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Explaining High Transport Costs within Malawi

Bad Roads or Lack of Trucking Competition?

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Abstract

What are the main determinants of transport costs: network access or competition among transport providers? The focus in the transport sector has often been on improving the coverage of "hard" infrastructure, whereas in reality the cost of transporting goods is quite sensitive to the extent of competition among transport providers and scale economies in the freight transport industry, creating monopolistic behavior and circular causation between lower transport costs and greater trade and traffic. This paper contributes to the discussion on transport costs in Malawi, providing fresh empirical evidence based on a specially commissioned survey of transport providers and spatial analysis of the country's infrastructure network. The main finding is that both infrastructure quality and market structure of the trucking industry are important contributors to regional differences in transport costs. The quality of the trunk road network is not a major constraint but differences in the quality of feeder roads connecting villages to the main road network have significant bearing on transport costs. And costs due to poor feeder roads are exacerbated by low volumes of trade between rural locations and market centers. With empty backhauls and journeys covering small distances, only a few transport service providers enter the market, charging disproportionately high prices to cover fixed costs and maximize markups.

Explaining high transport costs within Malawi –bad roads or lack of trucking competition?

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World Bank

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MOTIVATION AND MAIN FINDINGS

1.   In many countries, policymakers hope that spatial equity in the distribution of transport infrastructure will help in balancing economic opportunities across regions. Malawi is among these countries, where the government's growth and development strategy (MGDS) identifies transport infrastructure as a priority area for public investment. The national public sector investment program focuses on network expansion. Eleven roads have been upgraded in 2007 - 08, and the focus of investments is on "big infrastructure". However at the outset, it is not clear if bad roads the largest contributor to transport costs in Malawi – in fact, research from developed countries such as France show that there are considerable gains from improving competition in the transportation industry. And to get the highest payoffs from transport infrastructure improvements, there is need to prioritize improvements based on a location's natural and economic geography.

2.   Lessons from analytic work on economic geography and experience in developed and developing countries also tell us that reduction in transport costs in fact increase the spatial concentration of people and firms. The World Development Report 2009 "Reshaping Economic Geography" (WDR 2009, World Bank 2008) provides a succinct review of the drivers of transport costs and consequences of reducing them. These include the following:

- *What determines transport costs*? **It's not only infrastructure.** Estimates of transport costs suggest that these have fallen by almost 40 percent over the past three decades. As comprehensive statistics on prices for transport services do not exist, most empirical work is based on the estimation of transport costs. For example, in France trucking costs fell by 33 percent between 1978 and 1998,with the main contributors being the deregulation of the trucking industry (a reduction of 21.8 percentage points) and the lower vehicle costs (–10.9 percentage points). On the other hand transport infrastructure (–3.2 percentage points) and declining fuel costs (–2.8 percentage points) were much less important. While the importance of core infrastructure will vary depending on the coverage of the network (i.e. importance will be higher in countries with sparse network coverage), market structure of the transport services industry is an important contributor to transport costs. In addition, what is being traded also matters for transport costs: the lower weight value ratios of goods being traded along with changes in the modal composition of how goods are transported have reduced ad valorem transport charges (cost of transport as a share of the value of the traded goods).

- *What are policy priorities for reducing transport costs*? **Don't forget regulation.** Research in economic geography has assumed away the internal workings of transport—goods to be transported are seen as an iceberg to be hauled from one place to another, and transport costs are the part of the iceberg that melts away. Thus critical policy-related aspects have been neglected, and the policy focus has exclusively been on "hard" infrastructure.[2] However, policymakers should be concerned about scale economies in the transport sector that tend to create monopolistic behaviour and circular causation between lower transport costs and greater trade and traffic.

- *What are the implications of falling transport costs?* **More spatial concentration, not dispersion, of production.** Recent analytic work in economic geography points out that for activities that benefit from increasing returns to scale, a fall in transport

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[2] However investments on physical infrastructure have neglected road maintenance. In Africa, for example, it is estimated that $45 billion was lost in road stock value during the 1970s and 1980s, which could have been avoided by spending $12 billion for preventive road maintenance (World Bank 2008). Poorly maintained roads increase transport costs by increasing costs of maintaining vehicles and reducing their speed.

costs is accompanied by higher geographic concentration of economic activities. With high transport costs, large economies of scale will remain unexploited, and production is inefficient. When transport costs fall, spatial differences in production and economic growth will increase, both within and between countries. In the United States for example, the expansion of railroads in the mid nineteenth century transformed cities from public service providers to engines of growth. Cities in Illinois, Michigan, and Ohio close to transport hubs attracted people and industries with increasing returns to scale, reaping productivity effects from specialized inputs and larger labor markets.

3.   The World Bank and other donors such as the African Development Bank and UK DFID have been collaborating with the Government of Malawi to identify both the types of public investments that matter, as well as where these investments will be spatially efficient and generate the highest economic gains for the country. While these investment patterns are likely to support locations with demonstrated economic potential, thereby increasing regional disparities in production, this should not be an immediate concern for policymakers. They may in fact want to invest in human capital and social services in isolated regions, bringing parity in basic standards of living as well as creating opportunities for labor migration to better integrate their citizens with labor markets in dynamic locations. In fact, the WDR 2009 highlights that enabling geographic mobility of labor is a key ingredient for countries to gain from the geographic concentration of economic activities along with convergence in living standards.

4.   This paper contributes to the debate on transport costs in Malawi, providing fresh empirical evidence based on a specially commissioned survey of transport providers and spatial analysis of the country's infrastructure network. Typically, information on road network quality, traffic demand, and transport prices are hard to come by – making it difficult to separate the effects of road densities from quality and organization of the transport services industry.

5.   The main findings from the analysis are as follows:

Constraints:

- ***Infrastructure quality as well as market structure of the trucking industry are important contributors to regional differences in transport costs***: On infrastructure, the quality of the trunk road network is not a major constraint – rather differences in the quality of feeder roads connecting villages to the main road network have significant bearing on transport costs. The costs due to poor feeder roads are exacerbated by low volumes of trade between rural locations and market centers. With empty backhauls and journeys covering small distances, only a few transport service providers enter the market, charging disproportionately high prices to cover fixed costs and maximize markups.

- ***International and domestic transport markets are segmented***: The survey of truckers shows that the average unit transport price (per ton, per km) is 228.4 kwacha from rural areas to the country's main cities – in comparison, transport prices range between 10 and 12 kwacha per ton per km on routes linking the country to international markets. This is a clear indication that transport markets are segmented with limited mobility across segments. The domestic and international routes are significantly different to a point where most operators on international routes (if they had excess capacity) could not operate with their present fleets on domestic routes (their trucks could simply not run on some of these roads), and neither would expected profits warrant their trouble to go after such traffic.

Policies and Investment Priorities:

- To lower transport costs in rural areas, the government may want to explore options for encouraging the development of a domestic small vehicle transport sector. As international truckers are unlikely to find these routes profitable, alternate modes of transport need to be identified. It may be useful to consider options for promoting appropriate intermediate means of transport (IMTs) for connecting rural areas to market towns. Related work by the World Bank's transport department suggests that IMTs offer considerable opportunities in relation to the short distance travel and transport demands of rural communities with regard to efficiencies in terms of cost and time savings. IMTs are seen as important in reducing travel and transport burden and increasing overall rural mobility in terms of reduced effort and time and high carrying potential. Efforts on identifying appropriate IMTs are already underway in Malawi.

- To enhance agriculture led economic growth, public investments in transport infrastructure should be prioritized towards improving feeder roads that connect rural areas offering a combination of rich natural and economic geographies - favorable agronomic potential and high population densities - to major domestic and international markets. Most of these locations are in the South and Central regions of the country.

- For manufacturing to take-off, infrastructure investment should support emerging clusters in the country's main urban agglomerations – Blantyre and Lilongwe. As firms in Blantyre specialize in activities requiring reliable power supply and benefit from scale economies and international market access –public investments should be designed to amplify these market linkages. On the other hand Lilongwe specializes in agro processing - priority should be enhancing market linkages for adding value to local production and to transport local products at lower costs.

- Transport improvements in regions with good agronomic potential will also help in poverty reduction. However, when these improvements are targeted on spatial equity grounds to support remote regions with poor agronomic potential, they are likely to impose a trade off with national economic performance and aggregate poverty reduction.

6.   The rest of the paper is organized in three sections. Section 2 discusses the determinants of transport costs in Malawi and includes the spatial analysis of the transport network as well the survey of transport provides. In Section 3, we examine the implications of geographic variations in transport costs on economic specialization and productivity. Section 4 highlights priorities for public policies and investments to maximize the economic gains from transport improvements.

WHAT DETERMINES TRANSPORT COSTS IN MALAWI?

7.   In this section, we provide findings from two sets of empirical analysis. The first set examines what farmers report paying for transporting commodities to markets, and identify factors that contribute to these costs. The second set asks transporters (truckers) what prices they charge for transporting commodities across routes within the country and on specific international corridors. But first, we look at the geographic distribution of road quality and traffic volumes network. Information on the economic geography of the transport network is central to our analysis of separating issues of transport infrastructure from market structure of the transport services industry.

Figure 1: Malawi's road network
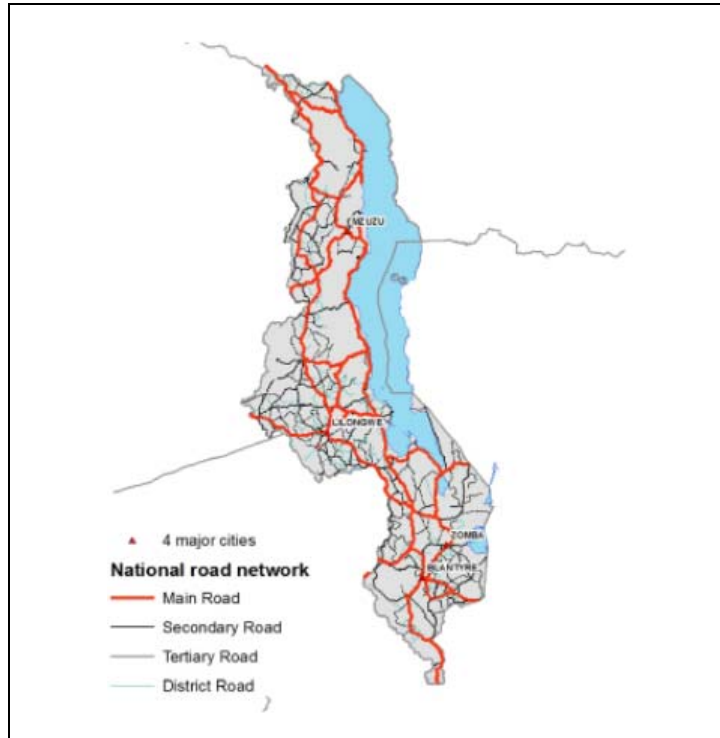
Geography of the transport network

8.   Road transport currently plays a major role in Malawi's domestic and international trade handling. Roads account for more than 70% of the internal freight and over 90% of the country's international freight traffic. However, rail has historically been the main mode for international freight transport, connecting Malawi with its southern neighbors of Mozambique, Zimbabwe and South Africa. However, the civil war in Mozambique from the-mid seventies cut off the two main rail arteries – the Nacala and Beira-Sena lines. With the Nacala being mined and the destruction of the main bridge across the Zambezi River on the Beira-Sena lines, the importance of rail in Malawi's international freight movements has declined.

9.   An extensive road network of 12,500 km physically connects settlements and markets within Malawi. Main, secondary, and tertiary roads are evenly distributed: 3,400 kilometers, 2,800 kilometers, and 3,800 kilometers respectively. In addition, the country has over 79,000 km of feeder roads. However, a large majority of roads are unclassified feeder roads (86% of national road network). Figure 1 shows the spatial distribution of the road network.

10.   However, the extensive physical connectivity masks considerable heterogeneity in terms of road quality. Using a matching procedure, the road authority's GIS data on road locations were linked to data on road quality and traffic volumes collected through the Highway Development and Maintenance Model 4 (HDM-4) – a standard model for analyzing road investments. As the data in the HDM-4 are not geo-referenced, it is difficult to directly link road quality and traffic data with data on the location of the road network. A spatial analysis program was developed to merge these two datasets. Box 1 discusses the details of this program.

Figure 2: Road quality and traffic volumes
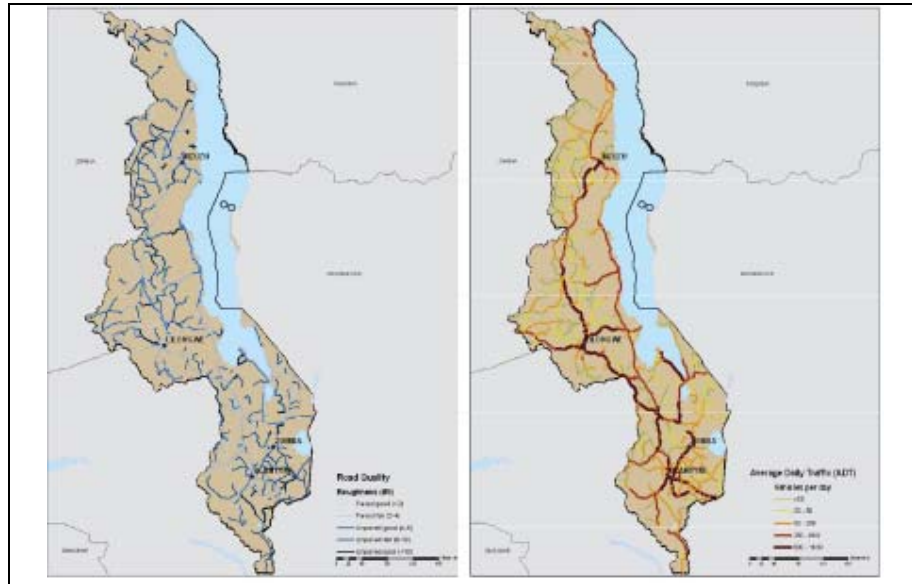
11.   Figure 2 shows the results of integrating information on road network information and quality. The panel on the left controls for network quality measured by roughness of the road surface. Clearly, there are considerable quality differences across segments of the network. The panel to the right shows traffic volumes across the network - which is concentrated around the major cities of Lilongwe, Blantyre, Mzuzu and Zomba.

Box 1: Linking spatial data on road networks with engineering estimates of quality

The Malawi National Road Authority (NRA) has compiled a GIS database of the roads network. In addition, the NRA is regularly implementing HDM4 surveys to collect information on overall road conditions. While the geo referenced road network data only include basic information such as road name and class, the non geo-referenced HDM4 compiles a rich dataset on pavement roughness (IRI), daily traffic volumes (AADT), and designated speed. Mapping road quality information into the geographic database of road placement is important for identifying specific locations where road quality is impinging on traffic flows as well as locations potentially facing congestion. However, as both databases were compiled independently and without coordination, they cannot be merged directly. A spatial linking algorithm - the "SIS" (Special Information System Ver.6.1) - was developed by the Oriental Consultants Co. in Japan to integrate these two databases. The process is outlined below.

First, the HDM4 location information, which is specifically the starting/ending points of each road segment in GPS longitude & latitude, is overlaid on the GIS road links with the same projection in order to confirm which road links should be identified for the HDM4 links.

Second, the HDM4 locations are revised when the starting/ending points are not on the GIS road link. This process requires engineering decision consulting extra information, such as road name, and road length.

Third, after the revision process being completed, new road links with the same starting/ending points are created using the tracing function of GIS application.

Procedure for data linkage

1. **Indication of the starting/ending points of HDM4 road segments into the GIS road link**

↓

2. **Revision of HDM4 points to match to the GIS road link**

↓

3. **Creation of new GIS road shape files connecting HDM4 points**

↓

4. **Addition of HDM4 information to the new GIS road shape files**

Finally, other HDM4 information is added to the newly-created GIS road link data.
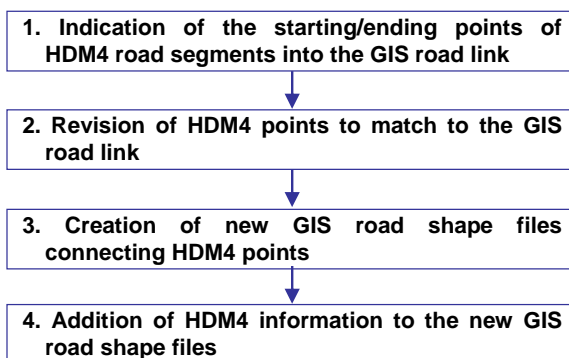
12.   The combined data from the GIS and HDM systems provide useful insights on road quality. Table 1 summarizes these findings. Consider for example road conditions and traffic flows across different parts of the network. Main roads are relatively wide (1.7 lanes on average) smooth (4.4 roughness) and paved (76%). The Average Daily Traffic (ADT) on these roads is 507 vehicles, with over 40% being motorized. In contrast, secondary roads are rougher and narrower with ADTs of 90 vehicles. Most tertiary roads are unpaved and rough and have lower traffic volumes. The average design road speeds are 57 kilometer per hour for main roads, 38 for secondary roads, and 34 for tertiary roads.

Table 1: Physical road conditions, GIS+HDM4, by road class

Road class	Total road length, km	number of lanes, average	Road roughness, average	% of paved	Average Daily Traffic (ADT)	Motorized transport
Main	1,931.6	1.7	4.4	75.7	506.9	204.9
Secondary	1,361.0	1.0	6.9	12.9	90.2	38.3
Tertiary	1,509.2	1.0	6.6	5.5	67.3	11.8
District	149.5	1.1	5.2	33.6	182.7	73.1
Other	3,577.1	1.2	6.1	33.9	223.1	65.8
Total	8,528.4	1.2	5.9	35.7	237.9	83.5

Note: The sample excludes unmatched road segments.
Data Source: Road network GIS data, and the HDM4

Asking farmers about transport costs

13.   Households in the IHS2 are asked if they are agriculture producers and what they pay to move their products to the nearest market. These data from the IHS2 are spatially linked to the GIS/HDM4 infrastructure data which provide information on road quality and traffic volumes (a proxy for demand and potential competition). The hypothesis to be tested is that both infrastructure supply and demand have bearing on transport costs. Transportation prices or transport costs paid by farmers are influenced by supply side conditions (road accessibility and quality) as well as the demand side (freight volume to be transported) and the structure of market competition. In addition, network externalities, or economies of scale, are important for transportation industry.

14.   A regression analysis is carried out where the dependent variable is a farmer's transport costs for taking tobacco to markets (in MKs). Results are reported in Table 2. We first control for the volume of tobacco transported (in MKs) and the transport distance (kilometers).[3] After controlling for the (strong) effects of those two variables, the ordinary least squares regressions imply that other policy-relevant factors also significantly affect a farmer's tobacco transport costs. In particular, **the quality of feeder roads (distance to asphalt roads, kilometers) connecting the farms to the main roads is an important factor influencing transport costs**.[4]

15.   In addition, road traffic volume data from the GIS+HDM4 data were used in the analysis. For farmers in each location (564 EAs), spatial analysis was used to compute the average road traffic volume (ADT) within a radius of 10 kilometers. The results from the regression show that the transport costs are lower in locations with high traffic volumes. This confirms our hypothesis that **competition and higher trucking demand are associated with lower transport costs**.

Table 2: The determinants of tobacco transport costs to markets: all tobacco farmers

	(1)	(2)	(3)	(4)
Dependent variable:	ln(a farmer's tobacco transport costs)			
Estimation	OLS, with IHS2 sampling weights			
Sample	all tobacco farmers			
ln(transport volume)	0.815***	0.800***	0.812***	0.804***
	(0.029)	(0.029)	(0.030)	(0.030)
ln(transport distance)	0.150***	0.139***	0.148***	0.152***
	(0.024)	(0.025)	(0.031)	(0.033)
ln(distance to asphalt roads)		0.032**		0.014
		(0.013)		(0.014)
ln(road traffic volume, ADT)			-0.066***	-0.061***
			(0.018)	(0.020)
Constant	Yes	yes	Yes	Yes
Observations	970	920	825	793
R-squared	0.646	0.637	0.665	0.656

Note: 1. Robust standard errors in parentheses
          2. * significant at 10%; ** significant at 5%; *** significant at 1%

16.   We also examine the impacts on tobacco transport costs for farmers who use lorries to transport tobacco to markets (see Table 3). For this sub-sample of farmers, the results are similar, but the impacts (coefficient estimates) of feeder road quality and traffic volumes on

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[3] Source: IHS2 household questionnaire.
[4] Source: IHS2 community questionnaire.

neighboring roads are much larger compared to the sample with all farmers. These findings have important implications - in order to maximize the efficiency of motorized freight transportation, it is important to simultaneously upgrade feeder roads and enhance competition on the trucking industry.

Table 3: The determinants of tobacco transport costs to markets: tobacco farmers using lorry transportation

	(1)	(2)	(3)	(4)
Dependent variable:	ln(a farmer's tobacco transport costs)			
Estimation	OLS, with IHS2 sampling weights			
Sample	tobacco farmers using lorry transportation			
ln(transport volume)	0.798***	0.786***	0.802***	0.800***
	(0.026)	(0.027)	(0.025)	(0.026)
ln(transport distance)	0.170***	0.161***	0.109***	0.121***
	(0.023)	(0.025)	(0.032)	(0.035)
ln(distance to asphalt roads)		0.052***		0.026*
		(0.013)		(0.014)
ln(road traffic volume, ADT)			-0.087***	-0.071***
			(0.019)	(0.021)
Constant	Yes	yes	yes	Yes
Observations	850	802	727	697
R-squared	0.661	0.660	0.684	0.677

Note: 1. Robust standard errors in parentheses
   2. * significant at 10%; ** significant at 5%; *** significant at 1%

17.   In summary, a farmer's transport costs of taking tobacco to markets are determined by both supply and demand side factors. Poor feeder road quality, which links farms to main roads and low traffic volume (limited competition and less trucking demand) on neighboring main roads raise transport costs. These findings are consistent with Africa wide studies that highlight infrastructure constraints (Pedersen 2001), low levels of competition between service providers (Rizet and Hine 1993), and weak infrastructure (Limao and Venables 2001) as contributors to high transport costs.

Asking truckers about transport prices

18.   To complement the analysis of transport costs faced by farmers, a survey of transport providers was carried out to understand how a combination of vehicle operating costs, indirect costs and profit margins contributed to the setting of transport prices. This survey builds on the trucking survey instrument and methodology developed in the World Bank Africa region's transport unit, and described in Teravaninthorn and Raballand (2008). Figure 3, from that report identifies the various components of transport prices.

Figure 3: Identifying drivers of transport prices

Figure 1.1   Various Definitions Related to Transport

Transport prices (Input cost to end user)

Profit markup

Total cost to transport provider

Toll and other roadblock payment

License and insurance

Vehicle operating costs

Maintenance

Tires

Fuel

Labor cost

Capital cost

1. Transport prices are the rates charged by a transport company or a freight forwarder to the shipper or importer. Normally transport prices = TC's + operator's overhead and profit margin.

2. Transport costs (TC's) = VOCs + other indirect costs, such as license, insurance, road toll, and roadblocks payment.

3. Vehicle operating costs (VOCs) include various direct costs to operate a given vehicle, notably maintenance, tires, fuel, labor, and capital costs.

19.   The design and implementation of the trucking survey is discussed in Box 2. Table 4 summarizes the main findings from the survey. The most important finding is the presence of considerable heterogeneity in transport prices on domestic and international routes. ***The average unit transport price (per ton, per km) is 228.4 kwacha from rural areas to the country's main cities – in comparison, transport prices range between 10 and 12 kwacha per ton per km on routes linking the country to international markets.*** This is a clear indication that transport markets are segmented with limited mobility across segments. *What explains these price differences*?

Table 4: Trucking Survey - Summary of main findings

Origin	Destination	unit transport price, per ton per km	total one trip distance	yearly mileage of a truck	empty haul pct (%)	price charged to go per ton	average load from origin to destination	most common factor for idleness, out of 40
		LCU (Kwacha)	km	km	%	LCU (Kwacha)	tons	1: lack of load/oversup ply of vehicles
agro town	major city	228.4	84.6	34,020.0	27%	19,323	2.5	27
agro town	exporting port	10.3	2,271.6	82,200.0	11%	23,462	24.6	40
major city	exporting port	12.1	2,012.3	71,102.5	5%	24,433	19.9	30

20.   The contracted trucking surveyors visited the identified origin locations in Malawi and collected aforementioned route specific information of 130 samples (70 samples from 20 trucking companies and 60 samples from 60 truckers). Specifically, 50 trucker samples are surveyed for Route type A, and 10 trucker samples for Route type C; and 40 trucking

company samples for Route type B, and 30 trucking company samples for Route type C. Overall 34 routes were surveyed (12 type A routes, 14 type B routes, and 8 type C routes). The survey questionnaire is available on request.

Box 2: Route-specific trucking survey in Malawi

To complement the spatial analysis for better spatial prioritization of transport infrastructure investments, the World Bank financed a route specific trucking survey in Malawi during November, 2008. Survey routes were identified with the help of IHS2 data and consultation meetings with the trucking survey company and the Bank staff. Three types of routes are identified: (i) Route type A: connecting high agriculture activity areas (IHS2 EAs with high agriculture production) and major cities in Malawi, (ii) Route type B: between high agriculture activity areas and exporting ports in neighbouring countries, and (iii) Route type C: between major cities in Malawi and exporting ports in neighbouring countries. The surveyed origin and destination locations are listed below.

The origin and destination for Malawi trucking survey

High agriculture activity Areas (towns)
TA Mpherembe (Mzimba)
TA Kaluluma (Kasungu)
SC Njombwa (Kasungu)
TA Santhe (Kasungu)
TA Wimbe (Kasungu)
TA Dzoole (Dowa)
SC Chakhaza (Dowa)
TA Kalolo (Lilongwe)
TA Zulu (Mchinji)
TA Chimaliro (Thyolo)

Major cities in Malawi
Blantyre
Lilongwe
Mangochi*
Mzuzu
Thyolo
Zomba*

* no survey response

Exporting ports in neighboring countries
Beira (MZ)
Dar es salam (TZ)
Durban (RSA)
Mtwara (TZ)*
Nacala (MZ)*
Quelimane (MZ)*

* no survey response

The contracted trucking surveyors visited the identified origin locations in Malawi and collected aforementioned route specific information of 130 samples (70 samples from 20 trucking companies and 60 samples from 60 truckers). Specifically, 50 trucker samples are surveyed for Route type A, and 10 trucker samples for Route type C; and 40 trucking company samples for Route type B, and 30 trucking company samples for Route type C. Overall 34 routes were surveyed (12 type A routes, 14 type B routes, and 8 type C routes). The survey questionnaire is available on request.

21.   There are several factors that explain differences in prices across these routes. First, small loads and short trips play an important role as fixed costs are distributed over small units (see Table 4). Notice that prices per ton across routes are in a comparable range – 19,300 kwacha on domestic and 24,400 on international routes. However, with a yield of around 1 ton per year per hectare for a farmer, and with less than 5000 kilometers per year per truck - fixed costs on domestic routes are much higher than for international transport; therefore, unit transport are much higher. In addition, the domestic and international routes are significantly different to a point where most operators on international routes (if they had excess capacity or wanted to compete because of a more attractive price per ton/km) could not operate with their present fleets on domestic routes (their trucks could simply not run on some of these roads), neither would expected profits warrant their trouble to go after such traffic (as large trucks on international routes would be using a small portion of their capacity and prices expressed in tons per kilometer would shoot up).

22.   Regression analysis is used to quantify the contribution of various factors to transport costs. Table 5 reports findings from an OLS specification. The sample in column 1 includes both domestic and international routes; column 2 is limited to domestic routes. First, the price charged to transport freight (per ton) depends on trip distance. Controlling for trip distance

variation, truck size is a significant factor: larger trucks reduce per unit transport price. As trucking companies possess bigger trucks and thus enjoy some economies of scale, they can charge less than individual truckers. And empty haul increases transport prices, as truckers may charge (part of) returning costs to customers.

23.   The main difference between the results for the complete samples and for domestic routes (column 2) is that empty back hauls are not important for transport price setting on domestic routes – considering that average distances are only 84 km on domestic routes compared to over 2000 km on international ones. Column 3 provides an additional specification with the full sample where a dummy variable for domestic truckers is introduced. Controlling for truck size and trip distance, domestic truckers charge higher prices relative to those servicing international routes.

Table 5: Determinants of trucking prices

	(1)	(2)	(3)
Dependent variable: ln(price charged to go per ton)			
Estimation: OLS			
Sample	Full sample	Domestic truckers	Full sample
ln(one trip distance)	0.668***	0.986***	1.023***
	(0.017)	(0.094)	(0.021)
ln(average tare weight of	-1.092***	-0.711**	-0.428
vehicles)	(0.063)	(0.302)	(0.281)
ratio of mileage on empty-	2.354*	0.914	1.028**
Haul	(0.555)	(0.868)	(0.120)
dummy for domestic			2.417**
truckers (type 1)			(0.455)
Constant	Yes	yes	Yes
Observations	59	31	59
R^2	0.710	0.813	0.868

Note: 1. Clustered (by route type) robust standard errors in parentheses

   2. * significant at 10%; ** significant at 5%; *** significant at 1%

ECONOMIC IMPLICATIONS OF INFRASTRUCTURE SHORTFALLS AND HIGH TRANSPORT COSTS

Agriculture development

24.   In the agriculture sector, the choice of where and what to produce depends on natural endowments such as climate, rainfall, soil quality, water availability, as well as proximity to markets. Data from the Integrated Household Survey of 2004 (IHS2) are used to examine the spatial distribution of agriculture production in Malawi. The IHS2 data identifies households in over 564 Enumeration Areas across the country. By spatially linking these household data to geo referenced data on agronomic potential and proximity to markets, it becomes possible to assess how the choice and intensity of crop production varies with natural and economic geography.
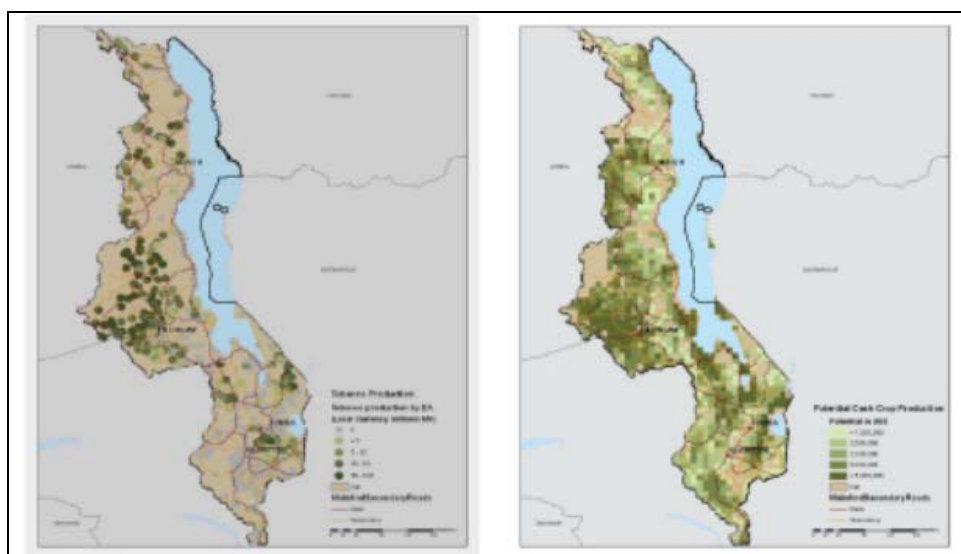
Agronomic potential

25.   Agronomic potential, or potential (maximum) crop production, reflects the geo-climatic constraints on the quantity and quality of suitable land. We focus on the agronomic potential of three cash crops (coffee, cotton, and groundnuts), which share similar biophysical

cultivation conditions as tobacco, the main cash crop in Malawi. The measure of agronomic potential comes from the IFPRI Spatial Allocation Model (SPAM), which provides a spatially detailed dataset on the distribution of crop production values. It measures the maximum crop production estimate given suitable land size and its quality in a 0.5 degree (about 9x9 kilometers) latitude/longitude 'pixels'. In computation, we multiply the suitable land size by corresponding potential yield of three cash crops in a pixel and aggregate them together. The suitable land size and potential yield data are originally from the Agro-ecological Zone (AEZ) data of FAO/IISA.[5] The left panel of Figure 4 shows the spatial distribution of tobacco production in Malawi, which is highest in the central region that offers good agronomic potential for cash crops, as mapped on the right panel. Maps of other cash crops also show similar patterns.

Figure 4: Tobacco Production Intensity and Agro climatic Conditions

26.   In addition, crop productivity – measured by crop production per square meter, is higher in areas with better agronomic potential (see Table 6). Overall crop productivity in the fifth quintile (best agronomic potential) is 50% higher than that in the first quintile (worst agronomic potential). Higher agronomic potential areas are relatively more specialized in high-value and high-productive crop production, such as cash crops and tobacco compared to low-value rainfed cultivation. Nationally, tobacco produces the highest yield (195 MK per m^2), followed by dry-season (Dimba) cultivation (77 MK per m^2). Rainfed cultivation is the lowest (32 MK per m^2).

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[5] The Agro-ecological Zone (AEZ) methodology developed by FAO and the International Institute for Applied Systems Analysis (IIASA) combines geo-referenced data on land resources (climate, soil and terrain) with a mathematical model for calculation of potential biomass and yields per crop and management system. Land resource data include an adjustment for estimated land requirements for housing and infrastructure, based on population and population density. Crop agronomic potential in each location is summarized in the Crop Suitability Index (SI) which is defined as:

$$SI = VS*0.9 + S*0.7 + MS*0.5 + NS*0.3,$$

where VS, S, MS and NS denote percentage of the grid-cell with attainable yields that are 80% or more, 60-80%, 40-60% and 20-40% of maximum potential yield. SI is essentially a measure of quality adjusted land area (the adjusted share of land suitable for cultivation of a particular crop or group of crops), with a maximum value of 0.9 and a minimum value of 0.

Table 6: Crop productivity, by agronomic potential

agro potential quintiles, cash crop	Crop productivity, tobacco+dry season+rainfed, MK per m^2	Crop productivity, tobacco, MK per m^2	Crop productivity, dry season crops, MK per m^2	Crop productivity, rainfed crops, MK per m^2
1 (worst)	29.0	191.3	59.3	26.8
2	30.2	160.4	52.1	29.6
3	38.3	198.0	82.3	35.4
4	36.3	245.7	113.3	31.5
5 (best)	43.4	176.6	78.4	37.7
Total	35.4	195.1	77.0	32.2

Data Source: IFPRI SPAM, and the IHS2

Market Access

27.   We also find that crop production intensity is influenced by market access. Easy access to urban centers can provide incentives for increasing the scale of crop production (market size), as well as provide better access to relevant price information, productivity-improving information, and reduced transport costs for crops and intermediate inputs. To examine if market access matters for agriculture specialization in Malawi, travel times to the nearest urban center (Lilongwe, Blantyre, Mzuzu, and Zomba) were computed using a Spatial Analysis program in ArcGIS. This program finds the route offering the shortest travel time from an origin to a destination location. The computation employed the combined GIS-HDM4 database along with the GIS files with information on the location of roads. The 564 IHS2 Enumeration Areas are grouped into travel time (to urban centers) quintiles.

Table 7: Cash crop production, by agronomic potential and travel time to urban centers

Cash crop production, share, %		travel time to nearest 4 major cities					
		5 (longest)	4	3	2	1 (shortest)	subtotal
Agronomic potential, cash crop	5 (worst)	1.1	3.3	3.5	0.1	0.0	8.0
	4	3.0	0.7	1.0	2.3	0.8	7.9
	3	5.4	13.7	1.4	1.0	0.5	22.0
	2	10.3	4.1	9.3	2.1	0.2	26.0
	1 (best)	1.2	7.6	10.0	15.1	2.2	36.0
	subtotal	21.0	29.4	25.3	20.6	3.7	100.0

Data Source: GIS+HDM4 data, IFPRI SPAM, and the IHS2

Table 8: Tobacco production, by agronomic potential and travel time to urban centers

Tobacco production, share, %		travel time to nearest 4 major cities					
		5 (longest)	4	3	2	1 (shortest)	subtotal
Agronomic potential, cash crop	5 (lowest)	1.0	3.5	2.9	0.0	0.0	7.5
	4	3.0	0.8	0.8	2.4	0.9	7.9
	3	5.6	13.9	1.4	0.9	0.5	22.3
	2	11.1	3.1	9.4	1.7	0.2	25.6
	1 (highest)	1.1	7.3	10.4	16.1	2.0	36.8
	subtotal	21.8	28.6	24.9	21.1	3.6	100.0

Data Source: GIS+HDM4 data, IFPRI SPAM, and the IHS2

28.   Table 7 and Table 8 combine information on agronomic potential with travel times (to urban centers) for cash crop and tobacco production respectively. Quintiles of agronomic potential are on the rows, and quintiles of travel times to urban centers are in the columns.

Thus, bottom- right cells of the tables refer to the share of crop production in areas with high agronomic potential and good connectivity (low travel times) to urban centers. The two tables show similar patterns. Crop production is concentrated in locations with good agronomic potential, and production shares increase with better access (lower travel times) to urban centers. An interesting observation is that crop intensities drop in locations closest to urban centers, as presumably land for agriculture competes with alternate urban land use (which may be of higher value).

Producers internalize geographic constraints

29.   The interaction between good agronomic potential and access to markets is further examined with an econometric model. This model uses data from the IHS2 on the extent of cash crop production by a household, and explains the decision to specialize in cash crops (cash crops more than a third of all crop production) using agronomic potential and access to domestic and international markets.

30.   At a micro-level, the patterns echo the summary tables above. As expected, being located in high cash crop agronomic potential areas increases the probability of specializing in cash crop production (see Table 9). Interestingly, this beneficial effect of good agronomic potential diminishes as a farmer is located in remote areas (longer travel time to urban centers) (column 2). Travel time to urban centers has an inverted-U shape relation (column 3). In remote areas, reducing travel time to urban centers, or better road connectivity, encourages a household's specialization in cash crop production. However, in areas very close to urban centers, households may be discouraged from specializing in cash crops due to competition with urban land uses. Therefore, a farmer's cash crop specialization, or selection of high-yield crop production, is maximized in the areas with intermediate road connectivity. Based on the econometric estimates, the "optimal" distance where a farmer maximizes cash crop production is 2.2 hours from a major city.

31.   Similarly, proximity to international markets generates similar results. Households very close to international markets are likely to specialize in non-agricultural activities. However, at intermediate distances there is an increase in production of cash crops, which drops in regions with large distances to markets.

Prospects for manufacturing

32.   In deciding where to set up a business, entrepreneurs are most likely to choose an area that offers conditions for maximizing profits. A recent survey of the empirical literature identifies the main drivers of location decisions by firms in developing countries (for details, see Deichmann and others 2008): These include *Factor prices*; Infrastructure—cost and quality of complementary utility services, including water, electricity, and telecommunications; *Market Access* – the availability of transport and communications to access markets; *Agglomeration economies*—the presence of firms in own industry (localization economies) and firms in other industries (urbanization economies); *Human capital*—the availability of skilled workers; and *Local regulations*—land use and zoning, tax policies.

Table 9: Factors influencing decisions to produce cash crops

	(1)	(2)	(3)
Dependent variable:	Households with 5 cash crop production[1] $\geq$ 1/3 of HH crop production		
Estimation	Probit, with IHS2 sampling weights		
Sample	households with crop production > 0		
ln(agro potential	0.215***	2.818***	0.171***
for cash crop production)	(0.022)	(0.967)	(0.023)
ln(travel time to the nearest	0.168***	1.415***	2.072***
major city in Malawi) [2]	(0.028)	(0.212)	(0.365)
ln(travel time to the nearest			-0.211***
Major city in Malawi), squared			(0.040)
ln(travel time to the nearest cross-	2.156***	4.143***	70.337***
border exporting ports) [3]	(0.146)	(1.036)	(14.879)
ln(travel time to the nearest cross-			-4.869***
Border exporting ports), squared			(1.061)
ln(travel time to the nearest		-0.157***	
Major city in Malawi)×ln(agro		(0.026)	
potential for cash crop production)			
ln(travel time to the nearest cross-		-0.262*	
border exporting ports))×ln(agro		(0.138)	
potential for cash crop production)			
Constant	Yes	yes	Yes
Parabola vertex (peak) of travel time to the nearest major city in Malawi, Hours			2.2
Parabola vertex (peak) of travel time to the nearest cross-border exporting ports, hours			22.8
Observations	8565	8565	8565

Note: 1. Five cash crops are tobacco, coffee, cotton, tea, and sugar cane.

2. Major cities are Blantyre, Lilongwe, Mzuzu, and Zomba.

3. Cross-border exporting ports are Beira (MZ), Durban (RSA), and Dar es Salaam (TZ).

4. Robust standard errors in parentheses

5. * significant at 10%; ** significant at 5%; *** significant at 1%

33.   Prices and quality of inputs, prices of outputs, and access to technology matter in location decisions. Access to social services and amenities are important for attracting skilled workers. These include access to clean water and sanitation, sewerage, and health facilities, as well as the amenities that people get for good air quality and open spaces. But firms often cluster in a few places for reasons beyond exploiting regional endowments. They are likely to cluster in areas that provide good transport infrastructure to help them access markets. *Proximity to markets* is important *for a*ctivities that benefit from increasing returns. As a disproportionate share of these activities is attracted to such a location, either the wage rate

will be bid up or labor will move to that location—further increasing its attractiveness. This is sometimes called the "home market effect," a term coined by Paul Krugman (Krugman 1991). Firms in areas with good market access will have higher demand for their products, which will push them to increase scale and invest in cost-reducing technologies. As a result of these forces, local policies may be effective in influencing industry location only in areas with good access to domestic and international markets. They are likely to have little impact in areas with poor market access.

34.   Firms may also be attracted to areas that already have firms established in their line of business. Why? Because of *localization economies.* By locating near other firms in the same industry, a firm learns about whom to hire, whom to buy from and sell to, what's new in technology, and what product lines are selling. Finally, firms may choose a location for its economic diversity. Why? Because of *urbanization economies.* Economic diversity means good access to a broad range of producer and consumer goods that typically increases with the size of the agglomeration. The economics literature identifies two main sources of gains from urbanization economies. The first is information sharing and innovation. Large cities are breeding grounds for new ideas and innovations because of the concentration and diversity of knowledge sources—and firms in such cities are more likely to develop new products (Duranton and Puga 2001). The second is access to producer amenities. Firms in large cities tend to have better access to such resources as business services, finance, logistics, banking, advertising, and legal services—all of which can enhance their performance (Abdel-Rehman 1988; Fujita 1988; Rivera Batiz 1988).

35.   The source of agglomeration benefits matters for regional industrial policies. If localization economies dominate, it may be possible to induce specific industries to relocate through strategic public expenditure policies. The challenge is to coordinate decisions across many firms in the same industry. But if urbanization economies dominate, so that firms' performance depends on being in a large, diverse city, using policies to move activities to secondary locations —and to sustain them there—is extremely difficult. Urbanization economies are typically more important for young industries in the innovation phase of their product cycle, while localization economies become more important for more mature industries.

Functional specialization in Blantyre and Lilongwe

36.   In Malawi, manufacturing is concentrated in the country's two major industrial clusters: Blantyre and Lilongwe. The Malawi Productivity & Investment Climate Survey (ICA, 2004) identifies that 61% of sampled firms are in Blantyre, and 20% in Lilongwe. The ICA data suggest that firms in Blantyre are specialized in relatively high/medium-tech and heavy industries, such as textiles, chemical/chemical products, rubber/plastic products, metal products, and machinery/equipment. Those industries tend to be international market oriented, and export/import linkages are important for firms in these lines of business. In contrast, firms in Lilongwe are producing relatively low-tech and domestic market oriented goods. Food and beverage industries, as well as rubber/plastic products and furniture are the main industries in Lilongwe (Table 10).

37.   The difference in Blantyre and Lilongwe's industrial composition is closely related to their upstream/downstream linkages with external markets. In Blantyre, the proportion of sales for direct exports is 45 percent – in contrast to 9% in Lilongwe. Similarly, 67% of intermediate inputs are imported in Blantyre – compared to 44% in Lilongwe. As producers specialize in activities that internalize location specific constraints, different infrastructure needs emerge in these cities. For firms in Blantyre – the lack of reliable provision of electricity, transportation, and telecommunications are major obstacles for their business operations, as high/medium tech and heavy industries are infrastructure hungry. In particular, unreliable and insufficient electricity supply seems to be the main bottleneck. 56% of ICA

firms in Blantyre own or share generators and on average 11% of overall electricity use comes from those private generators. In comparison, transportation is a relatively more important constraint in Lilongwe. Electricity shortages are less severe considering Lilongwe's specialization in low-tech domestic market oriented industries. Only 28% of Lilongwe firms install or share generators, and provides only 4% of electricity used by the city's manufacturers.

Table 10: Varying industrial specialization and bottlenecks in Blantyre and Lilongwe

Cities	Manufacturing firms			relative to national total/average, %	
	Blantyre (a)	Lilongwe (b)	National total/ average (c)	Blantyre (a/c)	Lilongwe (b/c)
Number of firms	97	32	159	61.0	20.1
By industry					
Food & Beverage	25	11	56	44.6	19.6
Textiles	10	1	11	90.9	9.1
Apparel	3	1	4	75.0	25.0
Wood & wood products	5	2	10	50.0	20.0
Paper	3	0	3	100.0	0.0
Chemical & Chemical products	14	2	17	82.4	11.8
Rubber & plastic products	12	5	17	70.6	29.4
Metal products	10	3	17	58.8	17.6
Machinery and equipment	3	0	3	100.0	0.0
Furniture	8	5	14	57.1	35.7
Construction Material	2	1	3	66.7	33.3
(exports/imports)					
proportion of sales for direct exports, %	44.7	8.8	41.6	107.5	21.2
Mode of export transportation, %					
maritime only	2.4	0.0	3.2	74.0	0.0
air only	4.1	16.7	5.5	74.7	305.3
land only	70.8	43.3	64.1	110.5	67.6
inter-modal	22.7	40.0	27.2	83.3	147.0
intermediate input purchase, %					
from domestic sources	33.3	56.3	45.2	73.6	124.5
through imports	66.7	43.7	54.8	121.7	79.8
infrastructure problem for doing business 1 (no obstacle),…, 5 (severe obstacle)					
Telecommunications	2.3	1.9	2.2	103.1	86.8
Transportation	2.6	2.7	2.7	99.0	99.4
Electricity	3.6	3.3	3.6	100.3	93.2
proportion of firms with generators, %	55.7	28.1	48.8	114.2	57.7
electricity use from generators, %	11.3	3.7	10.2	111.4	36.4
production cost, per revenues					
electricity cost	1.6%	1.3%	1.7%	92.6	77.3
Fuel cost	2.2%	1.1%	2.1%	101.3	49.6
water cost	0.3%	0.2%	0.2%	110.0	94.3
transport cost	5.6%	6.7%	5.5%	102.6	122.7
telecommunication cost	0.5%	0.5%	0.5%	98.5	107.4
marketing/advertising cost	1.8%	0.3%	1.7%	106.0	20.3

Data Source: ICA 2004

38. In summary, industrial specialization in Blantyre and Lilongwe is a response to differences in product market structures and their accessibility. As Blantyre is geographically closer to international markets, specifically to exporting ports in Mozambique – firms specialize in activities benefiting from access to international markets. As Lilongwe is located

in the heart of the agriculture belt, in particular cash crops and tobacco, firms are more linked to domestic markets and adding value to agro production.

GEOGRAPHICALLY PRIORITIZING INFRASTRUCTURE INVESTMENTS

Where do transport investments matter the most for growth?

39.   The analysis in this paper shows how linking GIS data to HDM4 provides an important tool for mapping areas of economic potential which could be targeted for infrastructure improvements.   The empirical analysis identifies that production of these cash crops is concentrated in the central and southern regions of the country – as they offer suitable agronomic conditions. In addition, production intensity is highest in locations that are close to the country's main urban agglomerations. The analysis of growth constraints and transport prices highlights that the poor quality of feeder roads linking these locations is an impediment to doing business (and raises transport costs). To get the highest return from transport infrastructure investments, resources should be allocated towards improving feeder roads in areas with good agronomic potential and are close to markets.

40.   The Malawi Growth and Development Strategy (MGDS) recognizes that poor infrastructure limits national economic performance and affects internal and external trade efficiency. Transport investment is a priority area for public intervention, and has been supported by significant real increase in budget allocation to the transport sector since 2003/04 FY from around US$5million to over US$20million in 2008. Despite Government's increased funding to the transport sector, the 2006/07 Annual MGDS Review reveals that project implementation in the transport sector has been very poor and not reflecting economic growth priorities (spatially inefficient).

Infrastructure Services Programme

41.   In 2006, the GoM developed infrastructure plans under the Infrastructure Services Programme (ISP) aimed at supporting economic growth in five prioritized corridors. These corridors contain about 30 districts that government determined would most likely benefit from coordinated infrastructure investments not only in terms of their needs but the importance of their potential contribution to overall economic growth. The basis for the selection of the five corridors was a priority ranking of the potential for value addition in key productive activities –agriculture, mining, and tourism. The evaluation attached points for high, medium and low productivity for each of these activities. The five corridors selected cover all of Malawi's three geographical divisions[6] - north, central and south. The total population in these corridors is over 2.6 million or 24 percent of total population. These corridors are:

- **_Rumphi-Nyika-Chitipa Corridor (location: northern region; population over 250,000)._** Chitipa is the district in Malawi that is most vulnerable to food insecurity and malnutrition. Agriculture and commerce are the main activities. However, the high cost of agricultural inputs has limited the development of the corridor's agricultural potential.   This scarcity results in part from a poor road network, contributing to the isolation of the districts from the key sources of agricultural inputs. And, as a result, many people in the corridor run out of food in the months of November through February. The main agricultural crops include tobacco, maize and groundnuts. Livestock production is an important activity and bee-keeping by local communities surrounding Nyika National Park - a major national tourist attraction-

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[6] Malawi has two major cities (Blantyre and Lilongwe) that have a population of around 670000 each; 2 smaller cities (Zomba and Mzuzu) with a population of just over 200000 between them; 50 towns; and 75 smaller market centers.

has a high potential for growth. The corridor also is rich in mineral resources such as coal and uranium. Poor road accessibility and other infrastructure barriers have constrained the development of large-scale mining.

- *Ntcheu-Tsangano-Mwanza Corridor (location: central region; population: over 510,000).* Economic activities include agriculture, commerce, industry, forest products, and mining. Agriculture is the main activity, which includes the production of Irish potatoes, a variety of other vegetables, and fruits, as well as cotton and tobacco. Commercial activities include small-scale trading in charcoal as well as some wheat and vegetables. The corridor also has a wide range of mineral deposits, which include granite, gold, phosphate, and gemstones. Although currently mining takes place on a small scale, an assessment of the area has indicated some export potential could develop with the adoption of modern technologies. Also there is significant potential for cultural, highland and mountain tourism.

- *Mangochi-Cape McLear Corridor (location: southern region; population: over 600,000).* Over 90% of the population in the district is engaged in growing crops and fishing . Food crops include maize and a variety of other vegetables. The main cash crops are tobacco, groundnuts and cotton. Fishing is one of the major sources of income and livelihood in the corridor. Furthermore, the corridor borders Lake Malawi and the country's Spatial Development Initiative has indicated that the corridor has the potential to become a major hub of tourism.

- *Zomba-Phalombe-Mulanje Corridor (location: southern region; population: over 1,200,000).* This corridor has a diversity of existing and potential economic development activities. There is a high potential for agro-processing and some of the main crops are maize, groundnuts and paprika. Tea in the Mulanje area is a significant foreign exchange earner. Mining prospects are substantial, given 26 million tons of bauxite resources. There is also some potential for phosphate mining for the production of fertilizer. The scope for tourism is sizeable given elements of some cultural and historical interest as well as mountains and areas of ecological interest.

- *Nsanje-Bangula-Tengani Corridor (location: southern region; population: 126,230).* This corridor has one of the major cotton growing areas in Malawi and therefore there is some scope for textile production. The main crops are cotton, maize, millet and sorghum. Mining potential includes about 15 million tons of coal. There are also areas of substantial wildlife interest and related tourism.

Tradeoffs with poverty reduction?

42. *Will prioritization of feeder roads in the south and central regions impose tradeoffs with objectives of poverty reduction*? To examine this question, data from the IHS2 were used to identify locations specific factors contributing to a households' probability of living in poverty (see Table 11). For all households in the IHS2 sample, higher agronomic potential and better transport connectivity to urban centers reduces the probability of being in poverty. Interestingly, this pattern is the same both for households who produce crops as well as non-agriculture households. This suggests higher agronomic potential benefits even households without any crop production due to upstream/downstream linkages between agriculture and non-agriculture industries.

Table 11: Location characteristics and the probability of living in poverty

	(1)	(2)	(3)
Dependent variable:	Households being trapped in poverty	Households being trapped in poverty	Households being trapped in poverty
Estimation	probit	probit	Probit
Sample	All households	Agro households (crop production > 0)	Non-agro households (crop production = 0)
ln(agro potential, cash crop	-0.101***	-0.104***	-0.103**
	(0.014)	(0.015)	(0.047)
ln(travel time to city)	0.227***	0.157***	0.189***
	(0.018)	(0.021)	(0.048)
Constant	yes	yes	Yes
Observations	9520	8660	860

Note: 1. Robust standard errors in parentheses
2. * significant at 10%; ** significant at 5%; *** significant at 1%

43. As living in locations with good agriculture potential reduces the probability of being poor, transport improvements in these areas are win wins in terms of growth and poverty reduction objectives. In locations with poor agronomic potential, transport investments may reduce poverty incidence but come with a trade-off with national economic growth.

Complementary policies to reduce domestic transport prices

44. The analysis of this study shows that rural routes have higher transport costs – while quality of feeder roads are important, lack of demand along these routes ends up inhibiting competition. While opening up international competition in the trucking services industry will reduce transport costs in urban markets (with higher trading volumes), it is unlikely that international operators will deploy their existing fleets to serve rural markets. Why? First, road quality on many segments is so bad that existing fleets will not be able to pass along these routes. Second, and more important, is the low level of trade volume in most rural areas – it would be unprofitable for large trucks to go and collect small volumes and often return with empty loads – they would have to charge high prices to cover fixed capital investments.

45. So what is the alternative? It may be useful to consider options for promoting appropriate Intermediate Means of Transport (IMTs) for connecting rural areas to market towns. Related work by the World Bank's transport department suggests that IMTs offer considerable opportunities in relation to the short distance travel and transport demands of rural communities with regard to efficiencies in terms of cost and time savings. IMTs are seen as important in reducing travel and transport burden and increasing overall rural mobility in terms of reduced effort and time, longer distances and high carrying potential since IMTs:

- Have a higher load capacity compared to head loading, which carries only a maximum of only 30 kg.
- Have a higher speed and range compared to head-loading saving on time and energy in transporting of people and goods compared to walking and head loading.
- Do not require very expensive infrastructure like motorways, and tarred roads used by motorized vehicles. Depending on the size of an IMT, well maintained access roads, tracks and footpaths are enough.
- Ensure that they can be easily maintained locally and at affordable cost.

46. A recent study for the Road Maintenance and Rehabilitation Project (Management Services for Rural Accessibility and Mobility Pilot Activity) in Malawi identifies that the choice of IMTs should take into consideration their appropriateness for specific tasks in rural communities, acceptability, availability, affordability in terms of cost (initial plus operating costs), and back-up and repair services.

- *"Appropriateness"* refers to the goods and services they can carry for the rural farmer, appropriateness of the terrain (whether flat, rolling, hilly, mountainous), appropriateness of rural transport infrastructure (RTI) i.e. whether road, track or footpath.

- *"Acceptability"* refers to how acceptable is the means of transport by the majority of the rural community.

- *"Availability"* refers to how readily available are the supply or fabrication sources of the IMT. That is, can it be sourced or manufactured at some points in the rural setting or it has to be always manufactured from cities or manufactured locally. In some cases, shortage of supply can be overcome through training of artisans and establishing of workshop interventions to meet the supply bottlenecks.

- *"Back-up and Repair"* refers to the potential for local maintenance/repair services and availability of reliable stocks of spare parts in the vicinity or neighboring villages, trading centers or district *Bomas*. It is essential that people have to be able to access maintenance facilities and spares without much difficulty. This involves amongst other interventions, issues of partnerships between artisans and private business people (local and semi-urban shops) regarding the stocking of back-up and repair supplies for the IMTs.

- "*Affordability/cost (in terms of initial plus operational cost*) refers to ability to buy on cash basis by the rural households and what are the operational costs. In some cases, low purchasing power of IMTs by rural households can be overcome by providing mechanisms for a credit facility. This involves look into issues of whether establishing an appropriate credit facility would help in promoting ownership and use of IMTs.

47. The other criterion employed is how the IMTs reduce the travel and transport burden of women. The choice of the IMT will also be determined to some extent by the potential market and the marketing strategy to be deployed. How marketable is the IMT, are groups or individual able to use it and get opportunity to hire it out to help repay the loan. The IMTs have been examined for suitability for Ntchisi district based on the above-mentioned criteria.

REFERENCES

Abdel-Rahman, H.M. 1988. "Product differentiation, monopolistic competition and city size". Regional Science and Urban Economics 18, 69-86.

Deichmann, U., Lall, S.V, Redding S.J. and Venables A. J. 2008. "Industrial Location in Developing Countries". World Bank Research Observer, 23, 2, 219-246.

Duranton, G., Puga, D., 2001. "Nursery cities: urban diversity, process innovation, and the life cycle of city products". American Economic Review 91, 1454–1477.

Fujita, M. 1988. "A monopolistic competition model of spatial agglomeration: A differentiated product approach". Regional Science and Urban Economics 18, 87-124.

Krugman, P.R. 1991. "Increasing returns and economic geography". Journal of Political Economy 99, 483-499.

Limao, N., and A. J. Venables. 2001. "Infrastructure, Geographical Disadvantage and Transport Costs". World Bank Economic Review 15 (3): 451–79.

Pedersen, P. O. 2001. "Freight Transport under Globalization and Its Impact on Africa". Journal of Transport Geography 9: 85–99.

Rivera-Batiz, FL. 1988. "Increasing returns, monopolistic competition and agglomeration economies in consumption and production". Regional Science and Urban Economics 18, 25-153.

Rizet, C., and J. Hine. 1993. "A Comparison of the Costs and Productivity of Road Freight Transport in Africa and Pakistan." Transport Reviews 13(2).

Teravaninthorn, S., and G. Raballand. 2008. Transport Prices and Costs in Africa : A Review of the International Corridors, World Bank, Washington, D.C.

World Bank (2008). World Development Report 2009 – Reshaping Economic Geography. Oxford University Press.