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Evaluating the impacts of the Dar es Salaam Bus Rapid Transit System

March 2020

Impact Evaluation Report 110

Transportation

3ie International Initiative for Impact Evaluation

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3ie accepted the final version of the report, *Evaluating the impacts of the Dar es Salaam Bus Rapid Transit System*, as partial fulfilment of requirements under grant DPW1.1029 awarded through Development Priorities Window 1. The report is technically sound and 3ie is making it available to the public in this final report version as it was received. No further work has been done.

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Abstract

Dar es Salaam, the economic hub of Tanzania, faced rapidly worsening traffic congestion, which threatened its economic growth prospects: in 2016, people's commute speed was 8.5 km per hour. In 2003 the Dar es Salaam City Council decided, as the core of its strategy to battle urban traffic congestion, to embark on the implementation of a city-wide Bus Rapid Transit (BRT) system. In May 2016 the first of six planned phases of the BRT started operations.

Bus Rapid Transit (BRT) systems have been successfully introduced in many large cities in developing countries throughout Latin America and Asia and are also increasingly adopted in developed countries. The BRT dedicate unique lanes to a bus system that provide metro-like services. By incorporating the features of a metro system such as rapid boarding and dedicated right of way, BRT systems can, for a fraction of the cost of a metro, transport almost the same number of people.

The introduction of a BRT is expected to reduce commuter travel times and urban congestion positively affecting a range of economic, social and environmental indicators. A location closer to the BRT line is expected to increase the share of the labour market reached by job seekers improving the quality of the skill match between jobs and workers resulting in higher productivity. In addition, consumers living in areas close to the BRT line are expected to access more variety of goods, making the area a more desirable place to live, and reducing the time spent in daily chores. Finally, more people will be able to access firms located close to the BRT increasing potential demand for their goods and services. This is expected to lead to an increase in the number of firms in the area. Overall, these three forces are expected to lead to an increase in land prices, transformation of land use, and changes in the socio-economic make-up of the population living in the area. The effects are expected to be stronger in locations closer to the BRT line and but can potentially change the make-up of the city in the long-term as firms and households move around.

However, there is little knowledge about the extent in which the BRT can ignite and result in this urban transformation. The goal of this study is to contribute to this literature by understanding whether the Dar es Salaam BRT Phase 1 created jobs, boosted income, encouraged firm productivity, trade and growth, improved property values, and increased the health, wealth and happiness of Dar residents – especially the poor.

To evaluate the impacts of the first phase of the BRT, we use a spatial triple-differences methodology (difference-in-difference-in-differences) that compares outcomes from places near and far from Phase 1, near and far from planned Phase 2, and before and after the implementation of BRT Phase 1. This approach identifies the local effect of the BRT Phase 1.

Our analysis shows that the time of commute has dropped in the city: people report getting to their jobs on average 10 minutes faster and to the city centre about half an hour faster. However, there is no evidence that these changes can be attributed to the operation of the BRT nor that they have translated into socio-economic improvements. Results from the triple-difference estimates show that Phase 1 did not have the expected

impacts on income and consumption across the city, nonetheless, it did not increase the cost of living, through rents, either.

Results need to be read with caution since the methodology only estimate impacts from Phase 1 relative to Phase 2. The triple-difference estimates capture relative changes but do not account for all the economic force interacting in the city after the introduction of the BRT. Further analysis to understand the general equilibrium effects of the BRT is being undertaken and will allow for more precise public policy recommendations as well as a cost-benefit analysis of the project. The research team is currently pursuing this extension to the originally planned project.

Complementary interventions could help reap the greatest benefits from this transport infrastructure. First, the extent of the impact of the BRT depends on its operational performance. Increasing the number of BRT buses and feeder routes, as *project managers* have planned*,* could potentially incentivize more people to use the BRT and improve key outcomes such as income and employment. Second, *policy makers* should aim to have complementary urban regulation changes that promote density along the BRT corridor to increase the share of business and households that benefit from better connectivity. For example, reducing minimum plot size or adjusting zoning regulations. Tsivanidis (2017) found that adjusting zoning regulations to allow increased building densities in Bogota would have led to higher welfare gains from Transmilenio, the city's BRT.

Researchers and *donors* should take into account that household split and move more frequently in urban settings, hence, fieldwork will be longer, more intensive and will probably require an additional follow-up data collection exercise. Our project included three rounds of data collection, and both the midline and endline follow-up surveys were followed by a "mop-up" fieldwork exercise. These exercises were key to reduce attrition.

Given this timing, we are still developing the empirical results and expect that they will be subject to iteration. We will also need to engage in a process of result-sharing with our government and World Bank counterparts and then develop generalizable lessons. We anticipate having further information to share about the policy and programme relevance once this process is completed.

Content

List of figures, Maps and tables

Abbreviations and Acronyms

BL	Baseline
BRT	Bus Rapid Transit
CBD	Central Business District
COSTECH	Commission for Science and Technology
DART	Dar Rapid Transit
DID	Difference-in-Difference
EL	Endline
FE	Fixed Effect
GE	General Equilibrium
GPS	Global Positioning System
GDP	Gross Domestic Product
HH	Household
IPA	Innovations for Poverty Action
IRB	Institutional Review Board
JICA	Japan International Cooperation Agency
NGO	Non-Governmental Organization
TSH	Tanzanian Shillings
TZS	Tanzanian Shillings
USD	United States Dollars

1. Introduction

Globally, cities are the drivers of economic growth and development: dense urban areas are better at generating new ideas, providing public goods, and matching people to jobs and goods. However, as urban populations grow, especially in Africa, city density is effectively falling: the influx of people means travel times are very large and the labour and goods markets that city dwellers can access are shrinking to the areas closest to where they live. In response, there is great pressure to upgrade transport options, however, the best approach to this transport problem is unclear. Several strategies could be pursued: upgrading of existing buses, congestion pricing, Bus Rapid Transit system (BRT), or light rail, to name some of the options. Assessing the appropriate approach requires evidence on outcomes, and this project aims to provide some evidence by studying the impact of Dar Es Salaam's newly built BRT on increased market access and how market access changes outcomes for people of different backgrounds.

Current public transport options and problems in Dar es Salaam are representative of those found in other fast-growing East African cities. Public transportation is provided by daladalas (minibuses), bajajs (rickshaws), bodabodas (motorcycles), two commuter trains, private taxis, and a ferry. Daladala minibuses hold 40 passengers each and there are approximately 5,200 privately owned daladalas in the city. Daladala fares range between TSH 400 /USD .25 cents and TSH 1,000/USD .50 cents and each daladala operator must have a license and specified route to operate. Bajajs provide destination-specific rides for minimum fares of TSH 1,000/USD .50 cents. Bodabodas are passenger motorcycles, which operate in areas not serviced by daladalas, and generally cover shorter distances. Two commuter trains run within Dar es Salaam city limits and operate only in morning and evening peak hours, carrying about 5,000 passengers per day. A ferry operates daily, connecting Kigamboni district and the City Business District at Kivukoni, with a travel time of 10 minutes and TSH 200 / USD .10 cents per person.

The city has high levels of congestion, especially on the city's main arterial roads. In consultation with the Japan International Cooperation Agency (JICA), the government conducted extensive transport policy and system development planning, ultimately deciding on a strategic corridor development pattern (as opposed to a monocentric radial or polycentric satellite development pattern). The BRT system was chosen from this plan as the best approach to combat the city's growing congestion issues. This system is akin to others (Lahore, Bogota, Quito) however there are few in Sub-Saharan Africa (Lagos and smaller cities in South Africa). It is the first BRT to be operational in East Africa.

Dar es Salaam is the commercial capital of Tanzania and provides port access to 6 landlocked countries in East Africa, making it an important trade hub. It is one of the fastest-growing cities in the world, with 5.6% annual growth rates from 2002 to 2012 (NBS & MoF, 2013)

Over the past decade, an increasing number of young adults with low rates of education have migrated to Dar es Salaam, and unemployment in the capital is notably high. In 2010, youth in Dar es Salaam was 6 times (13%) more likely to be unemployed than rural youth (2%), and 20% of youth with secondary education in Dar were unemployed (Morisset, et., 2013). In 2012, Tanzania had more unemployed youth per capita than 109 other countries around the world. This impact evaluation will help shed light on the

impacts of a BRT system in providing access to income-generating activities and other development outcomes not yet understood.

In this context, the primary question of this impact evaluation is: What is the impact of the Bus Rapid Transit system on socioeconomic factors of housing, employment, and mobility in Dar es Salaam?

From its inception, the impact evaluation has been developed in close collaboration with DART, and the research team's conversations with DART have revealed that there is high demand for these results and an evaluation strategy to build a strong feedback loop of credible information for future BRT planning, implementation, and management. Given the Tanzanian Government's plans to construct phases 2-6 of the BRT, the results will be critical to domestic policy in the near future. DART has indicated its interest in using evidence on travel times, public transport ridership, urban mobility, job search costs, private vehicle use, and inter-firm trade to spur further investment.

In addition to informing domestic policy, this study is a great contribution to the literature. First, the provision of transportation infrastructure is one way to reduce congestion, increasing effective density and hence productivity and amenity. Despite this, we have very little evidence on the impact of urban transportation infrastructure. To the best of our knowledge, this is the first evaluation of its kind in African cities, where BRTs are increasingly seen a viable transport solution and where different kinds of jobs are housed. In the developed world, Gibbons and Machin (2005) use a difference-in-difference method to evaluate the impact of the Jubilee line extension on house prices in London. Making the typical urban economics assumption that house prices capture all economic gains, their method produces estimates of the economic impact of the line, and they find large positive impacts, but can say nothing about inequality. Phillips (2014) uses a very different, experimental, method: he subsidises access to the DC Metro for the unemployed. He finds large positive impacts on employment levels from this implied increase in labour market access.

In the developing world, Cervero and Chang (2011) evaluates the impact of the BRT in Seoul but pays little attention to identification issues and considers only the impact on urban form in terms of housing density. Gaduh et., 2019 focuses on the effects of the Jakarta BRT on commuting outcomes and uses repeated cross-sections. Majid, et al., 2018 use retrospective questions to construct a quasi-panel but also focuses on commuting outcomes. A series of papers consider the Bogota BRT: Rodriguez and Targa (2004) using a hedonic approach, which is not careful about identification, find large increases in rental rates; Bocarejo et al. (2013) use a difference in difference estimator, but only consider indicators of urban form; Heres, et al., (2014) uses repeated cross-sections to look at earnings of locations close to the BRT lines, and Tsivandis (2018) studies the general equilibrium effects of the system. Heres, er al., 2014 find large increases in earnings but cannot determine whether this is because of the selection of people into the neighbourhoods connected to better public transport or a causal effect of improved public transport on jobs for initial residents. Likewise, Tsivandis (2018) undertakes an analysis using repeated cross-sectional analysis, so cannot separate out whether effects are due to selection or a casual effect. Zuk (2015) presents more studies, arguing that results are generally mixed.

Second, as detailed below, our evaluation uses a triple difference strategy, which significantly weakens identification requirements and can be used in the future evaluations of BRTs. Third, we collected data on locations throughout the city before the BRT Phase 1 started operations and tracked the same individuals 3 years after the start of operations. This allows us to understand the impact not only on jobs but also on displacement, which have not been explored in previous studies due to available datasets. Our methodology could also be extended to studies of other major infrastructure, such as access to piped water (Devoto et al. 2012,), access to electricity (Dinkelman 2011 and Lipscomb et al. 2013) as well as slum upgrading (Galiani et al. 2017). Fourth, we plan to estimate a general equilibrium (GE) model which can be used to understand the city level impacts of the BRT. This is important to quantify whether improved public transport leads to a net increase in jobs or only a relocation of economic activity inside the city.

This report has eight sections including this introduction. Section 2 explains the intervention and expected effects and Section 3 the evaluation design. Section 4 the exposes the main findings, and Section 5 the cost analysis. Section 6 discusses the policy implications and Section 7 concludes.

2. Intervention

2.1 Description

Dar es Salaam, the economic hub of Tanzania, has faced rapidly worsening traffic congestion, which threatened its economic growth prospects. In 2002 the Dar es Salaam City Council decided to embark on the implementation of a city-wide BRT system, as the core of its strategy to battle urban traffic congestion. The project studies, financed by the World Bank, were approved by the Government in July 2006. The implementing and contracting authority for the project, the Dar es Salaam Transit Agency (DART), was established in 2007, and in 2008 a credit of USD 290 million from the World Bank for infrastructure development was secured.

The Bus Rapid Transit (BRT) system project is a high capacity transport solution that dedicate segregated bus lanes at major roads and use feeder buses that operate on mixed traffic lanes to feed passengers to the trunk system. The BRT system is closed; passengers need to access stations and terminals through turnstiles. The Dar es Salaam BRT system has 6 planned phases, of which phase 1 completed construction in Fall 2015. The BRT network aims to optimize connectivity between the city's historic core, from where radial spokes of commercial development emanate, with the rest of the city (Malyan, 2018).

Phase 1 consists of 20.9 kilometres of trunk lanes, 57.9 kilometres of feeder routes, 5 terminals, 27 stations, 7 feeder stations, 3 connector stations, and 2 bus depots. Trunk lanes extend along Morogoro Road from the CBD towards the west to Kimara, with branches on Kawawa road from Morocco to Magomeni and along Msimbazi road up to Gerezani Kota, a main bus terminal connecting three phases of the project. Phase 2, under construction, consists of 20.3km of trunk lanes that connects with Phase 1 at the CBD and then extends towards the south along Kilwa Road corridor and part of Kawawa Road (AfDB, 2015). Phase 1 and planned Phase 2 are presented in the next map.

Map 1: Dar BRT Phase 1, 2 and 3 routes

Source: DART.

Phase 1 has been operating under full capacity. The number of buses operating have been substantially lower than initially planned. Pre-implementation models determined the system should have 177 trunk buses and 128 feeder buses, however, only 39 trunk and 101 feeder buses have been in operation, with some feeder buses being used in the trunk routes and many of the planned feeder routes not being yet served. Passenger trips per day was also expected to be almost four times larger than what it is today –this was, on average, 173 passenger trips per day between October 2017 and July 2019.

2.2 Theory of change

The expectation before the launch of the was that it would reduce commuter travel times and urban congestion and, ultimately have positive impacts on a range of economic, social and environmental indicators. The elements of the project and its projected causal path of impact are outlined in detail in Figure 1.

Reductions in travel times for BRT and non-BRT users were hypothesized to increase the access to different markets. People and businesses in a location close to the BRT

line were expected to see improved access to the labour market with several potential effects. First, job seekers would be able to find better matches (as they have access to more employers and because of shorter potential commute times) and so productivity would be higher. Second, consumers living in areas close to the BRT line would see an increase in access to goods markets, making the area a more desirable place to live, and reducing the time spent in daily chores. Third, firms that located close to the BRT would have access to a greater demand, because more people would be able to access their services. This would make the area more attractive to businesses and tend to increase the number of firms in the area. Overall, these three forces would lead to a potential increase in land prices, changes in land use and changes in the mix of people living in the area.

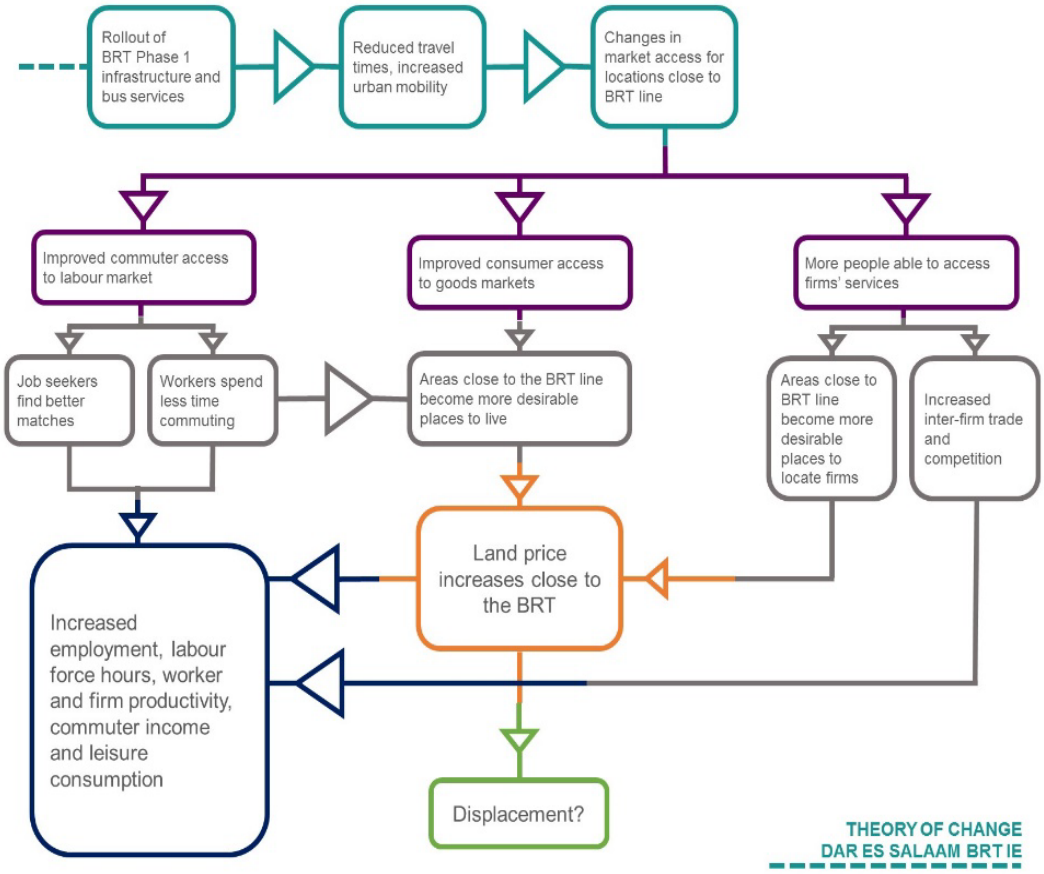
Changes in access to different markets due to the BRT was hypothesized to depend on the extent to which individuals are able to access and use the bus services (e.g. because of prices); the change in travel times to valuable markets; the value of those markets; market frictions that may limit their ability to realise these benefits; and potential general equilibrium effects of the new infrastructure, for instance on land and property prices.

Dar residents were expected to be happier due to the BRT because reductions in travel times would increase their leisure time. As firms grow and diversify, people would also have access to a more diverse array of goods and services. An increased pool of suppliers can also lead to price reductions making goods and services more affordable. Dar residents are also expected to be healthier, as reduced travel times may result in lower pollution. The net effect will depend on whether the BRT leads to reduced use of private vehicles, and other modal choices that emit more pollutants.

The introduction of the BRT was also expected to increase road safety as BRT drivers were expected to be more cautious than daladala drivers. The income of daladala drivers depends on the number of passengers transported motivating them to over-speed and dangerously over-pass. BRT drivers do not have these incentives. BRT stations are also lightened and closed reducing the likelihood of being mugged or run over while waiting for the bus.

These impacts were expected to be heterogeneous across both geographical location and individual characteristics. The urban poor might have been particularly constrained in their ability to realise benefits from the BRT, for example, as a result of job search frictions, credit constraints or behavioural factors. In addition, concurrent increases in rental prices might have led to displacement of poorer households to areas with lower connectivity to labour, goods and services markets.

Figure 1: Expected impacts of the Dar es Salaam BRT, Theory of change



Source: authors.

2.3 Monitoring plan

The data collection for this research project was undertaken by Innovations for Poverty Action, an international NGO with deep experience in research, both in Sub-Saharan Africa and around the world. Several steps were untaken to ensure data quality. First, enumerators were trained on the survey protocol, including time to pilot the survey. Each field team had a field manager who was able to assist with specific issues. The major field issues we faced were challenges in contacting households: we had much higher mobility rates than expected. This involved us doing a second “mop up” round of fieldwork after survey rounds two and three to try to recontact households that we were not able to find the first time. In summary, there were three steps taken to reach the respondents: (i) track them in person at their last reported residence three times at different times of the day, (ii) ask neighbours, local leaders and family members for contact information, and (iii) call all available phone numbers at least three times at different times of the day. If the respondent was not reached after following these steps, it was categorized as unreachable. High frequency data checks were performed on a bi-daily basis. Finally, one last data quality check came after the initial endline where we realized that survey respondents did not accurately answer a question about rents: the question did not appear to be consistently answered on a per room basis. We realized this issue only after comparing mean values and distributions with the baseline and midline dataset. We then mobilized an additional two weeks of fieldwork to recontact the survey respondents by phone and confirm their responses were in the correct units.

3. Evaluation

3.1 Primary and secondary questions

The evaluation seeks to understand the impact of BRT on Dar es Salaam citizens. The BRT will have heterogeneous impact for different locations depending on the extent to which it changes market access. We will evaluate if the BRT Phase 1 boosted income, encouraged firm productivity, trade and growth, improved property values, and increased the health, wealth and happiness of Dar residents – especially the poor.

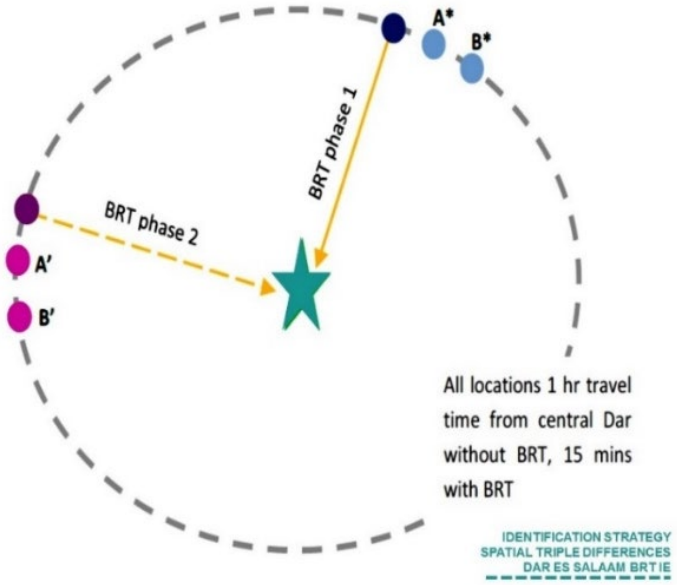
3.2 Design and methods

We use a triple-difference approach to measure the impact of the BRT on different socioeconomic outcomes. As depicted in Figure 2, we compare outcomes:

- From places *near (A*) and far (B*)* from Phase 1 – (first difference)
- From places *near (A') and far (B')* from planned Phase 2 – (second difference)
- *Before and after* the implementation of BRT Phase 1 ((A'-B')-(A*-B*)) – (third difference)

Living near and far from the BRT Phase (1 or 2) is not a discrete characteristic, instead we assume the intensity of treatment is a linear function of the distance to the closest BRT Phase: the further a household resides from the BRT phase, the lower the intensity of the impact.

Figure 2: Triple-difference approach used to analyse the impacts of the Dar BRT



Source: authors.

The use of this approach helps to get rid of changes caused by factors other than the BRT. For instance, if the BRT were constructed in high-growth neighbourhoods, we would expect to see more jobs, higher income – but not caused by BRT. Similarly, if the BRT attracts low-income people to move closer, we would see a drop in income – but not because BRT made people poorer.

Identification is based on the fact that all planned phases of the BRT system are arterial rays emanating from the CBD. We assume the gradient of outcomes with respect to distance from the arterial ray would have evolved in the same way in the catchment area of the Phase 1 and 2 routes. This does not require that rollout of BRT lines should be randomly phased, or that outcomes in locations with a similar distance from the Phase 1 and 2 routes should evolve in the same way. Instead, we require only the weaker identification assumption that, had the Phase 1 route not been rolled out, the difference in outcomes between locations "close to" versus "far from" the arterial routes would have evolved in the same way in the catchment areas of Phases 1 and 2.

The regression below will be used, where $logOutcome_{it}$ is the log of the outcome variable for household or individual i at time t, $closeness_i$ is the negative of the Euclidean distance in kilometres from the residence of the household to the nearest point on the route of BRT Phase (1 or 2), $Phase1_i$ is a dummy variable that takes the value of 1 if the household is closer to Phase 1 and zero if it is closer to Phase 2, and $post_t$ is a dummy variable that takes the value of one if the observation was collected during 2019 and zero if it was collected during 2016, and ε_{it} is the error term. In the equation, β_7 captures the impact of the BRT Phase 1, specifically, it says that, holding everything else constant, every additional kilometre closer to BRT Phase 1, changes the outcome on average $\beta_7 * 100\%$ in relation to one additional kilometre closer to Phase 2.

$$\begin{aligned} logOutcome_{it} = {} & \beta_0 + \beta_1 closeness_i + \beta_2 phase1_i + \beta_3 post_t + \beta_4 closeness_i * phase1_i \\ & + \beta_5 closeness_i * post_t + \beta_6 phase1_i * post_t + \beta_7 closeness_i * phase1_i \\ & * post_t + \varepsilon_{it} \end{aligned}$$

We evaluate the impacts of the BRT on employment outcomes (whether the respondent was employed in the last week), income (household per capita income, household total consumption, self-employment income and wages from last week) and monthly rent. Note that this strategy does not allow us to differentiate the mechanism through which the construction of the BRT impacts these socioeconomic outcomes, in particular, the triple-difference captures changes caused by changes in location of residence, location of work and mode of transport.

We use a three-round panel household survey to assess the economic, labour market, housing and amenity impacts of the BRT using our spatial triple differences approach. The first round of data collection, baseline, took place in early 2016, before the BRT started operations. Two follow-up rounds took place in the second half of 2017 and the first half of 2019. About 2,000 households across the city were tracked, as per our evaluation design and sampling strategy described below. The survey questionnaire incorporates information on households' and individuals' quantitative outcomes (such as commute times, employment outcomes, income, consumption and assets) as well as qualitative data on housing quality and perceived amenity values, among others, all of which we may expect the new infrastructure to affect. A timeline of the implementation of the program and data collection exercise can be found in Appendix 1.

The first additional area of data collection was a detailed travel time survey incorporating different modes of transport at different times throughout the day conducted prior to the baseline field work. We supplement the information collected in this survey with reported travel time from home to work collected through the baseline household survey and data

on the city's full road network from an open-source mapping platform (which provided route distances but not traffic conditions or travel times by mode), to estimate travel times between any points at different times of day. These datasets helped us implement an accurate spatial differences strategy based on current and projected future travel times after implementation of the BRT system.

3.3 Power calculations

Power calculations estimated before the baseline data collection suggested we would be able to detect a standardized effect size of 0.2 standard deviations with a sample of 141 clusters of 12-13 households based on the parameter assumptions outlined below.

In the baseline power calculations, we set the power at 80% and the significance level at 5%, in line with common best practice in the literature. We have one baseline and two follow-up measurements and assume a correlation of 0.5. The majority of our measured outcomes, for example wages, employment status, house prices and consumption levels are likely to be highly persistent in an urbanised area.

We assume an intra-cluster correlation of 0.3. Based on these parameters, a minimum of 112 clusters would be needed with 12 observations per cluster (or 110 clusters with 13 observations per cluster). The 141 clusters of 12-13 households included in our sampling strategy is therefore conservative by this standard and allows some leeway for variation in our parameter assumptions. For instance, 140 clusters would be needed if the intra-cluster correlation were increased to 0.4 with the other parameter values left unchanged.

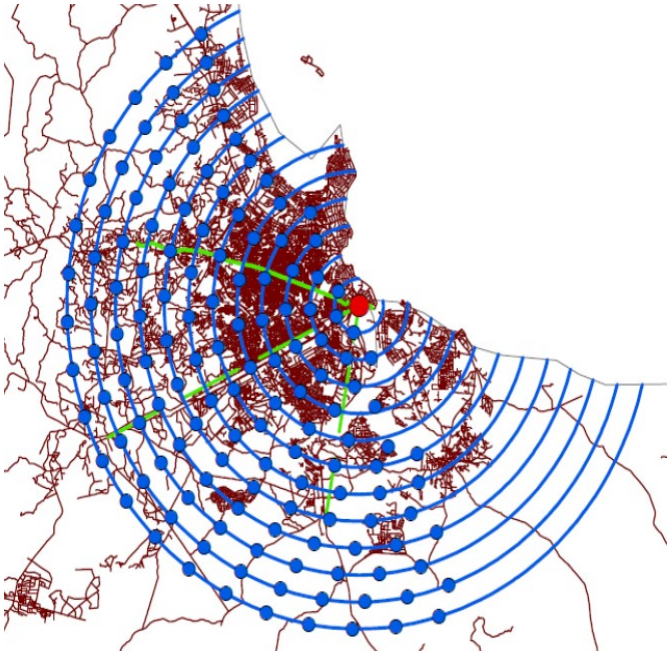
3.4 Sampling design and data collection

During baseline (2016), a geographical sampling strategy was used to select 141 clusters at equal intervals along 12 arcs at radii increasing at 1.5km intervals from the central business district of Dar es Salaam. The locations are alongside approximate routes of the BRT Phases 1-3. Map 2 shows the geographical sampling strategy, each cluster is represented by a dot. Of the 141 clusters 125 were used as interview locations. The remaining 16 were discarded because they were located in non-residential areas, military or special residence compounds or hazardous areas. At each cluster location, a random walk[1] was used to select 12-14 households for interview, yielding a total of 1,748 households who were available for and consented to interviews.

[1] The random walk was conducted following the steps below:

1. Two interviewers visited the coordinates of the center of the cluster provided by the research team.
2. One interviewer faced north and the other faced south. They walked in a straight line until they reached a household. This household was listed for interview.
3. Facing the front door of the interviewed dwelling, interviewers turn right and moved straight, walking past 3 dwellings, and then completing an interview in the fourth dwelling.
4. They repeated step two until seven households were interviewed.
5. If the interviewer could not advance any further before completing the seven interviews, they return to the dwelling of the previous interview and turn in the opposite direction.
6. If the next move brought them to a household that had been interviewed, the household in question was skipped and the next household was interviewed instead. After this interview, interviewers continued following the above rules.

Map 2: Geographical sampling strategy



Source: Authors.

Up to three interviews were conducted at each household. A household module was conducted with any knowledgeable household member found at the house, covering household demographics, dwelling information, assets, consumption and summary education and employment information for all household members. A separate survey was then administered to one male and one female respondent aged above 17 years, randomly selected from their respective qualifying group in the household. This survey included more detailed questions on employment, income, commuting and neighbourhood amenities, and was administered to a total of 3094 individuals. When households did not have an adult male or female member, the interview was only conducted with the available member to gather information of households with different demographic compositions and avoid inducing selection bias based on household composition.

At midline, we tracked all baseline male and female respondents and structures. Hence, if a baseline household had moved out of its baseline structure, we tracked the household to its new structure, enrolled the new structure in the survey, and surveyed the household if available. Additionally, we tracked the household's baseline structure and enrolled its new occupants in the survey, surveying them if possible. We did not track baseline households in person if they had moved out of Dar.

There were two survey rounds at midline: the midline survey was conducted from August - October 2017, and the midline attrition survey was conducted from February - April 2018. After the midline survey round was complete, there were still 497 baseline households or baseline household splitoffs that we had not found, so we tracked these households during attrition. We did not, however, track individual respondents (i.e. if we didn’t interview a male or female respondent but we interview someone in the household, we didn’t track this male or female respondent).

In defining household units at midline, there are three possible household types:

1. Baseline household: consists of all main baseline respondents and any others who co-inhabit their structure (the respondents remained in the same household together at midline)
2. Splitoff household consists of a baseline respondent who split from his or her baseline household, along with any other individuals the respondent now lives with
3. New household: consists of all individuals who now occupy a baseline structure from which a baseline household moved

It is important to note that a baseline household could have had one or two splitoffs; however, if both baseline respondents moved to the same structure and the rest of their baseline household remained together in their baseline structure, neither household would be considered a splitoff. Rather, the two main respondents would still be considered a baseline household and would be classified as having moved, and the other baseline household members would be enrolled as a new household in a baseline structure.

In addition, there are two categories of structures:

1. Baseline structure: structure that was occupied by a baseline household at baseline
2. New structure: structure into which a baseline or splitoff household moved at midline

At endline, our tracking exercise was similar. We conducted fieldwork from February 2019 to June 2019, and then followed up with some respondents to get additional information via a call centre in September-October 2019. The household types we tracked and surveyed at endline are:

1. Original household: households that were present at baseline and/or midline. These could be original baseline households, midline splitoffs, or households that were new at baseline
2. Splitoff household: main respondents that were part of a household at midline but have since split from that household
3. New household: a household made up of main respondents who were not enrolled in the survey at baseline or midline; consists of all individuals who now occupy an original structure from which an original household moved since midline

Additionally, there are two types of endline structures:

1. Original structure: structure that was enrolled in our survey at baseline or midline
2. New structure: structure that was not part of our sample until endline

Table 1 shows the results for the field work. The last part of the table shows a classification of the results in 5 main categories:

i) Base households still living in their base structures, the baseline sample serves as base for the midline data collection, and the midline (including mop-up) serves as base for the endline;
ii) Base households who had moved from their base structure to a new home (either in Dar or outside of Dar);
iii) New households who had moved into the structures vacated by base households and were not interviewed during the previous data collection round;
iv) Base structures that were empty – either because the home had been vacated and no one else has moved in, or the family who moved in was not in Dar at the time and could not be enrolled in the study;

v) Base male and/or female individual respondents who had split from their households – that is, they no longer live together. If neither the male and female respondents live in the base structure, the one we find first is considered a base household who moved and the other one is classified as a split. If the some of the base household members still live in the household, but neither the male nor female respondents live there, the base household members are considered a new household in the base structure.
vi) Male or female respondents who came back to their base household.

A total of 2,166 structures – baseline structures, or the new structures of baseline families – were located during midline. 27 of these had been torn down in the year and a half since baseline, mostly as a result of large-scale infrastructure projects in the city. 87% of households were contacted, either in person or over the phone. In some cases, respondents who were contacted telephonically refused to continue any further. This explains why the number of households contacted exceeds the number of structures found. Of the 1,850 households contacted, 88.5% completed the survey, 9% withdrew from the study, and 2.5% were unable to complete the survey due to travel or conflicting work schedules. The sample expanded 22.6% from the baseline initial sample, due to households that moved out of their baseline residence or male and female respondents who split.

A total of 2,043 structures were located during the endline, from which 35 were torn down. 89% of households were contacted, either in person or over the phone. Of the 1,883 households contacted, 95.9% completed the survey, and 4.1% withdrew from the study. Refusal rates for new households

Table 1: Field work results from midline and endline

	Midline	ML Attrition	ML total	EL total	Midline	ML Attrition	ML total	EL total
Structure status								
Structure not found	482	307	383	216	23%	56%	18%	10%
Structure found	1,594	236	1,756	1,991	76%	43%	81%	89%
Structure torn down	21	6	27	35	1%	1%	1%	2%
Total	**2,097**	**549**	**2,166**	**2,242**				
Household status								
Household surveyed	1,533	243	1,683	1,801	73%	46%	79%	85%
Household found, survey incomplete	0	0	0	3				
Household refused	135	21	167	78	6%	4%	8%	4%
Household not found	429	263	273	241	20%	50%	13%	11%
Household doesn't exist (i.e. because structure is empty or torn down)		22	43	119				
Total	**2,097**	**549**	**2,166**	**2,242**				
Household type								
Base HH in base structure	1,293	155	1,524	1,658	62%	28%	70%	74%
New HH in base structure	85	89	182	104	4%	16%	8%	5%
Base HH moved to new structure	188	96	222	177	9%	17%	10%	8%
Split base HH in new structure	182	122	195	184	9%	22%	9%	8%
Empty base structure	84	16	16	84	4%	3%	1%	4%
Torn down base structure	21	6	27	35	1%	1%	1%	2%
HH Type Unknown	244	65	0	0	12%	12%	0%	0%
Total	**2,097**	**549**	**2,166**	**2,242**				

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016), Midline (2017/8) and Endline Surveys (2019).

3.4.1 Quality control

We implemented back checks, and high frequency checks for data quality assurance protocols.

Back Checks: Back checks were conducted in person to all structures that were classified as empty or torn down by the enumerator. The backcheck enumerator went to the geolocation and verified with neighbours and local leaders that the structure was empty or torn down and used to belong to the household in our dataset. In addition, backchecks were performed on a 10% random sample of the completed interviews either over the phone or in person. Backcheck enumerators administered a short version of the survey (about 10 questions) that helped verify the veracity of the data registered by the enumerator.

High Frequency Checks: data submitted by the enumerators was analysed at least once per week. We analysed rates of entering certain types of data that could signal that the enumerator was not understanding the question, was cheating or that there were systematic errors in the way the data was being collected. For example, high refusal rates, very short household member rosters, very short or very long interview lengths, and high rates of "Don't know" or "Refusal" as answer.

3.5 Ethics

To ensure the research did not ethically compromise our respondents we took the following measures:

- The research team obtained an IRB approval from Stanford University's Research Compliance Office (the University's Human Subjects and IRB board) and the Tanzania Commission for Science and Technology (COSTECH).
- All research staff and principal investigators followed human subject's protection protocols throughout the duration of the study and will maintain adherence to protocols in the future.
- We only interviewed adults (men and women 18 years old or older) and we asked for oral consent. The consent explained the purpose of the project, time involvement required, risks and benefits for the respondent, payments, and rights, and provided contact information of representatives of the research team, as well as to an independent institution. A copy of the consent for the Endline survey can be consulted in Appendix 2.
- For the in-person surveys, all raw data was collected and stored in secure servers. Only staff approved by the IRB have access to data containing identification information.
- The respondents received a compensation for their time. During the midline data collection exercise, each household received a bar of soap, and during endline each respondent received Tsh. 3,000 (less than USD 1.50)

In addition, during the midline and endline we shared information about the project and its preliminary result with the participants. The form shared with the respondents can be consulted in Appendix 3.

4. Findings

4.1 Descriptive statistics and balance tables

Descriptive statistics suggest that today Dar es Salaam faces less congestion, which is expected to improve connectivity between workers and employers, and households and markets. While employment characteristics show small changes before and after the BRT Phase 1 began operations, there have been large reductions in travel time and satisfaction with transportation in general. Travel time from the residence to the main job decreased by about 10 minutes for people who work. The result holds for both people who changed and did not change residence between these two time periods. Benefits seem to have extended throughout the city since travel time to the city centre decreased by about 30 minutes, from 116 minutes in 2016 to 83 minutes in 2019. People are also more satisfied with public transit and security, and slightly more satisfied with travel times[2]. mean values for male and females at baseline and endline. The last column shows the p-value of a test evaluating if the difference in means between the two-time period for all respondent is significantly different from zero. Panel A includes all individuals in the dataset, while Panel B only includes1,982 individuals interviewed in both 2016 and 2019.

Table 2: Employment and commuting characteristics at the individual level

Panel A

Respondents available at baseline and/or endline	Baseline			Endline			
	Males	Females	All	Males	Females	All	p-value
Worked for payment in last 7 days	0.55	0.28	0.40	0.51	0.30	0.39	0.42
Current occupation: formal sector	0.21	0.05	0.13	0.17	0.06	0.11	0.03
Current occupation: informal sector/trader	0.54	0.39	0.46	0.55	0.40	0.47	0.42
Current occupation: house wife/retired/unemployed/student	0.14	0.49	0.32	0.17	0.48	0.34	0.12
Typical number of hours worked per day	8.98	7.49	8.38	9.71	8.26	9.08	0.00
Typical number of days worked per week	5.89	5.87	5.88	5.92	5.85	5.89	0.84
Number of hours worked in last 7 days	45.57	40.16	43.39	40.15	32.37	37.01	0.00
Self-employed in last 7 days	0.52	0.36	0.44	0.40	0.40	0.40	0.00
Minutes to main job	56.00	33.70	46.97	45.05	24.21	36.08	0.00
Minutes to CBD	111.80	119.97	116.07	78.49	84.40	81.52	0.00
Satisfaction with public transit (highest = 10)	2.86	2.84	2.85	5.75	5.91	5.83	0.00
Satisfaction with neighborhood (highest = 10)	6.36	6.37	6.37	8.60	8.38	8.48	0.00
Security walking during day (highest = 10)	7.87	7.73	7.79	9.30	9.22	9.26	0.00
Security walking at night (highest = 10)	5.28	5.00	5.13	7.62	7.16	7.36	0.00
Satisfaction with commute time (highest = 10)	4.75	6.41	5.42	6.24	6.92	6.53	0.00
No. of households			1746			1607	
No. of individuals	1475	1619	3094	1213	1416	2629	

Panel B

Respondents available at both baseline and endline	Baseline			Endline			
	Males	Females	All	Males	Females	All	p-value
Worked for payment in last 7 days	0.55	0.28	0.40	0.53	0.31	0.41	0.85
Current occupation: formal sector	0.21	0.05	0.12	0.18	0.05	0.11	0.23
Current occupation: informal sector/trader	0.56	0.41	0.48	0.56	0.42	0.49	0.55
Current occupation: house wife/retired/unemployed/student	0.12	0.47	0.31	0.15	0.47	0.32	0.27
Typical number of hours worked per day	8.90	7.38	8.25	9.71	8.23	9.05	0.00
Typical number of days worked per week	5.89	5.90	5.90	5.93	5.87	5.90	0.84
Number of hours worked in last 7 days	45.35	39.84	43.00	40.52	31.76	36.98	0.00
Self-employed in last 7 days	0.54	0.39	0.46	0.42	0.42	0.42	0.01
Minutes to main job	56.97	32.11	46.28	47.00	23.73	36.81	0.00
Minutes to CBD	113.93	124.10	119.45	78.87	84.65	81.84	0.00
Satisfaction with public transit (highest = 10)	2.80	2.83	2.81	5.69	5.89	5.80	0.00
Satisfaction with neighborhood (highest = 10)	6.43	6.44	6.44	8.63	8.38	8.49	0.00
Security walking during day (highest = 10)	7.95	7.76	7.85	9.31	9.23	9.27	0.00
Security walking at night (highest = 10)	5.27	4.98	5.11	7.66	7.23	7.42	0.00
Satisfaction with commute time (highest = 10)	4.76	6.47	5.49	6.21	6.95	6.53	0.00
No. of households			1262			1323	
No. of individuals	907	1075	1982	907	1075	1982	

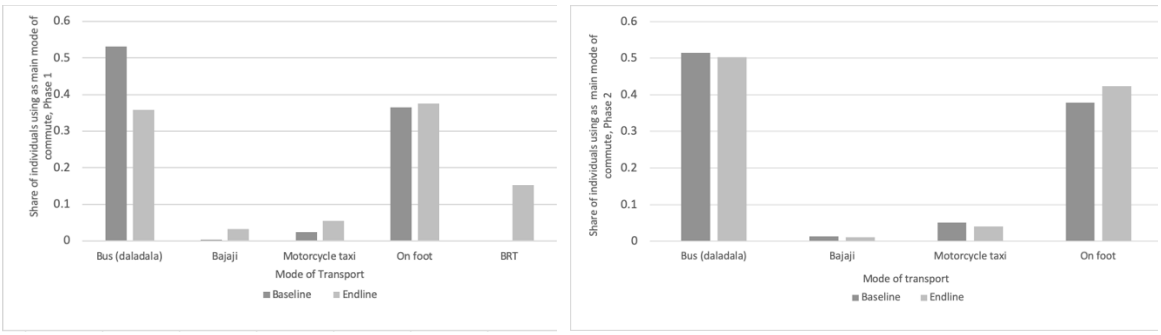
Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

[2] Respondents are asked to measure their satisfaction and perception of safety in a scale from 1 to 10 where 10 is safer and more satisfied.

Nonetheless, these results cannot be interpreted as casual, this is, improvements in commuting times cannot be uniquely attributed to the BRT. In the past years, Dar es Salaam has also invested in other transport infrastructure. In addition, the BRT is not the main mode of transport used by most Dar residents –only 7% use it to get to work. Some of this is due to the fact that the BRT is still in "interim'' operations: only the first of six expected phases is currently operational (Phases 2 and 3 are under construction) and is not operating at its full potential. The BRT has been used at least once by a wide share of the population (70%), 3% use it every day, 19% multiple times per week and 46% a few times per month.

A key question in the transportation literature is whether public transportation leads to modal change out of using private vehicles. We collected rich data on commuting patterns. Only 7.5% of the working sample reports using the BRT to get to work, and from these 18% only uses the BRT, 72% uses a multimodal combination that includes BRT and daladala, and 29% uses BRT and for hire services (bodaboda, bajaj and taxi)[3]. Close to Phase 1, the share of people using daladala fell. While the main mode used for commuting by individuals living within 2 km of Phase 2 has not substantially changed between the baseline and endline, more than 10% of people living near Phase 1 are using BRT instead of daladala. There has also been mode switch from daladala to bajaj and bodaboda in this area (Figure 3).

Figure 3: Mode of transport used by people living within 2 km form BRT Phase 1 and 2



Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

Households also have access to better quality amenities than they did three years ago. The use of non-latrine toilets increased 20 percentage points and the use of electricity as a source of lighting increased 10 percentage points. In 2019, a higher share of households also lives on a paved road. Table 3 shows mean values and tests at the structure level for the unbalanced and balanced panel. Results between these two panels are very similar, suggesting new structures are not different from baseline structures (further details are included in Appendix 4).

[3] These percentages are not exclusive. For example, if a person uses BRT, daladala and bodaboda to get to work he or she will be counted as using a multimodal combination that includes BRT and daladala, and BRT and for hire services.

Table 3: Housing characteristics at baseline and endline

Structures surveyed at baseline and/or endline	Baseline	Endline	p-value
Electricity in house for lighting	0.62	0.73	0.00
Street has lights	0.03	0.03	0.46
Road is paved	0.10	0.18	0.00
HH uses non-latrine toilet	0.52	0.73	0.00
Number of households in dwelling	2.01	2.06	0.51
Rooms household occupies in dwelling	3.02	3.33	0.00
No. of structures	1517	1614	
Structures surveyed at both baseline and endline	Baseline	Endline	p-value
Electricity in house for lighting	0.62	0.74	0.00
Street has lights	0.03	0.03	0.30
Road is paved	0.10	0.18	0.00
HH uses non-latrine toilet	0.52	0.72	0.00
Number of households in dwelling	1.96	1.92	0.56
Rooms household occupies in dwelling	3.08	3.57	0.00
No. of structures	1317	1317	

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

At baseline our treatment and control groups were, on average, different. Individuals living closer to Phase 1 than Phase 2 in 2016 had higher income, were more likely to being employed and being employed in the formal sector and were also more satisfied with their employment options. However, note that there are no statistically significant differences in mean household income, weekly earning and time to main job. Structures closer to Phase 1 were more likely to have a better quality (access to electricity, located on a paved road and more rooms per household member) and paid, on averages, a higher rent. Table 4 shows mean values and standard deviations for outcome variables at baseline for the treatment and control groups, as well as the p-value for a t-test of the differences in mean. Table 5 shows results for the household and structure characteristics.

Table 4: Difference in mean employment and commuting characteristics for treatment and control groups at the individual level

	Control Households		Treatment Households		p-value	
	Mean	SD	Mean	SD	treatment =	Observations
Highest education level completed: Standard 7	0.51	0.5	0.49	0.5	0.28	3,094
Worked for payment in last 7 days	0.37	0.48	0.44	0.5	0	3,094
Current occupation: formal sector	0.1	0.3	0.16	0.36	0	3,094
Current occupation: informal sector	0.17	0.37	0.17	0.37	0.82	3,094
Current occupation: trader	0.31	0.46	0.28	0.45	0.05	3,094
Weekly earnings, Tsh	30,714	61,511	38,968	71,300	0	3,057
Number of hours worked in last 7 days	44.16	23.97	43.02	22.11	0.25	2,137
Self-employed in last 7 days	0.47	0.5	0.4	0.49	0	3,094
Monthly gross household income (TSH)	512,391	461,770	578,544	518,017	0	2,768
Monthly gross household income per capita (TSH)	127,843	141,430	163,706	173,695	0	2,768
Minutes to main job	46.98	50.2	46.95	47.17	0.99	2,116
Cost to job (TSH)	1425.39	2802.51	1434.99	3064.31	0.94	2097
Minutes to Kariakoo	112.16	50.58	105.6	50.95	0	3069
Minutes to Posta	119.94	52.21	111.84	52.33	0	3,044
On a scale of 1-10, how happy are you with the public transportation options?	2.59	1.94	3.13	1.94	0	3,094

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016). Note: Treatment includes all households living closer to Phase 1 than Phase 2. Control includes the rest of the households.

Table 5: Difference in mean housing characteristics for treatment and control groups at the structure level

	Control Households		Treatment Households		p-value treatment = control	Observations
	Mean	SD	Mean	SD		
Electricity in house for lighting	0.53	0.5	0.73	0.45	0	1,748
Street has lights	0.03	0.16	0.02	0.15	0.77	1,748
Road is paved	0.07	0.26	0.13	0.33	0	1,748
HH uses non-latrine toilet	0.51	0.5	0.54	0.5	0.19	1,748
Number of households in dwelling	1.91	1.69	2.2	1.99	0	1,728
Rooms household occupies in dwelling	3	1.45	2.89	1.58	0.11	1,746
Number of rooms per household member	0.76	0.55	0.82	0.55	0.02	1,746
Monthly rent expected, Tsh	79976.1	59505.63	107892.47	77546.7	0	1,002

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016).
Note: Treatment includes all structures located closer to Phase 1 than Phase 2. Control includes the rest of the structures.

What matters for triple-difference validity is that these differences are stable over time. To test for parallel trends assumption between the two groups before the implementation of the BRT we use the Dar es Salaam Measuring Living Standards in Cities household survey (2015). To have comparable statistics between the two surveys, we average the log of expected rent –variable present in both surveys– at the enumeration area (e.a.) level and estimate the OLS model of this variables against dummy variables for the period of time (2015, 2016–BL, and 2019–EL) and its interaction with a dummy indicating if the e.a. is closer to Phase 1 than Phase 2 route. As shown. in Table 6, there is evidence of parallel trends: the coefficient of the interaction Phase 1 and BL is not significantly different from zero showing there is no evidence of a differential change in expected rent per room between 2015 and 2016 between the treatment and control groups.

Table 6: Parallel trends test based on log of expected rent

	b/se/p
BL	0.13
	-0.081
	[0.109]
EL	0.333***
	-0.081
	[0.000]
Phase1	0.449***
	-0.079
	[0.000]
BL # Phase1	-0.041
	-0.112
	[0.712]
EL # Phase1	-0.108
	-0.112
	[0.335]
N	255
Mean dependent variable	10.187

Source: using Dar es Salaam Measuring Living Standards in Cities Survey (2015) and Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline surveys (2019).
Note: regression at the enumeration area level.

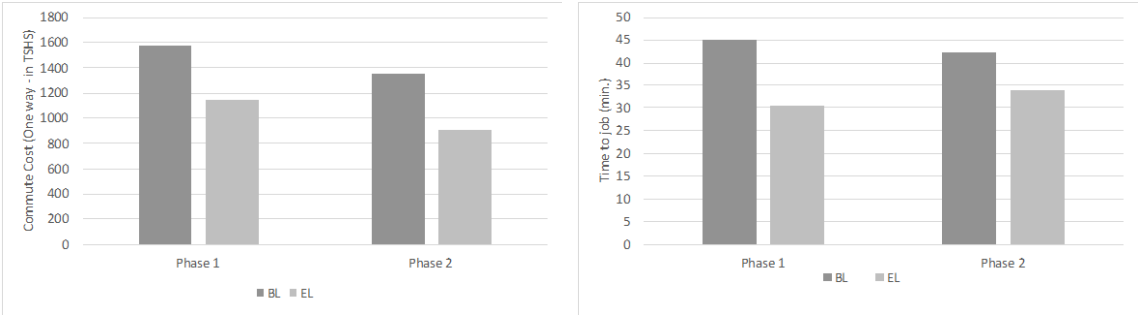
A simple comparison of means shows that people living close to the BRT Phase 1 have lower reductions in commute cost but larger reductions in travel time than people in the comparison group (near BRT expected Phase 2). Between 2016 and 2019, the average commute for respondents within 2 km of Phase 1 fell 13 percentage points more than for respondents near Phase 2. On the other hand, the cost decreased 6 percentage points less (Table 7 and Figure 4).

Table 7: Average commute cost and time to work for people living within 2 km from BRT Phase 1 and 2

	BL	EL	EL - BL	(EL-BL)/BL (%)
Cost to main job (Tsh.)				
Near Phase1	1,578	1,148	**-429**	***-27.2***
Near Phase2	1,354	909	**-445**	***-32.9***
Phase 1 - Phase 2			***16.0***	***5.7***
Time to main job (min)				
Near Phase1	44.98	30.70	**-14**	***-31.7***
Near Phase2	42.20	34.13	**-8**	***-19.1***
Phase 1 - Phase 2			***-6.2***	***-12.6***

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

Figure 4: Average commute cost and time to work for people living within 2 km from BRT Phase 1 and 2



Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

However, there is a week relation between the introduction of the BRT Phase 1 and changes in times and costs of commuting to work. Table 8 shows the results of regressing commute time and costs on a year dummy variable, a dummy indicating if the household lived closer to phase 1 during baseline and their interaction. The coefficient of the interaction term is not statistically different from zero showing that there are no differences in the average change in cost and time of commute between the individuals in the treatment and control catchment areas.

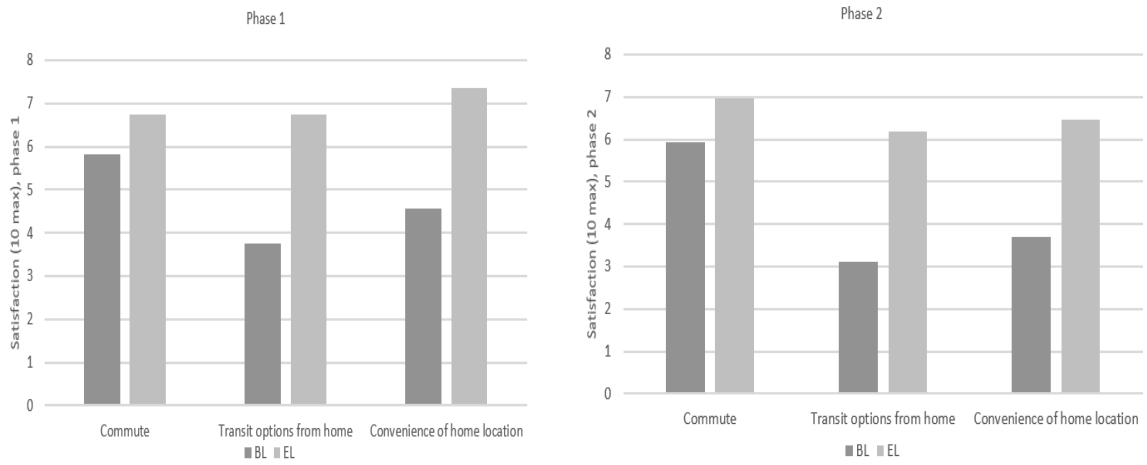
Table 8: Relation between the introduction of the BRT Phase 1 and changes in times and costs of commuting to work

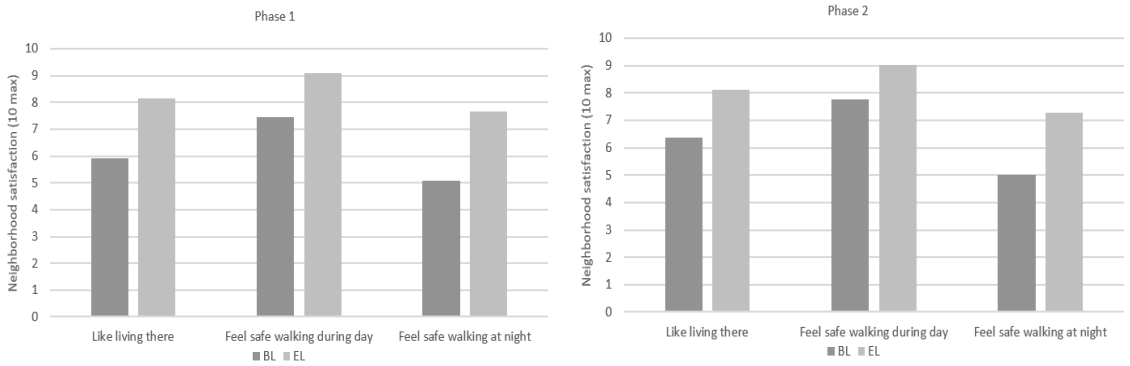
	(1)	(2)
VARIABLES	cost of commute	time of commute
phase1	9.599	-0.0321
	(216.9)	(2.988)
post	-298.1*	-7.410***
	(155.3)	(2.416)
phase1Xpost	-35.69	-6.283*
	(228.2)	(3.320)
Constant	1,425***	46.98***
	(150.8)	(2.053)
Observations	3,792	3,763
R-squared	0.003	0.015
Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

The BRT does not seem to have impacted people's satisfaction with commuting. There are no differences in changes in satisfaction with the location of the residence, transport options and commuting time between the baseline and endline, and people living near BRT Phase 1 and Phase 2. The two groups reported to be more satisfied with their location and commuting in 2019 than they did in 2016 (Figure 5).

Figure 5: Average satisfaction with commuting and neighbourhood amenities within 2 km from Phase 1 and 2





Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).
Note: satisfaction is measured on a scale from 1 to 10 where 1 is very unsatisfied and 10 is very satisfied.

4.2 Research analyses

The lack of impacts on rent is a robust result. Estimates from the triple-difference regression show that expenditure in rent per room increased for all households but it did not change differently for people living close to BRT Phase 1. Table 9 shows results at the household level reflecting the impact on household's rent expenditure, while Table 10 uses observations at the structure level, capturing the effect on the fixed location. The coefficient of post is significantly different from zero for all specifications using the log rent expected per room, showing an increase of about 20-28% in this variable between 2016 and 2019 in absence of the treatment. The increase in expected rent expenditure is similar in the regression at the structure level suggesting the changes are not explained by individuals splitting from their baseline households to live in more expensive areas of the city. However, as shown in Table 9 and Table 10, the coefficient on the interaction term $closeness_i \; x \; phase1_i \; x \; post_t$, which captures the impact of the BRT in our triple-difference model, is not statistically different from zero for any of the specifications and measures of rent used.

We use rent expected per room, reported by all households, as a proxy for the rent values throughout the city. Note that only renters know the true market price for renting the room, hence, this variable is subject to measurement error. To verify the robustness of the results we measure the impact on a subsample of only renters (columns 4-6) using the log of the rent actually paid per room as the outcome.

We use three variations of the model. Column 1 and 4 in Table 9 include the full sample with no fixed-effects, whereas Columns 2 and 5 include baseline household fixed-effects to control for baseline household characteristics that remain consistent over time. Columns 3 and 6 estimate the impact on households present at baseline for which we have baseline GPS location information; rather than using treatment variables based on actual baseline and endline locations of residence, we use treatment variables based on the households' baseline locations for both time periods. The regression shown in Column 7 suggest that households are not more likely to move when they live closer to Phase 1 than Phase 2. These results suggest that movers are not explaining the results of the rent regression.

Table 9: Impact of the BRT Phase 1 on rent, Triple Difference regression at the household level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log Monthly Rent Expected Per Room	Log Monthly Rent Expected Per Room	Log Monthly Rent Expected Per Room	Log Monthly Rent Paid Per Room	Log Monthly Rent Paid Per Room	Log Monthly Rent Paid Per Room	At Least One Member Moved
Closeness to BRT line	0.01	0.017	-0.002	0.014	-0.007	-0.026	0.003
	(0.016)	(0.012)	(0.005)	(0.025)	(0.023)	(0.023)	(0.004)
Closer to Phase 1 than Phase 2	0.485***	-0.192	0.228	0.508***	0.346*	0.359	0.026
	(0.138)	(0.299)	(0.181)	(0.1830	(0.176)	(0.22)	(0.04)
Endline	0.198***	0.219***	0.247***	0.027	0.115*	0.116	
	(0.066)	(0.046)	(0.047)	(0.122)	(0.068)	(0.072)	
Closeness to BRT line X Closer to Phase 1 than Phase 2	0.041*	0.008	0.013	0.034	0.059*	0.065	0.001
	(0.023)	(0.028)	(0.017)	(0.03)	(0.031)	(0.043)	(0.006)
Closeness to BRT line X Endline	-0.006	-0.012	-0.011	-0.011	-0.023	-0.028*	
	(0.011)	(0.008)	(0.009)	(0.024)	(0.017)	(0.016)	
Closer to Phase 1 than Phase 2 X Endline	-0.048	-0.028	-0.026	-0.002	0.009	-0.008	
	(0.107)	(0.076)	(0.078)	(0.178)	(0.120)	(0.126)	
Closeness to BRT line X Closer to Phase 1 than Phase 2 X Endline	-0.008	-0.006	-0.006	-0.012	0.006	0.006	
	(0.019)	(0.013)	(0.013)	(0.028)	(0.023)	(0.023)	
	2,521	2,307	2,194	636	431	388	1,341
		Yes	Yes		Yes	Yes	
			Yes			Yes	

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

Table 10: Impact of the BRT Phase 1 on rent, Triple Difference regression at the structure level

	(1)	(2)	(3)	(4)	(5)
	Log Monthly Rent Expected Per Room	Log Monthly Rent Expected Per Room	Log Monthly Rent Paid Per Room	Log Monthly Rent Paid Per Room	At Least One Member Moved
Closeness to BRT line	0.017	0.016	0.033	0.053*	0.006
	(0.016)	(0.016)	(0.029)	(0.030)	(0.006)
Closer to Phase 1 than Phase 2	0.490***	0.500***	0.478**	0.408*	0.023
	(0.137)	(0.136)	(0.221)	(0.233)	(0.049)
Endline	0.119*	0.251***	-0.089	0.141**	
	(0.068)	(0.034)	(0.143)	(0.064)	
Closeness to BRT line X Closer to Phase 1 than Phase 2	0.045**	0.046**	0.025	-0.004	-0.001
	(0.022)	(0.022)	(0.036)	(0.039)	(0.009)
Closeness to BRT line X Endline	-0.013	-0.01	-0.03	-0.008	
	(0.012)	(0.006)	(0.026)	(0.016)	
Closer to Phase 1 than Phase 2 X Endline	-0.047	0.031	0.048	-0.021	
	(0.108)	(0.060)	(0.196)	(0.126)	
Closeness to BRT line X Closer to Phase 1 than Phase 2 X Endline	-0.011	-0.002	0	-0.019	
Observations	2,350	1,934	531	250	1,323
Baseline structures only		Yes		Yes	

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

Table 11 and Table 12 show the triple-difference estimations for household income and consumption at the household and structure level. There is evidence that per capita income fell between 2016 and 2019 for households living closer to Phase 2, this is, in absence of the treatment. The drop is estimated between 24% and 27%. This is also true at the structure level. There is no evidence suggesting the BRT Phase 1 had any impact on per capita income or consumption relative to Phase 2 since the triple-interaction coefficient is not significantly different from zero in any of the specifications.

Table 11: Impact of the BRT Phase 1 on Income and Consumption, Triple Difference regression at the household level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Log Gross	Log Gross	Log Gross	Log Net	Log Net	Log Net			
	Per Capita	Per Capita	Per Capita	Per Capita	Per Capita	Per Capita			
	Household	Household	Household	Household	Household	Household	Log Total	Log Total	Log Total
	Income	Income	Income	Income	Income	Income	Consumption	Consumption	Consumption
Closeness to BRT line	0.018	0.015	-0.01	0.016	0.013	-0.013	-0.005	-0.008	-0.007
	(0.013)	(0.028)	(0.011)	(0.016)	(0.041)	(0.014)	(0.011)	(0.017)	(0.013)
Closer to Phase 1 than Phase 2	0.251**	-0.038	0.005	0.16	-0.282	0.096	0.221***	0.369*	0.560**
	(0.124)	(0.413)	(0.362)	(0.161)	(0.469)	(0.458)	(0.074)	(0.206)	(0.271)
Endline	-0.277***	-0.287*	-0.326**	-0.163	-0.209	-0.258	-0.143**	-0.144	-0.14
	(0.092)	(0.157)	(0.161)	(0.121)	(0.202)	(0.207)	(0.069)	(0.091)	(0.095)
Closeness to BRT line X Closer to Phase 1 than Phase 2	-0.001	-0.005	0.057	0.006	-0.042	0.005	0.021	0.072**	0.062*
	(0.023)	(0.045)	(0.042)	(0.029)	(0.063)	(0.058)	(0.014)	(0.034)	(0.037)
Closeness to BRT line X Endline	-0.02	-0.019	-0.021	-0.016	-0.022	-0.024	-0.001	-0.002	0.001
	(0.016)	(0.029)	(0.029)	(0.021)	(0.040)	(0.041)	(0.013)	(0.017)	(0.018)
Closer to Phase 1 than Phase 2 X Endline	-0.077	0.019	0.034	0.13	0.24	0.268	-0.064	-0.075	-0.076
	(0.140)	(0.201)	(0.206)	(0.185)	(0.257)	(0.266)	(0.090)	(0.121)	(0.128)
Closeness to BRT line X Closer to Phase 1 than Phase 2 X Endline	0.011	0.021	0.021	0.005	0.02	0.024	-0.005	-0.01	-0.013
	(0.022)	(0.035)	(0.035)	(0.030)	(0.048)	(0.049)	(0.018)	(0.023)	(0.024)
	3,106	2,403	2,266	3,075	2,343	2,206	3,380	2,798	2,666
		Yes	Yes		Yes	Yes		Yes	Yes
			Yes			Yes			Yes

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

Table 12: Impact of the BRT Phase 1 on Income and Consumption, Triple Difference regression at the Structure Level

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Gross	Log Gross	Log Net	Log Net		
	Per Capita	Per Capita	Per Capita	Per Capita		
	Household	Household	Household	Household	Log Total	Log Total
LABELS	Income	Income	Income	Income	Consumption	Consumption
Closeness to BRT line	0.018	0.015	0.016	0.02	-0.005	-0.005
	(0.013)	(0.015)	(0.016)	(0.017)	(0.011)	(0.010)
Closer to Phase 1 than Phase 2	0.251**	0.166	0.16	0.018	0.221***	0.205***
	(0.124)	(0.142)	(0.161)	(0.189)	(0.074)	(0.073)
Endline	-0.277***	-0.291**	-0.163	-0.18	-0.143**	-0.135*
	(0.092)	(0.123)	(0.121)	(0.160)	(0.069)	(0.073)
Closeness to BRT line X Closer to Phase 1 than Phase 2	-0.001	-0.01	0.006	-0.012	0.021	0.017
	(0.023)	(0.027)	(0.029)	(0.034)	(0.014)	(0.013)
Closeness to BRT line X Endline	-0.02	-0.019	-0.016	-0.019	-0.001	0.004
	(0.016)	(0.022)	(0.021)	(0.030)	(0.013)	(0.013)
Closer to Phase 1 than Phase 2 X Endline	-0.08	0.064	0.125	0.284	-0.064	-0.106
	(0.139)	(0.157)	(0.184)	(0.216)	(0.090)	(0.097)
Closeness to BRT line X Closer to Phase 1 than Phase 2 X Endline	0.01	0.021	0.005	0.026	-0.005	-0.019
	(0.022)	(0.027)	(0.030)	(0.038)	(0.018)	(0.018)
	3,105	2,200	3,074	2,142	3,379	2,622
		Yes		Yes		Yes

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

4.3 Heterogeneity of impacts

Table 13 and Table 14 show results from the triple-difference design for the women and men respectively. Panel A uses only the location at baseline to track changes in outcomes for people who lived in the treatment area before BRT Phase 1 started operations. Panel B includes values of *closeness* and *closer to Phase 1* that change for movers. Looking at individual-level outcomes, the BRT did not have a statistically significant effect on employment status from the last week, wages over the past week, or self-employment income for men or for women.

Table 13: Impact of the BRT Phase 1 on Wages and Employment for females, Triple Difference regression at the individual level

Panel A					
		(1)	(2)	(3)	(4)
			Log Wages	Log Gross	Log Gross
		Employed	from last	Self-Employ	Income from
VARIABLES	LABELS	last week	week	Income	All Sources
post	Endline	0.062	-0.647*	-0.291*	-0.099
		(0.054)	(0.346)	(0.167)	(0.141)
closeXpost_bl	Closeness to BRT line X Endline	0.007	-0.053	-0.037	0.024
		(0.009)	(0.077)	(0.035)	(0.023)
phase1Xpost_bl	Closer to Phase 1 than Phase 2 X Endline	0.064	0.415	-0.094	-0.051
		(0.087)	(0.411)	(0.290)	(0.183)
closeXphase1Xpost_	Closeness to BRT line X Closer to Phase 1	0.013	0.074	0.03	-0.023
		(0.015)	(0.086)	(0.057)	(0.031)
Observations		2,340	268	460	490
Individual-level FE		Yes	Yes	Yes	Yes

Panel B										
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Log Wages	Log Wages	Log Gross	Log Gross	Log Gross	Log Gross	
		Employed	Employed	from last	from last	Self-Employment	Self-Employment	Income from	Income from	
VARIABLES	LABELS	last week	last week	week	week	Income	Income	All Sources	All Sources	Moved after BL
close	Closeness to BRT line	0.01	-0.01	0.066**	0.128	0.013	-0.063	-0.018	-0.021	-0.013
		(0.007)	(0.013)	(0.028)	(0.098)	(0.019)	(0.066)	(0.028)	(0.031)	(0.008)
phase1	Closer to Phase 1 than Phase 2	0.064	0.138	-0.051	-1.489	0.189	-0.186	0.015	-0.921	0.013
		(0.051)	(0.190)	(0.199)	(1.470)	(0.147)	(0.435)	(0.211)	(0.668)	(0.060)
post	Endline	0.039	0.086	-0.664***	-0.724	-0.234**	-0.283	-0.302*	-0.055	
		(0.052)	(0.074)	(0.185)	(0.437)	(0.116)	(0.253)	(0.168)	(0.224)	
closeXphase1	Closeness to BRT line X Closer to Phase 1	-0.01	-0.015	-0.05	-0.538**	0.008	-0.015	0.006	0.007	0.004
		(0.009)	(0.022)	(0.041)	(0.232)	(0.034)	(0.102)	(0.038)	(0.043)	(0.011)
closeXpost	Closeness to BRT line X Endline	0.001	0.013	-0.051	-0.075	-0.003	-0.032	0	0.028	
		(0.009)	(0.013)	(0.039)	(0.080)	(0.023)	(0.050)	(0.029)	(0.037)	
phase1Xpost	Closer to Phase 1 than Phase 2 X Endline	0.077	0.035	0.357	0.461	-0.156	-0.037	0.456**	-0.053	
		(0.071)	(0.119)	(0.254)	(0.553)	(0.184)	(0.413)	(0.209)	(0.281)	
closeXphase1Xpost	Closeness to BRT line X Closer to Phase 1	0.018	0.006	0.066	0.093	-0.018	0.028	0.037	-0.023	
		(0.013)	(0.021)	(0.051)	(0.099)	(0.039)	(0.081)	(0.037)	(0.047)	
Observations		3,061	2,186	850	260	1,113	436	878	454	1,442
Individual-level FE			Yes		Yes		Yes		Yes	

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

Table 14: Impact of the BRT Phase 1 on Wages and Employment for males, Triple Difference regression at the individual level

		(1)	(2)	(3)	(4)
			Log Wages	Log Gross	Log Gross
		Employed	from last	Self-Employ	Income from
VARIABLES	LABELS	last week	week	Income	All Sources
post	Endline	0.023	0.098	-0.281	-0.093
		(0.069)	(0.226)	(0.175)	(0.079)
closeXpost_bl	Closeness to BRT line X Endline	0.013	0.035	-0.033	-0.001
		(0.014)	(0.055)	(0.032)	(0.013)
phase1Xpost_bl	Closer to Phase 1 than Phase 2 X Endline	0	0.055	0.426*	-0.064
		(0.088)	(0.279)	(0.253)	(0.128)
closeXphase1Xpost	Closeness to BRT line X Closer to Phase 1 th	-0.012	-0.041	0.056	-0.012
		(0.017)	(0.062)	(0.043)	(0.023)
Observations		1,988	564	482	850
Individual-level FE		Yes	Yes	Yes	Yes

Panel B										
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Log Wages	Log Wages	Log Gross	Log Gross	Log Gross	Log Gross	
		Employed	Employed	from last	from last	Self-Employment	Self-Employment	Income from	Income from	
VARIABLES	LABELS	last week	last week	week	week	Income	Income	All Sources	All Sources	Moved after BL
close	Closeness to BRT line	0.001	-0.002	0	0.173	0.001	0.047	-0.041*	0.002	-0.016*
		(0.009)	(0.023)	(0.016)	(0.106)	(0.016)	(0.045)	(0.021)	(0.024)	(0.010)
phase1	Closer to Phase 1 than Phase 2	-0.005	-0.124	0.075	-0.667	0.02	-0.039	0.368**	-0.028	0.031
		(0.067)	(0.258)	(0.151)	(0.996)	(0.135)	(0.317)	(0.146)	(0.225)	(0.066)
post	Endline	-0.009	0.022	0.197	0.183	-0.138	-0.386	-0.008	-0.119	
		(0.067)	(0.098)	(0.203)	(0.325)	(0.113)	(0.239)	(0.108)	(0.123)	
closeXphase1	Closeness to BRT line X Closer to Phase 1 th	-0.01	0	0.011	-0.169	0.018	-0.017	0.039	-0.065	0.006
		(0.011)	(0.031)	(0.023)	(0.125)	(0.024)	(0.048)	(0.026)	(0.066)	(0.013)
closeXpost	Closeness to BRT line X Endline	0.01	0.014	0.05	0.043	-0.009	-0.046	0.019	-0.003	
		(0.012)	(0.019)	(0.039)	(0.058)	(0.020)	(0.046)	(0.020)	(0.021)	
phase1Xpost	Closer to Phase 1 than Phase 2 X Endline	0.008	0.014	-0.359	-0.027	-0.003	0.591	-0.205	-0.048	
		(0.090)	(0.126)	(0.250)	(0.410)	(0.169)	(0.373)	(0.142)	(0.187)	
closeXphase1Xpost	Closeness to BRT line X Closer to Phase 1 th	-0.004	-0.009	-0.086*	-0.062	-0.008	0.077	-0.021	-0.006	
		(0.015)	(0.023)	(0.046)	(0.072)	(0.034)	(0.064)	(0.025)	(0.033)	
Observations		2,715	1,854	1,349	520	1,199	460	1,237	796	1,240
Individual-level FE			Yes		Yes		Yes		Yes	

Source: using Dar es Salaam BRT Impact Evaluation Household Baseline (2016) and Endline Survey (2019).

5. Cost analysis

A full cost-benefit analysis for the BRT line needs to take into account the construction and operational costs of the BRT and compare this to the full economic benefit of improved access to transport. One challenge with the triple-difference specifications above is that they provide estimates of the relative effect of the BRT: how did households that were closer to the operational Phase 1 change relative to households that were closer to the non-operational Phase 2. However, these numbers by themselves do not allow us to estimate the full economic benefits of the BRT accounting for spill-overs and changes within the city. In order to account for these, the research team is constructing a spatial general equilibrium model that will fully account for the direct and indirect changes and will extend the triple-difference analysis presented above. The framework will be based on Ahlfeldt et al (2015). Once completed, this structural analysis will provide an estimate of the full economic impact of the investment. On the cost side, the World Bank and government estimates are that the BRT cost TZS 384 billion, or approximately 166 million USD.

6. Discussion

6.1 Introduction

The BRT was hypothesized to increase employment rates, household income and consumption of households near Phase 1 of the BRT by reducing travel time to other parts of the city, hence increasing access to markets. Though we observed reductions in travel time in Dar es Salaam, these were not followed by positive impacts on income or consumption. However, it didn't increased rents either.

There are three caveats to these findings which mean that the results should not be interpreted as implying that the BRT is not a viable transport solution for Dar es Salaam or other African cities. First, the regression results above are triple-difference estimates, which pick up relative changes (Phase 1 relative to phase 2). In order to get a full economic accounting of the effects of the BRT is necessary to account for the general equilibrium forces. The research team is currently pursuing this as an extension to the originally planned project. Second, there are other potential impacts of the BRT that are beyond the scope of this study, such as improvements in road safety or reductions in pollution. The third caveat is that the current BRT in Dar es Salaam is currently only partially operational: only one phase of six is fully operational, and this phase has had several operational challenges, including a shortage of buses. This means that the effects we estimate should be interpreted with caution.

We also see that the results could be potentially improved with complementary interventions to reap the greatest benefits from this transport infrastructure. First, the extent of the impact of the BRT depends on its operational performance. The BRT is planning to increase the number of BRT buses and feeder routes, which could potentially connect more households to the BRT, improving key outcomes like income and employment. Second, complementary urban regulation changes that promote density along the BRT corridor can increase the share of business and households that benefit from better connectivity (e.g. reducing minimum plot size). For example, using simulations based in a general equilibrium model, Tsivanidis (2017) found that adjusting

zoning regulations to allow increased building densities in Bogota would have led to higher welfare gains from Transmilenio, the city's BRT.

Further analysis will show if the impact of the BRT differs for different segments of the population and, if so, which approach should be explored from a public policy perspective to extend the benefits of the intervention to all residents in Dar. Differentiated impacts may support the use of complementary measures, such as transport or housing subsidies for specific segments of the population. They can also inform how to prioritize routes; for instance, based on expected changes in market access. Additionally, the order in which phases of the BRT are built can be determined strategically in a way that maximizes net benefits and minimizes undesired results, such as gentrification.

6.2 Policy and programme relevance: evidence uptake and use

Fieldwork for this project was only completed at the start of October. Given this timing, we are still developing the empirical results and expect that they will be subject to iteration. We will also need to engage in a process of result-sharing with our government and World Bank counterparts and then develop generalizable lessons. We anticipate having further information to share about the policy and programme relevance once this process is completed.

6.3 Challenges and lessons

The primary challenges and lessons from this research project are related to fieldwork issues. As mentioned above, the fieldwork has only just completed for this project. This itself is one of the lessons of this project: collecting data in urban environments with a very mobile population requires more intensive fieldwork research than originally budgeted. We faced the need to field an additional "mop up'' survey team after both the midline and endline surveys because our tracking rates on households were lower than expected. Through this additional intensive survey effort, we were able to increase our household completion rate close to 80 percent. A second related fieldwork lesson came from piloting the survey. We realized, despite extensive piloting, that households had been inconsistently answering the question about household rent. Despite the questionnaire clearly asking for the rent per room, approximately 50 percent of the households seem to have answered the question as rent per building. In order to fix this data issue, we decided to resample the entire survey and to ask specific questions to ensure that the data was accurate. This led to approximately three weeks longer fieldwork than expected and provided a lesson for making sure that the piloting of the survey was comprehensive.

7. Conclusions and recommendations

Since the Dar BRT started operations in 2016, Dar residents spend less time travelling and report being more satisfied and feeling safer with their transport options. But estimates suggest the BRT have not had the expected outcomes increasing income and consumption across the city. It did not increase the cost of living, through increases in rent prices, either. Nonetheless, these results need to be read with caution since the triple-difference methodology used, which compares households living close and far from

BRT operational Phase 1 and planned Phase 2 in 2016 and 2019, only captures relative in the outcomes of interest and do not account for all the economic force interacting in the city after the introduction of the BRT. Further analysis to understand the general equilibrium effects of the BRT is being undertaken and will allow for more precise public policy recommendations as well as a cost-benefit analysis of the project.

Complementary interventions could potentially help improve the impacts of the BRT. First, the extent of the impact of the BRT depends on its operational performance. Increasing the number of BRT buses and feeder routes, as *project managers* have planned*,* could potentially access to the BRT, increase demand and result in improvements ins key outcomes such as income and employment. Second, *policy makers* should aim to have complementary urban regulation changes that promote density along the BRT corridor to increase the share of business and households that benefit from better connectivity. For example, reducing minimum plot size or adjusting zoning regulations. Tsivanidis (2017) found that adjusting zoning regulations to allow increased building densities in Bogota would have led to higher welfare gains from Transmilenio, the city's BRT.

Researchers and *donors* should take into account that household split and move more frequently in urban settings, hence, fieldwork will be longer, more intensive and will probably require an additional follow-up data collection exercise. Our project included three rounds of data collection, and both the midline and endline follow-up surveys were followed by a "mop-up" fieldwork exercise. These exercises were key to reduce attrition.

Given this timing, we are still developing the empirical results and expect that they will be subject to iteration. We will also need to engage in a process of result-sharing with our government and World Bank counterparts and then develop generalizable lessons. We anticipate having further information to share about the policy and programme relevance once this process is completed.

Appendix A: Timeline of the project

Source: authors.

Appendix B: Consent form read to the respondents during the endline survey

Field	Question	Answer
consent_new *(required)*	Hello, my name is [YOUR NAME], I'm working with Innovations for Poverty Action (IPA), a research organization, and the World Bank, a multilateral organization. We visited this dwelling before as a part of the research project we are conducting to study the changes in the quality of life and jobs of the people of Dar es Salaam during the past years. You are being invited to be one of the participants in this study. We hope to use the information we are gathering to improve access to services in Dar es Salaam, including public transportation. If you agree to participate in this study, we will ask you, and up to two other household members, questions about your employment, commuting, household, dwelling and neighborhood. We may request to repeat surveys and similar activities in the future. The questions today should take about 45 minutes to one hour to answer. We cannot and do not guarantee or promise that you will receive any benefits from this study, but we will give you and other members of your household who participate in the survey a small monetary gift of 3,000 shillings each at the end to thank you for your time. In addition, your responses will help us with the purpose of our study. You can keep this report describing the research project. There will be no cost to you for participating in this study. If you agree to participate, you may refuse to answer any of the questions we ask and you may stop me at any time to ask questions or to end the interview completely. Your participation in this study will be confidential and the answers you provide will be stored securely in electronic form. Your name and any other identifying information will be accessible only to the researchers and will never appear in any sort of report that might be published. If you have any questions or concerns you may ask me now, or you can contact the project Field Manager Mr. Justus Mugango through his phone which is (0)767003220. He can put you in touch with Rachel Steinacher at IPA (rsteinacher@poverty-action.org) or Juliana Aguilar at the World Bank (jaguilarrestrepo@worldbank.org). Independent Contact: If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the Tanzania Commission for Science and Technology (COSTECH) at 255-22-2927538 or 255-22-2927539. Do I have your consent to continue with the interview?	1 Yes 0 No

Source: Dar es Salaam BRT Impact Evaluation Household Endline Survey Questionnaire (2019).

Appendix C: Project information document shared with the respondent

A Research Study of the Dar es Salaam Bus Rapid Transit (BRT) System

Who is conducting the research?
A team of researchers from the World Bank, the London School of Economics, Stanford University, and Innovations from Poverty Action (IPA) is conducting a study on the Bus Rapid Transit (BRT) System in Dar es Salaam.

What is the research about?
We want to find out how the quality of life the people of Dar es Salaam has changed in the past years. This includes:

- How people travel around the city
- Where people live
- Where people work
- How much people earn
- People's ability to get to central areas, like Kariakoo

In particular, we want to understand the impact of the BRT.

If we answer these questions, we can help to improve public services and, in particular, public transportation in Dar es Salaam. If we can understand both the good and bad effects of the BRT, we can make sure new transportation projects are benefitting everyone in Dar.

Where is the study happening?
To figure out how the BRT will affect Dar es Salaam, we need to talk to people all over the city, not only people who live close to the BRT. This way, we can see what differences there are between people who live close to the BRT and people who live far away from the BRT.

Here is a map of Dar. Each dot shows a location in the city where we are conducting research:

Source: authors.

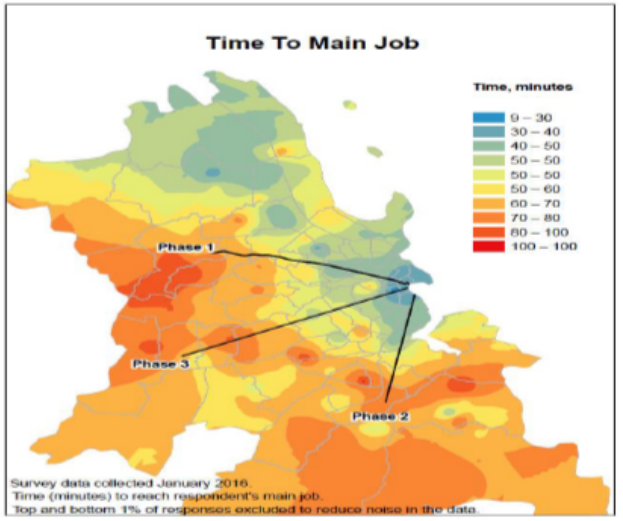
Why are you asking questions about housing, employment, and income?
In order to answer our research questions, we need to ask questions about where people in Dar work, what their earnings are, where they live, and what their house is like.

If we only ask questions about the BRT specifically, we will not be able to research the *impact* of the BRT on Dar. And this means we will not be able to make suggestions for how to improve public transportation in the city.

What are the results?
We still don't know! In order to answer our questions, we need to collect data from many households across Dar es Salaam. We collected information in January 2016 – before the BRT started –, in 2017 and are now collecting information again. This way, we can compare the information to see what changes have happened since the BRT started.

Collecting data all over the city takes a lot of time and work. Once all the data is collected, it will take more time to conduct the analysis. The final report may take a few years to finish. But in the meantime, we may have some early results that we could share the next time we come to visit you.

Here is an example of something we learned from our January 2016 visits. This is a map of Dar es Salaam, showing the amount of time it takes people to get to their main job. The redder the color, the more time it takes. The bluer/greener the color, the less time it takes.



If you have any questions, you can contact the project Field Manager Mr. Justus Mugango at 0767003220.

Appendix D: Additional mean-tests

Endline characteristics: renters versus owners

	Renters		Owners			
	Mean	SD	Mean	SD	p-value renters = owners	Observations
Highest education level completed: Standard 7	0.45	0.5	0.51	0.5	0.01	2,381
Worked for payment in last 7 days	0.46	0.5	0.38	0.49	0	2,639
Current occupation: formal sector	0.17	0.37	0.1	0.3	0	2,639
Current occupation: informal sector	0.33	0.47	0.31	0.46	0.16	2,639
Current occupation: trader	0.11	0.32	0.15	0.36	0.01	2,639
Weekly earnings, Tsh	41,196	110,314	51,042	584,113	0.66	2,602
Number of hours worked in last 7 days	38.52	28.69	37.48	27.93	0.59	1,023
Self-employed in last 7 days	0.33	0.47	0.41	0.49	0	2,639
Monthly gross household income (TSH)	384,485	348,619	448,019	443,913	0	2,231
Monthly gross household income per capita (TSH)	154,349	196,175	113,526	152,017	0	2,231
Minutes to main job	35.85	35.74	37.74	42.4	0.4	1,610
Cost to job (TSH)	1,082	2,203	1,152	2,359	0.58	1,660
Minutes to Kariakoo	64.66	39.5	73.65	42.11	0	2,450
Minutes to Posta	73.86	40.48	84.64	44.31	0	2,309
On a scale of 1-10, how happy are you with the public transportation options?	6.28	2.7	5.71	2.91	0	2,639

Endline characteristics: New and baseline structures

	New Households		Baseline Households		p-value new = baseline	Observations
	Mean	SD	Mean	SD		
Electricity in house for lighting	0.71	0.45	0.74	0.44	0.28	1,801
Street has lights	0.04	0.2	0.03	0.18	0.45	1,801
Road is paved	0.2	0.4	0.18	0.38	0.29	1,801
HH uses non-latrine toilet	0.75	0.43	0.72	0.45	0.29	1,801
Number of households in dwelling	2.42	2.03	1.92	1.84	0	1,771
Rooms household occupies in dwelling	2.37	1.45	3.58	1.68	0	1,782
Number of rooms per household member	0.99	0.92	1.01	0.87	0.6	1,782
Monthly rent (paid or expected), Tsh	78,745	94,786	102,134	108,522	0	1,683

Endline characteristics: New and baseline households, Individual level

	New Households		Baseline Households			
	Mean	SD	Mean	SD	ue new = bas	Observations
Highest education level completed: Standard 7	0.41	0.49	0.52	0.5	0	2,602
Worked for payment in last 7 days	0.42	0.49	0.4	0.49	0.27	2,879
Current occupation: formal sector	0.13	0.34	0.11	0.31	0.1	2,879
Current occupation: informal sector	0.31	0.46	0.33	0.47	0.49	2,879
Current occupation: trader	0.1	0.3	0.15	0.35	0.01	2,879
Weekly earnings, Tsh	34,565	74,041	49,836	538,051	0.5	2,840
Number of hours worked in last 7 days	37.58	27.69	37.49	28.21	0.97	1,108
Self-employed in last 7 days	0.32	0.47	0.41	0.49	0	2,879
Monthly gross household income (TSH)	384,916	377,683	426,886	423,847	0.04	2,446
Monthly gross household income per capita (TSH)	159,775	196,340	113,985	153,646	0	2,445
Minutes to main job	35.72	37.95	36.39	40.86	0.78	1,764
Cost to job (TSH)	1,058	2,030	1,108	2,313	0.71	1,815
Minutes to Kariakoo	71.15	43.47	71.53	41.45	0.86	2,659
Minutes to Posta	79.35	42.64	82.45	43.96	0.17	2,501
On a scale of 1-10, how happy are you with the public transportation options?	6.3	2.69	5.74	2.9	0	2,879

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