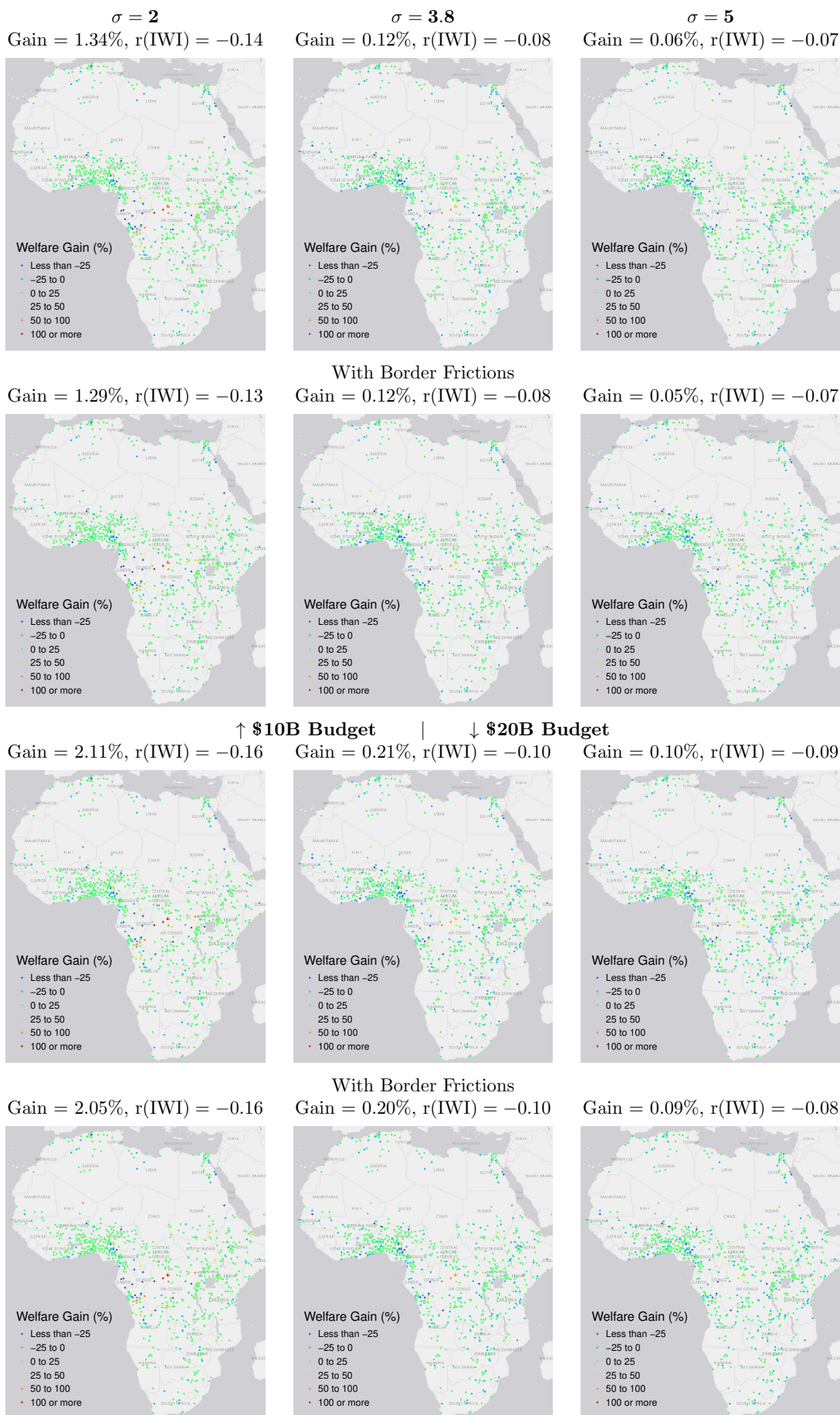


Figure A32: Optimal \$10B Trans-African Investments & Welfare with Inequality Aversion by  $\sigma$

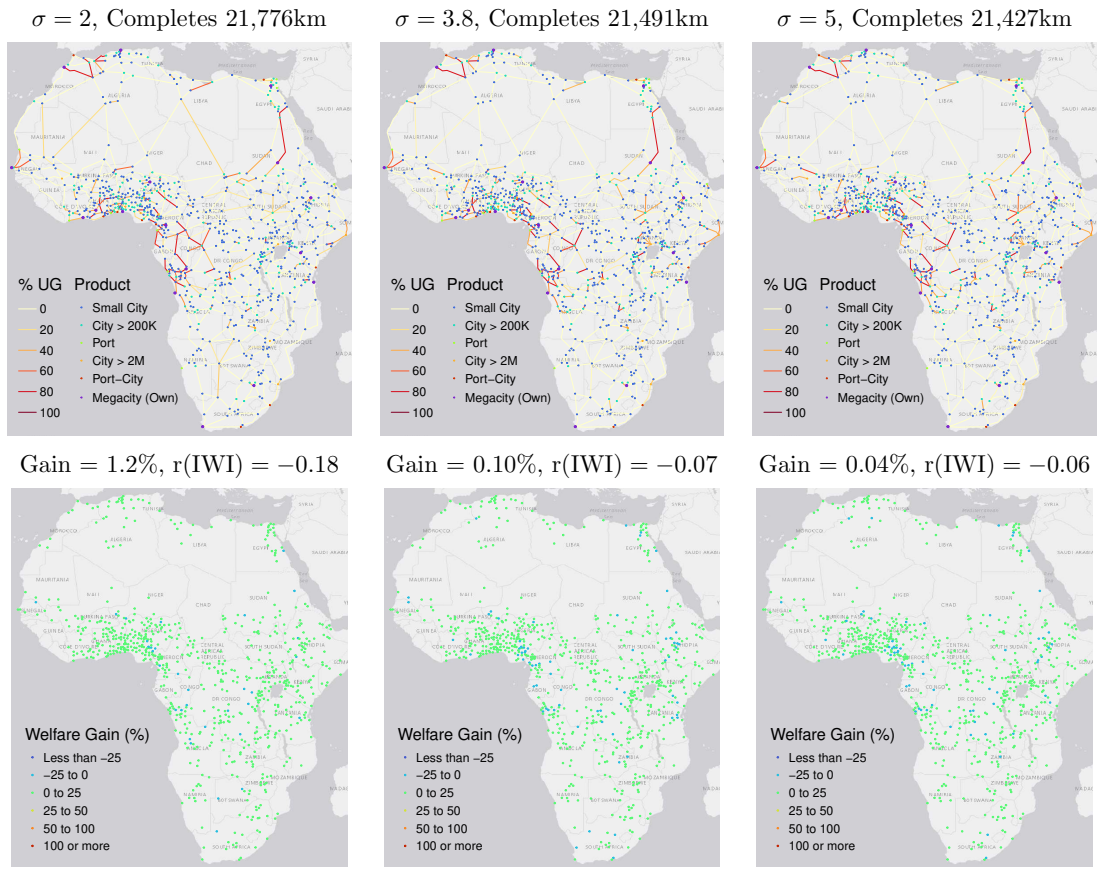


Figure A33: Optimal \$10B Trans-African Investments & Welfare with Increasing Returns by  $\sigma$

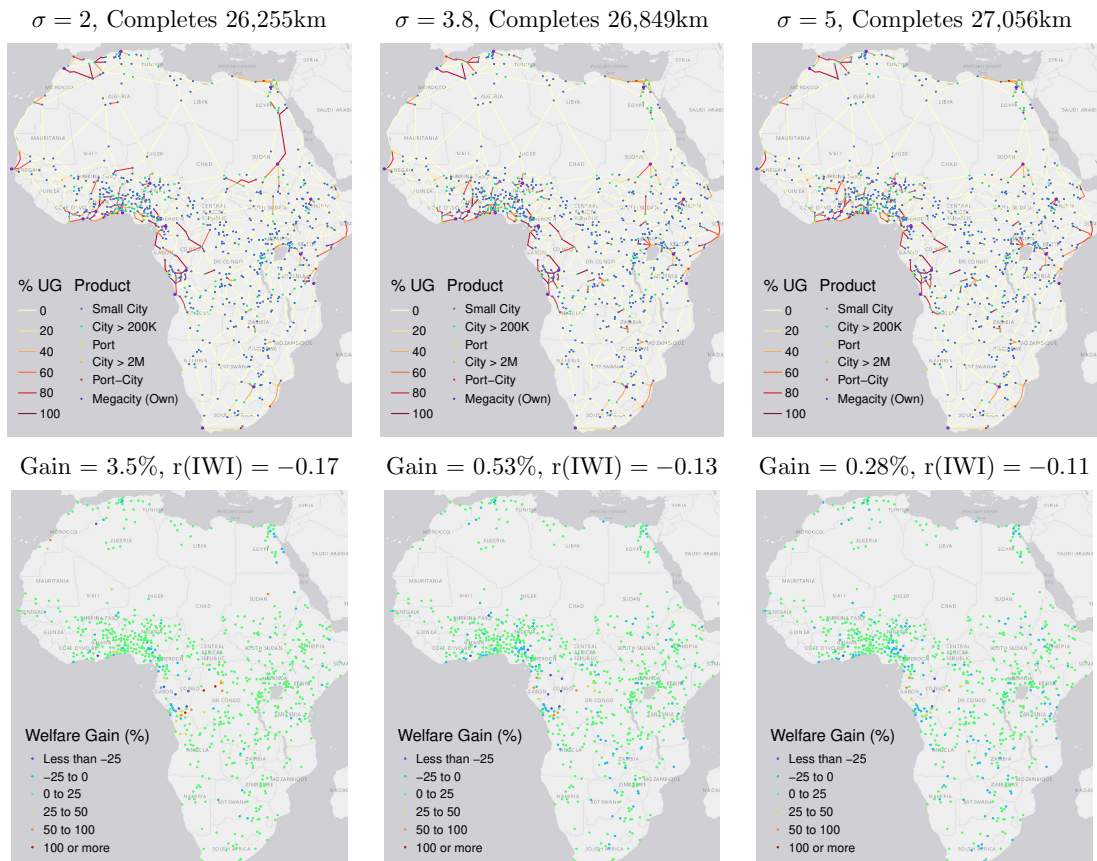
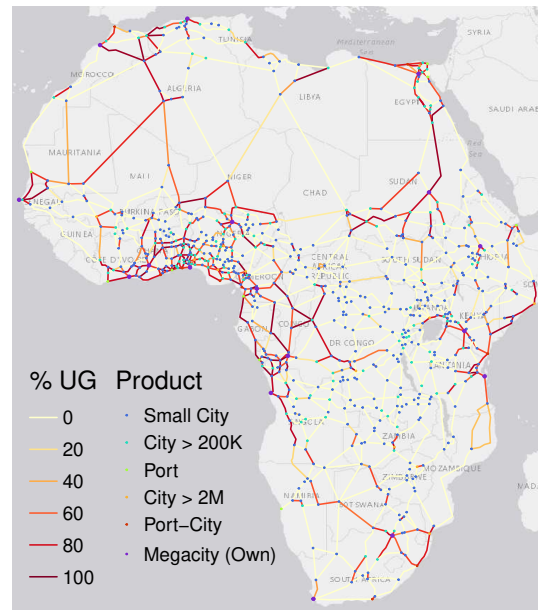
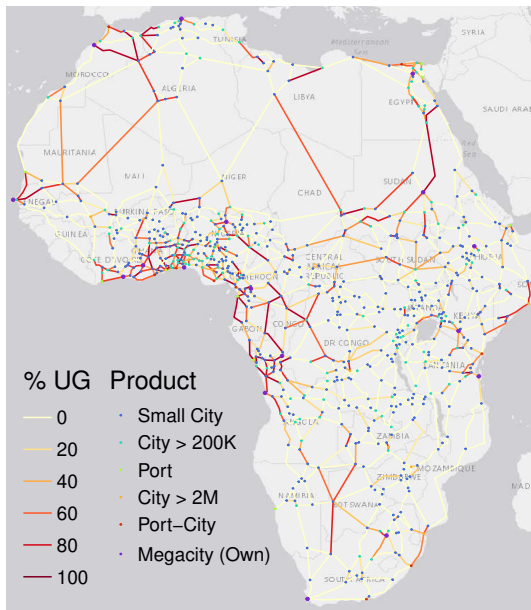


Figure A34: Optimal \$20B Trans-African Network Investments on Large Network with  $\sigma = 1.5$

Standard Planner: Builds 49,729km

Increasing Returns Planner: Builds 61,290km



Inequality Averse Planner: Builds 48,370km

Inequality Averse IRS Planner: Builds 59,487km

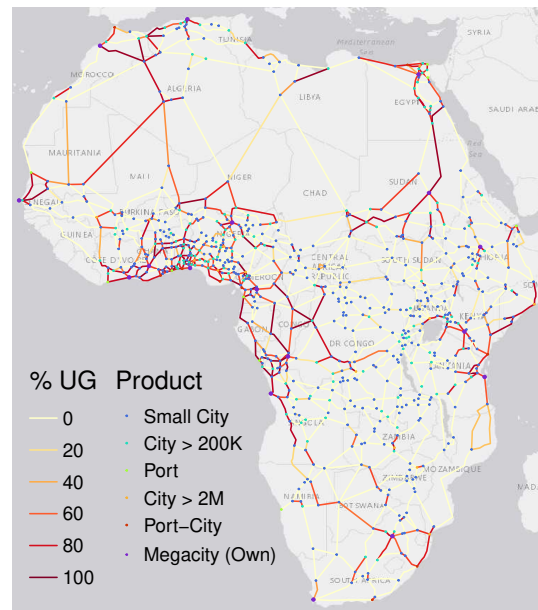
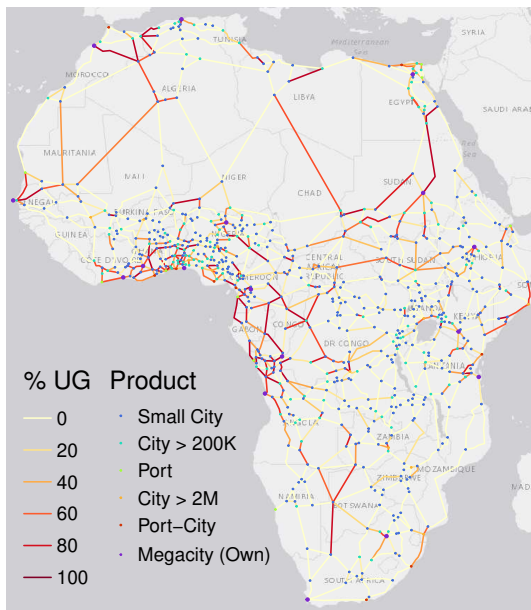




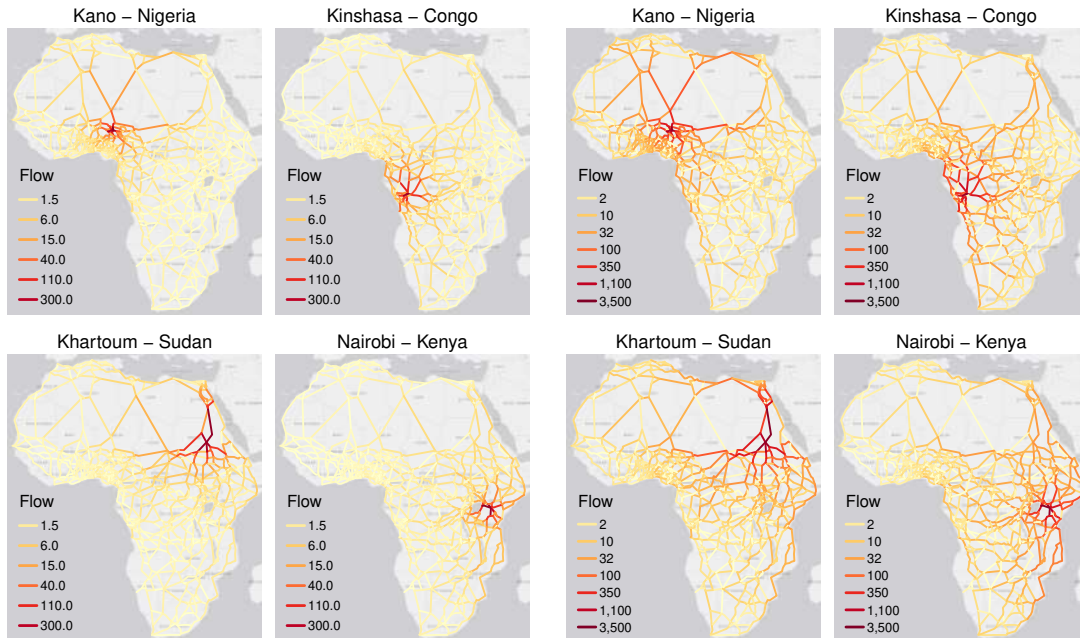
Figure A35: Optimal \$20B Trans-African Flows & Welfare on Large Network with  $\sigma = 1.5$

**Standard Planner**

**Increasing Returns Planner**

Own Consumption Share: >96%

Own Consumption Share: >78%



↑7.92% [p1: -22%, p50: 10%, p99: 80%, r: -0.24]

↑14.3% [p1: -5%, p50: 17%, p99: 84%, r: -0.25]

