EDI LTD

(Economic Development Initiatives)

FINAL REPORT

Consultancy Services for the Design and Implementation of Household Survey and Community Profile for Transport Sector

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On behalf of the Millennium Challenge Account (MCA) - Tanzania

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LIST OF ABBREVIATIONS AND ACRONYMS

AADT	Annual Average Daily Traffic
BADEA	Arab Bank for Economic Development in Africa
CWEST	Capture With Enhanced Survey Technology
DID	Difference-In-Differences
DMS	Database Management Supervisor
DPE	Database Programming Expert
EDI	Economic Development Initiatives
FGD	Focus Group Discussion
FTP	File Transfer Protocol
HBS	Household Budget Survey
HQ	Headquarters
LG-RICS	Local Government Road Inventory and Conditions Survey
LOL	Ladder of Life
MCA	Millennium Challenge Account
MKUKUTA	National Strategy for Growth and Reduction of Poverty
MOID	Ministry of Infratructure Development
PC	Personal Computer
PPP	Purchasing Power Parity
RO	Research Officer
RPC	Research Project Coordinator
RPD	Research Project Director
RS	Research Supervisor
TLU	Tropical Livestock Units
TSIP	Transport Sector Investment Programme
UMPC	Ultra-Mobile Personal Computer

CONTENTS PAGE

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This report documents the methodology, implementation and preliminary results of the road impact evaluation study commissioned by the Millennium Challenge Account – Tanzania (MCA-Tanzania) to Economic Development Initiatives (EDI). MCA-Tanzania will upgrade three rural roads (totalling 431 km) in Mainland Tanzania and 5 stretches of road (totalling 32 km) on the Island of Pemba and wishes to examine how better roads impact the well-being of the people and villages along the roads.

For Mainland Tanzania, the evaluation strategy consists of selecting appropriate comparison roads for each of the treatment roads. Roads were identified of comparable (initial) quality, in the same agro-ecological zones, districts and electoral consituencies. Importantly, comparison roads were confirmed not to be scheduled for upgrades. Villages were randomly selected along both types of road. Within these villages two vitongoji were selected: one close to the road and one further from the road. This stratification by distance to the road was included to allow an examination of the role of the distance to the road in the distribution of benefits of the road upgrade. Ideally, there should be no difference between the sample of 100 treatment and 100 comparison vitongoji, except for the reception of the treatment: treatment vitongoji will have a road upgrade whereas comparison vitongoji will not.

Elaborate data were collected in all sampled vitongoji through three survey instruments: a Community Profile, a Household Survey and a Participatory Wealth Ranking Exercise. This exercise was conducted between the beginning of March and mid May 2009 with 3,000 households in 200 communities and Table i summarizes some of the main indicators. It can be seen that treatment and comparison communities are comparable in terms of welfare indicators (literacy, poverty headcount, land size), access to key infrastructure (markets, roads and schools) and road quality. Notable differences between the treatment and comparison vitongoji are the traffic volume on their roads (higher for the treatment roads) and the time it takes to travel to the District Capital using public transport (higher for the comparison vitongoji). Using propensity score matching to get a

balanced and comparable sample of treatment and comparison vitongoji, we arrive at a final sample of 100 treatment and 99 comparison vitongoji (one comparison kitongoji has to be dropped due to its unique nature).

Table i: Baseline Characteristics, Mainland Tanzania

	Treatment Vitongoji	Comparison Vitongoji
% of Literate Adults (>15)	39.1	41.7
Poverty Headcount (CPL)	0.65	0.64
% Moved Up the Ladder of Life	0.52	0.53
Land Size (Acres)	4.41	4.17
Market in Kitongoji (% yes)	76.0	74.3
Time to Treatment or Control Road (minutes)	14.2	21.4
Time to District Capital (minutes)	85.7	161.7***
Time to Primary School (minutes)	16.7	22.1
Traffic Count (# of Vehicles during 4 Hours)	42.9	14.5***
Drive Test (# of Minutes)	5.0	5.4
Median Road Condition (appraisal by driver)	Good	Good

To evaluate the effects of the road upgrades in Pemba, we adopt a slightly different approach. First, we identify all villages along the treatment roads and take a random sample of treatment villages. Second, we identify all Shehias in North Pemba that will not benefit from the road upgrades nor from any other upgrades financed by other donors or development organizations. In each of those 14 remaining Shehia, we randomly sample 3 villages. Proceeding in this way, we arrive at a sample of 38 treatment and 42 comparison villages in North Pemba Region. In each of these communities 15 households were selected to participate in the household survey.

Baseline data were collected between June 27th and August 21st thorugh a Community Profile and a Household Questionnaire. Table ii shows that treatment villages seem better-off, witnessed by

higher literacy rates, higher consumption expenditures and a lower incidence of poverty (poverty headcount of 20.8% in treatment villages vs. 36.8% in comparison villages). More treatment villages have a daily market and people from the treatment villages have to walk less far to reach a bus stop. In contrast, treatment villages are located further from a road than the comparison villages. Propensity Score Matching results in a balanced sample of 38 treatment and 26 comparison villages.

Table ii: Baseline Characteristics, Pemba

	Treatment Vitongoji	Comparison Vitongoji
% of Literate Adults (>15)	54.5	49.8*
Expenditures (per capita per month, TSHS)	36157	29171***
Poverty Headcount	20.8	36.8***
Land Size (Acres)	1.79	2.30
Net Primary School Enrolment	72.2	74.9
Market in Kitongoji (% yes)	50.0	30.9*
Time to Road (minutes walking)	23.6	7.5***
Time to Public Transport (minutes walking)	37.9	86.8**
Time to District Capital (minutes with bus)	35.5	43.3

In summary, this work has aimed at putting in place the strongest possible baseline dataset to conduct a credible evaluation of the upcoming road upgrades. Initial matching results show that communities are comparable along a large set of observable characteristics. It is worth noting that any economy-wide effect, affecting both treatement and comparison communities, will be not be picked up as a difference between the two.

GENERAL INTRODUCTION

This final report documents the methodology, implementation and preliminary results of the road impact evaluation study commissioned by the Millennium Challenge Account – Tanzania to Economic Development Initiatives (EDI). The report consists of two parts, the first covering Mainland Tanzania and the second concentrating on Pemba Island. In each part, we document our strategy to evaluate the effects of the roads and construct the sample. We explain the logistical implementation of the surveys and provide descriptive statistics on treatment and comparison units. Finally, we present preliminary results from propensity score matching analyses to arrive at a matched and balanced sample which can be used in the final impact evaluation.

PART 1: MAINLAND TANZANIA

1. INTRODUCTION

The 2005 National Strategy for Growth and the Reduction of Poverty in Tanzania (MKUKUTA) identifies the poor state of the rural road network as one of the major impediments to growth and poverty reduction. In this light, the Government of Tanzania has adopted the 10-year Transport Sector Investment Programme (TSIP; see MOID, 2007). The TSIP identifies nine rural trunk roads – "development corridors" – that are important for opening up the country, spurring economic growth and alleviating rural poverty. The development corridors embrace 10,300 km of roads of which approximately 40% is currently bituminized. The challenge set forth by TSIP is to bituminize the remaining 60%.

In the framework of TSIP, the Millennium Challenge Account Tanzania has agreed to upgrade three important stretches of road on three development corridors (see Figure 1):

- Tanga to Horohoro road (the green line in Figure 1): A 68 km stretch of road linking the port of Tanga to the border with Kenya in Horohoro (Tanga region in northeast Tanzania). This is part of the northeast development corridor that will facilitate production of cash and subsistence crops, tourism and mining.
- Tunduma to Sumbawanga road (the yellow line in Figure 1): A 224 km stretch of road linking Tunduma at the Zambian border to the regional centre of Sumbawanga (Rukwa region). This is part of the western development corridor linking Zambia (Tunduma border) to Kigoma (Burundi border). Main economic activities along this corridor are agriculture, tourism, mining, fishing and gold smiting.
- Mtwara corridor (the two blue lines in Figure 1): Upgrading of two sections of the southern development corridor consisting of (1) the 61 km stretch of road between Namtumbo and Songea and (2) the 78 km stretch of road between the Peramiho junction (approximately 20 km west of Songea) and Mbinga. This corridor will promote agricultural production including

livestock and fishing, mining and trade. This corridor will also open up the yet unexploited steel and coal mines of Liganga and Mchuchuma.

2. EVALUATION STRATEGY

To evaluate the impact of the rehabilitation of the above mentioned roads on the socioeconomic development of the communities along the roads, we will use a combination of propensity score matching and difference-in-differences regression[1]. Combining propensity score matching and regression analysis is currently seen as best practice in impact evaluation and goes a long way in reducing biases that plague non-experimental causal studies (see Imbens and Wooldridge (2008)). The general idea is to match the communities along the roads scheduled for upgrades (the treatment communities) with other communities that have similar characteristics but will not benefit from the road upgrades (the comparison communities). Matching will result in two comparable groups of communities: one group that is situated along the roads and will receive the (benefits of) road upgrades and another group that will not. In a second stage, we will obtain pre-treatment and post-treatment data on both groups of communities. If the difference between the post-treatment and pre-treatment value of an outcome variable is different for the treatment group than for the comparison group, this difference can be attributed to the road upgrades (since both groups are similar before treatment thanks to matching, any differences after treatment can only be the result of the treatment)[2].

In order for the evaluation to be convincing, we have to match treatment and comparison communities based on covariates that influence placement of the road and/or the future growth potential of the community. Convincingly controlling for this is crucial for the credibility of the evaluation: if the treatment communities have a relatively higher (lower) growth potential to begin with, the estimate of the treatment effect will be biased upwards (downwards). The specific nature

[1] Ideally, one would use a randomized setting for an impact evaluation. However, since the roads to be upgraded were not chosen randomly, this is not possible.

[2] For difference-in-differences estimation, outcomes are observed for two groups in two time periods. One of the groups receives a treatment between the two time periods whereas the other group does not. The average gain over time of the second group (the control group) is substracted from the average gain of the first group (treatment group). The result is the average effect of the treatment (see Imbens and Wooldridge, 2008).

of this project (the upgrading of *existing* roads) poses an important constraint on the choice of potential comparison communities. Since only the communities that already have a road can receive road upgrades (the treatment), it would be methodologically unsound to select comparison communities that are not located along a road: if initial access to a practicable road matters for future growth, failure to select comparison communities that also benefit from initial (pre-treatment) road infrastructure will overestimate the effect of road upgrades. This is all the more important given the current pre-treatment condition of the roads, which is described as "fair to good" and "all weather"[3]. We therefore restricted the sample of potential comparison communities to those with access to an all weather road of comparable quality.

Difference-in-differences regression on communities matched on initial observable covariates that influence placement of the roads and/or future outcome trends will result in unbiased estimates of the treatment effect if there are no unobservable factors that simultaneously influence treatment and outcomes. One example of this might be a prominent local District politician with influence in Dodoma and Dar es Salaam who manages both to attract infrastructure projects to his/her District and influence outcome trends in his/her District through channels unrelated to the road. To limit the probability of the presence of such unobservables, we selected comparison communities that are located in the same administrative units (Districts) as the treatment communities. Communities in the same administrative units likely share many of the same unobservable characteristics due to geographical proximity. For each treatment community, the comparison communit(y)(ies) is located in the same district, and – in most cases - the same ward and electoral constituency. To account for potentially different economic activities and natural constraints and resources, comparison communities are located in the same agroecological zone as the treatment communities.

[3] This is based on personal communication with the transport officer and transport director of MCA-Tanzania on September 30th 2008 in Dar es Salaam.

Figure I.1: Roads Targeted for Upgrading by Millennium Challenge Account – Tanzania

Source: TANROADS Website. Coloured lines added by author.

Although geographical proximity limits the possibility of important differences in unobservables, comparison communities should not be located too close to treatment communities:

spillover effects from the road upgrades could bias the estimated treatment effect downwards. In short, we have made sure that comparison communities are located sufficiently close to treatment communities in order to account for unobservables but sufficiently far to minimize potential spillover effects from the road upgrades.

To summarize the preceding discussion, we have limited the sample of potential comparison communities to:

- communities along (or close to) a road of comparable quality
- communities in the same agroecological zone as the treatment communities
- communities in the same district as the treatment communities
- if possible, communities in the same ward and electoral constituency as the treatment communities (this was not always be possible)

Within this sample of potential comparison communities, we have used propensity score matching on key variables (initial covariates determining future outcome trends) to identify the comparison communities most similar to the treatment communities. This forms a possible control group in the evaluation of the impact of the road upgrades financed by MCA - Tanzania.

2. SELECTION OF COMPARISON ROADS

The discussion in the previous section implies that we had to select appropriate comparison roads for each of the three treatment roads. The comparison roads had to be located in the same Districts as the treatment roads and be of more or less comparable quality (pre-treatment). The communities located along the selected comparison roads formed the sampling frame for our comparison sample.

The selection of appropriate comparison roads was carried out during field visits to the four Regions involved in the road projects (Tanga, Ruvuma, Rukwa, and Mbeya). The field visits were carried out by the Research Director, the Survey Manager, the fieldwork Coordinator and a Consultant during October and November 2008.

2.1 TUNDUMA – SUMBAWANGA ROAD

The Tunduma to Sumbawanga road connects the Zambian border at Tunduma (Mbeya Region) to the regional centre of Sumbawanga (Rukwa Region). The road crosses two Regions and three Districts: Mbozi District in Mbeya Region and Sumbawanga Rural and Sumbawanga Urban Districts in Rukwa Region.

Figure 2 shows the current road network in Mbeya Region. The treatment road is the unpaved trunk road that runs from Tunduma to Mkutano (after Mkutano the road continues in Rukwa Region; yellow curve in Figures 2 and 3). The communities along this road are the treatment communities and are all located in Mbozi District. Figure 2 shows that there is a regional road parallel to the treatment road that runs from Mlowo to Kamsamba at the border with Rukwa Region (blue curve in Figure 2). This road is also located in Mbozi District. Tunduma and Mlowo are linked through a paved trunk road of approximately 35km. Several important similarities support the choice of the Mlowo-Kamsamba regional road as a suitable comparison road for the treatment road:

- Both roads are located in Mbozi District.
- Both roads are located in the same agroecological zone (southern and western highlands).
- The communities along the comparison road are located in wards that border the treatment wards.
- The bulk of the potential comparison communities are located in the same electoral constituency as the treatment communities (Mbozi Magharibi Constituency)[4].
- Both roads connect an urban centre in Mbozi District to neighbouring Rukwa Region (the urban centre is Tunduma for the treatment road and Mbozi for the comparison road).
- Both roads are currently unpaved.

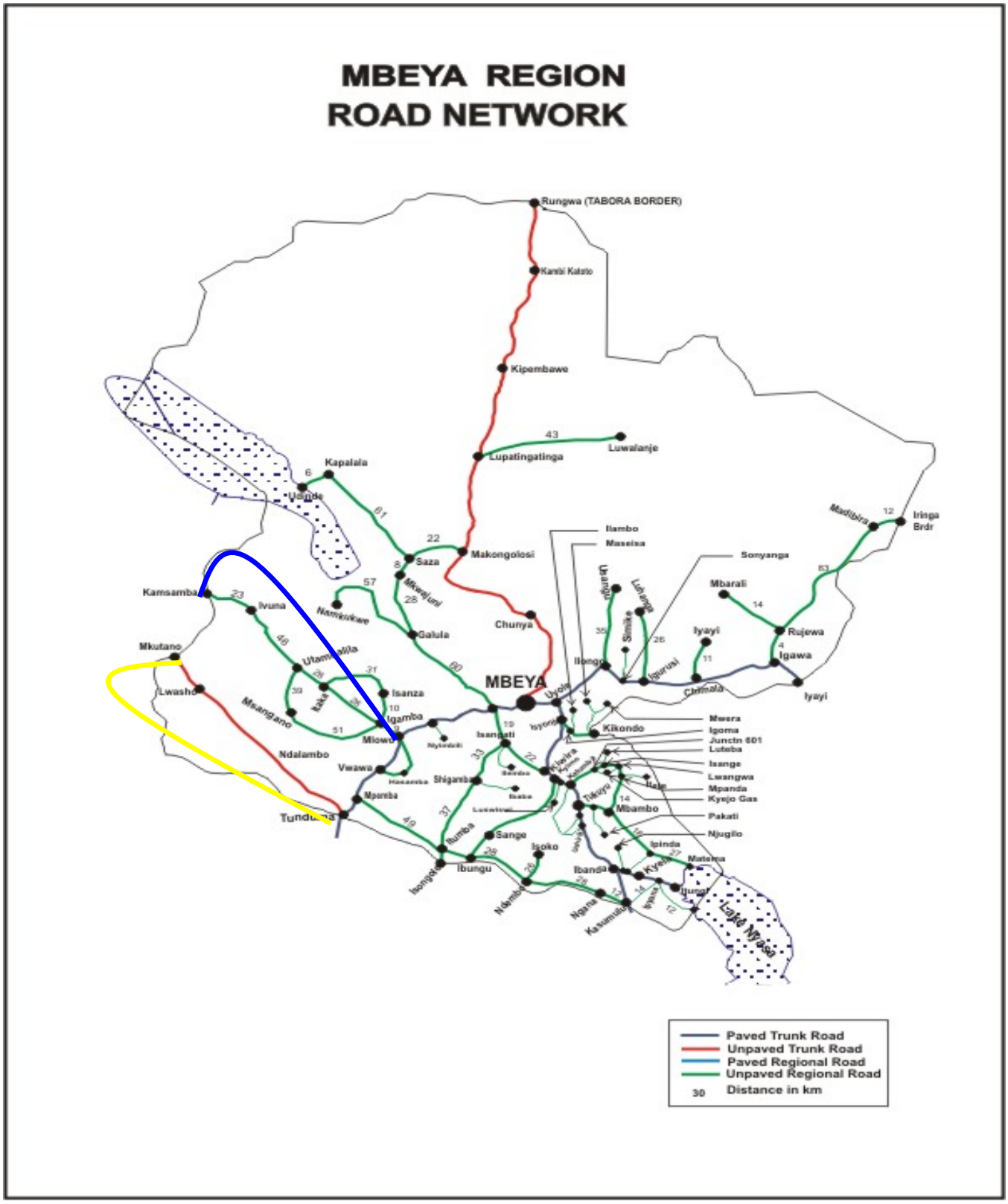
These similarities suggested that the regional road is a good benchmark for evaluating the impact of the trunk road upgrade. However, a field visit in November 2008 to Mbeya Region showed that the

[4] The remaining potential comparison communities are located in neighbouring Mbozi Mashariki Constituency.

regional road is a good comparison road between Mlowo and the village of Nambinzo but a poor one thereafter: after Nambinzo, the regional road makes a steep descent into the valley in the direction of Lake Rukwa. The difference in altitude and the proximity of Lake Rukwa make that the villages after Nambinzo grow different crops (no maize but paddy) and engage in different activities (fishing) than the villages in the mountains. Hence, we have selected the communities along the regional road between Mlowo and Nambinzo as potential comparison communities.

There are some remaining identification problems. First, one might argue that due to the proximity to the Tunduma border, the villages along the treatment road benefit more from trade with Zambia and therefore have higher outcome trends. Although this can be true, the potential comparison road leads to the main urban centre of Mbozi District (Mbozi Town), as a result of which there should also be considerable economic activity along this road. Moreover, Tunduma border is linked to Mbozi Town by a paved trunk road (approximately 35km). More likely than not, trade with Zambia happens along this bituminized corridor. In the difference-in-differences regression one can control for the potential differential trade activity along the treatment and the comparison villages (roads) by adding the initial distance to the Zambian border (either in km or in time) or the initial traffic volume along both roads (these data were collected by EDI).

Figure I.2: Road Network in Mbeya Region



Source: TANROADS website

The treatment road continues in Sumbawanga Rural District in Rukwa Region. Figure 3 shows the current road network in Rukwa Region. The treatment road is the unpaved stretch of road running from Mkutano (on the border with Mbeya Region) to the regional centre of Sumbawanga (yellow curved line). At first glance, it seemed warranted to use the Sumbawanga – Kasesya unpaved trunk road as a comparison for the Mkutano – Sumbawanga treatment road. However, field visits to Rukwa Region in November 2008 learnt that the Sumbawanga - Kasesya road is also scheduled for upgrading. Touring Rukwa Region with an informed official from Sumbawanga Rural District, we managed to identify two stretches of comparison road: the regional road running from Kaengesa to Kale (blue curve in Figure 3) and a part of the old trunk road between Mkima and Malonje (this stretch of old trunk road will not be upgraded by MCA.

The treatment road and the two comparison roads share various important characteristics:

- All roads are located in the same district (Sumbawanga Rural).
- All roads are located in the same agroecological zone (southern and western highlands) with similar rainfall and agricultural characteristics.
- All roads are currently gravelled.

Any initial differences between the treatment and the comparison roads (road quality, traffic volume,…) can be controlled for in the difference-in-differences regression.

To summarize, we identified the regional road from Mlowo to Nambinzo in Mbeya Region and the regional road from Kaengesa to Kale and a part of the old trunk road between Mkima and Malonje in Rukwa region as suitable comparison roads for the Tunduma – Sumbawanga treatment road.

Figure I.3: Road Network in Rukwa Region

Source: TANROADS Website. Coloured lines added by author.

2.2 MTWARA CORRIDOR

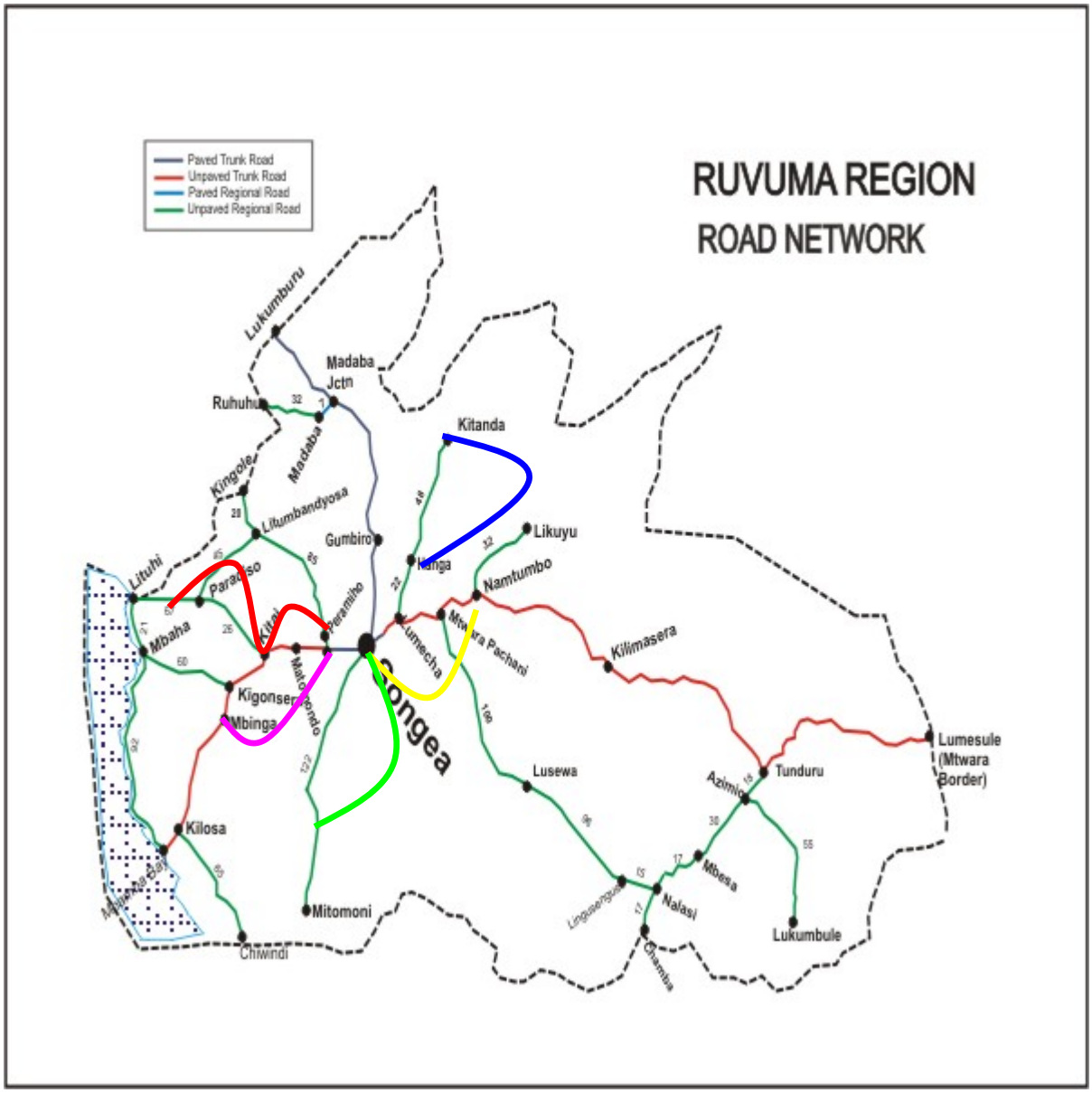
In the framework of the Transport Sector Investment Programme (TSIP), the entire southern development corridor linking the seaport of Mtwara to Mbamba Bay on Lake Malawi will be upgraded. MCA-Tanzania funds the upgrade of two stretches of road on this corridor, both located in Ruvuma Region: 61km between Namtumbo and Songea in Namtumbo District and another 78km between Peramiho Junction and Mbinga town (Songea Rural and Mbinga Districts).

Figure 4 shows the current road network in Ruvuma Region. The communities along the treatment road in Namtumbo District (yellow curve in Figure 4) will likely benefit from enhanced trade with Songea urban centre and enhanced access to public infrastructure once the road has been upgraded. In the same district, there is a regional road connecting Kitanda Ward to the same urban centre of Songea (blue curve in Figure 4). This road is unpaved and not scheduled for rehabilitation (except periodic maintenance works). Communities along this road form a potential benchmark for the evaluation of the impact of upgrading the trunk road. Both roads share important characteristics:

- They are located in the same district (Namtumbo).
- They are located in the same agroecological zone (Plateau).
- They are located in the same constituency (Namtumbo).
- They both lead to the Ruvuma regional centre (Songea Urban)

As usual, some identification problems remain. It is likely that initial traffic volume is higher on the trunk than on the regional road, as a result of which farmers along the trunk road can more easily sell their produce. In the DID analysis, one can control for this by adding pre-treatment traffic volume as an additional explanatory variable. Since important infrastructure assets are located in Songea urban centre, the impact analysis should also account for the distance (either in time or in km)

Figure I.4: Road Network in Ruvuma Region



Source: TANROADS Website. Coloured lines added by author.

between the communities and Songea. If necessary, we can control for initial differences in road quality (if the regional road is in worse condition than the trunk road) by using road quality data we gathered during the survey (see subsection 5.5).

The second stretch of road that will be upgraded in Ruvuma region connects Mbinga district headquarters with Peramiho junction close to Songea regional centre (pink curve in Figure 4). This road passes through the districts of Mbinga and Songea Rural. Figure 4 shows that there is an unpaved regional road linking Mbinga district to Songea regional centre (green curve in Figure 4). This regional road runs from the Mozambican border at Mitomoni to Songea Urban and offered a potential benchmark for evaluation:

- Both roads run through the same districts
- Both roads run through the same constituencies (Mbinga Mashariki and Peramiho)
- Both roads run through the same agroecological zone (Plateau)

However, field visits to Ruvuma Region in November 2008 showed that only a part of the Songea – Mitomoni regional road offers a good counterfactual: Between Songea and Muhukuru, villages along the regional road engage in similar activities as villages along the Peramiho junction - Mbinga treatment road. In the villages after Muhukuru (direction Mozambique), farmers engage more in cashew nut and simsim cultivation. Hence, we chose to use the villages along the regional road between Songea and Muhukuru as comparisons to evaluate the impacts of the Songea – Mbinga road upgrade. There remains however a problem: all villages along the regional road between Songea and Muhukuru are located in the district of Songea Rural. To make sure the sample will also include comparison units in Mbinga district, we identified an extra road as a suitable comparison road. This road can – for analytical purposes - be divided in two stretches: The stretch of district road connecting Peramiho village with the trunk road at Kitai - Liganga and the following stretch running from Kitai-Liganga to Lituhi in Mbinga District (we exclude however Lituhi itself due to its location on the shores of Lake Malawi). This road (red curves in Figure 4) is currently (in the dry season) in fair to good condition (a four-wheel-drive vehicle can easily do 90-100 km/h on the road) and the villages along it are spread out over Songea Rural and Mbinga districts.

To account for differential traffic volume, road quality and distance to important infrastructure (either in time or km), additional control variables can be included in the DID

regressions (such as pre-intervention traffic counts, road quality assessments, the time it takes to travel to the district and regional capitals…).

2.3 TANGA – HOROHORO ROAD

The Tanga – Horohoro road connects the seaport of Tanga with the Kenyan border at Horohoro. The first part of this road, between Tanga and Kiomoni is already paved, and MCC will bituminize the remaining 68 km stretch between Kiomoni and Horohoro. This road is located in Tanga and Mkinga Districts of Tanga Region.

Figure 5 shows the current road network in Tanga Region. On this figure, the treatment road is the only connection with the Kenyan border. Following consultations with TANROADS-Tanga and the Mkinga District Planning Officer, we selected the Mabokweni – Bombomtoni regional road (yellow curve in Figure 5) as the most suitable comparison road for the Tanga – Horohoro trunk road (blue curve in Figure 5):

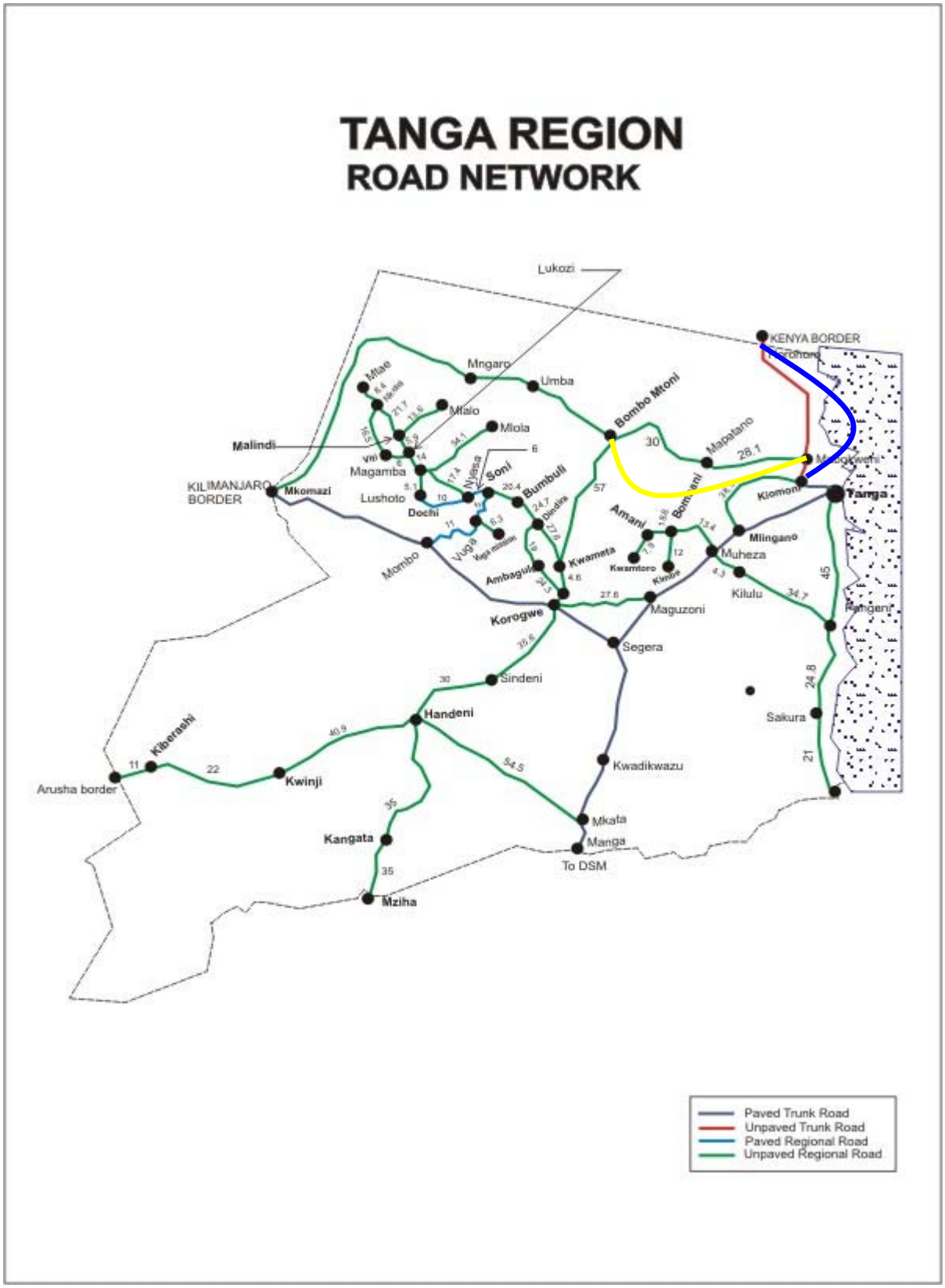
- Both roads (the regional road and the Horohoro trunk road) run through the same districts (Tanga and Mkinga).
- Both roads run though the same agroecological zone (coastal lands and islands)
- The villagers along both roads cultivate the same crops (coconuts and cashew as cash crops and cassava and maize as food crops)

The communities along the trunk road leading to Kenya will likely have a higher growth potential than communities along the regional road (due to higher traffic volume on the trunk road). This urges the inclusion of various control variables in the DID regression: The analysis should control for differences in road quality and traffic volume. In addition, the community profiles (see Section 5.1) gather information about the distance (both in time and in km) to Tanga regional centre and to the Kenyan border.

To summarize, we selected one comparison road in Mbeya Region (Mlowo – Nambinzo regional road), two comparison roads in Rukwa Region (Mkima – Malonje trunk road and Kaengesa – Kale

regional road), one comparison road in Tanga Region (Mabokweni – Bombomtoni regional road), and four stretches of comparison road in Ruvuma Region (Lumecha – Kitanda regional road, Likuyufusi – Muhukuru regional road, Peramiho – Liganga District road and Kitai – Lituhi regional road).

Figure I.5: Road Network in Tanga Region



Source: TANROADS Website.

3. SAMPLING STRATEGY

Following the Terms of Reference of the contract with MCA-Tanzania, the survey has been administered in 200 communities in the four Regions. In Tanzania, *vitongoji* – subunits of villages- are good approximations of the concept of a community. Hence, 200 *vitongji* needed to be selected into the sample. We distributed these 200 *vitongoji* along the three road projects proportional to the square root of the length of each road project. This design assures representativeness along the shorter roads as these roads are assigned proportionally more *vitongoji* than the longer roads. Table I.1 shows the distribution of the sample along the three roads

Table I.1: The Distribution of the Sample in Mainland Tanzania

Road	Length (km)	Scaling Factor	Square Root of Scaling Factor	Number of Villages	Number of Vitongoji
Tanga – Horohoro	68	1.00	1.00	24	48
Namtumbo –Songea - Mbinga	139	2.04	1.43	34	68
Sumbawanga – Tunduma	224	3.29	1.81	42	84

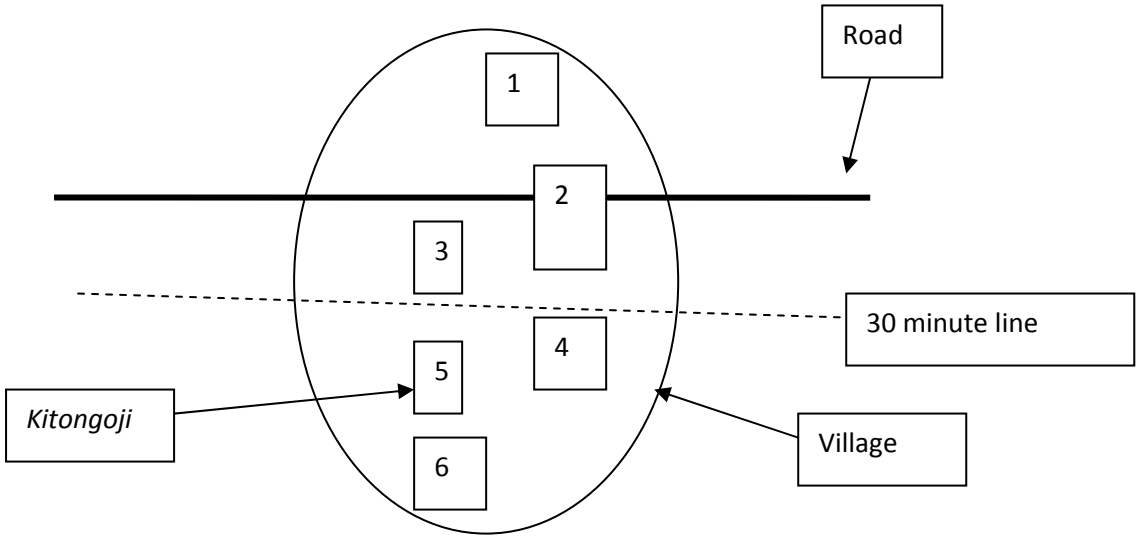
To construct the actual sample, we drew up an exhaustive list of villages along the treatment and comparison roads. Next, we randomly sampled the required number of villages per road project (24 for Tanga – Horohoro, 34 for Namtumbo – Songea – Mbinga, 42 for Sumbawanga – Tunduma), resulting in a sample of 100 villages. Since MCA-Tanzania expressed interest in stratification of the sample according to distance from the road (to examine whether the effects of road upgrades persist as one moves away from the road), we identified all *vitongoji* within each selected village (this was carried out by the *listing team*, which visited the selected villages ahead of the actual

survey teams –see Section 6). Per village, the listing team divided the *vitongoji* in two groups depending on whether the distance from the *kitongoji* to the road is **less than 30 minutes on foot** (close stratum) or **at least 30 minutes on foot** (far stratum). We then randomly selected one *kitongoji* in each stratum. In this fashion, we arrived at a stratified sample of 200 communities (*vitongoji*), 100 in each stratum. For each road project, we distributed the villages and *vitongoji* evenly between the treatment and comparison roads (for instance, Tanga – Horohoro has 12 treatment villages and 12 comparison villages)[5].

Figure 6 sketches the sampling strategy. Consider a village along a road. The village consists of 6 *vitongoji* that are distributed as in Figure 6. *Vitongoji* 1, 2 and 3 are located within 30 minutes on foot from the road (group one), while *vitongoji* 4, 5 and 6 are located further away (group 2) but within the same village. We will randomly sample one *kitongoji* in each group. If the road in the example is a treatment road, both selected *vitongoji* are treatment *vitongoji*. If the road is a comparison road (identified in section 3), both *vitongoji* are comparison units. Proceeding like this, we will obtain a treatment and comparison sample stratified by the distance (in time) to the road.

[5] In some cases, all *vitongoji* within a village fell into the same stratum (the close one). In those cases, we ranked the *vitongoji* according to the distance to the road (rank 1 for the closest *kitongoji*, rank 2 for the second closest *kitongoji*…). We then divided the *vitongoji* in a group with low ranks and a group with the higher ranks (the further ones). One *kitongoji* was randomly sampled out of each group.

Figure I.6: Illustration of Sampling Strategy



4. SAMPLE

For the Tanga – Horohoro road we identified 16 villages along the treatment road and 12 villages along the comparison road. Sample size for this road project was 24 villages (see Table I.1), spread out evenly among the treatment and the comparison road. We thus took a random sample of 12 out of 16 treatment villages. The comparison group consisted of all 12 villages along the comparison road. The listing team visited the 24 selected villages and drew up exhaustive lists of *vitongoji* within each village. *Vitongoji* were divided in two groups depending on their distance to the road and one *kitongoji* was randomly sampled from each group. Table I.2 shows the final sample (48 *vitongoji*) for the Tanga – Horohoro road project. Figures 1 and 2 in the appendix show the exact location (captured by GPS) of all surveyed *vitongoji* along the treatment (Figure 1) and comparison (Figure 2) road.

For the two stretches of road on the southern Mtwara corridor we identified 18 villages that are located on or along the roads that will be upgraded and 21 villages that are located along the selected comparison roads (see subsection 2.2). Sample size for this road project was 34 villages (see

Table I.1), spread evenly among treatment and comparison roads. We thus took a random sample of 17 out of 18 treatment villages and 17 out of 21 comparison villages. The listing team visited the 34 selected villages and drew up exhaustive lists of *vitongoji* within each village. *Vitongoji* were again divided in two groups depending on their distance to the road and one *kitongoji* was randomly sampled from each group. Table I.3 shows the final sample (68 *vitongoji*) for the Mtwara corridor road project.

For the longest road (Sumbawanga – Tunduma), we identified 27 villages along the treatment road and 26 villages along the selected comparison roads (see subsection 2.1). Sample size for the impact evaluation of this road was 42 villages spread out evenly among treatment and comparison roads. We thus took a random sample of 21 out of 27 treatment villages and 21 out of 26 comparison villages. Again, the listing team visited the selected villages and drew up exhaustive lists of *vitongoji* within each village. *Vitongoji* were again divided in two groups depending on their distance to the road and one *kitongoji* was randomly sampled from each group. Tables I.4 and I.5 show the final sample (84 *vitongoji*) for the Tunduma - Sumbawanga road project (Table I.4 for the Tunduma – Mkutano part in Mbeya Region and Table I.5 for the Mkutano – Sumbawanga part in Rukwa Region).

5. SURVEY INSTRUMENTS

To answer the specific research question, we designed three distinct instruments: A Community Profile Questionnaire, a Ladder of Life discussion and a short Household Questionnaire. Next to these main instruments, we gathered additional information on road quality and traffic volume. These variables will potentially be important in the subsequent DID regressions (after the follow-up survey).

5.1 COMMUNITY PROFILE QUESTIONNAIRE

The Community Profile Questionnaire was administered in all 200 selected *vitongoji*. Per vitongoji, five persons were invited as respondents to the Community Questionnaire. The selected persons had to be living in their *vitongoji* for a long time and be knowledgeable about all aspects of life in the *kitongoji* and the corresponding village. The Community Profile Questionnaire was designed to capture two types of information: Information on characteristics that (are likely to) influence future socioeconomic trends (to be used in the matching procedure) and baseline information on outcome variables that are likely to be influenced by better roads (to evaluate the impact of the road upgrades).

The Community Profile Questionnaire consisted of six sections. The first section (*Kitongoji Basics*) identified the location of the *kitongoji* and asked how long it takes to walk from the centre of the *kitongoji* to the road. Insofar as distance to a road matters for future growth, this variable is of crucial importance in the subsequent matching procedure. We also recorded the GPS coordinates of each *kitongoji* centre. The second section gathered standard information on demographics and land and water resources in the *kitongoji*. This section also probed for the most common tribes and religions in the *kitongoji*. The third section documented the baseline access to infrastructure, services, transport and markets. Here, we collected detailed information on travel time (both during dry and rainy season) to key infrastructure and service assets and the availability, frequency and cost

of various modes of transport. The exact location of all infrastructure and services was recorded by GPS. The information collected in this section is important both for the initial matching procedure and the evaluation of the effects of the road. In section four, we focused on agricultural production and sale of agricultural products in the *kitongoji*. This section documented the main channels through which agricultural produce is marketed, which will likely be affected by better roads. The information in this section is important both for the matching procedure and the ultimate evaluation. The fifth section gathered data on the access to health providers and the overall health status in the *kitongoji*. Here, we gathered detailed information on the availability of and travel time to important health facilities as well as the availability of medicines. The location of all health facilities/providers was captured by GPS. We also collected data on child and adult mortality and morbidity and pre- and postnatal care of pregnant women. The information in this section will serve mainly as indicators for the impact of better roads. Finally, the last section collected data on the all-year-round availability of goods, and their price, both of foods and non foods. The availability and price of goods will likely be influenced by road upgrades through diminished travel times and transport costs. Hence, the information in this section is important for evaluating the effects of the road upgrades.

5.2 HOUSEHOLD QUESTIONNAIRE

The original Terms of Reference for Mainland Tanzania did not include the administration of a Household Questionnaire. However, given the fact that some information cannot be collected in a reliable way through the Community Questionnaire, we designed a short Household Questionnaire that was administered to 15 randomly chosen households within each *kitongoji*. The Household Questionnaire consisted of six sections. The first section included the household roster and collected information on education, literacy and potential illness of household members. In addition, we collected anthropometric information on all children younger than five in the household (not by weighting the children but by reading their clinic cards). Education and health have been shown to matter much for future growth, so these are crucial variables in the initial matching procedure. The

second section of the household questionnaire collected information on households' asset and livestock holdings which will also be used in the initial matching. The quality of housing of the household is documented in the third section. The fourth section gathered information on the use of public transport by members of the household. This section detailed the travel time and transport fare the household faced when travelling to several destinations. Obviously, these will be important outcome variables of the road upgrades. The fifth section collected data on the economic activities of the households, in particular cash crop cultivation and non-agricultural work, while the final section documented briefly the spatial social network of the household.

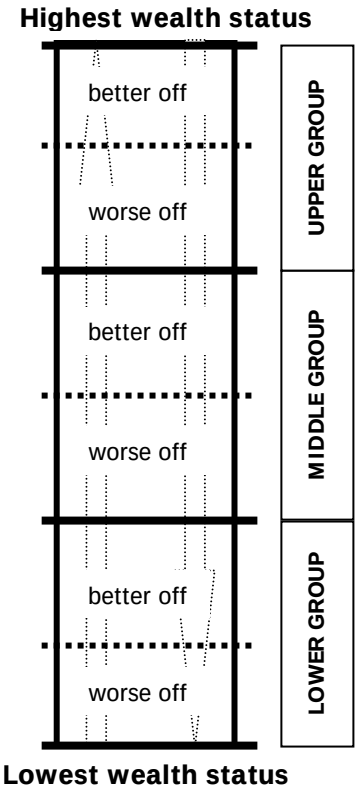
5.3 Ladder of Life

The 15 households who were randomly selected for the household questionnaire also participated in a focus group discussion, called the *Ladder of Life*. The aim of the Ladder of Life is to collect information on how a particular community defines welfare and to document the situation of the different participants on an ordinal welfare scale (the *Ladder*). During the FGD, the facilitator constructed three distinct welfare groups for the *kitongoji*: The worst-off, the middle, and the best-off in terms of wealth. Within each category the facilitator made an additional distinction: Those who are relatively worse-off within a particular category vs. those relatively better-off within the category. Proceeding in this way, there are 6 different welfare categories on the Ladder of Life (see Figure 7).

The participants were asked to elicit the characteristics of the six welfare categories (i.e. what determines membership of a certain wealth category?). For each welfare group, the participants agreed on five different characteristics which determine membership of the group. Once agreement was reached on the definitions of the welfare groups, participants were asked to rank the other participants on the welfare scale (on a scale from 1 to 6 using the definitions and criteria they themselves had provided). Once there was agreement on the rank of all participants, they were asked to put a poverty line on the welfare scale, that is, the step on the scale at which a person or

household is no longer considered poor. In this fashion, all participants whose rank is below the poverty line are considered poor in the kitongoji.

Figure I.7: Welfare Categories on the Ladder of Life



During the FDG all the participants were ranked two times: once for 2009 and once for 2004. The objective criteria that were set to define the different wealth groups help reduce the recall error for the 2004 data (the ordinal nature of the ranking exercise also reduces potential bias related to recall error: although it can be hard to quantify *how much* a person moved up or down the ladder, it is pretty straightforward to establish whether a person has become better or worse-off). The idea of the ranking through time is to get an idea of the recent growth experience in the *kitongoji*: if a lot of households moved up the Ladder of Life between 2004 and 2009 it indicates a favourable economic climate in the *kitongoji* during the past five years; if many households fell down the ladder, this is indicative of a poor economic climate in the *kitongoji*.

5.4 TRAFFIC COUNTS

The evaluation strategy consisted of selecting appropriate comparison roads for the different trunk roads that will be upgraded. It is possible that the trunk roads have higher traffic volumes than the regional roads we selected as comparisons. If this is true, then villages along the busier trunk roads might have higher outcome trends owing to the benefits of more traffic: More shops and kiosks along the road, more restaurants and hotels for truckers… To control for this possibility, we implemented traffic counts in each of the 100 villages in the sample.

The traffic counts were implemented as follows: During its first visit to the village, the listing team identified –in collaboration with the Village Executive Officer - a local person who is literate and masters at least basic arithmetics. This person was then hired by EDI to count the traffic during the actual interview day. For this, the person sat by the side of the road between noon (12 am) and 4 pm and recorded all vehicles coming from both directions. The traffic count person filled in a *Traffic Count Form*, which included seven types of vehicles: Saloon cars, pick-ups or vans, light lorries, medium lorries, heavy lorries, minibuses, and large buses. For the sake of uniformity, a picture of each vehicle type was included in the Traffic Count Form. Every time a vehicle of a specific type passed by, the person filled in the last two numbers of the vehicle's licence plate in the appropriate column on the form (the column corresponding with the vehicle type). The fact that the traffic counts were implemented in every village (rather than one per road) offers a check on the quality of the counts: Traffic counts implemented in adjacent villages during the same day should show many of the same licence plate numbers.

5.5 ROAD QUALITY

Initial differences in road quality between the treatment and comparison roads might bias the impact evaluation, as lower transport costs related to better initial roads may influence outcome trends. To control for initial differences in road quality, we designed a crude test of road quality, to

be administered to a five-kilometer stretch of road along each village. To administer the test, the research supervisor and the driver identified a five-kilometer stretch of road with three reference points: (1) The location of the traffic count person; (2) a point 2.5 km to the left of the traffic count point; (3) a point 2.5 km to the right of the traffic count point. At points (2) and (3), the supervisor planted a reference sign/flag. At the start of the five-kilometer stretch, the supervisor marked a 50 meter acceleration stroke. The driver accelerated for 50 meters and then crossed the first reference sign. When crossing the reference sign, the supervisor started recording the time necessary to bridge the five kilometres. Next to this time-based appraisal of road quality, the driver and the supervisor carried out a visual appraisal of the road stretches: How is the general condition of the road? Are there many potholes? Is the road wet or dry…?

6. FIELDWORK SETUP

6.1 LISTING TEAM

The Listing Team consisted of two Research Supervisors (RS), each of them working independently. Each RS was equipped with a PC for on-field data entry using CWEST programmes and an internet modem for instant data transmission. The duty of the listing team was to visit all sampled villages and carry out all necessary procedures before the arrival of the Survey Teams. The Listing Team visited each village twice. During the first visit to a village, the Listing Team drew up an exhaustive list of all *vitongoji* in the village and marked for each *kitongoji* the time it takes to walk from the *kitongoji* centre to the road. Based on this, the *vitongoji* were divided in two strata: The close stratum if the time it takes to walk to the road was less than 30 minutes; the far stratum if it took at least 30 minutes to walk from the *kitongoji* centre to the road. The Listing Team then randomly selected one *kitongoji* in each stratum (this was done automatically by the survey software). The Listing Team then visited the two selected *vitongoji* and asked the *vitongoji* chairmen to draw up exhaustive lists of all households in their *vitongoji* (a standardized *Household Listing Form* was provided). During the first visit, the Listing Team also identified a qualified person to carry out the traffic counts during the day of the actual interviews. A few days later, the Listing Team returned to

the village to pick up and verify the Household Listing Forms. The Listing Team then randomly selected 15 households from the form (this was carried out by generation of random numbers in STATA). During the second visit, appointments for the interviews were made with the respondents to the Community and Household Questionnaires.

6.2 SURVEY TEAMS

There were two Survey Teams, each consisting of four Research Officers (RO) working under a Research Supervisor (hence, a total of 10 persons). Each RO had an Ultra Mobile Personal Computer (UMPC) for on-field data entry using CWEST programmes, and each RS had a PC and an internet modem for instant data transmission. Every evening, the RS downloads gathered data from interviewers' UMPCs, checked them and uploaded them onto an FTP server, from which data was instantly available to the data processing team at HQ. In the morning, each Survey Team was dropped in a separate village. Once in the village, each Survey Team split up in two subteams of two RO's each. Each subteam administered the three instruments (Community Profile Questionnaire, Household Questionnaire and Ladder of Life Discussion) in one *kitongoji* per day. In this fashion, four *vitongoji* or two villages were surveyed each day.

6.1 TIMING OF FIELDWORK

The timing of the fieldwork is summarized in Table I.6: The Listing Teams left EDI HQ on 20th February, 2009 and arrived in Tanga Region on February 22nd. Between 23rd February and 10th March, 2009 the Listing Team worked in the sampled villages in Tanga Region (see Table I.2 for the detailed listing schedule). The next days were spent on recording GPS coordinates. The Listing Team left Tanga (and headed for Sumbawanga) on 12th March 2009. The Survey Teams left Bukoba HQ on February 27th. They arrived in Tanga on 1st of March and interviewed the first two villages on March 2nd (see Table I.2 for the detailed interview schedule). By the end of March 15th, all sampled *vitongoji* in Tanga Region had been surveyed. The Survey Teams left Tanga on March 17th.

Table I.6: Timing of Fieldwork

	Listing Teams	Survey teams
Left Bukoba	February 20th	February 27th
Arrived in Tanga	February 22nd	March 1st
Left Tanga	March 12th	March 17th
Arrived in Rukwa	March 13th	March 19th
Left Rukwa	April 2nd	April 3rd
Arrived in Mbeya	April 2nd	April 3rd
Left Mbeya	April 19th	April 23rd
Arrived in Ruvuma	April 20th	April 23rd
Left Ruvuma	May 15th	May 18th

The Listing Team arrived in Sumbawanga on March 13th and began listing the first villages the next day. The last villages were listed on March 31st (see Table I.3 for detailed listing schedule in Rukwa Region). The Listing Team headed for Mbeya on April 2nd. The Survey Teams arrived in Sumbawanga the 19th of March and started interviewing the day after. The last *vitongoji* were surveyed on April 1st. The Survey Teams headed to Mbeya on April 3rd.

The Listing Team arrived in Mbeya on April 2nd and started working the same day. They finished all listing in Mbeya on April 16th and headed for Songea (Ruvuma Region) on April 19th (see Table I.4 for detailed listing schedule in Mbeya Region). The Survey Teams arrived in Mbeya on April 3rd. After getting research clearance, they began surveying the first two villages on April 5th 2009. They completed work in Mbeya on April 21st. The survey teams headed to Songea in Ruvuma Region on April 23rd.

The Listing Team arrived in Songea on on April 20th 2009 and listed the first two villages the same day. They terminated listing in Ruvuma on May 13th and headed back to EDI headquarters in Bukoba two days later (see Table I.5 for the detailed listing schedule in Ruvuma Region). The survey teams arrived in Ruvuma Region on April 23rd 2009. After getting all necessary clearances from the

local authorities, they started surveying the first two villages on April 25th. The survey teams finished their work in Ruvuma on May 15th and headed back to Bukoba on May 18th.

7. DESCRIPTIVE STATISTICS

In this section, we will present some preliminary statistics on important baseline characteristics. Table I.7 describes the variables used in the descriptive statistics. Per district, we compare for each stratum the value of selected variables across treatment and comparison groups. Since this is pre-matching, we expect to observe a number of significant differences in variable values between treatment and comparison groups. Ideally however, the number of significant differences should remain rather limited. The tables that follow present the baseline characteristics for treatment and comparison *vitongoji*, split by stratum.

Table I.7: Variables for the Baseline Descriptive Analysis

Variable Name	Variable Description
Number of Households	Number of households in the kitongoji
% of Female-Headed Households	The percentage of households in the kitongoji with a female head.
# of Households who Left	The number of households that permanently left the kitongoji (to settle somewhere else) since 2005.
# of Households who Settled	The number of non-native households that permanently settled in the kitongoji since 2005.
Distance to Road	The time it takes to walk from the kitongoji centre to the relevant treatment or comparison road (in minutes). This will be higher for the vitongoji in the far stratum.
Permanent Source of Water	A dummy variable indicating whether the kitongoji has a permanent source of water. In the following tables, the value of this variable represents the proportion of vitongoji (between 0 and 1) that have a permanent water source.
Electricity in Kitongoji	A dummy variable indicating whether the kitongoji has electricity. In the following tables, the value of this variable represents the proportion of vitongoji (between 0 and 1) that have electricity.
Distance to District Capital	The time it takes to travel to the district capital using public transport in the dry season. Expressed in number of minutes.
Distance to Primary School	The time it takes to walk to the nearest primary school. Expressed in number of minutes
Distance to Dispensary	The time it takes to go to the dispensary using the mode of transport people usually use. Expressed in number of minutes
Access to Public Transport	The time it takes to walk to the nearest bust stop (or a point where a bus can be accessed). Expressed in number of minutes.
Daily Wage of Agr. Laborer	The amount an agricultural wage laborer earns in one day in the kitongoji (in TSHS)
Price of Acre of Fertile Land	The minimum price of one acre of fertile land in the kitongoji (for a native; TSHS)
% of Literate Adults (>15)	The percentage of literate adults in the kitongoji. Adult is defined as at least 15 years of age
Size of Land Holdings	The size of household land holdings in acres
% of Households with Bicycle	Percentage of households who own at least one bicycle.
% of Households with Radio	Percentage of households who own at least one radio.

Number of TLU	The number of tropical livestock units (TLU) a household owns. This is a composite measure of livestock holdings. The conversion factors are: 1 cow = 0.7 TLU; 1 goat = 1 sheep = 0.1 TLU; 1 pig = 0.2 TLU; 1 donkey = 0.5 TLU; 1 chicken = 0.01 TLU (Source: FAO)
% Cultivating Cash Crops	Percentage of households who cultivate cash crops
Income from Crop Sales	Household income from crop sales during the last 12 moths (TSHS)
% of Household Income Gained through Non-Agriculture	Percentage of total household income that was gained through non agricultural activities (during the last 12 months)
Frequence of Purchase by Traders	The number of times per month during the harvest season of a crop that traders visit the kitongoji to buy up produce of the crop.
Visits by Agricultural Exension Officer	The number of times during the last 12 months the kitongoji has been visited by an agricultural extension officer.
Immunizations Available	The percentage of kitongoji that have access to immunizations in their village
Anti-Malarial Drugs Available	The percentage of kitongoji that have access to antimalarials in their village
Clinical Officer Available	The percentage of kitongoji that have access to a clinical officer in their village
Trained Midwife Available	The percentage of kitongoji that have access to a trained midwife in their village
Child Mortality	The number of children under 5 who died during the last 12 months.
Adult Mortality	The number of adults who died during the last 12 months
Weight for Age Z-Score	A composite measure for the nutritional status and physical development of children younger than 5 years.
% of Underweight Children	The percentage of children in the kitongoji with a weight for age z-score smaller than -2.
Net Primary School Enrollment	The number of children of primary school-age who are currently enrolled in primary school.
Poverty Headcount	The percentage of households in the kitongoji who fall below a participatively-set poverty line.
% Moved Up the Ladder of Life	The percentage of households in the kitongoji who moved up the ladder of life between 2004 and 2009.
Time to Fetch Water	The time it takes a household to fetch water (minutes).
Time to Fetch Firewood	The time it takes a household to fetch firewood (minutes).

7.1 TANGA – HOROHORO ROAD

For the evaluation of the Tanga – Horohoro Road, we interviewed four vitongoji in Tanga District (two treatment and two comparison vitongoji, one in each stratum) and 44 vitongoji in Mkinga District (22 treatment and 22 comparison vitongoji, 11 in each stratum). Since there are only 2 villages in Tanga District (one *kitongoji* per stratum per treatment status), we pool the districts of Tanga and Mkinga.

1) TANGA AND MKINGA DISTRICTS

Table I.8 shows basic demographic information for the 48 surveyed *vitongoji* in Tanga and Mkinga districts. By and large, treatment and comparison *vitongoji* in both strata are very similar. More households settled permanently in the comparison than in the treatment vitongoji during the past five years.

Table I.8: Basic Demographics, Tanga and Mkinga Districts

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Number of Households	111.6	126.2	116.2	95.8
% Female-Headed Households	31.5	28.3	22.8	27.8
# Households who Left	3.8	5.5	3.4	2.6
# Households who Settled	5	7.7	4.4	7.1
N	12	12	12	12

Note: None of the differences in means between treatment and comparison *vitongoji* are statistically significant at conventional levels of significance.

Table I.9 shows the access to infrastructure in the treatment and comparison *vitongoji* in Tanga Region. The first variable –distance to road- is of crucial importance in the matching procedure and in the ultimate evaluation of the road upgrades. Following our sampling procedure, the connected *vitongoji* (both treatment and comparison) are located along or very close to the road (treatment

and comparison road, respectively). People in the connected treatment vitongoji have to walk for one minute to reach the road, while this is about 5 minutes for the connected comparison vitongoji. The people in the unconnected treatment *vitongoji* need to walk 11 minutes to reach the Tanga-Horohoro road, while the people in the unconnected comparison *vitongoji* walk over 40 minutes before reaching the Mabokweni – Bombomtoni comparison road. Within the close stratum, more treatment than comparison *vitongoji* have a market, access to electricity and a permanent source of water in the *kitongoji.*

Table I.9: Access to Infrastructure, Tanga and Mkinga Districts

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Treatment/Comparison Road (minutes)	1.1	4.8	10.8	41.1***
Market in Kitongoji (% yes)	0.33	0.08	0	0.08
Permanent Source of Water (% yes)	0.83	0.58	0.50	0.75
Electricity in Kitongoji (% yes)	0.25	0.08	0.17	0.17
Access to Public Transport (minutes)	0	0	8.75	6.25
Distance to District Capital (minutes)	97.5	137.5**	113.6	150.0
Distance to Primary School (minutes)	19.6	45.8	24.6	17.9

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

The opposite situation prevails in the far stratum, where comparison vitongoji seem to be better off (except for electricity). All treatment and comparison *vitongoji* in the close stratum can access public transport in the *kitongoji* (when public transport can be accessed in the *kitongoji*, the time to get to the nearest bust stop is 0). In the far stratum, people have to walk a bit before reaching a bus stop, though the walking time is limited: 8.75 minutes for treatment and 6.25 minutes for comparison vitongoji. The time it takes to go to the District Capital (Tanga) using public transport is

in both strata higher for the comparison than for the treatment vitongoji (this is of course a logical outcome of the sampling strategy). The time it takes to walk to the primary school amounts to 46 minutes in the connected comparison *vitongoji* but drops below 25 minutes for all other groups of *vitongoji*.

Table I.10 describes agricultural characteristics of the different groups of *vitongoji*. The size of household land holdings is fairly comparable within and across strata and amounts to just over 3.5 acres.

Table I.10: Agricultural Characteristics, Tanga and Mkinga Districts

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Size of Land Holdings (Acres)	3.64	3.60	3.52	3.56
% Cultivating Cash Crops	55.1	59.4	65.6	55.6*
Income from Crop Sales (Tshs)	48925	40259	67649	43269*
% of Non-Agr in Total Income	33.1	24.5**	23.3	29.1*
Price of Acre of Fertile Land (Tshs)	228333	120000	172727	194000
Daily Wage of Laborer (Tshs)	10042	8125	7042	2008*
Most Common Food Crop	Cassava	Maize	Cassava	Maize
Most Common Cash Crop	Cashew	Coconut	Coconut	Cashew
Frequency of Purchase by Traders	30	30	30	30
Visits by Agr. Extension Officer	10.8	25.6	9.25	11.75

Note: In the far comparison *kitongoji*, land cannot be bought or sold. ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

The percentage of households cultivating cash crops does not differ between the treatment and comparison *vitongoji* in the close stratum, but differs significantly between the treatment (65.6%) and comparison (55.6%) *kitongoji* in the far stratum. The same goes for crop income which –in the far stratum- is higher for households in the treatment vitongoji. The percentage of household income earned through non-agricultural activities is higher for the treatment (33.1%) than for the

comparison (24.5%) *vitongoji* in the close stratum, but lower in the far stratum (23.3% for treatment *vitongoji* vs. 29.1% for comparison *vitongoji*). Within the close stratum, the price of an acre of fertile land is higher in the treatment than in the comparison vitongoji, though the difference is not statistically significant. The daily wage of an agricultural wage labourer is higher in the treatment than in the comparison *vitongoji*. The main food crop for the surveyed treatment *vitongoji* in Tanga and Mkinga Districts is cassava, while this is maize for the comparison *vitongoji*. Main cash crops are coconuts and cashew nuts.

Table I.11: Health Statistics, Tanga and Mkinga Districts

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Dispensary (minutes)	42.5	56.9	38.3	60.4
Immunizations Available (% yes)	83.3	50.0*	41.7	66.7
Anti-Malarial Drugs Available (% yes)	16.7	25.0	8.3	25.0
Clinical Officer Available (% yes)	16.7	16.7	8.3	16.7
Trained Midwife Available (% yes)	25.0	33.3	0.0	50.0
Place of Childbirth	Dispensary	Dispensary	Dispensary	Dispensary
Most Common Cause of Death	Malaria	Malaria	Malaria	Malaria
Child Mortality (last 12 months)	2.8	1.3	2.75	2.00
Adult Mortality (last 12 months)	4.33	4.00	3.67	4.41
Weight for Age z-score	-1.03	-0.93	-0.95	-0.96
% of Underweight Children	14.9	17.9	24.5	18.2

The availability of and access to health infrastructure and services is presented in Table I.11. The time it takes to go to the nearest dispensary is higher for the comparison than for the treatment *vitongoji*, though the differences are not statistically significant. In the close stratum, immunizations are available in more treatment (83.3%) than comparison (50%) *vitongoji*. The opposite situation prevails in the far stratum. Despite the observation that malaria is the most common cause of death

in all groups of *vitongoji*, anti malarial drugs are only rarely available. One in four comparison *vitongoji* has access to antimalarials within the *kitongoji*; this drops to one in six or even one in 12 for the treatment vitongoji. Clinical officers are available in 16.7% of *vitongoji* in the close stratum and in even less vitongoji in the far stratum. In most *vitongoji*, pregnant women give birth in a dispensary. Child mortality (the number of children below 5 that died during the last year) is somewhat higher in the treatment than in the comparison vitongoji. Finally, we calculated the weight-for-age z-score for all children between 6 and 59 months of age. Weight-for-age reflects body mass conditional on age and is used for monitoring growth and malnutrition over time (WHO, 1995). If the weight-for-age z-score of a child is below -2, the child is considered underweight and malnourished. Overall, the z-scores do not differ much between the treatment and comparison *kitongoji*. The incidence of malnutrition (the proportion of children whose z-score is below -2) is highest in the far treatment *vitongoji*, where almost 25% of children are underweight. The incidence of malnutrition does not differ significantly within strata.

Table I.12 presents information on assets as well as welfare indicators. In both strata, households in the treatment *vitongoji* have higher livestock holdings than those in the comparison *vitongoji*. In contrast, literacy rates are higher in the comparison than in the treatment vitongoji. We calculated net primary school enrolment for each kitongoji by dividing the number of children aged 7-13 who are currently in primary school by the total number of children aged 7-13. In the close stratum, school enrolment is lower in the treatment (86.6) than in the comparison vitongoji (94.4), though the difference is not statistically significant. In the far stratum, school enrolment is similar across *vitongoji*. For each vitongoji, we also calculated a household poverty headcount based on the results from the Ladder of Life focus group discussion (FDG). During the FDG, respondents were presented a welfare scale with six steps, each step representing a specific welfare group (from poorest to richest). The participants were asked to describe each welfare group by providing five criteria which define the specific welfare group. Once agreement was reached on the definitions of the welfare

groups, participants were asked to rank the other participants on the welfare scale (on a scale from 1 to 6 using the definitions and criteria they themselves had provided).

Table I.12: Welfare Indicators, Tanga and Mkinga Districts

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
% of Households with Bicycle	0.47	0.44	0.41	0.42
% of Households with Radio	0.54	0.49	0.43	0.51
Livestock Holdings (TLU)	1.51	0.77	2.01	0.43**
% of Literate Adults (>15)	67.3	68.7	60.2	71.7***
Net Primary School Enrolment	86.6	94.4	92.3	91.1
Poverty Headcount (CPL)	68.6	62.2	72.2	81.7**
% Moved Up the Ladder of Life	56.1	48.9	51.6	41.1**
Time to Fetch Water (minutes)	70.1	64.0	61.5	62.1
Time to Fetch Firewood (minutes)	108.3	138.0***	109.6	108.6

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Once there was agreement on the rank of all participants, they were asked to put a poverty line on the welfare scale, that is, the step on the scale at which a person or household is no longer considered poor. In this fashion, all participants whose rank is below the poverty line are considered poor in the *kitongoji*. We observe that poverty headcount is higher in the far stratum than in the close stratum, and that within the far stratum comparison *vitongoji* have a higher poverty headcount than *treatment* vitongoji (81.7% vs. 72.2%).

During the FDG all the participants were ranked two times: once for 2009 and once for 2004. The idea here is to get an idea of the recent growth experience in the *kitongoji*: if a lot of households moved up the Ladder of Life between 2004 and 2009 it indicates a favourable economic climate in

the kitongoji during the past five years. Within the close stratum, 56.1% of households in the treatment *vitongoji* moved up the ladder vs. 48.9% in the comparison *kitongoji*. In the far stratum, we observe a statistically significant difference between the treatment *kitongoji*, where 51.6% of households moved up the ladder, and the comparison *kitongoji*, where 41.1% experienced upward mobility. Finally, the last two variables indicate the availability of two important resources, being clean water and firewood. Both are not readily available: The time it takes to fetch water exceeds one hour for all groups of *vitongoji*, while the time it takes to fetch firewood varies around two hours. The time to get firewood is higher in the close comparison (138 minutes) than in the close treatment *vitongoji* (108 minutes).

7.2 TUNDUMA – SUMBAWANGA ROAD

1) MBOZI DISTRICT

In Mbozi District, we interviewed 7 villages along the comparison road and 12 villages along the treatment road. Overall, we surveyed 38 *vitongoji*, 19 in each stratum. Table I.13 shows that the number of households does not differ much between the various groups of *vitongoji*. On average, treatment *vitongoji* are somewhat bigger than the comparison *vitongoji*. These latter *vitongoji* have a higher percentage of female-headed households, though the difference is not statistically significant. The difference in permanent out-migration in the close stratum is, with 12.8 households permanently leaving the comparison *vitongoji* vs. only 1.5 for the treatment *vitongoji*.

Table I.13: Basic Demographics, Mbozi district

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Number of Households	139.3	124.3	165.3	144.7
% Female-Headed Households	14.4	21.9	17.8	18.1
% Households who Left	1.5	12.8***	6.0	4.3
% Households who Settled	6.8	8.5	7.1	5.1
N	12	7	12	7

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Table I.14 summarizes the access to infrastructure for the surveyed *vitongoji* in Mbozi district.

Table I.14: Access to Infrastructure, Mbozi District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Treatment/Comparison Road (minutes)	8.1	11.0	25.5	33.3
Market in *Kitongoji* (% yes)	0.25	0.57	0.33	0.28
Permanent Source of Water (% yes)	0.75	1	0.83	0.86
Electricity in *Kitongoji* (% yes)	0	0	0	0
Access to Public Transport (minutes)	242.5	2.9**	462.5	24.9**
Distance to District Capital (minutes)	115.0	135.0	71.5	90.0
Distance to Primary School (minutes)	17.5	30	13.8	22.8

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Overall, the access to infrastructure does not differ much between treatment and comparison units. In the close stratum, more comparison than treatment *vitongoji* have markets (25% of treatment *vitongoji* vs. 57% of comparison *vitongoji*). The time it takes to go to the district capital (Mbozi town) and the primary school is also somewhat higher for the comparison than the treatment *vitongoji*. In the far stratum, treatment and comparison *vitongoji* are similar regarding access to infrastructure.

Treatment and comparison *vitongoji* are more different regarding agricultural characteristics. While household farm size is bigger in the treatment than in the comparison *vitongoji*, households in the latter *vitongoji* have higher crop incomes and higher valued land holdings. The price of an acre of fertile land is up to 8 times higher in the comparison than in the treatment *vitongoji*. The main cash crop in the comparison communities is coffee, versus maize (close stratum) and sunflower (far stratum) for the treatment vitongoji. During the harvest season of the cash crops, traders come to the vitongoji every single day to buy up the produce (30 times a month for all groups of vitongoji).

Table I.15: Agricultural Characteristics, Mbozi District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Size of Land Holdings (Acres)	5.23	3.57**	5.11	2.85***
% Cultivating Cash Crops	78.9	84.7	74.4	80.0
Income from Crop Sales (Tshs)	188847	263770*	187591	268357
% of Non-Agr in Total Income	9.9	16.3**	14.1	12.1
Price of Acre of Fertile Land (Tshs)	26667	147143***	19333	167143***
Daily Wage of Laborer (Tshs)	1583	1429	1667	1536
Most Common Food Crop	Maize	Maize	Maize	Maize
Most Common Cash Crop	Maize	Coffee	Sunflower	Coffee
Frequency of Purchase by Traders	30	30	30	30
Visits by Agr. Extension Officer	9.3	51.3	2.1	1.4

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

With regard to health, the most notable difference between the treatment and comparison *vitongoji* is the higher mortality in the comparison communities, both for adults and children. In line with this, child malnutrition is more prevalent in the comparison than in the treatment *vitongoji*. Malaria is the most common cause of death in all groups of *vitongoji*. Despite this, anti-malarial drugs are not widely available. None of the close treatment *vitongoji* have anti-malarial drugs available in the *kitongoji*. None of the 38 *vitongoji* surveyed in Mbozi have a clinical officer.

Table I.16: Health Statistics, Mbozi District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Dispensary (minutes)	80	53.6	92.5	95.7
Immunizations Available (% yes)	16.7	14.3	33.3	14.3
Anti-Malarial Drugs Available (% yes)	0.0	28.6	25.0	28.6
Clinical Officer Available (% yes)	0	0	0	0
Trained Midwife Available (% yes)	25.0	28.6	41.7	28.6
Place of Childbirth	Dispensary	Dispensary	Dispensary	Dispensary
Most Common Cause of Death	Malaria	Malaria	Malaria	Malaria
Child Mortality (last 12 months)	3.5	4	3.5	4.3
Adult Mortality (last 12 months)	2.25	7.57***	2.41	4.14
Weight for Age z-score	-1.09	-1.08	-1.16	-1.09
% of Underweight Children	27.8	30.6	23.1	27.9

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Concerning the welfare indicators, the households in the close treatment *vitongoji* seem to be somewhat better off than those in the close comparison *vitongoji*: A higher proportion of households in the treatment *vitongoji* own radios and bicycles and poverty headcount is lower (43.9% vs. 59.0%). Contrary to this, the literacy rate is higher in the close comparison *vitongoji* than in the treatment *vitongoji*.

Table I.17: Welfare Indicators, Mbozi District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
% of Households with Bicycle	0.53	0.39**	0.43	0.40
% of Households with Radio	0.63	0.60	0.49	0.55
Livestock Holdings (TLU)	1.80	1.48	1.02	1.26
% of Literate Adults (>15)	66.5	73.3*	63.3	72.9**
Net Primary School Enrolment	90.2	97.0*	84.3	95.2
Poverty Headcount (CPL)	43.9	59.0**	71.1	61.9
% Moved Up the Ladder of Life	62.8	60.0	54.4	61.9
Time to Fetch Water (minutes)	31.7	40.5***	44.8	47.5
Time to Fetch Firewood (minutes)	115.3	118.3	137.7	99.4***

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

In the far stratum, comparison *vitongoji* seem to be a little better off than treatment *vitongoji*. Literacy rates in the comparison *vitongoji* are higher and the poverty headcount is lower (although not statistically significant). More households in the comparison than in the treatment *vitongoji* moved up the ladder of life during the past 5 years (61.9% vs. 54.4%). However, this difference is not statistically significant either. In both strata, primary school enrolment is higher in the comparison than in the treatment *vitongoji*.

2) SUMBAWANGA RURAL DISTRICT

We interviewed 23 villages (46 *vitongoji*) in Sumbawanga Rural district, 9 along the treatment road and 14 along the various comparison roads. As usual, we equally divided the 46 *vitongoji* across the two strata. Table I.18 shows basic demographic data. While the *vitongoji* in the close stratum are roughly similar in demographic terms, *vitongoji* in the far stratum are not. The far treatment *vitongoji* are bigger than the far comparison *vitongoji*, have a higher percentage of female headed

households and experienced higher out-migration. These differences should however be eliminated during the matching procedure.

Table I.18: Basic Demographics, Sumbawanga Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Number of Households	131.6	104.9	123.0	79.2*
% Female-Headed Households	17.0	12.4	16.3	9.0**
# Households who Left	3.7	3.8	3.6	1.8*
# Households who Settled	8.2	9.6	6.3	5.4
N	9	14	9	14

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

In the close stratum, 56% of treatment *vitongoji* have a market in the *kitongoji* vs. only 14% for comparison *vitongoji*. People living in the treatment *vitongoji* also have better access to the district capital. In the far stratum, people in the treatment *vitongoji* have better access to public transport, though the difference is not statistically significant. By and large, treatment and comparison *vitongoji* in the far stratum do not differ much with regard to access to infrastructure.

Table I.19: Access to Infrastructure, Sumbawanga Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Treatment/Comparison Road (minutes)	2.6	3.0	45.1	23.5
Market in Kitongoji (% yes)	0.56	0.14**	0.22	0.35
Permanent Source of Water (% yes)	0.78	0.93	0.89	1
Electricity in Kitongoji (% yes)	0	0	0	0
Access to Public Transport (minutes)	246.7	107.1	25.9	51.1
Distance to District Capital (minutes)	128.1	234.0*	170.0	175.4
Distance to Primary School (minutes)	3.4	10.3	26.1	23.1

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Focusing on agricultural characteristics, we find that the treatment and comparison *vitongoji* in both strata are remarkably similar. The only statistically significant difference occurs in the far stratum and concerns the proportion of income gained through non-agricultural activities. This amounts to 12.5% in the treatment *vitongoji* vs. 18.7% in the comparison *vitongoji*.

Table I.20: Agricultural Characteristics, Sumbawanga Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Size of Land Holdings (Acres)	4.59	4.43	4.44	3.89
% Cultivating Cash Crops	74.8	75.2	76.3	78.1
Income from Crop Sales (Tshs)	218420	200493	188373	170850
% of Non-Agr in Total Income	22.9	18.0	12.5	18.7*
Price of Acre of Fertile Land (Tshs)	41111	41607	55714	49167
Daily Wage of Laborer (Tshs)	2167	2525	3044	2329
Most Common Food Crop	Maize	Maize	Maize	Maize
Most Common Cash Crop	Maize	Maize	Sunflower	Maize
Frequency of Purchase by Traders	30	29.7	22.6	30
Visits by Agr. Extension Officer	9.9	3.3	12.0	3.0

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

People in the treatment *vitongoji* in Sumbawanga have better access to a dispensary than the people in comparison *vitongoji*. Despite this, child malnutrition is higher in the treatment *vitongoji*, and so is adult mortality. Malnutrition is particularly prevalent in the close treatment *vitongoji*, where 45% of children are underweight. The most common cause of death is malaria, and anti-malaria drugs are not universally available. Clinical officers are rather rare.

Table I.21: Health Statistics, Sumbawanga Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Dispensary (Minutes)	21.1	59.3*	35	69.1
Immunizations Available (% yes)	33.3	42.8	44.4	42.8
Anti-Malarial Drugs Available (% yes)	33.3	35.7	11.1	14.3
Clinical Officer Available (% yes)	11.1	7.1	11.1	7.1
Trained Midwife Available (% yes)	55.5	78.6	0.0	50.0***
Place of Childbirth	Dispensary	Dispensary	Dispensary	Dispensary
Most Common Cause of Death	Malaria	Malaria	Malaria	Malaria
Child Mortality (last 12 months)	2.6	2.6	2.6	2.6
Adult Mortality (last 12 months)	4.11	1.93**	2.89	1.71
Weight for Age z-score	-1.42	-1.37	-1.71	-1.53
% of Underweight Children	45.1	27.5**	39.5	36.5

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Table I.22 shows the asset levels and poverty indicators for the surveyed *vitongoji* in Sumbawanga Rural. There are few differences between the treatment and comparison *vitongoji* in the close stratum. With the exception of radio ownership (which is higher in treatment than comparison *vitongoji*), all indicators are of comparable magnitude. There are more differences in the far stratum. Literacy rates are higher in the far comparison *vitongoji* than in the far treatment *vitongoji* and poverty levels lower (54.9% for the comparison *vitongoji* vs. 76.3% for the treatment *vitongoji*).

Table I.20: Welfare Indicators, Sumbawanga Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
% of Households with Bicycle	0.33	0.39	0.30	0.35
% of Households with Radio	0.58	0.44***	0.43	0.44
Livestock Holdings (TLU)	1.71	1.78	1.37	1.46
% of Literate Adults (>15)	74.5	75.1	57.5	70.9***
Net Primary School Enrolment	87.6	85.5	81.0	83.6
Poverty Headcount (CPL)	59.2	59.1	76.3	54.9***
% Moved Up the Ladder of Life	54.8	51.6	54.8	52.1
Time to Fetch Water (minutes)	38.3	32.9	24.2	35.5***
Time to Fetch Firewood (minutes)	171.2	167.5	157.3	160.9

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

7.3 MTWARA CORRIDOR

1) NAMTUMBO DISTRICT

We surveyed 10 villages in Namtumbo District, spread out evenly between the treatment and the comparison road and between strata. Overall, the comparison *vitongoji* are bigger than the treatment *vitongoji* and have a smaller percentage of female-headed households. Permanent migration since 2005 is fairly limited.

Table I.23: Basic Demographics, Namtumbo District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Number of Households	76.0	146.7	63.0	129.0**
% Female-Headed Households	28.3	12.2**	13.3	10.0
# Households who Left	4	2.8	3.8	1.8
# Households who Settled	6.5	4	3.3	7.4
N	5	5	5	5

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Table I.24 shows the access to infrastructure in Namtumbo. In the close stratum, 50% of treatment *vitongoji* have a market in the *kitongoji* vs. 17% of the comparison *vitongoji*. The treatment *vitongoji* also profit from a better connection to the District capital (79 minutes of travel for the treatment *vitongoji* vs. 201 minutes for the comparison *vitongoji*). In the far stratum, 67% of comparison *kitongoji* have a market. For the treatment *vitongoji*, this is 0%. The time to get to the District capital is more than double for the comparison than for the treatment *vitongoji*.

Table I.24: Access to Infrastructure, Namtumbo District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Treatment/Comparison Road (minutes)	0.8	0.3	17.5	6.5**
Market in Kitongoji (% yes)	0.5	0.17	0	0.67**
Permanent Source of Water (% yes)	1	1	1	1
Electricity in Kitongoji (% yes)	0	0	0	0
Access to Public Transport (minutes)	0	15.0	7.5	0*
Distance to District Capital (minutes)	78.8	201.0	50	111.3
Distance to Primary School (minutes)	13	5.8	13.8	16.7

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Table I.25 shows the agricultural characteristics for Namtumbo district. We do not observe any significant differences between treatment and comparison *vitongoji*. Maize is the most important food crop for all *vitongoji* and is also the most important cash crop for the *vitongoji* in the close stratum. In the far stratum, tobacco is the most important cash crop. The price of an acre of fertile land is considerably higher in the far treatment than in the far comparison *vitongoji* (33,333 Tshs vs. 21,000 Tshs), though the difference is not statistically significant. During the harvest season of the cash crops, traders visit the *vitongoji* every day to buy up the produce.

Table I.25: Agricultural Characteristics, Namtumbo District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Size of Land Holdings (Actes)	5.71	4.76	5.00	5.71
% Cultivating Cash Crops	86.7	88.9	81.7	81.1
Income from Crop Sales (Tshs)	182825	188887	142283	184419
% of Non-Agr in Total Income	14.3	15.1	18.5	17.4
Price of Acre of Fertile Land (Tshs)	22500	26667	33333	21000
Daily Wage of Laborer (Tshs)	2000	1967	1750	1500
Most Common Food Crop	Maize	Maize	Maize	Maize
Most Common Cash Crop	Maize•	Maize•	Tobacco	Tobacco
Frequency of Purchase by Traders	30	30	30	30
Visits by Agr. Extension Officer	10.8	97.2	2.8	121.0

Note: None of the differences in means between treatment and comparison *vitongoji* are statistically significant at conventional levels of significance.

Table I.26 summarizes the access to health care and the health situation in the *vitongoji*. In the close stratum, treatment *vitongoji* seem to be endowed with better access to health care than the comparison *vitongoji*. The time to get to the dispensary is more than three times higher for the comparison *vitongoji* than for the treatment *vitongoji*. More treatment than comparison *vitongoji* have anti-malarials and clinical officers in the *kitongoji*. Adult mortality is somewhat lower in the treatment *vitongoji*. In contrast, the percentage of underweight children is higher in the close treatment than in the close comparison *vitongoji* (45.8% vs. 40.7%). None of the differences are however statistically significant.

Table I.26: Health Statistics, Namtumbo District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Dispensary (minutes)	20.5	72.5	35	36.7
Immunizations Available (% yes)	50.0	50.0	25.0	33.3
Anti-Malarial Drugs Available (% yes)	25.0	16.7	0.0	16.7
Clinical Officer Available (% yes)	25.0	16.7	0.0	33.3
Trained Midwife Available (% yes)	25.0	33.3	0.0	50.0
Place of Childbirth	Dispensary	Dispensary	Dispensary	Dispensary
Most Common Cause of Death	Malaria	Malaria	Malaria	Malaria
Child Mortality (last 12 months)	3.0	3.0	2.7	4.7
Adult Mortality (last 12 months)	1.75	2.00	1.50	3.83**
Weight for Age z-score	-1.74	-1.54	-1.92	-1.86
% of Underweight Children	45.8	40.7	56.0	50.0

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

In the far stratum, none of the treatment *vitongoji* have anti-malarial drugs, clinical officers or trained midwives in the *kitongoji*. Despite this, both child and adult mortality is lower in the far treatment than the far comparison *vitongoji*. Child malnutrition is more prevalent in the treatment than in the comparison *vitongoji*, though the difference is not statistically significant. The most common cause of death in the surveyed *vitongoji* in Namtumbo district is malaria.

Concerning welfare indicators and assert holdings, households in the comparison vitongoji seem to be better off than households in the treatment vitongoji –in both strata. In both strata, more households in the comparison than in the treatment vitongoji own a radio and/or a bicycle and more adults are literate. Households in the comparison vitongoji also have higher livestock holdings.

Poverty levels are lower in the comparison vitongoji than in the treatment vitongoji. In contrast to this, primary school enrolment is higher in the treatment than in the comparison vitongoji.

Table I.27: Welfare Indicators, Namtumbo District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
% of Households with Bicycle	0.40	0.47	0.33	0.46
% of Households with Radio	0.50	0.61	0.42	0.64***
Livestock Holdings (TLU)	0.32	0.41	0.21	0.56***
% of Literate Adults (>15)	72.6	80.2*	74.4	79.3
Net Primary School Enrolment	98.3	90.9	96.1	93.0
Poverty Headcount (CPL)	84.0	49.3***	76.0	62.7*
% Moved Up the Ladder of Life	64.0	52.0	40.0	56.0*
Time to Fetch Water (minutes)	22.2	20.9	25.2	18.2*
Time to Fetch Firewood (minutes)	136.7	132.2	153.5	118.3**

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

2) *SONGEA RURAL DISTRICT*

We interviewed 16 villages in Songea Rural. These were divided evenly between the treatment and comparison roads. On average, comparison vitongoji are bigger than treatment vitongoji (see Table I.28). Permanent in-migration in the close treatment vitongoji is almost double that in the close comparison vitongoji. Considerably more households permanently settled in the far comparison than in the far treatment vitongoji (18.1 households vs 3.8 households).

Table I.28: Basic Demographics, Songea Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Number of Households	80.5	93.4	55.6	82.1
% Female-Headed Households	22.5	21.7	23.3	27.5
# Households who Left	1.3	3	3.8	2
# Households who Settled	8.7	4.5	3.8	18.1
N	8	8	8	8

Note: None of the differences in means between treatment and comparison *vitongoji* are statistically significant at conventional levels of significance.

Table I.29 shows the access to infrastructure for the surveyed vitongoji in Songea Rural. None of the vitongoji in Songea rural have a market or electricity. All vitongoji have access to a permanent source of water. People living in the comparison vitongoji spend more than twice as long travelling to the District capital (Songea town) than people in the treatment vitongoji. In the close stratum, people in the treatment vitongoji profit from easy access to public transport (a 7-minute walk). In contrast, people from the comparison vitongoji have to walk for an hour and a half before reaching a bus stop. This situation is reversed in the far stratum, where people from the treatment vitongoji spend more time walking to the nearest bus stop (62 minutes) than the people from the comparison vitongoji (41 minutes).

Table I.29: Access to Infrastructure, Songea Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Treatment/Comparison Road (minutes)	9.0	9.0	29.5	49.0
Market in Kitongoji (% yes)	0	0	0	0
Permanent Source of Water (% yes)	1	1	1	1
Electricity in Kitongoji (% yes)	0	0	0	0
Access to Public Transport (minutes)	6.9	88.1*	61.8	41.2
Distance to District Capital (minutes)	35.6	86.3*	43.8	90.0**
Distance to Primary School (minutes)	13.6	9.4	18.6	25.6

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Table I.30 shows agricultural characteristics for each stratum in Songea Rural. The treatment and comparison vitongoji in the close stratum are remarkably similar. The households in the treatment vitongoji have on average higher crop incomes and earn a relatively higher proportion of their income through non-agricultural activities, though the differences are not statistically significant. Maize is the most common cash crop in the close treatment vitongoji, while paddy earns cash for the comparison vitongoji. In the far stratum, households in the comparison vitongoji own more land and are more likely to cultivate cash crops. In line with this, crop income is higher in the comparison than in the treatment vitongoji. For all groups of vitongoji, traders visit the vitongoji almost every day to buy up the cash crop produce.

Table I.30: Agricultural Characteristics, Songea Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Size of Land Holdings	4.74	4.17	4.39	5.88*
% Cultivating Cash Crops	83.3	80.8	75.8	86.7**
Income from Crop Sales (Tshs)	194746	152246	145031	196710
% of Non-Agr in Total Income	21.4	15.8	22.6	16.7
Price of Acre of Fertile Land (Tshs)	23750	27500	32143	31667
Daily Wage of Laborer (Tshs)	1375	2187	2281	1688
Most Common Food Crop	Maize	Maize	Maize	Maize
Most Common Cash Crop	Maize	Paddy	Paddy°	Paddy
Frequency of Purchase by Traders	29.5	29.3	30	30
Visits by Agr. Extension Officer	12.1	3.3	22.1	1.1**

Note: ° Paddy ex-aequo with beans and sunflower. ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

The treatment and comparison vitongoji in the close stratum are also remarkably similar on the availability of health care. The average time it takes to get to the dispensary is about one hour for both groups of vitomgoji, anti-malarial drugs are only available in 12.5% of vitongoji and none of the vitongoji have a clinical officer. Most pregnant women give birth in the hospital, which might explain the low levels of child mortality in Songea compared to the other districts in the sample. In the far stratum, the comparison vitongoji seem somewhat worse-off as to what concerns health care: the time it takes to get to the dispensary is higher and the availability of clinical officers and trained midwives lower. Both child and adult mortality are somewhat higher in the comparison vitongoji, though the differences are small and statistically insignificant. However, the nutritional status of children –measured by their weight-for-age z-scores- is better in the comparison (z-score of -0.16) than in the treatment vitongoji (z-score of -0.79).

Table I.31: Health Statistics, Songea Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Dispensary (minutes)	54.3	55	45.7	77.5
Immunizations Available (% yes)	37.5	25.0	12.5	12.5
Anti-Malarial Drugs Available (% yes)	12.5	12.5	12.5	12.5
Clinical Officer Available (% yes)	0	0	12.5	0
Trained Midwife Available (% yes)	25.0	12.5	25.0	0
Place of Childbirth	Hospital	Hospital	Hospital	Hospital
Most Common Cause of Death	Malaria	Malaria	Malaria	Malaria
Child Mortality (last 12 months)	0.8	1.6	1.5	1.6
Adult Mortality (last 12 months)	2.00	1.00**	1.25	1.75
Weight for Age z-score	-0.74	-1.24	-0.79	-0.16*
% of Underweight Children	13.2	21.9	16.7	7.7

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Table I.32 shows asset holdings and welfare indicators of surveyed households in Songea Rural. Overall, we do not observe many differences between the treatment and comparison vitongoji. In both strata, literacy rates are higher in the treatment than in the comparison vitongoji. Poverty headcount is lower in the close than in the far stratum, but does not differ within stratum.

Table I.32: Welfare Indicators, Songea Rural District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
% of Households with Bicycle	0.57	0.62	0.38	0.54
% of Households with Radio	0.56	0.54	0.43	0.48
Livestock Holdings (TLU)	0.53	0.41	0.46	0.56
% of Literate Adults (>15)	88.6	77.2***	85.5	75.5***
Net Primary School Enrolment	98.7	98.2	96.4	93.2
Poverty Headcount (CPL)	61.7	56.7	69.1	68.3
% Moved Up the Ladder of Life	55.0	51.7	42.5	48.3
Time to Fetch Water (minutes)	21.5	24.9	21.0	22.4
Time to Fetch Firewood (minutes)	129.5	136.3	132.9	120.4

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

3) *MBINGA DISTRICT*

We surveyed 8 villages in Mbinga District, 4 along the treatment road and 4 along the comparison roads. There is an equal number of vitongoji in each stratum. Table I.33 shows basic demographics. Treatment vitongoji are on average bigger than the comparison vitongoji and have a smaller percentage of female headed households. Treatment vitongoji in the connected stratum experienced more migration in recent years than the comparison vitongoji in the same stratum. In the far stratum, migration is similar across treatment and comparison communities.

Table I.33: Basic Demographics, Mbinga District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Number of Households	170.5	58.3***	76.8	51.0
% Female-Headed Households	21.7	23.3	8.3	13.3
# Households who Left	7.3	0**	2	2.3
# Households who Settled	15	5.25	5	6.25
N	4	4	4	4

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Table I.34 shows the access to infrastructure for the 16 *vitongoji* in Mbinga.

Table I.34: Access to Infrastructure, Mbinga District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Treatment/Comparison Road (minutes)	1.3	11.2**	51.2	48.5
Market in Kitongoji (% yes)	50.0	0	25.0	25.0
Permanent Source of Water (% yes)	1	1	1	75.0
Electricity in Kitongoji (% yes)	0	0	0	0
Access to Public Transport (minutes)	0	0	63.8	60.0
Distance to District Capital (minutes)	62.5	202.5**	73.8	240.0*
Distance to Primary School (minutes)	3.8	40.0	18.8	25.0

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Within the close stratum, both the treatment and comparison *vitongoji* have access to public transport in the kitongoji. This is different for the far stratum, where people have to walk for an hour before reaching the nearest bus stop. People in the treatment *vitongoji* benefit from better access to the district capital (Mbinga town): while the trip to Mbinga takes somewhat more than one hour for the people in the treatment *vitongoji*, it takes between three and four hours for the people living in the comparison *vitongoji*. Children in the treatment *vitongoji* also benefit from closer schools.

The next table shows the agricultural characteristics of the *vitongoji* in Mbinga district. The households in the connected treatment *vitongoji* have more land and a higher crop income than households in the connected comparison *vitongoji* and they earn less of their income through non-agriculture.

Table I.35: Agricultural Characteristics, Mbinga District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Size of Land Holdings (Acres)	6.76	4.99*	6.61	6.92
% Cultivating Cash Crops	88.3	83.3	95.0	83.3**
Income from Crop Sales (Tshs)	325583	102166**	294908	141042**
% of Non-Agr in Total Income	20.5	23.4	19.2	17.9
Price of Acre of Fertile Land (Tshs)	75000	35000	42500	66667
Daily Wage of Laborer (Tshs)	1250	2125	2125	2000
Most Common Food Crop	Maize	Maize	Maize	Maize
Most Common Cash Crop	Coffee	Maize°	Maize	Beans
Frequency of Purchase by Traders	28	29	30	20
Visits by Agr. Extension Officer	11.0	2.3	0.5	4.3

Note: °Maize ex-aequo with beans, sesame and soya. ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

In the far stratum, more households in the treatment than in the comparison *vitongoji* grow cash crops and crop income for those households is higher. Maize is the most important food crop for all *vitongoji*.

People living in the treatment *vitongoji* in Mbinga district spend more time travelling to the nearest dispensary than people in the comparison *vitongoji* (80 minutes vs. 40 minutes in the close stratum and 94 vs. 30 minutes in the far stratum). Both child and adult mortality are higher in the treatment than in the comparison *vitongoji*, while child malnutrition is lower. Malaria is the most common cause of death in all groups of *vitongoji*. Malaria shares the first place with HIV/AIDS in the connected treatment *vitongoji*. Like in other districts, anti-malarial drugs are not widespread available. None of the *vitongoji* in the far stratum have a trained midwife in the kitongoji.

Table I.36: Health Statistics, Mbinga District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
Distance to Dispensary (minutes)	80	40	93.7	30
Immunizations Available (% yes)	50.0	50.0	25.0	25.0
Anti-Malarial Drugs Available (% yes)	25.0	25.0	0	25.0
Clinical Officer Available (% yes)	25.0	50.0	0.0	25.0
Trained Midwife Available (% yes)	50.0	25.0	0	0
Place of Childbirth	Dispensary	Dispensary	Hospital	Dispensary
Most Common Cause of Death	Malaria°	Malaria	Malaria	Malaria
Child Mortality (last 12 months)	5.5	2.8	1.5	0.0***
Adult Mortality (last 12 months)	7.00	1.50	1.25	1.00
Weight for Age z-score	-0.39	-0.69	-0.59	-1.05
% of Underweight Children	12.5	16.7	5.0	28.9**

Note: °Malaria and HIV/AIDS are most common causes of death (ex-aquo). ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Finally, Table I.37 summarizes asset holdings and welfare indicators of the surveyed households in Mbinga district. In the close stratum, relatively more treatment than comparison households own a bicycle and/or a radio. In contrast, livestock holdings of comparison households (1.88 TLU) are considerably higher than those of the treatment households (0.88 TLU). While poverty levels in both types of *vitongoji* are similar, the comparison *vitongoji* seem to have had a better growth experience in the past 5 years: 63.3% of comparison households moved up the LoL during the past five years, compared to 33.3% of the treatment households. In the far stratum, we also observe this differential growth experience: While 66.7% of households in the comparison *vitongoji* moved up the Ladder of Life in the pasr five years, this was only 43.3% in the treatment *vitongoji*.

Table I.37: Welfare Indicators, Mbinga District

	Vitongoji Close to Road		Vitongoji Far from Road	
	Treatment	Comparison	Treatment	Comparison
% of Households with Bicycle	0.55	0.32***	0.45	0.38
% of Households with Radio	0.70	0.63	0.55	0.65
Livestock Holdings (TLU)	0.80	1.88**	0.99	1.37
% of Literate Adults (>15)	91.3	88.3	84.2	77.5
Net Primary School Enrolment	100	96.4	96.8	94.6
Poverty Headcount (CPL)	66.7	70.0	68.3	63.3
% Moved Up the Ladder of Life	33.3	63.3***	43.3	66.7***
Time to Fetch Water (minutes)	17.3	22.5	27.9	20.9*
Time to Fetch Firewood (minutes)	88.2	72.4	56.5	74.2

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

8. MATCHING TREATMENT AND COMPARISON VITONGOJI

The previous section has shown that in some Districts the treatment and comparison *vitongoji* are rather similar while in other districts they are not. In this section, we will, for each road project, match treatment *vitongoji* to comparable comparison *vitongoji*. As argued in Section, it is of utmost

importance to match *vitongoji* on variables that are believed to influence future growth trends. Matching on such variables will result in couples of treatment-comparison kitongoji that have similar growth potential and differ only in one respect: the reception of the treatment (the road upgrades). Any difference observed after the road upgrades can thus be attributed to the treatment rather than to pre-existing differences in growth trends (with appropriate controls if and where necessary).

To carry out the matching, we will calculate –for each kitongoji- the probability of receiving the treatment based on variables that influence future growth. This probability is called the propensity score (Rosenbaum and Rubin). Units (*vitongoji*) with a similar propensity score have similar future growth trends (based on observable covariates). The idea is to match each treatment kitongoji to the comparison kitongoji with the same (or nearly the same) propensity score (hence the name 'propensity score matching'). By doing so, we make sure covariates are independent of the treatment indicator which eliminates potential bias arising from differences in covariates. The key assumption that remains is the assumption of 'unconfoundedness' (Rosenbaum and Rubin, 1983). Unconfoundedness assumes that beyond the observed covariates there are no unobservable factors in the kitongoji that simultaneously influence potential outcomes and reception of the treatment. Although is it impossible to eliminate the possibility of such unobservables, our sampling strategy has been designed to minimize their influence: Per road project, treatment and comparison *vitongoji* are located in the same district, the same agro-ecological zone, and almost always in the same ward and electoral constituency. While not 100% bullet-proof, this should minimize the possibility of unobservables considerably biasing the results.

In the remainder of this section we will estimate the propensity score and carry out a preliminary matching for each of the three road projects. To explore the robustness of the results, we will examine how different model specifications for the estimation of the propensity score affect matching decisions.

8.1 TANGA HOROHORO ROAD

TANGA AND MKINGA DISTRICTS

As mentioned in Section 8, we will match treatment *vitongoji* to comparison *vitongoji* located within the same District. For the Tanga – Horohoro road though, we will make an exception and pool the Districts of Tanga and Mkinga. There are two reasons to do so: (1) We surveyed only 4 *vitongoji* in Tanga district, which limits the possibilities for matching, and (2) Mkinga is a new district and the district capital (Mkinga town) is still being constructed. People living in Mkinga district still consider Tanga as their district capital, and all relevant infrastructure is located in Tanga.

To decide which variables to include in the estimation of the propensity score, we look at the descriptives presented in Section 7. The variables that differ significantly between treatment and comparison *vitongoji* potentially influence both reception of treatment and outcome trends. Those variables should be included in the estimation of the propensity score. For Tanga and Mkinga, the variables that differ between treatment and comparison *vitongoji* are: distance to road; time it takes to go to the district capital; % of households cultivating cash crops; proportion of income generated through non-agriculture; household crop income; livestock holdings; literacy rates; poverty headcount and the percentage of households who moved up the ladder of life. Table I.38 shows the estimation of the propensity score based on these variables. The results of the first specification are reassuring as most of the covariates are insignificant in explaining the reception of treatment. *Vitongoji* located far away (in terms of travel time) from the district capital and *vitongoji* with higher literacy rates are less likely to be treatment *vitongoji*.

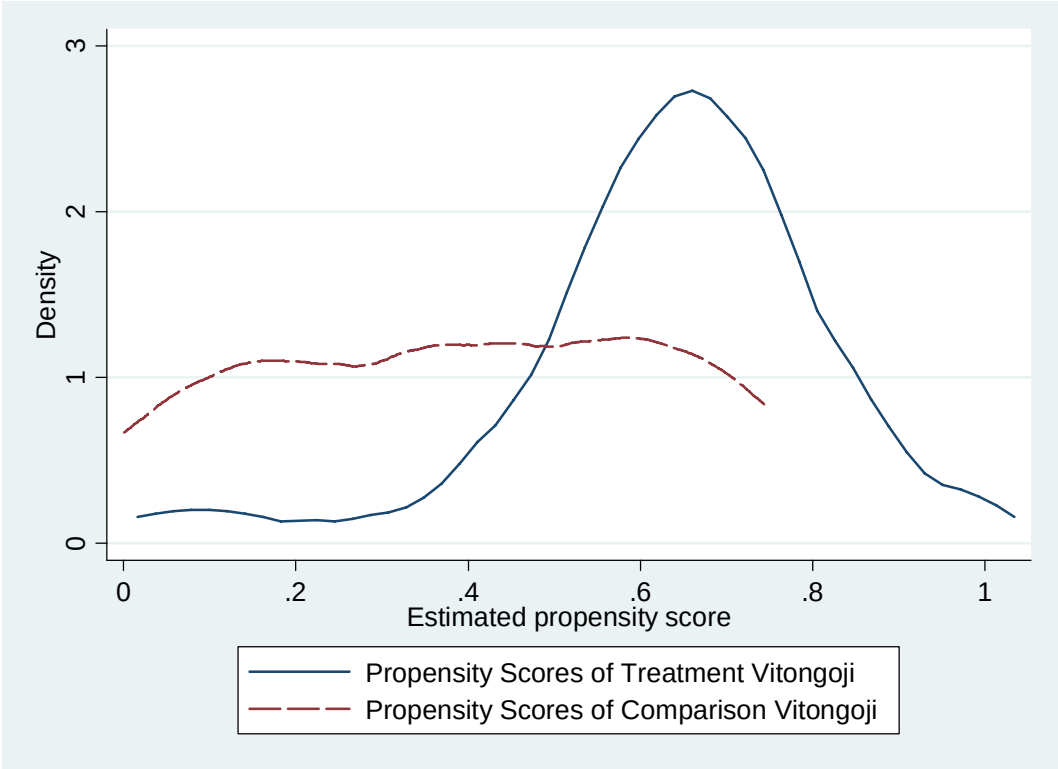
Table I.38: Estimating the Propensity Score for Tanga and Mkinga Districts

	PS1	PS2	PS3
Distance to Road	-0.002	-0.001	
	(0.014)		
Time to District Capital	-0.009*		
	(0.004)	0.017	
% Cultivating Cash Crops	-0.538	2.181	
	(1.602)	1.91	
Crop income	0.846	0.127	
	(0.852)	0.122	
Livestock Holdings	-0.214	-0.408	
	(0.251)	0.319	
Literacy rate	-4.231*	-5.594	
	(2.231)	8.456	
% of Non-Agr. Income	0.005	0.044	
	(0.018)	0.023	
Poverty Headcount	-0.172	-0.819	
	(0.745)	0.842	
% Moved up LoL	0.492	-0.416	
	(0.963)	1.356	
Pseudo R Squared	0.204	0.283	

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

Figure I.8 shows the distribution of estimated propensity scores according to treatment status. We immediately observe a lack of overlap at higher end of the distributions (at the higher end, there are many treatment *vitongoji* and no comparison *vitongoji*; At the lower end of the distribution, there are many more comparison than treatment *vitongoji*). This lack of overlap is common in observational causal studies (see Imbens and Wooldridge, 2008). It implies that for some comparison *vitongoji* (those with near-zero propensity scores) we will not be able to find a corresponding treatment *vitongoji* and that for some treatment *vitongoji* (those with very high propensity scores) we will not find appropriate comparison units. Matching units regardless this lack of common support is a well-known source of bias.

Figure I.8: Estimated Propensity Scores for Treatment and Comparison *Vitongoji* in Tanga and Mkinga Districts



Therefore, we use the 'common support' option in Stata when matching treatment to comparison *vitongoji*. Basically, this implies that units with either very low or very high propensity scores will be dropped since no match can be found for such units. Common support in specification 1 implies dropping 6 units with very low propensity scores and 3 with a very high propensity score. Overall, 9 units get dropped from the total sample of 48 *vitongoji* for the Tanga – Horohoro road.

Matching according to specification 1 results in 4 blocks of *vitongoji* defined by their propensity scores. Within each block there is no difference in propensity scores between the treatment and comparison *vitongoji*. Treatment *vitongoji* within each block can thus be coupled to comparison *vitongoji* within the same block. The balancing property is satisfied, which means that within each block, there are no more differences between covariates.

Table I.39: Blocks of Equal Propensity Scores, Tanga and Mkinga Districts

Propensity Score	Treatment	Comparison	Total
0.09	1	1	2
0.2	1	6	7
0.4	5	6	11
0.6	14	5	19
Total	18	21	39

Hence, all biases resulting from initial differences in observable covariates are eliminated.

MBOZI DISTRICT

The treatment and comparison *vitongoji* in Mbozi district differ with respect to access to public transport, literacy rates, average household land size and crop incomes, the proportion of income gained through non-agricultural activities, the price of land and the poverty headcount. The difference is particularly substantial for the access to public transport (access is much easier for the comparison *vitongoji*), crop income and the price of land (both much higher in the comparison *vitongoji*). Including these three variables in the estimation of the propensity score results in a complete lack of overlap between treatment and comparison *vitongoji* (and hence it is impossible to match). Instead of using these variables for the estimation of the propensity score, they will have to be included as initial characteristics in the difference-in-differences regression.

Table I.41 shows the estimation of the propensity score based on the other variables that differ significantly between treatment and comparison units.

Table I.41: Estimating the Propensity Score for Mbozi District

	PS1	PS2
Land Size	0.698**	0.719**
	(0.299)	(0.307)
Literacy rate	-4.304	-3.736
	(3.097)	3.417
% of Non-Agr. Income	-0.042	-0.021
	(0.048)	0.053
Poverty Headcount	-0.073	0.253
	1.560	1.546
% Moved up LoL	-0.620	-0.460
	(3.207)	1.361
Adult Mortality		-0.199
		(0.101)**
Pseudo R Squared	0.362	0.283

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

In PS1, land size is the only significant variable: The higher the average household land size, the higher the probability of being a treatment *vitongoji*. PS1 results in a matched and balanced sample of 32 *vitongoji*, 24 of which are treatment *vitongoji*.

PS2 in Table I.41 repeats PS1 but adds adult mortality. Results show that *vitongoji* with higher mortality are less likely to be treatment *vitongoji*. PS2 also results in a matched and balanced sample, though 2 additional comparison *vitongoji* are lost due to lack of common support[6]. Compared to the sample resulting from PS1, the comparison *vitongoji* of *Lunyego* and *Shikwale* are dropped in PS2.

[6] In general, the more variables included in the estimation of the propensity score, the more detailed the propensity score will be estimated and the more difficult it will be to match. The less variables included, the less difficult it will be to match but the matching will also be less precise.

SUMBAWANGA RURAL DISTRICT

Treatment and comparison *vitongoji* in Sumbawanga Rural differ with respect to: number of households, % of female-headed households, time it takes to go to the district capital, proportion of non-agricultural income, literacy rates and poverty headcount. We estimated the propensity score based on these variables and the past growth experiences of the *vitongoji* (percentage of households who moved up the ladder of life during the last 5 years).

Table I.43: Estimating the Propensity Score for Sumbawanga District

	PS1	PS2
Number of Households	0.010*	0.010*
	(0.005)	(0.005)
% of Female Headed Households	18.211**	18.214**
	(8.759)	(8.760)
Time to District Capital	-0.007*	-0.007*
	(0.004)	(0.004)
Literacy rate	-2.740	-2.749
	(1.955)	(1.976)
% of Non-Agr. Income	-0.028	-0.028
	(0.025)	0.027
Poverty Headcount	1.511	1.504
	1.009	1.023
% Moved up LoL	1.561	1.563
	(1.076)	1.077
Access to Transport		0.000
		(0.003)
Pseudo R Squared	0.328	0.328

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

PS1 results in a matched sample of 17 treatment and 13 comparison *vitongoji*. Overall, 16 *vitongoji* in Sumbawanga Rural District are lost due to lack of common support. This consists of one trestment *vitongoji* and 15 comparison *vitongoji*.

In PS2, we add access to transport to the specification. This variable also differs considerably between treatment and comparison *vitongoji*. However, adding this variable does not affect the results: Its effect is small and insignificant, and the specification results in a matched and balanced sample of the same 30 *vitongoji*.

8.3 MTWARA CORRIDOR

NAMTUMBO DISTRICT

The variables that differ significantly between treatment and comparison *vitongoji* in Namtumbo district are: Number of households, percentage of female-headed households, distance to road, the access to public transport, the presence of a market, the livestock holdings, the literacy rates and the indicators of poverty and growth experience (poverty headcount and the percentage of households that moved up the LoL). However, because the poverty headcount in Namtumbo is so much lower in the comparison than in the treatment *vitongoji*, estimating propensity scores including the poverty headcount-variable results in a complete lack of overlap in the distributions (propensity scores of all comparison *vitongoji* are close to 0 while for the treatment *vitongoji* they approach unity). Hence,

matching is impossible. Therefore, we construct a more parsimonious model for the propensity score. Bear in mind though that the poverty headcount-variable will need to be included as an initial characteristic in the difference-in-differences regressions (after the follow-up survey).

The first specification of the estimation of the propensity score shows that the higher the distance to a road, the more likely for a *vitongoji* to be a treatment unit. *Vitongoji* with higher livestock holdings are more likely to be comparison *vitongoji*. The other variables are not statistically significant. Accounting for common support, specification 1 results in a matched sample of 13 *vitongoji*. 7 comparison *vitongoji* are lost due to a very low propensity score. Table shows the matched sample (the balancing property is satisfied).

Table I.45: Estimating the Propensity Score for Namtumbo District

	PS1	PS2	PS3
Distance to Road	0.166*	0.200	0.119*
	(0.098)	(0.192)	(0.063)
Time to District Capital		-0.003	
		(0.005)	
Market in Kitongoji	-0.422	0.783	
	(1.036)	(1.260)	
Livestock Holdings	-6.715*	-3.272	-6.162*
	(3.986)	(3.814)	(3.324)
Literacy rate	-3.971	-7.028	
	(3.939)	5.406	
% Moved up LoL	6.732	4.628	
	(4.891)	4.233	
Access to Public Transport	0.017	0.000	-0.006
	(0.032)	(0.044)	(0.059)
% of Female Headed Households			36.182**
			(16.264)
Pseudo R Squared	0.337	0.471	0.463

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

In the second specification, we add the time it takes to travel to the District capital as an extra explanatory variable. Although this variable is not statistically significant, the goodness-of-fit of the model increases (however, this is due to the small sample size in Namtumbo).

Matching on the propensity scores estimated in the second specification results in a sample of 9 *vitongoji*, only one of them being a comparison *vitongoji*. Such a situation is not warranted.

Finally, PS3 estimates a parsimonious model including only five regressors. Compared to comparison *vitongoji*, treatment units are located further from a road, have less livestock and more households headed by women. Matching results in a sample of 11 *vitongoji*, 2 of which are comparison *vitongoji*.

PS1 in Table I.48 estimates the propensity score based on all variables which differ significantly between treatment and comparison *vitongoji* (access to public transport, literacy, land size, poverty headcount, time it takes to go to the district capital and the percentage of households cultivating cash crops. The results show that the probability to be a treatment kitongoji increase with

Table I.48: Estimating the Propensity Score for Songea Rural District

	PS1	PS2
Time to District Capital	-0.048*	
	(0.027)	
% Cultivating Cash Crops	-4.108	-2.930
	(2.923)	(2.229)
Land Size	0.295	-0.067
	(0.223)	(0.101)
Literacy rate	5.641*	7.257***
	(3.351)	(2.762)
Poverty Headcount	3.308*	1.628
	(1.952)	(1.247)
% Moved up LoL	2.750	1.610
	(2.219)	(1.434)
Access to Public Transport	-0.005	-0.002
	(0.005)	(0.003)
Pseudo R Squared	0.412	0.253

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

literacy and poverty in the kitongoji and decreases with the time it takes to go to the district capital. The first specification results in a matched and balanced sample of 21 *vitongoji*, 16 of which are treatment units.

PS2 leaves out the time it takes to go to the district capital. This results in an increase of matched comparison communities: instead of 5 the sample now includes 11 comparison *vitongoji*. These 6 comparison *vitongoji* were previously 'unmatchable' because the time it takes to go to the district capital is relatively high for those *vitongoji*. If this sample would be chosen for the purpose of the evaluation, the time it takes to get to the district capital would need to be included as an initial characteristic in the difference-in-differences regression.

MBINGA DISTRICT

Matching the *vitongoji* in Mbinga district is fraught with difficulties. As suggested by the descriptives in Section, treatment and comparison *vitongoji* differ substantially. Estimating the propensity score based on the variables which differ between treatment and comparison *vitongoji* results in a complete lack of overlap. Hence matching is not possible. Dropping one by one the variables responsible for the lack of overlap (% of households who moved up the ladder of life, the time it takes to go to the district capital, crop income, number of households) does not solve the problem. Only when excluding all four variables from the model we obtain a matched and balanced sample. However, this sample includes only 2 comparison *vitongoji*, vs. 8 treatment *vitongoji* (see Table I.51).

For Mbinga, a better approach might be to estimate the difference-in-differences regressions (after the follow-up survey) on the full sample of 16 *vitongoji* and including the four variables mentioned in the previous paragraph as initial-period control variables. Alternatively, the observations in Mbinga can be pooled with Songea in a regression using district dummies.

8.4 Pooled Matching for Mainland Tanzania

So far, we have matched villages within districts. While this approach most likely reduces the possibility of unobservables biasing the resukts, it also reduces the degrees of freedom in the analyses. In this subsection, we will pool all districts and add district dummy variables to control for district-level effects. Table I.52 shows some important variables broken up by treatment status. The most striking observation in Table I.52 is the sheer similarity of treatment and comparison *vitongoji*: Of the 15 variables presented in the table, only two differ significantly between treatment and comparison households. This similarity underlines the importance of a careful selection of appropriate comparison roads (as we did) and offers ex-post support for our choice of specific comparison roads (see Section 2). We observe that the time to get to the District Capital is higher for comparison *vitongoji*, and –as foreseen in the evaluation strategy- traffic volume is considerably higher on the treatment roads (on average, 43 vehicles per four hours were recorded for the

treatment roads vs. 14.5 for the comparison roads). In contrast, treatment and comparison roads appear not to differ in quality or condition: the 5-km drive test was completed in approximately 5 minutes for both types of roads and the median road condition for both types was labelled "good".

Table I.52: Treatment Vitongoji vs. Comparison Vitongoji for All Mainland Roads

	Treatment Vitongoji	Comparison Vitongoji
Livestock Holdings (TLU)	0.97	1.31
% Owning Radio	47.6	44.0
% Owning Bicycle	39.1	41.7
% of Literate Adults (>15)	71.9	73.0
Median Level of Education	Standard V	Standard V
% Adults Without Education	23.1	21.2
% Femaled-Headed Households	4.33	4.67
Poverty Headcount (CPL)	0.65	0.64
% Moved Up the Ladder of Life	0.52	0.53
Land Size (Acres)	4.41	4.17
% Non-Agr. Income	19.2	19.8
% Cultivating Cash Crops	76.0	74.3
Crop Income (Tshs)	165015	155041
Price of Land (Tshs)	74273	85454
Market in Kitongoji (% yes)	0.27	0.21
Time to Treatment or Control Road	14.2	21.4
Time to District Capital (minutes)	85.7	161.7***
Distance to District Capital (km)	39.6	44.6
Time to Primary School	16.7	22.1
Traffic Count (# of Vehicles)	42.9	14.5***
Drive Test (# of Minutes)	5.0	5.4
Median Road Condition	Good	Good

Note: ***: Difference statistically significant at 1% level; **: Difference statistically significant at 5% level; *: Difference statistically significant at 10% level

The figures in Table I.52 suggest that matching treatment and comparison villages across all road projects is a redundant exercise: The villages are so alike that matching will result in regressors that are statistically insignificant and a model with a very low R-squared (since nothing explains reception of treatment). Table I.53 confirms this. All explanatory variables are statistically insignificant ("Distance to Road" approaches significance with a p.-value of *0.122*) and the goodness-of-fit of the model is very low (*0.029*).

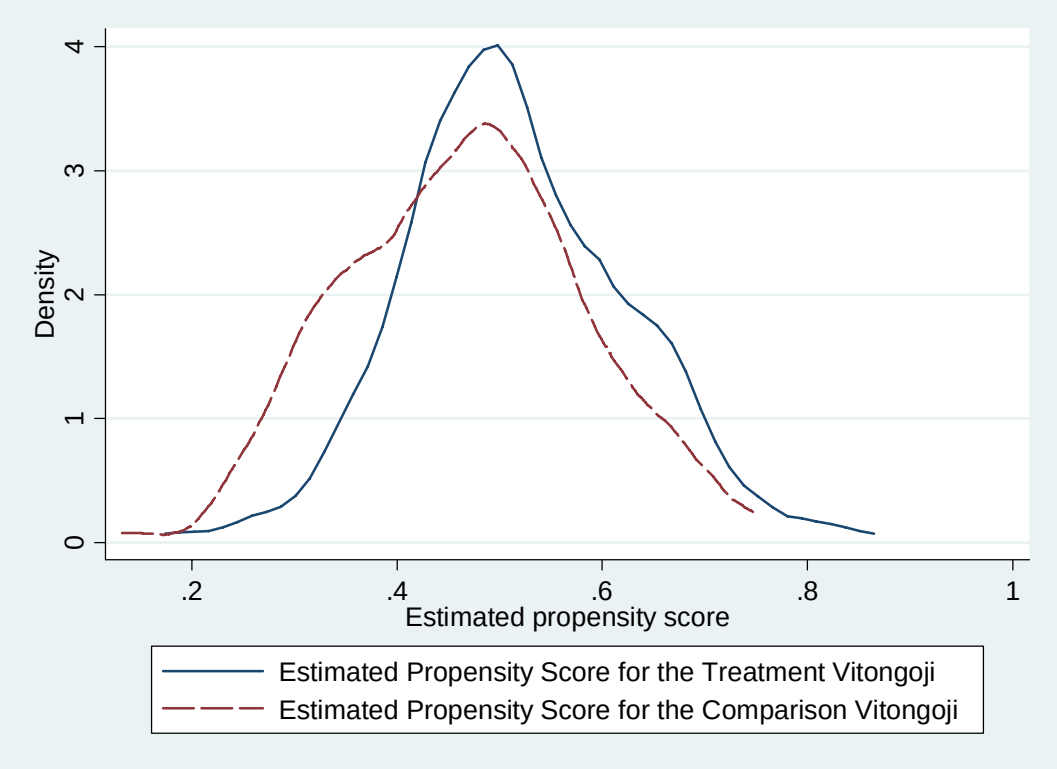
Table I.53: Estimating Propensity Scores for Mainland Tanzania, N=200

	PS1	PS2
Distance to Road	-0.005	-0.005
	(0.003)	(0.003)
Crop Income	0.548	0.303
	(0.805)	(0.840)
Literacy rate	-0.705	-0.668
	(0.763)	(0.771)
Poverty Headcount	-0.059	-0.127
	(0.368)	(0.373)
% Moved up LoL	-0.321	-0.341
	(0.393)	(0.400)
% Female-Headed Households		-3.663
		(3.005)
TLU		-0.116
		(0.090)
District Dummies	Yes	yes
Pseudo R Squared	0.03	0.04

PS1 results in a matched and balanced sample of 199 *vitongoji*. The comparison *vitongoji* of Zyangoma (in the far stratum of Sumbawamga Rural District) cannot be matched and is dropped from the sample (the propensity score is too low at *0.094*). Figure I.9 shows the estimated propensity scores for treatment and comparison *vitongoji* in Mainland Tanzania. There is a good overlap, which suggests that the sample of 199 *vitongoji* is indeed a good one for evaluating the effects of the road upgrades. Note that the eventual DID analyses (after the follow-up survey) need

to include both initial traffic volume and the initial distance to the District Capital as important control variables.

Figure I.9: Kernel Density Histogram of Estimated Propensity Scores, Mainland Tanzania



PS2 adds the percentage of female-headed households and the number of TLUs to the specification. Results are broadly similar: all explanatory variables remain statistically insignificant and goodness-of-fit of the model is still very low at *0.04*. Compared to PS2, an additional two comparison *vitongoji* are dropped from the matched amd balanced sample: Ngombeni and Mazizini A, both in Mkinga district. These are dropped due to low propensity scores (0.032 for Ngombeni and 0.060 for Mazizini A.

LIST OF REFERENCES

Ravallion, M., Chen, S. & Sangraula, P. (2008). "Dollar a Day Revisited." *World Bank Policy Research Working Paper*, Nr. 4620. Washington DC: The World Bank.

Imbens, G. & Wooldridge, J. (2008). "Recent Developments in the Econometrics of Program Evaluation." *National Bureau of Economic Research*, Working Paper Nr. W14251.

National Bureau of Statistics. (2009). *Household Budget Survey 2007 – Tanzania Mainland*. United Republic of Tanzania: National Bureau of Statistics.

WHO. (1995). "Physical Status: the Use and Interpretation of Anthropometry. Report of a WHO Expert Committee." *Technical Report Series,* Nr. 854. Geneva: World Health Organization.

MOID. (2007). *Ten-Year Transport Sector Investment Program (TSIP)*. The Government of Tanzania: Ministry of Infrastructure Development.