

Laying roads to more productive farming

Evidence from Ethiopia



In brief

- Starting in 1997, Ethiopia embarked on a comprehensive road infrastructure expansion programme, with its recent Universal Rural Road Access Programme focusing explicitly on connecting rural communities to markets.
- This research quantifies the effects of Ethiopia's new roads on aggregate and local agricultural productivity outcomes over 1996-2014. To do so, it combines a spatial framework and a novel district-level data set that overlays agricultural production data with geo-coded transportation cost data.
- The main finding at the aggregate level is that real output per hectare (yield) would increase 13.6 percent if transport costs alone changed from their 1996 levels to their 2014 levels. The implied gains account for about 1/10 of the actual overall gains in Ethiopia over 1996-2014.
- In terms of local effects, the gains are uneven across districts. There are other factors that matter such as the relative transport costs across crops and a district's comparative advantage in terms of productivity.
- Improvements in road networks have real productivity effects, and can contribute to a restructuring of the agricultural sector, with more export-oriented cash crop production, fewer farmers, and higher average farm size as employment shifts to other sectors of the economy. Improvements in road networks should be viewed as one of a set of policy initiatives that can generate farming productivity growth.

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Overview of the research

In the late 1990s, Ethiopia was one of the poorest countries in the world, with its economy heavily skewed towards agriculture, an employment share in agriculture of over 85 percent, and its agricultural productivity at 55 percent of its 1960s level, in real terms. At the same time, Ethiopia had one of the lowest road network densities and rates of motor vehicle usage in the world, and very high domestic transport costs. Entire rural communities were isolated from crop and input markets. These characteristics were shared by many other developing countries, particularly in Sub-Saharan Africa.

Starting in 1997, Ethiopia embarked on the most comprehensive road infrastructure expansion programme in its history, with its recent Universal Rural Road Access Programme focusing explicitly on connecting rural communities to markets. The investments dramatically increased the volume and quality of the road network. While the total road network tripled in length (kilometers), the rural network increased almost five-fold. The proportion of asphalt roads in good condition increased from 17 to 73 percent. Since then real agricultural productivity has not only rebounded, but surpassed its 1960s levels.

This research studies quantitatively the effects of Ethiopia's road expansion programme on aggregate and local agricultural productivity outcomes as well as its development process, over 1996-2014.

To measure the gains from the road infrastructure programme, this research combines a spatial framework and a novel district-level panel data set that overlays agricultural production data with geo-coded transportation cost data.

The agricultural data come from repeated annual household surveys conducted by the Central Statistical Agency in Ethiopia. Farmers are asked about the crops they produce, what their harvest is, how much land they cultivate under each crop, and what inputs they use. This research project uses this information to aggregate up to the district (woreda) level to obtain consistent observations on the same districts over time.

The geo-coded transport cost data are estimated travel times from each district to the major crop markets in Ethiopia. The key here is that this project uses software that geographers use to overlay on a map of Ethiopia the universe of the highway and road network, along with the GPS coordinates of the districts and the crop markets. Then the software is asked to find the fastest way from each district to the nearest crop market. The travel time over that fastest route is the estimated geo-coded transport cost. It is similar to what Google maps gives you when you want to find the travel time from location A to B, only that Google maps does it for today's infrastructure. The geo-coded transport costs here change over time as new and better roads are laid out. This research project also takes into account

elevation (speeds are different on uphill roads than on flat surface roads) as well as the type of terrain a farmer would have to travel through before reaching a road.

The spatial framework is a model that explicitly takes into account that agriculture is an activity that takes place across space. There is an urban center and then there are multiple rural locations that serve as agricultural production sites. Each rural location can produce food for people in the urban center or cash crops for exporting. In order to ship to the urban center for consumption or exporting, farmers have to pay transport costs. They also have to pay transport costs when they want to access intermediate inputs such as fertiliser or pesticides. The heterogeneity in transport costs across locations matters for which location produces relatively more of what crop, the mix of crops each location produces, how much fertiliser they use, and how much labour they need.

To measure the effects of transport costs the spatial framework is calibrated to the 1996 district-level agricultural production and geo-coded transport cost data. Then the question asked is: how would productivity and other outcomes change in each district if instead of the 1996 transport costs, farmers had the 2014 transport costs associated with the road infrastructure they had access to in 2014?

Policy motivation for research

This research is underpinned by two key pillars, agriculture and rural infrastructure investment, both of which are at the top of the growth policy agenda of developing countries. On the one hand, it is well understood that improving productivity in agriculture can be an important contributor to poverty alleviation, the structural transformation of the economy, and aggregate productivity growth. On the other hand, infrastructure investments in general, and road network expansion in particular, are priority policy interventions for developing country governments and international organisations. It is widely recognised that investments in transport infrastructure contribute much more to growth than the direct contribution of the transport sector to GDP, or the direct employment opportunities they create. The reason is that transport investments make other sectors of the economy more productive by stimulating market integration.

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The objectives of this research align with the Ethiopian government’s Growth and Transformation Plan (GTP 2010-2015), a strategic policy framework for achieving rapid and broad-based growth, in pursuit of the longer term goal of Ethiopia becoming a middle-income country. Two of the plan’s key strategic aims involve maintaining agriculture as a major source of growth and expanding the level and quality of infrastructure in the country. A major goal is to raise productivity in the agricultural sector through a variety of means: specialisation, adoption and efficient

use of modern agricultural technologies, irrigation expansion, adoption of high valued crops, intermediate input use, marketing, and distribution networks. Improved farmer access to markets can either directly or indirectly potentially affect several of these channels.

The GTP document also recognises the importance of road transport in the country's growth strategy. The Ethiopian government has made road network expansion a priority, through the Road Sector Development Programmes (RSDPs), starting in 1997. Through the implementation of successive RSDPs, there has been substantial improvement in the extent and quality of the road network. In response to the need of further improving road access, particularly for rural areas, the government embarked, as part of RSDP-IV, on a Universal Rural Road Access Programme (URRAP) in 2010-2015 that intended to connect all villages (kebele) by all-weather roads. The ultimate goal is to reduce isolation and provide year round access to markets in order to reduce poverty and raise agricultural productivity.

This research quantitatively assesses the impact of the expanded and improved road network on Ethiopia's agricultural productivity and development process.

Research findings

This study finds that at the aggregate level, real output per hectare (yield) would increase 13.6 percent, if transport costs changed alone from their 1996 to their 2014 levels. If the direct resource savings from lower transport costs were also included, the gains would be 20 percent higher. To appreciate the magnitude of these gains, note that they account for about 10 percent of the actual gains in output per hectare that Ethiopia experienced over 1996-2014. This research also finds that the economy shifts towards more cash crop production, reallocation of employment away from agriculture, and increased average farm size. The magnitude of these shifts is broadly consistent with the observed changes in the data over the same period.

In terms of local effects, the gains are uneven across districts. The research uncovers a U-shaped relationship between yield gains and changes in transport costs, implying that the biggest winners are not necessarily the ones that have the largest drop in the level of their transport costs. There are other factors that matter such as the relative transport costs across crops and a district's comparative advantage in terms of productivity. Interestingly, the U-shaped relationship found is similar to the one observed across districts in the data.

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Policy recommendations

- **Additional expansion of the road network would further integrate farmers with output and input markets.**

The research finds that geo-coded transport costs between rural districts and crop markets dropped both in terms of average level and dispersion. However, because Ethiopia started in 1997 from a very low base of infrastructure density, transport costs remain high even today, despite the gains. In addition, there is still considerable variation across districts and regions of the country.

- **Road infrastructure investment should be part of a strategy to raise agricultural productivity.**

High transport costs reduce the prices farmers receive for their crops when they sell to market and raise the costs of accessing modern inputs such as fertiliser and pesticides. This research finds that reducing transport costs will contribute to productivity gains and a restructuring of the agricultural sector, with more export-oriented cash crop production, fewer farmers, and higher average farm size as employment shifts to other sectors of the economy.

Expansions of the road network alone, however, are not going to be sufficient: they account for about 10 percent of the overall actual gains. There are other factors that could have additional efficiency gains such as the adoption of high yield varieties, irrigation, mechanisation, and adoption of modern technologies. While not examined in this study, transport cost reductions may contribute further to productivity growth indirectly through these channels as well.

- **Policymakers should not expect the benefits to be uniform across regions.**

The finding that the relationship between yield gains and transport cost reductions is U-shaped implies that the largest gains at the local district-level are not necessarily enjoyed by the districts with the largest drops in their transport costs. Some of this can be dealt with by reducing the dispersion of the transport costs across districts and crops, but some of it may simply be pure nature: some locations are better fit to produce certain crops than others. Reducing transport costs across the board would help each district unleash its potential by integrating with markets.

- **Given the importance of agriculture in the economy, productivity gains in agriculture translate to aggregate economic gains.**

For an economy like Ethiopia that is heavily skewed towards agriculture, any productivity gains in this sector will translate to aggregate productivity benefits. This is a characteristic shared by many other developing countries, particularly in Sub-Saharan Africa. Reallocations of employment away from agriculture, either stemming from agricultural productivity growth or non-agricultural productivity growth, would lessen the direct weight that agriculture carries in the economy.