Agricultural Factor Markets in Sub-Saharan Africa: An Updated View with Formal Tests for Market Failure

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Abstract

Using the recently collected LSMS-ISA data sets from five countries in sub-Saharan Africa, we provide a comprehensive overview of land and labor market participation by agrarian households, and test for failures in factor markets. Our approach is grounded in the standard model of the agricultural household. Under complete and competitive markets, households can solve their consumption and production problems separately, so that household endowments are not predictive of input demand. We implement a simple, theoretically grounded test of this separation hypothesis, which can be interpreted as a reduced form test of factor market failure. In all five study countries we find strong evidence of factor market failure.

1. Introduction

It is a tenet of economic theory that well-regulated, competitive markets, in combination with adequate institutional support, do a better job of allocating resources between and within sectors than do government planning programs. In the structural adjustment era of the 1980s-90s, this belief underpinned the broad transition away from government management and toward market liberalization in much of sub-Saharan Africa (SSA). In the ensuing decade and a half, as it has become clear that liberalization *per se* was not sufficient to raise growth rates and rapidly reduce poverty throughout the region, attention has turned to market failures. It is now presumed that failing markets are a general feature of African economies. Substantial resources are committed each year to programs aimed at diagnosing and remedying these failures.

The agricultural factor markets of sub-Saharan Africa are among those widely believed to be failing or incomplete. The proclaimed shortcomings are many: bad roads, unavailable or unreliable electrical and telecommunications services, insufficient credit, lack of insurance, tenure systems that do not ensure secure property rights, corrupt officials, crowded ports, slow development of improved technologies at agricultural research centers, labor supervision problems, and others. The perceptions among governments and practitioners are that (i) these deficiencies interfere with the efficient distribution of resources, leaving farmers ill-served by the markets for land, labor, seeds, and other factors of production, and (ii) these failures prevent the efficient allocation of resources among households, and among plots managed by a single household, leading to lower output and slower growth than would otherwise be achieved. Proposed solutions to these deficiencies range from direct involvement in factor markets by the highest levels of government – as embodied in the commitment of the 2010 Abuja Declaration on Fertilizer by governments across Africa to increase subsidization of fertilizer – to numerous micro-lending programs and small-scale input subsidy programs run by NGOs.

As in the structural adjustment era, however, this belief in market failure is based as much on speculation as on hard empirical evidence about how markets function in Sub-Saharan Africa (Berg 2013). Writing about credit market failures in the New Palgrave Dictionary of Economics, Ray (2008) comments that while such failures are a consistent theme in both the research and donor communities, "direct empirical evidence on the existence of credit constraints is surprisingly sparse." Fafchamps (2004) argues that markets in SSA in many ways are more

robust and active than those in the developed world because trade in Africa is typically accomplished with cash-and-carry exchange at prices negotiated on the spot, resource allocation usually involves market exchange between intermediaries rather than administrative decisions internalized within vertically integrated firms, and many Africans act as both buyers and sellers of commodities and labor.

These arguments should not be read as evidence that factor markets function well across SSA. Instead, they serve as a reminder of the need for careful empirical research on market performance in specific settings. A steady stream of price transmission research on African agricultural output markets has rigorously tested hypotheses – such as the 'law of one price' – relating to how completely and quickly demand or supply shocks transmit across space and time.[1] Those studies have been able to precisely identify where transport costs, trade policies, etc. lead to inefficiencies in product market performance and where they do not. There has been little corresponding effort to explore comprehensively how well factor markets function in rural Africa, much less precisely where and why those breakdowns occur.

The aim of this paper is to offer a first step toward filling this important knowledge gap. Using newly available data from the Living Standard Measurement Study-Integrated Surveys on Agriculture Initiative (LSMS-ISA),[2] we test for market failures in five of the major economies of sub-Saharan Africa (Ethiopia, Malawi, Niger, Tanzania, Uganda). The LSMS-ISA data are large-scale, nationally representative, recently and rigorously collected, agriculturally intensive, and comparable across countries. As the first data sets of this kind, they present a unique, high-value opportunity to make progress on important questions about agriculture factor market performance in Africa.

The specific goals of this paper are twofold, and admittedly modest. First, we document the observed patterns of factor market participation by agricultural households. We focus on land and labor markets, as the prevailing wisdom seems to be that few farmers participate in these markets in rural Africa, instead relying on household labor and owned or informally allocated land. We show that, in fact, a large share of farmers transact in agricultural labor or land markets.

[1] For good, if slightly dated, surveys of the literature, see Fackler and Goodwin (2001) and Abdulai (2006,2007) and for some more current studies, see van Campenhout (2007), Moser et al. (2009) and Myers and Jayne (2012).
[2] The LSMS-ISA is coordinated by the Development Economics Research Group of the World Bank in cooperation with national statistical offices in surveyed countries.

These markets plainly exist and are used extensively, naturally raising the question of how well they function.

Our second goal is to use a well-established, reduced form approach to test for market failures using the input demand functions of agrarian households (Benjamin 1992, Udry 1999). For all five study countries we are able to strongly reject the null hypothesis of complete and competitive factor markets.

The test of market failure that we employ is grounded in the standard model of the agricultural household (Singh et al. 1986). The model makes explicit the prediction that when markets are complete and competitive, households can make decisions about production and consumption separately and recursively. This is the "separation hypothesis". If the separation hypothesis holds, households behave as if they allocate resources so as to maximize farm profits first, and then make consumption choices conditional on the budget set that results from farm profit maximization. Because that budget set depends on households' holdings of land, labor, and capital, endowments necessarily affect consumption behaviors. But if factor markets work well, endowments should not affect first-stage production behaviors. This is because, for example, a household could hire labor to replace household labor that is devoted to leisure or off-farm work. Or it could hire in land that it could farm productively even if it does not own land. Conversely, if the separation hypothesis does not hold, then consumption decisions – which are partly determined by endowments – affect factor allocation choices in production. This potentially leads to economy-wide inefficiencies in factor usage.

At the heart of the reduced form test employed in this paper is the observation that when markets are complete and competitive and the separation hypothesis holds, household size – the household's labor endowment – is not predictive of labor demand.[3]

Non-separation between the two sides of the household's resource allocation problem is generally understood to be a consequence of two conditions. First, households must have

[3] There is also a structural approach to the study of the separable household model, involving estimation of production functions and comparison of the marginal product of inputs to their market prices (Jacoby 1993, Skoufias 1994, Barrett et al 2008). Le (2010) describes the two approaches in detail and develops a GMM-based estimation technique to implement both methods simultaneously. We focus on the reduced form approach developed by Benjamin (1992) and Udry (1999) because it lends itself more readily to interpretation as a test of specific market failures.

preferences over some factor of production independent of those related to the value of final output. One obvious example in the case of agrarian households is that household members use their time to supply labor to the family farm, but also consume time as leisure. If hired labor is a perfect substitute for household labor, the consumption and production uses of that resource can be effectively separated. Second, *at least two* factor markets must fail to clear at prices determined competitively by the prevailing supply and demand curves. If credit, labor, land and other factor markets are complete and competitive, and if household-specific shadow prices do not vary substantially around prevailing market prices (de Janvry *et al* 1991, Barrett 1996, Barrett et al. 2008), then the efficient allocation of resources on the farm is independent of household endowments.

A number of other recent papers have sought to evaluate market function in a variety of settings in Africa. Not surprisingly, results have been mixed. Berg (2013) uses anticipated changes in household income in South Africa to test for the presence of credit constraints. While he cannot reject that the observed patterns are due to precautionary savings, he does find strong indicative evidence in support of credit market failures. In the context of a multi-faceted randomized controlled trial, Karlan et al. (2013) find strong evidence for incomplete insurance markets among farmers in Ghana. Barrett et al. (2008) show with data from Cote d'Ivoire that significant differences exist between shadow wages derived from estimated production functions and local market wages paid the same workers, which can be interpreted as evidence of failure in a number of agricultural input markets. On the other hand, separate studies from Kenya and Malawi suggest that given the relative prices of outputs and fertilizer, subsidies may induce most farmers to apply fertilizer at levels well beyond that which is profitable, calling into question the degree to which input market failures are a binding constraint on productivity (Ricker-Gilbert et al. 2009, Sheahan 2011).

The paper proceeds as follows. In the following section we briefly discuss the link between the separation hypothesis and policymaking, and summarize references in the general development literature to market failure in African agricultural factor markets. Section 3 briefly reviews the core theoretical model, the optimal conditional factor demand functions derived from that model that underpin the separation hypothesis, and the empirical specification of the workhorse reduced

form test of that hypothesis. Descriptive statistics are presented in Section 4. Section 5 presents results, and Section 6 concludes with implications for both policymakers and researchers.

2. Market Failure and the Policy Dialogue

Policy reports and strategic plans put forward by the development community frequently presume that market failures are common across SSA, and make recommendations accordingly. For example, the 2011 Rural Poverty Report of the International Fund for Agricultural Development (IFAD) contains an in-depth discussion of key markets for rural households, including the markets for information, infrastructure, credit and insurance (pp. 125-140). The report also touches on contract farming and on the pressing need for low income countries to capture a larger share of the agricultural value chain. However, while the IFAD report considers a range of policies that could be considered remedies for failing markets, no evidence for the existence of market failures is provided.

Similarly, input market failures are implicitly assumed in various sections of the 2008 World Development Report (WDR) on *Agriculture for Development*. On page 12 of the overview, the WDR covers the topic of "mak[ing] input markets work better" without discussing how it is that we know that input markets do not currently work well. The policy discussion in this part of the WDR is restricted to a discussion of input subsidies.

In the FAO Regional Strategic Framework for Africa, 2010-2015, the authors point out that Africa has lowest levels of improved inputs per unit land in the world (p. 10). While this is not necessarily evidence of failures in input markets, it is consistent with such failures, and it underpins an emphasis on correcting input market failures.

Finally, the 2010 Abuja Declaration on Fertilizers for an African Green Revolution makes explicit the concern that input market failures contribute directly to food insecurity. The authors of the declaration assert that degraded soils badly need fertilizer if intensification is to be achieved, and resolve to adopt targeted fertilizer subsidies. Yet while there is little dispute about the degradation of soils across SSA from underinvestment in land productivity, it is not clear that fertilizer subsidization is the highest return use of public resources to support agricultural

intensification and reductions in rural poverty (Marenya and Barrett 2009, Ricker-Gilbert et al. 2009, Sheahan 2011).

We mention these four documents not to implicate them in misstating the problems facing small-scale farmers in Africa. Indeed, these reports typify the public discourse on this issue. Rather, our point is that priority setting in this area is based largely on longstanding perceptions about factor markets, and not on empirical evidence from rigorous hypothesis testing. Given the magnitude of the investments made based on this assumption, careful empirical studies of the nature and extent of market failure in sub-Saharan Africa are urgently needed to better inform priority setting by governments and the development community. In the absence of such research we cannot determine whether markets in Africa frequently fail to clear, or whether markets generally work well but the central problem is that many households are endowed with quantities and qualities of land and labor that are insufficient to generate returns, *at market prices*, leading to sustained growth out of poverty. Furthermore, if the presumption of widespread factor market failures is indeed accurate, research needs to identify precisely which markets fail among the multiple candidates so that interventions can be targeted effectively at the source(s) of the problem.

Consider the following example. High transaction costs, weak enforcement of contracts, significant output risk – features common to rural economies in SSA – could induce market failure by causing mismatches in supply and demand or supporting non-competitive pricing. But these features also increase suppliers' costs, which shifts supply curves inward, raises equilibrium prices, and reduces trading volumes. In this latter case, low levels of factor usage are the equilibrium outcome of competitive markets, even though they may be sub-optimal from a social perspective. Distinguishing between these two cases is essential to policy design, because the instruments to fix broken markets are not the same as those to add value to products in well-functioning markets. If markets actually work well (in the sense that prices adjust to clear supply and demand), the implication is that greater attention should be paid to other pathways to growth, for example increasing the value *above* current market prices of the land and labor that constitute the primary endowments of most poor households in Africa. If, by contrast, we can reject the hypothesis that African agricultural factor markets are complete and competitive, then directly

targeted interventions to address the sources of market failure can help liberate the latent productivity and growth potential of African rural households.

3. Theory and empirical framework

In this section we outline a basic model of the agricultural household and emphasize the role played by the separation hypothesis. We derive the reduced form test of the separation hypothesis that will represent the baseline specifications for our empirical results. Our goal is only to describe the basic empirical framework, so we leave aside certain complicating factors that can be readily incorporated in future work. The exposition in this section is most directly indebted to Udry (1999) and Barrett et al. (2008).[4]

In a particular cropping year a household has a total labor endowment of $\bar{L}$, which it divides between leisure L^l, work on the household farm L^h, and supply of labor to the market, L^m. The household has preferences over consumption of goods, C, and leisure, L^l, represented by the strictly increasing, concave utility function $U(C, L^l|Z)$. The utility function is conditional on household characteristics Z, which includes endowments not explicitly denoted elsewhere. The household produces a single food commodity for sale or consumption using a strictly increasing, concave production technology $F(L, X, A\,|W)$, where L represents total labor application, X is a vector of non-labor inputs, A represents land inputs, and W represents exogenous agro-climatic factors such as pests and weather conditions. The household owns land A^o and rents in (net) land area A^r, the sum of which is total land in cultivation, A. The household can hire labor on the market, represented by L^d. Let p_x be the vector of non-labor input prices, w be the market wage rate, p_A be the price of land, and p be the price of the output, all of which are known to the household. Abstracting from uncertainty over exogenous conditions, the household's utility maximization problem is:

$$(1) \qquad \text{Max}_{C,L^l,L^h,L^d,L^m,A^r,X}\, U(C, L^l|Z)$$

[4] The canonical reference is Singh et al. (1986). Lau et al. (1978) and Benjamin (1992) were also helpful in developing the model outlined here.

subject to:

(2) $$pC - wL^m \leq pF(L, X, A\,|W) - wL^d - p_x X - p_A A^r$$

(3) $$L \equiv L^h + L^d$$

(4) $$A \equiv A^o + A^r$$

(5) $$\bar{L} \geq L^h + L^m + L^l$$

(6) $$L^l, L^h, L^d, L^m, X, A, C \geq 0$$

Under the standard assumptions about the utility function, weak inequalities (2) and (5) are binding at the solution. The problem can be solved by first choosing total agricultural labor demand L, non-labor inputs X, and land inputs A to maximize farm profit, conditional on W. This is represented by the right-hand side of the inequality in (2). The household then solves its utility maximization problem conditional on optimal profits. This is the essence of the separation hypothesis. With complete and competitive markets, the household can buy and sell labor, land and other inputs at exogenous, market-clearing prices, so that its production and consumption decisions can be explored as if they were made completely separately.

If the separation hypothesis holds, then the solution to the household's problem implies the following:

(7) $$\Pi^*(p, p_x, p_A, w) = \max_{A,X,L} pF(L^*, X^*, A^*|W) - wL^{d*} - p_x X^* - p_A A^*$$

(8) $$L^* = L(p, p_x, p_A, w|\, W)$$

(9) $$A^* = A(p, p_x, p_A, w|\, W)$$

(10) $$X^* = X(p, p_x, p_A, w|\, W)$$

(11) $$C^* = C(p, p_x, p_A, w, \bar{L}, A^o|\, W, Z)$$

where equation 7 is the profit function, equations 8–10 are the input demand functions, and equation 11 is the consumption function.

Various sets of tests based on equations 7–10 that can be interpreted as tests of the underlying assumption of complete and competitive factor markets. As is clear in these equations, inputs depend only on exogenous prices, plot and weather characteristics if the separation hypothesis holds. This suggests that a reduced form strategy for testing the separation hypothesis is to include in the estimation of an input demand functions any other variable that is an argument of the consumption function – per equation (11) – but that does not appear in equations 7-10. Natural options are the household labor endowment or other household characteristics that should influence consumption patterns without impacting the household's full income. A test of complete and competitive markets can be implemented as a test of the exclusionary restriction that input demands are invariant to household characteristics. In particular, labor factor demand should be invariant to household labor endowments, $\bar{L}$. This is the intuition underlying most of the tests in the seminal paper of Benjamin (1992). Following this approach, in this paper we are focus on the restriction implied by equation 8, the conditional labor demand function of the household under the null hypothesis of complete and competitive markets.

To test this restriction we estimate regressions of total labor demand on prices, land inputs, and household characteristics Z_h, using the following general specification:

$$\log L_h = \alpha + \beta \log \bar{L}_h + \delta \log A_h + \gamma Z_h + \phi Prices + \mu_h \quad (12)$$

where $(\alpha, \beta, \delta, \gamma, \phi)$ represent coefficients, the subscript h indicates households, and μ is a mean zero, iid, normally distributed error term. In this case the separation hypothesis is represented by the null hypothesis, $H_0: \beta = 0$. Rejection of that null in favor of the alternate hypothesis, $H_A: \beta \neq 0$, implies rejection of the exclusionary restriction that follows from the presence of complete and competitive markets.

We report OLS estimates of equation 12, separately for each of the five study countries. This is similar to the "parsimonious OLS" specification in Benjamin (1992). In focusing on this baseline specification we make a number of simplifying assumptions. In particular, we treat land inputs as

fixed within the cropping season and household size as exogenous, we do not disaggregate household size by demographic characteristics of household members (although we do include some demographic controls in X_h), and we ignore the role of supervisory household labor as a complement to hired labor. We also do not make adjustments for possible productivity differences between hired workers and household workers. Finally, following Benjamin (1992), we drop child labor inputs from the calculation of total labor demand, and we ignore harvest period labor out of concern that if labor markets fail, they are most likely to do so during this peak period of labor demand.[5] Extensions to cover these additional concerns are left for future work.

The test of the separation hypothesis implicit in equation 12 cannot be interpreted as a test of labor market failure specifically. It is well understood that multiple market failures are required to generate distortions in factor or output markets because relative prices – not absolute prices – are what matters in determining the efficient allocation of resources. If we reject the null hypothesis that the coefficient on household size is statistically indistinguishable from zero, all that we can conclude is that *some multiple* factor markets (potentially including markets for credit, insurance, or land) are failing (Udry 1999). A detailed exploration of precisely *which* markets are failing requires structural estimation that is left to future analysis.

4. Data

The data for this paper are from the Living Standards Measurement Study and Integrated Surveys on Agriculture (LSMS-ISA) project, sponsored by the Bill and Melinda Gates Foundation and implemented by the national statistics offices of participating countries with technical expertise and oversight provided by the Development Research Group of the World Bank.[6] These data sets are nationally representative, and they cover a comprehensive set of demographic, health, economic and agricultural topics. Although there is variation in survey content between countries, efforts were made to ensure as much comparability as possible in questionnaire design and coverage. Panel data are available for some countries and will be available for all study countries in the coming years, though in this paper we make use of only a

[5] Harvest labor is included in total labor demand for households in Uganda, because hired labor is not disaggregated by activity.
[6] See the project website for additional details: http://go.worldbank.org/OQQUQY3P70.

single cross section for each country. For each country we restrict the sample to households that report cultivation of a positive number of acres during the season under study.

Of the six LSMS-ISA countries – Ethiopia, Malawi, Niger, Nigeria, Tanzania, and Uganda – we use data from all but Nigeria, because the Nigeria data lack sufficient information on agricultural labor demand. Because the hypotheses of interest to this paper relate to market function within a cultivation period, we have not combined data across multiple cropping seasons. Instead, we use data relevant for the major cropping season in the most recent wave of each of the data sets. These are the 2011 cropping season in Ethiopia; the 2008/2009 rainy season in Malawi; the 2010 rainy season in Niger; the 2010 long rainy season in Tanzania; and the first cropping season of 2010 in Uganda.

Household-level summary statistics

Table 1 shows summary statistics at the household level for all five study countries. In Ethiopia, the average household has 5.24 members of all ages, with slightly more males than females. Just over 80% of households are male-headed. Education levels among household heads are the second lowest of the study countries, at 1.61 years of education on average. Of the 2.81 acres owned by the average household, 76% is cultivated, 3% is left fallow, and 22% is used for all other purposes, including pastures, forest land, and renting out. The average household cultivates more than 11 plots, with each crop stand on a single parcel listed as a separate plot. Eighteen percent of cultivated acreage is described as rented or borrowed. Household allocate a majority of cultivated land to the production of staple grains – maize, sorghum, and teff – with significant allocation of remaining land to cash crops, pulses, and nuts.[7]

The next set of columns show similar statistics from the 2010-2011 Malawi survey. The Malawi survey includes over 10,000 households, only a quarter of which are designated as panel survey households. We restrict our analysis to the panel households because the labor demand modules given to cross-sectional and panel households are slightly different, and labor demand issues are central to the questions in this paper.

[7] For Ethiopia, Malawi, and Tanzania we use only the primary crop listed on the plot, ignoring inter-cropping. However, the Uganda survey provides data on the percentage of land allocated to each crop at the plot level, and we use this information to distribute plot-level acreage to every crop listed on each plot.

In Table 1 we see that households in Malawi are slightly smaller than those in Ethiopia, with 4.96 members on average. Household heads are far more educated on average (4.98 years of education) than in Ethiopia, and almost a quarter of households are female-headed. The average household owns 1.58 acres and owns or cultivates 2.05 separate plots.[8] Of the acreage owned by households, only a very small fraction is listed as "rented out".[9] Finally, crop distributions in Malawi are heavily dominated by maize production, which accounts for 1.45 acres of cultivated land on average. Farmers primarily use the remaining land to cultivate pulses, nuts, and cash crops.[10]

In the middle of Table 1 we show summary statistics for the Niger sample. Niger is the poorest country in the study. Households are large, encompassing almost seven people, on average. Only 8% of household heads are female. Educational attainment by household heads is the lowest among study countries, averaging less than 1 year completed. Households report significantly greater land ownership than in the other study countries, with average holdings of almost 12 acres. Although this statistic is driven in part by a small number of large landowners, the median household owns 7.4 acres, which is still larger than the average acres owned in any other study country. Households in Niger cultivate almost all of the land that they own, and rent an average of 1.6 acres of additional land for cultivation. Cultivation is concentrated heavily in sorghum, millet, and beans, with relatively small amounts of land allocated to other crops.

The next set of columns in Table 1 provides summary statistics for the 2010-2011 data from Tanzania. As mentioned above, agricultural variables for Tanzania refer only to the long rainy season. Not surprisingly, the demographic characteristics of households in Tanzania are more similar to those for Malawi than Ethiopia or Niger. The average sample household from Tanzania has 5.55 members, with slightly more females than males. Household heads are 25% female, and have 4.58 years of education on average. Households in Tanzania report owning less land than those in Niger, but much more land than those in smaller Malawi or more populous Ethiopia: 5.31 acres on average, 81% of which is cultivated and 15% of which is fallow. Only 2% of owned land is described as "rented out", while 14% of cultivated land is

[8] The definition of a "plot" varies between surveys, so that this statistic is not directly comparable across countries.
[9] We are not sure what to make of this figure, given that households in Malawi describe a much greater proportion of land as "rented in" than "rented out".
[10] For the summary statistics we define as cash crops all non-food crops, including tobacco, cotton, and sisel, as well as coffee and tea.

listed as rented in or borrowed. Maize is the primary crop in Tanzania, with 2.2 acres of maize grown by the average household. Land allocation to the other crop categories – other grains, rice, tubers (including cassava), pulses and nuts, cash crops, and other crops (including banana) – ranges from 0.31-0.57 acres on average.

Finally, in the rightmost columns of Table 1 we provide a similar set of summary statistics for Uganda. Households in Uganda have 6.64 members on average, again with slightly more females than males. Only 71% of households in Uganda are male-headed. Households own 3.29 acres on average, and own or cultivate 5.65 plots. Ninety percent of owned land is cultivated, 7% is fallow, and essentially none is described as "rented out". Households report cultivating just under 3 acres on average, 79% of which is owned and 21% of which is described as rented in or borrowed. Tubers, including cassava, account for the largest proportion of cultivated acreage, followed by pulses/nuts and "other crops" (which includes all bananas). Only 0.41 acres of maize are cultivated on average.

Factor market participation: summary statistics

In Table 2 we present sample statistics for participation in land markets by sample households. Across study countries there is surprising consistency in the pattern of renting or borrowing land for cultivation, with percentages ranging from 23.2% in Tanzania to 36.6% in Uganda. The percentage of sample households renting land in is much larger than that renting land out. There is likewise general consistency in the average amount of land rented or borrowed in, with estimates in all countries but Niger lying between 0.44 and 0.55 acres. In Niger the average household cultivated almost two acres of rented or borrowed land. Average acres rented out is less than average acres rented in for all study countries, likely because absentee landlords are difficult to sample despite the sampling protocol of the LSMS-ISA surveys that aims to be representative at the national level.

Turning to the market for agricultural laborers, Table 3 shows the percentage of households that report hiring workers for various activities during the studied cultivation period. This is one area where there is substantial heterogeneity in the level of detail covered in the LSMS-ISA surveys, therefore cross-country comparisons should be made cautiously, if at all. Nevertheless the overall pattern of labor hiring is consistent across study countries, with approximately 30-50% of

households hiring workers at some point during the cultivation season. In Ethiopia and Tanzania, just under a third of households report hiring of some laborers (30.2% and 30.8%, respectively). For these two countries the distribution of hiring across activities is generally consistent, with the exception of very limited hiring for fertilizer application in Tanzania. In Malawi, Niger, and Uganda, over 40% of households hire workers. In Malawi and Niger the rate of hiring for non-harvest activities is almost twice that for the harvest. This is consistent with the widespread perception that if labor constraints bind because of seasonality in demand, they are most likely to do so in the harvest period (Benjamin 1992). The labor module in Uganda does not disaggregate activities by type.

The clear message of Tables 2 and 3 is that a large, albeit minority, share of African agricultural households hire in labor, land, or both, in any given year. Clearly these markets exist and have sufficient numbers of transactors that households in large part act as price-takers. But the existence of markets with adequate transactional density is merely a necessary condition for the separation hypothesis to hold. As de Janvry et al. (1991) make clear, markets can fail idiosyncratically for specific households for any of a host of reasons.

Descriptive kernel regressions of labor hiring and labor demand patterns give a preview of the OLS regression results we present in the next section. Figure 1 shows a local polynomial regression at the household level of the demand for non-household labor (person-days) on the land-to-labor endowment ratio (acres owned per household member) for households in Ethiopia.[11] In aggregating labor across individuals, each child person-day is counted as 50% of an adult person-day. Grey shading indicates the 95% confidence interval around the regression estimate in each figure. There are two things to note in the figure. First, labor hiring is increasing in the number of acres per household member, as we would expect in a country with at least some agricultural labor market activity. Second, to the extent that any patterns are apparent in the figure, the relationship is concave at higher levels of owned acreage. Or, if linear, the slope of the regression line is clearly less than one. As the number of acres per household member increases, hiring of outside workers does not increase proportionally. In theory, this could be due to economies of scale in either household labor, hired labor, or both, although the empirical literature on smallholder agricultural production routinely supports the constant returns

[11] The estimator for each of these figures is a local mean smoother using an Epanechnikov kernel and a bandwidth chosen using the Stata default optimal rule-of-thumb.

to scale hypothesis. However, this pattern is also consistent with labor or credit market failures that prevent households with greater need for outside laborers from hiring at optimal levels.

Figure 2 shows a kernel regression of total labor demand (family labor plus hired labor in units of adult person-days) on total household size, again for households in Ethiopia. If labor markets were complete and competitive and the separation hypothesis held, we would expect to see no clear relationship between these two variables. Instead we see that total labor demand is increasing in the number of household members until a household size of 7, after which the regression line tapers off and becomes noisier. Although this figure does not constitute a formal separation test, because the underlying result does not condition on important covariates, it does suggest that there exists a strong relationship between household labor endowments and the application of labor on the family farm.

Figures 3-4, 5-6, 7-8, and 9-10 show similar pairs of kernel regression results for Malawi, Niger, Tanzania, and Uganda, respectively. The general patterns in Figures 3, 7, and 9 are consistent with that from Figure 1 for Ethiopia: hiring of outside workers in increasing in the number of acres per household member, but at a decreasing marginal rate. In Figure 5, however, we see no such pattern for households in Niger, particularly in the region over which most of the data is concentrated, i.e., below eight acres per person. Instead, the number of person-days demanded from outside workers is flat or even slightly decreasing in the household land:labor endowment ratio. One interpretation of this result, in combination with the observation that households in Niger rent significantly more land than those in other study countries, is that credit-constrained households are able to borrow against expected harvest output to rent land, but that such loans cannot be converted into cash to hire workers.

In Figures 4, 6, 8, and 10, the picture is clearer. Total labor demand is increasing in household size in all study countries. This patterns anticipates the formal results provided below, that household factor demand varies strongly with household labor endowments, contradicting the separation hypothesis implied by the canonical agricultural household model under the assumption of complete and competitive factor markets.

5. Regression results

In Table 4 we show summary statistics for the variables used in the country-specific OLS estimates of equation 12. Median wages in local currency units are based on reported wages, including both cash and in-kind payments. These median wages are calculated at the smallest level of geographical aggregation with at least 10 observations (beginning at the zone, *grappe*, or TA level, depending on the country, and moving to larger areas as needed).[12] "Prime age" is defined as ages 15-60 years, while "Elderly" indicates age >60 years. The excluded demographic category is elderly male.

The results of the basic OLS implementation of the separation hypothesis test from equation 12 are provided in Table 5. All regressions are weighted by inverse sampling probabilities, and standard errors are clustered at the level of the zone (Ethiopia), TA (Malawi), *grappe* (Niger) or district (Uganda and Tanzania). All of the signs of the estimated coefficients in Table 5 are consistent with expectations, when statistically significant. The elasticity of labor demand with respect to area cultivated ranges from 0.34 in Niger to 0.53 in Malawi and is statistically significant in all cases. It is not possible to determine whether the finding that this elasticity is less than unity is due to economies of scale, labor market constraints, credit market constraints, or some other factors. Only in the Malawi regression is the coefficient on median wages statistically significant, and it is negative as expected. The coefficient on wages is also negative in the Niger and Tanzania regressions, where the t-statistic is greater than one in absolute value. The household composition variables are for the most part not statistically significant, although when they are we see that labor demand is increasing in the share of prime age adults and decreasing in the share of elderly females (relative to elderly males).

Finally, and most importantly for this paper, the null hypothesis of separation can be strongly rejected at the 1% level of significance in all regressions. The elasticity of labor demand with respect to household size ranges from 0.21 in Uganda to 0.64 in Niger, and is highly statistically significant in all cases. The magnitude of this elasticity can be taken as a rough indicator of the depth of market failure. In this sense the findings are similar to those from the kernel regressions, in that demand side participation in labor markets appears to be weaker in Niger than in the other study countries. Although many households in Niger hire agricultural laborers

[12] This measure has some shortcomings in this setting. In particular, counterfactual or marginal wages are likely underestimated in those places with potentially thin labor markets, because the probability of hiring (and therefore of observing a wage) is decreasing in the wage level.

(Table 3), the total amount of labor applied to farms in Niger is linked more closely to the size of the household than it is in the other study countries. Nevertheless, the consistent message in Table 5 is that across all study countries, agrarian households are not served by complete and competitive markets for factors of production.

Table 6 provides one set of robustness checks, in which we repeat the regressions from Table 5 but use location fixed effects. The wage is no longer identified because it was constructed as a location median from observed wage payments. Results are very similar to those in Table 5, and the separation hypothesis can again be rejected for all study countries.

Finally, Table 7 repeats the specifications from Table 6, but includes land endowments (log acres owned) as an additional explanatory variable. Under complete and competitive markets this variable should not be related to labor demand. Although the coefficient on log acres owned is only statistically different from zero in the Malawi and Niger regressions, the land and labor endowments are highly jointly significant in all cases. The F statistics for this joint test are shown in Table 7. In fact, land endowments likely play a greater role in determining input demand than suggested by these regressions, because acres cultivated is highly correlated with acres owned, rendering their separate effects difficult to identify in a single regression. The implication is that market failures create a dependency on endowments that spans multiple factor markets.

6. Conclusions

Using a theoretically-grounded, reduced form test for complete and competitive markets, we have shown that the relationship between labor demand and household size is broadly consistent with the existence of pervasive multiple market failures across agrarian communities in five sub-Saharan African countries. Despite widespread participation in labor and land markets by agricultural households across SSA, regression results based on a simple exclusionary restriction derived from the first order necessary conditions of the household optimization problem indicate that household endowments influence factor demand in a way that is inconsistent with the separation hypothesis implied by the assumption of complete and competitive factor markets. This finding corresponds with the unconditional results suggested by simple kernel regressions of labor demand on household factor endowments. The overall conclusion supports the

widespread but previously untested assumption among the development community: factor markets regularly fail African farmers. But we emphasize that the reduced form separation hypothesis tests implemented here, even though they rely on an analysis of labor market transactions, does not allow us to identify precisely *which* factor markets fail. In particular, these test results do not imply that labor markets fail, as violations of the separation hypothesis can occur even with perfectly functioning labor markets (Barrett 1996).

As the development community and African governments increasingly intervene to try to rectify perceived market failures, the onus now falls on researchers to more precisely locate the sources and causes of factor market failures that impede productivity and income growth in rural Africa. Effective targeting of interventions depends on more precise, structural estimation that goes beyond the reduced form tests we offer in this paper. This will require methodological advances to take advantage of data now becoming available to help inform the design and evaluation of policies intended to help stimulate African agricultural and rural development.

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Figures

Figure 1. Kernel regression, non-household labor on land:labor endowment ratio, Ethiopia

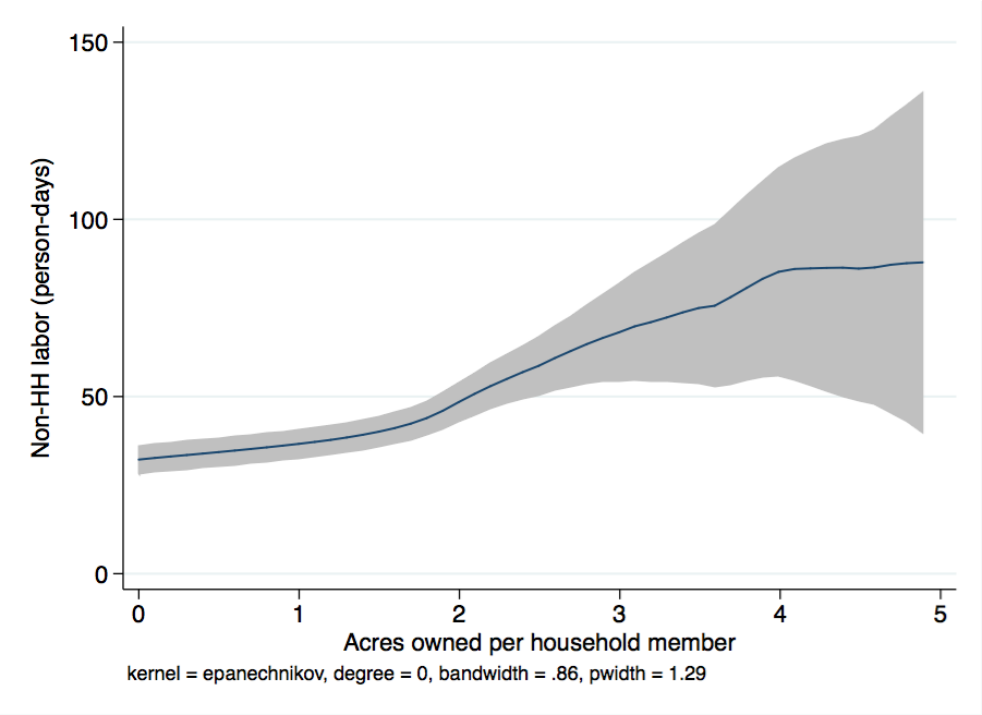

Figure 2. Kernel regression, total labor demand on household size, Ethiopia

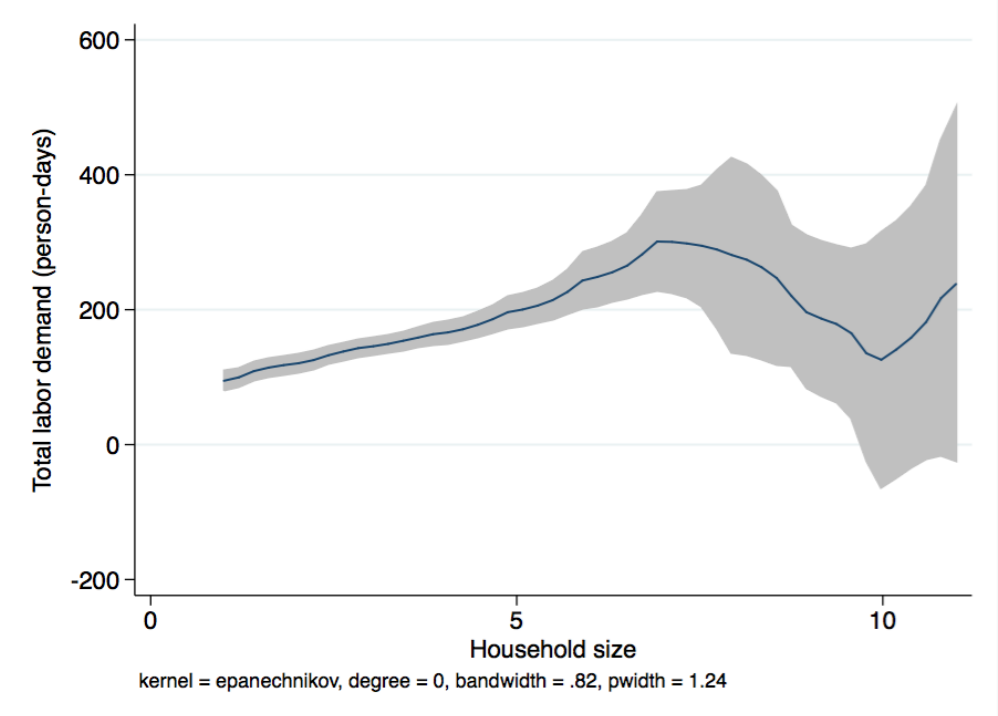

Figure 3. Kernel regression, non-household labor on land:labor endowment ratio, Malawi

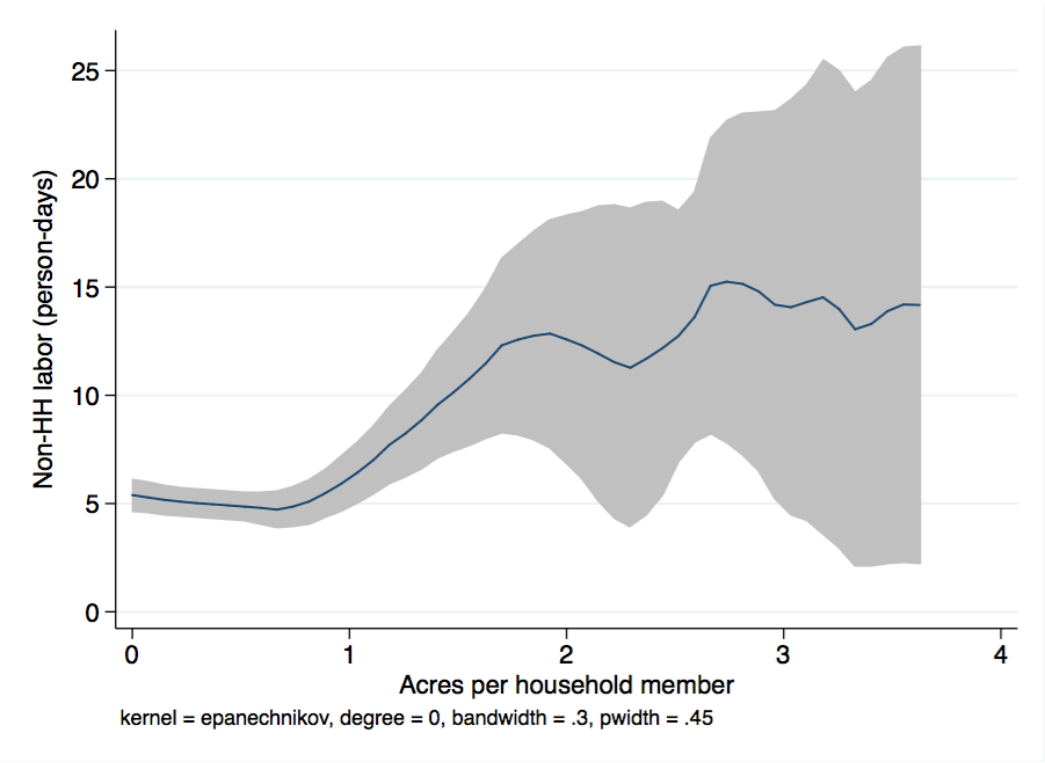

Figure 4. Kernel regression, total labor demand on household size, Malawi

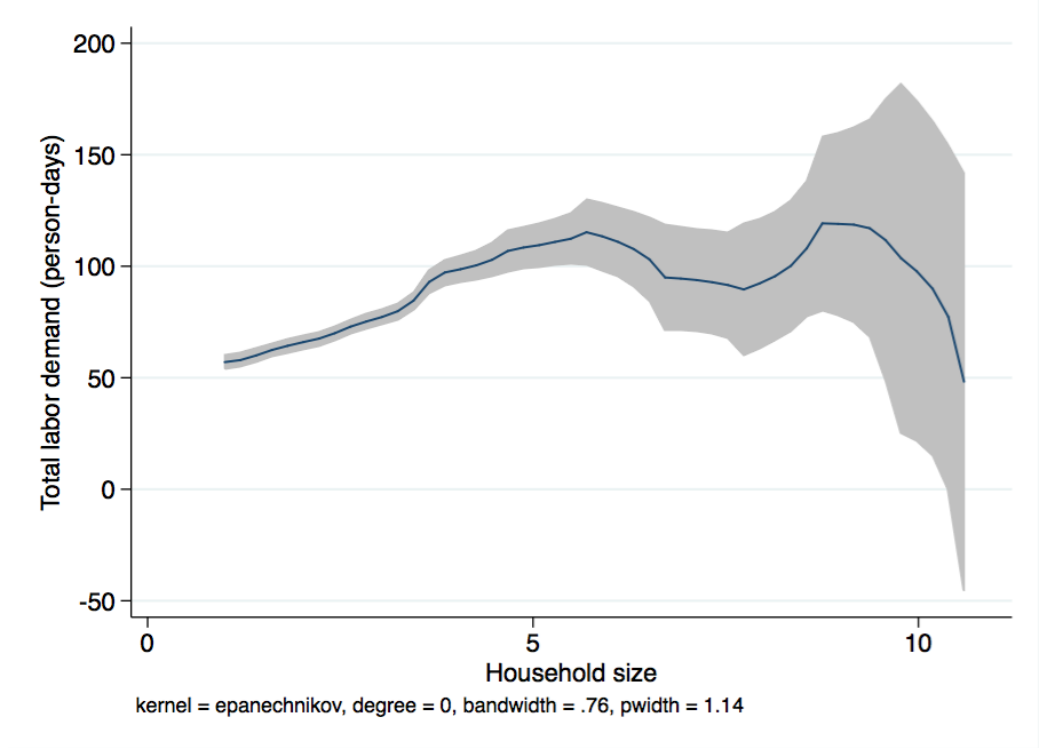

Figure 5. Kernel regression, non-household labor on land:labor endowment ratio, Niger

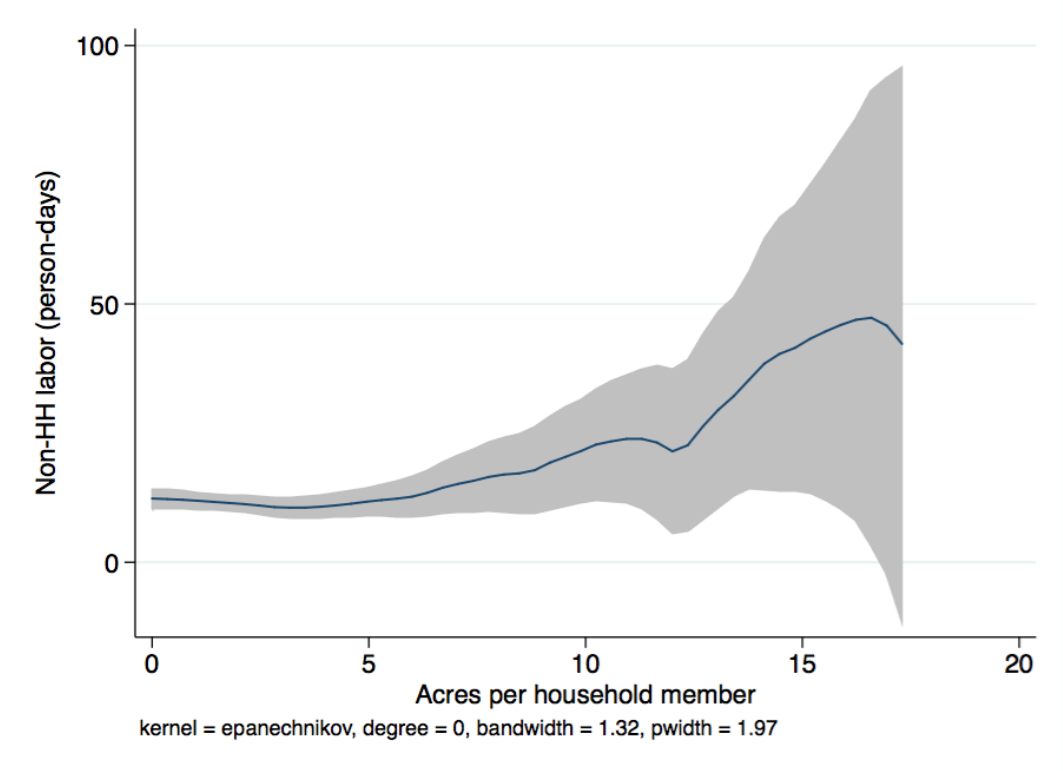

Figure 6. Kernel regression, total labor demand on household size, Niger

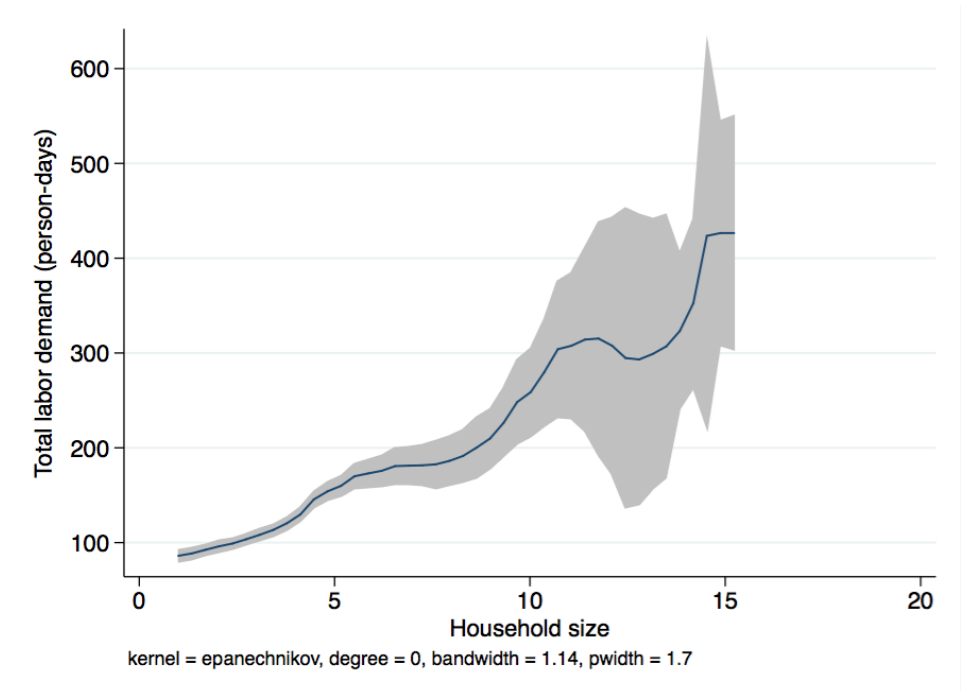

Figure 7. Kernel regression, non-household labor on land:labor endowment ratio, Tanzania

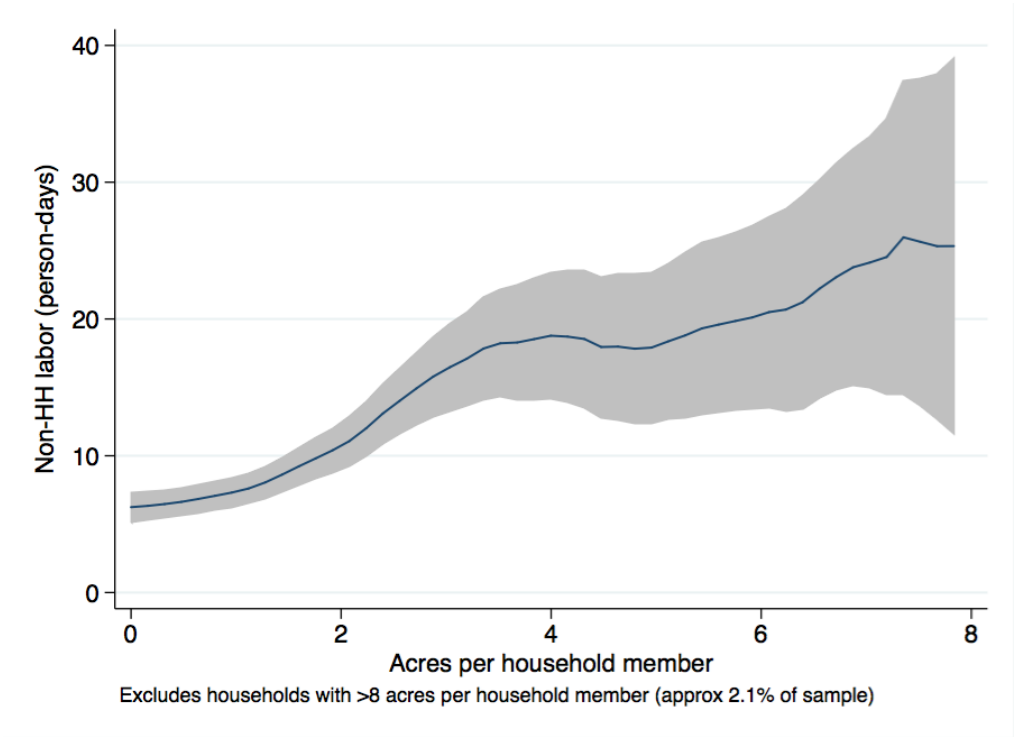

Figure 8. Kernel regression, total labor demand on household size, Tanzania

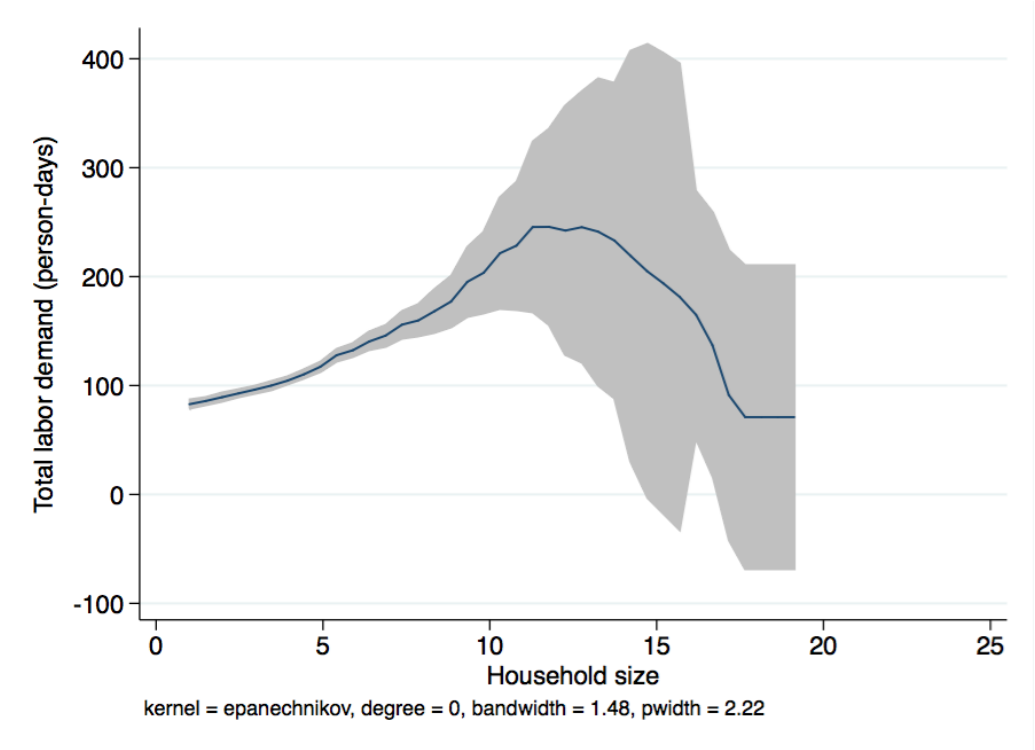

Figure 9. Kernel regression, non-household labor on land:labor endowment ratio, Uganda

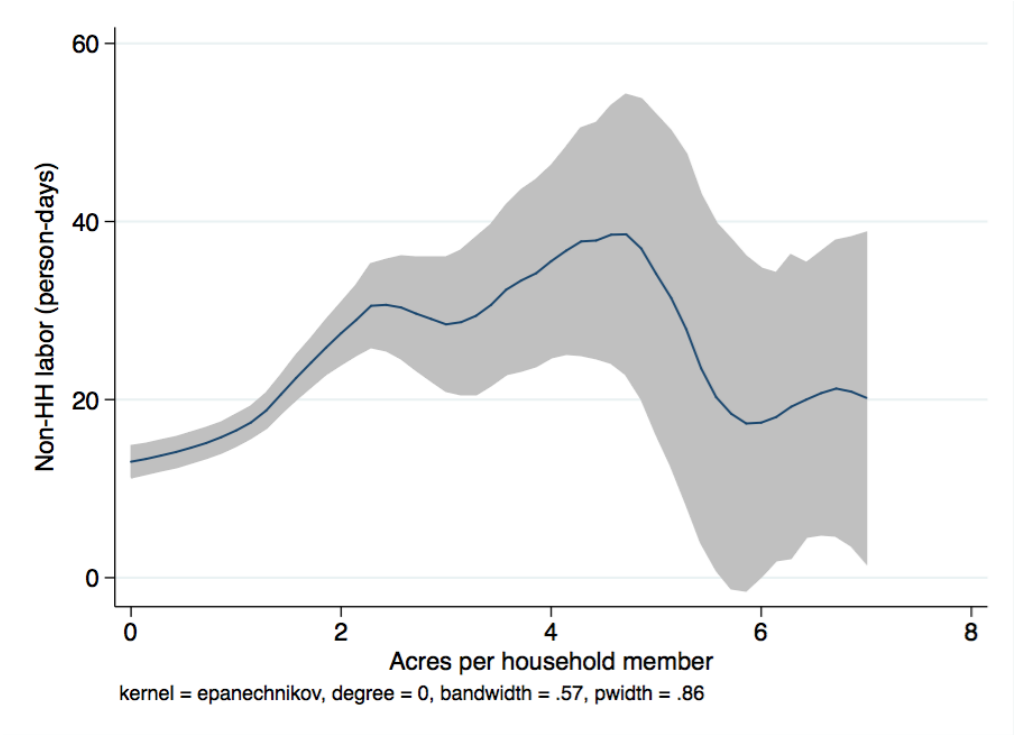

Figure 10. Kernel regression, total labor demand on household size, Uganda

Tables

Table 1. Household-level summary statistics for all study countries

	Ethiopia			Malawi			Niger			Tanzania			Uganda		
	Mean	s.d.	N	Mean	s.d.	N	Mean	s.d.	N	Mean	s.d.	N	Mean	s.d.	N
Household size	5.24	2.2	3094	4.96	2.29	2666	6.78	3.53	2339	5.55	2.95	2630	6.64	3.46	2135
Male head = 1	0.81		3094	0.77		2666	0.92		2339	0.75		2630	0.71		2135
Education of head (yrs)	1.61	2.72	3039	5.22	4.18	2646	0.87	2.35	2339	4.58	3.37	2582	4.69	3.34	1813
Number of males	2.66	1.52	3094	2.4	1.53	2666	3.37	2.09	2339	2.7	1.8	2630	3.22	2.09	2135
Number of females	2.56	1.38	3094	2.56	1.44	2666	3.41	2.11	2339	2.85	1.78	2630	3.43	2.11	2135
No. plots own/cultivate	11.69	7.33	3094	2.05	1.13	2666	3.04	1.96	2339	2.3	1.32	2630	5.65	2.69	2135
Acres own	2.81	5.25	3094	1.58	1.73	2666	11.98	19.65	2339	5.31	10.51	2630	3.29	10.27	2135
--- share cultivate	0.76	0.26	2790	0.99	0.1	2043	0.98	0.12	1969	0.81	0.34	2341	0.9	0.24	1952
--- share rent out				0.01	0.07	2043	0.01	0.08	1969	0.02	0.12	2341	0	0.05	1952
--- share fallow	0.03	0.11	2790	0.01	0.06	2043	0.01	0.07	1969	0.15	0.31	2341	0.07	0.2	1952
--- share other	0.22	0.24	2790	0	0.01	2043	0.01	0.07	1969	0.03	0.14	2341	0.02	0.14	1952
Acres cultivate	2.7	4.23	3094	1.92	1.73	2666	13.62	19.05	2339	4.31	7.93	2630	2.98	7.41	2135
--- share own	0.82	0.32	2810	0.79	0.39	2588	0.81	0.35	2202	0.86	0.32	2409	0.79	0.34	2073
--- share rent/borrow	0.18	0.32	2810	0.21	0.39	2588	0.19	0.35	2202	0.14	0.32	2409	0.21	0.34	2073
Maize: acreage	0.49	1.83	2826	1.45	1.27	2567				2.2	4.13	2402	0.41	2.21	2075
Sorghum: acreage	0.37	1.12	2826				2.42	4.49	2127						
Rice: acreage				0.03	0.23	2567				0.44	2.13	2402	0.03	0.21	2075
Millet: acreage							6.14	8.25	2127						
Other grains: acreage	1.01	1.54	2826	0.03	0.24	2567	0.13	0.74	2127	0.39	2.45	2402	0.21	0.88	2075
Tubers: acreage	0.02	0.09	2826	0.04	0.31	2567	0.05	0.41	2127	0.57	2.11	2402	0.94	5.14	2075
Pulses/nuts: acreage	0.32	0.88	2826	0.22	0.51	2567	4.56	6.44	2127	0.49	5.18	2402	0.62	2.47	2075
Cash crops: acreage	0.24	0.79	2826	0.18	0.57	2567	0	0.06	2127	0.34	2.25	2402	0.23	1.47	2075
Other crops: acreage	0.23	0.55	2826	0.01	0.1	2567	0.37	1.85	2127	0.31	1.83	2402	0.61	3.29	2075

Notes: "Other" categories cover missing data from the same column, e.g., "Other grains" in Tanzania includes sorgum and millet acreage; sample limited to panel households

Table 2. Participation in land rental markets

	Ethiopia*	Malawi	Niger	Tanzania	Uganda
N	3094	2666	2339	2630	2135
Household rents land out	6.1%	0.9%	1.2%	3.4%	0.4%
Household rents land in	19.5%	13.1%	7.3%	6.2%	18.1%
Household rents or borrows land in	30.3%	28.4%	27.7%	23.2%	36.6%
Acres rented out (mean)	0.500	0.017	0.098	0.139	0.006
Acres rented out (sd)	1.344	0.219	1.028	1.774	0.121
Acres rented in (mean)	0.480	0.451	1.912	0.444	0.551
Acres rented in (sd)	1.382	1.093	6.537	1.291	2.639

*Acres rented out is not identifiable in the ISA Ethiopia data; reported statistics are for "other" uses of land, which appears to be an upper bound on land rentals

Table 3. Percent of agricultural households hiring labor

Country	Activity	Number of households	Percent hiring workers
Ethiopia	*Cultivation*	3091	18.5%
	Harvest	2666	20.9%
	Overall	2666	30.2%
Malawi	*Non-harvest*	2605	32.6%
	Harvest	2605	16.0%
	Overall	2605	42.0%
Niger	*Preparation*	2339	19.5%
	Cultivation	2339	37.4%
	Harvest	2339	18.6%
	Overall	2339	47.8%
Tanzania	*Planting*	2630	18.5%
	Weeding	2630	18.9%
	Fertilizing	2630	2.6%
	Harvest	2630	16.0%
	Overall	2630	30.8%
Uganda	*Overall*	2109	46.8%

Table 4. Summary statistics of variables used in regressions

	Ethiopia	Malawi	Niger*	Tanzania	Uganda
Log labor demand (person-days)	4.257	3.851	4.287	4.332	4.756
	1.302	0.989	0.982	0.974	0.776
Log area (acres)	0.496	0.384	2.13	1.179	0.818
	1.332	0.82	1.124	1.05	1.001
Log median wage (local curr.)	2.768	5.563	6.998	7.82	8.761
	1.083	0.539	0.443	0.489	0.649
Log HH size	1.157	0.862	1.029	1.033	1.229
	0.457	0.454	0.46	0.498	0.571
Prime male share	0.326	0.408	0.431	0.408	0.361
	0.207	0.229	0.185	0.233	0.223
Prime female share	0.378	0.479	0.499	0.459	0.42
	0.21	0.238	0.167	0.229	0.226
Elderly female share	0.136	0.071	0.027	0.078	0.124
	0.204	0.206	0.111	0.192	0.208
N	2499	2556	2183	2346	2047

Notes: First row for each variable is the mean, second is the standard deviation

Table 5. Regression results from parsimonious OLS specification

	Ethiopia	Malawi	Niger	Tanzania	Uganda
Log area (acres)	0.489***	0.528***	0.343***	0.444***	0.379***
	(0.040)	(0.048)	(0.026)	(0.027)	(0.033)
Log median wage	0.036	-0.121**	-0.155	-0.077	0.012
	(0.051)	(0.052)	(0.107)	(0.065)	(0.043)
Log HH size	0.379***	0.399***	0.635***	0.399***	0.211***
	(0.055)	(0.061)	(0.061)	(0.043)	(0.044)
Prime male share	0.446**	0.036	0.008	-0.085	0.223*
	(0.186)	(0.140)	(0.198)	(0.136)	(0.128)
Prime female share	0.152	-0.068	-0.216	-0.147	0.314**
	(0.247)	(0.132)	(0.214)	(0.140)	(0.131)
Elderly female share	-0.371**	0.108	-0.416	-0.249	0.042
	(0.171)	(0.165)	(0.286)	(0.187)	(0.166)
Constant	3.454***	3.993***	4.045***	4.056***	3.869***
	(0.251)	(0.283)	(0.802)	(0.516)	(0.402)
R-squared	0.33	0.278	0.301	0.321	0.312
N	2499	2556	2183	2346	2047

Notes: Standard errors in parentheses; standard errors clustered at the level of the zone (Ethiopia), TA (Malawi), grappe (Niger) or district (Tanzania and Uganda); sampling weights used for all regressions; dependent variable is the log of total labor demand, defined as total person-days employed on all plots; children under age 15 are counted as 0.5 adults; harvest labor is excluded for ET, MW, NG, and TZ, but included for UG because it cannot be separately distinguished; population shares defined with respect to adults > age 14

Table 6. Regression results from parsimonious OLS specification w/ district FE

	Ethiopia	Malawi	Niger	Tanzania	Uganda
Log area (acres)	0.530***	0.447***	0.324***	0.421***	0.380***
	(0.045)	(0.045)	(0.029)	(0.029)	(0.032)
Log HH size	0.377***	0.515***	0.609***	0.488***	0.237***
	(0.045)	(0.056)	(0.070)	(0.046)	(0.039)
Prime male share	0.531***	0.061	0.141	-0.078	0.238*
	(0.138)	(0.128)	(0.195)	(0.134)	(0.137)
Prime female share	0.21	-0.069	-0.152	-0.124	0.312**
	(0.182)	(0.129)	(0.223)	(0.137)	(0.138)
Elderly female share	-0.214	0.085	-0.480*	-0.209	0.028
	(0.139)	(0.166)	(0.288)	(0.192)	(0.166)
Constant	3.230***	3.295***	4.052***	3.634***	3.019***
	(0.132)	(0.121)	(0.221)	(0.120)	(0.127)
District/zone FE	Yes	Yes	Yes	Yes	Yes
R-squared	0.47	0.415	0.5	0.44	0.42
N	2765	2556	2183	2364	2047

Notes: Standard errors in parentheses; standard errors clustered at the level of the zone (Ethiopia), TA (Malawi), grappe (Niger) or district (Tanzania and Uganda); sampling weights used for all regressions; dependent variable is the log of total labor demand, defined as total person-days employed on all plots; children under age 15 are counted as 0.5 adults; harvest labor is excluded for ET, MW, NG, and TZ, but included for UG because it cannot be separately distinguished; population shares defined with respect to adults > age 14

Table 7. Regression results with district FE and both land and labor endowments

	Ethiopia	Malawi	Niger	Tanzania	Uganda
Log acres cultivated	0.529***	0.409***	0.298***	0.418***	0.362***
	(0.048)	(0.049)	(0.035)	(0.034)	(0.041)
Log HH size [A]	0.377***	0.519***	0.602***	0.488***	0.233***
	(0.045)	(0.056)	(0.071)	(0.046)	(0.039)
Log acres owned [B]	0.001	0.039***	0.024*	0.002	0.016
	(0.016)	(0.012)	(0.013)	(0.014)	(0.015)
Prime male share	0.531***	0.021	0.165	-0.077	0.241*
	(0.138)	(0.130)	(0.193)	(0.134)	(0.136)
Prime female share	0.209	-0.107	-0.136	-0.123	0.315**
	(0.183)	(0.133)	(0.222)	(0.137)	(0.139)
Elderly female share	-0.214	0.053	-0.473	-0.209	0.023
	(0.139)	(0.168)	(0.290)	(0.192)	(0.168)
Constant	3.231***	3.393***	4.066***	3.636***	3.051***
	(0.134)	(0.125)	(0.224)	(0.121)	(0.138)
District/zone FE	Yes	Yes	Yes	Yes	Yes
F-test (joint sig of [A] & [B])	35.08	45.56	42.12	56.54	18.38
R-squared	0.47	0.42	0.502	0.44	0.42
N	2765	2556	2183	2364	2047

Notes: Standard errors in parentheses; standard errors clustered at the level of the zone (Ethiopia), TA (Malawi), grappe (Niger) or district (Tanzania and Uganda); sampling weights used for all regressions; dependent variable is the log of total labor demand, defined as total person-days employed on all plots; children under age 15 are counted as 0.5 adults; harvest labor is excluded for ET, MW, NG, and TZ, but included for UG because it cannot be separately distinguished; population shares defined with respect to adults > age 14; for households with zero acres owned, "Log acres owned" = ln(0.01); F-test statistic is for a test of the joint significance of "Log HH size" and "Log acres owned"; all F-stats are signficant at the 10e-8 level