Labor Calendars and Rural Poverty: A case study for Malawi

Alain de Janvry, Claire Duquennois, and Elisabeth Sadoulet
University of California at Berkeley*

April 20, 2020

Abstract

The persistence of rural poverty in Sub-Saharan Africa is a major challenge to meet the Sustainable Development Goal on poverty eradication. Using data for Malawi, we investigate the contribution of seasonality to this phenomenon by showing that labor calendars for rural households offer similar employment opportunities as for urban households in terms of time worked at peak planting time, but much lower opportunities throughout the rest of the year. Due to a high level of urban unemployment, an urban-based structural transformation is not the current solution to rural poverty. By contrast, we show that elements of both an agricultural and a rural transformation can help fill-in and smooth-out labor calendars, providing a pathway to rural poverty reduction.

*We are indebted to Calogero Carletto, manager of the LSMS-ISA project, for facilitating our use of the data.

Rural poverty is the most prevalent form of extreme poverty at a world scale, and it is increasingly concentrated in Sub-Saharan Africa and among households dependent on agriculture. In 2013, Sub-Saharan Africa accounted for 51% of the total number of poor at a PPP $1.90/day poverty line, up from 18% in 1993.[1] In 2013, 82% of the Sub-Saharan Africa poor lived in rural areas, and 75% of Sub-Saharan Africa rural households income was obtained in agriculture (Beegle et al. 2016). With eradication of extreme poverty the number one Sustainable Development Goal, there is much interest in understanding why poverty in Sub-Saharan Africa is associated with agriculture and rural areas and in exploring what can be done with agriculture and the rural economy in reducing poverty.

Labor is the main asset of the poor in generating income. The conversion of the poor's labor endowments into income depends on both the productivity of labor when people work and on the amount of time they work. Previous research has focused on differences in labor productivity on an annual basis between the agricultural and non-agricultural sectors (McMillan and Rodrik 2011; Gollin, Lagakos, and Waugh 2013). When labor productivity has been measured on a per hour worked basis, the measurement has been done contrasting agriculture and non-agriculture by McCullough (2017). Poverty is however not defined by sector, but determined by the portfolio of activities that households develop in the rural and urban sectors. In this paper, we make two advances relative to this literature. First, we focus on rural vs. urban households, and second we assess productivity both in terms of returns to labor when people work and in terms of time worked. Our attention is consequently drawn to the role of labor calendars in understanding poverty based on the observation that there is a strong correlation between poverty, as measured by per capita consumption, and the use of household labor across months of the year. While the time worked each year relative to capacity depends on overall under-employment levels in both rural and urban areas, the seasonality of rural labor calendars further reduces labor hours in rural areas, greatly aggravating household under-employment for the vast majority of months. Recognizing seasonal under-employment as a major contributor to low consumption levels opens up new pathways for rural development focused on transforming and diversifying agricultural and rural economies.

There has been a long standing controversy as to whether rural poverty will be reduced through the structural transformation of the economy–shifting labor out of agriculture into the urban economy–or through agricultural and rural transformations–increasing labor productivity and intensifying labor use in agriculture and in the rural non-farm economy where the rural poor reside. The debate started with Lewis (1954) who argued that labor incomes will only rise with resorption of surplus labor in agriculture as employment is created through capital accumulation in the urban industrial sector. Gollin, Lagakos, and Waugh (2013) showed that annual value added per worker is much higher in the non-agricultural sector than in agriculture, with a productivity gap typically in excess of four in developing countries and reaching six in the African countries. Based on these

[1] Using data from PovcalNet http://iresearch.worldbank.org/PovcalNet.

results, labor is considered to be greatly misallocated in most developing countries, with too much labor in agriculture and a large agricultural productivity deficit. This led many authors to argue that structural transformation would be an important source of aggregate output growth and an instrument for poverty reduction. Collier (2008), Collier and Dercon (2014), and Dercon and Gollin (2014) have endorsed this agro-pessimist viewpoint, whereby agriculture offers limited promise as a source of employment growth and poverty reduction compared to urban-industrial growth.

Using the LSMS-ISA data for four African economies, McCullough (2017) makes the important distinction between annual per capita labor productivity (used by Gollin, Lagakos, and Waugh (2013)) and labor productivity per hour worked in comparing agriculture and non-agriculture. For Malawi, she finds that labor productivity per person per year is 4.8 times higher in non-agriculture than in agriculture, confirming the Gollin, Lagakos, and Waugh (2013) observation.[2] By contrast, labor productivity per hour worked is only 40% higher in non-agriculture than in agriculture. The discrepancy between the two ratios is due to the high seasonality of agricultural labor calendars, with a few months of high employment at peak time (planting in this case) and a large number of months with high hidden unemployment. On an annual basis, the ratio of the two productivity measures says that the number of hours worked in a sector divided by the number of persons that declare their main activity to be in that sector is 3.3 times higher in non-agriculture than in agriculture. This suggests that lack of opportunities for year-round labor use in agriculture is a more important contributor to differentially higher poverty than lower labor productivity when working.

The policy implication of this observation is stark. As opposed to the ineluctable need for a structural transformation to secure growth and eradicate extreme poverty, other transformations become a possibility. One is an agricultural transformation following which farming systems become more diversified, correspondingly diversifying sources of income in agriculture and smoothing-out labor calendars throughout the year. The other is a rural transformation following which a rural non-farm economy largely linked to agriculture emerges locally, allowing rural households to diversify their sources of income outside of agriculture and further smooth-out labor calendars. This approach focusing on agriculture and rural areas has been recently advocated by IFAD (2016) and by Beegle and Christiaensen (2019). McMillan, Rodrik, and Verduzco-Gallo (2014) observed that structural change in countries like Malawi has been growth reducing as it shifted labor from low productivity agriculture to even lower productivity urban informality. As a consequence, focusing on productivity growth in agriculture and rural areas where the poor live is an appealing option for as long as extensive urban unemployment prevails.

A key question for implementation of an agricultural and rural transformation is to determine whether there is full employment at peak time in rural areas and how much under-employment

[2] This is computed as the total revenue generated in each sector–net returns to farming and livestock or non-farm enterprises and wage income by sector of employment– divided by the number of household members sorted by their primary sector of occupation

there is in other months. Full employment at peak time would put emphasis on the importance of labor productivity gains in agriculture (such as through mechanization) to increase value added in the peak labor-constrained tasks (principally planting). Large under-employment in other periods of the year stresses the need to pursue agricultural and rural transformations to smooth labor calendars in agriculture and the rural non-farm economy.

In this article, we use the 2004, 2010, and 2016 LSMS data for Malawi, with most of the analysis done with the 2010 data which are of higher quality for our purpose. Data were collected monthly over a 13-month period, allowing the measure of seasonality in labor use. We analyze the use of rural and urban labor, estimating unemployment in high and low seasons of labor demand and throughout the year. We find that unemployment affects both urban and rural areas, throughout the year. Unemployment in Malawi is thus an overall problem, limiting the potential gains for rural poverty reduction coming from seasonal or permanent rural-urban migration as advocated for example by Lagakos, Mobarak, and Waugh (2018) for Bangladesh. In analyzing the case of Malawi, Evidence Action (2014) thus concluded that, "there are insufficient potential migration destinations to absorb excess labor from rural areas."

We decompose total unemployment in rural areas between what we call peak unemployment (the high-season unemployment level extended throughout the year) and seasonal unemployment (the additional unemployment in other months of the year). We find that seasonal unemployment amounts to 2/3 of total rural unemployment and peak unemployment to 1/3. We then explore in detail elements in both the agricultural and rural transformations that could help increase high-season employment and smooth out seasonal employment.

We find that that there is no silver bullet to smooth out rural labor calendars and that a broad array of instruments need to be mobilized to have impact, as each of them only makes a (small) contribution to addressing the seasonal under-employment problem. For the agricultural transformation, raising livestock and, in a limited way, dry-season planting permitted by irrigation and crop diversification reduce the variability of hours worked across months. Growing tobacco may smooth out labor demand in the growing and harvest seasons but its high planting season labor demand corresponds to that of the main staples. Rural transformation includes labor market participation and engagement in a non-farm enterprise. Both of these activities add labor use throughout the year, with labor market participation more effective as a counter-cyclical activity.

Our results are in sharp contrast with the conclusion drawn by Wodon and Beegle (2006) who analyzed the same 2004 LSMS data for Malawi. Like us, they find an important seasonality in labor use and substantial under-employment during most of the year in rural areas. But contrary to us, they find labor shortages in some months of the cropping season that, they conclude, limits households' ability to fully use their productive endowments such as land. Part of the difference in overall employment is due to changing conditions over time, with a large decline in farm size, as we will see below. But there is also a methodological difference with our analysis, as they include in total time worked not only productive activities in agriculture (on-farm self-employment, labor exchange, and wage labor) and the rural non-farm economy (off-farm self-employment and wage labor), but also domestic chores and the production of z-goods such as fetching water and firewood collection. These activities roughly add 23 hours to women's weeks and 4 hours to men's in both rural and urban contexts, with almost no variation across months of the year. We opted for a narrower definition of total work that solely includes income generating activities (productive activities in agriculture and the rural non-farm economy), more in line with the focus of our article on the poverty consequences of under-employment. This choice does not negate the long hours that households have to spend on these other activities, with their potential gender imbalance, nor the time and cost that workers may have to spend getting to their employment. In that sense, our measure of under-employment is strictly a measure of lack of opportunities for income generating activities, not of leisure.

The outline of the article is as follows. The first two sections present the data and the context of rural poverty in Malawi. The following three sections represent the core of the paper, where we construct and contrast labor calendars for rural and urban households, measure the share of unemployment that is due to seasonality, and verify that the differential welfare between urban and rural household is driven by underemployment rather than productivity differences. In the last two sections we explore elements of the agricultural transformation that can help smooth out labor calendars and the following section does the same for the rural transformation. The final section concludes and draws policy implications.

Data

To investigate labor market seasonality, we utilize principally data from Malawi's Third Integrated Household Survey (IHS3) collected in 2010-11. This is a living standards measurement survey (LSMS) covering a cross section of more than twelve thousands households. The IHS3 uses a stratified two-stage sample design, first sampling enumeration areas (EA) in the 2008 Population and Housing Census stratified by rural/urban location and then sampling households from a list that was constructed for each sampled EA. A minimum of 24 EAs were sampled in each district. For practical reasons, a multiple of 12 EAs were sampled in each stratum in order to distribute the sample evenly across the 12 months. The IHS3 is a very comprehensive household survey designed to monitor conditions in Malawian households.

The rural labor supply can be observed using the time use questions featured in the employment module of the household questionnaire. The questions ask each member of the household above the age of five to report the number of hours spent in the past seven days on several different activities which we group into four categories: agriculture (agricultural activities including livestock and fishing), business (running a household business and helping in a household business), casual labor, and regular wage-paying labor.[3] In this article, weekly work hours will be analyzed at both the household and individual levels. Household labor hours per week aggregates the hours reported by all members of the household over the age of five thereby capturing the labor of household members that may not be the primary bread winners. Our main household sample consists of 12,266 households of which 10,037 are rural and 2,229 are urban. Analysis of individual labor hours per week only includes individuals of working-age (15 to 65 years old) who report that they are not attending school, which we will refer to as 'individuals' or 'adults' without further reference to these selection criteria. Our adult sample consists of 23,324 individuals in 11,492 households as 774 households have no working-age adults. Of theses adults, 18,699 are rural and 4,625 are urban. Since interviews were spread throughout the year, we can observe the seasonality of activities and establish labor calendars for the whole population or subgroups of the population, at both an individual and a household level.

These two levels of analysis correspond to different ways of looking at labor use. Employment is normally measured at the individual level, leading to clear measures of unemployment (no hours worked) and underemployment (comparing hours worked to a norm of full employment). However, the averaging of these hours worked does not necessarily measure the aggregate availability of work in any particular area in the given month. This is because working age members of a household may temporarily leave or come back in response to availability of income generating opportunities where the household resides. At the extreme, a fully unemployed person migrating during the low season would raise the average per individual employment while obviously it does not increase the household's in situ employment. It is much less likely that any household would entirely leave an area for seasonal migration. Additionally, fluctuations in labor demand may induce the young and elderly to provide supplemental labor in times of need which would not be reflected in the individual analysis. For these reasons the average number of hours worked by households in a week of a given month should give a better measure of aggregate work availability during that month, where the household resides.

We also use the other surveys in this series, the second and fourth Integrated Household Survey collected using the same methods in 2004 and 2016, respectively. However, we rely primarily on the 2010 results as the 2010 survey features both a large number of EAs and the most even spread of the timing of EA interviews across calendar months. We use the data from the 2004 and 2016 waves to observe aggregate trends over these 12 years in some household characteristics, and as robustness checks for the results established with the 2010 survey.

[3] The survey questions distinguish between "casual, part-time or ganyu labor", and "for a wage, salary, commission, or any payment in kind, excluding ganyu". It is this second category that we name 'regular wage-paying labor' or 'wage labor' as 93% of the respondents declare working at least 35 hours last week, while the majority of those under casual labor worked less than 15 hours. The survey also asks about unpaid apprenticeships but we drop this category as very few respondents engage in it. The time use survey also asks respondents how much time was spent yesterday on collecting firewood and water which we omit from our analysis.

Rural poverty in Malawi

Malawi, with a population estimated at 18 million in 2016, is one of the least developed countries in the world ranking 170 out of 188 countries on the UNDP's Human Development Index.[4] Though Malawians have experienced significant improvements in life expectancy and education since 1990, estimated GNI per capita has not grown proportionally during this time period, contributing to the reproduction of monetary poverty.[4] While 71% of the population lived below the international absolute poverty line of US$1.90 PPP per day in 2010, this percentage was still equal to 70% in 2016.[5]

Representing about 30% of the country's GDP, agriculture is central to livelihoods.[5] 92% of rural households and 38% of urban households surveyed report farming at least one plot of land. In all three of Malawi's regions–North, Central, and South–the agricultural sector is characterized by smallholder farms primarily cultivating maize on rainfed plots during the rainy season, the main agricultural cycle, that runs from October to June. Irrigation is rare leaving crops vulnerable to floods and droughts and limiting farming in the dry season (Chafuwa 2017). During the rainy season, 99% of plots in our sample are rainfed. Only 10% of households report planting during the dry season that runs from June to October and those that do so rely primarily on bucket irrigation.

Farms are small, with a mean holding of 2.38 acres though it is slightly higher in the central region where it reaches 3.47 acres. Maize and intercropped maize account for the majority of farmed acreage, accounting for 72% of the area cultivated by the mean household.[6] Tobacco is an important cash crop, particularly in the central region, accounting for 51% of national export revenues in 2010.[7]

63% of farming households in our sample report relying solely on household labor. 27% make use of hired labor and 14% of labor that was "free of charge, as exchange laborers, or to assist for nothing in return," with 4% using both. Off farm employment opportunities are limited mostly to small scale entrepreneurship and casual day labor (referred to as "ganyu" labor).

Regular wage-paying jobs are scarce, even in the cities, which experience high levels of unemployment which we will characterize in the next section. A feasibility analysis by Evidence Action in 2014 for a migration subsidy intervention interviewed 81 respondents who reported very low success rates at finding urban jobs leading the report to conclude that "there are insufficient potential migration destinations to absorb excess labor from rural areas" (Evidence Action 2014). Overall, unemployment in both rural and urban areas is a serious issue in Malawi.

[4]Human Development Report 2016, UNDP, www.hdr.undp.org, accessed 5th Feb. 2018.

[5]World Bank Country Data: Malawi, www.worldbank.org/en/country/malawi, accessed 5th Feb. 2018.

[6]Table A1 in the appendix gives the average acreage planted per household by crop or intercropped combination for surveyed households for the country and each of the three regions. Categories were defined by first grouping varietals of the same crop (i.e., hybrid maize, local maize, etc.) and then looking for common crop combinations as multiple crops are commonly grown on the same plot.

[7]The Atlas of Economic Complexity, http://atlas.cid.harvard.edu, accessed 5th Sep. 2018.

Continued demographic pressure on the land and lack of urban employment opportunities has resulted in a dramatic decline in farm size and in time worked by households across surveys. Farm size declined from 2.29 acres per household engaged in agriculture in 2004 to 1.38 in 2016. Total household labor hours declined from 59.2 per week in 2004, to 41 in 2010, and 31.7 in 2016, while the number of adults in the household declined from 2.0 in 2004 to 1.8 in 2016.[8] This means that land per adult decreased by 18% from 1.13 to 0.93 acres. Malawi thus epitomizes countries stuck in a Malthusian trap.

Comparing rural and urban labor calendars

In this section we build and compare the labor calendar of rural and urban households. Overall results are reported in Figure 1 and Table 1.

Figure 1 reports the estimated average hours work per week by households throughout the year from the estimation of:

$$L_h = \beta_1 Mar10_h + \beta_2 Apr10_h + ... + \beta_{12} Feb11_h + \beta_{13} Mar11_h + \epsilon_h, \quad (1)$$

where L_h is total hours spent engaged in labor activities by household h during the reference week, calculated as the sum of hours spent on all four productive activities (agriculture, business, casual and wage labor), summed over all household members, and the regressors are dummy variables set to one if the reference week for the time use questionnaire of household h falls in that month. Estimated parameters $\widehat{\beta_m}$ with 95% confidence intervals are reported for rural households and urban households separately. We observe that urban households have a relatively stable employment level through the year, of 50 to 60 hours per week. In contrast household employment in rural areas shows a clear seasonal pattern.

Table 1 reports several summary statistics from these calendars. In column 1 of panel a, the total annual hours worked is calculated using the estimates from equation 1, which are multiplied by the number of weeks in the month, and then summed across months,[9] or

$$\text{Estimated Annual Household Total} = \widehat{LL} = \sum_{m=1}^{12} \widehat{\beta_m} * \text{\# weeks in } m. \quad (2)$$

Observing the marked seasonal pattern of rural employment in figure 1, we define the high season as the months of December and January, during which planting takes place, and the low

[8]Table A3 in the appendix shows the evolution of farm size over time. Because GPS measures are not available for 2004, to make the comparison over time we use self reported areas in all three years. Furthermore, because there are far more outliers in the self reported area (mainly due to what are likely miscoding of the unit of measurement (m2 vs acres), we winsorized the area at 5 pct.

[9]Since the survey lasted 13 months, we have two observations for the month of March, in 2010 and 2011. Figures report them separately, but for all calculations that refer to one year, we use the mean of the two observations for March in our calculations.

season as the months of July and August, where labor use is at its low point. Weekly hours in the high and low seasons are calculated by taking the mean of the corresponding $\widehat{\beta_m}$ coefficients from equation 1. The reported standard deviation is the standard deviation of the 13 $\widehat{\beta_m}$, and the coefficient of variation the ratio of this standard deviation to the mean value of the estimated coefficients, multiplied by 100. Panel b of Table 1 reports similar statistics for the binary variable of whether the household provides any labor hours, which we refer to household labor engagement. These statistics exhibit some striking patterns that we now analyze.

There is significantly more variability in rural than in urban labor calendars.

Notable in these urban-rural contrasts in labor calendars is that high season activity offers similar work opportunities for rural and urban households, both in terms of hours worked (both 57-58 hours as observable in column 2) and the percent of active households (column 2 shows a statistically insignificant difference in household labor engagement, with urban areas higher by only 4 percentage points).[10] There is however a large significant discrepancy in the rest of labor calendar months, with labor per week for rural households 57% of that for urban households and engagement 10 percentage points lower among rural households in the low season as noted in column 3. This higher variability of rural calendars is captured by comparing the coefficients of variation of work over the different months of the year. The coefficients of variation in hours worked is 136% higher for rural compared to urban households, as noted in the third row of column 5.

We can decompose the difference in the coefficient of variation between rural and urban households into the difference in mean values and the difference in standard deviations as follows:

$$\frac{\Delta CV}{CV} \approx \frac{\Delta St.Dev.}{St.Dev.} - \frac{\Delta Mean}{Mean} \tag{3}$$

In this case, rural households have both a higher standard deviation in work across months of the year (70 and 50% for hours and participation, respectively) and, for hours work, a lower mean value (by 28%). Both of these contribute to the very large difference in variability of labor calendars.[11]

Figure 2 disaggregates the labor hours reported in figure 1 by activity. It shows that agriculture is by far the largest and the most cyclical source of work for rural households, and that employment in the other activities–household business, casual labor, and wage labor–is relatively stable throughout the year. Importantly, they are not countercyclical to agriculture. Their contributions to overall

[10]Households are considered active if they report spending any time in labor activities. Figure A1 of the appendix displays the percent of active households by month of interview for rural and urban areas.

[11]We verify the results in Table 1 obtained with the 2010 data for household labor supplied and for individuals participation in tables A4 and A5 using the 2004 and 2016 LSMS-ISA data. We see that results are broadly consistent to those of 2010. Rural household labor calendars for hours worked have a CV which is larger than their urban counterparts. The same applies to individual labor engagement, with exception of the 2004 result. Pooled data across the three surveys show a CV which is almost three times higher for rural household hours worked and double for individual labor participation compared to their urban counterparts.

smoothing of the labor calendar (reduction of the coefficient of variation of labor across months) is thus by adding labor opportunities in less seasonal activities throughout the year rather than by complementing work in agriculture when the latter is low.

There is significant underemployment in rural areas even in the high season.

Looking now at effective unemployment, we turn to individual level observations. There is a dramatic seasonal contrast in the distribution of hours worked by rural adults in all activities. Close to 50% of surveyed rural adults report working no or a very low number of hours in the low seasons. [12] To obtain labor calendars at the individual level we estimate an equation similar to equation 1 at the individual level, and report corresponding statistics in table 1. We observe that unemployment rises from 7% in high season to 36% in low season and the average number of hours worked per week falls by half from 24.6 to 12.4. However, even in high season, underemployment prevails. With 25 hours per week, underemployment is 38% for a benchmark full-employment of 40 hours per week.

There is also significant unemployment in urban areas.

Referring to table 1 panel b, we see significant unemployment in urban areas too. The mean individual unemployment rate is 36%, and it remains high throughout the year. Hence although urban adults work more hours on average than rural adults, this high urban unemployment rate limits the opportunity for rural workers to use seasonal or permanent migration to fill in their unused time given the challenges to finding productive employment in the urban economy. Labor displacement to the urban sector is not accompanied by productive employment, but by accumulation of labor in urban slums and no effect on growth. This phenomenon was observed in the 2008 World Development Report (World Bank 2007) for many Sub-Saharan Africa countries where a decline in the share of the labor force employed in agriculture is not accompanied by a corresponding increase in GDP per capita. Malawi was one of them.

Low employment is associated with dependence on agriculture

In this section we try to get some insights on who is most affected by high unemployment, especially in rural areas. Figure 3 compares the employment structure across the four major categories of activities for rural individuals based on working hours reported when interviewed in the low season (July and August). Note that 34% of individuals report no work at all and are not included in this table. We see that individuals severely underemployed in the low season are less likely to be working in occupations else than agriculture. Hence, despite working very few hours in agriculture, they depend on agriculture for 68% of their work time compared to 38% for those working over 30 hours. Work in household non-agricultural businesses and in casual labor gains

[12] Figure A2 in the appendix shows histograms of hours worked in the past week for rural adults in all activities. Panel a shows the distribution for the high season while panel b shows the distribution for the low season.

some importance as we move from households that work less than 10 hours to those working more than 30 hours. The main activity that makes a difference for those working full time is engagement in the wage labor market. As a group, these individuals work on average 18 hours in agriculture, 8 in their businesses, 9 in casual labor, and 14 in wage labor. It becomes apparent that while low employment may be a problem throughout Malawi's economy, it is particularly pronounced for rural households that are dependent on agriculture as their primary occupation, highlighting the importance of not only an agricultural transformation but the need for opportunities in the rural non-farm economy that would emerge in a rural transformation.

Urban-rural labor time equilibrates in the high season.

Against this backdrop of large unemployment in both rural and urban areas, one should notice that in the high season, hours worked in the two sectors are not very different (table 1a). Households work 56.9 hours per week in the rural areas and 58.2 in the urban areas. Individuals work 24.6 hours per week in rural areas and 28.1 in urban areas. Yet, participation rates for individuals show a striking contrast, with 93% of the population employed in rural areas, indicating extensive work sharing, while all work available in urban areas is shared among 67% of the population, leaving 33% unemployed.

The role of unemployment in understanding differences in welfare between rural and urban households.

We decompose the differences in labor productivity between rural and urban areas. We consider how much of the rural-urban income gap is due to differences in hourly productivity and how much is due to underemployment in rural areas.

The IHS3 survey administers a consumption module to each household. The first row of table 2 compares urban and rural household consumption levels, C_h, at the mean and median levels, showing a low rural/urban ratio of 0.42 for means and 0.54 for medians. Similarly to McCullough (2017)'s adjustments for sectoral productivity, we proceed to adjust the mean household consumption by our estimate of households total labor hours worked, $\hat{L}_{yh}$, as calculated in equation 2. For this we calculate $\bar{C}_h/\hat{L}_{yh}$, at the mean and median, for rural and urban households. Results are reported in row 2 of table 2. Since rural households work on average 72% of the hours worked by urban households, annually, calculating consumption on a per hour worked basis leads the the rural/urban ratio raises sharply to 0.58 for means and 0.75 for medians.

One issue with this adjustment by average hours worked at the household level is that it assumes the same annual employment level for all households.[13] If employment and consumption levels are

[13]Recall that we only observe each household labor use for one week in a very seasonal calendar. Hence we cannot infer its own annual labor use, and need to resort to an average over the population or a segment of the population.

correlated (which we expect, larger households having higher employment and consumption), this would not be correct. An alternative is then to compare household consumption per working age individuals, by calculating the mean and median of $C_i = C_h/I_h$ for urban and rural areas, where I_h is the number of working age individuals in household h. These results are report this in row 3 of table 2. As above, we further adjust this value by the annual hours worked per individual, in rural vs. urban areas, by calculating $\bar{C}_i/\hat{L}_i$ in row 4.

These per adult calculations have a potential opposite bias if adults in a household share work opportunities, and the employment rate of adults decreases with the number of adults in the household. Results reported in table 2 show our results to be very robust to the method used. Because the number of adults per household is lower in rural than in urban areas, the rural/urban ratio in consumption per adult is a bit higher in per adult terms, but the main adjustment comes from measuring it on a per-hour basis. The rural/urban ratio of consumption per hour worked is 0.66 for the mean and 0.81 for the median.

This result is similar to McCullough (2017) comparing the sectoral productivity contrast between agriculture and non agriculture. It stresses the fact that urban-rural consumption gaps come not so much from a differential return per hour worked than from a differential in number of hours worked, much to the advantage of the urban population.

Decomposing rural unemployment between peak and seasonal deficits

In the previous section, we observed substantial unemployment in rural areas throughout the year, characterized by an important seasonal pattern. In this section, we propose an approach to measure the share of unemployment faced by rural households that results from seasonality. Any measure of unemployment is based on a definition of full employment. We thus start with a definition of full employment appropriate to this context, and proceed to decompose annual unemployment into what we call peak unemployment and seasonal unemployment.

Malawi distinguishes itself as having a large deficit in employment opportunities. If we define full employment as 48 weeks per year (to allow for unexpected shocks such as illness and political disruptions) and 40 hours per week (to allow time for household maintenance and reproduction), annual hours reported in table 1, panel a, show urban individuals to be at 67.1% of the 1920-hours work potential and rural individuals at 47.3%. Looking at the high season, urban workers work 28.1 hours per week and rural workers 24.6. Urban workers are thus still only at 70.2% of a 40 hour week, and rural workers at 61.5%. Hence, a deficit in work opportunities applies to both urban and rural workers, and exists throughout the year. It is this large and pervasive urban work deficit that limits the possibility of using rural-urban migration as a major instrument for poverty reduction (Evidence Action 2014). Solving the deficit in work opportunities, basically through labor-intensive aggregate economic growth, remains the key issue for large scale poverty reduction in Malawi.

Given this important deficit, what is the importance of seasonality in rural households labor calendars in their opportunities to work? Since full employment as defined above is completely out of reach, we propose to consider the current high-season urban workload as the benchmark employment for rural adults throughout the year. Using the numbers reported in column 2 of table 1, we see that the high-season urban workload is 28.05 hours a week per adult, which amounts to a benchmark of 1459 annual hours for the year. We then define the peak deficit as the annualized difference between the high season work load in rural areas and this potential maximum. Since the high-season rural work load is 24.61 hours a week, the peak deficit accounts for 3.44 hours a week, for an annual deficit of 179 hours. In other words, this is the under-employment level that would prevail in rural areas assuming that high-season employment was constant throughout the year. Seasonal under-employment is then defined as the difference between the observed labor hours in the year and this annualized high-season level. We estimate 909 annual labor hours per rural adult, as noted in column 1 of table 1. When compared to our benchmark of 1459 annual hours, this gives us a deficit of 550 hours. Since the peak deficit accounts for 179 annual hours, we attribute the remaining 371 hours to the seasonal deficit. The seasonal deficit is then 67% of the total deficit. Beyond addressing the high-season deficit for urban and rural workers, the seasonality of rural labor calendars is indeed a big issue. Finding ways of smoothing rural labor calendars through agricultural and rural transformations is thus a key policy problem in addressing rural poverty. This is what we explore in the following section.

Elements of an agricultural transformation that can help smooth labor calendars

In this section, we explore the timing of agricultural labor requirements to better characterize the reason behind the seasonality in labor demand that rural household face. We begin by looking at the timing of the labor requirements associated with the main crops grown in Malawi. We then consider the timing of labor in other agricultural activities and activities associated with the rural non-farm economy to consider how rural households may smooth their labor throughout the year by engaging in counter cyclical activities.

Agricultural labor calendars

In order to better understand the extreme seasonality of labor demand in rural Malawi, and to validate our results using the time use survey, we use information in the agriculture questionnaire of the LSMS to construct an estimate of labor demand by crop per acre for each day of the agricultural season. We construct labor demand calendars for the most common types of crops and intercropping combinations reported in the 2009/2010 rainy season.[14]

Constructing these crop level labor demand calendars is not trivial as it effectively entails calculating the household labor used each week on each plot in the dataset so that we can then generate a representative calendar for each crop. While non-trivial, we find this exercise both informative and methodologically interesting. Informative because this allows us to observe how crops agronomy contributes to the seasonality of labor demand. Methodologically interesting because this approach could easily be applied to other contexts and datasets that include agricultural modules similar to the one found in the LSMS. Indeed, unlike our results using the time use modules, the approach that follows does not require that the survey be conducted continuously across the calendar year as it relies on retrospective data commonly found in agricultural modules.

Estimates of the mean weekly labor demand per acre of a crop are generated by constructing plot level labor demand calendars for each plot farmed. These household plot calendars are constructed using two key pieces of information reported in the agricultural questionnaire for the plot. The timing of planting and harvest activities as well as the amount of household labor that was applied to the plot.

Respondents are asked about the timing of planting and harvesting. Using this information, for each plot j we estimate the duration in weeks D_j^p, beginning date p_j^b, and end date p_j^e of planting activities on the plot [15] as well as the duration in weeks D_j^h, beginning date h_j^b, and end date h_j^e of harvest activities[16] and define the period between these as the growing season such that $p_j^e = g_j^b$ and $g_j^e = h_j^b$ with a duration in weeks of D_j^g.[17]

For each of these three activities (planting, growing and harvesting), respondents are also asked about household labor,[18] reporting the number of weeks, the days per week and the hours per day

[14]Maize and intercropped maize is the main crop grown in Malawi followed by tobacco and groundnuts. Table A1 of the appendix gives the average acreage planted per household for the main crops.

[15]The start and end dates of a household's planting activities are determined using two elements reported in the LSMS survey. First, the survey asks respondents the month in which they planted the seed on the plot. Second, the survey asks each household member the number of weeks they were engaged in planting activities on the the plot. We select the maximum number of weeks reported by any of the n household members and set this as the duration of the household's engagement in planting on plot j, $D_j^p = \max_{i \in n}(weeks_{ij}^p)$. We randomly select a day in the month in which seeds were reported to be planted and set this as the midpoint of planting activities. We use this date and the duration of planting activities, D_j^p, to calculate the beginning date p_j^b and end date p_j^e of planting.

[16]The start and end dates of a household's harvest activities are determined using two elements reported in the LSMS survey. First, the survey asks respondents the month in which they started harvesting the plot. Second, the survey asks each household member the number of weeks they were engaged in harvesting activities. We select the maximum number of weeks reported by any of the n household members and set this as the duration of the household's engagement in harvesting on plot j, $D_j^h = \max_{i \in n}(weeks_{ij}^h)$. We randomly select a day in the month in which the harvest started and set this as h_j^b and then use the duration of harvest activities, D_j^h, to calculate h_j^e.

[17]The timing of growing season activities is not specified in the survey. We opt to define the duration of growing season activities on plot j, D_j^g, as the number of weeks between the end of planting, p_j^e, and the beginning of harvest activities, h_j^b, though the number of weeks people actually report working in growing season activities during that period suggest that these hours are often lumped together over a few weeks rather than spread evenly across the growing months.

[18]In order to build a representative calendar of labor demand by crop we use the 69.4% of plots that rely solely on household labor. We exclude households that engage in hiring and exchanging labor as non-household labor is not

each household member was engaged on the plot. We can thus calculate L_j^a, the total amount of household labor hours applied by n household members to the plot j for activity a, adjusted for plot size, as

$$L_j^a = \frac{\sum_{i=1}^{n} weeks_{ij}^a * days/week_{ij}^a * hours/day_{ij}^a}{Acres_j}. \tag{4}$$

Plot level, acreage adjusted weekly labor hour demand for each of the three activities, l_j^a, is then estimated as

$$l_j^a = \frac{L_j^a}{D_j^a}. \tag{5}$$

For each plot we can then assign l_j^a, to the each day of the calendar year in which the household is engaged in activity a. This defines, ℓ_{dj}, the acreage adjusted weekly labor hour demanded for the week of day d on plot j, such that

$$\ell_{dj} = \begin{cases} 0 & \text{if } d \leq p_j^b \\ l_j^p & \text{if } p_j^b \leq d < p_j^e \\ l_j^g & \text{if } p_j^e \leq d < h_j^b \\ l_j^h & \text{if } h_j^b \leq d < h_j^e \\ 0 & \text{if } h_j^e < d. \end{cases} \tag{6}$$

We then calculate the average number of hours $\bar{\ell}_d$ for each day of the agricultural season to generate a representative calendar for a one acre plot of that crop. Estimated labor calendars are plotted in figures 4a and 4b for the most common crop and intercropped combinations.[19]

We see that the November-December planting period is the peak of labor demand. Maize and intercropped maize accounts for over 70% of the acreage of the typical household farm,[20] thus the timing of maize planting and harvest as illustrated in figure 4a governs the fluctuation in the

disaggregated by task and is measured in days rather than hours, making comparisons to household labor difficult. We verified that while these households typically farm fewer acres, their crop composition is broadly comparable to that of households hiring and exchanging labor. Estimates of the timing of farming activities and the labor hours required for each task and crop using this subset consisting of 10,253 plots farmed by 6,260 households should thus be generalizable to the full sample.

[19]Generating the plot level labor calendar for intercropped plots is more complicated. We limit our calculation of daily labor calendars to plots with no more than four intercropped crops. The questionnaires elicit timing questions for each crop on the plot, however labor applied to the plot is not differentiated by crop. We opt to divide the reported planting and harvesting labor hours equally across crops such that $L_{jc}^h = \frac{L_j^h}{C}$ and $L_{jc}^p = \frac{L_j^p}{C}$ where C is the total number of crops planted on a plot. Furthermore, we also divide the number of weeks households report being engaged in planting and harvesting activities by the number of crops. We then use the crop specific timing question responses to calculate the beginning p_{jc}^b and end p_{jc}^e, of planting activities for each crop, as well as the beginning h_{jc}^b, and end h_{jc}^e, of harvest activities of each crop using the same approach as above. The growing period captures any remaining undefined days between the earliest planting and last harvesting day.

[20]See appendix A1.

labor demand calendar of the typical households. The other commonly grown crops, tobacco and groundnuts, also compete for labor hours during the same high demand planting season. Labor demand at harvest time is much lower and exhibits more dispersion between different crops. Peak harvesting for maize happens in April. Plots that are intercropped with pigeon-peas continue to require labor inputs until the late pigeon-peas harvest in July and August. As seen in figure 4b groundnut harvesting is more labor intensive than the maize harvest but still does not require a substantial labor input as compared to planting activities.[21] The timing of the groundnut harvest is also more spread out running from April to June. The only crop that has a very different pattern in the timing of labor demand as compared to the maize staple is tobacco. Tobacco leaves start to get harvested quite early in the agricultural season and continues until the end of March, right before the maize harvest begins. The tobacco harvest is highly labor intensive, including of child labor (Xia and Deininger 2019), requiring 2.5 times more labor hours than harvesting maize. [22] Finally, while the tobacco harvest is counter cyclical to the maize harvest, the peak labor demand for tobacco is also its planting season which coincides with the planting of other crops.

For each household h, [23] we can then re-weight the plot level labor calendar ℓ_{dj} by the acres of plot j and sum across the household's J plots to generate $\mathcal{L}_{dh}$, the weekly agricultural labor hours demanded for household h in the week of day d. Thus for each day, we calculate

$$\mathcal{L}_{d=x,h} = \sum_{j=1}^{J} \ell_{d=x,j} * Acres_j. \quad (7)$$

From these daily household labor calendars, we then calculate the average number of hours across households, $\bar{\mathcal{L}}_d$, for each day of the agricultural season to generate a representative calendar for household agricultural labor demand, plotted in figure 5.

The agricultural labor demand calendar generated with this procedure covers the 2009/2010 agricultural season (rather than the 2010/2011 survey season) and relies on retrospective recalls of significant agricultural dates and labor requirements. Nonetheless, this calendar is consistent with the labor hours in agriculture reported in figure 2a.[24] Figure 5 shows a sharply concentrated labor calendar, particularly at planting time. These concentrated labor demands in agriculture are at the origin of the high seasonality in rural households' labor calendars. Else than planting (and to a lesser extent harvesting), labor demand per household in agriculture is minimal given the small size of the average family holding.

[21]See appendix table A2 for total labor demand estimates for each activity by crop.

[22]See appendix table A2.

[23]We select only households that do not hire or exchange labor on any plots leaving 8,543 plots farmed by 5,094 households. We do this to avoid concerns about substitution of household and outside labor between plots.

[24]Differences between these two graphs could be due to differences between years and recall errors. In addition, the phrasing of recall questions about labor hours induce respondents to report in a lumpy way which creates some arbitrariness in the way we define the length and intensity of work when there are different members of the household working different lengths of time. Finally, figure 2a also include hours spent on other activities not associated with specific crops (eg livestock).

Specific contributors to labor smoothing

We saw in figure 2a that agricultural activities have a very strong seasonal pattern of labor use, largely responsible for the seasonality in rural labor calendars. In this section, we look into more specific activities or characteristics of agricultural production that could contribute to smoothing the agricultural labor calendars. In order to do this, we contrast the time use survey labor supply calendars of rural households that do or do not participate in these activities. Note that undertaking an activity may or may not generate higher employment depending on whether it fully substitutes or not to the other household activities, which we can check by comparing total annual hours worked. In terms of its contribution to smoothing the labor calendar, best would be that the activity be counter-cyclical to the other activities in which households are engaged, as it will then generate a decline in the standard deviation (SD) of labor use across months. Nonetheless, even if it is not counter-cyclical, an activity that generates a constant amount of labor through the year will induce no change in SD but a decline in the coefficient of variation (CV) of the labor calendar, as illustrated by equation (3).

Table 3 reports total hours worked, high and low season work, SD and CV of hours worked across months of the year for households that do or do not participate in these activities. Because we are looking at potential smoothing of the agricultural work calendar, the sample used in this table consists of the 9,389 rural households (93.5% of all rural households) that are directly engaged in agriculture by cultivating a plot of land and/or owning livestock. We use this grid of indicators to assess in this section the contributions of livestock, tobacco, crop diversity, farm area, irrigation, and use of non-family labor to smoothing the agricultural labor calendar.

Livestock. About 56% of rural households engaged in agriculture own livestock. Of the households that own livestock, the mean is of 10.7 heads, of which 62% are poultry, 24% are sheep or goats, 7% pigs, and 3% cattle. Figure 6a shows working hours for households that own livestock compared to those that do not. The figures show households that raise livestock have higher household work hours throughout the year, with no seasonal effect, except possibly during the harvesting period when livestock has to be herded away from crops. This is reflected in a 33% increase in total hours worked with almost no difference in the SD (table 3). By adding to work opportunities, livestock reduces the CV of the agricultural labor calendar by 23-24% for both households and individuals.

Tobacco. Most of the tobacco in Malawi is cultivated by smallholder farmers (Lea and Hanmer 2009). As observed by Orr (2000) and by Xia and Deininger (2019), tobacco is highly labor intensive, especially at harvest time. Comparing hours worked in households that grow tobacco compared to those that do not shows that tobacco adds a significant 33% to household labor. Because the labor intensive planting season coincides with that of other crops, tobacco provides limited smoothing opportunities. Nonetheless, as visible in figures 4b and 6b, the labor intensive harvest season of tobacco does create an increase in labor requirements during the early period of the growing season prior to the harvest of other crops. The net of these two effects results in an increase of the SD, and the CV of agricultural labor calendars is 2% higher for tobacco growing households than for the other households.

Crop diversity. A similar analysis applies to crop diversification. Here we compare households with three or more crops to households planting only one crop. In general one expects crop diversity to smooth the agricultural calendar. Yet here, as with the case of tobacco, the seasonal patterns of rain implies that planting of all crops happen at the same time, and hence multiple crops provide substantially more work but no relief from seasonality of demand for labor.

Farm area. Comparing reported hours for rural households in the top 25% of farmed area compared to the bottom 25% shows that land area is a major determinant of household time worked. By increasing labor a bit more in the low season than in the high season, larger farms have an 11% lower CV of labor calendar than smaller farms.

Irrigation and dry season cultivation. We compare household labor hours in households that report planting a plot in the previous year's dry season. This is generally done with bucket irrigation. What is interesting is that households that irrigate have higher labor demand not only in the dry period, but also during the wet season, suggesting that it is associated with intensification of land use. Irrigation decreases the CV of agricultural labor calendars by 7%.

Use of hired labor. The last two comparisons look at the use of non-family labor in periods of high labor demand. Only 25% of the households ever hire labor. Among those that do hire labor, they hire on average 16 days of labor per year, although the distribution has a long tail with 1% of the households hiring more than 60 days. These numbers are small relative to annual work, although they are certainly critical at particular times of the year. We see very little difference in family labor between households that hire and those that do not hire labor. The interpretation is that households can easily hire labor when their demand is higher than what they would like to supply, so that households maintain their own labor supply in either case. There could have been some difference by selection, as households that do not hire labor include households that are always in surplus of labor. This is likely very marginal as we see that total hours worked is also very similar across these two groups.

Use of exchange labor. The contrast between the roles of exchange labor and hired labor is interesting. Labor exchange is a within season arrangement between households. Typically, instead of having a short very intense few days of work on your own field, you get neighbors to come and help you and then go on to help them. This helps spread each household's work over a longer period of time if there is some heterogeneity in the exact timing of the operation, or if the operation is for technical reason difficult to spread over more days. The CV of monthly hours worked in agriculture is 34% lower for household that use labor exchange and this is all due to spreading labor rather than adding any labor.

In conclusion, agricultural activities on the farm have little countercyclical patterns of labor use with the main crops that could contribute to smooth the labor calendars. Only households raising livestock and to a lesser extent having irrigation that allows intensification of agriculture or more crop diversification have a lower variability in hours worked across months, and this is mostly due to increased labor use throughout the year. In contrast, using labor exchange seems to allow smoothing labor calendars, without any change in aggregate annual labor.

Elements of rural transformation that can help smooth labor calendars

While the agricultural transformation may affect labor calendars through agricultural activities, the rural transformation seeks to affect labor calendars through decisions beyond agriculture such as engagement in non-farm activities. We look into the effect of seasonal participation to labor market activities by household members and the role of household enterprises. Results are summarized in table 4.

Agricultural Labor Markets. Participation in the labor market is associated with a large increase of annual hours worked by 37%. It decreases a bit the SD of monthly hours worked by adding a few more hours in the low season than in the high season, but the very large 33% decline in the CV is largely due to the increased overall level of employment. Ricker-Gilbert (2014) shows that fertilizer subsidies, as extensively used in Malawi, can increase labor absorption in the home plot, demand for hired labor, and create a small spillover benefit on all farm workers through higher agricultural wage rates.

Household Enterprises. Figure 6c compares reported hours worked by rural households that run a household enterprise to those that do not. Most of the households that run an enterprise are engaged in retail or trade selling consumer products or services. With the exception of some basket weaving, brick making, mat weaving, and tailors there is very little manufacturing of non-perishable goods. Household enterprises increase work hours throughout the year (by an average 36%) with no evidence of counter-cyclical smoothing, to the contrary (the SD is higher by 22%). Work in household enterprises reduces the CV of labor calendars by 11%.

In conclusion, participation to the labor market and having a non-farm enterprise are both associated with a large increase in total employment, and through this with a decrease in the seasonality of work. Participation in the labor market is also associated with some counter-cyclical opportunities that allow a large decrease in the overall seasonality of the labor calendar, which the non-farm enterprises do not provide.

Conclusion

Structural transformation has been advocated as an engine of growth and poverty reduction for the agriculture-based economies, which include most of the Sub-Saharan Africa countries. In that perspective, land and labor productivity growth in agriculture enables the transfer of labor out of rural areas at no opportunity cost on the price of food. Released labor can then be employed at a higher level of productivity in the urban industrial and services economy. As a consequence, the shares of agriculture in employment and GDP decline while the engine of aggregate growth and poverty reduction is found in capital accumulation and employment creation in the urban economy. The analysis of rural household data permitted by some LSMS surveys shows that this approach to growth and poverty reduction is less evident in countries like Malawi where there is a large deficit of urban employment. Labor transfers from the rural sector are less likely to stimulate GDP growth than to displace poverty to the urban environment. As a consequence, we have focused on growth and poverty reduction in the rural areas themselves through agricultural and rural transformations. Key in using these transformations for rural poverty reduction is to reduce seasonality in labor calendars. We have seen that, taking the urban high season employment rate as the maximum workload that could be attained by rural households under current circumstances, the seasonal work deficit explains 2/3 of the total work deficit for rural households. Smoothing rural labor calendars can be achieved in the agricultural transformation through a variety of instruments including livestock, crop diversity, irrigation, and use of non-family labor, especially exchange labor. Smoothing of labor calendars through the rural transformation includes labor market participation and rural non-farm enterprise development. We have shown that there is no single magic bullet among these various instruments to smooth out labor calendars, requiring instead a comprehensive agenda focusing on all available instruments. Activities that contribute to labor smoothing are however not countercyclical to the labor demands of staple crops agriculture. They instead add to labor opportunities throughout the year. As a consequence, family members are likely to each specialize in one or several of these new activities, rather than engaging in seasonal job switching. In any case, our main result is that the increasingly prevalent agro-pessimism needs revisiting and that, for agriculture-based countries like Malawi, facilitating the engagement of rural households in agricultural and rural transformations seems to be the most effective policy option for growth and poverty reduction.

Tables

Table 1: Rural-Urban Contrasts in Labor Calendars: Labor Supply and Engagement

Panel 1a: Labor supplied (*hours worked*)

	Contrast	Total annual hrs	High weekly hrs	Low weekly hrs	Standard deviation	Coeff. of variation (%)
Rural vs. urban, household	Rural	2,065	56.93	29.23	9.58	24.26
	Urban	2,863	58.21	51.38	5.62	10.26
	Rural/urban	0.72***	0.98	0.57***	1.70	2.36
Rural vs. urban, individual	Rural	909	24.61	12.39	4.14	23.85
	Urban	1,288	28.05	23.26	2.63	10.67
	Rural/urban	0.71***	0.88**	0.53***	1.57	2.24

Panel 1b: Labor engagement (*indicator set to 1 if any labor hours are reported*)

	Contrast	Mean % active	High % active	Low % active	Standard deviation	Coeff. of variation (%)
Rural vs. urban, household	Rural	0.88	0.97	0.78	0.06	7.31
	Urban	0.91	0.93	0.87	0.04	3.88
	Rural/urban	0.97***	1.04	0.90***	1.50	1.88
Rural vs. urban, individual	Rural	0.79	0.93	0.64	0.10	13.08
	Urban	0.64	0.67	0.61	0.05	8.58
	Rural/urban	1.23***	1.39***	1.05	2	1.52

Note: Sample consists of 23324 working age individuals who are not in school and 12266 households of which 10037 are rural. Tests for statistical significance of the ratio between the comparison groups being different from 1 are reported for columns 1-3 with * p<0.1, ** p<0.05 and ***p<0.01. Mean percent active is the mean value over the year of the percentage of households that report positive working hours in any given month. High season is December and January, low season is July and August.

Table 2: Consumption per Hour Worked

Household consumption units		Rural	Urban	Rural/urban
Per household	Mean	197,000	468,000	0.42
	Median	152,000	284,000	0.54
Per household hour worked	Mean	95	163	0.58
	Median	74	99	0.75
Per individual	Mean	109,000	233,000	0.47
	Median	86,000	151,000	0.57
Per individual hour worked	Mean	120	181	0.66
	Median	95	117	0.81

Note: The adjustment for hours worked is done by dividing consumption by the estimated annual hours worked for the relevant group reported in Table 1.

Table 3: Agricultural Labor Supply by Participation in Activities of Agricultural Transformation

	Contrast	Obs	Total annual hrs	High weekly hrs	Low weekly hrs	Standard deviation	Coeff. of variation (%)
Livestock	Livestock	5,275	1,667	50.37	20.43	10.40	32.62
	No livestock	4,114	1,252	41.87	13.93	10.15	42.36
	Liv/NoLiv		1.33***	1.20***	1.47***	1.02	0.77
Livestock (individual)	Livestock	10,552	641	19.08	7.46	3.96	32.33
	No livestock	7,158	550	18.16	5.75	4.47	42.46
	Liv/NoLiv		1.17***	1.05	1.30***	0.89	0.76
Tobacco	Tobacco	1,255	1,870	54.32	20.25	13.01	36.32
	No tobacco	8,134	1,404	44.43	17.19	9.59	35.72
	Tob/NoTob		1.33***	1.22**	1.18	1.36	1.02
Crop diversity	More diverse	1,920	1,899	61.43	22.92	14.31	39.41
	Less diverse	2,510	1,133	36.62	9.84	8.86	40.87
	More/Less		1.68***	1.68***	2.33***	1.62	0.96
Large farm	Highest quartile	2,343	1,926	58.33	20.96	13.13	35.61
	Lowest quartile	2,379	1,001	32.76	10.70	7.68	40.12
	Highest/Lowest		1.92***	1.78***	1.96***	1.71	0.89
Dry season planting	Planting	1,287	1,903	57.27	23.36	12.72	34.95
	No planting	8,102	1,408	45.15	16.38	10.10	37.49
	Plant/NoPlant		1.35***	1.27***	1.43**	1.26	0.93
Uses hired labor	Hires	2,309	1,493	45.07	20.31	9.76	34.16
	No hiring	7,080	1,460	46.38	16.17	10.41	37.28
	Hires/NoHires		1.02	0.97	1.26**	0.94	0.92
Uses exchanged labor	Exchanges	1,242	1,460	37.34	17.43	6.98	24.97
	No exchange	8,147	1,464	46.82	17.55	10.59	37.81
	Exch/NoExch		1	0.80***	0.99	0.66	0.66

Note: Sample consists of rural households that report cultivating a plot or owning livestock. Household crops are considered more diversified if they report planting three or more crops and less if they report planting a single crop. Tests for statistical significance of the ratio between the comparison groups being different from 1 are reported for columns 1-3 with * $p<0.1$, ** $p<0.05$ and *** $p<0.01$. High season is December and January, low season is July and August.

Table 4: Rural Household Labor Supply by Participation in Activities of Rural Transformation

	Contrast	Obs	Total annual hrs	High weekly hrs	Low weekly hrs	Standard deviation	Coeff. of variation (%)
Work as paid labor	Paid work	6,077	2,323	61.13	35.49	9.40	21.17
	No paid work	3,960	1,698	50.70	21.15	10.21	31.45
	Paid/NoPaid		1.37***	1.21***	1.68***	0.92	0.67
Non-farm enterprise	Enterprise	1,755	2,659	70.96	40.17	11.46	22.53
	No enterprise	8,282	1,948	54.34	27.13	9.43	25.31
	Ent/NoEnt		1.36***	1.31***	1.48***	1.22	0.89

Note: Sample consists of all rural households. Household are categorized as working as paid labor if any houshold member reports working for a wage, salary or in casual labor in the past 12 months. Tests for statistical significance of the ratio between the comparison groups being different from 1 are reported for columns 1-3 with * $p<0.1$, ** $p<0.05$ and ***$p<0.01$. High season is December and January, low season is July and August.

Figures

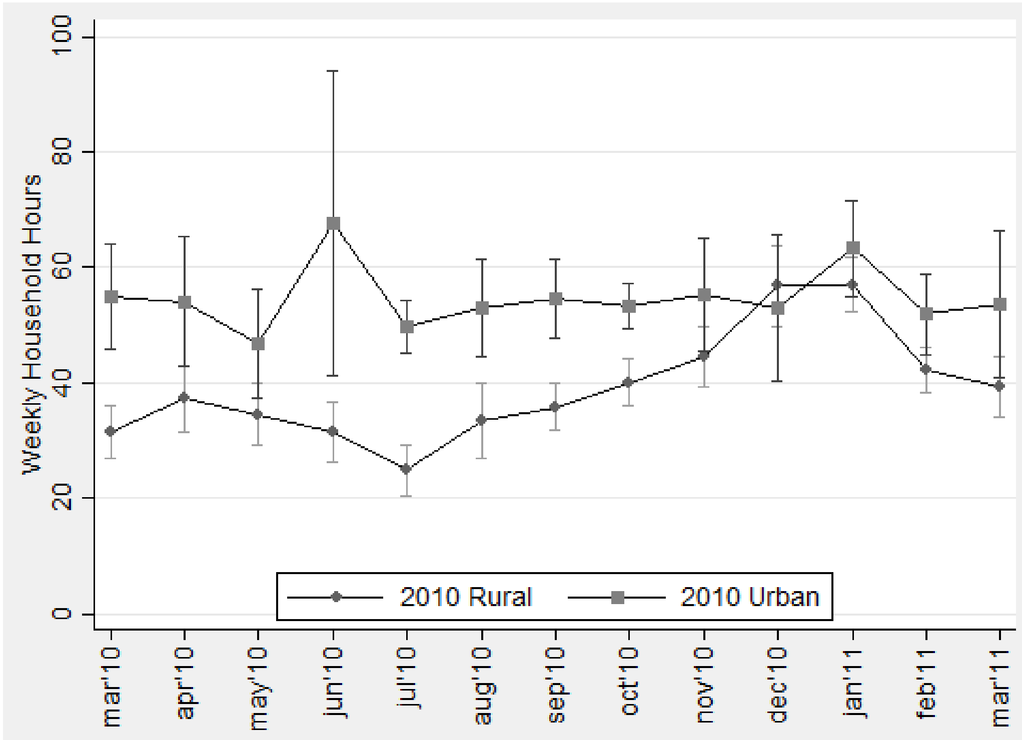
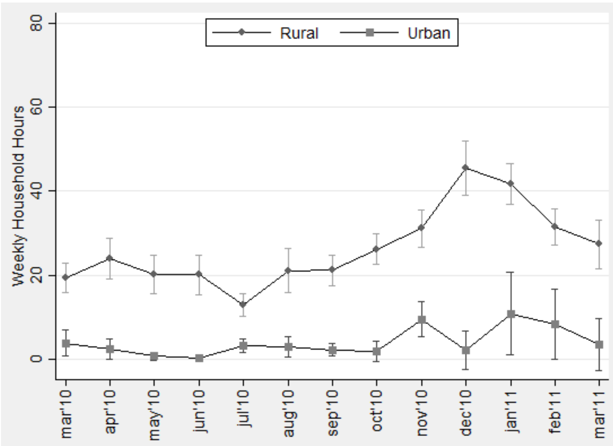
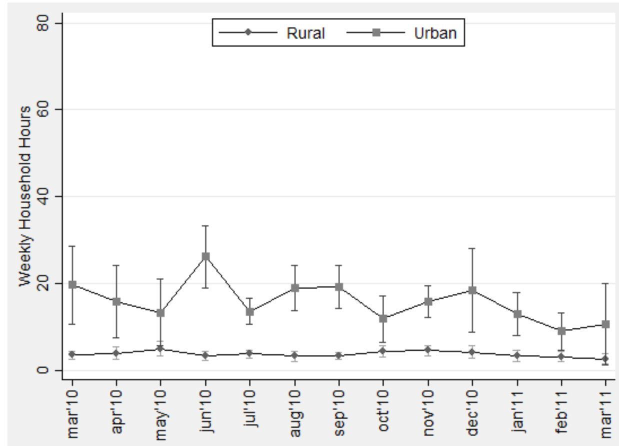


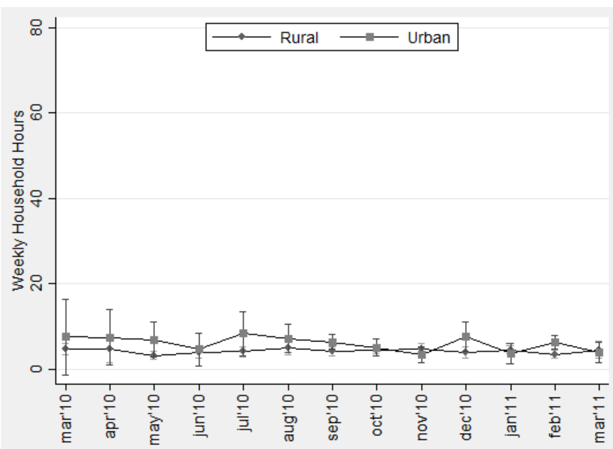
Figure 1. Total household labor hours worked last week



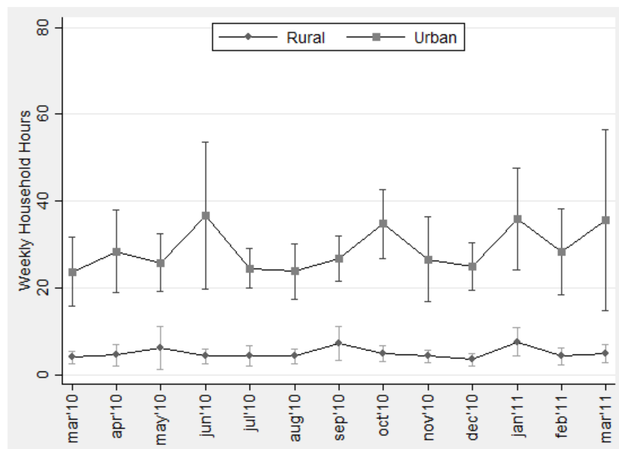
(a) Hours supplied to agriculture



(b) Hours supplied to household businesses



(c) Hours supplied to casual labor



(d) Hours supplied to wage labor

Figure 2. Household labor supplied last week by activity

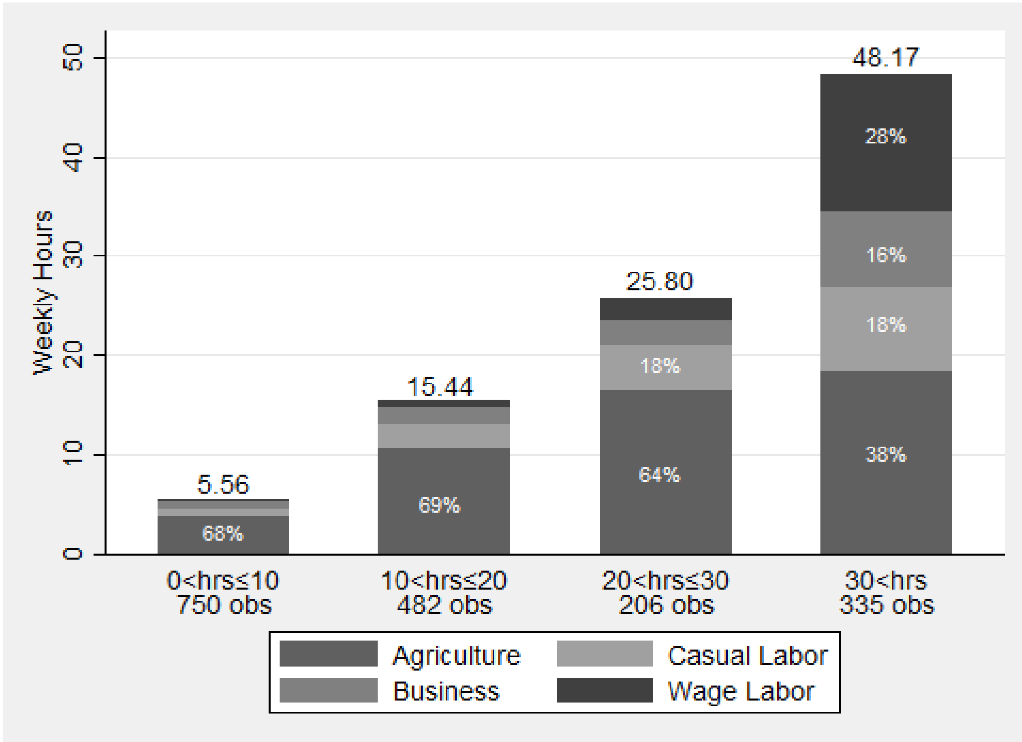
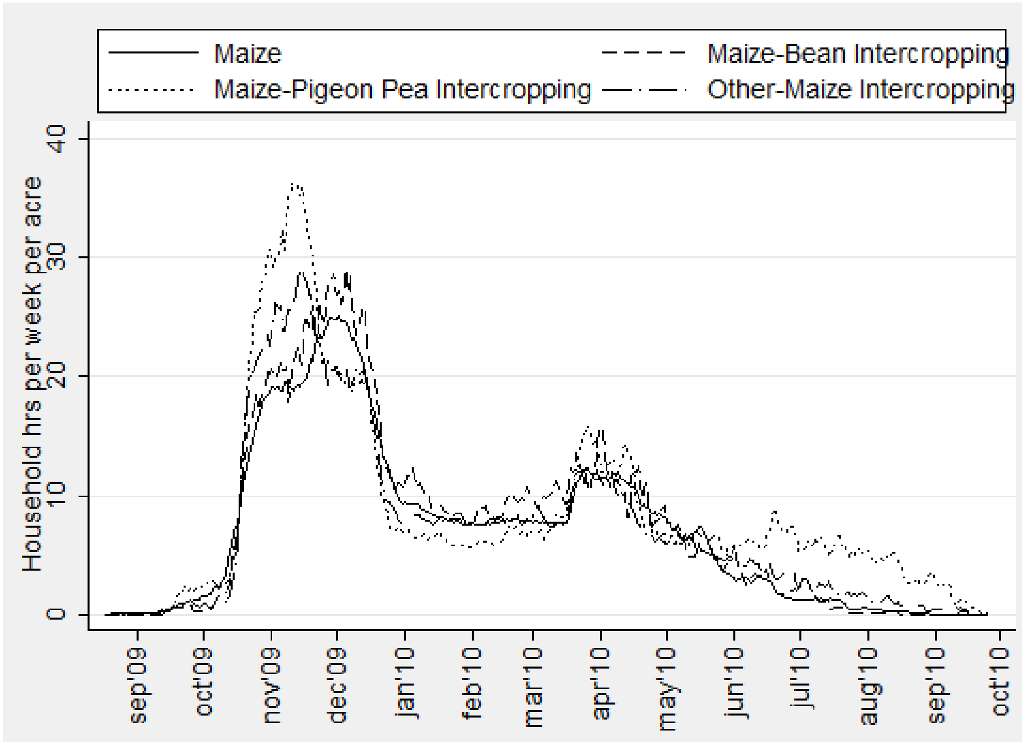
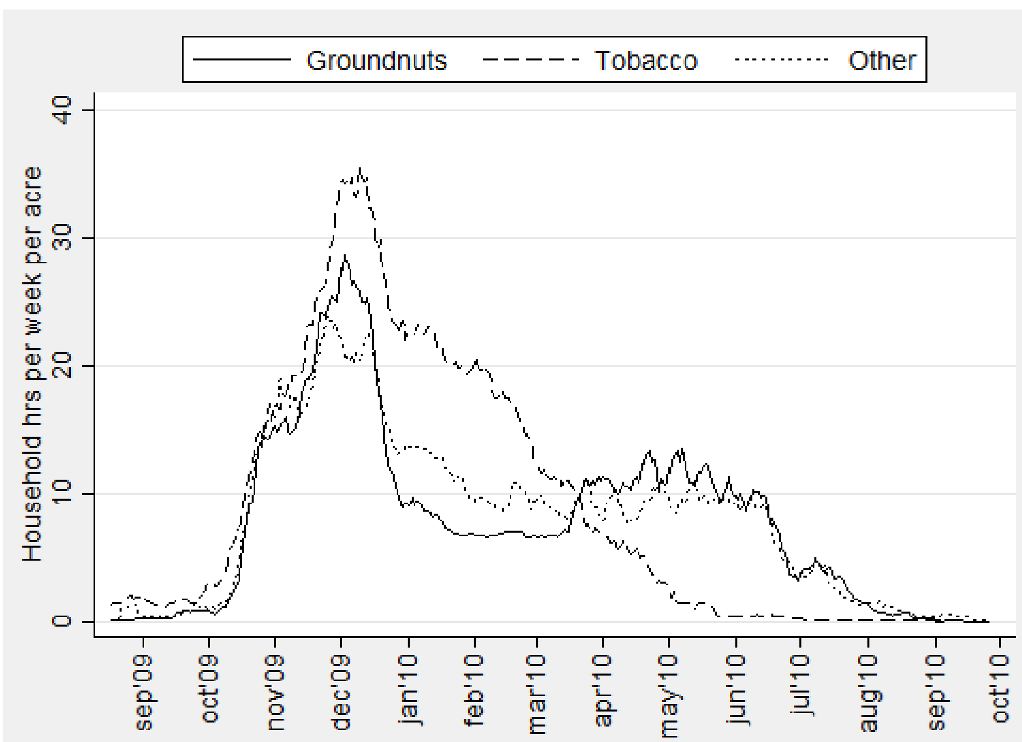


Figure 3. Allocation of time across activities in rural areas during the low season

Note: Sample consists of 2703 rural individuals interviewed in July and August. 930 individuals (34 % of the sample) who report working no hours are not included in the table.



(a) Maize and intercropped maize



(b) Non-maize

Figure 4. Estimated labor demand per week for an acre of the crop

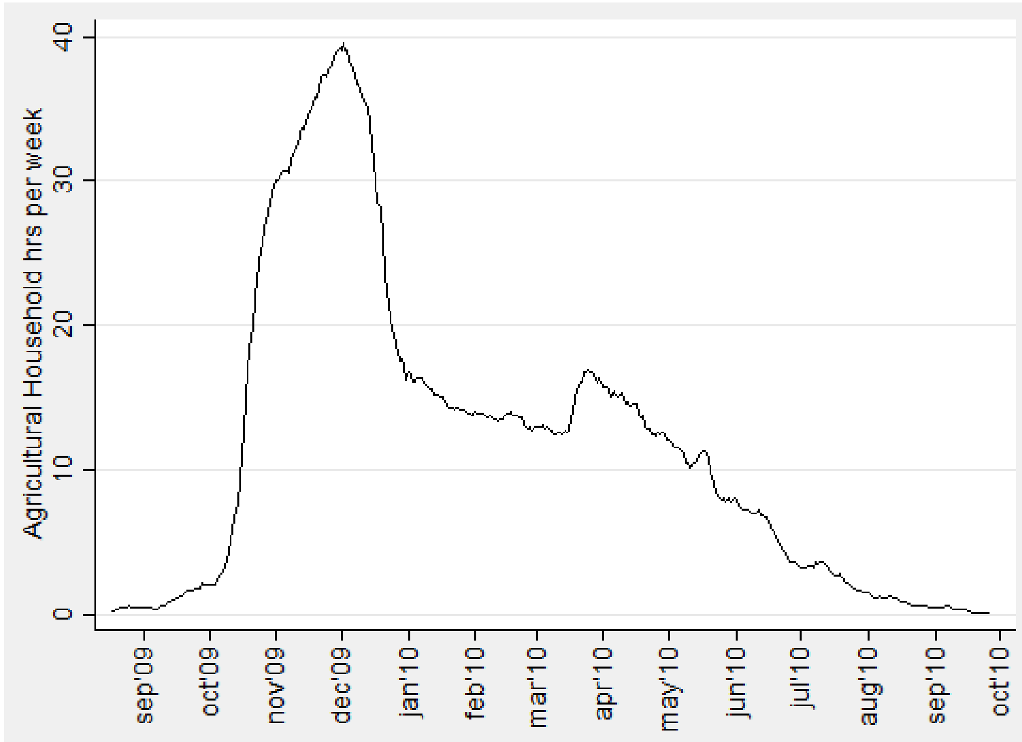
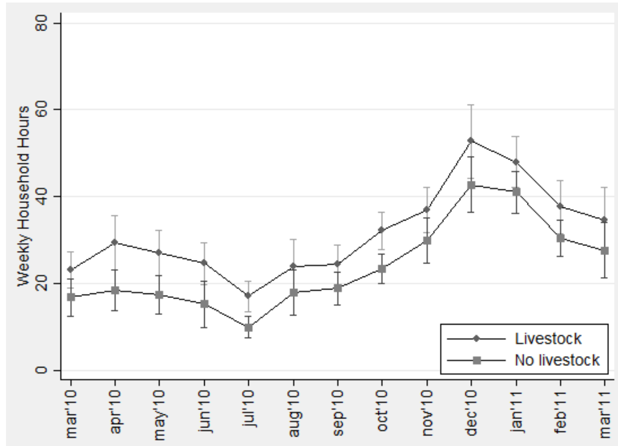
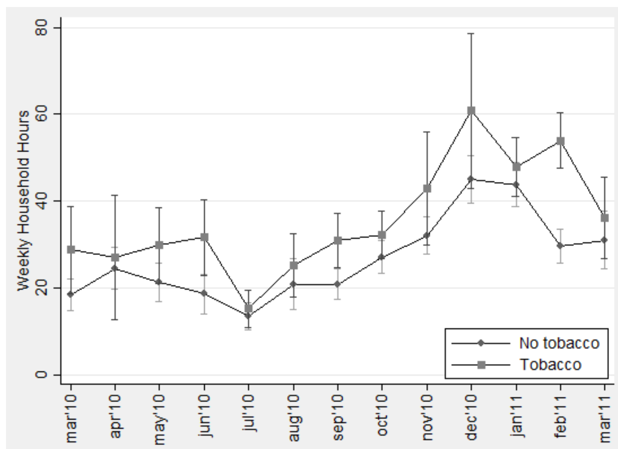


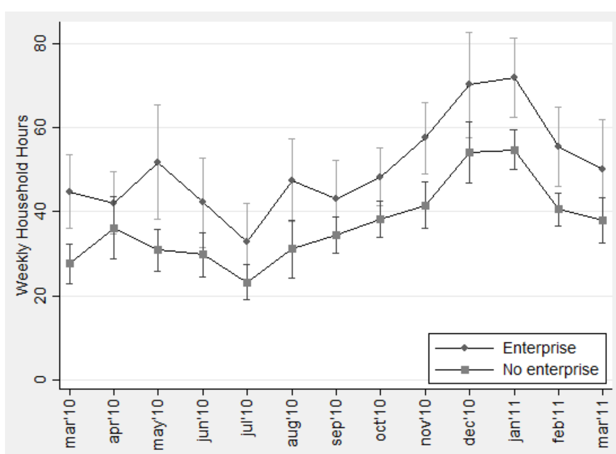
Figure 5. Estimated household agricultural labor demand per week for farming households using the retrospective agricultural questionnaire



(a) **Household hours in agriculture by ownership of livestock**



(b) **Household hours in agriculture by tobacco cropping**



(c) **Total household hours by presence of household enterprise**

Figure 6. Labor supply by household activites

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Appendix

Table A1: Cropping Patterns

Mean acres	All	North	Central	South
Total	2.381	1.971	3.473	1.486
Maize	1.172	0.956	2.040	0.431
Maize-Beans	0.056	0.092	0.076	0.028
Maize-Pigeonpeas	0.135	0.001	0.006	0.290
Groundnuts	0.193	0.116	0.406	0.017
Tobacco	0.294	0.187	0.615	0.026
Other	0.180	0.271	0.150	0.183
Other-Maize	0.351	0.348	0.180	0.510
Observations	10,100	1,696	3,575	4,829

Note: Sample consists of all households reporting at least one cultivated plot. This includes 851 urban households. Land area is calculated using GPS measures of plot area.

Table A2: Mean Labor Hours per Acre, by Crop

	Maize (MZ)	MZ-Beans	MZ-Pigeon Pea	MZ-Other	Groundnuts	Tobacco	Other
Total	418	441	471	410	484	592	496
....Planting	183	203	216	185	188	201	196
....Other	150	167	168	155	150	158	160
....Harvest	73	67	75	63	127	181	117
Observations	3,846	300	1,190	2,100	786	693	1,240

Note: Sample consists of all reported plots farmed using household labor only. Labor hours per acre are first winsorized at .05.

Table A3: Descriptive Statistics by Year for Households Engaged in Agriculture

		2004	2010	2016
Cultivated area in acres	Mean	2.29	1.80	1.38
	Median	2	1.50	1
Total household labor hours in past week	Mean	59.19	41.00	31.73
	Median	50	30	21
Labor hours in past week in peak season (Dec-Jan)	Mean	72.20	58.91	45.57
	Median	63	51	36
Household size	Mean	4.77	4.72	4.43
	Median	5	5	4
Household working-age individuals not in school	Mean	2.02	1.91	1.79
	Median	2	2	2
Observations		9,798	10,096	9,470

Note: Sample consists of all households reporting at least one cultivated plot. For consistency across years, land area is calculated using self-reported plot size winsorized at 5pct.

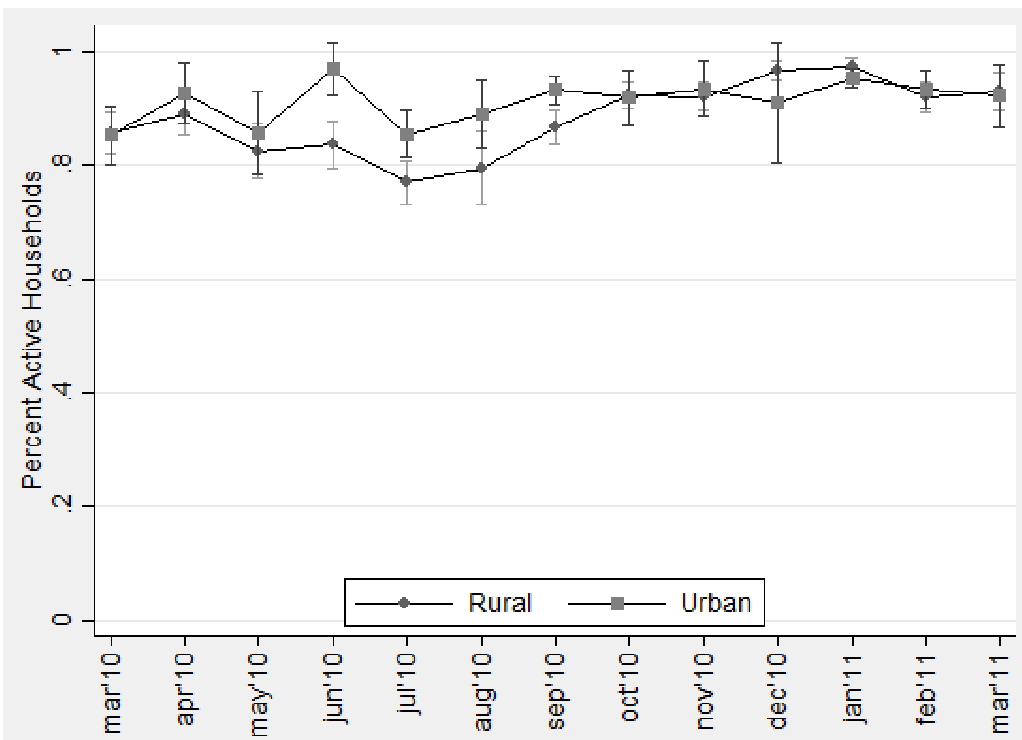
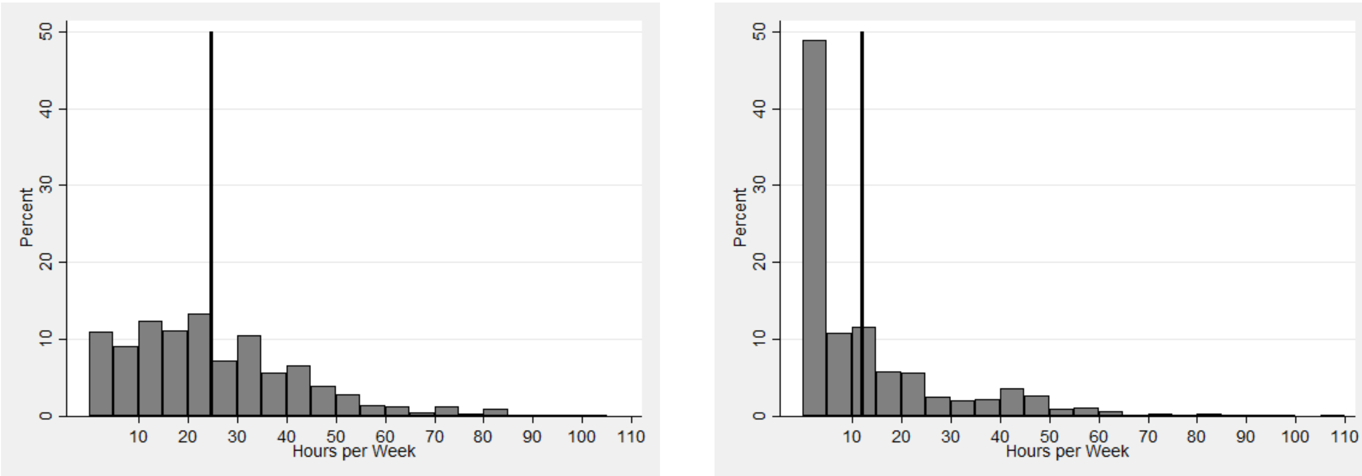


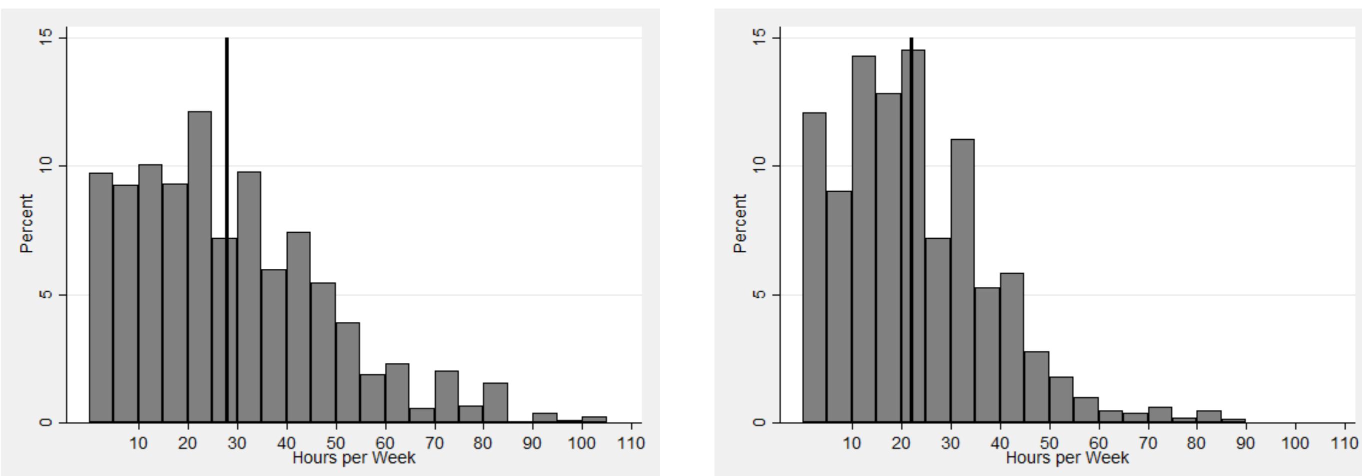
Figure A1. Percent of active households last week



(a) High season (Dec-Jan)

(b) Low season (Jul-Aug)

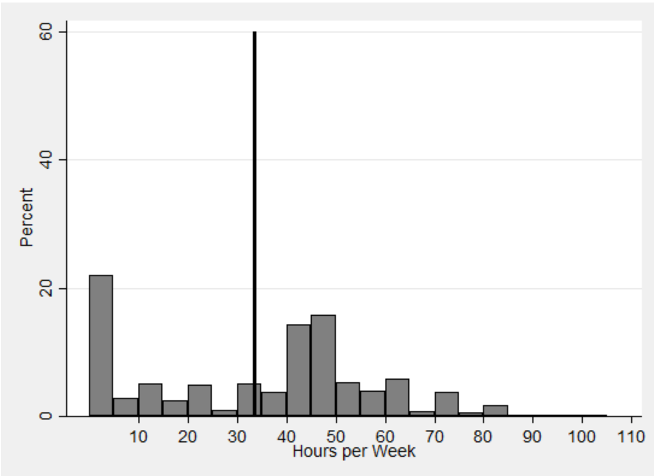
Figure A2. Distribution of weekly hours reported by rural individuals by season



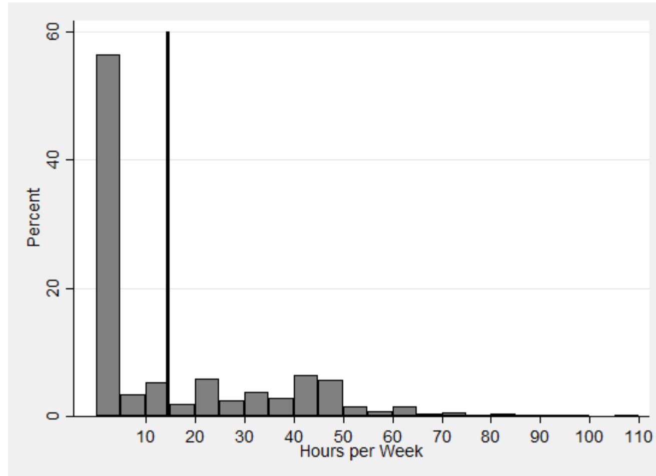
(a) Rural men (Dec-Jan)

(b) Rural women (Dec-Jan)

Figure A3. Distribution of weekly hours reported by rural individuals in the high season by gender



(a) Urban men



(b) Urban women

Figure A4. Distribution of weekly hours reported by urban individuals by gender

Table A4: Labor Supplied by Households, Rural vs. Urban: 2004, 2010, and 2016

	Contrast	Obs	Total annual hrs	High weekly hrs	Low weekly hrs	Standard deviation	Coeff. of variation (%)
Rural vs. urban, 2010	2010 Rural	10,037	2,065	56.93	29.23	9.58	24.26
	2010 Urban	2,229	2,863	58.21	51.38	5.62	10.26
	2010 Rural/urban		0.72***	0.98	0.57***	1.70	2.36
Rural vs. urban, 2004	2004 Rural	9,840	3,088	70.98	48.41	8.75	14.82
	2004 Urban	1,440	3,266	66.67	61.58	6.06	9.72
	2004 Rural/urban		0.95	1.06	0.79***	1.44	1.52
Rural vs. urban, 2016	2016 Rural	10,175	1,488	37.12	26	7.97	25.67
	2016 Urban	2,272	2,277	54.39	43.99	11.31	23.76
	2016 Rural/urban		0.65***	0.68***	0.59***	0.70	1.08
Rural vs. urban, 04-10-16	Pooled Rural	30,052	1,858	49.37	27.06	8.33	23.45
	Pooled Urban	5,941	2,651	58.70	49.30	4.15	8.18
	Pooled Rural/urban		0.70***	0.84**	0.55***	2.01	2.87

Note: High season is December and January, low season is July and August.

Table A5: Labor Engagement of Individuals, Rural vs. Urban: 2004, 2010, and 2016

	Contrast	Obs	Mean % active	High % active	Low % active	Standard deviation	Coeff. of variation (%)
Rural vs. urban, 2010	2010 Rural	18,699	0.79	0.93	0.64	0.10	13.08
	2010 Urban	4,625	0.64	0.67	0.61	0.05	8.58
	2010 Rural/urban		1.23***	1.39***	1.05	2	1.52
Rural vs. urban, 2004	2004 Rural	19,674	0.88	0.95	0.79	0.05	6.09
	2004 Urban	3,114	0.67	0.72	0.62	0.05	7.48
	2004 Rural/urban		1.31***	1.32***	1.27***	1	0.81
Rural vs. urban, 2016	2016 Rural	18,039	0.70	0.78	0.65	0.10	14.20
	2016 Urban	4,424	0.64	0.69	0.67	0.06	9.58
	2016 Rural/urban		1.09***	1.13***	0.97	1.67	1.48
Rural vs. urban, 04-10-16	Pooled rural	56,412	0.75	0.87	0.62	0.09	12.42
	Pooled urban	12,163	0.64	0.67	0.63	0.04	6.08
	Pooled rural/urban		1.17***	1.30***	0.98	2.25	2.04

Note: Sample consists of working age individuals who are not in school. High season is December and January, low season is July and August.