Labor Calendars and Rural Poverty: A case study for Malawi

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Abstract

The persistence of rural poverty in Sub-Saharan Africa is a major challenge for meeting the Sustainable Development Goal on poverty eradication. Using detailed data for Malawi, we investigate the association between seasonality in labor calendars and low consumption. We find that (1) seasonality in rural labor calendars runs deep, accounting for 2/3 of total rural underemployment, (2) we do not observe activities with labor requirements that run clearly counter-cyclical to the main agricultural season, (3) gaps in rural-urban annual consumption are strongly associated with differences in time worked due to seasonality differentials. The implication is that reducing rural seasonality in labor calendars should be a major objective in seeking to increase rural consumption levels. Methodologically, we show that labor calendars can be constructed from standard annual rural household survey data with information on labor use by crop and task.

It is well known from official statistics that world poverty is mainly and increasingly located in Sub-Saharan Africa (SSA), and that poverty in SSA is mainly rural and closely associated with work in agriculture (World Bank (2020)). Also well known is that rural labor calendars are deeply seasonal. Yet, few studies give a precise empirical characterization of the seasonality of rural labor calendars to show where seasonality is coming from, by connecting the labor requirements of crops to the labor supply reported by households, and how deeply it relates to employment opportunities and low consumption. This paper uses detailed seasonal labor data from Malawi, one of the poorest countries in SSA, to address this issue. Specifically, the paper makes four contributions to the characterization and understanding of seasonality in labor calendars.

The first is to show that seasonality is both deep and highly entrenched in rural labor calendars. We decompose total underemployment in rural areas between what we call high season underemployment (the peak time underemployment level extended throughout the year) and seasonal underemployment (the additional underemployment in other months of the year). We find that seasonal underemployment accounts for 2/3 of total rural underemployment and high season underemployment for 1/3.

The second is to explore in detail which activities in agriculture and in the rural non-farm economy (RNFE) are associated with increased labor hours by either generating work opportunities throughout the calendar year or by providing counter-cyclical labor opportunities that smooth out employment across the calendar year. We find that there is no silver bullet to fill in rural labor calendars but that a broad array of activities are associated with (slightly) lower levels of seasonal underemployment. Raising livestock and, in a limited way, dry-season planting permitted by irrigation, and crop diversification are associated with reduced variability of hours worked across months. Growing tobacco is also associated with smoother labor demand in the growing and harvest seasons, but its high planting season labor demand corresponds to that of the main staples. Labor market participation and engagement in a non-farm enterprise are both associated with higher labor use throughout the year, though the additional hours are not distinctly counter-cyclical to agricultural activities.

The third contribution is to show that low household per capita consumption in rural areas is critically associated with lack of work opportunities, and not with low labor productivity when people work compared to urban households. Important work by McMillan and Rodrik (2011) and Gollin, Lagakos, and Waugh (2013) has shown that the annual sectoral labor productivity gap in SSA can be of the order of 4 to 6 in favor of non-agriculture, leading to recommendations that income growth can be achieved by shifting labor out of agriculture. In this paper, we focus on labor outcomes not by sector but by geographical area of residence (rural vs. urban) because consumption is measured at the household level, and households typically have diversified sources of income that cut across sectors. To understand how labor calendars contribute to low consumption, it is important that we measure the return to labor when people work. McCullough (2017) has shown that gaps in labor productivity by hour worked between agriculture and non-agriculture in SSA countries are actually quite small. She finds that lower work opportunities in agriculture explains much of the annual vs. hourly sectoral productivity gap, and thus that a key contributor to the annual labor productivity gap is underemployment in the agricultural sector. She concludes with a call for work that improves our understanding of agricultural underemployment, as we do in this exploration of the importance of seasonality. As consumption is measured at the household level, and households are categorized not by sector but by area of residence, we assess the differential in per household consumption achievements by rural-urban residence when it is measured on an annual basis versus per labor hour. We find that rural-urban consumption differentials per hour worked are indeed much smaller than per year. These results are consistent with the findings of Hamory et al. (2021) who observe no hourly productivity gains, as measured by wages, for rural-urban migrants in Kenya and Indonesia. This suggests that low consumption in rural areas is associated not so much with labor productivity when working as with time worked. The key issue is consequently opportunities to work. We find that hours worked are similar in rural and urban areas at peak labor time in agriculture, with high underemployment characterizing both of these labor markets. Thus, the large difference in annual income between the two areas is associated with a difference in available work opportunities during the rest of the year. This motivates us to characterize in detail how labor is used in different activities every month of the year, revealing deep seasonality in agriculture as an important correlate to differentially low consumption levels in rural areas.

The final contribution is methodological. To characterize labor calendars, we use the 2010-11 LSMS-ISA data for Malawi. This survey was collected monthly over a 13-month period and was designed to be temporally representative, allowing us to measure seasonality in labor use at the activity level. We verify that the sample is balanced to provide statistical representation for each quarter and within quarter for every month. For agriculture we show that seasonal agricultural labor requirements can be estimated using either the household time use survey or the agricultural questionnaire by estimating labor demand by crop per acre for each day of the agricultural season.

There is a large literature on the impacts of seasonality on rural households.[1] Our paper contributes to the literature focused on the characterization of seasonality's impact on rural households' labor calendars (Wodon and Beegle (2006), Fink, Jack, and Masiye (2020), Breza, Kaur, and Shamdasani (2021), and Bryan, Chowdhury, and Mobarak (2014)). Like Dillon, Brummund, and Mwabu (2019) who also analyze the 2010 LSMS data for Malawi to identify separation failures, we observe a labor market characterized by excess labor supply. On the other hand, these results are in sharp contrast with the conclusion drawn by Wodon and Beegle (2006) who analyzed the 2004 LSMS data for Malawi. Like us, they find deep seasonality in labor use and substantial underemployment 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, limit 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 between 2004 and 2010, 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 RNFE (off-farm self-employment and wage labor), but also the production of home services such as domestic chores (cooking, laundry, and cleaning), fetching water, and firewood collection. They find that these activities roughly add 23 hours to women's work weeks and 4 hours to men's in both rural and urban contexts, with almost no variation across months of the year.

[1] A large segment of this literature has focused on the inter-temporal consumption smoothing problem these households face and the financial and storage technologies that can help address this problem (Stephens and Barrett (2011),Basu and Wong (2015), Aggarwal, Francis, and Robinson (2018), Dillon (2020), Cardell and Michelson (2021)).

We opted for a narrower definition of total work that solely includes income generating activities (productive activities in agriculture and the RNFE). While this definition differs from that of Wodon and Beegle (2006), it is the same approach as that taken by McCullough (2017) and Hamory et al. (2021) who like us are interested in understanding productivity gaps. This choice allows us to define underemployment and generate measures that are in line with the focus of our paper on the consumption consequences of underemployment and the lack of opportunities to produce market goods and services.[2] In that sense, our measure of underemployment is strictly a measure of lack of opportunities to produce market goods and services, not of leisure, and our measure of work is strictly a measure of market-production, be it through paid-work or self-employment. This narrow focus on market-production does not negate the long hours that households have to spend on the production of home goods, with their strong gender imbalance. There is no evidence however that their omission impacts the analysis of the seasonality of remunerated work as the time demands of these activities are fairly constant throughout the year (Wodon and Beegle (2006), appendix figures A2 and A3).

Our paper also contributes to the literature on the role of agriculture for development and the associated process of transformation. While most of the literature has been focused on structural transformation (Lewis (1954), Lele and Mellor (1981)), extensive urban underemployment in many poor countries such as Malawi has shifted emphasis on what can be done for growth and poverty reduction by transforming agriculture and rural areas while relying less on urban-based industrialization (IFAD (2016), Goyal and Nash (2017), Beegle and Christiaensen (2019)). McMillan, Rodrik, and Verduzco-Gallo (2014) observed that structural change in countries like Malawi in the 1990's, before the international commodity boom (which has not been sustained), has been growth reducing as it shifted labor from low productivity agriculture to even lower productivity urban informality.

Finally, the comprehensive analysis of which activities in agriculture and rural areas are associ-

[2]While the implications for non-market production and leisure time are important, the IHS3 only includes questions on time spent fetching water and collecting firewood. It does not include questions on domestic chores (as in the 2004 LSMS), nor does it include time spent on peripheral production related activities such as commuting. This makes it impossible to make valid urban-rural comparisons and to differentiate home production and peripheral production activities such as commuting from leisure time.

ated with smoother labor calendars is a novel contribution of this paper, and builds on work that has looked at how interventions in particular areas of the rural economy (e.g. livestock, irrigation, credit, workfare policies) have impacted the seasonal distribution and availability of work (Bandiera et al. (2017), Jones et al. (2020), Fink, Jack, and Masiye (2020), Imbert and Papp (2015)).

The outline of the paper is as follows. The first two sections present the data and the context of Malawi. The following three sections constitute the core of the paper, where we construct and compare labor calendars for rural and urban households, show that the differential consumption level between urban and rural households is driven by underemployment, and measure the share of underemployment that is due to seasonality. In the last two sections we reconstruct the labor demand of different crops. We do this using a new approach that can be applied to other contexts as it relies on commonly available agricultural survey responses. With this understanding of agricultural labor demand, we then explore agricultural and rural activities that are associated with smoother labor calendars. The final section concludes.

Data

To investigate labor market seasonality, we principally use data from Malawi's Third Integrated Household Survey (IHS3) collected in 2010-11.The IHS3 is a very comprehensive household survey designed to monitor conditions in Malawian households. It is an exceptionally large living standards measurement survey (LSMS) covering a cross-section of 12,266 households. While LSMS surveys are available for other countries, certain attributes of the IHS3 are essential for our analysis. First, the large cross-section is important in order to have a sufficient number of observations conducted within each month of the survey. Secondly, Malawi's climate and agriculture are relatively homogeneous allowing us to work with the entire dataset instead of having to split the data to map out the labor supply calendars for different micro-climates within a country. Finally, and importantly, the IHS3 was designed to be temporally representative. The subsample of enumeration areas (EAs) assigned to be surveyed in each quarter were randomly selected so as to produce weighted estimates that are nationally representative for each quarter. Additionally, within a quarter, EAs were randomly allocated to months. Thus the month in which a household completed most of the household modules, including the consumption, labor and time use modules that are our main focus, are well spread out throughout the year in a randomized manner.[3] Nevertheless, implementation disruptions in the summer of 2010 led to some unevenness in the sample distribution across months and is reflected in the larger standard errors for estimates in under-represented months.[4] The balance of survey timing is further discussed and evaluated in appendix A1 and table A1.

Because the survey is temporally representative, we can observe rural labor supply throughout the calendar year by using the time use questions featured in the employment module of the household questionnaire. These questions ask respondents about labor activities in the past week, thus avoiding issues associated with retrospective end-of-season recall bias discussed in Arthi et al. (2018). The questions ask each household member 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.[5] 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 are not prime-age workers. Our main household sample consists of 12,266 households of which 10,037 are rural and 2,229 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 23,183 individuals in 11,486 households as 780 households have no working-age adults. Of theses adults, 18,620 are rural and 4,563 are urban. Since interviews were spread throughout

[3]Though designed to be representative at the quarter level, conducting this analysis at the quarter level would mask much of the seasonal variation we are investigating.

[4]We would like to thank Talip Kilic and Gero Carletto at the World Bank for their assistance in clarifying these survey administration procedures.

[5]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.

the year, we can observe the seasonality of activities and establish labor calendars for the whole population or subgroups of the population, at both the individual and household levels.

These two levels of analysis allow us to make comparisons across two dimensions. Looking at individual hours worked allows us to measure traditional labor market indicators such as unemployment (an individual reporting no hours worked) and underemployment (comparing hours worked by an individual to a full employment norm). These can be used to make urban-rural comparisons without the concern that the mean number of working age adults in a household is 2.06 in urban areas but 1.86 in rural areas.[6] However, as much of our analysis focuses on the seasonality of work in rural areas, we are also interested in the total work hours reported by the entire household, as this household measure better captures the aggregate availability of work in a given month where the household resides. Seasonal labor demands or specific agricultural tasks induce the young and elderly to provide supplemental labor in times of need, as illustrated in appendix figure A4. We wish to capture these hours with our aggregate measure of work. Similarly, the household measure will avoid overstating average employment as a result of the movement of individuals in and out of the household.[7] For instance, if a fully unemployed person departs a rural area during the low season, this would raise the average individual work hours while obviously it does not increase the household's in-situ work availability. Thus we present tables and figures reporting both household and individual hours worked, or only household hours worked, as appropriate for the analysis at hand.

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. For context, data reported by the United Nation's Food and Agriculture Organization (FAO) on the agricultural climate in the 2010 and 2011 agricultural years for Malawi suggest these years were climatically and agriculturally

[6]See appendix figure A8.
[7]Note that seasonal migration is not common in our context, a pattern we will explore.

uneventful with low levels of drought and agricultural stress and small positive increases in the crop production index (The Food and Agriculture Organization (2021)).[8]

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.[9] 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.[9] 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.[10] In this context, increasing household livelihoods and consumption is key to poverty reduction efforts.

Representing about 30% of the country's GDP, agriculture is central to livelihoods.[10] 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). 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, occupying 72% of the area cultivated by the mean household.[11] Tobacco is an important

[8] For 2010 and 2011, the standardized values of the annual mean vegetation health index over the 1984-2020 period were -0.48 and 0.11 respectively. The annual agricultural stress index, which depicts the percentage of Malawi's arable land that was affected by drought conditions over the entire cropping season for these years was 1.07 and 0.26 percent. Finally, the percentage change in the crop production index between from 2009 to 2010 and 2010 to 2011 was 0.58% and 3.4% respectively (The Food and Agriculture Organization (2021)).

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

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

[11] Table A7 in the appendix gives the average acreage planted per household by crop or intercropped combination

cash crop, particularly in the central region, accounting for 51% of national export revenues in 2010.[12]

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 cities, which experience high levels of underemployment that 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). We will document later in the paper that indeed very few rural households use seasonal rural-urban migration and that, while permanent migration is not uncommon, the unemployment rate of migrants is very high. Overall, underemployment in both rural and urban areas is a serious issue in Malawi.

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.[13] This means that land per adult decreased by 18% from 1.13 to 0.93 acres, a substantial drop.

Comparing rural and urban labor calendars

In this section, we construct the labor calendars for rural and urban households and proceed to compare their features. We discuss several important aspects in turn. First, we show that there is

for surveyed households for the country and each of the three regions.

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

[13] Table A3 shows the evolution of farm size over time.

much more seasonal variability in rural than in urban labor calendars. Second, we observe that labor is more evenly spread across individuals in rural than in urban areas. Third, we see significant underemployment in rural areas, even in the peak season. Fourth, we also see large unemployment in urban areas throughout the year. Finally, we find that employment is lower for rural households more dependent on agriculture.

Figure 1a reports the estimated total weekly hours worked per household throughout the year from the estimation of:

$$L_h = \sum_{m=1}^{13} \beta_{1m} Month_h + \sum_{m=1}^{13} \beta_{2m} Month_h * Rural_h + \epsilon_h, \tag{1}$$

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 market activities (agriculture, business, casual, and wage labor), summed over all household members. The 13 $Month_h$ regressors which run from March 2010 to March 2011 are dummy variables set to one if the reference week for the time use questionnaire of household h falls in that month. $Rural_h$ is an indicator variable set to one for rural households. All estimates throughout the paper are weighted using survey weights. Estimated parameters $\widehat{\beta_m^{urban}} = \widehat{\beta_{1m}}$ and $\widehat{\beta_m^{rural}} = \widehat{\beta_{1m}} + \widehat{\beta_{2m}}$ are reported in figure 1a with 95% confidence intervals. 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. Figure 1b presents individual level estimates for working age individuals, revealing a similar pattern.

Table 1 reports several summary statistics for these calendars. In column 1 of panel a, the total annual hours worked in urban and rural zones are calculated using the $\widehat{\beta_m^{zone}}$ estimates, which are multiplied by the number of weeks in the month, and then summed across months[14], or

$$\text{Estimated Annual Total Household Labor by Zone} = \widehat{LL^{zone}} = \sum_{m=1}^{12} \widehat{\beta_m^{zone}} * \text{\# weeks in } m. \tag{2}$$

Observing the absence of seasonality in urban labor hours and the marked seasonal pattern of

[14]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 pool all March observations.

rural labor hours in figure 1, we define the agricultural high season as the months of December and January, during which planting takes place, and the low season as the months of July and August, where labor use is at its low point.[15] Weekly hours in the high and low seasons are calculated by taking the mean of the corresponding $\widehat{\beta_m^{zone}}$ coefficients from equation 8. The reported standard deviation is the standard deviation of the $\widehat{\beta_m^{zone}}$ coefficients, and the coefficient of variation the ratio of this standard deviation to the mean value of the estimated coefficients, multiplied by 100. This same information is also presented for individual labor hours. Panel b of table 1 reports similar statistics for the binary variable of whether the household or individual provide any labor hours, which we refer to as household or individual labor engagement. These statistics exhibit some striking patterns that we now analyze.

There is significantly more monthly variation 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 individuals. In terms of hours worked, rural individuals report working 24.6 hours, or 88% of the 28 hours reported by urban individuals as observable in column 2. There is however a much larger and significant difference in the other labor calendar months, with labor per week for rural individuals 53% of that for urban individuals in the low season. This higher monthly variation in rural calendars is captured by comparing the coefficient of variation in hours worked over the different months of the year. The coefficient of variation in hours worked is 131% higher for rural compared to urban individuals, as noted in column 5. Comparisons using total household hours are similar.

We can decompose the difference in the coefficient of variation between rural and urban individuals 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 individuals have a 62% higher standard deviation in work across months of the

[15]We use these months for both urban and rural areas. While the coefficient for June in the urban areas is higher, there is a high degree of uncertainty surrounding June's coefficient, reflected in the large standard errors (see appendix A1).

year and, for hours worked, a lower mean value (by 30%). Both of these contribute to the very large difference in the variability of labor calendars between urban and rural areas.[16]

Figure 2 disaggregates the labor hours reported in figure 1 by activity for both urban and rural households and individuals. It shows that agriculture is the most cyclical source of work, and that employment in the other activities–household business, casual labor, and wage labor–is relatively stable throughout the year in both urban and rural area, whether considered at the household or individual level.[17] Though some urban households are engaged in agriculture, generating a small amount of seasonal variation in urban labor calendars, the reliance of rural households on agricultural work as the dominant source of rural employment generates the seasonality observed in figure 1. Importantly, the other activities reported in rural areas are not counter-cyclical to agriculture. Their contributions to overall 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.

Work hours are more evenly shared amongst individuals in rural than in urban areas.

Individual participation rates are 22% higher in rural than in urban areas. This contrast is particularly pronounced during the high season when 93% of rural individuals report labor engagement as compared to only 67% in urban areas, leaving 33% of urban individuals unemployed. This is visible in the bi-modal distribution of labor hours in urban areas shown in appendix figure A5. Furthermore, this work sharing is not restricted to working age individuals as illustrated in appendix figure A4. A large share of household labor hours are supplied by non-working age individuals in rural areas, particularly during the peak season.

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

[16] We verify the results in table 1 obtained with the 2010 data in tables A5 and A4 using the 2004 and 2016 LSMS-ISA data. Results are broadly consistent to those of 2010. Rural individual labor calendars for hours worked have a CV which is larger than their urban counterparts, work fewer total hours in the year, and are more likely to be engaged in the labor market. Pooled data across the three surveys show a CV for rural household hours that is almost three times that of urban households.

[17] Agricultural labor throughout this paper refers to agricultural work on the household's plots. It is worth noting that casual (ganyu) labor is also often agricultural work though as hired labor on someone else's plot.

Though participation rates are high in rural areas, there is substantial underemployment, even in the high season. At 24.6 hours per week for working age adults, peak season labor hours are low with a substantial share of individuals reporting less than 15 hours per week as illustrated in appendix figure A6, panel a.[18] This underemployment becomes even more pronounced in the low season. The average number of hours worked per week by individuals falls by half from 24.6 to 12.4 (panel a), with a proportional decline at the household level. Close to 50% of surveyed rural adults report working no or a very low number of hours in the low season as visible in figure A6 panel b. Individual participation rates drop to 64% (panel b).

There is also significant unemployment in urban areas, limiting seasonal migration opportunities.

Referring to table 1 panel b, we see significant unemployment in urban areas too. It is the case that in the cross-section rural individuals work only 70% of the hours that urban individuals work. However urban labor hours are bi-modal in their distribution with many urban adults reporting either no work hours or full-time employment (40+ hours).[19] The mean individual employment rate is 65%, lower than the 79% reported in rural areas, and it remains low throughout the year.

Permanent rural-urban migration is not uncommon though it does not often result in productive employment. The IHS3 asks heads of households to report on the activities and location of any adult biological children living outside the home. Of the 7662 adult children reported by rural households, 24.75 % are reported as currently residing in one of the four main urban areas of Malawi. Among these rural-urban migrants, the employment rate is especially low at 36%.[20] Marginal labor displacement to urban areas in this context is not often accompanied with productive employment, but with labor accumulating in urban slums with little effect on growth. This phenomenon was observed in the 2008 World Development Report (World Bank 2007) for many countries in SSA where a decline in the share of the labor force employed in agriculture is not accompanied by a

[18]In their paper comparing cross-country work hours reported in similar surveys, Bick, Fuchs-Schündeln, and Lagakos (2018) calculate the average country wide weekly hours worked for all adults over the age of 15 to be 28.5 hours in the low income countries within their sample. This is substantially higher than the hours we observe in rural areas, even during the peak season, despite their inclusion of elderly individuals in their calculations.

[19]See appendix figure A5.

[20]557 are reported by their surveyed parents as employed and 972 as unemployed. The remaining are reported as either students, homemakers or handicapped.

corresponding increase in GDP per capita. Malawi was one of them.

Given the difficulties of finding urban employment, migration is not widely used as a seasonal smoothing strategy by rural households. Despite the pronounced agricultural seasons, there is little evidence of seasonal migration in this context. Only 3.8 % of rural working age adults lived away from their household for a month or more in the past year, for any reason. This value is similar to the 4.0 % reported by urban households. Figure A8 in the appendix plots the number of working age adults in the household by month which is stable across the year for rural households.[21] Figure A9 in the appendix shows the probability that a rural household reports the recent departure (in the past 12 months) of an adult child by month. Though the estimates are imprecise given the small number of such departures, there is no clear evidence of seasonality to these events.

Finally, we also find that migration is not used as an emergency coping strategy. Of the 8484 households that report experiencing a negative shock in the past year, only 0.16 % mention using migration as a coping strategy.

Low employment is associated with dependence on agriculture.

In this section we ask who is most affected by high underemployment, especially in rural areas. Rural households are more diversified than urban households. They are more likely to report being engaged in two or more income generating activities as illustrated in panel a of figure 3. Nevertheless, households are quite specialized. Only 32.9 % of rural households report engaging in more then one labor category in the past week and at the individual level, only 18.4 % of working age rural individuals report engaging in multiple labor categories. Of these non-diversified households that only report engaging in a single activity, 77.4 % are working in agriculture.

Figure 4 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 market production activities at all and are not included in this figure. We see that individuals severely underemployed in the low season are less likely to be working in occupations other than agriculture. Hence, despite working very few

[21] There does seem to be a small decrease in the size of urban households in the peak season which could suggest a pattern of peak season return migration.

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 some importance as we move from individuals that work less than 10 hours to those working more than 30 hours. As a group, these fully employed individuals work on average 18 hours in agriculture, 8 in their businesses, 9 in casual labor, and 14 in wage labor. The main activity that makes a difference for those working full time is engagement in the wage labor market.

It becomes apparent that while low employment may be a problem throughout Malawi's economy, it is particularly pronounced for rural individuals that are dependent on agriculture as their primary occupation.

The role of underemployment in understanding differences in consumption between rural and urban households.

In this section, we look at the role of seasonality on rural vs. urban consumption by considering how much of the rural-urban consumption gap is due to differences in average hourly productivity and how much to differences in labor hours. Average hourly productivity is proxied by consumption per hour worked by the household based on the idea that consumption is a relatively smooth measure of income.

The IHS3 survey administers a consumption module to each household and generates an estimate of the household's total real annual consumption.[22] The first panel of table 2 compares means and medians of urban and rural household consumption levels C_h. The second panel repeats this exercise after dividing the household's consumption by the number of working age adults in the household to calculate C_i. The rural/urban consumption ration is 0.42 for means and 0.54 for medians for the household total or 0.46 for means and 0.57 for medians for household consumption

[22] The consumption aggregate as reported in the IHS3 uses spatially and temporally adjusted 2013 prices. Consumption is comprised of four main components: food, non-food, durable goods, and housing. Market and non-market transactions are included and adjustments are made for durable goods and the different reference periods used for different components. A description of how the IHS3 constructs the consumption aggregate is available in chapter 7 of the IHS3 Household and Socio-Economic Characteristics report (National Statistical Office (2012)).

per working age individual.[23]

This consumption gap is attributable to lower productivity when working and/or lower annual working hours. Following the adjustments made in McCullough (2017) for sectoral productivity, we proceed to adjust the mean household consumption by our estimate of households' total labor hours worked, $\widehat{LL_h}$, as calculated in equation 2. For this we calculate $\bar{C_h}/\widehat{LL_h}$ for rural and urban households, where $\bar{C_h}$ represents the mean or median of household consumption. Similarly, we also calculate $\bar{C_i}/\widehat{LL_i}$ for individuals. Results are reported in panels 3 and 4 of table 2. Since rural households work on average 72% of the annual hours worked by urban households, calculating consumption on a per hour worked basis leads the rural/urban ratio to rise sharply to 0.58 for means and 0.75 for medians at the household level and 0.66 for means and 0.80 for medians when adjusted by hours worked by working age individuals.[24]

This result is similar to McCullough (2017) who focuses on cross-sector productivity between agriculture and non agriculture. Our result stresses the fact that urban-rural consumption gaps, like the sectoral productivity gap documented by McCullough (2017), come from both a differential return per hour worked as well as from a significant difference in the number of hours worked, much to the advantage of the urban population. Furthermore our findings highlight that rural populations are not able to overcome the low work hours in the agricultural sector by working additional hours in other sectors. The low standard of living, as measured by per capita consumption, that characterizes rural Malawi is thus inevitably correlated with the inability of households in rural areas to make productive use of their labor, their main asset, for much of the year.

[23]The interpretation of the relative measures of consumption per household are straightforward. However, caution is warranted when interpreting the measures of consumption per working age individual. As household consumption is measured at the household level, it is not possible to identify what share of household consumption is attributable to the labor hours of working age individuals versus those contributed by other members of the household. Household hours attributable to non-working age individuals are substantially higher in rural areas with a mean of 7.07 compared to 3.71 hours per week in urban areas. As calculated and reported in table 2, the consumption resulting from the labor of non-working age individuals is attributed to working age individuals, thereby overstating their contribution, and more so for rural individuals. Adjusting our calculations for this bias requires an assumption about the relative productivity of working age and non-working age household members. If we assume that the productivity of non-working age individuals is the same as that of working age individuals, we can calculate the mean share of household labor hours contributed by working age individuals as $\alpha = \overline{\textit{working age in hh}} \times \frac{\widehat{LL_i}}{\widehat{LL_h}}$. As the mean number of working age individuals is 1.86 in rural areas and 2.06 in urban areas, with the values reported in table 1 we calculate $\alpha_{rural} = 0.82$ and $\alpha_{urban} = 0.93$. The adjusted individual level rural/urban ratio is then given by 0.41 for means and 0.50 for medians.

[24]Adjusting for the mean share of household labor hours contributed by working age individuals ($\alpha_{rural} = 0.82$ and $\alpha_{urban} = 0.93$) gives a rural/urban ratio of 0.51 for means and 0.71 for medians.

Decomposing rural underemployment between peak and seasonal deficits

In the previous section, we observed substantial underemployment in rural areas throughout the year, characterized by an important seasonal pattern. In this section, we propose an approach to measure the share of underemployment faced by rural households that comes from seasonality. Any measure of underemployment 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 underemployment into what we call high season underemployment and seasonal underemployment.

Malawi distinguishes itself as having a large deficit in employment opportunities. We begin by defining 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). Though this benchmark of 1920 potential work hours is arbitrary it does reflects the work schedule experienced by many employed urban men in Malawi as illustrated in appendix figure A5a. For most of our analysis, however, we move away from this benchmark as it is very far from the work hours experienced by the majority of the Malawian population and populations living in other low income countries (Bick, Fuchs-Schündeln, and Lagakos (2018)).[25]

The annual hours reported in table 1, panel a, show urban individuals to be at 67.1% (1288 hours) of the 1920-hour benchmark and rural individuals at 47.3% (909 hours). Looking at the high season, urban workers work 28.05 hours per week and rural workers 24.61. 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 a key issue for large scale poverty reduction in Malawi.

[25] Bick, Fuchs-Schündeln, and Lagakos (2018) conduct a cross-country analysis of weekly labor hours reported in similar surveys. The weekly hours they report for Malawi are much lower than most of the low income countries included in their sample, but are comparable to the weekly hours they calculate for Rwanda and Uganda.

Given this large deficit, what is the importance of seasonality in rural labor calendars in determining the 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, 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, rather than the 1920 hours used above. We then define the rural 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 underemployment level that would prevail in rural areas assuming that high season employment was constant throughout the year. Seasonal underemployment 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 rural seasonal deficit is then 67% of the total rural deficit.[26] 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 activities is thus a key policy problem in addressing low rural consumption. This is what we explore in the following two sections.

[26]A careful inspection of figure 1b suggests that urban individuals also experience some minor fluctuations in work hours throughout the calendar year. As shown in figure 3a these are in part driven by urban workers who report some engagement in agriculture. Since the urban peak work time is used to define the benchmark of 1459 annual hours, there is, by construction, no annual deficit for urban areas, while the urban seasonal deficit can be calculated as 1459-1288=171 hours, or 11.7% of the benchmark employment level.

Agricultural and rural activities associated with smoother labor calendars

We now explore the reasons behind the seasonality in labor demand that rural households face. We begin by looking at the timing of labor requirements associated with the main crops grown in Malawi. We then compare the labor calendars of households engaged in different agricultural and rural non-farm activities to asses which activities are potentially counter-cyclical and associated with smoother labor calendars.

Constructing agricultural labor calendars

The fourth contribution of this paper is methodological, demonstrating an alternative way of constructing the agricultural labor calendars. 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.[27] These crop calendars allow us to better understand the seasonality of labor demand in rural Malawi, to validate our results using the time use survey, and to identify counter-cyclical crops whose labor timing differs from other crops.

Constructing these crop-level labor demand calendars is not trivial as it entails calculating the quantity of 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 it allows us to observe how crops' agronomy contributes to the seasonality of labor demand. Methodologically interesting because 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 the agricultural modules of farm surveys. This approach could thus easily be applied to other

[27] For the construction of these graphs, we drop urban households and households for whom the reference season in the agricultural module was the 2008/2009 season. Maize and intercropped maize is the main crop grown in Malawi followed by tobacco and groundnuts. Table A7 in the appendix gives the average acreage planted per household for the main crops.

contexts and datasets that include agricultural modules similar to the one found in the LSMS.

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 plot level 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 as well as the duration D_j^h, beginning date h_j^b, and end date h_j^e of harvest activities.[28] We define the period between these as the growing season with beginning date $g_j^b = p_j^e$, ending date $g_j^e = h_j^b$, and a duration in weeks of D_j^g.[29]

For each of these three activities (planting, growing, and harvesting), respondents are also asked about household labor, reporting the number of weeks, the days per week, and the hours per day each household member was engaged on the plot.[30] 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

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

[29]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.

[30]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 plots that use hired or exchanged labor as non-household labor is not disaggregated by task and is measured in days rather than hours, making comparisons to household labor difficult. As can be seen in table A6 of the appendix, compared to plots that only use household labor, plots that use hired and exchange labor have a similar crop composition, mean size, but use substantially more chemical fertilizer. Importantly, if we assume non-household labor days to be 8 hours long, the two types of plots have a similar total quantity of total labor inputs with outside labor substituting for household labor. These comparisons confirm the validity of using plots that rely only on household labor to build calendars of labor demand by crop.

$$L_j^a = \frac{\sum_{i=1}^{n} weeks_{ij}^a * days/week_{ij}^a * hours/day_{ij}^a}{Acres_j}, \text{with } a \in \{p, g, h\}. \tag{4}$$

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 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 5a and 5b for the most common crops and intercropped combinations.[31]

We see that the November-December planting period is the peak of labor demand. Maize and intercropped maize account for over 70% of the acreage of the typical household farm,[32] thus

[31]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.

[32]See appendix A7.

the timing of maize planting and harvest as illustrated in figure 5a governs the fluctuation in the labor demand calendar of the typical household. 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 is spread out over a longer harvest season as different crops mature at different speeds. Peak harvesting for maize happens in April. Plots that are intercropped with pigeon-peas continue to require labor inputs until the late pigeon-pea harvest in July and August. As seen in figure 5b groundnut harvesting is more labor intensive than the maize harvest but still does not require substantial labor inputs as compared to planting activities.[33] The timing of the groundnut harvest is also more spread out running from April to June. The only crop that has a noticeably 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 this continues until the end of March, right before the maize harvest begins. The tobacco harvest is highly labor intensive, including in child labor (Xia and Deininger 2019), requiring 2.5 times more labor hours than harvesting maize.[34] Finally, while the tobacco harvest happens before the maize harvest, the peak labor demand for tobacco is also its planting season which coincides with the planting of other crops.

From these crop calendars, we can generate a representative calendar for household agricultural labor demand. First, 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.[35] For each of these households h, we 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

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

From these daily household labor calendars, we then calculate the average number of hours across

[33] See appendix table A8 for total labor demand estimates for each activity by crop.

[34] See appendix table A8.

[35] While these households typically farm fewer acres (the median farm size being 1.2 versus 1.75 acres) their crop composition is broadly comparable to that of households hiring and exchanging labor.

households, $\bar{\mathcal{L}}_d$, for each day of the agricultural season to generate a representative calendar for weekly household agricultural labor demand, plotted in figure 6. Figure 6 shows a sharply concentrated labor calendar, particularly at planting time. This concentrated household labor demand in agriculture is at the origin of the high seasonality in rural households' labor calendars. Other 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.[36]

Specific correlates 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 specific activities or characteristics of agricultural production that correlate with smoother agricultural labor calendars. To do this, we contrast the labor calendars of rural households that do and do not participate in a particular activity, estimating the following equation:

$$L_h = \sum_{m=1}^{13} \beta_{1m} Month_h + \sum_{m=1}^{13} \beta_{2m} Month_h * Activity_h + \gamma_n (X_h - \bar{X}) + \epsilon_h, \quad (8)$$

where the $Activity_h$ indicator is set equal to one if the household is engaged in the activity. Because households self-select into the activities we consider, we also present estimates that include $\gamma_n(X_h - \bar{X})$ terms to adjust for observable household characteristics, X_h.[37] While we are able to control for a

[36]Estimates of household labor demand per week using the retrospective agricultural questionnaire are lower than those using the time-use questionnaire. A few caveats are important when comparing the estimates using these two approaches. First, the retrospective agricultural labor demand calendar as constructed only covers rainy season plots. Household labor being supplied to any dry season (July-October) plots is not reflected in the retrospective calendar but would be included in the time use calendar. Secondly, the retrospective calendar is calculated using reports for the 2009/2010 agricultural season (rather than the 2010/2011 survey season). Climatic differences between these years would be reflected in this figure, though the FAO data suggests they did not substantially differ from one another. Thirdly, the time use responses also include hours on other agricultural activities not associated with specific plots (including livestock and fishing activities). Finally, the retrospective approach questions relies on recall questions for significant agricultural dates and labor requirements, inducing respondents to report plot labor inputs in a lumpy way which could lead to under reporting of time spent on small plot tasks, particularly in the growing and fallow seasons. Overall, the retrospective approach is effective at identifying the peak labor demand months and how seasonally concentrated household labor demand is in Malawi, though it likely substantially underestimates total time spent by households on all agricultural activities.

[37]These controls include the number of adults in the household, the total number of individuals in the households, the number of acres farmed by the household, the household's region, whether the household is female headed and the number of years of education for the most educated adult in the household.

number of observable household characteristics, we cannot control for selection on unobservables so these comparisons are descriptive and should not be interpreted as the causal effect on labor calendars of engagement in these activities. Nevertheless, we believe this to be an informative exercise as, to our knowledge, quantitative research has not documented, even in a descriptive manner, which agricultural and rural activities are associated with smoother rural labor calendars.[38]

Note that undertaking an activity may or may not correlate with higher employment depending on whether it fully substitutes or not for 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 would then produce 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 panel a reports total annual agricultural hours worked, high and low season weekly hours in agriculture, and the SD and CV of agricultural hours worked across months of the year for households that do and do not participate in activities that could smooth the strong cyclical pattern of crops. For this we restrict the analysis to 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 own livestock. We use this grid of indicators to assess the correlations between livestock, tobacco, crop diversity, irrigation, use of non-family labor in agriculture, and farm area and intra-annual variation in supply of agricultural labor hours. These values are calculated using the estimates from equation 8 without controls. The ratio between the value for participating and non-participating households is reported. The same ratio is also reported for estimations of equation 8 that include controls. For columns 1-3, significance stars indicate if the ratio between the two groups is statistically significant. In panel b, we look at activities that are beyond agricultural on-farm work: engagement in paid

[38] A number of papers have evaluated the causal effects of interventions designed to directly increase low season employment (Imbert and Papp (2015), Bryan, Chowdhury, and Mobarak (2014)). While related, the labor hour consequences of these interventions is very direct by design. The activities that we consider are distinct from these types of policies as they do not target low season labor demand by design but may effectively allow households to increase low season labor while also affecting labor hours in other seasons.

work and employment in non-farm enterprises, using the full sample of all rural households and looking at the impact on all household labor hours in all labor activities.

Livestock. About 56% of rural households engaged in agriculture own livestock. Of the households that own livestock, the mean is 10.7 heads, of which 62% are poultry, 24% sheep or goats, 7% pigs, and 3% cattle. Figure 7a shows agricultural labor hours for households that own livestock compared to those that do not. We see that households that raise livestock have higher household agricultural work hours throughout the year, with no seasonal effect, except possibly during the harvesting period. This is reflected in a 33% higher total agricultural hours worked (16% with controls) and almost no difference in the SD. By adding to agricultural work opportunities, livestock is associated with a 23% lower CV of the agricultural labor calendar. Though the reduction is only of 11% with controls. This pattern is consistent with the findings of Bandiera et al. (2017) in Bangladesh who observe that shifting out of casual labor to livestock rearing allows low-income women to smooth their labor supply over the year.

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 agricultural hours worked in households that grow tobacco compared to those that do not shows that tobacco is associated with household agricultural labor being 33% higher (15% with controls). Because the labor intensive planting season coincides with that of other crops, tobacco provides limited smoothing opportunities. Nonetheless, as visible in figures 5b and 7b, the labor intensive tobacco harvest season is associated with higher labor requirements during the early period of the growing season prior to the harvest of other crops. The net of these two patterns is a higher SD, and a 2% higher CV (15% higher with controls) of labor calendars for tobacco growing households compared to other households.

Crop diversity. A similar analysis applies to crop diversity. 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 rainfall pattern implies that planting of all crops happens at the same time, and hence multiple crops correlates with substantially more work but no relief from seasonality of labor demand.

Irrigation and dry season cultivation. We compare household agricultural labor hours for households that report planting a plot in the previous year's dry season. This is generally done with bucket irrigation. The choice to irrigate is correlated with higher labor demand not only in the dry period, but also during the wet season, suggesting that it is associated with a more intensive use of land and a shift in the high season peak from December to January as visible in figure 7c. Irrigation is associated with a CV of agricultural labor calendars that is lower by 7% (3% with controls). Jones et al. (2020) examine the effects of the introduction of irrigation in Rwanda finding that adoption depends critically on the shadow wage a household faces as labor is the dominant input associated with irrigation which is consistent with the correlation we observe here.

Use of hired labor. The next 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 agricultural labor between households that hire and do not hire labor.

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 agricultural labor calendars is 34% lower for household that use labor exchange (24% with controls) and is mainly due to spreading labor rather than adding 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 in agriculture. The impact of farm area on household hours worked in agriculture is twofold. First, the larger farms demand substantially more labor inputs, even in the low season, thereby reducing the CV. Secondly, larger farms demand substantially more hours in the peak season and thus have a larger standard deviation in agricultural hours worked across the calendar months, which raises the CV. Thus the CV of hours worked in agriculture is lower by 11% for large farms without controls but higher by 9% with the addition of controls.[39]

Work as Paid Labor. Participation in the labor market is associated with a large 37% increase in total annual hours worked across all activities (30% with controls). It decreases a little 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 principally due to the increased overall level of employment. Ricker-Gilbert (2014) shows that fertilizer subsidies, as extensively used in Malawi, can increase labor absorption on the home plot and the demand for hired labor, and create a small spillover benefit on all farm workers through higher agricultural wage rates.

Non-farm Enterprises. Figure 7e compares the total 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 tailoring there is very little manufacturing of non-perishable goods. Household enterprises increase work hours throughout the year by an average 36% (27% with controls) 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% (6% with controls).

[39]The farm area control is omitted from this estimation.

In conclusion, raising livestock and to a lesser extent crop diversification and the use of irrigation that allows intensification of agriculture, are correlated with a lower variability in agricultural hours worked across months. This is mostly due to higher labor use throughout the year rather than a pattern of counter-cyclical timing. Similarly, participation to the labor market and having a non-farm enterprise are both associated with a large increase in total employment, and thus a lower variability in hours worked, even though these hours are not distinctly counter-cyclical. In contrast, using labor exchange seems to correlate with smoother labor calendars, with little change in aggregate annual labor. On the whole, engagement in these activities does not correlate with patterns of labor use that are strongly counter-cyclical to the timing of labor demand generated by the main crops.

Conclusion and Policy Implications

Eliminating extreme poverty is the stated number one development goal for the international community. Data suggest that, for this, attention must be given to Sub-Saharan Africa, rural populations, and households whose sources of income depend heavily on agriculture. Analyzing labor use in Malawi, we find that annual consumption per individual adult is indeed much lower in rural compared to urban areas, but that individual consumption per hour worked is not so different in the two areas. In addition, individual time worked at peak labor time in rural areas is similar to that in urban areas, with a high rate of underemployment in both. Using LSMS-ISA data that allow us to statistically estimate monthly time worked, we find that a major correlate to low average annual consumption in rural areas is labor calendars that offer much lower off-peak work opportunities to rural individuals, while urban labor calendars are basically a-seasonal. We estimate 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 accounts for 2/3 of the total work deficit for rural households. With high underemployment in both urban and rural environments, a classical urban-based structural transformation is not currently generating sufficient urban employment opportunities to absorb this surplus rural labor through rural-urban labor migration. For this reason, we explore which of the diverse activities in agriculture and in the rural non-farm economy are associated with increased market work opportunities that help smooth out and fill in rural labor calendars.

Smoother agricultural labor calendars are associated with a variety of agricultural sector practices including the raising of livestock, crop diversity, irrigation, and use of non-family labor, especially exchange labor. Labor market participation and rural non-farm enterprise development are also associated with smoother labor calendars. Activities that currently contribute to filling in labor calendars mainly tend not to be counter-cyclical to the labor demands of staple crops agriculture. They instead add to labor opportunities throughout the year. Thus we find that there is no single silver bullet among these various means to fill in labor calendars. Instead, a comprehensive agenda focusing on all available means, such as those evaluated in existing work by Bandiera et al. (2017), Jones et al. (2020), Fink, Jack, and Masiye (2020), and Imbert and Papp (2015) is needed. With high urban unemployment limiting gains from an urban-based structural transformation in countries like Malawi, facilitating the engagement of rural households in agriculture and rural non-farm activities that increase labor opportunities thus currently seems to be an important policy option for growth and poverty reduction.

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Tables

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

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

	Contrast	Total hrs/yr	High season mean hrs/wk	Low season mean hrs/wk	Standard deviation	Coeff. of variation (%)
Rural vs. urban, household	Rural	2,065.00	56.93	29.23	9.58	24.26
	Urban	2,863.00	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	913.00	24.61	12.61	4.08	23.39
	Urban	1,299.00	28.05	23.98	2.52	10.13
	Rural/urban	0.70***	0.88**	0.53***	1.62	2.31

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

	Contrast	Mean % active	High season % active	Low season % 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	0.65	0.10	12.56
	Urban	0.65	0.67	0.63	0.05	7.98
	Rural/urban	1.22***	1.39***	1.03	2.00	1.57

Note: 'Mean percent active' is the mean value over the year of the percentage of households or individuals that report positive working hours in any given month. 'High season' is December and January, 'low season' is July and August. Sample consists of 23181 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 *** $p<0.01$.

Table 2: Rural-Urban Contrasts in Consumption

Household consumption		Rural	Urban	Rural/urban
Per household	Mean	197,000.00	468,000.00	0.42
	Median	152,000.00	284,000.00	0.54
Per individual	Mean	110,000.00	238,000.00	0.46
	Median	86,000.00	152,000.00	0.57
Per household hour worked	Mean	95.00	163.00	0.58
	Median	74.00	99.00	0.75
Per individual hour worked	Mean	120.00	183.00	0.66
	Median	94.00	117.00	0.80

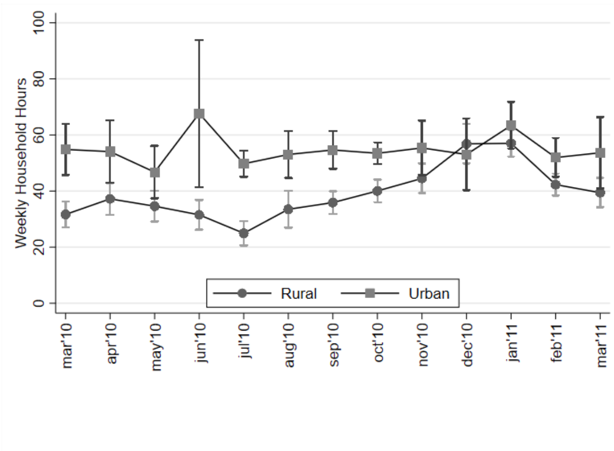
Note: The adjustment for hours worked is done by dividing consumption by the estimated annual hours worked for the relevant group reported in Table 1. Values are total real annual consumption (spatially and temporally adjusted) in 2013 prices. Individuals is the number of working age individuals in the household.

Table 3: Labor Supply by Household Activities

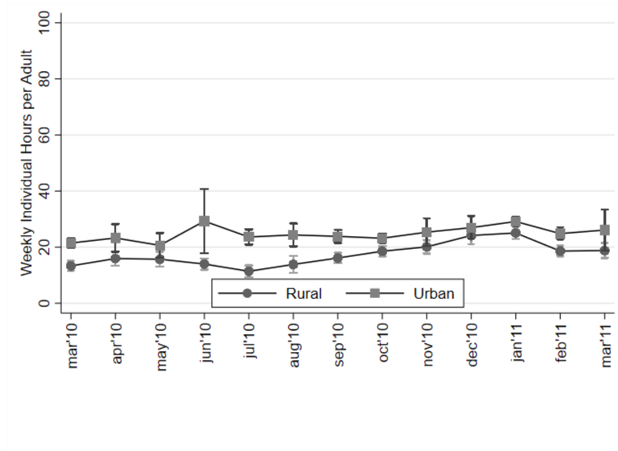
	Contrast	Obs	Total hrs/yr	High season mean hrs/wk	Low season mean hrs/wk	Standard deviation	Coeff. of variation (%)
Panel 3a: Agricultural labor hours of cultivating rural households							
Livestock	Livestock	5275	1667	50.37	20.43	10.40	32.62
	No livestock	4114	1252	41.87	13.93	10.15	42.36
	Liv/NoLiv		1.33 ***	1.20***	1.47***	1.02	0.77
	–ratio w/ controls		1.16 ***	1.13**	1.22**	1.04	0.89
Tobacco	Tobacco	1255	1870	54.32	20.25	13.01	36.32
	No tobacco	8134	1404	44.43	17.19	9.59	35.72
	Tob/NoTob		1.33 ***	1.22**	1.18	1.36	1.02
	–ratio w/ controls		1.15 ***	1.10	0.86	1.33	1.15
Crop diversity	More diverse	1920	1899	61.43	22.92	14.31	39.41
	Less diverse	2510	1133	36.62	9.84	8.86	40.87
	More/Less		1.68 ***	1.68***	2.33***	1.62	0.96
	–ratio w/ controls		1.52 ***	1.55***	2.08***	1.50	0.99
Dry season planting	Planting	1287	1903	57.27	23.36	12.72	34.95
	No planting	8102	1408	45.15	16.38	10.10	37.49
	Plant/NoPlant		1.35 ***	1.27***	1.43**	1.26	0.93
	–ratio w/ controls		1.26 ***	1.19**	1.34	1.21	0.96
Uses hired labor	Hires	2309	1493	45.07	20.31	9.76	34.16
	No hiring	7080	1460	46.38	16.17	10.41	37.28
	Hires/NoHires		1.02	0.97	1.26**	0.94	0.92
	–ratio w/ controls		1.01	0.96	1.26*	0.92	0.91
Uses exchange labor	Exchanges	1242	1460	37.34	17.43	6.98	24.97
	No exchange	8147	1464	46.82	17.55	10.59	37.81
	Exch/NoExch		1	0.80***	0.99	0.66	0.66
	–ratio w/ controls		1.08 *	0.93	1.03	0.80	0.75
Farm area	Highest quartile	2343	1926	58.33	20.96	13.13	35.61
	Lowest quartile	2379	1001	32.76	10.70	7.68	40.12
	Highest/Lowest		1.92 ***	1.78***	1.96***	1.71	0.89
	–ratio w/ controls		1.57 ***	1.60***	1.33**	1.71	1.09
Panel 3b: All labor hours of all rural households							
Work as paid labor	Paid work	6077	2323	61.13	35.49	9.40	21.17
	No paid work	3960	1698	50.70	21.15	10.21	31.45
	Paid/NoPaid		1.37 ***	1.21***	1.68***	0.92	0.67
	–ratio w/ controls		1.3 ***	1.20***	1.62***	0.95	0.73
Non-farm enterprise	Enterprise	1755	2659	70.96	40.17	11.46	22.53
	No enterprise	8282	1948	54.34	27.13	9.43	25.31
	Ent/NoEnt		1.36 ***	1.31***	1.48***	1.22	0.89
	–ratio w/ controls		1.27 ***	1.25***	1.38***	1.20	0.95

Note: These values are calculated using the estimates from equation 8 without controls. Panel a is estimated on agricultural labor hours using the sample consisting of rural households that report cultivating a plot or owning livestock. Panel b is estimated on all labor hours using the sample consisting of all rural households. Household crops are considered more diversified if they report planting three or more crops and less if they report planting a single crop. Household are categorized as working as paid labor if any household member reports working for a wage, salary or in casual labor in the past 12 months. High season is December and January, low season is July and August. Estimates that are adjusted for household observables control for the number of adults in the household, the total number of individuals in the households, the number of acres farmed by the household, the household's region, whether the household is female headed and the number of years of education for the most educated adult in the household. The farm area control is omitted from the estimation investigating the effect of farm area. 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 ***$p<0.01$.

Figures



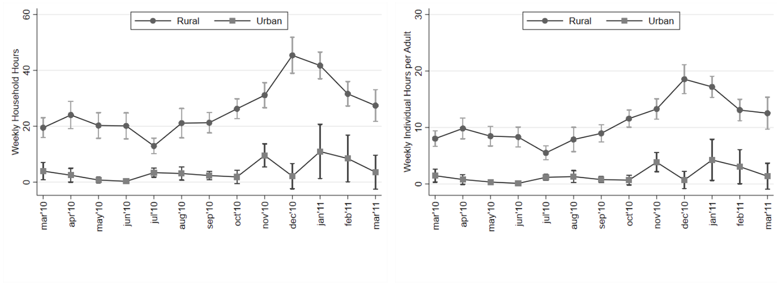
(a) By all household members



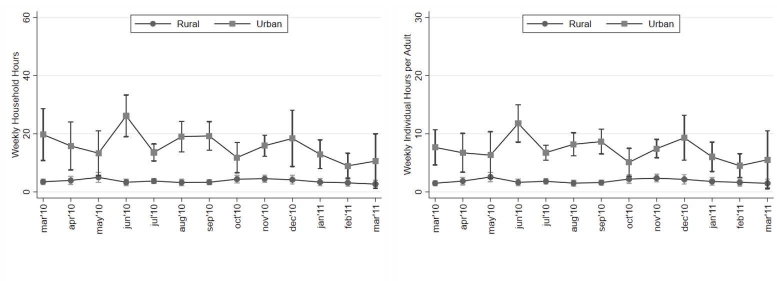
(b) Per working age adult

Figure 1. Total labor hours worked last week

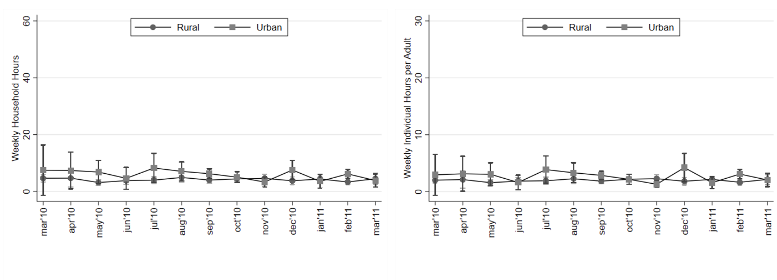
Note: Panel a reports the estimated total weekly hours worked by the entire household by month of interview for urban and rural households. Panel b reports the estimated total weekly hours worked for working age adults by month of interview for urban and rural individuals. Coefficients are reported with 95% confidence intervals. Sample sizes for some sub-group months are small leading to large confidence intervals (see appendix A1).



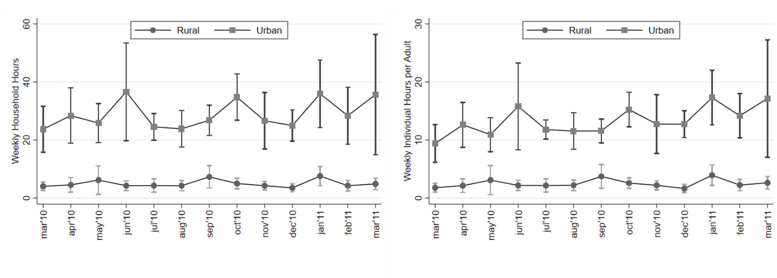
(a) Hours supplied to agriculture (household and individual)



(b) Hours supplied to household businesses (household and individual)



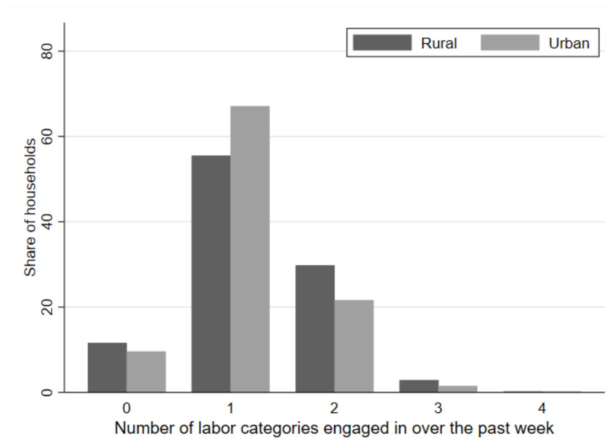
(c) Hours supplied to casual labor (household and individual)



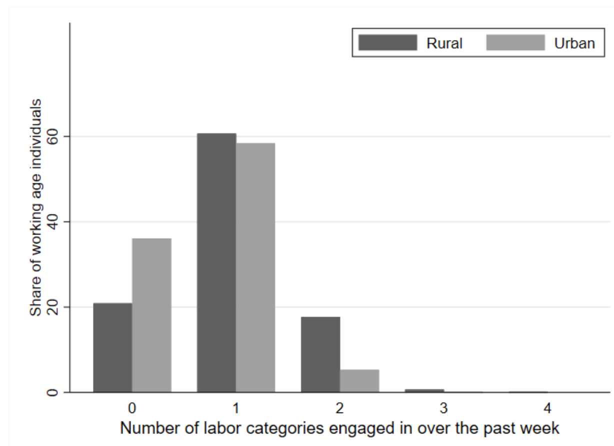
(d) Hours supplied to wage labor (household and individual)

Figure 2. Labor supplied last week by activity

Note: The first column of figures reports total labor supplied by all household members and is plotted on on a 60 hour scale. The second column of figures reports labor supplied by working-age adult individuals and is plotted on a 30 hour scale. Panel a reports the estimated total weekly hours worked in household agriculture by month of interview for urban and rural area. Panel b reports the estimated total weekly hours worked in a household business by month of interview for urban and rural areas. Panel c reports the estimated total weekly hours worked in casual labor by month of interview for urban and rural area. Panel d reports the estimated total weekly hours worked in wage labor by month of interview for urban and rural areas. Coefficients are reported with 95% confidence intervals.



(a) By households



(b) By individuals

Figure 3. Household and individual engagement in multiple labor activities

Note: This figure plots the share of households (panel a) and individuals (panel b) by the number of distinct labor activities (household agriculture, casual work, household enterprise, wage labor) that they report engaging in over the past week.

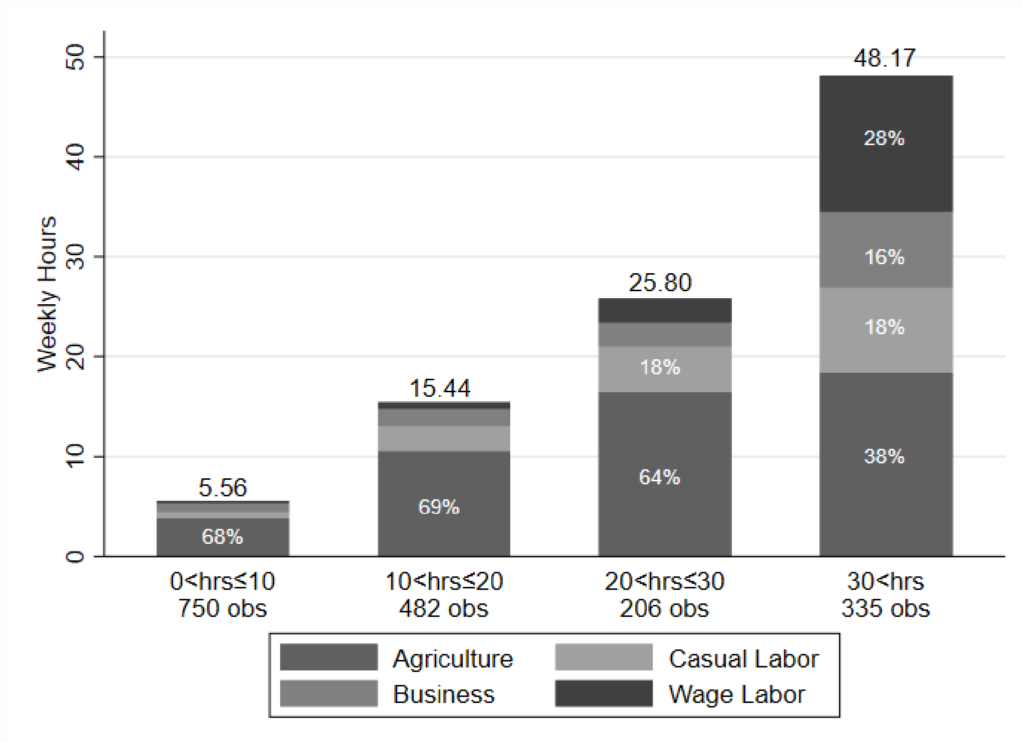
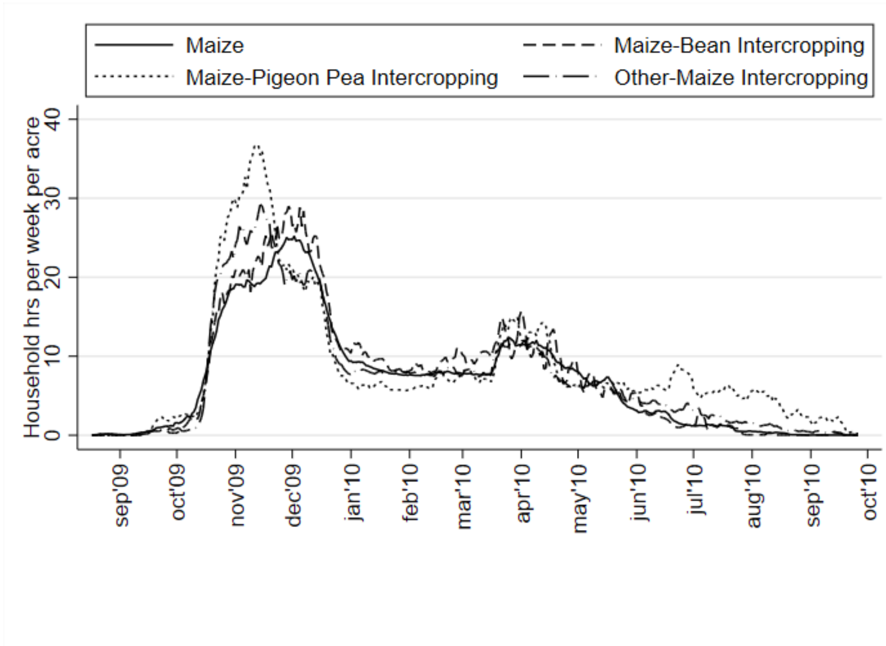
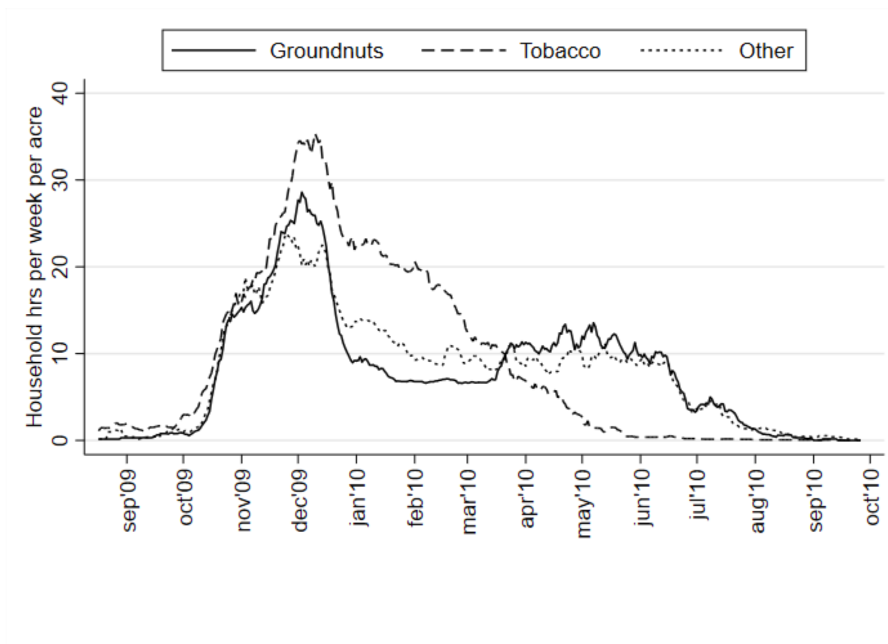


Figure 4. Allocation of time across activities in rural areas during the low season

Note: This figure plots the share of hours spent in different activities for rural individuals in the low season after classifying them by weekly hours worked. Sample consists of 2660 rural individuals interviewed in July and August. 887 individuals (33 % of the sample) who report working no hours are not included in the figure.



(a) Maize and intercropped maize



(b) Non-maize

Figure 5. Estimated labor demand per week for an acre of the crop

Note: These figures show the estimated mean hours of labor demanded per week for an acre of the listed crops by day of the year, as calculated using the retrospective agricultural questionnaire. Estimates are generated using data for plots that do not use any hired or exchange labor as inputs.

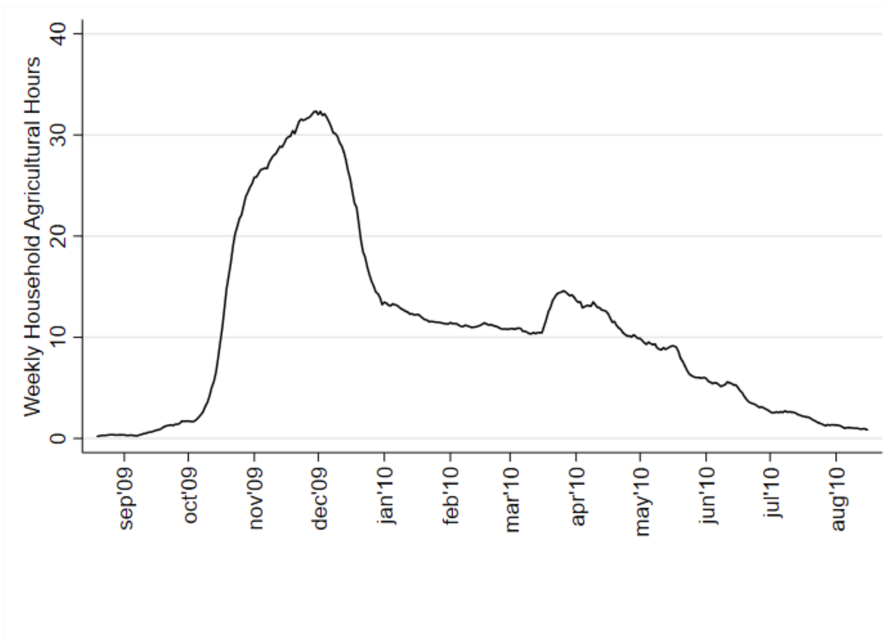
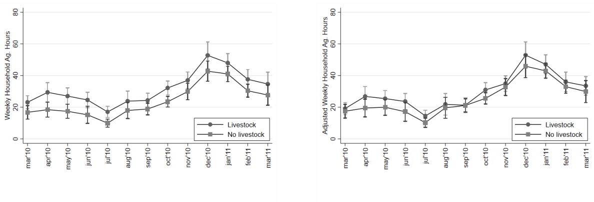
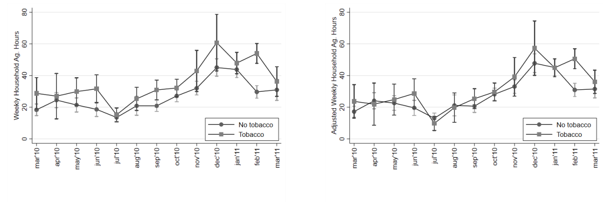


Figure 6. Household agricultural labor demand per week

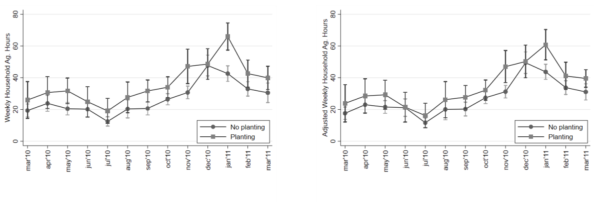
Note: This figure shows the estimated mean hours per week demanded by household farms for farming households who do not engage in labor hiring or exchange by day of the year, as calculated using the retrospective agricultural questionnaire.



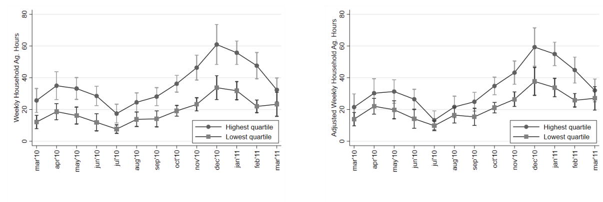
(a) **Household hours in agriculture by ownership of livestock (without and with controls)**



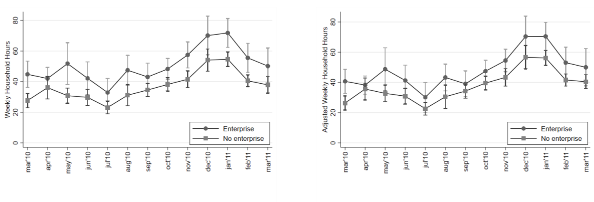
(b) **Household hours in agriculture by tobacco cropping (without and with controls)**



(c) **Household hours in agriculture by dry season planting (without and with controls)**



(d) **Household hours in agriculture by farm area (without and with controls*)**



(e) **Total household hours by presence of non-farm household enterprise (without and with controls)**

Figure 7. Labor supply by household activities

Note: Figures in the first column report the coefficients from equation 8 estimated without controlling for observed household characteristics. The figures in the second column add controls for the number of adults in the household, the total number of individuals in the household, the number of acres farmed by the household, the household's region whether the household is female headed and the number of years of education for the most educated adult in the household. The farm area control is omitted from the estimation investigating the effect of farm area. The figures report the weekly hours in agriculture worked by the entire household by month of interview for households engaged or not in the following activities: livestock rearing (panel a), tobacco farming (panel b), farming in the past dry season (panel c), highest and lowest farm area quartiles (panel d). Panel e reports the total weekly hours in all market activities worked by the entire household by month of interview for households running a household enterprise (panel e). Additional figures are available in appendix figure A10. Coefficients are reported with 95% confidence intervals.

Appendix

A1 Balance of survey timing

The IHS3 sample was designed to provide nationally-representative estimates of consumption expenditures for each quarter. The IHS3 uses a stratified two-stage sample design, first sampling enumeration areas (EAs) 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. To facilitate the distribution of the sample temporally, a multiple of 12 with a minimum of 24 EAs were sampled in each district. Subsamples of EAs for each quarter of the IHS3 data collection were selected from the full sample systematically with equal probability. Within each quarter, EAs were randomly allocated to each month. Thus the month in which a household completed most of the household modules, including the consumption and the labor and time use modules that are our main focus, are well spread out throughout the year in a randomized manner. Note that in the IHS3, sample households are allocated to three types of surveys: the cross-section survey, the panel A survey, and the panel B survey. Panel A and B households are visited twice during the survey year, in a manner that lines up with the agricultural season, in order to get better quality responses on agricultural modules. The first visit was conducted between March and June in the post-planting period and the second was conducted about 3 months later in the post-harvest period. At each visit the panel A and B households complete a household roster. Panel A households complete the full household questionnaire, and the time use module that is of interest to us, in the first visit. Panel B households do this in the second visit. For our purposes the month of an observation needs to be the date in which a household completes the time use and labor module of the household questionnaire. This module is completed in visit 1 for panel A households and in visit 2 for panel B households.

Table A1 shows the percentage of the total EAs and households that were interviewed by survey quarter and month.[1] The survey was designed to be temporally representative at the quarter level and EAs are well distributed across quarters. Within a quarter, EAs were randomly allocated to months. EAs are reasonably well distributed across the survey months though funding and fuel shortage related disruptions midway through the fieldwork led to some imbalance in the number of households covered. Nevertheless, all months are reasonably well covered with exception of the dearth of observations for urban areas in June, which is reflected in the large standard errors of these coefficients throughout our analysis.

To evaluate how survey disruptions might have affected sample balance, in table A2 we check sample balance for a number of time invariant household characteristics across quarters and months. We focus on household characteristics that are particularly relevant to our analysis as well as observable household characteristics that should be time invariant in that they should not be subject to seasonality or recall bias. The first column reports the variable's mean and it's standard error. The second and third columns report the p-values of tests for joint significance for quarters (column 2) and months (column 3). F-tests are used for continuous variables or tests that require controlling for the season of reference. Chi-squared tests are reported for binary variables. EA characteristics such as distances to markets, urban centers, and roads are balanced across quarters and months. Indicators for easily observed time invariant household infrastructure are as well. Household responses to questions on the main agricultural season are also balanced though there does appear to be imbalance in responses regarding whether households engaged in planting during the past dry season. It is worth noting that responses to this question might be subject to recall bias. Plots planted in the dry season are typically very small, the median size being of 0.4 acres and because respondents are asked about the last completed dry season, some households should be answering with regards to planting that would have happened close to a year ago, but may be responding in regards to the contemporaneous dry season. The imbalance in reporting that the household operated a household enterprise in the past 12 months is more difficult to explain but could also reflect recall bias if there is seasonality in the operation of household enterprises.

[1] As household interviews within an EA can occur in multiple months we assign EAs to the month closest to the mean interview date of households within that EA.

Table A1: Distribution of Labor Surveys throughout the Year

Interview Period	Percent of EAs	Percent of Households	Weighted Percent of Households	Weighted Percent of Rural Households	Weighted Percent of Urban Households
Panel a: By quarter					
Mar-Jun 2010	25.00	25.04	26.95	27.75	22.59
Jul-Sep 2010	24.61	24.50	24.96	22.25	39.63
Oct-Dec 2010	26.43	26.46	26.31	27.32	20.89
Jan-Mar 2011	23.96	24.00	21.78	22.68	16.88
Panel b: By month					
Mar. 2010	6.77	6.82	7.79	8.10	6.10
Apr. 2010	5.21	5.10	4.99	4.70	6.56
May 2010	7.42	7.51	8.56	8.57	8.50
Jun. 2010	5.60	5.76	5.82	6.63	1.43
Jul. 2010	9.51	9.31	10.55	9.53	16.10
Aug. 2010	6.25	6.24	6.31	5.35	11.52
Sep. 2010	8.85	8.85	8.00	7.26	12.01
Oct. 2010	10.16	10.02	9.95	10.35	7.74
Nov. 2010	11.07	11.26	10.74	11.38	7.23
Dec. 2010	5.21	5.23	5.65	5.65	5.64
Jan. 2011	10.03	9.95	9.16	9.47	7.50
Feb. 2011	9.51	9.51	8.73	9.17	6.32
Mar. 2011	4.43	4.44	3.75	3.82	3.34

Note: The first column displays for each time period of the survey year the percent of the 768 enumeration areas whose mean labor supply reference week for households within it falls within that time period. The second column displays for each time period of the survey year the percent of the 12,266 interviewed households that are interviewed about their labor supply for a week in that time period. The third column repeats this with surveys weights and columns four and five do so for the rural and urban sub-samples. Panel a shows the distribution over survey quarters while panel b shows the distribution over survey months. March 2010 is included in the first survey quarter.

Table A2: Balance of Survey Timing

	Mean	Quarters	Months
Panel a: Enumeration areas			
Distance to urban area	116.75	[0.90]	[0.74]
	(4.03)		
Distance to daily market	19.11	[0.21]	[0.53]
	(2.40)		
Distance to paved road	17.53	[0.36]	[0.34]
	(0.89)		
Panel b: Households			
Area planted in the past rainy season*	1.98	[0.75]	[0.47]
	(0.47)		
Household reports planting in the past dry season*	0.11	[0.01]	[0.10]
	(0.01)		
Household grew tobacco in past rainy season*	0.11	[0.38]	[0.59]
	(0.01)		
Household reports operating an enterprise in the past 12 months (urban)	0.35	<0.73>	<0.15>
	(0.02)		
Household reports operating an enterprise in the past 12 months (rural)	0.17	<0.36>	<0.03>
	(0.01)		
Reported value of home (urban)	1202973	[0.46]	[0.60]
	(385005)		
Reported value of home (rural)	65471	[0.55]	[0.48]
	(4082)		
Household has electricity	0.07	<0.34>	<0.70>
	(0.01)		
Household has its own toilet	0.33	<0.38>	<0.78>
	(0.01)		
Household owns a stock corral	0.12	<0.52>	<0.59>
	(0.00)		
Household owns a chicken house	0.10	<0.21>	<0.03>
	(0.01)		

Note: Sample consists of all enumeration areas in panel a and, unless specified, all households in panel b. Standard errors of the mean are reported in parenthesis. Values in square brackets report the p-values of the F-statistic of a test for the joint significance of the survey weighted regression coefficients for survey quarters in column 2 and months in column 3. Rows indicated with a * include controls for the season of reference. When the dependent variable is an indicator and no controls are required, the values in triangular brackets report the p-values of the survey weighted chi-squared test.

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	2.00	1.50	1.00
Total household labor hours in past week	Mean	59.19	41.00	31.73
	Median	50.00	30.00	21.00
Labor hours in past week in peak season (Dec-Jan)	Mean	72.20	58.91	45.57
	Median	63.00	51.00	36.00
Household size	Mean	4.77	4.71	4.43
	Median	5.00	5.00	4.00
Household working-age individuals not in school	Mean	2.02	1.90	1.79
	Median	2.00	2.00	2.00
Observations		9,798.00	10,096.00	9,470.00

Note: Sample consists of all households reporting at least one cultivated plot. For consistency across years, as GPS measures are not available for 2004, we use self-reported areas in all three years. 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.

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

	Contrast	Obs	Total hrs/yr	High season mean hrs/wk	Low season mean hrs/wk	Standard deviation	Coeff. of variation (%)
Panel a: By households							
Rural vs. urban, 2010	2010 Rural	10,037.00	2,065.00	56.93	29.23	9.58	24.26
	2010 Urban	2,229.00	2,863.00	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	9,840.00	3,088.00	70.98	48.41	8.75	14.82
	2004 Urban	1,440.00	3,266.00	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	10,175.00	1,488.00	37.12	26.00	7.97	25.67
	2016 Urban	2,272.00	2,277.00	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	30,052.00	1,858.00	49.37	27.06	8.33	23.45
	Pooled Urban	5,941.00	2,651.00	58.70	49.30	4.15	8.18
	Pooled Rural/urban		0.70***	0.84**	0.55***	2.01	2.87
Panel b: By individuals							
Rural vs. urban, 2010	2010 Rural	18,618.00	913.00	24.61	12.61	4.08	23.39
	2010 Urban	4,563.00	1,299.00	28.05	23.98	2.52	10.13
	2010 Rural/urban		0.70***	0.88**	0.53***	1.62	2.31
Rural vs. urban, 2004	2004 Rural	19,674.00	1,329.00	30.05	21.16	3.08	12.12
	2004 Urban	3,114.00	1,502.00	29.36	28.68	2.27	7.93
	2004 Rural/urban		0.88***	1.02	0.74***	1.36	1.53
Rural vs. urban, 2016	2016 Rural	18,039.00	706.00	17.22	12.10	3.83	25.99
	2016 Urban	4,424.00	1,070.00	25.57	22.04	5.12	22.89
	2016 Rural/urban		0.66***	0.67***	0.55***	0.75	1.14
Rural vs. urban, 04-10-16	Pooled rural	56,331.00	840.00	21.82	11.86	3.63	22.62
	Pooled urban	12,101.00	1,219.00	27.97	23.58	2.57	11.05
	Pooled rural/urban		0.69***	0.78***	0.50***	1.41	2.05

Note:Note: ‘High season’ is December and January, ‘low season’ is July and August. In panel b sample consists of working age individuals who are not in school. 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 *** $p<0.01$.

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

	Contrast	Obs	Mean % active	High sea. % active	Low sea. % active	Standard deviation	Coeff. of variation (%)
Panel a: By households							
Rural vs. urban, 2010	2010 Rural	10,037.00	46.00	0.97	0.78	0.06	7.31
	2010 Urban	2,229.00	48.00	0.93	0.87	0.04	3.88
	2010 Rural/urban		0.96***	1.04	0.90***	1.50	1.88
Rural vs. urban, 2004	2004 Rural	9,840.00	50.00	0.99	0.92	0.03	2.66
	2004 Urban	1,440.00	49.00	0.96	0.92	0.04	3.82
	2004 Rural/urban		1.02***	1.03	1.00	0.75	0.70
Rural vs. urban, 2016	2016 Rural	10,175.00	39.00	0.87	0.78	0.07	8.24
	2016 Urban	2,272.00	42.00	0.93	0.86	0.08	8.62
	2016 Rural/urban		0.93	0.94	0.91	0.88	0.96
Rural vs. urban, 04-10-16	Pooled Rural	30,052.00	45.00	0.93	0.76	0.06	7.19
	Pooled Urban	5,941.00	47.00	0.94	0.87	0.03	3.05
	Pooled Rural/urban		0.96***	0.99	0.87***	2.00	2.36
Panel b: By individuals							
Rural vs. urban, 2010	2010 Rural	18,618.00	0.79	0.93	0.65	0.10	12.56
	2010 Urban	4,563.00	0.65	0.67	0.63	0.05	7.98
	2010 Rural/urban		1.22***	1.39***	1.03	2.00	1.57
Rural vs. urban, 2004	2004 Rural	19,674.00	0.88	0.95	0.79	0.05	6.09
	2004 Urban	3,114.00	0.67	0.72	0.62	0.05	7.48
	2004 Rural/urban		1.31***	1.32***	1.27***	1.00	0.81
Rural vs. urban, 2016	2016 Rural	18,039.00	0.70	0.78	0.65	0.10	14.20
	2016 Urban	4,424.00	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	56,331.00	0.75	0.87	0.63	0.09	12.09
	Pooled urban	12,101.00	0.64	0.67	0.65	0.04	5.96
	Pooled rural/urban		1.17***	1.30***	0.97	2.25	2.03

Note: 'Mean percent active' is the mean value over the year of the percentage of households (panel a) or individuals (panel b) that report positive working hours in any given month.'High season' is December and January, 'low season' is July and August. In panel b sample consists of working age individuals who are not in school. 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 ***$p<0.01$.

Table A6: Characteristics of plots that use only household labor

Variable	Household labor only plots mean	Outside labor plots mean	Difference
Area planted (acres)	1.28	1.36	.08
			(.17)
Chemical fertilizer per acre (kg.)	54.92	82.94	28.02***
			(4.84)
All labor inputs per acre (hrs.)	510.63	491.52	-19.11
			(19.2)
Household labor inputs per acre (hrs.)	510.63	386.65	-123.98***
			(17.74)
Outside labor inputs per acre (days)	0	13.5	13.5***
			(.78)
Tobacco plot indicator	.22	.22	-.01
			(.01)

Note: Outside labor days are assumed to be 8 hrs. long when summing all labor input hours. Standard errors are reported in parentheses.

Table A7: Cropping Patterns

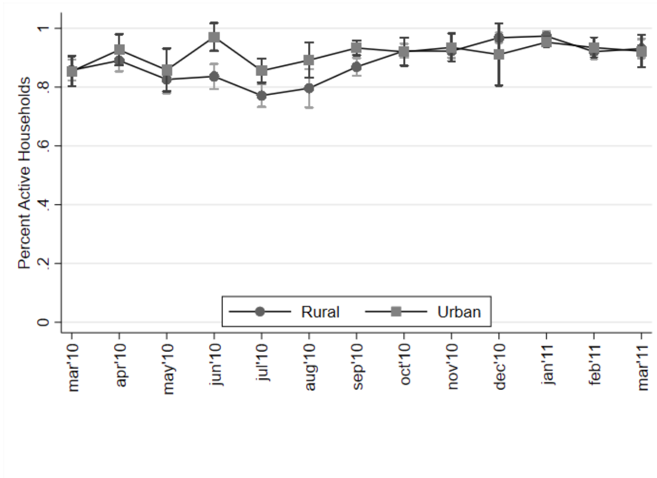
Mean acres	All	North	Central	South
Total	2.381	1.971	3.473	1.486
Maize	1.172	0.956	2.040	0.431
Maize-Beans	0.056	0.092	0.076	0.028
Maize-Pigeonpeas	0.135	0.001	0.006	0.290
Groundnuts	0.193	0.116	0.406	0.017
Tobacco	0.294	0.187	0.615	0.026
Other	0.180	0.271	0.150	0.183
Other-Maize	0.351	0.348	0.180	0.510
Observations	10,100.000	1,696.000	3,575.000	4,829.000

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.

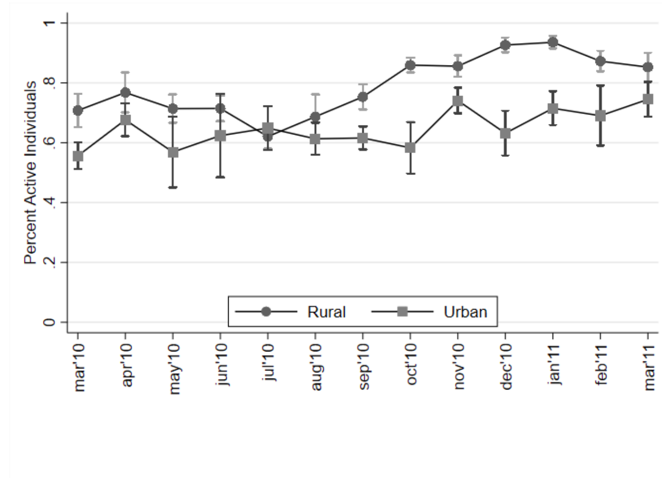
Table A8: Mean Labor Hours per Acre, by Crop

	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.



(a) Households



(b) Individuals

Figure A1. Percent of active households and individuals last week

Note: This figure reports the probability that any individual in the household (panel a) and any individual (panel b) reports engaging in a work in the past week by month of interview for urban and rural households. Coefficients are reported with 95% confidence intervals.

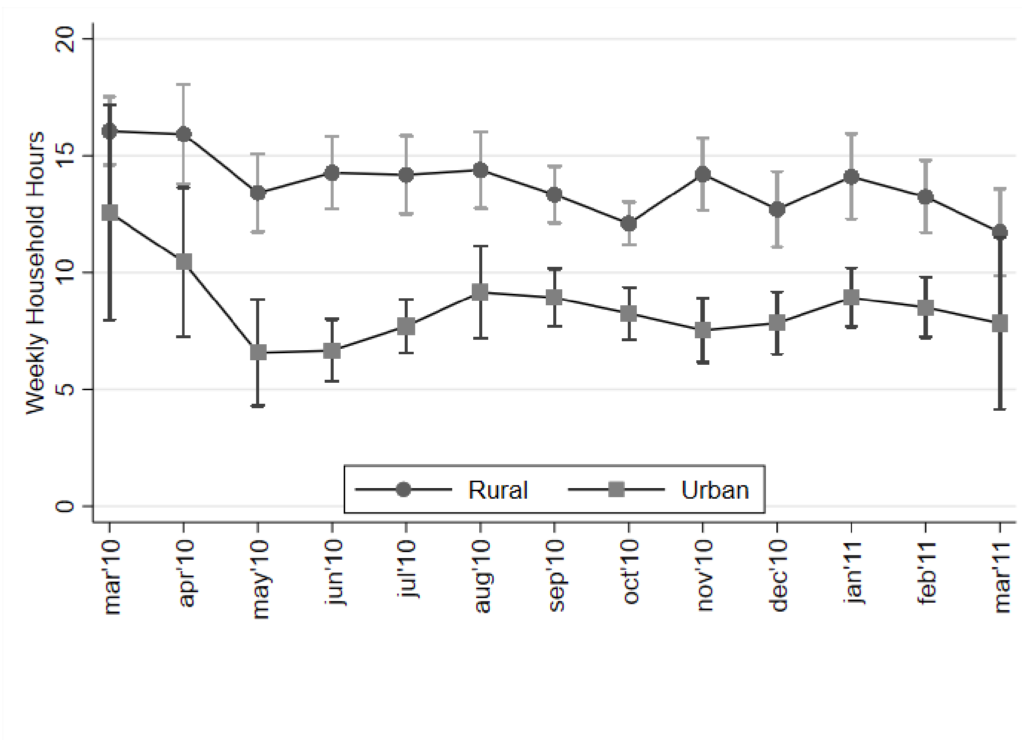
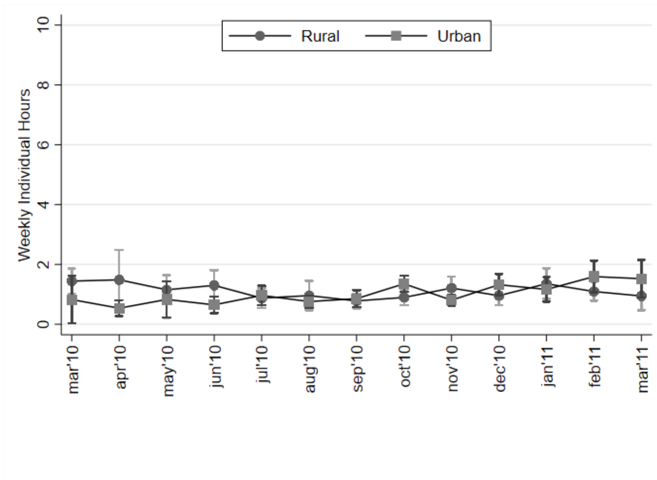
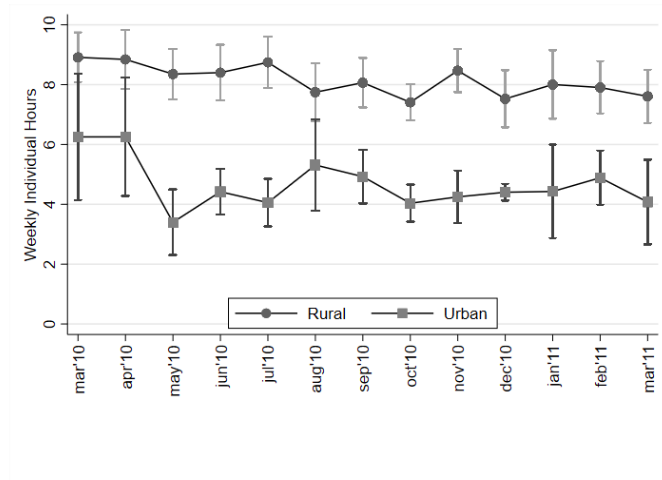


Figure A2. Weekly household hours on water and wood collection

Note: This figure reports the estimated total weekly hours spent by household members on water and wood collection by month of interview for urban and rural households. Coefficients are reported with 95% confidence intervals.



(a) Men



(b) Women

Figure A3. Weekly hours for working age-individuals on water and wood collection by gender

Note: This figure reports the estimated total weekly hours spent by working age individuals on water and wood collection by month of interview for urban and rural households for men in panel a and women in panel b. Coefficients are reported with 95% confidence intervals.

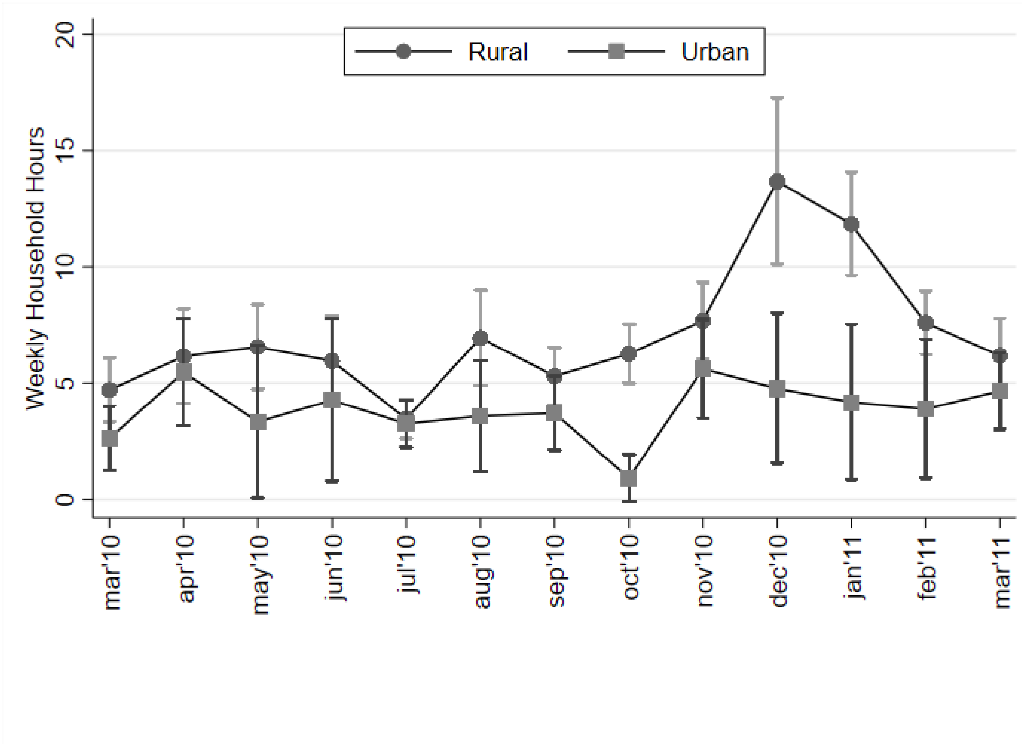
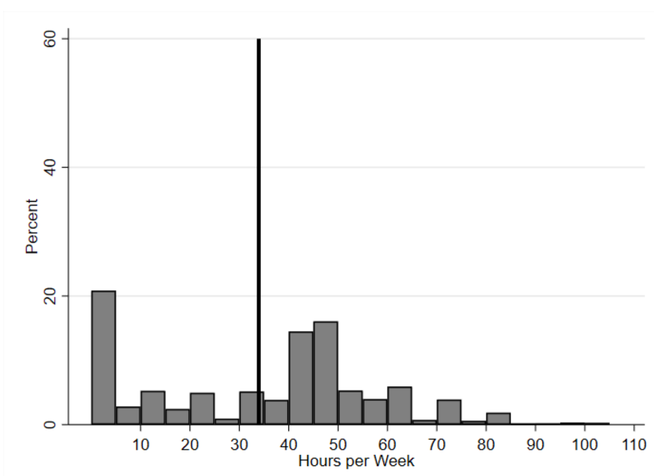
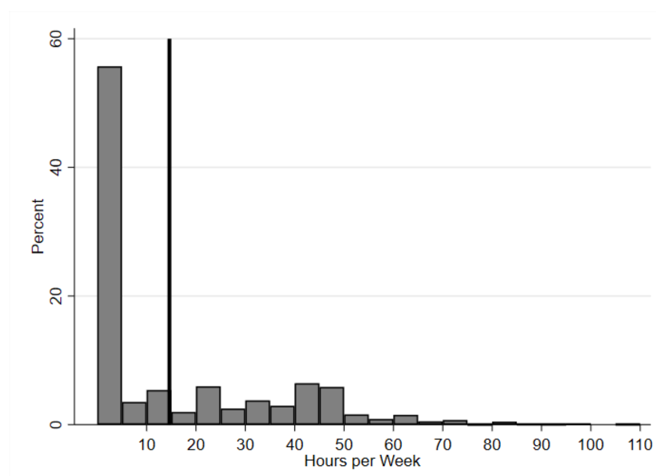


Figure A4. Household hours supplied by non-working age household members

Note: This figure reports the total household hours reported in the past week for non-working age individuals in the household by month of interview for urban and rural households. Coefficients are reported with 95% confidence intervals.

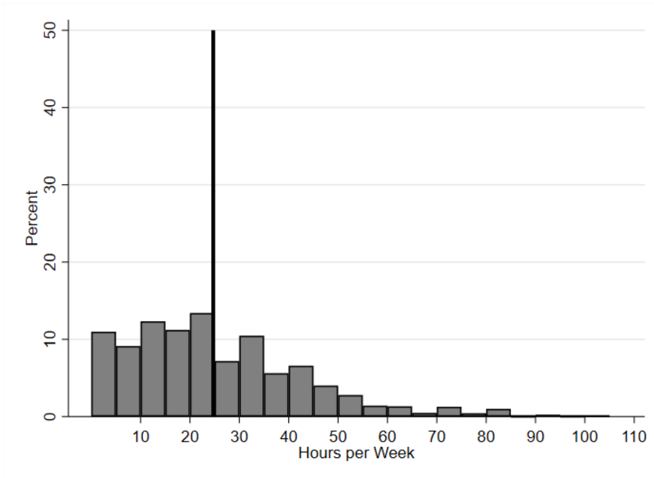


(a) Urban men

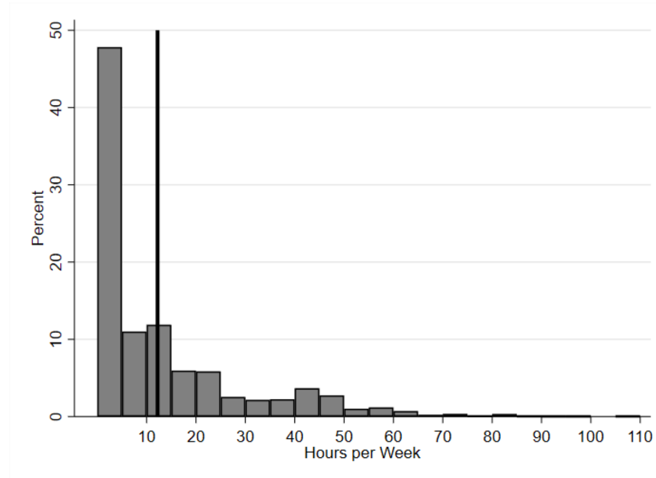


(b) Urban women

Figure A5. Distribution of weekly hours reported by urban individuals by gender

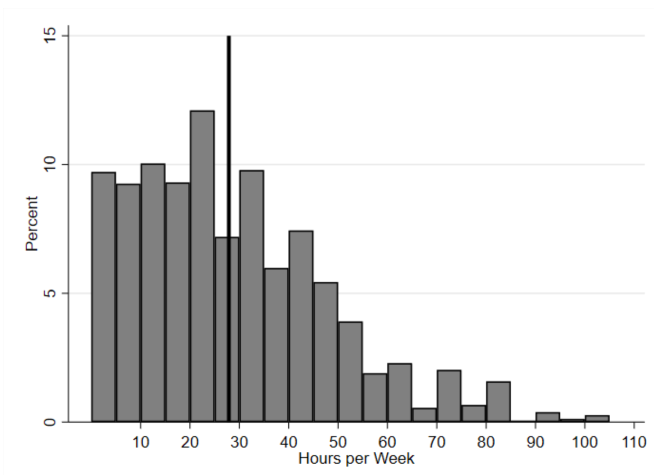


(a) High season (Dec-Jan)

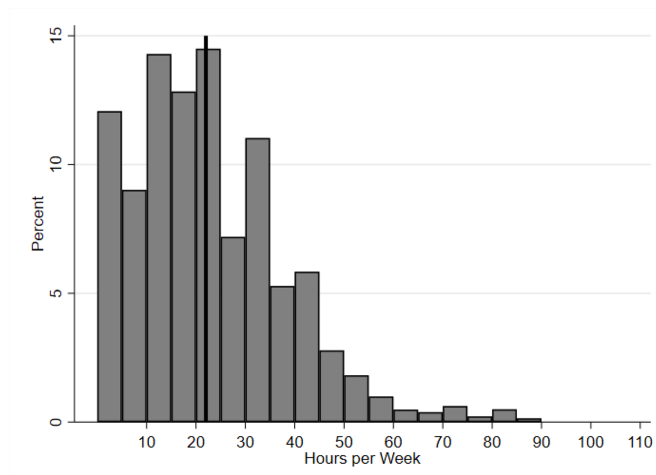


(b) Low season (Jul-Aug)

Figure A6. Distribution of weekly hours reported by rural individuals by season



(a) Rural men (Dec-Jan)



(b) Rural women (Dec-Jan)

Figure A7. Distribution of weekly hours reported by rural individuals in the high season by gender

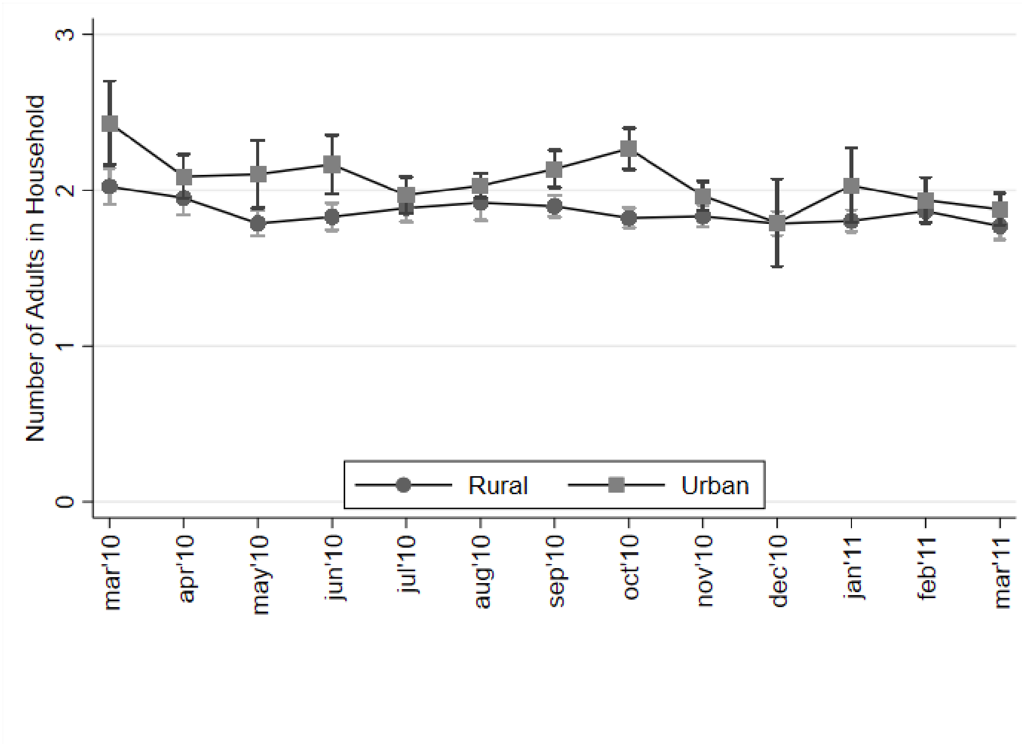


Figure A8. Working age adults

Note: This figure reports the number of adults reported by households as household members by month of interview for urban and rural households. Coefficients are reported with 95% confidence intervals.

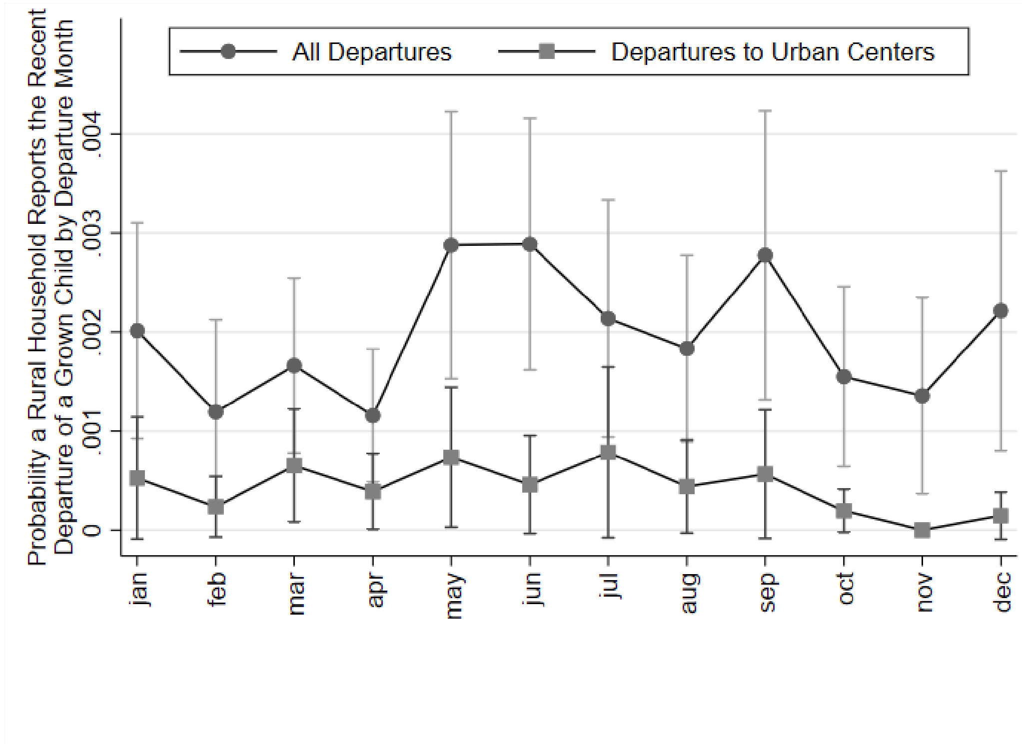
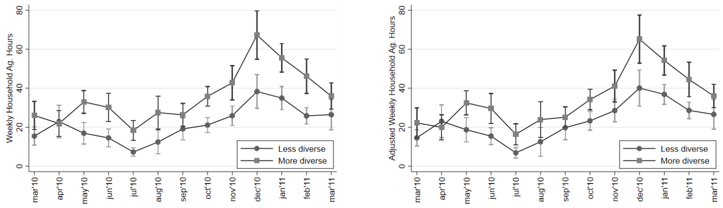
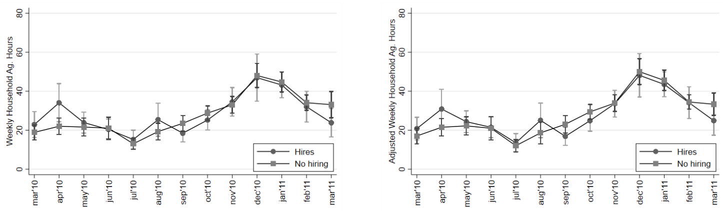


Figure A9. Probability rural households report the departure of an adult child by departure month

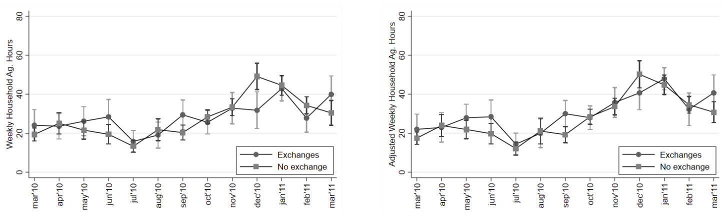
Note: This figure reports the probability a household reports the recent departure of a grown child by month of departure for all departures and departures to urban centers. Coefficients are reported with 95% confidence intervals.



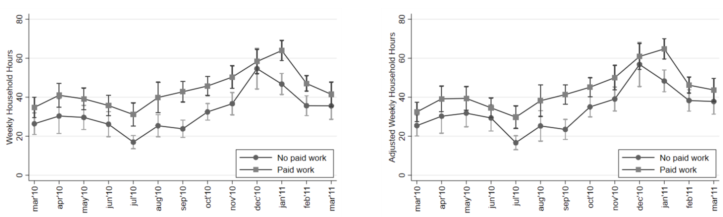
(a) **Household hours in agriculture by crop diversity (without and with controls)**



(b) **Household hours in agriculture by labor hiring (without and with controls)**



(c) **Household hours in agriculture by labor exchange (without and with controls)**



(d) **Total household hours by engagement in paid work (without and with controls)**

Figure A10. Labor supply by household activities

Note: Figures in the first column report the coefficients from equation 8 estimated without controlling for observed household characteristics. The figures in the second column add controls for the number of adults in the household, the total number of individuals in the household, the number of acres farmed by the household, the household's region whether the household is female headed and the number of years of education for the most educated adult in the household. The figures report the weekly hours in agriculture worked by the entire household by month of interview for households engaged or not in the following activities: diversified farming (panel a), use of hired labor (panel b),use of exchange labor (panel c). Panel d reports the total weekly hours in all market activities worked by the entire household by month of interview for households engaged in paid work (panel d). Coefficients are reported with 95% confidence intervals.