Public Roads on Private Lands: Land Costs and Optimal Road Improvements in Urban Uganda

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Draft Updated Regularly - Latest Version Here

October 28, 2024

Abstract

Land acquisition costs can undermine the net returns of public infrastructure projects in developing cities, hindering the implementation of high-benefit projects. I investigate this issue in Kampala, Uganda, using new survey data with real estate brokers and landowners to evaluate the benefits and costs of 140 km of road improvements since 2017. By exploiting variation in the timing of upgrades, I estimate local benefits and develop a quantitative spatial model that accounts for spillovers and the fiscal cost of land acquisition. I find that, due to the high fiscal wedge, acquiring land through eminent domain could have resulted in negative net returns. However, the government's voluntary land acquisition approach reduced costs, generating net welfare gains equivalent to 99 USD per resident. I also show how the city's three property rights regimes influenced land costs, with weaker property rights functioning as a Pigouvian subsidy. Finally, I solve for the optimal road improvements under different institutional settings and funding restrictions, offering insights for policy design to enhance allocative efficiency and welfare outcomes.

1 Introduction

In African cities, only one-third of roads are paved (Kumar and Barrett 2008). Given the link between urban mobility and economic development (Akbar et al. 2023), road improvements have significant potential benefits. Consequently, transportation infrastructure upgrades have become a priority for both domestic governments and international agencies. However, for African governments attempting to improve these roads, such projects also entail substantial costs. For example, in addition to construction expenditures, the underlying land on which the roads are built must be acquired from private landowners.

Despite the importance of these costs, they have often been overlooked by the literature and by policy makers designing these projects. This oversight has had major consequences. Governments' inability to raise the funds needed to acquire this underlying land has led to costly delays, project revisions, and diminished net returns (World-Bank 1996). Better understanding the drivers of land acquisition costs in African cities is crucial to explaining the lack or suboptimal location of high-benefit infrastructure projects.

In this paper, I address this gap by examining a series of road improvement projects in Kampala, Uganda. I analyze how local government land acquisition practices affect the net returns to these improvements. With less than 45% of its major roads paved, Kampala resembles many other African cities. To enhance the quality of the road network, 140 km of road upgrades have been rolled out since 2017. Construction is primarily funded by the World Bank and the African Development Bank, while the domestic government is responsible for acquiring the underlying land. Citing concerns that compensating landowners at market value, as required by the eminent domain legal framework, would jeopardize the project's full implementation (World-Bank 2023), the government asked owners to voluntarily give up small portions of their land without compensation. However, the success of this *"voluntary land take approach"* varied across the city, with owners in areas with stronger property rights less likely to participate and more inclined to seek the financial compensation to which they are legally entitled.

To study the impacts of the road improvement projects and the associated land acquisitions in this data-scarce environment, I begin by integrating several data sources. I collect new data on the property-level benefits and land costs of road improvements throughout the city, including two novel surveys conducted with real estate brokers and landowners. I then add data on network-level effects of the road improvements, including commuting pattern data from a local ride sharing company and traffic data from Google Maps. Using this data, I estimate the reduced-form benefits of road improvements initiated in 2017, exploiting variation in the timing of the policy. I leverage the coexistence of three property right regimes in the city (Bird and Venables 2020) to characterize how land costs are influenced by land institutions. Next, I build and estimate a quantitative spatial model that accounts for changes in traffic flows and adjustments in the locations where residents live and work to measure the city-level returns of road improvements. Finally, I solve the model for the optimal road improvements under different institutional frameworks and in the absence of restrictions on the use of external funds for land acquisition, to evaluate how these institutional differences affect the location of road improvements.

I find that the road improvement projects in Kampala yielded large, positive net returns only because the government was able to acquire most of the underlying land without compensating landowners, instead relying on weak property rights to facilitate cheaper and easier land acquisition. In the presence of a

large fiscal wedge, weak property rights can act as a Pigouvian subsidy by enabling the government to construct more roads with large positive externalities on city-level welfare. Moreover, in Kampala, the areas hosting road improvements with the largest benefits tend to correspond with those that have the strongest property rights regimes. Consequently, the local structure of property rights also has important distributional and allocative implications.

To show how weak property rights can increase the net returns to road improvements, I start by collecting novel datasets. I first conduct a survey with 377 real estate brokers, which includes a retrospective panel of transactions. I show that if road builders were to pay the market value of residential properties under an eminent domain regime, these costs would constitute 80% of overall project costs. Next, I interview 548 landowners whose properties border the upgraded roads in Kampala. I find that under the existing "voluntary land take approach", 80% of landowners consented to forfeit their land without compensation, averaging 73 square meters of land per property. These interviews also show that the decision of landowners to forfeit their land is partly motivated by the high cost of negotiating with the government and by the difficulties of obtaining official copies of ownership documents. These challenges are heterogeneous along the lines of Kampala's three main property right regimes: leasehold, freehold and mailo. *Leasehold* land features limited term ownership with a strong record of property titles. *Freehold* land features perpetual ownership but land titles are poorly tracked. *Mailo* land is characterized by double legal rights - landowner and legal occupant - over a single plot of land (Bird and Venables 2020). I find that leasehold landowners, who report the lowest cost of getting a copy of their ownership documents, are 55% more likely to negotiate than mailo owners, and 75% more likely to negotiate than freehold owners. Consequently, this approach ties land costs, and therefore the likelihood of road improvements, to the different property right regimes in the city.

I then estimate the local benefits of the road improvement projects in Kampala. I start by calculating the impact of road improvements on traffic speed by leveraging information from the Google Maps queries. I use variation in the timing of the policy and compare traffic speeds on the roads upgraded at the start and end of the policy to isolate the effects of the improvements. I estimate that the intervention increased uncongested local traffic speeds by 4.1 km/h (16% faster than baseline speed). Consistent with this change in local speed, I also show that trips across pairs of neighborhoods became more likely to take upgraded roads over time.

Road improvements also increased local property values. Using the appraisal of a standardized hypothetical property from the broker survey, I find that the assessed sales price of a residential property increases by 25% if the road in its immediate vicinity is improved. Extrapolating this estimated increase in sales price to all properties that border upgraded roads implies a total increase in local property values of 76 million USD, less than the 80 million USD it costs to construct the roads. I also estimate this effect using a retrospective panel of transactions from the same survey and I find that improving roads in a parish (neighborhood) leads to a 19% increase in the sales price of local properties.

While informative, these reduced-form estimates do not capture the full net returns of the implemented policy. Indeed, road improvements also have benefits in distant locations through the rerouting of traffic patterns, and the location choices of residents and firms in equilibrium. In addition, using residential land

for roads has an opportunity cost. To capture these effects, I build a static general equilibrium quantitative spatial model of a closed city. This model includes standard elements as workers freely choose residential and workplace locations trading off between high commuting costs and high rents (Redding and Rossi-Hansberg 2017 Allen and Arkolakis 2022). In addition, I explicitly model the competition for land between residential and road uses and assume that residential land is owned by immobile private landowners.

Through the lens of the model, I formalize the benefits and costs of road improvements. On the one hand, commuting costs decrease, inducing workers to relocate, their welfare to increase, and property values to change all over the city. On the other hand, residential land supply decreases, decreasing the welfare of some landowners. If land is acquired under eminent domain, owners are compensated at market value. If land is acquired under the existing voluntary approach, owners are only compensated if they incur a fixed cost to negotiate with the government. Property rights are associated with distinct distributions of negotiation costs, so that not all owners are compensated in equilibrium. Road construction expenditures can be covered by external funds from international donors, but owner compensation is funded through a local property tax. A fiscal wedge captures the high costs of levying funds domestically in this context and implies that owner compensation is costly.

The model described above has a number of parameters that need to be estimated in order to compute the benefits and land costs of road improvements. To estimate the elasticity of commuting flows on commuting times, I partnered with a local prominent ride hailing company with more than $160,000$ monthly users. Using the universe of rides (flows) by users of the app for a random sample of weeks from 2019 to 2024, I estimate that the number of commuters between two locations decreases by 0.33 to 0.45 percent for every one percent increase in commuting times. This elasticity is in the bottom half of existing estimates in middle and high income country settings and the first such estimate in a LIC city. I use my reduced-form estimates to recover the elasticity of road speed on road infrastructure and owners' negotiation costs.[1] I calibrate the rest of the parameters using public data for Kampala or from the literature.

Equipped with this model and the parameters described above, I compute the benefits of road improvements implemented in Kampala since 2017. I solve for workers' new equilibrium residential and workplace locations to estimate that workers' average commuting time decreased by 7%, and that total property values in the city increased by 1.48% as compared to the period before road improvements. Using the model, I solve for the compensating differential transfer that would need to be made to each resident (lump sum) to reach the same level of welfare gains realized by the road upgrades. Abstracting from land payments, I estimate that this one time transfer is equal to 120 USD, or 164% of the median monthly wage of a worker in Kampala. Summing over all residents, this implies 108 million USD net welfare gains in the absence of land payments (but accounting for construction costs). Comparing this number to the 66 million USD increase in local property values from the brokers' appraisal exercise highlights the importance of accounting for city-level benefits and general equilibrium effects when assessing the impacts of road improvements on property values.

Payments for land may decrease the net returns to road improvements in the presence of large costs of

[1] I estimate that increasing road width by 10% decreases average trip time by 0.39%. This estimated elasticity of travel time on road infrastructure is on the upper end of existing estimates, all of them in high or middle income countries (Couture et al. 2018, Fajgelbaum and Schaal 2020, Bordeu 2024).

levying taxes to raise domestic funds. I solve for the fiscal wedge rationalizing the government's claim that acquiring land at market value would threaten the viability of the project (World-Bank 2023). I find that acquiring all land at market value would lead to negative net welfare gains of the realized road upgrades if the fiscal wedge was above 0.7. This number is consistent with Regan and Manwaring (2024), who find that for every 1 dollar due in property taxes, the Kampala capital city government recovers only 39 cents, or a fiscal wedge of 0.61. Given this high fiscal wedge, the net welfare gains of the policy under the existing voluntary land take approach are equivalent to a one time 99 USD lump-sum transfer to all Kampala residents. Importantly, I find a positive correlation between the realized upgrades and the corresponding net welfare gains from specific link-level improvements predicted by my model, consistent with the realized improvements being relatively well allocated given the existing costs and benefits. I also find a negative correlation between the land costs and predicted share of owners negotiating, consistent with the model capturing property right regimes as a relevant feature of the city government's decision.

I then use the model to study how the land institutions impact the allocation and welfare gains of road improvements by conducting counterfactual exercises with alternative land cost structures. I fix the maximum total kilometers of roads improved to match the policy and I solve for the welfare-maximizing (optimal) road improvements. Under compensation at market value, I estimate net welfare gains equivalent to a one-time transfer to each resident of 114 USD, or 1.6 times the median monthly wage. Under the voluntary land take approach, net welfare gains of the optimal policy would instead by equivalent to a 397 USD transfer by resident. Because of the large fiscal wedge, weak property rights act as a Pigouvian subsidy, enabling the government to improve more high benefit roads and reach higher welfare gains than under market value compensation. Yet, this voluntary land take approach also ties land payments to spatially heterogeneous property rights, affecting the spatial distribution of optimal investments. If these property rights were homogeneous (fixing the fiscal cost as under the voluntary land take approach), net welfare gains would be 419 USD per resident as improvements would be allocated towards the highest benefit locations, leading to a larger decrease in commuting times and larger increase in property values.

Finally, given the key role played by the fiscal wedge in driving these results, I investigate the impact of a policy removing existing restrictions on the use of external funds. Currently, the city government can only use funds from the World Bank and the African Development Bank for road construction, not for land acquisition. I solve for the optimal improvements removing this restriction. I find that under the voluntary land take approach in place, the net welfare gains would be 6% larger in the absence of fund use restrictions than under the existing restrictions. Under compensation at market value, the net welfare gains would be 125% larger in the absence of fund use restrictions than under the existing ones. Both results hold despite less roads being improved, as some external funds are instead being used for land acquisition. The existing restrictions are likely driven by corruption concerns, which are outside the scope of this paper. Yet, given the World Bank's stated objective to ensure that owners are *"provided prompt and effective compensation [...] for losses of assets attributable directly to the project."* (World Bank OP 4.12), these numbers should be used to benchmark whether the anticorruption benefits outweigh the potential benefits in terms of better compensating affected owners, and allocating improvements towards higher benefit locations.

Related Literature

My work contributes to a growing literature at the intersection of development and urban economics.[2]

First, my paper is the first measure the net returns to road improvements in a LIC city, accounting for both benefits and land costs. On the benefits side, existing evidence on the impact of road quality on speed is either in the US (Duranton and Turner 2011,Currier et al. 2023) or across cities worldwide (Akbar et al. 2023). One of the few within-city studies on the benefits of road paving in low or middle income country cities comes from Gonzalez-Navarro and Quintana-Domeque (2016), who randomize the rollout of road paving in Acayucan, Mexico and study the impact on local property values, but do not account for the city-level impacts. Instead, I build on a literature that has developed quantitative spatial models (Ahlfeldt et al. 2015, Allen and Li 2015, Redding and Rossi-Hansberg 2017, Monte et al. 2018, Heblich et al. 2020, Severen 2023, Almagro et al. 2024) to study the benefits of improved transportation infrastructures, and add competition between private and public land use while papers usually model competition between residential and business land uses (Lucas and Rossi-Hansberg 2002). Within-city studies using quantitative spatial models in low and middle income countries have focused on the impacts of Bus Rapid Transit (BRTs) (Majid et al. 2018, Balboni et al. 2020, Tsivanidis 2023, Zarate 2024, Kreindler et al. 2023). In Kampala, as in the majority of LIC cities, road is the only transportation mode, so that the improvements will be experienced by all commuters.[3] On the costs, high land costs have been shown to have increased the costs of transportation infrastructure since 1960s in the US (Brooks and Liscow 2023), and a few policy reports have discussed their role in LICs (World-Bank 1996). Collier and Venables (2016) discuss the cost of land use for LIC infrastructures but I am the first to formalize and quantify this mechanism through my quantitative spatial model of optimal road improvements, building on the recent methodologies developed by Allen and Arkolakis (2022), Fajgelbaum and Schaal (2020) and Bordeu (2024). I micro-found land cost heterogeneity in Kampala's historical property right regimes under the voluntary land take approach, and show how they affect the optimal location of road investments by shifting the distribution of relative costs.

Second, I show how, in the presence of a high fiscal wedge, weak property rights can act as a Pigouvian subsidy for investments in public infrastructures, increasing city-level welfare and the net returns from road improvements. On the one hand, I estimate that any fiscal wedge above 0.7 would lead to negative net welfare gains from road improvements if land was acquired at market value, in line with estimates for Kampala by Regan and Manwaring (2024) and consistent with a dense literature on the widespread challenges faced by LICs to levy domestic and property taxes (Besley and Persson 2014, Traxler 2010, Knebelmann 2019, Bergeron et al. 2023, Brockmeyer et al. 2023). On the other hand, I provide new evidence on the relationship between property rights structure and efficiency of investments, through the channel of public good provision. Unclear property rights yield higher risks of expropriation, associated

[2]Collier and Venables (2016) and Glaeser and Henderson (2017) highlight that this intersection has historically been overlooked by both development and urban economists, partly to the absence of detailed data needed to estimate quantitative spatial models.

[3]Most existing studies on road improvements in LIC countries focus on rural or cross-city infrastructure (Baum-Snow et al. 2017, Asher and Novosad 2020, Alder et al. 2022, Balboni 2023, Gertler et al. 2024, Morten and Oliveira 2024,Herzog et al. 2024). There are also several studies on the impact of railroad development on across-city transportation costs and migration, including Gollin and Rogerson (2010), Faber (2014), Ghani et al. (2016), Jedwab and Moradi (2016), Donaldson (2018) and Bryan and Morten (2019).

with lower economic development (North 1990, Acemoglu et al. 2001, Besley and Ghatak 2010), including in Kampala (Bird and Venables 2020). However, in the context of public goods provision, weak property rights can act as a Pigouvian subsidy, as strong private property rights conflict with public interests (Acemoglu and Robinson 2012, Posner and Weyl 2017), which in turn justifies eminent domain (Munch 1976, Shavell 2010, Jeong et al. 2016) for public purposes. As in Holland (2023), who studies the role of strong property rights in shaping opportunistic behavior by private owners in Colombia, I find that payments are increasing with the strength of owners' property rights. My contribution is to show how this relationship can affect the optimal amount of high benefit infrastructure improvements and, in the presence of spatially heterogeneous property rights, potentially shift their location away from the highest benefit areas.

The rest of the paper is organized as follows. Section 2 describes the context and the data I collected. Section 3 details how I estimate the reduced-form benefits and land costs of road improvements. In Section 4, I build a quantitative spatial model to study the city-level impacts of these improvements and study the welfare effects of spatially heterogeneous land costs. In Section 5, I estimate the model on Kampala, characterize the net returns of the road improvements. In Section 6, I solve for the optimal road improvements to quantify the welfare consequences of the existing property right regime, land acquisition rule and fund use restrictions. Section 7 concludes.

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