Staff Paper

Unpacking the Meaning of "Market Access"

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Abstract

Improving farmers' access to markets is widely recognized as a major development challenge. A review of the literature suggests that indicators of market access may bear little relationship to the specific processes of interest and hence provide misguided evidence of the impacts of improved market access. This paper attempts to "unpack" the dimensions of market access and, in the process, uses farm survey data from Kenya to investigate changes in multiple indicators during the post-liberalization period. Findings show that market access conditions experienced by rural Kenyans exhibit considerable variation across time, space, and indicator type. We suggest ways in which structured hypothesizing and sensitivity analysis may strengthen empirical treatments of market access issues in applied research.

Highlights

- Access conditions for smallholders have largely improved in post-liberalization Kenya
- However, market access has multiple dimensions that may be highly commodity-specific
- Commonly used empirical access indicators may not reflect processes of interest
- Correlations among alternative empirical indicators are typically low
- Access indicator choices have major consequences for analytical conclusions

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1. Introduction

There is widespread agreement that smallholder farmers require improved access to agricultural markets to raise their farm productivity and living standards. The prevailing policy narratives on market access in sub-Saharan Africa may be characterized by two major features. First, a majority of rural smallholders operate under dismal market access conditions, with generally high levels of remoteness and associated high marketing costs and risks, and poor access to information and supporting services. Furthermore, these poor access environments have for the most part been either stagnant or worsening in recent decades: many remote areas have not experienced significant infrastructural changes since independence, and the private sector has generally not filled the void left by the withdrawal of governmental supply of public assets under market liberalization programs. A second feature of the dominant narrative is a generality in both the conceptualization and empirical measurement of market access. The importance of access for agricultural development is readily accepted at the level of stylized fact, as are the general mechanisms of impacts: smallholders in remote areas face higher input costs, lower output prices, fewer buyers competing for their surplus production, and weak access to supporting services, which together result in disincentives to adopt new technologies and produce for the market. These reinforcing market access problems contribute to stagnant productivity growth and mire millions of rural farm households in chronic poverty. In practice, however, indicators of market access seem to be selected on an *ad hoc* basis, with indicator choice varying widely across studies and rarely discussed in terms of specific marketing channels, explicit transactions costs, or price formation processes.

We suggest that these features of the prevailing discourse may be linked. An under-conceptualization of market access (and ways to represent its multiple aspects) may be associated in part with a highly generalized portrayal of African smallholders challenged by persistently poor access situations. Excessive

bundling of assumptions about market access into simple indicators is likely to mask important variation in the modes and costs of access for different input and output marketing chains. The purpose of this paper is to "unpack" the dimensions of market access and, in the process, to investigate changes that have been taking place across a variety of access indicators in a sub-Saharan African rural economy. To achieve this objective, we take advantage of panel survey data on 1,233 farm households in 22 districts of Kenya to explore multi-indicator access changes during the post-liberalization decade spanning 1997-2010.

Our work shows that market access conditions experienced by rural Kenyans exhibits a surprising degree of variation, across time, space and indicator type. The levels of some access indicators are remarkably high, even in areas which alternative indicators would suggest are remote. Additionally, significant improvements have taken place in the post-liberalization decade, although varying somewhat across indicator types.

We use these empirical observations to anchor a broader discussion of market access measurement. The low degree of correlation between alternative indicators in our study, and the fact that these correlations vary widely over time and space, suggest that the choice of indicator has major consequences for analysis. A weakly conceptualized role of access in theoretical models may lead to indicator choices which are un-representative of the processes of interest. The consequences of such choices may be profound: poorly selected variables may result in econometric specification problems, specious analytical conclusions, and misguided implications for policy action. Given our case study findings, we suggest ways in which structured hypothesizing and sensitivity analysis may strengthen empirical treatments of market access issues in other contexts.

The remainder of the paper is organized as follows. The next two sections review the dimensions of market access in the development economics literature, acknowledging the conceptual underpinnings,

and examining variables used in empirical analysis of small farm behavior and rural development. Section 4 describes the Kenyan household panel data that we use to explore the relationships between access indicators and trends in these indicators over time, which are then presented in the fifth section. We conclude with some comments about the implications of these relationships for empirical analyses involving market access variables.

2. Theoretical perspectives on market access

A stylized fact of rural development is that remote places are poorer, less productive and less integrated with input and output markets. Physical access has been the principal defining characteristic of remoteness, captured largely if not exclusively through the physical mediation of roads, along with the costs of transportation, travel time to urban markets, and other transactions costs (TCs) implied. Poor access has been identified as an important explanatory factor for persistent underdevelopment in Sub-Saharan Africa, from explicitly theorized microeconomic studies (e.g. de Janvry *et al.,* 1991; Omamo 1998; Key *et al.,* 2000) and macroeconomic perspectives (e.g. Krugman, 1999) to more generalized perspectives on the costs and consequences of remoteness (e.g. Sachs *et al.,* 2000). Prioritizing a microeconomic view, we briefly review the key conceptual bases for this notion, then lay out some generic issues with empirical measurement, and finally review indicators and analytical results from the literature.

Conceptual foundations

von Thünen's incorporation of transportation costs into spatial patterns of comparative advantage for market-oriented production (1826) was perhaps the earliest full expression of the idea of economic

space. His essential insight was that market prices, relative to production costs, implicitly define a rent value for land.[i] Because of the costs associated with physical transportation of goods between locations of production and exchange, the effective market price decays with physical distance, ultimately defining a threshold beyond which production is not economically feasible (i.e. the point at which location rent is zero). Furthermore, because market prices vary across commodities, at any given location, the production of some commodities will capture a higher location rent than alternative production choices. This effectively results in land uses (tied to production choices) being a function of market access. In other words, abstracting from the specifics of production endowments and issues such as perishability, von Thünen showed that market-oriented rural economic activity is fundamentally conditioned by physical market access. To the extent that even autarkic production behavior is a function of market options (Barrett 2008), most production choices can be framed in this manner.[ii]

In what might be thought of as a generalized extension of this idea – that market exchange itself has costs – new institutional economics formalized the notion of transaction costs (TCs) as a major conditioner of interactions, influencing not only production and exchange decisions, but also institutional norms and organizational forms (Coase 1937, North 1990). Much of the emphasis of this work has been on non-physical coordination costs (e.g. contract enforcement), although most of the essential insights apply equally to place-bound transportation, communication and other costs. de Janvry *et al.* (1991) proposed idiosyncratic variation in TCs to explain the failure of rational farmers to engage in markets: costs of accessing markets can drive an effective wedge between input and output prices at the farmgate, rending participation non-economic. Because such costs vary both spatially and aspatially, and in a multitude of ways, they are not always readily perceived. An important corollary of this is the observation that transaction costs (and any measure of access defined in terms of such costs) must be understood from the perspective of a given set of actors in order to be meaningful. A slight extension of this would be to note that even the same actors may use quite different marketing

channels for different goods, each of which may have a distinct set of transactions costs and separate processes of price formation.

Furthermore, transaction costs components may be usefully differentiated. Building on Goetz's (1992) separation of the market engagement choice into decisions on participation and amount traded, Key *et al. (*2000) distinguished between fixed and variable transactions costs, showing that the decision of whether or not to participate in a market is a function of both, while the decision of how much to trade, conditional on the participation decision, is a function of variable transactions costs only. The implication of this, together with the notion of idiosyncratic wedges, is that, if access is most usefully understood in terms of transactions costs, different indicators of access may mean quite different things for different economic actors and the (likely multiple) marketing processes they are involved in.

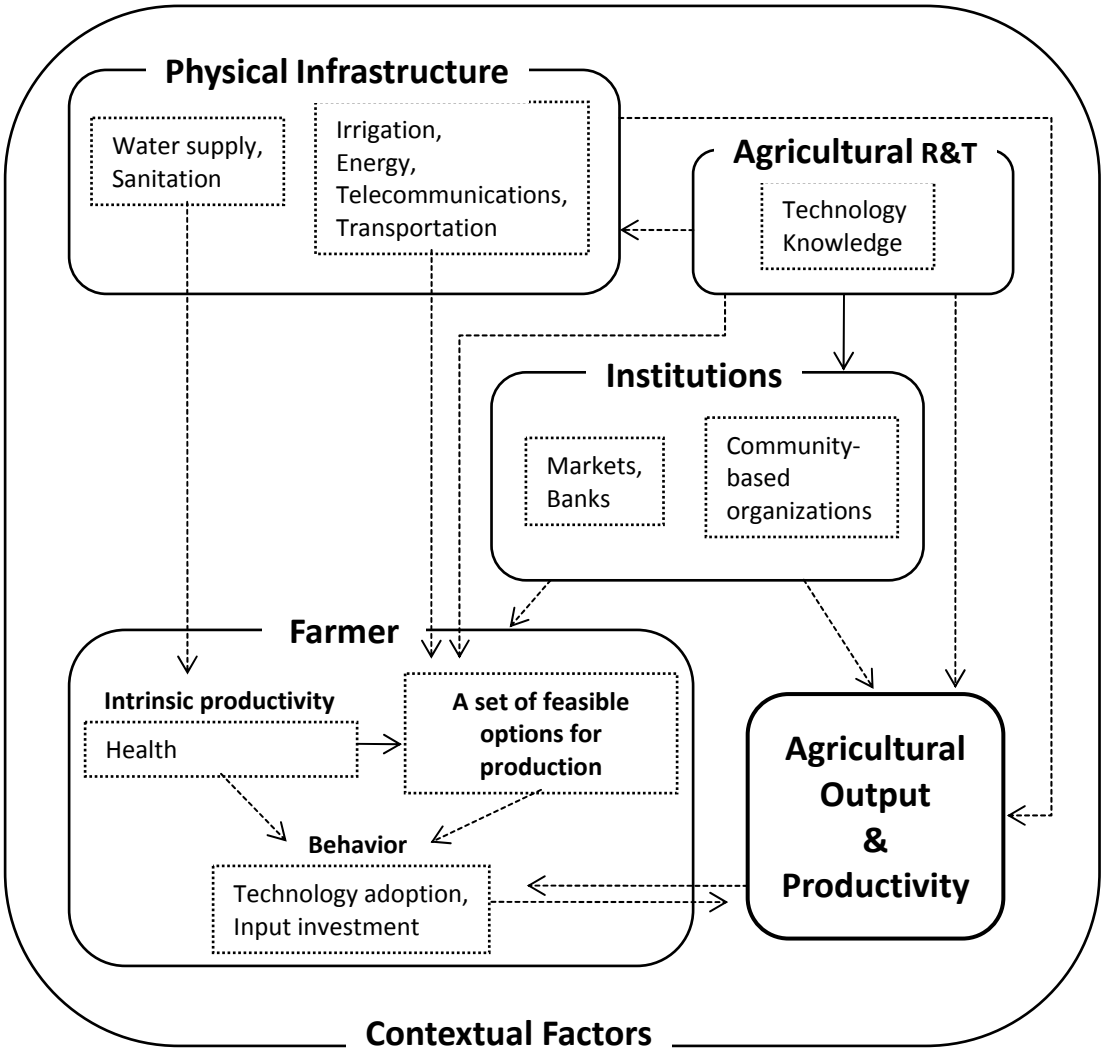
The spatial expression of these costs is important. Available evidence indicates that rural marketing TCs in developing countries are often dominated by transportation costs, e.g. Fafchamps and Gabre-Madhin's (1997) study of agricultural traders in Benin and Malawi. Such costs involve the costs of transporting commodities as well as trader travel. To the extent that such costs are central components of TCs and that they play out over space in logical ways (e.g. may be expressed as cost per kilogram per kilometer or something similar), physical distance indicators may serve as useful – if partial – proxies for the TCs involved in effective input and output price formation at the farm gate.

Broader views of remoteness and rural infrastructure

In contrast to the specificity of the perspectives above (which heavily emphasize variable transportation costs), is the notion that remoteness in a more general sense matters a great deal for development choices and outcomes. Despite some empirical ambiguity (which we explore further below), the conceptual importance of remoteness and/or poor infrastructure as an exogenous conditioner of a variety of outcomes has resulted in persistent inclusion of a wide variety of

remoteness/access/infrastructure indicators in models of rural development and diagnoses of agricultural development failures. Many studies, for example, have used aggregate data to link infrastructure investment levels with indicators of smallholder productivity growth and related outcomes (e.g., Antle 1984; Binswanger, Khandker, and Rosenzweig 1993; Fan, Hazell, and Thorat 2000; Mundlak, Larson, and Butzer 2002; Fan, Zhang, and Zhang 2002; Fan and Zhang 2004). While the idea of cumulative transactions costs remains important in conceptual exegeses, multiple and diffuse channels of impact may be traced. Pinstrup-Anderson and Shinokawa (2006), for example, sketch several channels by which rural infrastructure impacts productivity and, ultimately, production and market decisions (Figure 1).

Figure 1: "How Infrastructure Promotes Agricultural Development"



Source: adapted from Pinstrup-Anderson and Shinokawa 2006

There is ample evidence of the importance of multiple pathways by which "access" affects rural development outcomes, both directly and indirectly. Improvements in rural road networks have been linked with higher agricultural wages and crop production in Bangladesh (Khandker *et al.,* 2006), increased food availability, school completion rates and agricultural wages in Vietnam (Mu and van de Walle, 2007), and expanded non-agricultural opportunities in Peru (Escobal and Ponce, 2002). Escobal (2005) found a positive association between road infrastructure and a variety of household health and

education indicators in rural Peru. Jacoby (2000) found evidence of a negative relationship between distance to markets and land values in rural Nepal. de Janvry and Sadoulet (2001) and Escobal (2001) found positive relationship between rural road indicators and farm and non-farm employment. Proximity to urban centers has been positively correlated with specialization of production and labor (Fafchamps and Shilpi 2005) and with patterns of child education and labor in Nepal (Fafchamps and Wahba 2005), and with collective action and social capital formation in the Philippines (Godquin and Quisumbing 2005). Escobal and Torero (2005) find that household welfare outcomes in rural Peru are associated with access to primary and secondary schools (which they characterize as human capital generating public services) and access to telephones (which they suggest captures important dimensions of access to information) as well as access to roads. Furthermore, they document positive interaction effects: access to multiple services had an additionally positive impact on outcomes, what Escobal and Torero refer to as public asset complementarities.

de Janvry *et al*.'s (1999) work on transactions costs also recognized multi-dimensionality: "the poorer the infrastructure, the less competitive the marketing systems, the less information is available, and the more risky the transactions, the greater the size of [the gap between buying and selling price of a given commodity]" (p. 1204). This multidimensionality is at the heart of the spatial poverty trap literature, in which such traps occur where "geographic capital" -- which may be local biophysical production endowments, supply of public goods and infrastructure or the endowment of local private goods -- is lower or less efficient than elsewhere (Jalan and Ravallion 1997). Where geographic capital conditions the marginal productivity of private assets, it directly affects aggregate productivity and welfare outcomes. In addition to reducing transactions costs, improved access to infrastructure and services may raise the value of household assets (such as land or human capital).

In a recent paper, Stifel and Minten (2008) evaluate the impact of remoteness in rural Madagascar on food crop productivity (and, by implication, on output market participation and poverty). They find a strong negative relationship between remoteness and yields, controlling for land quality and other factors. Their use of road-based travel time and cost to define remoteness is consistent with other access studies over the last two decades. Unlike many other studies, they offer a fairly detailed conceptualization of what remoteness entails: with respect to productivity, they identify remoteness in terms of increasing transportation-induced transactions costs, increasing price risk and, for Madagascar in particular, decreasing plot size and increasing insecurity. This represents a more explicit conceptual treatment of what remoteness means, as well as a move toward the spatialization of productivity determinants previously treated aspatially. However, a discussion of empirical indicator selection alternatives is still absent. Related to this, we believe, is the fact that market access is still very often proxied by a single variable without reference to either (a) whether or not there are other and/or multiple dimensions of access that are important to the question being investigated, (b) whether the access indicator being used is the correct one; or (c) whether the correlation between alternative indicators is high enough that one indicator should adequately proxy for other more conceptually appropriate indicators.

3. Empirical measurement of market access

Despite agreement about the theoretical importance of market access, empirical evidence concerning its impacts is sometimes ambiguous. For example, Pender *et al. (*1999) found access to roads to have no significant impact on either profitability or productivity in the northern highlands of Ethiopia, contrasting with theoretical perspectives and local expert opinion. In another study, Pender *et al. (*2001) found, based on analysis of community survey data for the highlands of Tigray and Amhara regions, that

better access to towns was associated with cereals-perennial production as a livelihood strategy and with better outcomes in terms of several welfare and natural resource indicators, while access to all-weather roads was found to have less significant impacts. Using the same community survey data from Tigray, Kruseman *et al.* (2006) conducted a factor analysis of several market access variables (distance and travel times to towns, all weather roads and bus service), and found all of these variables to be highly correlated with a single market access factor. This factor was found to be associated with significantly more production of teff (the most important cash crop in the region), less production of relatively subsistence-oriented sorghum, less ownership of livestock, but a higher indicator of household wealth (proportion of houses with metal roofs). Using household-level survey data from Tigray, Pender and Gebremedhin (2006) found that access to roads and towns had significant impacts on several agricultural practices (e.g., increasing use of labor, oxen and fertilizer) and that access to towns was associated with higher crop productivity, but that neither factor was significantly associated with differences in household income. Using similar household data for Amhara, Benin (2006) found market and road access to be associated with some differences in input use and land management practices, that these impacts were different in high vs. low rainfall areas of the region, and that crop yields were higher further from roads in high potential areas (no significant effect of road or market access on yields in low rainfall areas). Thus, while market and road access, based on the ways in which they were defined, are often found to have positive impacts, this is not always the case.

The multiplicity of ways in which market access can be conceptualized and translated into measurable variables may be a factor in this empirical ambiguity. Even within the same geographic area, indicators vary widely. Studies in the Ethiopian highlands, for example, include the distance or walking time to the nearest district administrative seat ("woreda town"), "market town" (which may be different than the woreda town), all-weather road, seasonal road, bus service, development agent, input supply shop, or grain mill; whether access to a road had improved in the recent past; whether an all-weather road

passes through the woreda; and road density in the woreda (Tefera *et al.,* 2000; Desta *et al.,* 2001; Pender *et al.,* 2001; Benin *et al.,* 2003; Gebremedhin *et al.,* 2003, 2004; Pender and Gebremedhin, 2004, 2006; Jagger *et al.,* 2005; Benin, 2006; Kruseman *et al.,* 2006). Access indicators used in similar explanatory frameworks elsewhere have included: whether or not a road passes through a local district capital (Pender *et al.,* 1999), district road density (von Oppen *et al.,* 1999), road access dummy variable (equaling one if the household "has access to" a road capable of supporting truck and bus traffic in both the rainy and dry seasons: Dercon *et al.,* 2006[iii]), and binary definitions of "distant" and "not-distant" input and output markets (e.g. Alene *et al.,* 2008, who categorize input and output markets as "distant" when they are located >15 and >10 kilometers, respectively, from survey households). Similarly, in a recent review of infrastructure and development studies using more aggregate statistics, Calderón and Servén (2008) note that although "infrastructure is a multi-dimensional concept, comprising services that range from transport to clean water […] many studies take a single indicator (most often telephone density) to proxy for 'infrastructure'."

In practice, there is considerable ambiguity about what constitutes a "market"; in some cases this is further refined as "nearest" wholesale or retail market, "usual" market, "local" market, "urban" market. etc.; in other cases, it is not defined. In any case, the specification is fundamentally subjective. (Proximity defined in relation to nearest "urban area" is usually similarly vague.) Furthermore, a single indicator is often used for multiple commodities and for both input and output markets. As Wood (2006) notes in a review of econometric studies employing access indicators, "there is no *a priori* reason why there could not be multiple markets for demand or supply of the same or different agriculture-related goods and services but, with notable exceptions (e.g., Vakis *et al.,* 2003; Staal *et al.,* 2002; Escobal, 2005), only one market … per household is considered" (:56).

Moreover, household-level differences in the distance to retail or urban market may or may not be correlated with variations in farm-gate prices. It is often assumed that farm prices should decline as distance from urban markets increase as per von Thünen. However, contemporary theory would suggest that whether prices in location *i* are higher or lower than in the reference urban market would depend on the direction of trade flow between location *i* and the urban market. Many rural areas are net importers of food commodities, and the direction of trade may reverse halfway through the marketing year depending on the season. For these reasons, many of the most common indicators of market access used in household survey data may bear little relationship, or a temporally changing relationship, to effective farm-gate prices. Additional information on trade flows and other factors is generally needed to appropriately hypothesize the relationship between a given household's distance to market and farm-gate prices.

Distance to urban market or travel time indicators are also frequently argued as being a meaningful proxy of access to buyers, services, or the degree of non-competitive behavior that a farmer may face. Yet on this point as well, the assumed relationship is tenuous at best. The conceptual relationship between distance and market structure is conditioned by a multitude of factors, and because of data limitations, the validity of this implied relationship is seldom tested. We present evidence below from two independent samples of Kenyan maize farmers to show that the number of traders buying grain directly in the village in the most recent marketing year is roughly the same in villages regarded as relatively accessible vs. remote on the basis of distance to nearest district market. Hence it may not be too surprising that empirical findings on the impacts of conventional market access indicators tend to vary widely.

In order to establish the range of access indicators used in current research, we conducted a review of analyses in recent agricultural economics and rural development literature. The 40 papers in our review

used a wide variety of indicators, usually without discussion of the choice made, or the availability of alternative indicators and the degree of consistency among them. Simple measures included walking time to local market, distance in kilometers to the nearest market town, cost in local currency to transport a bag of maize from the farm to the main market, the number of connecting roads in the village, etc. Compound measures were generally indices constructed from multiple measures of market distance and/or type of infrastructure in local environs. More than half of the selected articles used a single indicator in their models (n=23), including dummy variables (n=4). About a quarter of the articles used multiple indicators (n=11). Six of the models used some index of market access, described with varying degrees of thoroughness.

In all cases, the identification of the marketplace referred to in variable definitions (as in "kilometers to market") was not made fully explicit, i.e. the defining criteria for a market (such as population size, presence of people buying or selling specific food products, whether the market was an assembly market where a farmer could sell her goods or a wholesale or retail market where she typically could not) was not made explicit. The choice of market in the likely context of multiple markets (e.g. for different commodities) was generally also not made explicit, although some articles did specify "local market," "main market," "district town," or "market/supply depot" as the market of interest.

The review selection methodology and results are summarized in more detail in Appendix A. Our results and conclusions are very consistent with those of a similar review exercise carried out by Wood (2007), which we summarize in Appendix B.

4. Data

To investigate changes in farm households' access to markets and services in Kenya, we used household data from a nationwide panel survey collected by the Tegemeo Institute of Egerton University. Detailed plot and farm data was collected from 1,233 agricultural households interviewed in 1997, 2000, 2004, 2007 and 2010. The balanced panel survey contains information on household production, marketing activities, and a variety of self-reported indicators of access to markets, related infrastructure and services.

The sampling frame for the panel was prepared in consultation with the Kenya National Bureau of Statistics (KNBS) in 1997. 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 AEZs 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 the 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, 2007 and 2010. After the 2010 survey, 1,233 households were consistently interviewed in all five years.[iv]

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 5 years, in order to track changes over time.

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 retailer	Private
Km to private veterinary services	Private
Km to public telephone (landline or mobile)	Both
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	Primarily 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 sales transactions by households in the sample. Neighboring households and the National Cereals and Produce Board accounted for 22% and 7%, respectively, of maize sales transactions.

The survey sample design allows for summary statistics to be made for all major agroecological zones in which significant agricultural production is found. Because of this, we were able to look at the geographical patterns of access and changes over the survey period.

In addition to the nationwide household panel survey data, this study also draws from a separate survey and set of focus group discussions undertaken by Tegemeo Institute, ACDI/VOCA, and Moi University in June 2009. The survey was specifically designed to understand the marketing constraints faced by maize-selling farmers in Kenya. Respondents' inclusion in the survey and focus group discussion was dependent on a "yes" answer to an initial screening question "did your household sell maize in the past year?" The survey covered four maize surplus districts (Trans Nzoia, Nakuru, Bomet, and Bungoma) and two districts that are generally maize deficit (Kisii, and Machakos). Within these districts, 41 survey villages were stratified into relatively accessible (n=26) vs remote (n=15) areas. Villages were categorized as isolated or accessible by the study team in consultation with the local District Agricultural Officers, based on multiple criteria: distance of most households in the village to the nearest wholesale market center, distance from the village to the nearest tarmac road, conditions of the tarmac road and

the road linking the village to that tarmac road. . A total of 534 maize-selling farmers were assembled for focus group discussions and for individual interview. For further details of survey design and findings, see Kirimi *et al.* (2011).

5. Smallholder access to markets in Kenya: 1997-2010

Levels of smallholder accessibility indicators

Basic patterns in access are summarized for 2010 in Tables 2 and 3. The intent of these tables is to convey the absolute and relative magnitudes of indicator values across sample space and how they vary according to conventional measures of market access, in this case the distance to the nearest district town. Although most farmers live quite close to motorable roads, the distance to the nearest all-weather road averages about 7 kilometers. In the absence of motorized transportation, this may represent about an hour by bicycle and up to several hours' travel by foot. Electricity and telephone services are generally located somewhat closer than all-weather roads, while the distance to the nearest improved water source is surprisingly long on average, and varies highly across zones. Market- and production-oriented services show similar magnitudes of variation: on average these services are 3 to 5 kilometers distance from farmers' homes. Many of the services (fertilizer sellers, extension and veterinary services) and infrastructure (motorable roads, health centers and telephones) appear fairly uniformly distributed, although others (tarmac road and improved water) are less uniformly so.

Table 2: Mean kilometer distance from farm household to various markets and services, 2010

Agroecological 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	0.00	5.67	7.36	4.16	7.15	1.75	8.83	3.77	2.84	1.89
Eastern Lowlands	1.21	3.78	6.19	5.35	7.48	0.49	11.49	1.37	3.34	2.26
Western Lowlands	0.63	4.31	4.85	3.97	5.38	0.69	5.38	6.43	2.56	2.15
Marginal Rain Shadow	0.59	2.92	3.25	5.59	3.33	0.16	17.19	10.13	2.31	2.09
Western Transitional	0.70	4.06	3.85	3.99	4.91	0.34	7.87	4.02	2.49	2.04
High Potential Maize	1.28	4.95	5.08	5.38	6.01	0.38	6.65	6.41	3.44	2.13
Western Highlands	0.98	2.74	3.39	3.71	4.53	0.51	5.16	5.39	2.64	1.27
Central Highlands	0.12	1.46	2.67	2.77	3.60	0.13	4.98	0.08	2.53	0.37
Total	*0.85*	*3.70*	*4.46*	*4.29*	*5.33*	*0.46*	*7.13*	*4.07*	*2.88*	*1.69*

Note: Values shown are mean household responses within each zone.

Table 3: Household distances to markets and services, 2010, by village distance to district town

	Kilometers to nearest									
Household-level percentile	point of maize sale	fertilizer seller	veterinary service	telephone service	extension service	motorable road	tarmac road	improved water source	health center	electricity
Relatively accessible villages										
10th	0.0	0.5	0.5	0.6	1.0	0.0	0.5	0.0	1.0	0.0
25th	0.0	1.0	1.5	1.5	2.0	0.0	1.5	0.0	1.3	0.2
50th	0.0	2.5	3.0	3.0	4.0	0.1	4.0	1.5	2.0	0.7
75th	0.0	4.3	5.0	5.4	6.0	0.5	7.0	4.0	3.5	2.0
90th	2.6	7.0	7.6	7.5	8.0	1.0	10.0	7.2	5.0	4.0
95th	3.5	8.0	8.0	8.0	9.0	1.5	15.0	9.0	6.0	5.0
99th	8.0	15.0	17.0	15.0	17.0	3.0	40.0	20.0	9.0	8.0
Relatively Remote villages										
10th	0.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.8	0.1
25th	0.0	1.5	2.0	1.5	2.0	0.1	3.0	0.3	1.2	0.5
50th	0.0	3.0	3.0	3.0	4.0	0.2	7.0	2.0	2.0	1.4
75th	0.5	5.0	7.0	6.0	10.0	0.5	13.0	6.0	4.0	3.0
90th	2.0	10.0	12.0	12.0	14.0	1.5	20.0	15.0	6.0	5.0
95th	7.0	12.0	15.0	15.0	17.0	2.5	25.0	27.0	10.0	5.2
99th	25.0	19.0	21.0	27.0	30.0	6.0	40.0	37.0	15.0	12.0

Note: "Relatively accessible" /"Relatively remote" households are categorized as those residing in villages where the average reported distance from a district town was greater/less than the median value in the sample in 2010.

Small farm maize marketing and village remoteness characteristics

There is evidence that even where villages are "remote" in terms of roads or other indicators, other indicators of market accessibility and competition do not always differ greatly from less remote areas. Recent survey data from Kenya and Malawi indicate that in both remote and accessible village there are (a) a large number of small traders competing for local purchases, and (b) many villagers are both able to and choose to sell their grain surpluses at the farm gate (Kirimi *et al.,* 2011; Jayne *et al.,* 2010). This second point is corroborated by findings in the first column of Table 3, showing that the distance travelled from the farm to the point of maize sale was zero for over 50 percent of the farmers selling maize to private traders. In other words, traders collected and bought maize directly from households' farms for the majority of farmers who sold maize.

Farmers' subjective perceptions about market liberalization also appear to bear a surprising relationship to conventional measures of remoteness. A common view in sub-Saharan Africa is that market liberalization cut off farmers from access to markets that was previously provided by state marketing board buying stations. One of the questions asked in the 1997 and 2000 Tegemeo household surveys (n=1,468 and n=1,377 respectively) was "in the past 10 years since the maize market was liberalized, do you prefer the current maize marketing situation or the state-led system prior to reform?" Respondents preferring the current liberalized marketing system in 1997 ranged from 57% in the more accessible areas to 66% in the relatively remote areas. In 2000, this percentage rose to 64% in the relatively accessible areas to 69% in the relatively remote areas. Evidently, smallholder farmers' perceptions that the maize marketing environment improved after liberalization was most discernable in the relatively remote areas.

Table 4 presents findings from the independent 2009 farmer maize marketing survey and the 2010 Tegemeo rural household survey designed to understand farmers' maize marketing constraints as described in Section 4. These data indicate that villagers in nominally remote areas appear to have competitive local maize marketing conditions that do not differ considerably from those of non-remote areas. Maize channel choices are similar in most areas,

and the share of farmers selling at the farm gate is similar. In all environments, a large number of small traders were found to be buying and assembling grain in the village, and focus group discussions indicate that farmers find trader competition to have beneficial effects on price. The average distance to point-of-sale was actually higher for farmers in the relatively accessible areas. This is because a small proportion of farmers, especially those with greater surpluses to sell, preferred to organize their own transport to sell directly to buyers in regional markets, thereby by-passing the smaller assembly middlemen who travelled into the villages to buy maize from most maize-selling households; this is evident from examining the distribution of distance traveled to the point of maize sale in Table 3. These findings indicate that for at least some grain selling farmers, long distances between the farm and point of sale do not reflect major market access problems but rather a deliberate strategy to bypass rural assembly traders to fetch a higher price with larger buyers in towns. Table 4, which stratifies the nationwide samples from both surveys into "relatively accessible" and "relatively remote" groups according to their distance to the nearest district town, also shows that farmgate maize prices show little variation between the two access categories.

Collectively, these data stand in stark contrast to the generic picture of remote villages suffering from lack of marketing services and intermediaries and disadvantaged by huge price wedges. Furthermore, the changes brought about by liberalizing markets do not seem to have systematically disadvantaged the more remote communities in this sample. Although it is true that contraction of the state marketing system (NCPB) is relatively pronounced in more remote areas (shown by larger travel distances in 2009 compared with the early 1990s), these changes do not seem to be perceived as disadvantageous: fewer villages in remote areas reported that the NCPB should play a big role in future maize marketing. This may indicate that private marketing intermediaries have stepped in to fill the gap left by the NCPB's contraction. According to the 2009 survey, for 72 and 74 percent of the households that sold maize to private traders in the "accessible" and "remote" areas, respectively, the distance traveled from the farm to the point of sale was zero, indicating that traders were penetrating deep into rural areas to buy grain. The 2010 survey largely matches this finding, with 70/80 percent of accessible/remote maize sellers transacting at the farmgate. Private market development has almost certainly been facilitated by changing technologies. In these data,

mobile phones were much more frequently cited as a significant positive factor in marketing conditions in remote areas.

Of course, these findings do not imply that farmers no longer face major problems in selling their agricultural commodities. Even though most Kenyan smallholders report having many grain traders to choose from, travel very short distances from their farms to sell their maize, and are paid in cash immediately, the focus group discussions revealed several serious grain marketing problems. In order of frequency mentioned in the focus group discussions, these are: under-weighing of commodity by traders, feelings of receiving usuriously low prices by traders, and general feelings of being at an informational disadvantage relative to traders.

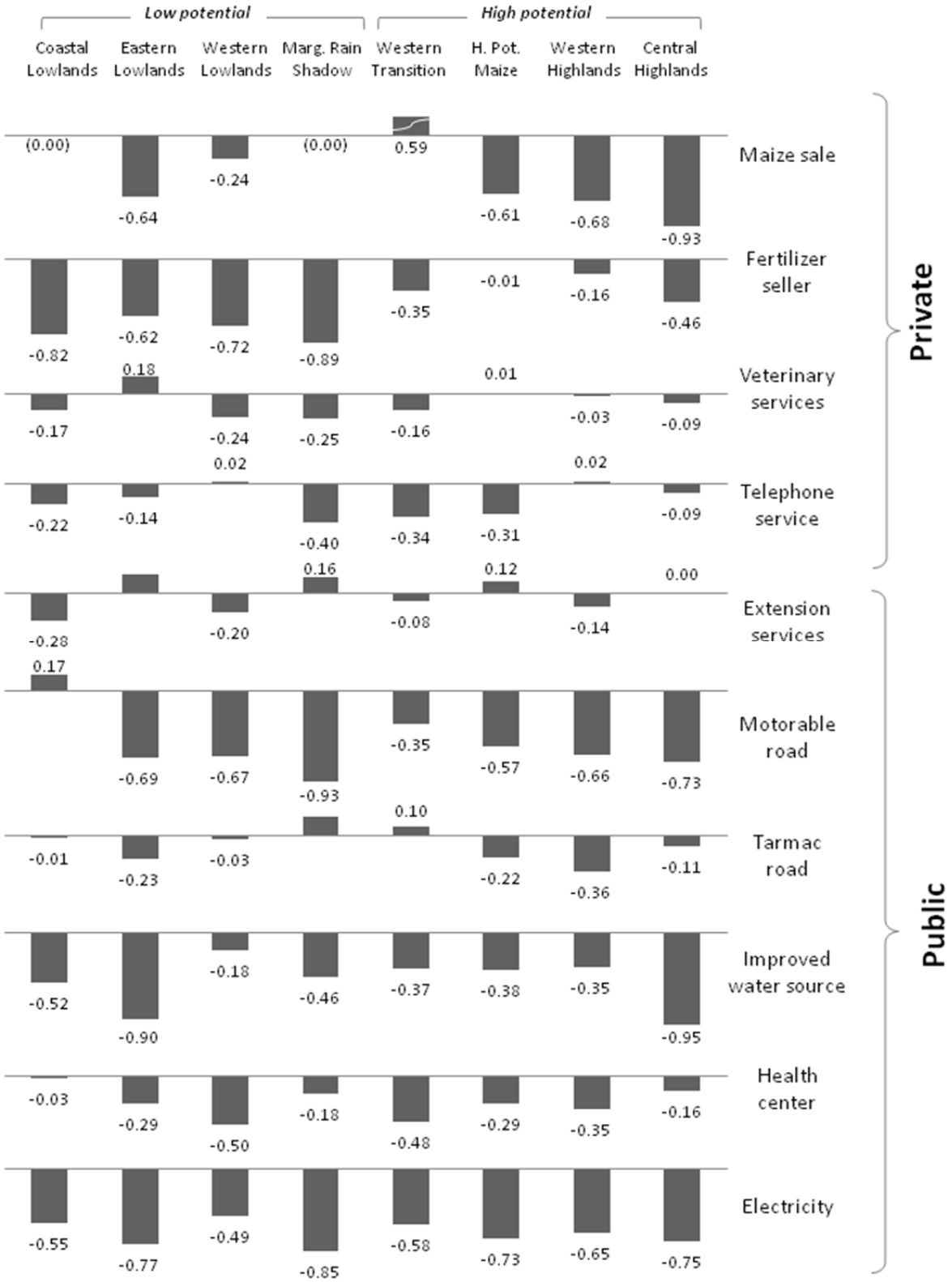
Table 4: Maize marketing characteristics in "relatively accessible" and "relatively remote" villages

	2009 Maize Marketing Survey		*2010 Rural Household Survey*	
	Relatively accessible villages	Relatively remote villages	Relatively accessible villages	Relatively remote villages
Villages in sample	14	19	58	49
Households in sample	-	-	655	578
% of village households selling maize	90.8%	91.4%	37.56%	34.95%
% of maize sales through…				
small traders	54%	57%	34%	26%
large traders	22%	24%	41%	59%
NCPB	-	-	1%	5%
other households	11%	7%	24%	9%
Average number of traders operating in village	94	83	-	-
Average distance to point of sale	2.5	1.0	0.6	1.2
Share of sales at farm gate	72%	74%	70%	80%
Average price at farm gate (Ksh/kg)	22.1	21.2	20.7	20.7
Distance to NCPB in early 90s	8.5	7.5	-	-
Distance to NCPB at present	17.6	24.7	19.5	22.5
Share of villages indicating that...				
…NCPB should play a major role in maize marketing	42%	29%	-	-
…cell phones have made moderate or large improvement in marketing	26%	43 %	-	-
…cell phones are important or very important for output marketing activities	-	-	32%	36%

Sources: 2009 Kenya Maize Marketing Survey (Tegemeo Institute); 2010 TAPRA Survey (Tegemeo Institute).

Notes: For 2009, classification of "relatively accessible" versus "relatively remote" villages is described in Section 4. . For 2010, "relatively accessible" / "relatively remote" households are those residing in villages where the median of household-reported distances to the nearest District town was greater/less than the 2010 sample median.

Figure 2. Percentage reduction in median kilometer distance by AEZ, 1997 to 2010



Trends in smallholder accessibility indicators

From 1997 to 2010 average distances to services and infrastructure improved throughout the country. Figure 2 summarizes such changes as percentage reductions in the median kilometer distance to a variety of resources (or marketing activity) by agroecological zone. Changes are calculated over the 1997 to 2010 period. From these data, a picture of broadly improving access emerged with several interesting characteristics. 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 in have tended to be more or less geographically equitable. This may be due to political considerations, but further exploration of the reasons for these patterns is beyond the scope of this paper.

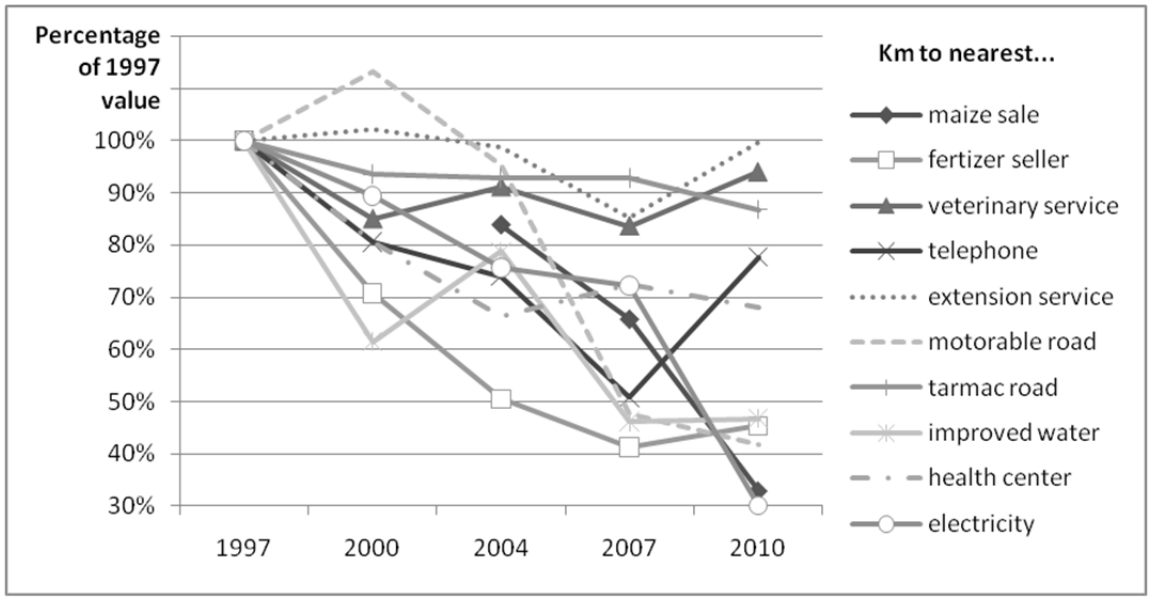
Second, there were also broad improvements in indicators of market access attributable to private sector investment. In particular, the average distance households traveled to the point of maize sale and to the nearest fertilizer retailer declined by 1.8 km and 4.5 km, respectively, between 1997 and 2010. This represents a 67% and 55% reduction in distance and reflects an increased density of grain buyers and fertilizer sellers operating in rural areas. By 2010, 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 81% of the sales transactions in 2010; neighboring households and the NCPB accounted for the remaining 16% and 3% 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 mid-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 provides 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 the 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 districts) and the Coast (Taita, Teveta, 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 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 in earlier decades in the high-potential areas, thus providing greater returns to additional investment in the relatively under-served areas.

One way of summarizing the access changes is by comparing indicator changes relative to their initial values. Figure 3 shows average indicator changes indexed to that indicator's average value in 1997. Although general trends across all indicator types were of similar direction and absolute magnitude, the relative improvements differ markedly. The greatest relative improvements can be seen to have occurred for distance to fertilizer seller, followed by distances to motorable roads, telephone service and improved water sources.

Figure 3: Relative changes in mean indicator values, indexed to 1997



Of particular note is the pronounced reduction in mean distances to the nearest fertilizer retailer, which decreased steadily over the first decade of this 13-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.

Although many indicators showed pronounced reductions in distances during the 2004 to 2007 period, there is a notable slackening of improvement (and, in some cases, deterioration) in the final 2007-2010 period. This is particularly true for services (extension, vet, telephone) rather than fixed infrastructure. We suspect that the widespread social unrest associated with the 2008 presidential elections played a major role in the implied

contraction of service provision. Nonetheless, the overall trends across the entire period can easily be described as improvements.

In general, when changes in access are calculated across each panel period, we note a fairly strong pattern of improvement in the first decade, followed by slight worsening in the final 2007-2010 period. Table 5 summarizes average annual rates of change for each pair of sequential panel rounds.

Table 5. Average annual change in distance from farm to selected services and market infrastructure, 1997-2010

distance to…	1997-2000	2000-2004	2004-2007	2007-2010
fertilizer retailer	-11%	-11%	-5%	3%
veterinary services	-5%	2%	-2%	4%
Telephone	-7%	-3%	-9%	15%
Extension	1%	-1%	-4%	5%
motorable road	4%	-6%	-16%	-5%
tarmac road	-2%	0%	0%	-2%
improved water	-15%	9%	-13%	0%
health center	-7%	-6%	2%	-2%
Electricity	-4%	-5%	-1%	-25%

Correlation across indicators

An important observation is the generally low level of correlation between access measures. Tables 6 and 7 show correlation matrices for indicator observations in 2010 and 1997, respectively[v]. Two immediate conclusions may be drawn. First, it is quite difficult to identify a single indicator which represents the overall state of access to markets[vi]. Indicators of access to markets and services are of moderate or low correlation across most indicators collected in the surveys. The distance from farm to point of maize sale is particularly uncorrelated with most other access indicators. 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.

Table 6. Correlation coefficient matrix of market access indicators, 2010

	Kilometers to nearest																	
	point-of-sale for maize		fertilizer seller		veterinary service		telephone service		extension service		motorable road		tarmac road		improved water source		health center	
maize point-of-sale	1																	
fertilizer seller	0.07		1															
veterinary svc	0.02		0.38	***	1													
telephone service	0.10	**	0.32	***	0.25	***	1											
extension service	0.02		0.38	***	0.70	***	0.34	***	1									
motorable road	0.07		0.16	***	0.25	***	0.01		0.20	***	1							
tarmac road	0.07		0.12	***	0.19	***	0.13	***	0.22	***	0.20	***	1					
improved water source	0.04		0.27	***	0.23	***	0.17	***	0.21	***	0.12	***	0.34	***	1			
health center	0.13	***	0.32	***	0.31	***	0.35	***	0.27	***	0.07	**	0.06	**	0.20	***	1	
electricity	0.03		0.29	***	0.27	***	0.29	***	0.25	***	0.22	***	0.23	***	0.25	***	0.27	***

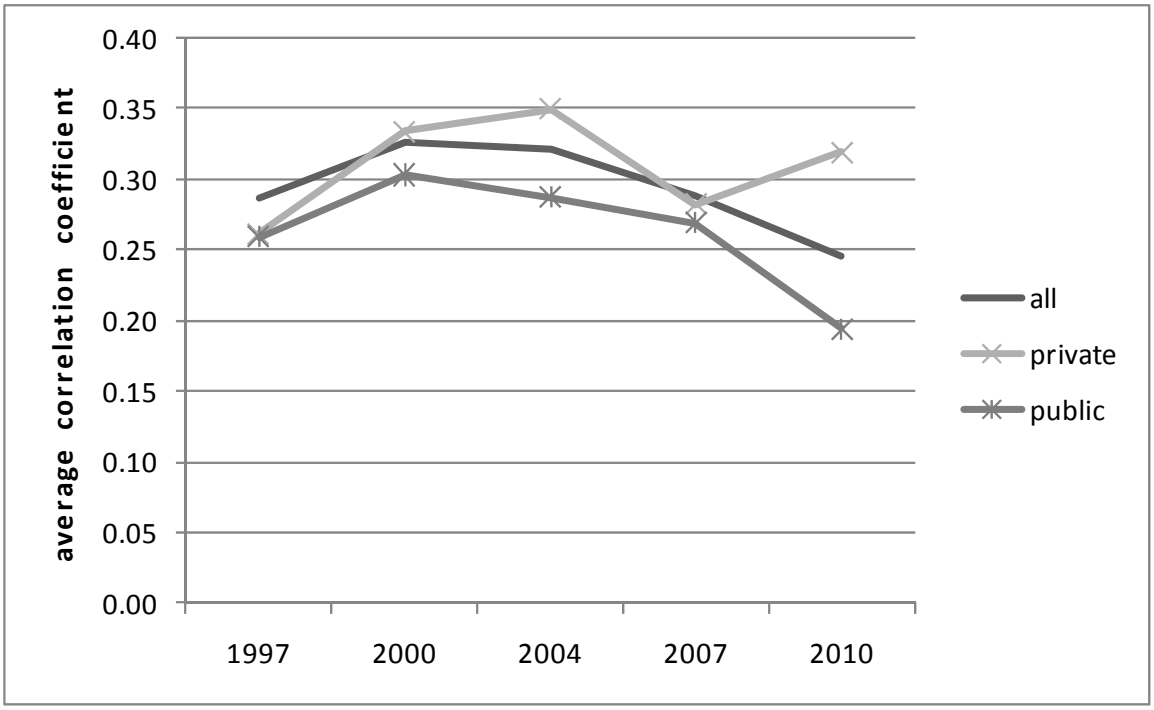
Notes: Values shown are pairwise correlation coefficients. Stars indicate confidence level of the coefficient estimates: ** = .05 confidence level; *** = .01 confidence level. In 2010, for distance to point of sale for maize, the number of observations ranges from 428-436 (households not selling maize are of course excluded). For all other variables, number of observations ranges from 1181-1233.

Table 7. Correlation coefficient matrix of market access indicators, 1997

	Kilometers to nearest																	
	point-of-sale for maize		fertilizer seller		veterinary service		telephone service		extension service		motorable road		tarmac road		improved water source		health center	
maize point-of-sale	1																	
fertilizer seller	0.04		1															
veterinary svc	0.03		0.32	***	1													
telephone service	0.03		0.14	***	0.33	***	1											
extension service	-0.03		0.28	***	0.61	***	0.28	***	1									
motorable road	0.15	***	0.24	***	0.21	***	0.10	***	0.12	***	1							
tarmac road	0.15	***	0.36	***	0.30	***	0.44	***	0.22	***	0.23	***	1					
improved water source	0.06		0.37	***	0.24	***	0.37	***	0.17	***	0.26	***	0.61	***	1			
health center	0.00		0.00		0.34	***	0.19	***	0.25	***	0.11	***	0.10	***	0.16	***	1	
electricity	0.03		0.32	***	0.24	***	0.49	***	0.17	***	0.21	***	0.65	***	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 354-412. For all other variables, number of observations ranges from 897-1161.

Figure 4: Average correlation coefficients for nine village-level mean indicators of market access, by survey year



Note: The nine indicators of privately and publicly provided investments are defined as in Table 1. "Private" includes: distance to fertilizer seller, veterinary services and telephone services. "Public" includes: distance to extension services, motorable road, tarmac road, improved water source, health center, and electricity. Distance to maize point-of-sale is not included in these averages because this variable was not collected the year 2000.

Correlation over time

We also observe, somewhat more surprising, that the correlation between market access 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 balanced panel, response variation 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 vary widely according to the indicator used, that there is a varying and somewhat unstable degree of correlation among these

access indicators across time, and that it may therefore be highly problematic to use only one or two indicators as a generalizable measure of market access.

Lastly, it might be hypothesized that the overall degree of correlation between these indicators has increased over time. Increasing correlation would indicate increasing convergence in these indicators as markets develop over time. To examine this, we computed mean and median values of village-level correlation coefficients for each year and compared them over time as shown in Figure 4. Although pairwise correlations vary considerably, the central tendency does not show any pronounced trend across the study time period. The degree of correlation among publicly provided indicators of market access has even declined steadily in the three survey rounds since the 2000 survey.

6. Discussion

Market access conditions in Kenya are diverse and multidimensional. Many variables typically used to represent market access in empirical studies are not highly correlated with one another. Some indicators of market access vary little between areas defined as accessible and remote on the basis of distances to a regional town or wholesale market. Furthermore, changes in access over the past decade appear similarly complex. Although all indicators of access have shown a general pattern of improvement over the last decade, there are considerable differences in the patterns of change across time, across space and across indicator types.

Indicators of market access that reflect private sector investment all show an improvement in access conditions over time, especially in fertilizer retailing, with the exception of the last survey period in 2010, which followed a period of widespread disruption caused by post-election violence. The reduction in distances to services provided by private traders and service providers are most apparent in the relatively low-potential regions, which 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. 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 (Figure 2), perhaps reflecting political demands for equity in resource distribution.

Several indicators from this nationwide panel survey reveal market access conditions that are quite inconsistent with views commonly articulated by local policy makers. For example, most farmers who sell maize do so directly on their farms. The mean distance traveled from the farm to the point of maize sale was under one kilometer. Over 80 percent of maize-selling farmers indicated that at least 50 grain traders came directly into their villages during the buying season to buy maize. Distances traveled by farmers to acquire fertilizer was somewhat higher at 3.70 km in 2010 but this distance has declined dramatically from 8.7km in 1997.

In contrast to the general trend of improvement across all access indicator types is the fact that there is considerable divergence across the levels and changes of alternative indicators for any particular location. Alternative measures of access are characterized by relationships which are weak and unstable across time and space. These changing patterns of correlation strongly suggest that the choice of indicator to employ in empirical analysis may have important consequences for derived analytical conclusions. In our Kenyan case study, for example, any single indicator would do a poor job of summarizing a multivariate access situation. At the same time, our review of recent literature suggests that the selection of access indicators may often be *ad hoc*. Certainly, researchers are at the mercy of available data. Nonetheless, we suggest that, given the importance of indicator choice on analytical outcomes, explicitly structured conceptualizations of access should guide survey design and indicator selection

wherever possible – e.g. what variable best represents the actual marketing channel used for a particular commodity, by a particular actor, or at a particular time of year. Finally, where possible, the variable selection process should include sensitivity analysis of alternative indicators.

The findings of this study hold several implications for the empirical measurement of market accessibility. We offer these issues as a conceptual checklist for indicator identification.

- *Specificity of access indicators to the issue being addressed*

Different production choices are associated with marketing chains that have different spatial expressions (for example, from the farmgate, grain may go mainly to local buyers in the village, bananas to the nearest city, and cotton to the nearest ginnery). The many loci of exchange mean that there may be crop-specific market structures and access conditions that may not be highly correlated with each other. Hence, empirical study of market access conditions and their impacts on farmer behavior could provide more accurate insights by using variables that are highly specific to the issue being addressed.

Looking at predominant production activities within a region (say, by agroecological zone) may be one way of distilling this complexity. Looking at relative attraction of different opportunities is another. This latter approach, for example, is central to gravity models which define some distance-decay function of initial "attraction" values of central places (e.g. Hanson 1959). But the point remains that "one size fits all" indicators do not necessarily fit all contexts: any single metric is unlikely to explain all market-driven behavior, especially across scales and production systems.

Added to the difficulty of multiple markets, is that of synthesizing multiple modes of physical access to a market. Euclidean geographical distance is straightforward, and easily calculable within a geographic information system. Economic distances may be more relevant, however. In particular, time and cost of travel to a particular target, using an accumulative cost model, are widely used. But assumptions are sometimes hard to make in constructing such models. For example, in the highlands of Ethiopia, basing a travel time model on the average vehicle speed for

different road types will not reflect that walking speeds are about the same (in a country where the majority of smallholder production is carried to market by hand or by donkey).

As noted in the previous section, the non-physical elements of market access may also interact with physical/spatial elements. For example, market information may influence the perceived costs of market participation over and above actual transportation costs. Institutional and cultural factors likely also play a role in actual market accessibility at the community level. At the household level, of course, even more factors come into play. Such interactions may be non-linear and for this and other reasons be difficult to detect.

- *Variation over time*

Incorporating the temporal dynamics of accessibility is an additional challenge. These dynamics may be regular (e.g., seasonality), probabilistic (e.g., different degrees of stability associated with different markets), or may change according to changes in trader behavior or the shifting of local supply and demand conditions that alter the direction of trade between source and destination markets. Clearly, time-invariant variables such as the distance to the nearest town are unable to capture temporal variations in access conditions due to such dynamics. Finally, changes in urbanization, infrastructure development (and decay), regional trade reforms, etc. will translate into changing geographical patterns of physical accessibility to markets. These factors can all limit the ability of even well-conceptualized metrics which are based on solid data, to hold up over time and over a diversity of analytical applications.

- *Liberalization and technology changes*

Changing technologies and market institutions may result in changes in the economic meaning of a given indicator over time. For example, Overå (2006) describes ways in which recent changes in access to telecommunications technology are affecting the transactions costs of local trade. Her study of small traders in Ghana illustrates how mobile phones are lowering the transaction costs of interactions over dispersed areas: discovery and exchange of information, negotiation, and monitoring. She identifies a number of mechanisms by which cell phones lower

transaction costs: by reducing the number of physical trips necessary to carry out these functions, overall costs are reduced; enhanced communication leads to the potential for more rapid establishment of new trading relationships and social capital in low-trust, high-risk environments; traders may cultivate more spatially diffuse networks and use faster discovery and negotiation times to take advantage of shorter trade opportunity windows. More broadly, Overå's study shows how marketing and communication technologies may reduce transaction costs and effectively extend geographical thresholds of viable market participation. In liberalized settings elsewhere in Sub-Saharan Africa, similar changes may be taking place which are not necessarily captured by local physical infrastructure indicators. Such changes are not limited to new technologies. Our Kenya data, for example, indicate the important expansion of fertilizer retailer activity following liberalization of this market.

- *Infrastructural and non-infrastructural components of access*

Our documentation of trader presence in otherwise remote villages indicates the need to question assumptions about market access conditions based on physical infrastructure. Many "remote" villages appear to have competitive local marketing conditions, characterized by large numbers of independent traders buying directly in the villages, and farmgate prices that reflect modest adjustments for distance from principal markets. The conditions apparent from the nationwide survey of Kenya from which our findings are derived may or may not closely approximate conditions in many other areas of Sub-Saharan Africa. It is likely that market access conditions are considerably worse in many parts of the continent and it is therefore important to conduct similar analysis elsewhere to assess the robustness of our main findings. However, we see no major *a priori* reason why commonly used uni-dimensional indicators of market access based on distance or travel time to towns or physical infrastructure should necessarily perform better in most other parts of the region than they do in Kenya. At a minimum, the findings of this paper call for a broader rethinking of the meaning of market access in the context of African agriculture and how to measure it. Packing in too many assumptions about the economic implications of road conditions is tantamount to a kind of infrastructural determinism which may not accord with the actual modes or costs of the exchange processes being researched.

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Appendix A: Literature review of access indicators

Review of micro models in literature for use of market access indicators

Procedure

Our selection procedure followed three basic steps. We first used ScienceDirect, the peer-reviewed literature catalogue, to identify four mainstream academic journals which most frequently feature agricultural economic research on issues related access to rural markets in the developing world. Using the terms "market access" AND ("agriculture" OR "rural" OR "smallholder") in Title+Abstract+Keywords over the 10 most recent years yielded 155 journal articles. Within this set of article matches, the four most frequent journals were the following (with number of matching articles in parenthesis): World Development (20); Food Policy (12); Agricultural Economics (10); and Agricultural Systems (9).

The second step was to systematically review these articles to understand the range of ways in which market access is typically modeled. Starting with the most recent issue, we reviewed issue contents in reverse chronological order and selected the most recent 10 articles from each journal which met the following criteria:

- The article featured research on small farm household behavior or outcomes in a rural, developing country context;
- The research featured an econometric model at the household level;
- The modeling attempted to explain agricultural supply response, market participation, technology adoption, land use, or farm performance, using one or more indicators of market access as explanatory variables.

The third step involved summarizing the use and performance of market access indicator variables. To do this, we evaluated our 40 selected articles for:

- Type of model
- Indicator(s) of market access

- Empirical results

Our summary findings are presented in the table below. Corresponding discussion is found in Section 3 of the text. We note that our review, by its design, only covered models which featured explicit access indicators. We did not include articles which depended on geographical dummy variables (such as regions) to control for market access and other location attributes.

Table A1: Recent microeconomic models involving access indicators as independent variables

#	journal	year	issue	no.	article	micro model	access indicator	impact
1	Food Policy	2009	34	4	Rahman 2009	small farm production efficiency	index of underdevelopment of infrastructure (13 elements: market & other, e.g. bus stop)	significant, sign as expected
2	Food Policy	2008	33	6	Bezu & Holden 2008	Heckman 2-step: Probability & intensity of fertilizer use	walking time to local market	significant, sign as expected
3	Food Policy	2008	33	6	Langyintuo & Mungoma 2008	double-hurdle model, 2nd hurdle: adoption intensity		partially significant (well-endowed households only)
4	Food Policy	2008	33	4	Alene *et al*. 2008	Fertilizer adoption, demand	Distant fertilizer market (>15km = 1)	partially significant (adoption model only)
5	Food Policy	2006	31	5	Feleke & Zegeye 2006	ML logistic adoption model: improved maize varieties	distance to market (undefined?)	singificant at 10%, sign as expected
6	Food Policy	2005	30	5-6	Amarasinghe *et al*. 2005	determinants of poverty and poverty clustering	Average distance to roads, towns (km)	partial
7	Food Policy	2004	29	5	Binam *et al*. 2005	technical efficiency	Distance of the plot from the main access road (kilometres).	significant
8	Food Policy	2003	28	5-6	Rahman 2003	production efficiency	index of underdevelopment of infrastructure	significant
9	Food Policy	2003	28	3	Lapar etal. 2003	livestock market participation (Bayesian)	the return time to transport goods to market	not significant
10	Food Policy	2002	27	2	Heltberg & Tarp 2002	market participation (Heckman)	2 main variables: log km to Province capital; log km to railway	mostly significant
1	World Development	2009	*in press*		Muto and Yamano 2009	commercialization	distance from the community center to the district center	significant?

2	World Development	2009	37	5	Schmook and Vance 2009	land use	highway distance dummy	mixed
3	World Development	2009	37	3	Deichmann etal. 2009	RNFE	various	positive, significant
4	World Development	2008	36	12	Lay etal. 2008	RNFE	distance to nearest access road	mixed
5	World Development	2008	36	11	Laszlo 2008	returns to labor	various	positive, significant
6	World Development	2008	36	9	Bigsten and Shimeles 2008	poverty state & transition	ratio pop/dist to town	mixed?
7	World Development	2008	36	5	Minten and Barrett 2008	productivity	multivariate remoteness index quintile	significant
8	World Development	2007	35	8	Matuschke etal. 2007	WTP for hybrid wheat seeds	Distance of the village to the input dealer (in km)	not significant
9	World Development	2006	34	10	vanBastelaer and Leathers 2006	loan repayment rates	km to line-of-rail town	significant
10	World Development	2005	33	9	Dewi etal. 2005	economic diversity index; village wellbeing index	various travel times	mostly significant
1	Agricultural Economics	2009	40	2	Pfeiffer etal. 2009	input use; value of production	frequency of transport to market center	yes; no
2	Agricultural Economics	2009	40	2	Stampini and David 2009	change in expenditure (Livestock, Seeds, Fertilizers, Pesticides, Services, Hired labor)	Index of access to infrastructure	mixed
3	Agricultural Economics	2009	40	2	Huang etal. 2009	off-farm employment (probit, OLS, tobit)	Distance to county road (km)	mostly not significant
4	Agricultural Economics	2009	40	2	Takahashi and Otsuka 2009	determinants of (income, fertilizer expense, land and labor demand)	ln distance from Manila (km)	mostly not significant
5	Agricultural Economics	2009	40	1	Tipraqsa & Schreinemachers 2009	commercialization	# connecting roads; distance from major market	# connecting roads significant; distance from major market not

6	Agricultural Economics	2009	40	1	Xu *et al*. 2009	probability of fertilizer use	Distance from a district town	significant
7	Agricultural Economics	2008	39	3	Shilpi & Umali-Deininger 2009	marketing (various)	various	re-read
8	Agricultural Economics	2008	39	1	Stifel & Minten 2008	productivity	various	significant
9	Agricultural Economics	2008	39	1	Kyeyamwa *et al*. 2008	Reduced-form estimation of market choice (instrumental variable conditional logit)	various	significant
10	Agricultural Economics	2008	38	2	Kassie *et al*. 2008	crop production value - Mundlak's approach	distance to market	significant
1	Agricultural Systems	2008	98	2	Babulo *et al*. 2008	Multinomial logit regression of livelihood strategy choices (different model for each LS)	log transformed walking distance (in minutes) to all-weather roads. This variable is a proxy for access to markets	mostly significant
2	Agricultural Systems	2007	94	2	Kristjanson *et al*. 2007	logit regression: poverty dynamics	improved market access (undefined dummy)	partial
3	Agricultural Systems	2006	90	1-3	Erenstein 2006	multiple binomial logit models	2(4): Travel time lowland-town (hour); Square of travel time lowland-town (hour2); [Distance lowland-village (km); Square distance lowland-village (km2)]	significant (partially significant for latter indicators)
4	Agricultural Systems	2006	89	2-3	Overmars and Verberg 2006	multi-level model: maize land use	Cost to transport a bag of corn from the residence to main market	significant
5	Agricultural Systems	2006	88	1	Kruesman etal. 2006	multiple models: indicators for heterogeneity for investment, crops, livestock and technology	multiple: distance to market (km); km^2; km^3; 5 interaction terms	mostly significant

6	Agricultural Systems	2006	88	1	Jansen etal. 2006	multinomial logit regression of livelihood strategy choices	index: Travel time between the center of the community and the nearest urban market, adjusted for road type and slope	mostly significant
7	Agricultural Systems	2005	85	2	Nkonya etal. 2005	multiple models: Determinant of soil nutrient inflows, outflows, by type	dummy (1 = high market access)	mostly significant
8	Agricultural Systems	2004	82	3	Gebremedhin etal. 2004	Determinants of collective action for grazing land management (5 models)	walking time to nearest market town in minutes	partial
9	Agricultural Systems	2004	82	3	Krishna 2004	Index of Development Performance	km to nearest market town	not significant, wrong sign
10	Agricultural Systems	2003	76	2	Floyd etal. 2003	household adoption of multiple technologies (10)	classes of mean walking times (laden return journey) to nearest roadhead or market/supply center (<4, 4-8, 8-12, >12)	mostly not significant

Appendix B: Literature review of access indicators from Wood (2007)

Wood (2007) undertook a review of market access and related infrastructure variables used in recent rural- and agricultural development-oriented "literature which explicitly forcused on linking market access to agricultural livelihood/enterprise measures" (ibid:57). He encountered a wide variety of indicator variable definitions, which are summarized in the table below.

Table B1: Market access indicator variables used in recent agricultural livelihood/enterprise studies

Variable*	Frequency**
(Distance | Time) from (household | plot | pixel) to...	
... road	6
... railway	1
... [(nearest | usual | local) | (market | permanent market | market center | sales point | population center)]	20
... [(all accessible | nearest (1|N))| (urban markets | urban centers)]	6
... nearest (collection point | service center | agricultural cooperative)	8
... district (town | capital | main market | major city)	9
... country capital	3
(Existence of | Access to) a road?	2
Road (quality | class)	2
Road network density	1
Means of transport	7
Transport cost/kg/km	8
Other access cost	2
(Regional | Location) dummy	8

*Terms in parentheses indicate the alternative descriptors or definitions encountered in the literature, e.g., (nearest | usual): in some literature this descriptor is "nearest," in other literature the descriptor is "usual."

**Frequency = number of articles in which variable is used, out of 32 total articles reviewed. The total frequency in the table sums to more than 32 because some of the articles used multiple indicator variables.

Source: Adapted from Wood 2007

[i] Von Thünen's location rent is the rent accruing to land strictly on the basis of its location relative to a market; that is, holding land quality constant. Ricardo's land rent, on the other hand, reflects different rents accruing to land of differing quality, without consideration of market location (Wood 2006).

[ii] Our analytical emphasis on this paper is on access to local markets, but of course there are several other major dimensions that condition production and marketing behavior, such as available production technologies, market demand, and the degree of integration of local, regional and international markets.

[iii] This study is also in Ethiopia, but includes lowlands as well as highlands.

[iv] There are actually 1243 households surveyed in each wave of the panel. However, because our focus is on smallholder farmers, we restricted our analysis to households reporting average cultivated areas of 10 hectares or less; this resulted in 10 households being dropped from our sample, leaving a total of 1,233 households in each of the 5 panel waves.

[v] Correlation matrices for 2007, 2004 and 2000 show similar patterns. These are available from the authors upon request.

[vi] The same can be said of indicator changes: although we do not report them here, correlation coefficients for rates of change over time are similarly low.