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EGERTON

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**TEGEMEO INSTITUTE OF AGRICULTURAL
POLICY AND DEVELOPMENT**

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**HAS KENYAN FARMERS' ACCESS TO
MARKETS AND SERVICES IMPROVED?
PANEL SURVEY EVIDENCE, 1997-2007**

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Tegemeo Institute

Tegemeo Institute of Agricultural Policy and Development is a Policy Research Institute under Egerton University with a mandate to undertake empirical research and analysis on contemporary economic and agricultural policy issues in Kenya. The institute is widely recognized as a centre of excellence in policy analysis on the topical agricultural issues of the day, and in its wide dissemination of findings to government and other key stakeholders with a view to influencing policy direction and the decision making process. Tegemeo's empirically based analytical work, and its objective stance in reporting and disseminating findings has over the past decade won the acceptance of government, the private sector, civil society, academia and others interested in the performance of Kenya's agricultural sector.

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Executive Summary

This report uses panel data on 1,267 smallholder households to monitor changes in their access to markets and services. We find that Kenyan smallholders' proximity to infrastructure, markets, and services has improved markedly over the last decade. These improvements, however, have not been uniformly distributed over either time or space. Farmers in high-potential areas of the country continue to enjoy closer proximity to most kinds of markets and services compared to low-potential areas, but the greatest relative improvements over the 1997-2007 period have been in areas of medium and low potential. We also distinguish between public and private investments in examining changes in smallholders' access to markets. Changes deriving from public investments have tended to be most geographically equitable; private investments appear to have been relatively concentrated in the less productive farming areas of the country, possibly because earlier investments focused on high-potential areas, leaving unexploited investment opportunities in the less productive areas. These changes in smallholders' access to markets may offer important insights about the private sector's response to market liberalization in recent Kenyan history.

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Acronyms

AEZ	Agro-ecological zones
CCK	Communications Commission of Kenya
CDF	Constituency Development Fund
DFID	Department for International Development
FAO	Food and Agriculture Organization of the United Nations
KNBS	Kenya National Bureau of Statistics
MSU	Michigan State University
NCPB	National Cereals and Produce Board
USAID	United States Agency for International Development

1. Introduction

Smallholder farmers' access to markets and agricultural support services has been a major concern for Kenyan policy makers since independence. Agricultural policies have often been conceived as a necessary response to weak market access. It is commonly perceived that private traders and input suppliers tend to locate and confine their business close to towns and market hubs where infrastructure is relatively well developed. Consequently, farmers residing in the more remote rural areas are largely cut off from markets and services, with obviously adverse implications for farm productivity growth and poverty reduction.

This paper measures changes over time in indicators of market access as revealed through household panel survey data. Some of these access indicators reflect investment patterns by national and local government, while others reflect investment patterns of private entrepreneurs. We use these data to evaluate the current state of Kenyan smallholders' access to markets and services, determine how these access indicators have changed over the 1997-2007 period, and examine the geographic pattern of public and private investments in infrastructure and market access. Distinguishing between public and private investment-driven changes is an important way to understand the private sector's response to the liberalization of input and food markets.

This work is guided by a number of issues about market liberalization. First, there remains major controversy as to whether market liberalization has stimulated major private sector investment in input and output marketing services and improved smallholders' access to these markets. One hypothesis to test would be that there has been rapid improvement in smallholders' access to services provided by private firms. A more nuanced view might lead to the hypothesis that market liberalization has created investment incentives that differ spatially according to where the marginal payoffs to investment are greatest. Under the assumption that markets are at a nascent state of development in almost all areas of Sub-Saharan Africa, we might expect that the marginal payoffs to private sector investment would be greatest in areas of higher productive potential and, hence, be concentrated in such areas, whereas relatively little private sector investment would have occurred in areas of low agricultural potential. A more pessimistic view of private sector response to liberalization

might produce the hypothesis that smallholders' proximity to marketing services provided by private firms has remained weak and relatively unchanged in low- and high-potential areas alike since the liberalization process began.

Another set of hypotheses revolve around the criteria driving public investments. For example, we might expect that public investments in infrastructure and public services are more likely targeted to areas of high population density, or perhaps to relatively underprivileged areas for equity reasons, and not necessarily to areas with the highest financial returns. Moreover, because of administrative reform starting in 2004 aimed at decentralizing the control over public expenditures, e.g., the Constituency Development Fund (CDF), it will be interesting to evaluate whether household-level indicators of access to infrastructure and services provided by the state have improved since 2004.

The remainder of this paper is organized as follows. Section 2 describes the data used in the analysis. Section 3 presents patterns and trends in indicators of market access in 2007, 1997, and the changes over this 10-year period. Section 4 presents data on the variation across households in these access indicators to examine the dispersion around the medians. Section 5 examines geographic differences in indicators of access, focusing on whether access to infrastructure and markets have improved more over the past 10 years in the relatively low-potential or high-potential areas. This section also differentiates between access indicators that reflect private sector investments (such as the distance that households travel to the nearest fertilizer retailer and point of maize sale) as opposed to public sector investment (such as the distance from the household to the nearest motorable road and source of electricity). Section 6 determines the degree of correlation across these indicators at the household level. Finally, we present the main conclusions and consider the significance of these findings for both public policy in Kenya and for the undertaking of research on market access.

2. Data

This study uses household panel survey data collected by Egerton University's Tegemeo Institute with technical support from Michigan State University. Tegemeo Institute has collected detailed plot and farm data from 1,267 agricultural households in 24 districts, which together comprise a panel covering four years over the past decade: 1997, 2000, 2004, and 2007. The survey contains information on household production, marketing activities, and a variety of self-reported indicators of access to markets. These indicators are primarily kilometer distance variables separating the household from the nearest source of the service or market. In many cases, these variables have a highly skewed distribution in which 2-3% of the observations in the right-side tail of the distribution have a noticeable effect on mean values. For this reason, we report both mean and median changes in market access indicators and also present results on the distribution of these variables across households. The general findings about changes in households' access to markets and services over time are highly consistent regardless of whether means or medians are used.

The sample frame was developed by Tegemeo Institute in consultation with the government's Central Bureau of Statistics, now the Kenya National Bureau of Statistics (KNBS); see Argwings-Kodhek 1997, for details on sample design. Twenty-four (24) districts were purposively chosen to represent the broad range of agro-ecological zones (AEZs) and agricultural production systems in Kenya. Next, all non-urban divisions in the selected districts were assigned to one or more AEZ based on agronomic information from secondary data. Third, proportional to population across AEZs, divisions were selected from each AEZ. Fourth, within each division, villages and households in that order were randomly selected. A total of 1,578 households were selected in 1997 in 106 villages covering 24 districts within the country's eight agriculturally-oriented provinces. The sample excluded large farms with over 50 acres and two pastoral areas. The initial survey was implemented in 1997, which covered both the 1996/97 and 1995/96 cropping seasons. Subsequent follow up surveys were conducted in 2000, 2004, and 2007. After the 2007 survey, we were able to consistently interview 1,267 households in all four years. The attrition rate for the panel was 19% over the 10-year period, although roughly half of the attrition is due to the decision to no longer survey households in two pastoral districts starting in 2004.

Table 1. Access indicators used in this study

Variable	Investment type
Km to point of maize sale transaction with private trader*	Private
Km to nearest private fertilizer stockist	Private
Km to private veterinary services	Private
Km to public telephone (landline or mobile)	Private
Km to extension advice	Public
Km to a motorable road	Public
Km to a tarmac road	Public
Km to piped water source	Public
Km to health centre	Public
Km to electricity supply	Public

Notes: *This variable was only collected for farmers who sold maize to private traders. Farmers' sales to private traders accounted for 71% of the total number of maize sale transactions by households in the sample. Neighboring households and the National Cereals and Produce Board (NCPB) accounted for 22% and 7%, respectively.

The access indicators used are presented in Table 1. Although a larger number of indicators is available for any given year of the survey, we restricted our selection to those indicators which were consistently available across all four years, in order to track changes over time.

The survey sample design allows for summary statistics to be made for the major agro-ecological zones in which significant agricultural production is found. The location of these villages within the country is shown in Figure 1. The 106 villages covered in the survey were allocated to the following eight agro-ecological zones:

Coastal Lowlands: Kilifi, Kwale, and Taita-Taveta districts (n=70 households)

Eastern Lowlands: Mwingi, Machakos, Makueni, and Kitui (n=145 households)

Western Lowlands: Kisumu and Siaya districts (n=151 households)

Marginal Rain Shadow: Laikipia (n=37 households)

Western Transitional: Bungoma, lower elevation divisions in Kakamega (n=148 households)

High-Potential Maize Zone: Trans Nzoia, Uasin Gishu, Nakuru, Bomet, upper elevation divisions in Kakamega (n=345 households)

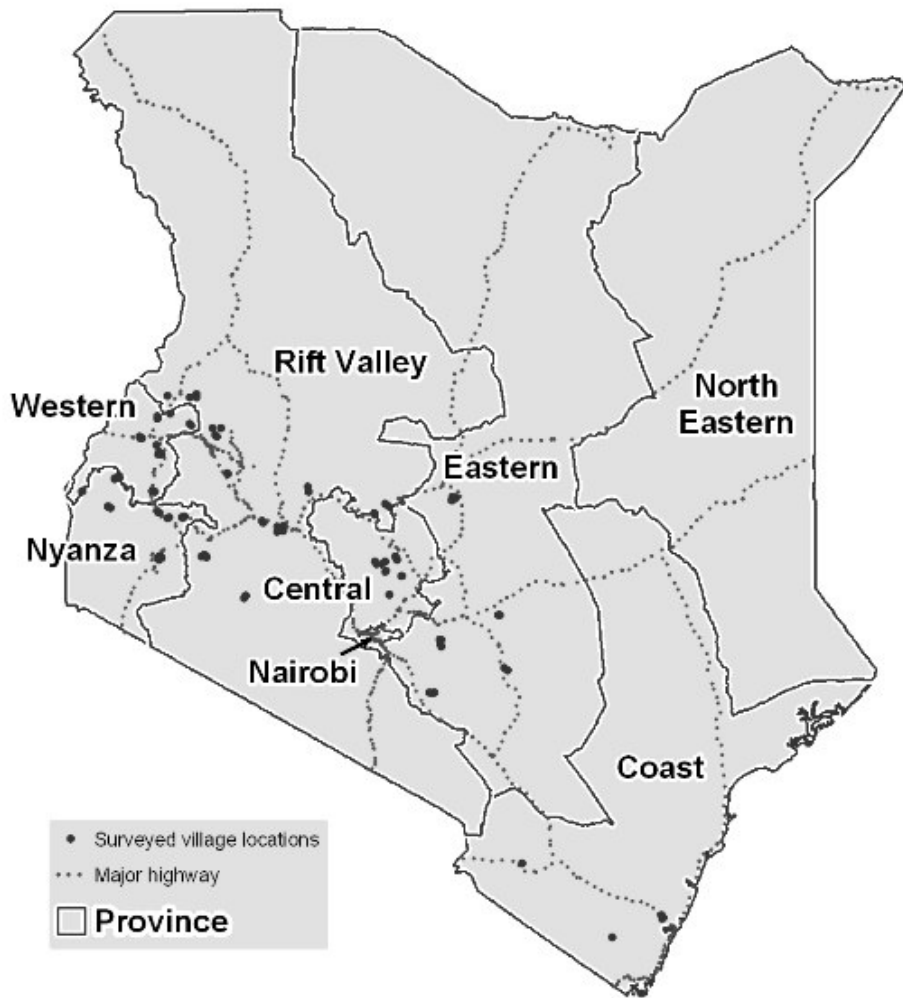
Western Highlands: Kisii, Vihiga (n=129 households)

Central Highlands: Meru, Embu, Muranga, Nyeri (n=242 households)

Zones were aggregated into areas of high vs. low potential to examine possible differences over time in the market access indicators and underlying investment trends. Relatively low-

potential zones were the Coastal Lowlands, Eastern Lowlands, Western Lowlands and the Marginal Rain Shadow. The relatively high-potential zones include Western Transitional, High-Potential Maize Zones, Western and Central Highlands.

Figure 1. Village sites in Tegemeo household survey, 1997, 2000, 2004, 2007



3. Patterns and Trends in Accessibility Indicators, 1997 To 2007

Tables 2 and 3 report median and mean distance travelled from the farm to various markets, services, and infrastructure.¹ These access indicators are reported for each agro-ecological zone and for the full sample. Table 2a and 2b compare these market access indicators between 2007 and 1997, while Tables 2c and 2d report the absolute and percentage change in the distance travelled from households to these services over this 10-year period.

The geographic differences in market access are striking. For example, the median distance from the farm to the nearest tarmac road was 9.0 km in 2007 overall, but this distance varied from 2.0 km in the districts comprising the Western Lowlands to 11.0 km in the more remote Marginal Rain Shadow Zone. The median distance travelled by farmers to the nearest fertilizer retailer was 2.0 km in 2007, but this varied from 1.0 km in the Central Highlands, where over 85% of the sample purchased fertilizer, to 3.0 km in the semi-arid areas of the Coastal Lowlands region, where fertilizer use is extremely low.

Most farmers live quite close to roads. The median distance to the nearest motorable road in 2007 was 0.2 km.² However, the median distance to the nearest tarmac road was 6.0 km. The latter distance may represent up to several hours travel in the absence of motorized transportation. Median distances to most public-provided services range from 2 to 5 km, although some indicators vary considerably across zones. In 2007, distance to tarmac roads, improved water sources and electricity all vary widely across zones (as they also did in 1997). The access indicator that varied the least across zones is distance to motorable road.

Median distances to all of the most market- and production-oriented locations (e.g., distance from the farm to the point of maize sale, fertilizer retailer, veterinary services, and extension advice) are generally small: less than 3 km nationally and only exceeding 5 km in the Marginal Rain Shadow zone.

¹ This information was obtained from asking household survey respondents the following questions: (1) for your largest maize sales transaction, how many kms is the farm from the point of maize sale. (2) How many kms is it to the nearest fertilizer stockist /...provider of veterinary services / ...agricultural extension service / ...road that is motorable throughout the year / ...tarmac road / ...health facility / ...source of electrification.

² Appendix Figures 1 and 2 show maps of two randomly selected areas in the Tegemeo sample to provide a spatial impression of the density of road infrastructure in rural areas of the country.

Table 2c summarizes the changes between 1997 and 2007 by calculating the differences in median distances for each indicator. There has been a clear reduction (improvement) for most indicators and geographic areas over the past decade. For example, the median reported distance travelled by a farm household to a fertilizer retailer decreased by 1.0 km nationally (from 3.0 to 2.0 km). The biggest reductions in distance to fertilizer retailer occurred in the semi-arid areas such as the Coastal Lowlands, Western Lowlands, and Marginal Rain Shadow where fertilizer retailing had been (and remains) least developed. For example, median distance travelled to a fertilizer retailer in the Western Lowlands area has declined from 12 km in 1997 to 3 km in 2007. There was no decline in the median distance travelled by farmers selling maize to the point of sale between 1997 and 2007 because the median distance in both years was zero. As shown in Tables 3a to 3d, which report mean distances instead of medians, the mean distance from the farm to the point of maize sale declined from 0.9 km to 0.5 km. These findings indicate that maize assembly traders have penetrated far into rural areas of Kenya and are buying maize directly in the villages. However, these results do not count households that might have maize to sell but could not do so due to problems of market access. More detailed tables indicating changes over time in smallholders' access to maize buyers is presented in Appendix 2.

Table 2a. Median household indicator values, 2007

Agro-ecological zone	maize									
	point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	1.0	3.0	2.0	2.0	2.0	0.5	2.0	0.2	1.5	1.0
Eastern Lowlands	1.5	2.0	3.0	3.0	4.0	0.3	9.0	1.0	3.0	3.0
Western Lowlands	0.0	3.0	5.0	2.0	6.0	0.3	2.0	2.0	2.5	2.0
Marginal Rain Shadow	0.0	2.5	2.5	2.0	2.0	0.3	11.0	9.0	2.0	20.0
Western Transition	0.0	2.8	3.0	2.0	3.5	0.2	6.0	4.0	3.0	2.0
High Potential Maize	0.0	2.5	3.0	2.5	3.0	0.2	6.0	5.0	3.0	2.0
Western Highlands	1.5	2.0	2.5	2.0	3.0	0.4	8.0	4.0	2.0	2.0
Central Highlands	0.0	1.0	1.0	1.0	1.4	0.1	5.0	0.0	1.0	0.2
<i>National</i>	0.0	2.0	2.5	2.0	3.0	0.2	6.0	2.0	2.0	2.0

Table 2b. Median household indicator values, 1997

Agro-ecological zone	maize									
	point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	0.0	25.0	3.0	3.0	3.0	0.5	2.0	0.2	2.0	1.8
Eastern Lowlands	3.5	4.0	4.0	4.0	4.0	0.5	10.0	3.0	4.0	4.5
Western Lowlands	0.0	12.0	5.0	3.0	5.0	2.0	2.0	4.0	4.0	3.0
Marginal Rain Shadow		25.0	2.0	3.0	2.0	2.0	10.0	20.0	2.5	12.0
Western Transition	0.0	5.0	3.0	4.0	5.0	0.2	6.0	4.0	3.0	3.0
High Potential Maize	0.0	2.0	3.5	6.0	4.0	0.2	6.0	6.0	4.0	4.0
Western Highlands	2.0	2.0	3.0	4.0	5.0	1.0	10.0	6.5	4.0	3.5
Central Highlands	0.0	1.5	2.0	2.0	2.5	0.1	4.5	0.5	2.0	1.0
<i>National</i>	0.0	3.0	3.0	4.0	4.0	0.4	5.0	4.0	3.0	3.0

Table 2c. Absolute kilometer changes in median household indicator values, 2007-1997

Agro-ecological zone	maize									
	point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	1.0	-22.0	-1.0	-1.0	-1.0	0.0	0.0	0.0	-0.5	-0.8
Eastern Lowlands	-2.0	-2.0	-1.0	-1.0	0.0	-0.2	-1.0	-2.0	-1.0	-1.5
Western Lowlands	0.0	-9.0	0.0	-1.0	1.0	-1.7	0.0	-2.0	-1.5	-1.0
Marginal Rain Shadow		-22.5	0.5	-1.0	0.0	-1.7	1.0	-11.0	-0.5	8.0
Western Transition	0.0	-2.3	0.0	-2.0	-1.5	0.0	0.0	0.0	0.0	-1.0
High Potential Maize	0.0	0.5	-0.5	-3.5	-1.0	0.0	0.0	-1.0	-1.0	-2.0
Western Highlands	-0.5	0.0	-0.5	-2.0	-2.0	-0.6	-2.0	-2.5	-2.0	-1.5
Central Highlands	0.0	-0.5	-1.0	-1.0	-1.1	0.0	0.5	-0.5	-1.0	-0.8
<i>National</i>	0.0	-1.0	-0.5	-2.0	-1.0	-0.2	1.0	-2.0	-1.0	-1.0

Table 2d. Percentage changes in median household indicator values, 2007-1997

Agro-ecological zone	maize									
	point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	<i>na</i>	-88%	-33%	-33%	-33%	0%	0%	0%	-25%	-43%
Eastern Lowlands	-57%	-50%	-25%	-25%	0%	-40%	-10%	-67%	-25%	-33%
Western Lowlands	<i>na</i>	-75%	0%	-33%	20%	-85%	0%	-50%	-38%	-33%
Marginal Rain Shadow		-90%	25%	-33%	0%	-85%	10%	-55%	-20%	67%
Western Transition	<i>na</i>	-45%	0%	-50%	-30%	0%	0%	0%	0%	-33%
High Potential Maize	<i>na</i>	25%	-14%	-58%	-25%	0%	0%	-17%	-25%	-50%
Western Highlands	-25%	0%	-17%	-50%	-40%	-60%	-20%	-38%	-50%	-43%
Central Highlands	<i>na</i>	-33%	-50%	-50%	-44%	0%	11%	-100%	-50%	-77%
<i>National</i>	<i>na</i>	-33%	-17%	-50%	-25%	-50%	20%	-50%	-33%	-33%

Table 3a. Mean household indicator values, 2007

Agro-ecological zone	maize point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	1.0	9.9	4.5	2.3	6.0	0.9	8.8	3.3	3.2	4.0
Eastern Lowlands	1.7	2.7	3.7	3.1	5.5	0.5	12.4	1.8	3.3	6.6
Western Lowlands	1.2	3.8	5.3	2.7	5.9	0.6	6.4	4.0	2.6	2.6
Marginal Rain Shadow	0.0	2.3	4.5	2.3	2.3	1.0	12.4	11.5	2.2	16.2
Western Transition	0.1	3.6	3.9	2.8	4.3	0.4	8.4	5.6	3.7	3.6
High Potential Maize	0.2	3.6	5.3	3.6	5.6	0.6	6.6	6.5	3.9	5.6
Western Highlands	1.7	2.4	2.8	2.5	3.8	0.5	7.4	4.1	2.8	2.7
Central Highlands	0.4	1.3	2.0	2.0	2.3	0.2	5.4	0.4	1.9	0.5
<i>National</i>	0.5	3.3	4.0	2.8	4.6	0.5	7.6	4.1	3.1	4.1

Table 3b. Mean household indicator values, 1997

Agro-ecological zone	maize point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	0.0	28.3	8.9	5.8	9.0	1.4	8.3	6.8	3.1	4.3
Eastern Lowlands	3.5	9.8	5.2	6.1	5.5	1.5	14.9	13.1	4.7	9.8
Western Lowlands	0.1	15.9	6.3	3.9	6.8	2.1	5.8	8.1	5.1	4.2
Marginal Rain Shadow		26.2	4.2	8.7	2.8	2.2	11.4	19.9	2.8	15.1
Western Transition	0.7	6.3	4.6	6.0	5.4	0.5	7.2	6.6	4.7	4.9
High Potential Maize	0.4	5.0	5.1	7.8	5.4	0.8	8.3	10.2	4.9	7.7
Western Highlands	3.2	3.3	3.5	3.6	5.3	1.5	8.2	8.4	4.1	3.7
Central Highlands	0.9	2.7	2.9	3.1	3.6	0.5	5.6	1.7	3.0	1.5
<i>National</i>	0.9	7.9	4.8	5.5	5.3	1.1	8.2	8.7	4.2	5.7

Table 3c. Absolute kilometer changes in mean household indicator values, 2007-1997

Agro-ecological zone	maize point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	1.0	-18.4	-4.4	-3.5	-3.0	-0.5	0.5	-3.5	0.1	-0.3
Eastern Lowlands	-1.8	-7.1	-1.5	-3.0	0.0	-1.0	-2.5	-11.3	-1.4	-3.2
Western Lowlands	1.1	-12.1	-1.0	-1.2	-0.9	-1.5	0.7	-4.1	-2.5	-1.6
Marginal Rain Shadow		-23.9	0.3	-6.4	-0.5	-1.2	1.0	-8.4	-0.6	1.1
Western Transition	-0.6	-2.7	-0.8	-3.2	-1.1	-0.2	1.2	-1.0	-1.1	-1.2
High Potential Maize	-0.1	-1.4	0.2	-4.2	0.1	-0.2	-1.7	-3.7	-0.9	-2.2
Western Highlands	-1.4	-0.9	-0.6	-1.1	-1.5	-1.0	-0.7	-4.3	-1.3	-1.0
Central Highlands	-0.5	-1.4	-1.0	-1.1	-1.3	-0.3	-0.2	-1.4	-1.1	-1.0
<i>National</i>	-0.4	-4.7	-0.8	-2.7	-0.7	-0.6	-0.6	-4.6	-1.2	-1.6

Table 3d. Percentage changes in mean household indicator values, 2007-1997

Agro-ecological zone	maize point of sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water	health center	electricity service
Coastal Lowlands	<i>na</i>	-65%	-50%	-61%	-33%	-34%	6%	-51%	4%	-7%
Eastern Lowlands	-51%	-73%	-29%	-49%	-1%	-66%	-17%	-86%	-29%	-33%
Western Lowlands	823%	-76%	-16%	-30%	-13%	-72%	11%	-51%	-48%	-39%
Marginal Rain Shadow		-91%	7%	-74%	-16%	-54%	9%	-42%	-22%	7%
Western Transition	-89%	-43%	-17%	-54%	-21%	-29%	17%	-15%	-22%	-25%
High Potential Maize	-34%	-29%	4%	-53%	3%	-25%	-20%	-36%	-19%	-28%
Western Highlands	-45%	-27%	-18%	-30%	-28%	-65%	-9%	-51%	-31%	-28%
Central Highlands	-53%	-53%	-34%	-36%	-37%	-52%	-3%	-78%	-36%	-64%
<i>National</i>	-43%	-59%	-16%	-49%	-14%	-52%	-7%	-53%	-27%	-29%

The biggest changes in median distance occurred for access to telephone services and improved water sources, distances to which decreased by 2 km. Other gains are visible for indicators reflecting investments of private agents (km to nearest fertilizer retailer, extension advice) as well as more general public resources (health services, electricity). The least dramatic improvements were for veterinary services, motorable roads, and the distance traveled to the point of maize sale (which, as discussed earlier, was zero for the majority of households even in 1997).

The only indicator for which the national median travel distance increased was the kilometres to the nearest tarmac road, which was 5.0 km in 1997 and 6.0 km in 2007. Note, however, that median distances for this indicator either decreased or stayed the same in six out of eight agro-ecological zones.

Table 2d presents the percentage change in the median distance variables between 1997 and 2007. The overall patterns of percentage changes are similar to those of kilometer reductions, although the improvements in variables with relatively small starting points are emphasized. Thus, for example, the small absolute changes between 1997 and 2007 in the median distance to motorable roads are actually quite large percentage improvements.

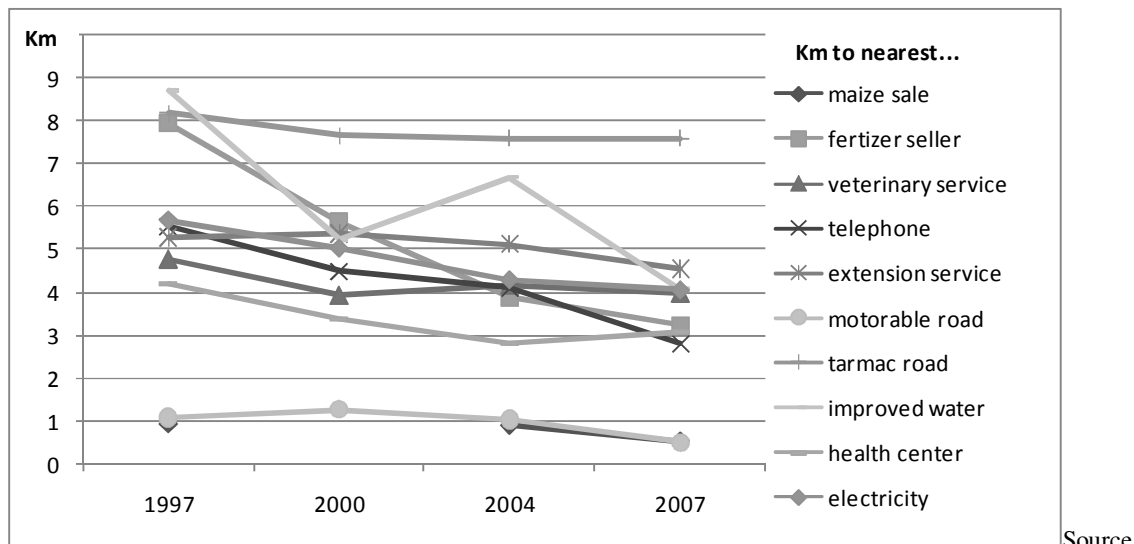
Table 2d shows that many of the largest improvements in percentage terms have occurred in the higher potential zones (Western Transition, High Potential Maize, Western Highland, and Central Highland zones), although for some indicators – particularly the median distance to fertilizer retailer and motorable road – the largest improvements take place in lower potential zones (Coastal Lowlands, Eastern Lowlands, Western Lowlands, and Marginal Rain Shadow).

Evidence of improvements in access as indicated by changes in median values (Table 2) is consistent with the story told by mean values (Table 3). In fact, the improvements tend to be more pronounced when calculated on the basis of means. Half of the indicators improved by more than 40%; nine of the ten indicators improved by more than 10%. The higher reductions in mean values (compared to median reductions) are partly due to the fact that distributions are skewed, with a small number of households reporting relatively large travel distances. This skewness characterizes all the indicator values in all agro-ecological zones. Yet the

general picture is consistent whether examined in terms of median or mean changes. Overall, the household survey data provide strong evidence that access to markets and basic services have improved for rural households over the past decade in Kenya, in some cases dramatically.

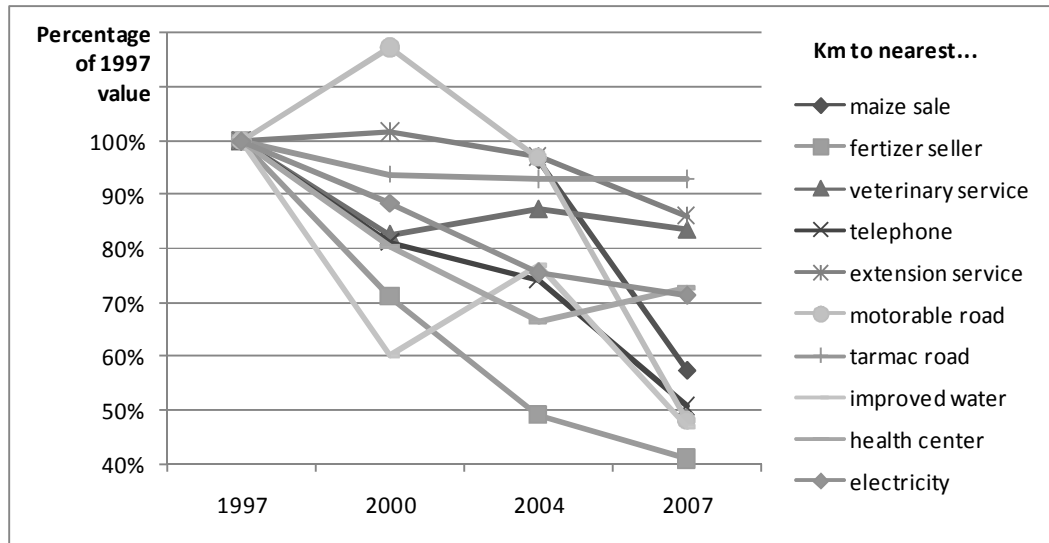
Figures 2a and 2b plot these changes in access graphically. Figure 2a reports the absolute kilometer distance over time in selected indicators, while Figure 2b shows the percentage reduction in mean distance relative to 1997, for which values are normalized to 100. Of particular note is the pronounced reduction in mean distances to the nearest fertilizer retailer, which decreased steadily over this 10-year period after the deregulation of the fertilizer market in the early 1990s. Smallholders' purchases of fertilizer over the sample period rose rapidly during this period and their purchases were all from private stockists. The reduction in the distance to fertilizer retailers during this period as measured in the survey data reflects the expansion of geographical coverage that occurred after the liberalization of this market. Thus, the trends shown may be interpreted as the expanding discovery of and response to opportunities for fertilizer sales.

Figure 2a. Changes in mean kilometer distance to selected indicators, 1997-2007



: Tegemeo Rural Household Survey.

Figure 2b. Relative changes in mean indicator values, indexed to 1997



Source: Tegemeo Rural Household Survey.

Another notable trend in these figures is the pronounced reductions in travel distances for some indicators during the 2004 to 2007 period. This is particularly true for rural roads, telephones, improved water sources, and distance to the point of maize sale to private trader. The Constituency Development Fund, under which local authorities were given increased control of resources, was established in 2003/4. The sharp reduction in the distance to roads, telephone, and water points between the 2004 and 2007 surveys may be associated with this administrative reform.

4. Variation across Households in Distance Variables

The tables above do not enable us to understand the degree of variation in households' access to these markets and services across the entire sample. To examine this issue, we compute the kilometer distances for each variable at various percentiles of the household sample distribution (Table 4a for 2007 and Table 4b for 1997). The figures in Table 4a can be interpreted as follows, using the case of veterinary services as an example: 10% of households travelled 0.5 km or less to the nearest veterinary service; 25% of the households travelled 1.0 km or less; 75% of all the households in the sample travelled 5.0 kilometers or less; 90% of the sample travelled 8.0 or less, meaning that 10% of the households travelled more than 8 km to access veterinary services.

The findings show considerable dispersion in access to markets across the household sample. For example, while 50% of households were located 2.0 km or less to a fertilizer retailer, 10% of the sample had to travel more than 6.0 km to access a fertilizer retail store. While 50% of the sample was less than 6 km from a tarmac road, 10% of the sample was over 15 km from one.

By comparing the figures in Table 4a and 4b, it is again clear that access to markets and services has improved, dramatically so for those who were the furthest from such services in 1997. For example, 90% of households in 1997 were 24 kilometres or less from a fertilizer seller; this means that 10% of the sample were more than 24 kilometres from one. By 2007, 90% of households were less than 6 km from a fertilizer seller and only 10% were more than 6 km from one. Comparable progress has been made in reducing the distance to improved water sources, electricity, telephone services, and motorable roads for households that were relatively remote from such services in 1997. Smaller gains have been achieved for households who were relatively close to such infrastructure and markets in 1997, but these gains held for almost all access indicators.

Table 4a. Variation across households in distance to markets and services, 2007

Household-level percentile	Kilometers to nearest									
	point of maize sale	fertilizer seller	veterinary svc	telephone service	extension service	motorable road	tarmac road	improved water source	health center	electricity
10th	0.0	0.5	0.5	0.5	1.0	0.1	0.8	0.0	0.7	0.1
25th	0.0	1.0	1.0	1.0	1.5	0.1	2.0	0.2	1.0	0.5
50th	0.0	2.0	2.5	2.0	3.0	0.2	6.0	2.0	2.0	2.0
75th	0.0	4.0	5.0	3.5	6.0	0.5	10.0	6.0	4.0	4.0
90th	2.0	6.0	8.0	6.0	10.0	1.0	15.0	10.0	6.0	8.0

Table 4b. Variation across households in distance to markets and services, 1997

Household-level percentile	Kilometers to nearest									
	point of maize sale	fertilizer seller	veterinary svc	telephone service	extension service	motorable road	tarmac road	improved water source	health center	electricity
10th	0.0	0.8	1.0	1.0	1.0	0.0	0.5	0.0	1.0	0.5
25th	0.0	1.5	2.0	2.0	2.0	0.1	2.0	1.0	2.0	1.5
50th	0.0	3.0	3.0	4.0	4.0	0.4	5.0	4.0	3.0	3.0
75th	0.0	10.0	6.0	6.0	7.0	1.5	11.0	12.0	5.0	6.0
90th	3.5	24.0	10.0	12.0	12.0	3.0	17.0	25.0	8.0	12.0

5. Geographic Differences in Access Indicators

The biggest reductions in the distance variables were generally achieved in the most remote zones (Figure 3, which corresponds to Table 2d). A major element of access improvements in the last decade has been progress in redressing imbalances in access to markets and services across geographic areas. This is particularly true for distance to fertilizer sellers, but also for some public investments: electricity services and (in a relative sense) improved water sources also show greatest gains in more remote areas. Other access changes resulting from public investments have resulted in greater uniformity across geographic areas in access to services.

Figure 3 categorizes the percentage reduction in access variables between those attributable to the private vs. public sector investment. The variables reflecting investment patterns by the private sector include the distance from farm to point of maize sale to private trader, distance from farm to nearest fertilizer retailer, veterinary services, and telephone services.³ The variables primarily reflecting investment patterns by the public sector include distance to the nearest motorable road, tarmac road, extension services, piped water source, health center and electricity.

Figure 4 summarizes the percentage reduction in distance, disaggregated between the services provided by the public and private sectors. On the whole, the patterns of change shown in Figure 4 convey greater uniformity across geographic zones in the improvement in public sector

³ The telephone variable actually reflects both public and private investment and coordination. In 1999, the telecommunications industry was deregulated (under the 1998 Kenya Communications Act, which went into effect in 1999). Before 1999, the Kenya Posts and Telecommunication, a state monopoly, was in charge of regulation and service provision across the sector. Since 1999, the Communications Commission of Kenya (CCK) is in charge of regulating the sector, and two parastatals - Telkom Kenya and Postal Corporation - provide telephone and postal services, respectively. From 1999 to 2004, Telkom Kenya had a 5-year exclusivity arrangement. In 2004, competition opened up. Most private telecom firm entry has been in the mobile phone sector, although there are now also 18 licensed "last mile" service providers for fixed line service (2 of which are active at present). In 2007, France Telecom acquired 51% of Kenya Telkom, with the Government of Kenya remaining the next major holder. However, CCK still has active role in guiding the provision of service throughout the country. The ICT Policy of 2006 mandates that CCK "facilitate the provision of communications services throughout the country." This policy has a universal access goal, which includes having the national network be "non-discriminatory in terms of geographical location, religion, race, and sex."

investments than private sector investments. However, the greatest percentage reductions (improvements) in distances have been for private sector investment compared to public investments. Largely driven by changes in distance to fertilizer sellers, private-investment access changes have occurred to a greater extent in zones which may be characterized as moderate to low productivity – in other words, the less traditional surplus production areas of the country. This is particularly true for fertilizer sales.

The fact that private sector investments in support of smallholder market access have been most apparent in the relatively low-potential zones may reflect where unmet profit opportunities are the greatest. For example, if most farmers in the higher potential areas (e.g., Central Highlands, Western Highlands) are already participating in marketing chains with interlinked crop marketing-input provision, then there may be less scope for new entrants.

Figure 3. Percentage reduction in median kilometer distance by AEZ, 1997 to 2007

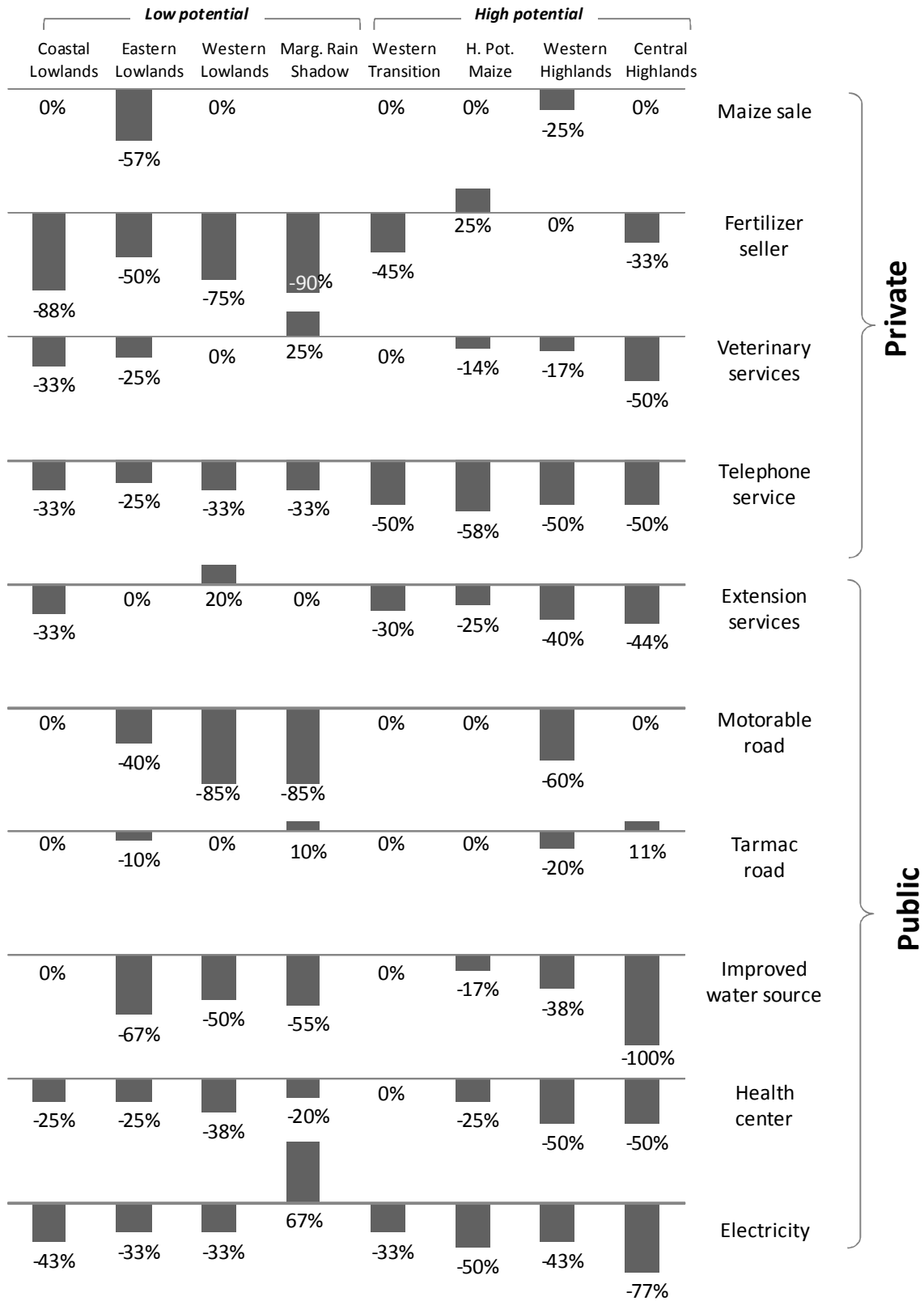
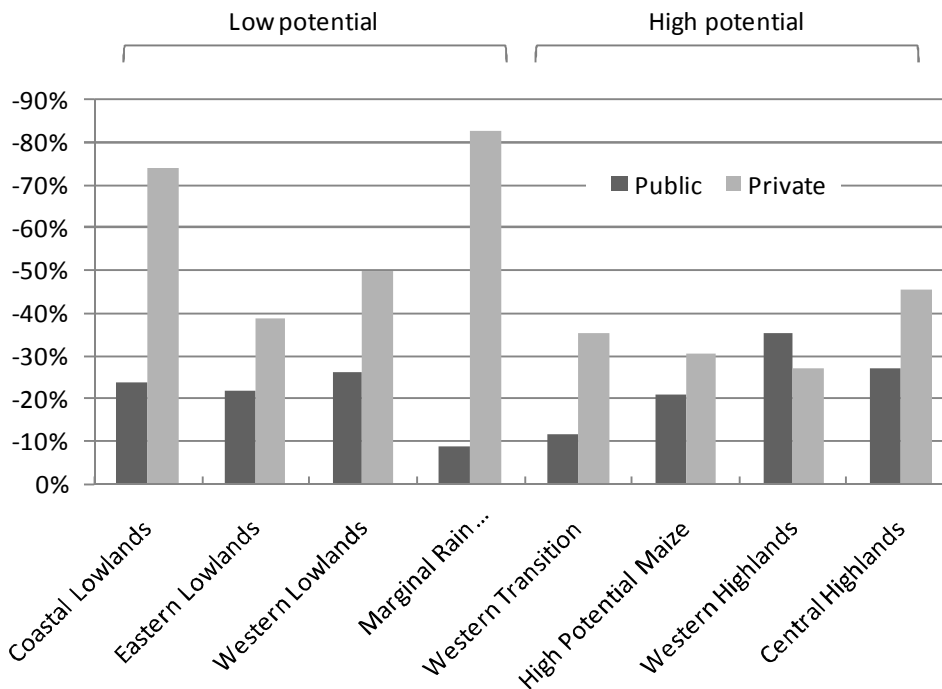


Figure 4. Average percentage reduction in distance to public and private services and infrastructure, 1997-2007



Note: Private services include fertilizer sales and veterinary services. Public services/infrastructure includes: extension services, roads, improved water source, health center, electricity, and telephone service. Changes are calculated on the basis of median values.

In such a case, the highest marginal returns to new private investment in input retailing might very well be in the medium- to lower-potential areas which have been historically underserved. This interpretation might indeed explain the higher rates of change in indicators of private investment in areas which were previously underserved. Fan and Hazell (2003) found a similar pattern of greater private investment in relatively low-potential areas of India during the 1990s because substantial investments had already been made earlier in the high-potential areas, thus providing greater returns to additional investment in the relatively under-served areas. Public investments, on the other hand, show much more uniform distributions of change between high- and low-potential areas (Table 5), perhaps reflecting political demands for equity in resource distribution.

Table 5. Percentage change in average distance, 1997-2007, by investment type

	Private	Public
High potential zones	-34%	-30%
Low potential zones	-57%	-34%

Note: The indicators belonging to private and public categories are specified in Table 1 and equally weighted within each category. Change is calculated on the basis of median values.

6. Correlation between Access Indicators

Tables 6a and 6b show the correlations between the various indicators of market access for 2007 and 1997. Correlation coefficients vary between -1.0 and +1.0. A correlation coefficient of zero between two indicators would mean that the two indicators are totally uncorrelated – variations among households in one indicator would not be associated with any change in the other indicator. At the other extreme, a correlation of +1.0 would indicate that the two measures are totally in sync with each other. An important observation from Table 6a and 6b is the generally low level of correlation between access measures, even though they are statistically significantly related. Correlation coefficients tend to be relatively low, with most falling in the range of 0.1 to 0.4. Only four pairs of indicators have correlation coefficients greater than 0.5 in 1997; a single pair of indicators has a correlation coefficient exceeding 0.5 in 2007 (distances to veterinary and extension services). Furthermore, many indicators with logical associations, such as locations of maize output sales and those of input market services, show no greater degree of association than other indicator pairs. However, almost all correlation coefficients are highly significant.

Two immediate conclusions may be drawn. First, “market access” appears to be a multidimensional concept. It is quite difficult conceptually to imagine a single indicator which accurately represents a household’s “access to markets”. Access to markets and services may vary according to the type of market and service. Most importantly, distance to the nearest motorable road, which is often used as a proxy for household market access in empirical research applications, shows a limited degree of correlation with most other access indicators (in the range of 0.07-0.28 in 2007). Hence, despite the plausible idea that remoteness will generally mean greater distances to all types of infrastructure and services, this dataset indicates that any single indicator would do a mediocre job at best, of summarizing an overall access situation.

A second observation, somewhat more surprising, is that the correlation between indicators varies considerably over time. For data from a household survey, some response variability might be expected to derive from sample variation and/or outlying values. However, because all respondents in this analysis are part of a panel, variation in the correlations among indicators

over time due to sample variation can be ruled out. Furthermore, the correlations shown in the tables below are for village-level means (averaged across all households in a village), which further controls for idiosyncratic household responses. This suggests that indicators of physical access to markets and services vary substantially over time – indicators that are correlated with each other at one point in time may become less highly correlated in subsequent years, as both the private and public sectors make new investments in different areas over time. For both of these reasons, it may, therefore, be highly problematic to use only one or two indicators as a generalizable measure of market access.

Table 6a. Correlation coefficient matrix, 2007

	point-of-sale for maize	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water source	health center
fertilizer seller	0.03	1							
veterinary svc	0.06	0.25 ***	1						
telephone service	0.02	0.32 ***	0.31 ***	1					
extension service	0.00	0.28 ***	0.53 ***	0.22 ***	1				
motorable road	0.07	0.23 ***	0.21 ***	0.16 ***	0.12 ***	1			
tarmac road	0.15 ***	0.33 ***	0.19 ***	0.15 ***	0.16 ***	0.11 ***	1		
improved water source	-0.08	0.21 ***	0.41 ***	0.24 ***	0.21 ***	0.18 ***	0.35 ***	1	
health center	0.13***	0.29 ***	0.48 ***	0.39 ***	0.33 ***	0.16 ***	0.21 ***	0.41 ***	1
electricity	0.12 **	0.20 ***	0.47 ***	0.25 ***	0.30 ***	0.28 ***	0.48 ***	0.49 ***	0.46 ***

Notes: Values shown are pairwise correlation coefficients. Stars indicate confidence level of the coefficient estimates: ** = .05 confidence level; *** = .01 confidence level. In 2007, for distance to point of sale for maize, the number of observations ranges from 431-441. For all other variables, number of observations ranges from 1221-1267.

Table 6b. Correlation coefficient matrix, 1997

	point-of-sale for maize	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water source	health center
fertilizer seller	0.21 ***	1							
veterinary svc	-0.02	0.29 ***	1						
telephone service	0.09	0.15 ***	0.34 ***	1					
extension service	-0.03	0.24 ***	0.62 ***	0.29 ***	1				
motorable road	0.24 ***	0.22 ***	0.20 ***	0.11 ***	0.10 ***	1			
tarmac road	0.29 ***	0.36 ***	0.29 ***	0.44 ***	0.20 ***	0.22 ***	1		
improved water source	0.22 ***	0.38 ***	0.22 ***	0.36 ***	0.14 ***	0.25 ***	0.61 ***	1	
health center	0.05	0.01	0.34 ***	0.19 ***	0.26 ***	0.11 ***	0.10 ***	0.16 ***	1
electricity	0.20 ***	0.33 ***	0.24 ***	0.48 ***	0.18 ***	0.20 ***	0.64 ***	0.68 ***	0.19 ***

Notes: Values shown are pairwise correlation coefficients. Stars indicate confidence level of the coefficient estimates: ** = .05 confidence level; *** = .01 confidence level. In 1997, for distance to point of sale for maize, the number of observations ranges from 234-267. For all other variables, number of observations ranges from 923-1212.

7. Discussion and Conclusions

Based on this sample of 1,267 households surveyed in 22 districts of Kenya, smallholders in rural Kenya have seen considerable improvements in physical access to market services and infrastructure over the past decade. Access conditions have improved for most areas and for almost all indicators for which data was consistently collected over the 1997-2007 period. Evidence of improvement in access to motorable roads and clean water supply since 2004 may reflect the impact of the CDF, which devolved authority to local district authorities after 2004. Also, the Water Act of 2002 established a Water Services Trust Fund to help finance the provision of water services to areas without adequate coverage. This may be related to some of the changes documented in this paper.

After categorizing the access indicators available in the survey data to those reflecting public expenditures vs. private sector investment, the following conclusions emerged. First, access indicators attributed to public sector investment improved in virtually all regions, and these improvements were relatively similar across relatively high-potential and low-potential areas. The changes in access deriving from public investments have tended to be more or less geographically equitable, as we expected. This may be due to political considerations, but further exploration of the reasons for these patterns is beyond the scope of this paper.

Second, there were also broad improvements in indicators of market access attributable to private sector investment. In particular, the distance households traveled to the point of maize sale and to the nearest fertilizer retailer declined by 0.4 km and 4.7 km, respectively, between 1997 and 2007. This represents a 43% and 59% reduction in distance and reflects an increased density of grain buyers and fertilizer sellers operating in rural areas. By 2007, over 75% of smallholder households selling maize stated that the private trader to which they sold came to their farm or village to buy their maize. Private traders accounted for 71% of the sales transactions in 2007; neighboring households and the NCPB accounted for the remaining 22% and 7% of transactions. There were also improvements in the distance travelled to access veterinary services. Maize and fertilizer markets were fully liberalized in Kenya in the early 1990s, hence the proximity of farm households to fertilizer retailers and maize buyers reflects changes in the density of traders

operating in smallholder areas. Similarly, the distance travelled by farmers to access veterinary services reflects the extent to which private veterinary providers have penetrated into rural areas.

Third, the improvements in access to markets reflecting private sector investment were greatest in the relatively low-potential areas. For example, the decline in distance to nearest fertilizer retailer was greatest in the Eastern Lowlands (Machakos, Makueni, Mwingi, and Kitui districts), Western Lowlands (Kisumu and Siaya districts), the Marginal Rain Shadow (Laikipia district) and the Coast (Taita-Taveta, Kilifi, Kwale districts). The greatest improvements in access to veterinary services were in the Coast, Eastern Lowlands, and Central Highlands (the latter being a relatively high-potential area). The tendency for access indicators reflecting private investment to improve to a greater extent in the relatively low-potential zones may reflect where unmet profit opportunities are the greatest. The highest marginal returns to new private investment in input retailing and output marketing might very well be in the medium- to lower-potential areas which have been historically under-served. Fan and Hazell (2003) found a similar pattern of greater private investment in relatively low-potential areas of India during the 1990s because substantial investments had already been made in earlier decades in the high-potential areas, thus providing greater returns to additional investment in the relatively under-served areas.

Fourth, there has been a major improvement in access to telephone services, reflecting the diffusion of cell phone technology after the liberalization of the telecommunications market. Appendix 3 provides details on factors driving the cell phone rollout in Kenya and the proportion of households in the nationwide sample owning a cell phone in 1997, 2000, 2004, and 2007.

Fifth, we find a surprisingly low degree of correlation between the various indicators of access to markets and services, and that the patterns of correlation change over time. This suggests that the choice of indicator of “market access” is highly important in deriving analytical conclusions. Market access appears to be a multidimensional concept, varying across households and regions according to the type of market and service. For example, distance to the nearest motorable road, which is often used as a proxy for household market access in empirical research, shows a limited degree of correlation with most other access indicators (in the range of 0.07 to 0.28 in 2007). Future analysis measuring the impact of market access may benefit from considering

multiple measures of access, or emphasizing a more structured conceptualization of access – i.e., what kind of indicator best captures the specific marketing channel being evaluated.

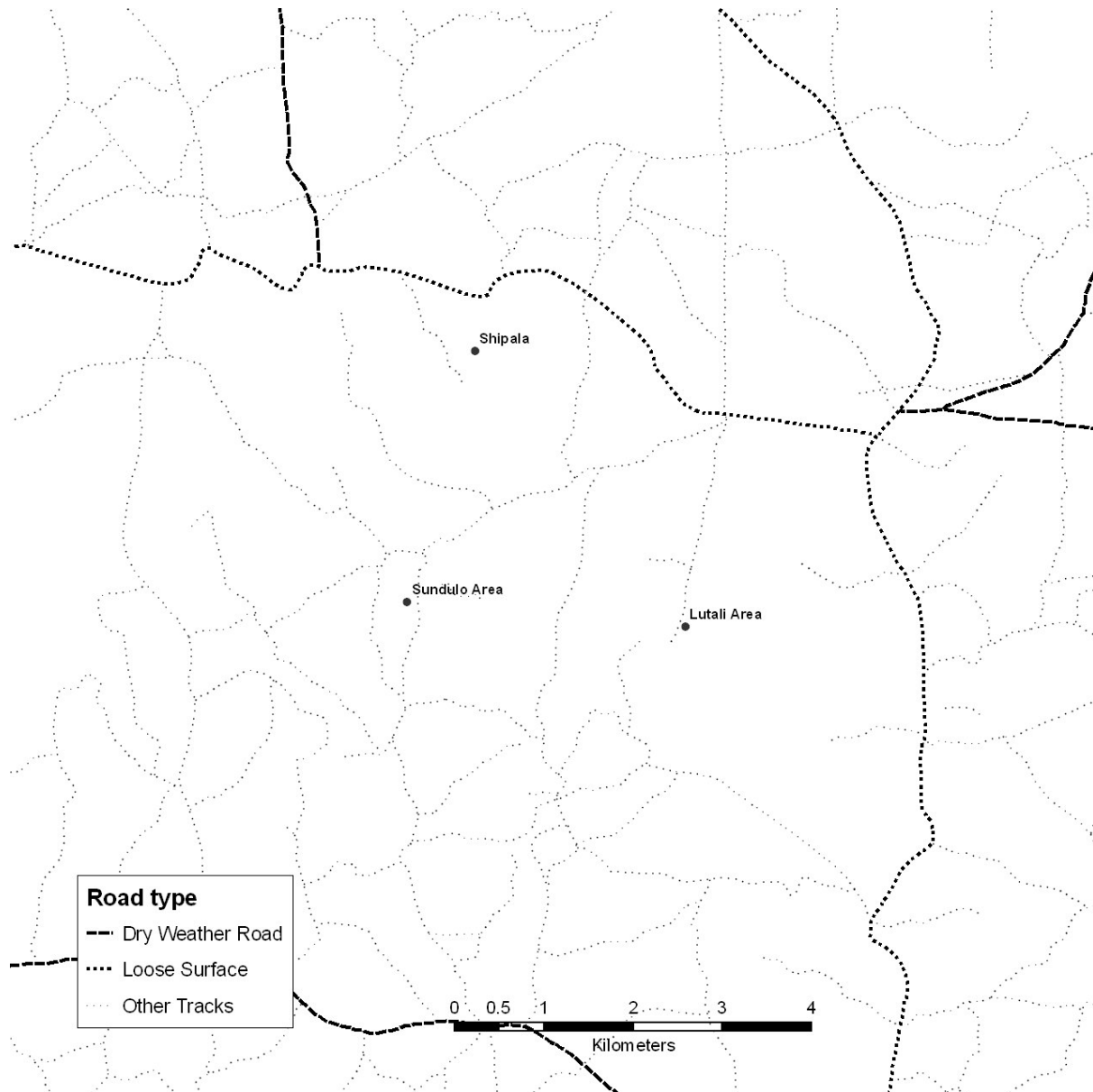
Although improvements in market access feature prominently in theoretical and pragmatic policy discussions to transform smallholder agriculture in Kenya and Sub-Saharan Africa in general, the impact of the changes described in this paper on small farm behavior and welfare remains open questions. We suggest the importance of further study of this question. Our analysis suggests that such analysis should pay considerable attention to the selection of access indicators and include sensitivity analysis of alternative indicators. The analyses presented here suggest that empirical assessments of smallholders' access to markets and the impacts of market access on their behavior may depend on a range of different types of access conditions which may interact in complex ways.

Appendices

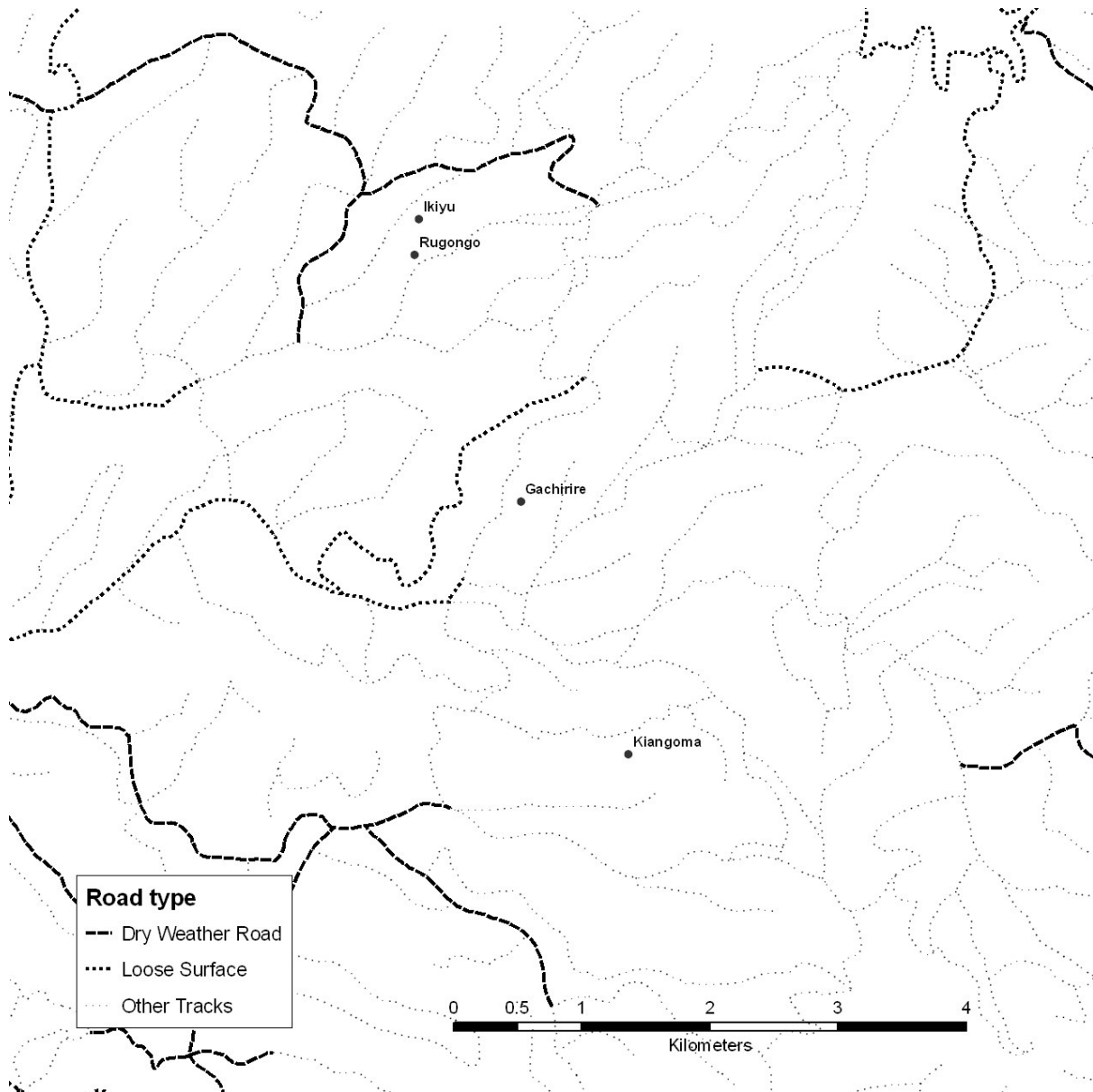
Appendix 1

Appendix Figure 1. Road description around randomly selected sample villages in Western Lowlands Zone

Western Lowlands



Appendix Figure 2. Road description around randomly selected sample villages in Eastern Highlands Zone



Sou
 rces: Village locations are shown as the mean longitude and latitude values of sample household coordinates for the corresponding village; households within a given village are located in the area surrounding the point indicated on the map. Geographic coordinates of households were collected with handheld GPS receivers by field researchers from Tegemeo Institute. Road locations and type assignments are from a field survey conducted in 2008 commissioned by the Kenya Ministry of Roads.

Appendix 2.

Appendix Table 1a. Median distance from farm to maize buyer, 1997-2007⁴

	N	Private Trader	NCPB	Millers/ Processors	Cooperative	Household Consumers
Coastal Lowlands						
1997	7	0.00	-	-	-	0.00
2004	4	0.00	-	-	-	1.00
2007	18	0.00	-	-	-	0.00
Eastern Lowlands						
1997	58	3.50	-	-	-	0.00
2004	94	1.50	-	-	-	0.00
2007	88	1.50	0.00	-	-	0.00
Western Lowlands						
1997	21	0.00	-	-	-	0.00
2004	48	1.50	-	-	-	2.00
2007	50	0.00	-	-	-	0.00
Western Transitional						
1997	41	0.00	-	-	-	0.00
2004	108	0.00	-	-	5.00	0.00
2007	90	0.00	-	-	-	0.00
High Potential Maize Zone						
1997	230	0.00	13.00	12.00	2.00	0.00
2004	313	0.00	19.00	10.00	32.00	0.00
2007	312	0.00	15.00	12.50	-	0.00
Western Highlands						
1997	40	2.00	-	-	-	1.00
2004	116	2.50	-	-	-	1.50
2007	105	1.00	-	-	-	0.00
Central Highlands						
1997	82	0.00	0.00	-	-	0.00
2004	85	0.00	-	20.00	-	0.00
2007	125	0.00	0.25	24.00	-	0.00
Marginal Rain Shadow						
1997	1	-	-	0.00	-	-
2004	15	0.00	-	-	-	0.00
2007	24	0.00	-	-	-	0.00

⁴ Distance to the point of sale data was not collected in 2000.

Appendix Table 1b. Mean distance from farm to maize buyer, 1997-2007

	N	Private Trader	NCPB	Millers/ Processors	Cooperative	Household Consumers
Coastal Lowlands						
1997	7	0.00	-	-	-	0.00
2004	4	0.00	-	-	-	1.33
2007	18	0.78	-	-	-	0.22
Eastern Lowlands						
1997	58	6.55	-	-	-	1.27
2004	94	3.15	-	-	-	1.46
2007	88	1.62	0.00	-	-	1.28
Western Lowlands						
1997	21	0.13	-	-	-	1.00
2004	48	2.48	-	-	-	2.50
2007	50	1.04	-	-	-	0.26
Western Transitional						
1997	41	0.71	-	-	-	0.00
2004	108	0.25	-	-	4.67	0.34
2007	90	0.07	-	-	-	1.55
High Potential Maize Zone						
1997	230	1.80	12.77	29.88	2.00	0.59
2004	313	1.13	18.57	9.48	32.00	2.88
2007	312	0.40	13.50	9.75	-	2.69
Western Highlands						
1997	40	3.15	-	-	-	2.70
2004	116	2.62	-	-	-	2.24
2007	105	1.81	-	-	-	0.96
Central Highlands						
1997	82	0.94	0.00	-	-	2.07
2004	85	1.32	-	19.33	-	0.26
2007	125	0.42	0.25	24.00	-	0.50
Marginal Rain Shadow						
1997	1	-	-	0.00	-	-
2004	15	0.71	-	-	-	0.00
2007	24	0.00	-	-	-	0.20

Appendix 3

Mobile phone services in Kenya: 1992-present

Mobile telephone services in Kenya were launched with an analog system in 1993. Service provision during the first years was very expensive, and therefore largely restricted to the wealthy. Because of these costs, mobile subscribers were few in number for most of the 1990s.

The Kenya Communications Act of 1998 opened the cellular mobile industry to competition. There are now four licensed mobile service providers in the country: Safaricom, Zain (formerly known as Celtel Kenya), Telkom Kenya (operating commercially as Orange Mobile) and Econet Wireless.

With the opening of the market, the number of subscribers has grown tremendously over the last decade, as has the geographical coverage of service. For example, the combined subscriber base of the two main mobile service providers, Safaricom and Zain, reached 12.9 million in June of 2008. There are now twenty times as many mobile network subscribers as there are fixed network subscribers. This growth in mobile telephony strongly suggest that the improved access to telephones as indicated in the Tegemeo rural sample is being largely, if not exclusively, driven by cell phone purchases.

Source: Communications Commission of Kenya (<http://www.cck.go.ke>)

Appendix Table 2. Share of households that own a phone by agricultural zone over time

Agro-Ecological Zone	Share of households that own a phone (%)			
	1997	2000	2004	2007
Coastal Lowlands	4.0	0.0	16.0	61.3
Eastern Lowlands	1.4	1.4	18.6	52.4
Western Lowlands	0.0	.7	17.0	41.2
Western Transitional	0.0	0.0	10.1	37.8
High Potential Maize Zone	0.6	1.2	22.0	60.4
Western Highlands	0.0	0.8	14.0	50.4
Central Highlands	1.2	3.7	19.4	66.5
Marginal Rain Shadow	2.7	0.0	18.9	67.6
Total Sample	0.9	1.3	17.9	55.0

Source: Tegemeo Household Survey Data 1997, 2000, 2004, 2007.

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