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

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Abstract

High land acquisition costs are a key factor behind the shortfall of high-benefit infrastructure projects in developing cities, but are rarely accounted for when quantifying the net returns of these projects. In this paper, I estimate the net returns of 140 km of road improvements in Kampala, Uganda, since 2017, accounting for land acquisition costs. Using new survey data from real estate brokers and landowners, I take advantage of variation in the timing of improvements to estimate local benefits. I then develop a quantitative spatial model to capture the city-level impacts of the policy, accounting for general equilibrium effects and spatially heterogeneous land acquisition costs. Leveraging the coexistence of three property rights regimes in the city, I show that weak property right regimes are associated with lower land acquisition costs, supporting more extensive road improvements. I find that the net welfare gains from the realized road improvements were equivalent to a 119 USD transfer per Kampala resident, but would have been negative if land had been acquired at market value as legally mandated under eminent domain, because of the high cost of raising domestic funds. Finally, I solve for the optimal road improvements under different institutional settings and demonstrate the importance of accounting for land costs when designing, funding and evaluating transportation infrastructure projects, especially in low- and middle-income countries where land acquisition relies on fragile land and financial institutions.

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Two versions of the introduction: existing and following the structure suggested by Michael

1 Introduction (existing)

Infrastructure is crucial for economic development, but African cities face a severe deficit in transportation infrastructure, with only one third of roads paved (Kumar and Barrett 2008). Yet, investments to address Sub-Saharan Africa's urban transportation infrastructure deficit remain insufficient (World Bank 2019), suggesting either low benefits or prohibitively high costs. On the one hand, despite research linking urban mobility with economic development (Akbar et al. 2023), data scarcity has limited empirical evidence on the benefits of specific transportation infrastructure projects, which are not only local but also have spillovers throughout the city. On the other hand, in addition to construction costs, mostly funded by international agencies, governments are often required to formally acquire the land on which these roads are built from private landowners against fair compensation (Collier and Venables 2016). These high land acquisition costs have had a significant impact on the net returns of transportation infrastructure projects (World Bank 1996) because of especially high costs of raising domestic funds in low- and middle-income countries (Besley and Persson 2014), but have been largely overlooked by the literature.

This paper addresses the gap in the literature by estimating the benefits, land costs, and net returns to several road improvement projects undertaken in Kampala, Uganda, a city with less than 45% of its major roads paved. Construction has been primarily funded by the World Bank and the African Development Bank, while the domestic government has been responsible for acquiring the underlying land from private landowners. Yet, the government expressed concerns that acquiring land at market value, as mandated under the eminent domain legal framework, would lead to high costs jeopardizing the project's implementation (World Bank 2023), and instead encouraged owners to cede small portions of their land without compensation. The success of this 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 estimate the net returns of road improvement projects in this data-scarce environment, I collect new data and build a model accounting for both land costs and citywide benefits. I conduct two novel surveys with real estate brokers and landowners, and leverage the coexistence of three property right regimes in the city (Bird and Venables 2020) to analyze how property rights lead to heterogeneous land acquisition costs over space. I estimate the local reduced-form benefits of 140 km of road improvements initiated in 2017 by using variation in the timing of these projects, along with data on commuting patterns from a local ride sharing company, and traffic data from Google Maps. Next, to measure the city-level net returns of these improvements, I build and estimate a quantitative spatial model that accounts for the equilibrium changes in traffic flows, the relocation of residents, and both the opportunity and financial costs of land. Finally, I solve the model for the road improvements made by a central planner maximizing city-level welfare, under different institutional frameworks. I evaluate how heterogeneous property rights and other institutional constraints affect the allocation and returns of these optimal investments.

I find that despite large benefits, high net returns from road improvements in Kampala are enabled only because weak property rights reduce land acquisition costs. Since any funds the government aims to raise

incur losses due to a high wedge on tax revenues (Regan and Manwaring 2024), weak property rights enable the construction of more roads that generate large positive externalities on city-level welfare, that private landowners do not internalize. This finding aligns with theoretical work on the tension between private property rights and public goods provision (Acemoglu and Robinson 2012, Posner and Weyl 2017). In addition to affecting the net returns from realized improvements, land costs affect the level and allocation of welfare-maximizing investments and both costs and benefits are spatially heterogeneous. In Kampala, areas with large benefits from road improvements often coincide with those that have strong property right regimes, shifting optimal investments away from high-benefit but high-cost locations. These findings have important implications for both academic research and policy. They emphasize the importance of accounting for land costs when designing, funding and evaluating transportation infrastructure projects, especially in low- and middle-income countries where land acquisition relies on fragile land and financial institutions.

To study the net returns to road improvements in Kampala, I start by collecting novel datasets to estimate land costs. I first conduct a survey with 377 real estate brokers, which includes a retrospective panel of transactions. I show that if the government was to pay the market value of residential properties, as required under the legal eminent domain framework, land costs would sum up to 80% of construction costs. Next, I interview 548 landowners whose properties border the upgraded roads in Kampala. I find that 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 *voluntary land take* approach decreases overall land costs for the government, but ties them, and therefore the likelihood of road improvements, to the different property right regimes in the city.,

I then estimate the local benefits of these road improvement projects. 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. 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 sale prices 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 of road construction costs, implying that the project would not have

net positive returns if benefits were only local. 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 sale 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, as it reduces the land available for housing, which strains the stock of valuable residential land and increases prices. To capture these effects, I build a static 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.

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 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 consistent with the few existing estimates in Low Income Country (LIC) cities (Balboni et al. 2020, Kreindler and Miyauchi 2023). 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 city-level 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 6.6%, and that total property values in the city increased by 1.36% 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 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 306 USD, or 208% of the average monthly wage of a worker in Kampala. Summing over all residents, this implies 265 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 welfare gains from road improvements in the presence of large costs of levying taxes to raise domestic funds. I solve for the wedge on tax revenues rationalizing the government's claim that acquiring land at market value would threaten the viability of the project (World

[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).

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 tax revenue wedge was above 0.51. 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 wedge of 0.61. Under this high tax revenue wedge, the net welfare gains of the policy under the existing *voluntary land take* approach are equivalent to a one time 119 USD 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 local land costs and road upgrades, 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 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 optimal road improvements chosen by a utilitarian central planner maximizing residents' welfare. Under compensation at market value, I estimate net welfare gains equivalent to a one-time transfer to each resident of 153 USD, or 104% of the median monthly wage. Under the voluntary land take approach, net welfare gains of the optimal policy would instead be equivalent to a 500 USD transfer by resident. Because of the large tax revenue wedge, weak property rights act as a 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. The optimal road improvements under uniform property rights set at the weakest regime in the city would yield 563 USD per resident. 30% of this increase comes from a lower fiscal burden and 70% comes from a better allocation, 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 tax revenue 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 12% larger in the absence of fund use restrictions than under the existing restrictions. Under compensation at market value, the net welfare gains would be 56% larger in the absence of fund use restrictions than under the existing ones. Both results hold despite fewer 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.

Abstract

There is a recognized need for increased transportation infrastructure in developing cities, yet investments remain insufficient, often due to high land acquisition costs. Empirical estimates of net returns to these investments are scarce, primarily because data constraints have made it difficult to estimate city-level benefits and because land costs have been overlooked. In this paper, I collect novel data to estimate the net returns of 140 km of road improvements in Kampala, Uganda, since 2017, accounting for both benefits and land acquisition costs. Using new surveys with real estate brokers and landowners, I exploit variation in the timing of improvements to estimate local benefits. I then develop a quantitative spatial model to capture the city-level impacts of the policy, accounting for general equilibrium effects and spatially heterogeneous land acquisition costs. Leveraging the coexistence of three property rights regimes in the city, I show that weak property rights are associated with lower land acquisition costs, enabling more extensive road improvements. I find that the net welfare gains from the realized road improvements were equivalent to a 119 USD transfer per Kampala resident, but would have been negative if land had been acquired at market value, as legally mandated under eminent domain, due to the high cost of raising domestic funds. These findings align with theoretical work on the tension between private property rights and public goods provision, highlighting how weak property rights can facilitate more extensive infrastructure investments. Finally, I solve for the optimal road improvements under different institutional settings and demonstrate the importance of accounting for land costs when designing, funding, and evaluating transportation infrastructure projects, especially in low- and middle-income countries where land acquisition relies on fragile land and financial institutions.

2 Introduction (following structure suggested by Michael)

Infrastructure is crucial for economic development and African cities face a severe deficit in transportation infrastructure, with only one third of roads paved (Kumar and Barrett 2008). Yet, investments to address this infrastructure deficit are still insufficient (World Bank 2019), potentially suggesting low net returns.

Estimating the net returns to these investments is challenging. Despite research linking urban mobility with economic development (Akbar et al. 2023), data scarcity has limited empirical evidence on the benefits of specific transportation infrastructure projects. Additionally, in addition to construction costs, mostly funded by international agencies, governments are often required to formally acquire the land on which these roads are built from private landowners against fair compensation (Collier and Venables 2016). These high land acquisition costs have had a significant impact on the net returns of transportation infrastructure projects (World Bank 1996) because of especially high costs of raising domestic funds in low- and middle-income countries (Besley and Persson 2014), but have been largely overlooked by the literature.

This paper addresses the gap in the literature by estimating the benefits, land costs, and net returns to several road improvement projects undertaken in Kampala, Uganda over the period starting in 2017. I conduct two novel surveys with real estate brokers and landowners, and leverage the coexistence of

three property right regimes in the city (Bird and Venables 2020) to analyze how property rights affect land acquisition costs. I estimate the local reduced-form benefits of these projects by using variation in their timing, along with data on commuting patterns from a local ride sharing company, and traffic data from Google Maps. Next, to measure the city-level net returns of these road improvements, I build and estimate a quantitative spatial model that accounts for equilibrium changes in traffic flows, the relocation of residents, and land costs. Finally, I solve the model for the road improvements made by a central planner maximizing city-level welfare, under different institutional frameworks. I evaluate how heterogeneous property rights and other institutional constraints affect the allocation and returns of these optimal investments.

By collecting the most comprehensive data on both the benefits and land costs of road improvements in a Sub-Saharan African city, I show that despite large benefits, high net returns from road improvements in Kampala are enabled only because weak property rights reduce land acquisition costs. In addition, in Kampala, areas with large benefits from road improvements often coincide with those that have strong property right regimes, shifting welfare-maximizing investments away from high-benefit but high-cost locations, as private landowners do not internalize the city-level positive externalities of road construction. These findings are consistent with theoretical work on the tension between private property rights and public goods provision (Acemoglu and Robinson 2012, Posner and Weyl 2017) and have important implications for both academic research and policy. They emphasize the importance of accounting for both land costs and city-level benefits when designing, funding and evaluating transportation infrastructure projects, especially in low- and middle-income countries where land acquisition relies on fragile land and financial institutions.

I start by characterizing the state of Kampala's road network. With less than 45% of its major roads paved, Kampala is a typical Sub-Saharan African city. To improve urban mobility in the city, about 140 km of road improvements have been initiated in 2017. Upgrading road networks commonly requires additional land. As in most World Bank and African Development Bank funded projects, construction is primarily funded by international agencies, while the domestic government has been responsible for acquiring the underlying land from private landowners. Yet, the government expressed concerns that acquiring land at market value, as mandated under the eminent domain legal framework, would lead to high costs, thereby jeopardizing the project's implementation (World Bank 2023), and instead encouraged owners to cede small portions of their land without compensation.

The paper presents five main results.

First, I estimate the land acquisition costs and how they depend on the different property right regimes in the city. I collect a novel survey with 377 real estate brokers, which includes a retrospective panel of transactions. I show that if the government were to pay the market value of residential properties, as required under the legal eminent domain framework, land costs would sum up to 80% of construction costs. Next, I interview 548 landowners whose properties border the upgraded roads in Kampala. I find that 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 the challenges associated with

obtaining official copies of ownership documents. These challenges are heterogeneous along the lines of Kampala's three main property right regimes: leasehold, freehold as well as 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 voluntary land take approach decreases overall land costs for the government, but ties them, and therefore the likelihood of road improvements, to the different property right regimes in the city.

Second, I estimate the local benefits of these road improvement projects. I start by calculating the impact of road improvements on traffic speed by leveraging information from Google Maps queries. I exploit 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 4.1 km/h (16% faster than baseline speed). Consistent with this change in local speed, I also show that trips between pairs of neighborhoods became more likely to take upgraded roads over time.

I show that 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 sale prices 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 of road construction costs, implying that the project would not have positive net returns if benefits were only local. 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 sale 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 decisions of residents and firms in equilibrium. In addition, using residential land for roads has an opportunity cost, as it reduces the land available for housing, which strains the stock of valuable residential land and increases prices. To capture these effects, I build a static 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.

I estimate key parameters of the model that are needed 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 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 consistent with the few existing estimates in Low Income Country (LIC) cities (Balboni et al. 2020,

Kreindler and Miyauchi 2023). 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.

Third, equipped with this model and the parameters described above, I compute the city-level 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 6.6%, and that total property values in the city increased by 1.36% 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 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 306 USD, or 208% of the average monthly wage of a worker in Kampala. Summing over all residents, this implies 265 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.

Fourth, I leverage the model to investigate the mechanisms through which land acquisition affected the projects' net returns. Payments for land may decrease the net welfare gains from road improvements in the presence of large costs of levying taxes to raise domestic funds. I solve for the wedge on tax revenues 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 tax revenue wedge was above 0.51. 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 wedge of 0.61. Under this high tax revenue wedge, the net welfare gains of the policy under the existing voluntary land take approach are equivalent to a one time 119 USD 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 local land costs and road upgrades, consistent with the model capturing property right regimes as a relevant feature of the city government's decision.

Fifth, I use the model to study how 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 optimal road improvements chosen by a utilitarian central planner maximizing residents' welfare. Under compensation at market value, I estimate net welfare gains equivalent to a one-time transfer to each resident of 153 USD, or 104% of the median monthly wage. Under the voluntary land take approach, net welfare gains of the optimal policy would instead be equivalent to a 500 USD transfer by resident. Because of the large tax revenue wedge, weak property rights act as a 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. The optimal road improvements under uniform property rights set at the weakest

regime in the city would yield 563 USD per resident. 30% of this increase comes from a lower fiscal burden and 70% comes from a better allocation, 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 tax revenue 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 12% larger in the absence of fund use restrictions than under the existing restrictions. Under compensation at market value, the net welfare gains would be 56% larger in the absence of fund use restrictions than under the existing ones. Both results hold despite fewer 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 and Contributions

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. I find that while road improvements had large impacts on local speed and local property values, as well as on city-level average commuting time and property values through general equilibrium effects, they also had high land costs. In turn, the structure of these costs affect both the net returns of existing improvements, and the optimal location of road improvements. On the benefits side, existing evidence on the impact of road quality on speed is either in the United-States (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 infrastructure, 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 impact of Bus Rapid Transit (BRTs) (Majid et al. 2018, Balboni et al. 2020, Tsivanidis 2023, Zarate 2024, Kreindler et al. 2023), and very few estimates of the models' key elasticities exist in LIC cities (Kreindler and Miyauchi 2023).[3] 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 show how, in the presence of a high tax revenue wedge, weak property rights can increase city-level welfare and the net returns from road improvements by decreasing financial losses from land acquisition. On the one hand, I estimate that any tax revenue wedge above 0.51 would lead to negative net welfare gains from road improvements if land was acquired at market value, in line with estimates

[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] Works on between-city and rural impact of road paving in LIC countries include Storeygard (2016), Aggarwal (2018) Gertler et al. (2024a), Graff (2024).

[4] 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. 2024b, 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).

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 (Traxler 2010, Besley and Persson 2014, 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 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, I show that clear property rights can have large negative welfare gains, by preventing budget constrained governments from seizing land that could be used more efficiently for the public good because there are positive externalities of road improvements on the whole city that owners do not internalize. I build on existing literature that acknowledges the conflict between strong private property rights and public interests (Acemoglu and Robinson 2012, Posner and Weyl 2017), which is traditionally used to justify eminent domain (Munch 1976, Shavell 2010, Jeong et al. 2016) for public purposes. I further show how, however, in LICs, eminent domain may lead to suboptimal investments, given the high costs of raising public funds. 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, 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.

The realized welfare gains are higher because not all owners get compensated, especially if they have weak property rights. In the context of public good provisions, clear property rights can have large negative welfare gains, by preventing budget constrained governments from seizing land that could be used more efficiently for the public good (Acemoglu and Robinson 2012), because there are positive externalities of road improvements on the whole city that owners do not internalize. In counterfactual scenarios, I further explore how land acquisition under more uniform property right regimes could improve welfare outcomes by shifting investments towards higher benefit locations.

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