Referee Report:
"Spatial Inefficiencies in Africa's Trade Network"

Summary

The paper considers how reallocating the existing stock of road infrastructure across space within each African country could improve welfare given the spatial distribution of people and economic activity. The author collects data at the level of 10,000 grid cells across the entire continent on population, economic activity as proxied by night lights, topography and existing transport links between cells from Open Street Map in order to construct a discretized network representation for every African country. This is then used to simulate the effect of reshuffling the existing stock of roads to achieve the optimal distribution within each country implied by the model. The results suggest that such reallocation exercizes could yield welfare gains of 1.1% across the continent, with substantial heterogeneity across countries. The author then considers how the degree of within-country misallocation of road infrastructure implied by this exercise may be linked to measures of colonial railroad investments, ethnic favouritism and aid allocations.

Main comments

1. The paper undertakes an impressive data collection exercise in order to consider potential inefficiencies in the distribution of road infrastructure within African countries. The analysis uses an 'altered version' of the framework developed in the recent working paper by Fajgelbaum & Schaal (2017). It would be helpful to be clearer about the ways in which the simulation exercizes in this paper build on the analysis in the Fajgelbaum & Schaal paper in order to be able to assess the relative contribution of this analysis. In particular, the description on page 9 of the differences between the model used here and that used in Fajgelbaum & Schaal (2017) seem to suggest that the framework here makes a number of simplifications relative to that in Fajgelbaum & Schaal (2017), but the reasons for making these simplifications, their empirical relevance in this setting and what they might contribute to our understanding of the problem considered, are not made clear. The central simulation exercizes in the paper seem to be closely linked to those in Fajgelbaum & Schaal (2017) applied in a new context. While the final section considers some interesting potential determinants of the inefficiencies suggested by the simulation exercizes, it would be helpful to clarify the central intended contributions of the analysis and how these advance our understanding of potential inefficiencies in transport infrastructure allocations relative to the existing literature.

2. One of the differences outlined between the framework used here and that in Fajgelbaum & Schaal (2017) is that this analysis shuts down the endogenous migration channel. This seems to be a strong assumption that is at odds with much of the recent literature in spatial economic modelling incorporating labour mobility. Indeed the results in Fajgelbaum & Schaal (2017) suggest that this channel has a quantitatively important impact on estimated welfare effects. It would be helpful to consider how sensitive the results in this paper are to making alternative assumptions about labour mobility in this setting.

3. The simulation exercizes conducted in the paper consider within-country reallocation of roads without modelling connections between locations in different countries. While the justification for considering within-country reallocations based on policies that are within national governments' locus of control (footnote 17) seems sensible, it seems highly likely that the optimality of networks within a given country should also be affected by how the network connects to international markets. Some of the paper's results appear to be consistent with this. For instance, the finding that South Sudan's network looks especially inefficient because it 'inherited a road network that was not conceived to sustain an independent nation, but rather connect it to its former capital up north' might be attenuated to the extent that continued trade links with the north remain important and facilitated by connections that are no longer considered within the optimization problem for South Sudan. More generally, the author notes that national borders 'can at times even clearly be inferred from the printed map' of the estimated infrastructure discrimination index. This seems potentially worrisome if, for instance, this reflects the fact that border areas systematically appear to be inefficiently 'favoured' with infrastructure simply because the solution algorithm does not take into account the advantages these regions enjoy in terms of international trade links. It would be helpful to consider how such factors might influence the results even within the confines of simulation exercizes that restrict attention to within-country reallocations.

4. Related to point 3, it seems plausible that the finding that colonial railway lines are associated with 'too much' road infrastructure could in part be explained by the importance of railroads for long distance haulage, and their distribution potentially linked to international trading routes. As such, the omission of international trade access from the analysis might be particularly important for this analysis.

Additional comments

- The Open Street Map data comes from 2017, while the night lights and population data are from 2010 and 2015 respectively. The claim in footnote 6 that this should render the identified inefficiencies a lower bound is not clear to me; for instance, conversely it might be the case that the 2017 road network might reflect changes in economic activity that occurred between 2010 and 2017, rendering the distribution more efficient than the paper's results would suggest.

- It would be helpful to outline how the parameter values used in the trade network optimization were chosen and the sensitivity of results to varying these parameters.

- The reallocation exercises do not restrict possible investments from above, such that the proposed networks include stretches with implausibly high speeds. Footnote 12 notes that less than 0.8% of built roads in the proposed network exceed 260 km/hr, but it would seem more empirically relevant to consider the share above a more sensible driving speed (e.g. 100 km/hr) and consider how the results might change if the planner were constrained to avoid speeds higher than this.

- It would be helpful to understand how many edges have no road connection in the proposed network and are therefore by default assigned the walking speed of 4 km/hr. Given the very large distances between cells (at least 55 km), it seems unlikely that any government would want to entirely cut off populated cells in this way.

- In the construction of optimal routes where start or destination locations do not fall onto a street, the author adds the straight line walking time to the nearest street. Given that the start and end points are grid cell centroids, these are arbitrary with respect to the location of economic activity and these walking segments are likely more important than in, for instance, an analysis using administrative centres within administrative spatial units. How much do the results change if the nearest points on the road network to the centroid are used as the start and end points instead of the centroid itself?

- In several places, the claims that the paper's analysis identifies the 'unique optimal trade network' or 'perfect transport network' seem too strong. The concept of optimality will depend on the assumptions of the model used and will be influenced by, for instance, the distribution of other modes of transport, dynamic considerations and connections with international trading routes. I would suggest that the strong phrasing with reference to optimality of the derived networks is tempered to reflect this.

- The references in the introduction relating to transportation infrastructure in Africa seem old given rapid development of these networks over the past decade.