

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

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Abstract

Despite large potential benefits, transportation infrastructure improvements often fail to be implemented in developing cities because of land acquisition. In this paper, I collect new survey data with real estate brokers and landowners to characterize both benefits and costs of road improvements in Kampala. I use variation in the timing of 140 km of road improvements and estimate large local benefits in terms of traffic speed and local property values. I then develop a quantitative spatial model of road improvements that accounts for spatial spillovers and the fiscal cost of land acquisition. I show that acquiring the underlying land at market value, mandated under eminent domain, could have led to negative net returns because of a high fiscal wedge. Instead, the voluntary land acquisition approach adopted by the government decreased costs and resulted in net welfare gains equivalent 99 USD per resident. Leveraging the coexistence of three property right regimes in the city, I show how, however, this approach tied land costs to property rights, as weak property rights in parts of the city act as a Pigouvian subsidy. Solving for the optimal road improvements, I examine the allocative and welfare impacts of alternative land acquisition rules, property rights and fund use restrictions.

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 become a priority for both domestic governments and international agencies. Yet, despite large potential benefits, many projects fail to be implemented because of various inefficiencies in infrastructure operations or spending (Foster and Briceno-Garmendia 2010). In addition to the expenditure for the construction of the roads themselves, the underlying land must be acquired from private landowners. Land acquisition is commonly the sole responsibility of domestic governments. In turn, their inability to levy the corresponding funds leads to costly delays, redefining projects and dampening their net returns (World-Bank 1996).

In Kampala, Uganda, 140 km of road upgrades have been rolled out since 2017 to improve the quality of the city’s road network, where less than 45% of the major roads are paved. Construction is mostly funded by the World Bank and the African Development Bank, but the city government is responsible for acquiring the underlying land. Arguing that compensating landowners at market value, as mandated under the eminent domain legal framework, jeopardized the project’s full implementation (World-Bank 2023), the government asked owners to voluntarily give small portions of their land, without compensation. The coexistence of three property right regimes in Kampala (Bird and Venables 2020) tied land costs to owners’ heterogeneous ability to claim the compensation they are legally entitled to.

In this paper, I study how the returns to road improvements in Kampala depend on the land acquisition framework. I ask two questions. First, what are the net returns of realized road improvements in Kampala, accounting for both benefits and land costs? Second, how do the existing land institutions affect the locations of, and returns to road improvements? To answer these questions in a data scarce context, I collect new data on the benefits and land costs of road improvements throughout Kampala, including two novel surveys with real estate brokers and property owners, data from a local ride sharing company, and GoogleMaps data. Using variation in the timing of the policy and variation in property rights, I estimate the reduced-form benefits and costs of realized improvements. I characterize how these costs depend on the land acquisition rule. To measure the city-level benefits of road improvements, through changes in traffic flows and residents adjusting their choice of residence and workplace, I build and estimate a quantitative spatial model with land acquisition. I recover the fiscal wedge rationalizing the government’s decision to move away from acquiring land at market value. Last, I solve the model for the optimal road improvements to examine the location of improvements and welfare under different institutional frameworks, including eminent domain, voluntary land take, and in the absence of restrictions on the use of external funds for land acquisition.

Landowners forfeit rental income and valuable land when their property is taken for road improvements. While eminent domain compensates them for their loss, the fiscal burden associated with levying the corresponding funds may be so large as to outweigh the city-wide benefits of road upgrades. As a result, governments maximizing residents’ welfare and accounting for fiscal costs may choose not to compensate landowners, instead relying on weak property rights to allow easier and cheaper land acquisition. In Kampala, however, the areas that benefit the most from road improvements are correlated with those that have stronger property rights. Therefore, optimal improvements are shifted away from high benefits

locations.

To study the net returns of road improvements in this context, I need data on both the benefits of the program and the cost of land. Potential benefits include improvement in road quality, changes in local speed and commuting times, and a capitalization of these effects into property values. As for most Low Income Country (LIC) cities, such data is not available in Kampala, so I collect my own surveys and partner with local actors to fill this gap.

I query a panel of GoogleMaps trips from March 2023 to August 2024. The panel includes 180,000 trips and spans roads targeted by the policy as well as a representative sample of trips all over the city. To study the impact of road improvements on traffic speed, 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. I estimate that the intervention increased uncongested local traffic speeds by 4.1km/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.

I then conduct a survey with 377 real estate broker. The survey includes the appraisal of a standardized hypothetical property with characteristics varied one-by-one, as well as a retrospective panel of 3,000 transactions. From the appraisal exercise, I estimate that on average, an improvement to a road within a five minute walk increases the assessed sales price of the standardized property by 22%. Extrapolating to all properties on the side of upgraded roads implies an total increase in local property values by 66 million USD, which is less than the 80 million USD construction costs. I also estimate this return using the transacted properties. While more limited in terms of statistical power, I estimate that improving roads in a parish (neighborhood) leads to a 19% increase in the sales price of local properties.

To characterize land costs, I first use my panel of transactions from the broker survey. I show that the market value of residential properties, to be paid under eminent domain is high, up to 80% of the construction costs. Second, 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 an average of 73 square meters of their land without compensation, and that their decision is partly motivated by high costs of negotiating with the city government (hereafter government) and the difficulties of getting official copies of ownership documents.¹

Consequently, while the voluntary land take approach decreases the fiscal burden of land payments for the government, individual owners may be hurt by the land take, especially among the weakest property right regimes. In Kampala, land is owned under three main property right regimes: leasehold land features limited term ownership but a good track of property, freehold ownership is perpetual but land titles are poorly tracked, and 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 also 55% more likely to negotiate than *mailo* owners, and 75% more likely to negotiate than *freehold* owners.

¹The assumption that all owners who negotiated got compensated is motivated by qualitative evidence from focus group discussions. In the quantitative survey, many owners reported that they did not get paid officially yet by the time of the interview, but that bribery was prevalent and accepted, casting doubt on trusting all self-reported payments.

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 traffic rerouting and residents and firms adjusting their location choice 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 high commuting costs for 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 I assume that residential land is owned by immobile private landowners. Improving road infrastructure has both benefits and costs. 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 get 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 and the resulting financial cost of land is heterogeneous over space. 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.

I use my reduced-form estimates to recover key parameters of the model: the elasticity of road speed on road infrastructure and owners' negotiation costs.² In addition, 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 calibrate the rest of the parameters using public data for Kampala or from the literature.

Equipped with this model, I compute the benefits of road improvements implemented in Kampala since 2017. First, I fix workers' residence and workplace at their pre-policy levels, shutting down equilibrium relocation and focusing on the partial equilibrium channel. I estimate that workers' average commuting time decreased by 8.4% (1 min 28 sec) and total property values in the city increased by 1.52%. Second, I solve for workers' new equilibrium residential and workplace locations to estimate that workers' average commuting time decreased by 7% compared to pre-policy, as workers responded to the decrease in commuting costs by increasing the distance between their residence and workplace, in search of cheaper housing further from their workplace. In response, property values adjusted back slightly, for a 1.48% final increase compared to baseline. I solve for the compensating differential transfer that would have had to be made to each resident (lump sum) to reach the same level of welfare gains that with the realized road upgrades. I find that in the absence of land payments, this one time transfer is equal to 120 USD, of 164% of the median monthly wage. Summing over all residents, this implies 108 million USD net welfare

²I 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).

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 levying domestic funds. The Kampala government argued that acquiring land at market value would threaten the viability of the project ([World-Bank 2023](#)), so I solve for the fiscal wedge rationalizing its decision. 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 voluntary land take approach are 86 million USD. Importantly, I find a positive correlation between the realized upgrades and the corresponding marginal net welfare gains from specific road 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 study how the land institutions impact the allocation 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 be equivalent to a 397 USD transfer by resident, average commuting time would decrease by 13.2% and property values would increase by 2.9%. 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 (13.9% against 13.2%) and larger increase in property values (3.2% against 2.9%).

Finally, I investigate the welfare impacts 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, but 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.³

First, my paper is the first measure the net returns to road improvements in a LIC city. On the benefits, I add to cross-city evidence (Akbar et al. 2023) on the impact of road quality on speed worldwide, and within-city evidence in the US (Duranton and Turner 2011, Currier 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. 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.⁴ 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 study the interaction of two widespread features in LICs: challenges to levy domestic taxes and uneven property rights. I illustrate how high costs of levying public funds to acquire land may prevent beneficial public infrastructure improvements. 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). I also provide new evidence

³Collier 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.

⁴Most 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).

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 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 in the clarity 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 described 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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