AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Feed the Future Innovation Lab for Food Security Policy

Research Paper 61 July 2017

Tanzania ASPIRES

LAND PRICES HEADING SKYWARD? AN ANALYSIS OF FARMLAND VALUES ACROSS TANZANIA

By

Ayala Wineman and Thomas S. Jayne

Food Security Policy *Research Papers*

This *Research Paper* series is designed to timely disseminate research and policy analytical outputs generated by the USAID funded Feed the Future Innovation Lab for Food Security Policy (FSP) and its Associate Awards. The FSP project is managed by the Food Security Group (FSG) of the Department of Agricultural, Food, and Resource Economics (AFRE) at Michigan State University (MSU), and implemented in partnership with the International Food Policy Research Institute (IFPRI) and the University of Pretoria (UP). Together, the MSU-IFPRI-UP consortium works with governments, researchers, and private sector stakeholders in Feed the Future focus countries in Africa and Asia to increase agricultural productivity, improve dietary diversity, and build greater resilience to challenges like climate change that affect livelihoods.

The papers are aimed at researchers, policy makers, donor agencies, educators, and international development practitioners. Selected papers will be translated into French, Portuguese, or other languages.

Copies of all FSP Research Papers and Policy Briefs are freely downloadable in pdf format from the following Web site: www.foodsecuritypolicy.msu.edu
Copies of all FSP papers and briefs are also submitted to the USAID Development Experience Clearing House (DEC) at: http://dec.usaid.gov/

Authors

Wineman is Assistant Professor, International Development and Jayne is University Foundation Professor, both of the Department of Agricultural, Food, and Resource Economics, Michigan State University, USA.

Authors' Acknowledgement:

The authors are grateful for the encouragement and support of the Food Security Group in the Department of Agricultural, Food, and Resource Economics of Michigan State University. We also thank Patricia Johannes for her editorial and formatting assistance. The views expressed in this study are those of the authors only.

This document reflects the November 2016 version of this paper.

This study is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the Feed the Future initiative Policy Cooperative Agreement with Michigan State University (MSU), and by The Bill and Melinda Gates Foundation through the Guiding Investments in Sustainable Agricultural Intensification in Africa (GISAIA) grant to Michigan State University. The contents are the responsibility study authors and do not necessarily reflect the views of USAID, GISAIA, MSU, or the United States Government.

Copyright © 2017, Michigan State University. All rights reserved. This material may be reproduced for personal and not-for-profit use without permission from but with acknowledgement to MSU.

Published by the Department of Agricultural, Food, and Resource Economics, Michigan State University, Justin S. Morrill Hall of Agriculture, 446 West Circle Dr., Room 202, East Lansing, Michigan 48824, USA.

ABSTRACT

Although studies of the determinants of farmland prices are common in developed country settings, such analyses are extremely scarce in Sub-Saharan Africa. This paper offers a comprehensive examination of land values across Tanzania. Land prices rose significantly between 2008/09 and 2012/13, presenting a potential obstacle to land access for poor and aspiring farmers. A hedonic analysis reveals that indicators of agricultural potential, local population density, and access to markets/urban centers are all statistically significant determinants of land values in Tanzania. The paper concludes with a discussion of promising directions for future research on land values in Sub-Saharan Africa.

TABLE OF CONTENTS

LIST OF TABLES

TABLE **PAGE**

LIST OF FIGURES

FIGURE **PAGE**

ACRONYMS

AEZ	Agro-ecological zone
CPI	Consumer price index
FE	Fixed effects
GPS	Global Positioning Systems
LSMS	Living Standards Measurement Study
TSh	Tanzanian shillings
USD	United States dollar
VIF	Variance inflation factor

1. INTRODUCTION

The determinants of agricultural land values have long been of interest to economists (Ricardo 1817; von Thünen 1842), and are of continued relevance to farm households and analysts of the agricultural sector. Land markets in Sub-Saharan Africa have been historically thin, likely reflecting the abundance of land across many countries and the extent of market frictions and various legal obstacles to market development (Holden, Otsuka, and Place 2009). However, land markets are now growing increasingly active in the region (ibid), indicating that insights may indeed be derived from the price signals that emerge in these rapidly developing markets. Furthermore, anecdotal evidence suggests that land prices may be rising faster than the rate of inflation in several countries, including Tanzania (authors' observation). If true, this could present a significant shift in the ease with which smallholder farmers in Sub-Saharan Africa are able to access land, making it imperative to better understand the determinants of land values. In this paper, we test the reliability of the available data on land values in Tanzania and provide a comprehensive hedonic analysis of land values across the country. We believe this opens a promising direction for future research on land prices in Sub-Saharan Africa.

Analyses of the determinants of farmland prices are common in the U.S. (Huang et al. 2006; Tsoodle, Golden. and Featherstone 2006; Borchers, Ifft, and Kluethe 2014; Guiling, Brorsen, and Doye 2009; Livanis et al. 2006; Plantinga, Lubowski, and Stavins 2002) and Western Europe (Maddison 2000; Patton and McErlean 2003), and have recently been conducted in Eastern Europe (Sklenicka et al. 2013) and South America (Choumert and Phélinas 2015; Foster et al. 2016; Merry, Amacher, and Lima 2008). However, such analyses of non-commercial farmland are extremely scarce in Sub-Saharan Africa. Perhaps owing to a lack of data on land sales or to some measure of skepticism regarding the validity of farmer-estimated land values, there remains a dearth of information on the drivers of non-commercial land prices in Sub-Saharan Africa.[1]

Why study about land values in a setting of (primarily) small-scale farmers? First, as land grows scarcer with rising population densities in many parts of Sub-Saharan Africa, rural youth are likely to inherit ever-smaller land areas (Jayne, Chamberlin, and Headey 2014). This suggests that new or aspiring farmers must increasingly rely on the market, rather than inheritance, as a means of accessing land. It follows that land values may become the primary barrier to entry into farming for a growing proportion of the rural population in Sub-Saharan Africa, especially young adults. If new farmers are unable to earn back the cost of their investment within a reasonable time frame, then a job path as an agriculturalist will be closed to those for whom it may be their best –or only– option. Rental markets do provide an alternative (albeit short-term) entry point into farming, although the determinants of land sales and rental prices are likely to overlap.

Second, land prices may affect the likelihood that farmers would sell their land (perhaps in the process of exiting agriculture) or supply land to the rental market. Thus, an understanding of trends in land values can offer insight into likely future land market activity, along with potential labor movements. Third, and relatedly, as the land market continues to develop in Sub-Saharan Africa, the trends and determinants of land values will affect the trajectory of agricultural systems, as well as broader economic transformation processes. Note that the population of rural Africa is expected to

[1] One noteworthy exception is the work of Maddison, Manley, and Kurukulasuriya (2007) regarding the effects of climate change on African agriculture. However, this focuses almost exclusively on the climate-related determinants of land values. Although Ricardian analyses of climate change effects can be conducted with reference to either land values or farm revenue, most studies in Africa rely on net farm revenue (e.g., Seo et al. 2009).

grow by roughly 62% from 2014 to 2050 (United Nations 2014), pointing to ever-greater demand for farmland, with substantial demand also deriving from urban households in some countries (Jayne et al., forthcoming). It is therefore likely that the value of arable land will continue to rise, with implications that merit scrutiny.

The remainder of this paper is organized as follows. Section 2 provides background information on factors found to affect land prices in other settings. The research hypotheses and hedonic pricing method are outlined in Section 3. Section 4 offers a description of the data and variables. Section 5 provides both a descriptive account of land values in Tanzania and the results of our hedonic analysis. Section 6 concludes with a discussion of results, along with a delineation of directions for future research.

2. BACKGROUND

Farmland values are understood to be determined by the discounted stream of expected returns, inclusive of all uses for the land. Within the realm of agriculture-related determinants of land values, Ricardo (1817) famously focused on agricultural productivity, while von Thünen (1842) noted the role of distance to markets, a key factor in the profitability of the farming enterprise. Thus, agricultural factors that drive land values include soil characteristics (Huang et al. 2006; Maddison 2000; Choumert and Phélinas 2015; Patton and McErlean 2003); climate characteristics and elevation (Maddison 2000; Mendelsohn, Nordhaus, and Shaw 1994); farm returns or yields (Devadoss and Manchu 2007; Borchers, Ifft, and Kluethe 2014; Livanis et al. 2006; Goodwin et al. 2003); and proximity to agricultural markets (Choumert and Phélinas 2015; Merry, Amacher, and Lima 2008).[2] Several additional factors are indirectly related to agricultural productivity, including the tenure status of farmland (Choumert and Phélinas 2015) and local population density or population growth rates (Devadoss and Manchu 2007; Goodwin et al. 2003; Huang et al. 2006; Maddison 2000). Of less relevance to the current study, considerable attention has also been paid to the role of agricultural program payments in influencing land prices (Weersink et al. 1999; Goodwin et al. 2003).

As noted by Plantinga, Lubowski, and Stavins (2002), the price of land reflects not only the current use of farmland, but also its potential uses. Studies consistently find that land prices are higher near urban areas (Huang et al. 2006; Livanis et al. 2006; Sklenicka et al. 2013; Plantinga, Lubowski, and Stavins 2002; Guiling, Brorsen, and Doye 2009; Goodwin et al. 2003), an effect that seems to occur through multiple channels. In the first case, farms close to cities are likely to engage in the production of high-value crops, resulting in higher returns to agriculture (Livanis et al. 2006). This pattern is consistent with the argument put forth by von Thünen (1842), who assumed that high-value crops exhibit the highest transportation costs. Second, urban sprawl necessarily results in the conversion of farmland to urban uses, bidding up land prices for this alternate usage. A third channel is the speculative effect, or the manner in which farmland represents *potential* land for urban expansion (Plantinga, Lubowski, and Stavins 2002; Livanis et al. 2006). Thus, the option to convert the land to residential or commercial use in the future is factored into the price of farmland today (Borchers, Ifft, and Kluethe 2014). In the U.S., Barnard (2000) estimates that non-agricultural factors account for approximately one quarter of the average price of farmland, and Hardie, Narayan, and Gardner (2001) conclude that farmland values are more responsive to non-farm factors than to farm returns.

Another determinant of land values is plot (parcel) size. On one hand, larger parcels may be more expensive (on a per acre basis) if they are more desirable, owing to economies of scale in agricultural production. On the other hand, smaller parcels may be more expensive if demand for the, is relatively high (Patton and McErlean 2003). This could reflect the limited capital and borrowing constraints of potential buyers, coupled with the multiple uses of parcels that are appropriate for agricultural, residential, or commercial purposes (Guiling, Brorsen, and Doye 2009). In actuality, farmland values are commonly found to increase as parcel sizes decrease, a phenomenon referred to as the *small parcel size premium* (Tsoodle, Golden. and Featherstone 2006; Guiling, Brorsen, and Doye 2009; Ma and Swinton 2012; Brorsen, Doye, and Neal 2015; Maddison 2000). Brorsen, Doye, and Neal (2015) find that this premium in the U.S. mostly reflects the way small parcels, located closer to

[2] Note that most analyses do not distinguish between distance to agricultural markets and urban centers.

roads and residential areas, are priced at their non-agricultural use values. However, patterns in Sub-Saharan Africa may differ from those observed in developed country contexts.

A brief overview of land access and administration in Tanzania will help to place our empirical analysis of land values in context. Approximately 75% of Tanzania's population of over 40 million resides in rural areas, and an even higher percent (80%) of the working population is engaged in agriculture (USAID 2011). Land is most commonly accessed through inheritance, borrowing from family members, rental or purchase, or allocation by village councils (similar to a village government). Since the early 1980s, Tanzania has undergone a gradual transition toward individualized control of resources and the commoditization of land – a process that is not without its critics. The Land Act of 1999 recognizes customary rights to land as valid (even without a formal certificate) and as perpetual, heritable, and transferable to those within and outside of the village, albeit with some oversight of the village council. Although the Land Act also introduced a formal land market, most land transactions continue to occur on the informal market, with exchanges often sealed with an informal contract and/or witnessed by neighbors or clan leaders (USAID 2011; Daley 2005; Wineman and Liverpool-Tasie 2016). We turn now to examine the land prices that emerge from this system.

3. HYPOTHESES AND RESEARCH METHOD

The goal of this paper is to broadly identify the factors that determine land values in Tanzania, drawing on the available data. We approach this with a set of hypotheses outlined in Table 1. Anticipating the high demand among poor farmers for small plots, we hypothesize that land values will initially decrease with plot size. However, following the results of Brorsen, Doye, and Neal (2015), this inverse relationship is expected to disappear as plot size increases. Population density is also understood to indicate local scarcity of land, thus driving up the price. Because continuous cultivation can deplete the soil of nutrients (Barrett and Bevis 2015), we expect a plot that is *not* cultivated to obtain a higher price, holding other factors constant. We naturally hypothesize that factors related to agricultural potential, such as soil quality and conducive climate conditions, are positive determinants of farmland value. Amendments to the land, such as erosion control structures or the presence of permanent crops, should increase farmland value as the land price is necessarily inclusive of these improvements. The experience of pre-harvest crop losses on a plot is expected to diminish its value as it may reflect, among other things, the local prevalence of crop disease or animal pests. In terms of market access and urban pressure, we anticipate that plots located closer to (or within) urban centers command higher land values. As noted earlier, this may reflect the farm's higher profitability; more favorable access to amenities or nonfarm income-generating opportunities that are also of interest to potential buyers; or the potential conversion value of the farm to non-agricultural uses.

We apply a hedonic approach to test these hypotheses. This well-established method, introduced by Rosen (1974), is a revealed preference technique that exploits the manner in which a good's observed price is a function of its distinct attributes or characteristics. Essentially, each characteristic is valued by its implicit price (Nickerson and Zhang 2014). The hedonic approach is, therefore, suitable for analyzing the prices of a heterogeneous good in order to determine the marginal value of its underlying characteristics; this technique is commonly applied to the analysis of farmland prices in order to value farmland amenities or nonmarket goods, such as environmental quality (e.g., Ma and Swinton 2012; Patton and McErlean 2003; Maddison 2000).

Table 1. Hypothesized Determinants of Land Values in Tanzania

Topic	Factor	Hypothesized relationship
Miscellaneous	Plot size	Convex
	Population density	+
	Tenure security	+
	Forest/ Fallow/ Other use	+
Agricultural potential	Soil quality	+
	Slope	-
	Average rainfall/ temperature	+/-
	On-farm amendments	+
	Pre-harvest crop losses	-
Market access/ urban pressure	Rural location	-
	Distance from road/ town	-
	Household's market orientation	+

Source: Authors.

The hedonic method involves regressing the sale price per unit area (or the rental value) of a farm plot on the plot's characteristics. The general equation is:

$$Price\_land_i = \alpha + \boldsymbol{X_i}'\boldsymbol{\theta} + \varepsilon_i \quad (1)$$

where $Price\_land_i$ is the value per acre of plot i, $\boldsymbol{X_i}$ is a vector of agricultural and location-related characteristics associated with the plot, and ε_i is a stochastic error term. Note that the relationships captured in $\boldsymbol{\theta}$ do not establish causality, but should rather be regarded as measures of correlation. The functional form (linear, semi-log, or double-log) is often selected with reference to the Box-Cox test. An underlying assumption of equation (1) is that the sample is drawn from a single land market (Nickerson and Zhang 2014). While some hedonic analyses are limited to the state level in the U.S. (Tsoodle, Golden. and Featherstone 2006; Huang et al. 2006), others are focused at the country level (see Borchers, Ifft, and Kluethe (2014) and Mendelsohn, Nordhaus, and Shaw (1994) in the U.S., and Foster et al. (2016) in Chile).

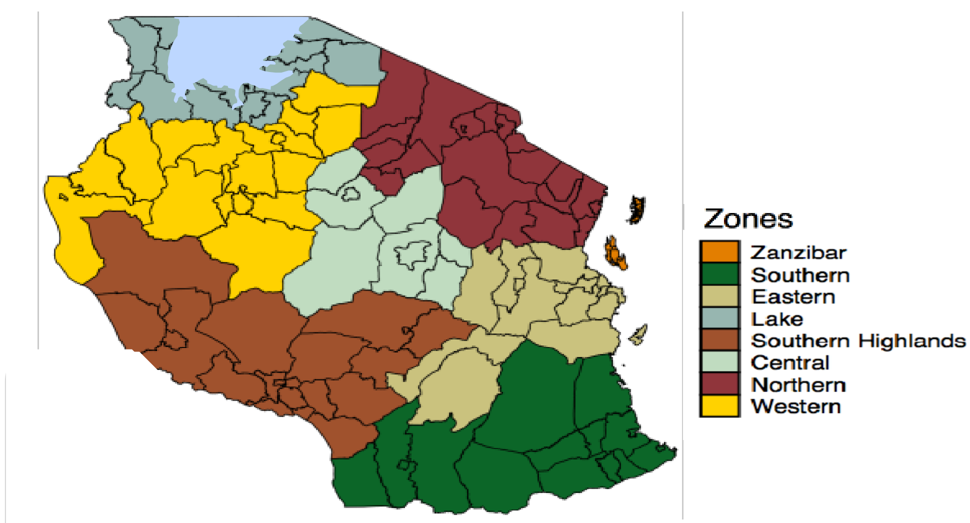
4. DATA AND VARIABLES

To implement a hedonic analysis of farmland values, this study draws mainly from the Living Standards Measurement Study (LSMS) for Tanzania, a nationally representative longitudinal data set collected in 2008/09, 2010/11, and 2012/2013.[3] The LSMS (also known as the National Panel Survey) is carried out by the Tanzania National Bureau of Statistics and is a research initiative within the Development Economics Research Group of the World Bank. In 2008/09, the survey can be considered as representative of each of Tanzania's eight administrative zones (NBS 2014; Figure 1), although because household members were subsequently tracked when they migrated from their initial locations, it is not necessarily representative at the zone level by 2012/13.

For agricultural households, the LSMS captures a rich set of detailed information on agricultural production over the previous year, household landholdings, and characteristics of individual plots that were cultivated and/or owned over the previous year. Area estimates were collected for all plots, among other characteristics, and additional plot characteristics, such as soil quality, were noted for cultivated plots.[4]

In addition, for each plot of land, respondents were asked its value *if it were sold today*. This estimate will serve as the main dependent variable in our analysis. The original sample in 2008/09 includes 2,298 households that owned or cultivated land, and because many households held multiple plots, the survey includes information on 5,220 plots. Because individual household members were tracked in later survey waves, with the survey administered to the individual's new household, the number of agricultural plots grew to 6,076 by 2010/11 and 7,474 by 2012/13. For plots that were retained by the same household in subsequent survey waves, a unique plot identifier can be used to link plots

Figure 1. Zones of Tanzania



Source: Authors.

[3] Another LSMS survey was implemented in 2014/15, though the data are not yet available.

[4] In each survey wave, a number of plots containing only permanent crops/tree crops were (mistakenly, it seems) categorized as *uncultivated*. Information on crop production was recorded, but not on plot amendments, etc., such that sample sizes can vary according to the information required for a given model.

over the years, making possible a plot fixed effects (FE) analysis.[5] In total, 3,528 plots were tracked over all three survey waves. An additional feature of the data set is that, although plot areas were only infrequently measured in 2008/09, by 2012/13, enumerators measured plots using Global Positioning Systems (GPS) whenever possible.[6] This information is available for 5,406 plots in this year. Population weights are used in all analyses, and monetary variables are inflated to 2013 Tanzanian shillings (TSh) using the consumer price index (CPI).[7]

Appended to the LSMS data set are additional data drawn from other sources and linked to each plot or homestead (i.e., residence). These include local population density estimates, distance to towns and markets, long-term average climate variables, slope, and agro-ecological zone (NBS 2014). Because some of these data are available only for the homestead, econometric analyses are limited to plots within 50 km of the homestead (dropping 1.3% of plots located farther away), thus reducing the likelihood that variables are not similar for the homestead and the household's plots. Finally, for descriptive purposes we refer to another data source, the 2007/08 Tanzania Agriculture Sample Census Survey (NBS 2011). This survey, covering 52,594 rural agricultural households[8] across the country, provides a measure of land market activity rarely captured in household surveys in Sub-Saharan Africa.

A description of variables used in analysis is given in Table 2. As noted, our key dependent variable is the per-acre farmer-estimated value of farmland. Though observed sales prices might have been ideal, there exists no register of land transactions on the informal market in Tanzania. Other authors have also turned to farmer-estimated land values in the U.S. (Borchers, Ifft, and Kluethe 2014; Goodwin et al. 2003) and in more data-scarce regions (Choumert and Phélinas 2015; Merry, Amacher, and Lima 2008). As will be reported, and consistent with the conclusions of Merry, Amacher, and Lima (2008), our results seem to validate the suitability of these land value estimates simply because many of our hypotheses bear out. One advantage of using land value estimates is that, as this information was collected for all plots, we need not worry about sample selection bias or the incidental truncation problem that would accompany analysis of actual sales or rentals (Nickerson and Zhang 2014). It should be noted, however, that farmer-reported land values are determined through both value estimates and area estimates, and although we have no reason to suspect systematic bias in the former, the latter has been found to differ systematically from GPS measurements in several African countries (Carletto, Gourlay, and Winters 2015). GPS measurements are therefore used in a cross-sectional analysis of the 2012/13 survey wave, when this information is available. Otherwise, we rely on farmer estimates in analyses that pool data from multiple years.

---

5 In theory, plots can be traced even if held by new households in later survey waves. However, we were unable to confidently link these in all cases, and they are therefore omitted from our plot fixed effects analysis.
6 Enumerators were instructed to measure all plots within one hour of the homestead, as long as respondents gave permission and the terrain was not too difficult.
7 The January 2013 exchange rate was 1,614 TSh = USD $1. The CPI accounts for the price of food, which rose more quickly than non-food items around this time (based on authors' analysis of 2010-2014 index values). It thus seems that use of the comprehensive CPI may, if anything, over-compensate for inflation when it comes to land prices, leading us to under-state the degree to which land prices rose (relative to inflation) over the study period.
8 An additional 1,006 large-scale farms, not considered *agricultural households*, were also enumerated. However, their precise location is not reported.

Table 2. Variable Definitions

Variable	Definition	Level[a]
Plot area (acres)	Estimated area[b]	P
Land value (TSh/acre)	Estimated sales value of plot/estimated area[b]	P
Net value crop production (IHST, TSh/acre)	(Value of crop production on plot over previous 12 months, minus costs of seed, fertilizer, agro-chemicals, and hired labor applied to the plot)/estimated area.[b] This is transformed using an inverse hyperbolic sine transformation (IHST) to account for values of zero.	P
At residence	1=Plot is right at residence	P
Formal document/ Less formal document	1= Plot has a granted right of occupancy, certificate of customary right of occupancy, or residential license *or* 1= Plot has a purchase agreement, letter of inheritance, or other less formal document	P
Can be left uncultivated	1= Respondent is comfortable leaving plot uncultivated for several months	P
Good/bad soil quality	1= Soil quality categorized as *good or* 1= Soil quality categorized as *bad*, relative to *average*	P
Flat/steep slope	1= Slope categorized as *bottom flat* or *top flat or* 1= Slope categorized as *very steep*, relative to *slightly sloped*	P
Slope (%)	Slope of plot (from the SRTM 90m Digital Elevation Database, available for GPS-measured plots in 2012/13)[d]	P
Pre-harvest crop loss	1= There was pre-harvest crop loss on this plot in the previous main growing season	P
Erosion control	1= Any type of erosion control implemented on the plot	P
Irrigated	1= Plot was irrigated	P
Permanent crops	1= Plot contains some fruit trees or permanent crops	P
Proportion of crop value marketed	Proportion of crop value produced by the household in the past year that was sold	HH
Rural household	1= Household resides in rural area[c]	HH
Distance to road (km)	Plot distance to road (km), estimated	P
Distance to town (km)	Distance to home (estimated)[b] + Homestead distance to nearest town of ≥ 20,000 population (from Statoids)[d]	P
Distance to major market (km)	Distance to home (estimated)[b] + Homestead distance to nearest major market (from Statoids)[d]	P
Population density (100s persons/km^2)	2010 population density (persons/km^2) (from WorldPop), estimated at midpoint of a range.[d]	H
Average annual temperature (10s °C)	Average annual temperature (from WorldClim, 1960-90 reference period)[d]	H
Average annual rainfall (100s mm)	Average annual rainfall (from WorldClim, 1960-90 reference period)[d]	H
Agro-ecological zones	Standardized agro-ecological zones (dummy variables) (from HarvestChoice)[d]	H
Forest/Fallow	1= Plot was forested *or* 1= Plot was fallow in previous year. In some cases, tree crops were harvested from these plots.	P

[a] P = plot, H = homestead, HH = refers to household

[b] Plot area and distance to home are measured in 2012/13 for GPS-measured plots, and these measured values are used in Table 5.

[c] The data set does not contain information on the rural status of each plot, among other variables. Instead, some homestead-level characteristics are linked to the household's plots within 50 km.

[d] These variables were compiled and made available by the LSMS (NBS 2014).

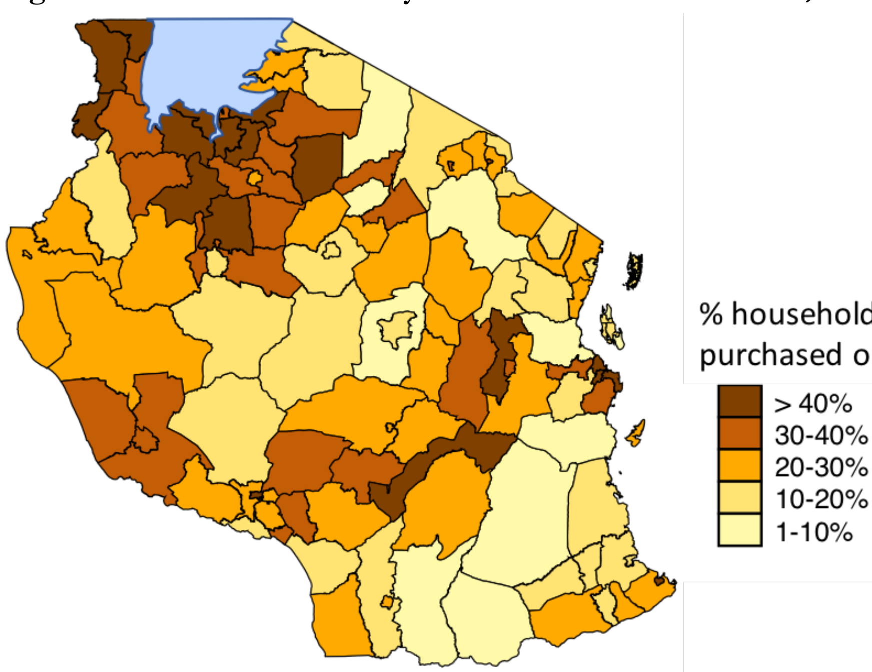
5. RESULTS

5.1. Descriptive Results

We begin by acknowledging that farmer-estimated land values may be of little worth in a context where monetary values are not assigned to land and land is not transacted on the market. Before delving into our analysis, we first refer to the Agriculture Sample Census Survey data set to assess the extent of land market activity across the country, as of 2007/08. Figure 2 illustrates the percent of agricultural households that access land through the market in each district. In total, 19.4% of households possess land that was acquired through purchase, 10.7% access land as renters, and 27.4% access land through either the purchase or rental market. It thus seems that the land market may be *thick* enough to provide farmers with a fair understanding of the monetary value of their land. Note that the extent of land market activity is far from uniform throughout the country. Some districts exhibit quite an inactive land market, while elsewhere this rate extends up to 74.7%. Nevertheless, there is no district with zero land market activity. Furthermore, because districts with greater land market activity also tend to be more populated, almost three-quarters of agricultural households live in a district with at least a 20% market participation rate.

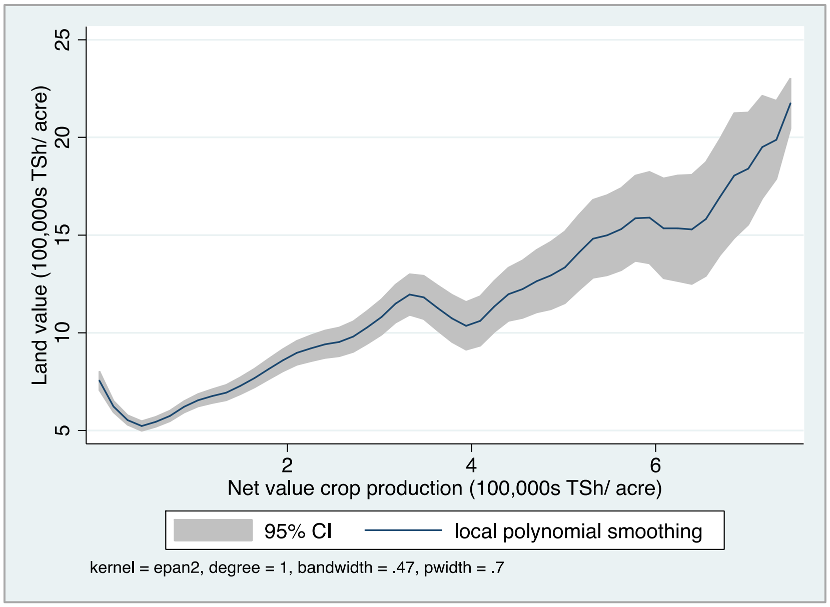
Now referring to the LSMS data set, Figure 3 presents a non-parametric estimate of the relationship between per-acre net values of crop production and per-acre land values. A non-parametric local polynomial regression requires no assumptions of the functional form; rather, a weighted least squares regression is fit at each point, using data from the surrounding neighborhood.

Figure 2. Land Market Activity across Districts in Tanzania, 2007/08



Source: Tanzania Agriculture Sample Census Survey 2007/08 (authors' summary)

Figure 3. Land Value and Net Value of Crop Production, 2008/09, 2010/11, 2012/13 (Pooled)



Notes: N=16,887 (all plots with crop production and/or crop harvest). Bandwidth selected based on the rule-of-thumb bandwidth estimator in Stata.

Returns to crop production are often excluded from hedonic analyses of farmland values, likely because profits are themselves determined by the other factors being assessed (e.g., soil quality or climate characteristics). Using data pooled from all three years of the LSMS, Figure 3 displays a clear, positive relationship between gross margins of crop production and land values. (The figure looks very similar for each individual year.) Acknowledging that one would not expect a perfect correlation between stochastic returns and land values, this strong relationship gives us confidence that the farmer-estimated land values are suitable for further analysis.

Table 3 provides a summary of estimated land values across administrative zones in Tanzania over the three survey waves. To avoid the influence of outliers in the descriptive statistics, land values are winsorized at the 5th and 95th percentile.[9] These results illustrate, first, that land values vary considerably over space. While the national median price in 2008/09 was 239,490 TSh/acre (approximately $148), this varied from a low of 119,745 TSh in Central zone to a high of 673,567 TSh/acre in Northern zone and 748,407 TSh/acre in Zanzibar. The results also illustrate that land prices rose over the study period, with each additional year associated, on average, with an increase in the per-acre land price of 32,245 TSh/acre ($23). The per-year increase in the median value is slightly lower at 15,127 TSh/acre ($9). Anecdotal evidence of rising land prices seems therefore to bear out in the data. This leap in prices occurred mostly between 2008/09 and 2010/11, a time of sharply rising food prices (Ivanic, Martin, and Zaman 2012) and also high monetary inflation in Tanzania (Adam et al. 2012), which would make farmland a more attractive investment. As noted in the introduction, such growth may represent a boon to landowners, but it can also present an obstacle to poor farmers or rural youth hoping to become farmers if they do not approach the market with sufficient capital.

[9] In winsorization, observations below the 5th (above the 95th) percentile were set to the value of the 5th (95th) percentile. In regression analyses in which land values are logged, land values are *not* winsorized as the logarithmic transformation itself reduces the influence of extreme values.

Table 3. Land Values across Tanzania, 2008/09 to 2012/13

	Land value (100,000s TSh/acre)											Test[a]
	2008/09			2010/11			2012/13			Δ 2008/09 to 2012/13 (per year)		2008/09 = 2012/13
	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	P-value
Whole country	2.39	7.02	11.69	2.87	7.89	12.48	3.00	8.51	12.79	+0.15	+0.37	0.000
Zone												
Western	2.00	3.69	6.18	2.18	4.54	8.37	2.00	3.87	6.72	0.00	+0.05	0.621
Northern	6.74	15.73	17.95	7.98	17.63	18.32	10.00	17.91	18.30	+0.82	+0.55	0.037
Central	1.20	1.89	2.47	1.20	2.17	2.78	1.50	2.69	4.51	+0.08	+0.20	0.003
Southern Highlands	1.80	5.07	8.51	2.39	5.97	10.10	3.00	7.66	11.34	+0.30	+0.65	0.000
Lake	3.99	8.83	12.31	4.79	10.83	13.66	5.00	9.62	12.53	+0.25	+0.20	0.339
Eastern	2.99	9.04	13.65	3.59	8.85	12.99	4.67	11.27	14.77	+0.42	+0.56	0.013
Southern	1.80	4.87	8.54	2.05	4.81	8.21	2.00	5.41	8.98	+0.05	+0.14	0.113
Zanzibar	7.48	13.90	15.42	7.18	12.05	12.98	8.57	12.19	11.67	+0.27	-0.43	0.057

P-values of a t-test for a significant difference in means

Note: Land values are winsorized at the 5th and 95th percentile to address outliers. The magnitude of any change in average land prices does vary according to how outliers are addressed, although a statistically significant increase in land prices is evident with all methods tried (e.g., maintaining all observations, dropping outliers, or winsorizing within each year).

5.2. Hedonic Analysis of Land Values

We turn next to an econometric analysis of the determinants of land prices. A Box-Cox transformation, carried out on the pooled sample, indicates that the semi-log functional form is more appropriate than a linear functional form.[10] Consistent with the approach of others (e.g., Huang et al. 2006; Livanis et al. 2006), we therefore use the natural log of land values as our dependent variable. This has the added benefit of a straightforward interpretation of coefficients. For a continuous explanatory variable, a one-unit increase leads to a change of [100*β]% in land value, while for a binary variable, the change is [100*($e^{\beta}-$ 1)]%. It is possible for plot-level prices to exhibit spatial autocorrelation, as when plot values are influenced by their neighbors' values (a spatial lag structure) or when unobserved land characteristics in a given area are correlated (a spatial error structure). When data are spatially referenced, it is therefore common to test for spatial autocorrelation and, as appropriate, to model spatial relationships using a spatial weights matrix (Patton and McErlean 2003). Unfortunately, the LSMS data set does not include the precise location of each plot or even each household. In our models, region fixed effects[11] are included to control for unobserved administrative factors that may uniquely affect the land market within each region. This is analogous to a spatial weights matrix with a weight of one for plots within the same region and a weight of zero otherwise. Standard errors are also clustered at the district level to allow for the correlation of error terms of nearby observations.[12]

Table 4 presents results of equation (1) when data from the three survey waves are pooled,[13] with column 1 limited to cultivated plots and column 2 inclusive of all plots. Because several of these variables may be collinear, we confirm that the mean variance inflation factor (VIF) in each column is suitably low, with the greatest individual VIF below 5.[14] A VIF above 10 would indicate a problem of multicollinearity (Wooldridge 2009: 99). The R^2 values of 0.33-0.35 are comparable to those found in hedonic studies elsewhere (e.g., Livanis et al. 2006).

Results of Table 4 (column 1) show that, as hypothesized, the relationship between land value and plot size is convex—the *small parcel size premium* is evident in Tanzania. A plot located right beside the homestead is associated with 30.7% (that is, 100*($e^{0.268}-$1)) higher land values. This may be because it would only be sold together with the home, such that the plot's value is actually conflated with that of the house. Several indicators of tenure security yield mixed results.

While both formal and less formal documents associated with the plot are significantly correlated with higher land values, a farmer's confidence that a plot can be left uncultivated is not significantly correlated with its value. As for indicators of agricultural potential, soil categorized as *good* is associated with 12.7% higher land values, and while the coefficient on *bad* soil is negative, it is not statistically significant (P=0.160). Slope is also not a statistically significant determinant of land

---

[10] In a Box-Cox test for the appropriate form of the dependent variable, in which θ=0 indicates a logarithmic relationship, the value of theta is statistically significantly different from 0 at the 10% level (P=0.088). However, the value is close to zero (θ=0.028), and the test statistic for the linear form is several orders of magnitude larger.

[11] Tanzania contained 26 administrative regions and 132 districts at the time of data collection.

[12] This pooled analysis contains multiple observations on the same plots, suggesting that standard errors may be clustered at the plot level to allow for correlation across same-plot observations. However, standard errors clustered at the plot-level are smaller than those clustered at the district level. We therefore present the more conservative (district level) results.

[13] Results are robust when considering land values from a single year.

[14] At this step, *elevation* was removed from the model to limit collinearity with temperature.

values. Higher rainfall is significantly correlated with higher land values, with a marginal increase of 100 mm rainfall associated with 3.9% higher land values, *ceteris paribus*. Several plot amendments also significantly raise the value of land, including the presence of erosion control (leading to an increase of 16.4%), irrigation (43.5%), and fruit trees or permanent crops (47.0%).

The influence of market and urban access on land values emerges clearly in these results. Location in a rural area is associated with a 20.4% decrease in land values, on average and holding all else constant. The coefficients on several measures of remoteness reveal a consistently negative relation with land prices. An additional km from the nearest road, from the nearest town of at least 20,000 people, and from the nearest major market are associated with, respectively, 2.3%, 0.04%, and 0.02% lower land values. We also proxy for market access with the household's observed market orientation, or the proportion of crop value produced over the previous year that was sold. This is positively and significantly associated with higher land values. Finally, local population density is also positively and significantly associated with land prices, and this may reflect either land scarcity or the urban (or urban-like) conditions associated with higher densities.[15]

In column 2 of Table 4, the sample is expanded to include plots that were not *cultivated* in the past year. This includes plots that were rented/given out, forested, fallow, or put to another use, as well as some plots from which only tree crops/permanent crops were harvested. (As noted earlier, the latter seem to have been miscategorized during data collection.) Results show that a plot left fallow is estimated to have a 7.3% lower value per acre. This may be a case of reverse causality in which the less productive plots are those left in fallow. However, this pattern may also present a disincentive to landowners considering whether to maintain soil fertility through fallowing, as it suggests that this investment cannot be recouped in a potential land sale.

In order to verify that these results are not merely a reflection of potentially biased plot size estimates, we now repeat the analysis with a cross-section of plots from 2012/13 for which areas were measured. This directly affects the area measures and the dependent variable. We also make use of additional information associated with precise plot locations, including the continuous estimate of plot slope and the GPS-measured distance from the homestead. Note that these results should be regarded with some caution, as there are systematic differences between plots that were and were not measured. For example, measured plots are statistically significantly closer to a road (on average, 1.6 km versus 4.8 km for all plots, P=0.000) and more likely to be held by a rural household (on average, 90.3% versus 84.5% for all plots, P=0.000). Results of this cross-sectional analysis, presented in Table 5, generally confirm the findings of the pooled analysis. However, there are a few exceptions. Indicators of tenure security are no longer found to be significant determinants of land value, though the coefficients are still positive. And an additional km from the nearest road is now associated with a smaller penalty than previously estimated (1.3% versus 2.3% from Table 4, $P>\chi^2$=0.026).

[15] These results are very similar across different variations of this model, such as the exclusion of Zanzibar from the sample or the inclusion of district (not region) fixed effects.

Table 4. Determinants of Land Values, 2008/09, 2010/11, 2012/13 (Pooled OLS)

		(1)		(2)	
		Dependent variable: Land value (ln, TSh/acre)			
	Mean Values (cultivated plots)	Cultivated plots		All plots	
		Coef	P-value	Coef	P-value
Area (acres)	2.410	-0.052***	0.000	-0.049***	0.000
$Area^2$		0.0002***	0.000	0.0002***	0.000
1= At residence	0.334	0.268***	0.000	0.254***	0.000
1= Formal document	0.034	0.203**	0.030	0.278***	0.002
1= Less formal document	0.069	0.241***	0.000	0.287***	0.000
1= Can be left uncultivated	0.878	0.100	0.192		
1= Forested	0.014 (all)			-0.0001	0.999
1= Fallow	0.127 (all)			-0.076*	0.057
1= Good soil quality[a]	0.474	0.120***	0.000		
1= Bad soil quality	0.064	-0.083	0.160		
1= No slope (flat)[a]	0.623	0.018	0.602		
1= Steep slope	0.046	-0.020	0.844		
1= Pre-harvest crop loss on plot	0.450	-0.024	0.471		
1= Erosion control	0.130	0.152***	0.005		
1= Irrigated	0.024	0.361**	0.024		
1= Contains fruit trees or permanent crops	0.541	0.385***	0.000	0.366***	0.000
Proportion of crop value marketed	0.360	0.261***	0.000		
1= Rural household	0.896	-0.228**	0.019	-0.212**	0.017
Distance to road (km)	2.112	-0.023***	0.000	-0.005	0.227
Distance to town (km)	55.103	-0.004***	0.001	-0.004***	0.001
Distance to major market (km)	78.658	-0.002**	0.039	-0.002**	0.043
Population density (100s persons/km^2)	5.201	0.005***	0.005	0.005***	0.002
Average annual temperature (10s °C)	220.053	-0.002	0.520	-0.001	0.681
Average annual rainfall (100s mm)	9.904	0.039***	0.009	0.039**	0.013
1= Agro-ecological zone (AEZ) is warm/ semiarid[a]	0.095	-0.231	0.356	-0.254	0.268
1= AEZ is warm/humid	0.013	0.150	0.660	0.220	0.536
1= AEZ is cool/semiarid	0.044	-0.087	0.660	-0.127	0.499
1= AEZ is cool/subhumid	0.374	-0.053	0.645	-0.049	0.651
1= AEZ is cool/humid	0.018	0.587**	0.047	0.632**	0.030
1= Year 2010/11		0.190***	0.005	0.166**	0.011
1= Year 2012/13		0.158***	0.000	0.118***	0.005
Constant		12.215***	0.000	12.327***	0.000
Region fixed effects (FE)		Y		Y	
Observations		15,058		18,429	
Adjusted R-squared		0.349		0.328	
Mean variance inflation factor (VIF)		1.92		2.03	

Standard errors clustered at district; *** p<0.01, ** p<0.05, * p<0.1.

Note: For column 1, 15,410 plots were categorized as *cultivated* and located within 50 km of the homestead, and 352 of these observations are dropped (mostly in 2008/09) due to missing information. For column 2, 18,449 plots were located within 50 km of the homestead, and 20 observations are dropped due to missing information. Column 2 contains 1,536 plots with some crop harvest (usually tree crops) that were not classified as *cultivated*.

[a] Mean values of base groups: Average soil quality = 0.462; slight slope = 0.331; AEZ warm/sub-humid = 0.456.

Table 5. Determinants of Land Values, 2012/13 – Based on GPS Measurements (OLS)

	Dependent variable: Land value (ln, TSh/acre) Cultivated plots	
	Coef	P-value
Area (acres)	-0.041***	0.000
$Area^2$	0.0002***	0.000
1= At residence	0.286***	0.000
1= Formal document	0.117	0.386
1= Less formal document	0.060	0.524
1= Can be left uncultivated	0.067	0.580
1= Good soil quality	0.194***	0.000
1= Bad soil quality	-0.122	0.256
Plot slope (%)	-0.007	0.171
1= Pre-harvest crop loss on plot	-0.044	0.473
1= Erosion control	0.187*	0.076
1= Irrigated	0.020	0.921
1= Contains fruit trees or permanent crops	0.428***	0.000
Proportion of crop value marketed in this year	0.247**	0.015
1= Rural household	-0.066	0.638
Distance to road (km)	-0.013*	0.087
Distance to town (km)	-0.006***	0.000
Distance to major market (km)	-0.002*	0.083
Population density (100s persons/km^2)	0.008**	0.026
Average annual temperature (10s °C)	-0.002	0.506
Average annual rainfall (100s mm)	0.060***	0.002
1= Agro-ecological zone is warm/semiarid	-0.115	0.658
1= warm/humid	-0.077	0.842
1= cool/semiarid	0.018	0.936
1= cool/subhumid	-0.090	0.499
1= cool/humid	0.193	0.498
Constant	12.223***	0.000
Region FE	Y	
Observations	4,590	
Adjusted R-squared	0.367	
Mean VIF	1.44	

Standard errors clustered at district; *** p<0.01, ** p<0.05, * p<0.1

Note: Of the plots that were measured in 2012/13, 4,604 were categorized as *cultivated* and located within 50 km of the homestead. Fourteen observations are dropped due to missing information.

We next exploit the fact that individual plots were tracked over the survey years by setting up a plot fixed effects analysis to explore how a plot's value adjusts to changes in time-variant explanatory variables. Equation (1) is augmented with a plot fixed effect and limited to the plots that were tracked and consistently cultivated in all three panel waves. The plot fixed effect is intended to capture all time-invariant characteristics of these plots, including those observed in the data that would not change over such a short time interval (e.g., distance to town or local climate conditions), as well as characteristics that are unobserved (e.g., tillability of the soil or the extent to which the clan exercises control of the plot). As plot characteristics that would determine farm profits are omitted, the net value of crop production is now included as a regressor. Because 26.3% of plots captured in 2008/09 were not traced over the next two panel waves, we first test our model for attrition bias with a dummy-variable regression-based method (Wooldridge 2002: 577). Inclusion in the subsequent survey wave is a statistically significant correlate of a plot's land value ($\beta = 0.18$, P=0.026), suggesting that patterns of attrition may, indeed, bias our results. We, therefore, apply inverse probability weights to control for the likelihood of inclusion over three survey waves, with the determinants of consistent inclusion comprising a large set of plot- and household-level characteristics in 2008/09. (However, results without any adjustments to the population weights are very similar.)

Results in Table 6 show that when a plot acquires an informal document, such as a letter of allocation, its value increases by an estimated 21.3% (that is, 100*($e^{0.193}-1$)), and this is significant at the 5% level. This seems to highlight the importance of informal documents in local systems of tenure security in Tanzania. When a farmer feels confident that their land can be safely left uncultivated, the estimated value also increases by 17.5%. Two variables related to agricultural productivity lend weight to the argument of a causal relationship with land values, now that we have controlled for time-invariant plot characteristics. Specifically, a 1% increase in the value of crop production is associated with a 0.01% increase in the perceived value of the farmland, while the experience of pre-harvest crop loss is associated with a 10.4% decrease in the perceived value. Finally, when a farmer adds fruit trees or other permanent crops to a plot, this also boosts the estimated value by 10.6%.

Table 6. Determinants of Land Values, 2008/09, 2010/11, 2012/13 (Plot Fixed Effects Regression)

	Dependent variable: Land value (ln, TSh/acre)	
	Coef	P-value
1= Formal document	0.029	0.776
1= Less formal document	0.193***	0.010
1= Can be left uncultivated	0.161**	0.023
Net value of crop production in past year (IHST, TSh/acre)	0.012***	0.002
1= There was pre-harvest crop loss on this plot	-0.110***	0.003
1= Any type of erosion control on this plot	0.065	0.291
1= Plot was irrigated in main season	0.083	0.685
1= Plot contains some fruit trees or permanent crops	0.101*	0.080
Proportion of crop value produced that was sold in this year	0.041	0.614
1= Year 2010/11	0.168***	0.000
1= Year 2012/13	0.249***	0.000
Constant	12.299***	0.000
Plot FE	Y	
Observations	6,934	
Number of plots	2,316	
Within R-squared	0.029	

Standard errors clustered at household; *** p<0.01, ** p<0.05, * p<0.1

Note: Of the plots that were tracked, 2,388 were located within 50 km of the homestead and cultivated in every wave (approximately 24% of plots were cultivated in just one or two years), and 24 observations are dropped due to missing information. Results are similar when using an unbalanced panel.

6. DISCUSSION AND CONCLUSIONS

This analysis of land values has produced several key findings related to land in Tanzania. First, although farmer-estimated land values might be regarded with skepticism by some analysts, we have provided evidence on both the existence of a land market in Tanzania and on the validity of these price estimates. Specifically, we find that land values are positively correlated with the net value of crop production per acre. This reasonable finding suggests that farmers are, indeed, able to make an informed estimate of the monetary value they would receive if they were to put their land up for sale. Second, consistent with anecdotal evidence on rising land prices, we confirm that average land values in Tanzania rose significantly over this four-year interval. This increase was especially pronounced between 2008/09 and 2010/11, though prices remained high in 2012/13. A higher price tag may move land out of reach of Tanzania's poorest citizens. This concern deserves attention from policy makers, as rural youth may have few other employment options (Filmer and Fox 2014), and if this self-employment path were closed to aspiring farmers, we propose that the effects could be potentially wide-ranging and destabilizing for Tanzania's economy. Further research is needed to determine the extent to which land buyers (or renters) are able to earn a return on their investment.

Third, our hedonic analysis reveals that tenure security, as represented by land-related documents associated with specific plots, is a significant determinant of land values. What's more, this correlation is not only limited to formal documents, such as certificates of customary rights of occupancy. While programs often devote attention to the benefits that accrue from formal land titles (Sjaastad and Cousins 2008), it seems that informal documents, such as unofficial sales contracts or letters of inheritance, also play a role in local systems of tenure security. Fourth, farmland values are only partially explained by agricultural factors, and the influence of market and urban access on land prices in Tanzania is substantial. This is evident in the statistically significant relationships between prior market orientation or distance to town and the value of land. It is not possible to untangle how much this reflects the greater agricultural revenues that accompany more favorable market access, versus the potential to convert farmland to residential or other urban uses. Nevertheless, this pattern echoes the insight of von Thünen (1842) that farmland values are derived from attributes beyond mere agricultural productivity.

We conclude with a comment on promising directions for future research on land values in Tanzania and Sub-Saharan Africa. A number of factors, not captured in this paper, are likely determinants of land prices. These include local market structures and the extent to which market power is held by different actors, as well as local institutions that facilitate or regulate the land market. Some tribes, for example, may require their members to prioritize transactions with other tribe members, ensuring that land is exchanged at below-market values (see Wineman and Liverpool-Tasie 2015). Even in the U.S., farmland transactions between related parties or friends are accompanied by a sharp price discount (Tsoodle, Golden. and Featherstone 2006; Robison, Myers, and Siles 2002). Thus, the most likely transaction partner may affect respondents' estimates of their land values in a household survey. Another variable not well-captured in our analysis is the effect of population growth on land prices, with a focus on whether this reflects *natural* population growth (i.e., fertility trends and mortality rates) or in-migration. (Recall that our measure of local population density was not time-varying.) A final factor of interest may be the influence of large-scale land acquisitions by foreign or domestic investors on local land prices. In settings of land scarcity, this could logically place upward pressure on land prices. While a number of studies focus on the employment or productivity spillover effects of large commercial farms in rural Sub-Saharan Africa (e.g., Ali, Deininger, and Harris 2016), an analysis of ripple effects within the local land market is thus far missing.

Though the vast majority of land transactions in Tanzania take place on the informal market (USAID 2011; Wineman and Liverpool-Tasie 2016), and may therefore be challenging to track, the collection of data on realized sales prices would be instrumental to discern the extent to which the farmer-estimated land values analyzed in this paper seem to reflect actual sales values. Such data would shed light on whether some categories of farmers (for example, those with low levels of education) systematically under-estimate the value of their land, thereby drawing down the price received through negotiation in the event of a sale. Data on realized sales prices can also be used to determine the extent to which land sales motivated by distress are characterized by depressed prices. This leads to yet another motivation to seek a better understanding of land values in Sub-Saharan Africa: When engaging with the land market, poor people need to know the fair price that can be expected, and should be able to make an informed decision on whether to sell or buy sooner versus later. As yet, knowledge of non-commercial land values is quite thin—though much can be gained by changing that.

REFERENCES

Adam, C., D. Kwimbere, W. Mbowe, and S. O'Connell. 2012. *Food Prices and Inflation in Tanzania*. Working Paper No. 163. Abidjan, Ivory Coast: African Development Bank.

Ali, D., K. Deininger, and A. Harris. 2016. Spillover Effects of Large-Scale Commercial Farms in Ethiopia. Paper presented at the World Bank Land and Poverty Conference, March 14–18. Washington, D.C.

Barnard, C.H. 2000. Urbanization Affects a Large Share of Farmland. *Rural Conditions and Trends* 10.2: 57–63.

Barrett, C.B. and L. Bevis. 2015. The Self-reinforcing Feedback Between Low Soil Fertility and Chronic Poverty. *Nature Geoscience* 8: 907–912.

Borchers, A., J. Ifft, and T. Kluethe. 2014. Linking the Price of Agricultural Land to Use Values and Amenities. *American Journal of Agricultural Economics* 96.5: 1307–1320.

Brorsen, B.W., D. Doye, and K.B. Neal. 2015. Agricultural Land and the Small Parcel Size Premium Puzzle. *Land Economics* 91.3: 572–585.

Carletto, C., S. Gourlay, and P. Winters. 2015. From Guesstimates to GPStimates: Land Area Measurement and Implications for Agricultural Analysis. *Journal of African Economies* 24.5: 593-628.

Choumert, J. and P. Phélinas. 2015 Determinants of Agricultural Land Values in Argentina. *Ecological Economics* 110: 134–140.

Daley, E. 2005. Land and Social Change in a Tanzanian Village 2: Kinyanambo in the 1990s. *Journal of Agrarian Change* 5.4: 526–572.

Devadoss, S., and V. Manchu. 2007. A Comprehensive Analysis of Farmland Value Determination: A County-level Analysis. *Applied Economics* 39.18: 2323–2330.

Filmer, D. and L. Fox. 2014. *Youth Employment in Sub-Saharan Africa*. Africa Development Series. Washington, D.C.: World Bank.

Foster, W., G. Anriquez, O. Melo, D. Yupanqui, and J. Ortega. 2016. Geographic Disparities in Rural Land Appreciation in a Transforming Economy: Chile, 1980 to 2007. *Land Use Policy* 57: 65–668.

Goodwin, B.K., A.K. Mishra, and F.N. Ortalo-Magné. 2003. What's Wrong with Our Models of Agricultural Land Values? *American Journal of Agricultural Economics* 85.3: 744–752.

Guiling, P., B.W. Brorsen, and D. Doye. 2009. Effect of Urban Proximity on Agricultural Land Values. *Land Economics* 85.2: 252–264.

Hardie, I.W., T.A. Narayan, and B.L. Gardner. 2001. The Joint Influence of Agricultural and Nonfarm Factors on Real Estate Values: An Application to the Mid-Atlantic Region. *American Journal of Agricultural Economics* 83.1: 120–132.

Holden, S., K. Otsuka, and F. Place. 2009. Land Markets and Development in Africa. In *The Emergence of Land Markets in Africa*, ed. S.T. Holden, K. Otsuka, and F.M. Place. Washington, D.C.: Resources for the Future.

Huang, H., G.Y. Miller, B.J. Sherrick, and M.I. Gómez. 2006. Factors Influencing Illinois Farmland Values. *American Journal of Agricultural Economics* 88.2: 458–470.

Ivanic, M., W. Martin, and H. Zaman. 2012. Estimating the Short-Run Poverty Impacts of the 2010–11 Surge in Food Prices. *World Development* 40.11: 2302–2317.

Jayne, T.S., J. Chamberlin, and D. Headey. 2014. Land Pressures, the Evolution of Farming Systems, and Development Strategies in Africa: A Synthesis. *Food Policy* 48: 1–17.

Jayne, T.S., J. Chamberlin, L. Traub, N. Sitko, M. Muyanga, F.K. Yeboah, W. Anseeuw, A. Chapoto, A. Wineman, and C. Nkonde. Forthcoming. Africa's Changing Farmland Ownership: The Rise of Medium-Scale Farms. *Agricultural Economics* 47.

Livanis, G., C.B. Moss, V.E. Breneman, and R.F. Nehring. 2006. Urban Sprawl and Farmland Prices. *American Journal of Agricultural Economics* 88.4: 915–929.

Ma, S. and S.M. Swinton. 2012. Hedonic Valuation of Farmland Using Sale Prices versus Appraised Values. *Land Economics* 88.1: 1–15.

Maddison, D. 2000. A Hedonic Analysis of Agricultural Land Prices in England and Wales. *European Review of Agricultural Economics* 27.4: 519–532.

Maddison, D., M. Manley, and P. Kurukulasuriya. 2007. *The Impact of Climate Change on African Agriculture: A Ricardian Approach*. Policy Research Working Paper No. 4306. Washington, DC: World Bank.

Mendelsohn, R., W. Nordhaus, and D. Shaw. 1994. The Impact of Global Warming on Agriculture: A Ricardian Analysis. *American Economic Review* 84.4: 753–771.

Merry, F., G. Amacher, and E. Lima. 2008. Land Values in Frontier Settlements of the Brazilian Amazon. *World Development* 36.11: 2390–2401.

National Bureau of Statistics (NBS). 2011. Technical and Operation Report, Agriculture Sample Census Survey 2007/08. Dar es Salaam: NBS.

National Bureau of Statistics (NBS). 2014. Basic Information Document, National Panel Survey 2012-13. Dar es Salaam: NBS.

Nickerson, C., and W. Zhang. 2014. Modeling the Determinants of Farmland Values. In *The Oxford Handbook of Land Economics,* ed. J.M. Duke and J. Wu. Oxford: Oxford University Press.

Patton, M. and S. McErlean. 2003. Spatial Effects within the Agricultural Land Market in Northern Ireland. *Journal of Agricultural Economics* 54.1: 35–54.

Plantinga, A.J., R.N. Lubowski, and R.N. Stavins. 2002. The Effects of Potential Land Development on Agricultural Land Prices. *Journal of Urban Economics* 52.3: 561–581.

Ricardo, D. 1817. *On the Principles of Political Economy and Taxation*. London: Murray.

Robison, L., R. Myers, and M. Siles. 2002. Social Capital and the Terms of Trade for Farmland. *Review of Agricultural Economics* 24.1: 44–58.

Rosen, S. 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy* 82.1: 34–55.

Seo, S.N., R. Mendelsohn, A. Dinar, R. Hassan, and P. Kurukulasuriya. 2009. A Ricardian Analysis of the Distribution of Climate Change Impacts on Agriculture across Agro-ecological Zones in Africa. *Environmental and Resource Economics* 43.3: 313–332.

Sjaastad, E. and B. Cousins. 2008. Formalisation of Land Rights in the South: An Overview. *Land Use Policy* 26.1: 1-9.

Sklenicka, P., K. Molnarova, K.C. Pixova, and M.E. Salek. 2013. Factors Affecting Farmland Prices in the Czech Republic. *Land Use Policy* 30.1: 130–136.

Tsoodle, L.J., B.B. Golden. and A.M. Featherstone. 2006. Factors Influencing Kansas Agricultural Farm Land Values. *Land Economics* 82.1: 124–139.

United Nations. 2014. *World Urbanization Prospects: The 2014 Revision*. Department of Economic and Social Affairs. New York: United Nations.

United States Agency for International Development (USAID). 2011. Tanzania Country Profile: Property Rights and Resource Governance. Available at http://usaidlandtenure.net/tanzania

Von Thünen, J.H. 1842. *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie*. Rostock: Leopold.

Weersink, A., S. Clark, C.G. Turvey, and R. Sarker. 1999. The Effect of Agricultural Policy on Farmland Values. *Land Economics* 75.3: 425–39.

Wineman, A., and L.S. Liverpool-Tasie. 2015. Land Markets and Migration Trends in Tanzania: A Qualitative-Quantitative Analysis. Mimeo, Michigan State University: East Lansing.

Wineman, A., and L.S. Liverpool-Tasie. 2016. Land Markets and Land Distribution in Northwestern Tanzania. Paper presented at the Agricultural and Applied Economics Association Annual Meeting, August 1–3. Boston, MA.

Wooldridge, J. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: Massachusetts Institute of Technology Press.

Wooldridge, J. 2009. *Introductory Econometrics: A Modern Approach*. Mason, OH: South-Western Cengage Learning.