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 poverty. We find that (1) seasonality in rural labor calendars runs deep, accounting for 2/3 of total rural underemployment and occurring across most household activity choices, and (2) gaps in rural-urban welfare are principally associated with differences in time worked, in turn associated with large seasonality differentials in labor calendars, rather than with labor productivity differentials when people work. The implication is that reducing rural seasonality in labor calendars should be a major objective in seeking to reduce rural poverty. 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.

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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 poverty. We find that (1) seasonality in rural labor calendars runs deep, accounting for 2/3 of total rural underemployment and occurring across most household activity choices, and (2) gaps in rural-urban welfare are principally associated with differences in time worked, in turn associated with large seasonality differentials in labor calendars, rather than with labor productivity differentials when people work. The implication is that reducing rural seasonality in labor calendars should be a major objective in seeking to reduce rural poverty. 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 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 welfare. This paper uses detailed seasonal labor data from Malawi, one of the poorest countries in SSA, to address this issue. Specifically, the paper makes three contributions to the characterization and understanding of seasonality in labor calendars.

The first is to show that seasonality is both deep and highly entrenched. 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 accounts for 1/3. We 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 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 second contribution is to show that rural poverty (low household per capita consumption) is principally associated with lack of work opportunities, and hence with the depth of seasonality in labor calendars, 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 poverty is defined at the household level, and households typically have diversified sources of income that cut across sectors. To understand how labor calendars contribute to poverty, 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 is what 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. With poverty defined not by sector but by area of residence, we assess the differential in per household consumption achievements by rural-urban residence when these are 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 excess rural poverty 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, making rural-urban labor movements an unlikely solution to rural poverty. 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 a main source of differentially high poverty in rural areas.

The third 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 this measurement of monthly labor time can be done using either the household time use survey or the agricultural questionnaire to estimate labor demand by crop per acre for each day of the agricultural season, with similar results.

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 domestic chores and the production of home services such as fetching water and firewood collection. 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. We opted for a narrower definition of total work that solely

[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))

includes income generating activities (productive activities in agriculture and the RNFE), more in line with the focus of our paper on the poverty consequences of underemployment. This choice does not negate the long hours that households have to spend on these other activities, with their strong gender imbalance, nor the time and cost that workers may have to spend getting to their place of employment. In that sense, our measure of underemployment is strictly a measure of lack of opportunities for income generating activities, not of leisure.

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. The comprehensive analysis of which activities in agriculture and rural areas are associated 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 rural poverty in 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 welfare between urban and rural households is driven by underemployment rather than productivity differences, 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 and draws policy implications.

Data

To investigate labor market seasonality, we principally use data from Malawi's Third Integrated Household Survey (IHS3) collected in 2010-11. This is a living standards measurement survey (LSMS) covering a cross section of more than twelve thousands households. The IHS3 sample was designed to provide nationally temporally representative estimates of consumption expenditures and poverty for Malawi.[2] The IHS3 uses a stratified two-stage sample design, first sampling enumeration areas (EA) in the 2008 Population and Housing Census stratified by rural/urban location and then sampling households from a list that was constructed for each sampled EA. A minimum of 24 EAs were sampled in each district. For practical reasons, a multiple of 12 EAs were sampled in each stratum in order to distribute the sample evenly across the 12 months as the survey was designed to be nationally representative for each quarter. Within each quarter, EA's were then randomly allocated to each month. The balance of survey timing is further discussed and evaluated in appendix table A1. The IHS3 is a very comprehensive household survey designed to monitor conditions in Malawian households. Survey weights are used in estimations throughout the paper.

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).[3] The questions ask each household member above the age of five to report the number

[2]Though LSMS surveys are available in other countries, certain attributes of the IHS3 in Malawi are essential for our analysis. First, the IHS3 was intentionally designed to be temporally representative as discussed in appendix section A1. Second, with a cross-section of 12,266 households, the Malawi IHS3 is exceptionally large. A large cross section is needed in order to have a sufficient number of observations conducted within each month of the survey. Finally, 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.

[3]We compare these results to results plotted in figure 6 which uses retrospective survey questions and find broadly consistent estimates of agricultural labor timing across the year.

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.[4] 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 23,324 individuals in 11,492 households as 774 households have no working-age adults. Of theses adults, 18,699 are rural and 4,625 are urban. Since interviews were spread throughout the year, we can observe the seasonality of activities and establish labor calendars for the whole population or subgroups of the population, at both an individual and a household level.

These two levels of analysis correspond to different ways of looking at labor use. Employment is normally measured at the individual level, leading to clear measures of unemployment (no hours worked) and underemployment (comparing hours worked to a full employment norm). However, the averaging of these hours worked does not necessarily measure the aggregate availability of work in any particular area in the given month. Fluctuations in labor demand may induce the young and elderly to provide supplemental labor in times of need which would not be reflected in the individual analysis. Additionally, it is unlikely that an entire household would leave an area for seasonal migration. On the other hand, individual working age members may temporarily leave or come back in response to seasonal income generating opportunities, though such seasonal migration is uncommon in our context.[5] At the extreme, a fully unemployed person migrating

[4] 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.

[5] There is little evidence of substantial seasonal migration in Malawi. Only 3.8% of rural working age adults report living away from home for more than a month in the past year.

during the low season would raise the average per individual employment while obviously it does not increase the household's in situ employment. For these reasons the average number of hours worked by households in a week of a given month should give a better measure of aggregate work availability during that month where the household resides.

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

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.[6] 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.[6] 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.[7]

Representing about 30% of the country's GDP, agriculture is central to livelihoods.[7] 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

[6] Human Development Report 2016, UNDP, www.hdr.undp.org, accessed 5th Feb. 2018.
[7] World Bank Country Data: Malawi, www.worldbank.org/en/country/malawi, accessed 5th Feb. 2018.

so rely primarily on bucket irrigation.

Farms are small, with a mean holding of 2.38 acres though it is slightly higher in the central region where it reaches 3.47 acres. Maize and intercropped maize account for the majority of farmed acreage, accounting for 72% of the area cultivated by the mean household.[8] Tobacco is an important cash crop, particularly in the central region, accounting for 51% of national export revenues in 2010.[9]

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 rural-urban migration either seasonally or permanently and that the unemployment rate of migrants is extremely 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.[10] This means that

[8]Table A3 in the appendix gives the average acreage planted per household by crop or intercropped combination for surveyed households for the country and each of the three regions. Categories were defined by first grouping varietals of the same crop (i.e., hybrid maize, local maize, etc.) and then looking for common crop combinations as multiple crops are commonly grown on the same plot.

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

[10]Table A5 shows the evolution of farm size over time. Because GPS measures are not available for 2004, to make the comparison over time we use self-reported areas in all three years. Furthermore, because there are far more outliers in the self-reported area (mainly due to what are likely miscoding of the unit of measurement m2 vs. acres), we winsorized the area at 5 pct.

land per adult decreased by 18% from 1.13 to 0.93 acres, a substantial drop.

Comparing rural and urban labor calendars

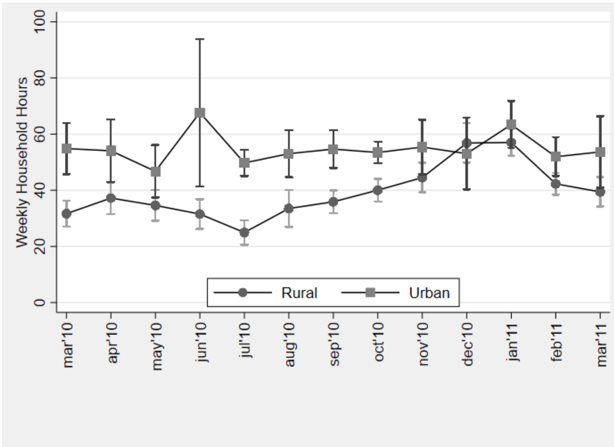
In this section, we construct the labor calendars for rural and urban households and proceed to compare their features. We discuss several important features in turn. First we show that there is much more seasonal variability in rural than in urban labor calendars. Second we show high underemployment in rural areas even at peak labor time. Third we see large unemployment in urban areas throughout the year. Fourth we find that employment is lower for rural households more dependent on agriculture. Finally, we find that labor times in the high season are similar in rural and urban areas.

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

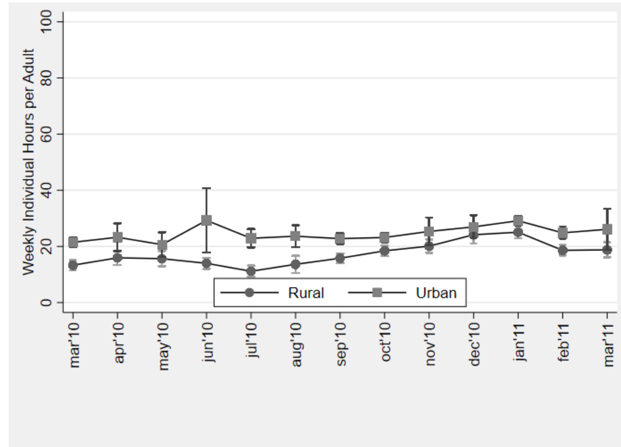
$$L_h = \sum_{m=1}^{13} \beta_{1m} Month_h + \sum_{m=1}^{13} \beta_{2m} Month_h * Rural_h + \epsilon_h, \tag{1}$$

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 productive 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. Figure1b presents individual level estimates for working age individuals and reveals a similar pattern.

Table 1 reports several summary statistics from 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



(a) By all household members



(b) Per working age adult

Figure 1. Total labor hours worked last week adding the individual graph

multiplied by the number of weeks in the month, and then summed across months[11], or

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

Observing the marked seasonal pattern of rural employment in figure 1, we define the high season as the months of December and January, during which planting takes place, and the low season as the months of July and August, where labor use is at its low point. Weekly hours in the high and low seasons are calculated by taking the mean of the corresponding $\widehat{\beta_m^{zone}}$ 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. Panel b of table 1 reports similar statistics for the binary variable of whether the household provides any labor hours, which we refer to household labor engagement. These statistics exhibit some striking patterns that we now analyze.

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

Notable in these urban-rural contrasts in labor calendars is that high season activity offers

[11]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.

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	909.00	24.61	12.39	4.14	23.85
	Urban	1,288.00	28.05	23.26	2.63	10.67
	Rural/urban	0.71***	0.88**	0.53***	1.57	2.24

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

	Contrast	Mean % active	High 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	0.64	0.10	13.08
	Urban	0.64	0.67	0.61	0.05	8.58
	Rural/urban	1.23***	1.39***	1.05	2.00	1.52

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

similar work opportunities for rural and urban households, both in terms of hours worked (both 57-58 hours as observable in column 2 and the percent of active households (column 2 shows a statistically insignificant difference in household labor engagement, with urban areas higher by only 4 percentage points).[12] There is however a large significant discrepancy in the rest of labor calendar months, with labor per week for rural households 57% of that for urban households and engagement 10 percentage points lower among rural households in the low season as noted in column 3. This higher variability of rural calendars is captured by comparing the coefficients of variation of work over the different months of the year. The coefficients of variation in hours worked is 136% higher for rural compared to urban households, as noted in the third row of column 5.

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

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

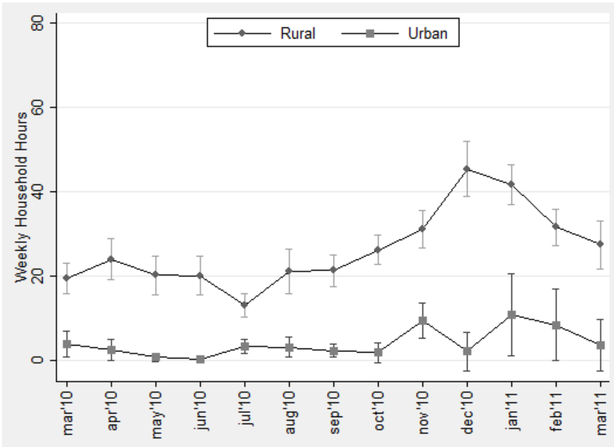
In this case, rural households have both a higher standard deviation in work across months of the year (70 and 50% for hours and participation, respectively) and, for hours worked, a lower mean value (by 28%). Both of these contribute to the very large difference in variability of labor calendars.[13]

Figure 2 disaggregates the labor hours reported in figure 1a by activity for both urban and rural households. 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 for both urban and rural households.[14] Though some urban households are engaged in

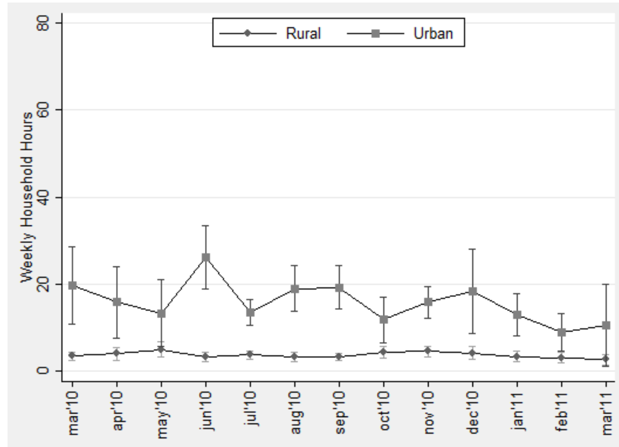
[12]Households are considered active if they report spending any time in labor activities. Figure A1 of the appendix displays the percent of active households by month of interview for rural and urban areas.

[13]We verify the results in table 1 obtained with the 2010 data for household labor supplied and for individuals participation in tables A6 and A7 using the 2004 and 2016 LSMS-ISA data. We see that results are broadly consistent to those of 2010. Rural household labor calendars for hours worked have a CV which is larger than their urban counterparts. The same applies to individual labor engagement, with exception of the 2004 result. Pooled data across the three surveys show a CV which is almost three times higher for rural household hours worked and double for individual labor participation compared to their urban counterparts.

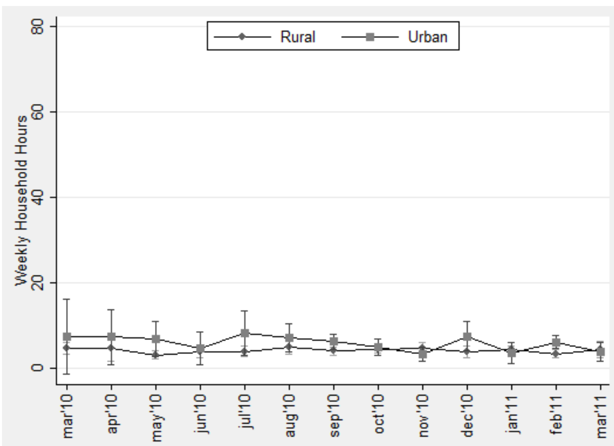
[14]Agricultural labor throughout this paper refers to agricultural work on the household's plots. It is worth noting that casual (ganyu) labor is also often agricultural work though as hired labor on someone else's plot.



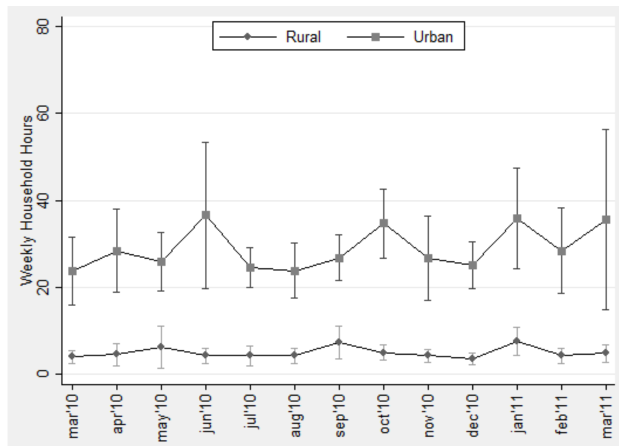
(a) Hours supplied to agriculture



(b) Hours supplied to household businesses



(c) Hours supplied to casual labor



(d) Hours supplied to wage labor

Figure 2. Household labor supplied last week by activity

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 countercyclical 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.

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

Looking now at effective unemployment, we turn to individual level observations. There is a dramatic seasonal contrast in the distribution of hours worked by rural adults in all activities. Close to 50% of surveyed rural adults report working no or a very low number of hours in the low season.[15] To obtain labor calendars at the individual level we estimate an equation similar to equation 8 at the individual level, and report corresponding statistics in table 1. We observe that rural employment decreases from 93% in high season to 64% in low season (panel b) and the average number of hours worked per week falls by half from 24.6 to 12.4 (panel a). However, even in the high season, underemployment prevails. With 24.6 hours per week, underemployment is 38% for a benchmark full-employment of 40 hours per week.

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

Referring to table 1 panel b, we see significant unemployment in urban areas too. The mean individual employment rate is 64%, and it remains low throughout the year. Hence although urban adults work more hours on average than rural adults, this high urban unemployment rate limits the opportunity for rural workers to use seasonal or permanent migration to fill in their unused time given the challenge of finding productive employment in the urban economy. Labor displacement to urban areas in this context is rarely accompanied by productive employment, with labor instead accumulating in urban slums with little effect on growth. This phenomenon was observed in the 2008 World Development Report (World Bank 2007) for many Sub-Saharan Africa countries where a decline in the share of the labor force employed in agriculture is not accompanied by a corresponding increase in GDP per capita. Malawi was one of them. 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 unemployment rate is especially high at 64%.[16] Given the difficulties to finding urban employment, migration is not widely used as an emergency or seasonal smoothing strategy by rural households.

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

[16] 557 are reported as employed and 972 as unemployed. The remaining are reported as either students, homemakers or handicapped.

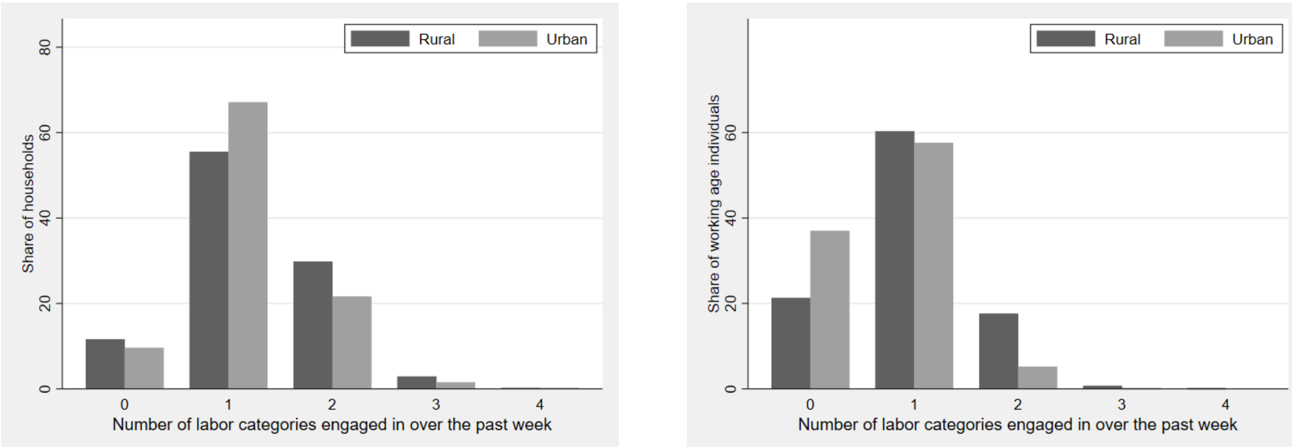
Of the 8484 households that report experiencing a negative shock in the past year, only 0.16 % report using migration as a coping strategy. Similarly, despite the pronounced agricultural seasons, there is little evidence of seasonal migration in this context. Only 3.8 % of rural working age adults lived away from their household for a month or more in the past year, for any reason. This value is similar to the 4.2 % reported by urban households. Figure A5 in the appendix plots the number of working age adults in the household by month which is quite stable across the year for rural households.[17] Figure A6 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.

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 illustrate 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 18.3 % 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 work 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 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 households that work less than 10 hours to those working more than 30 hours. The

[17] 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.



(a) By households **(b) By individuals**

Figure 3. Household and individual engagement in multiple labor activities

main activity that makes a difference for those working full time is engagement in the wage labor market. 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.

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

Urban-rural labor time equilibrates in the high season.

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

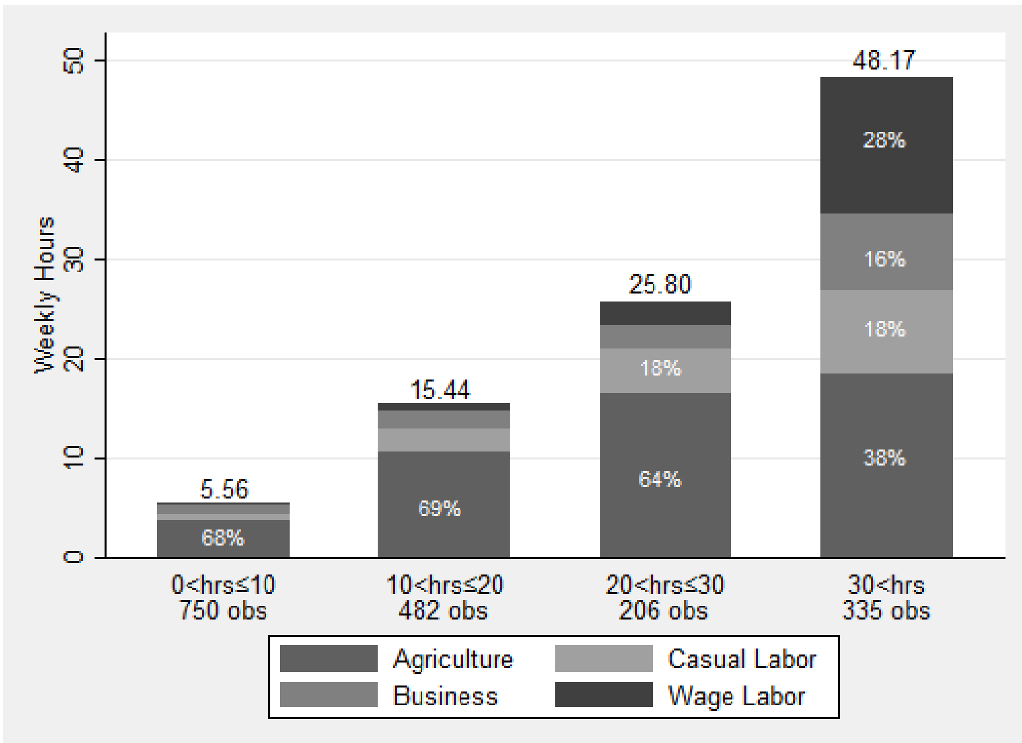


Figure 4. Allocation of time across activities in rural areas during the low season

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

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

In this section, we look at the role of seasonality on rural vs. urban welfare by considering how much of the rural-urban consumption gap is due to differences in average hourly productivity and how much to differences in underemployment. Average hourly productivity is here proxied by consumption per hour worked by the household based on the idea that consumption is a relatively smoothed 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.[18] The first row of table 2 compares means and medians of urban and rural household consumption levels C_h, showing a low rural/urban ratio of 0.42 for means and 0.54 for medians. Rural households are indeed much less well-off than their urban counterparts. This consumption gap could be attributable to lower productivity when working 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, $\widehat{LL}$, as calculated in equation 2. For this we calculate $\bar{C}_h/\widehat{LL}$ for rural and urban households, where $\bar{C}_h$ represents the mean or median of household consumption. Results are reported in row 2 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.

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

[18] 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))

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 household hour worked	Mean	95.00	163.00	0.58
	Median	74.00	99.00	0.75

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.

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 intricately linked to the inability of households in rural areas to make productive use of their labor, their main asset, for much of the year.

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 as an additional element of the first contribution of this paper on the depth of seasonality in rural labor calendars. 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. If we define full employment as 48 weeks per year (to allow for unexpected shocks such as illness and political disruptions) and 40 hours per week (to allow time for household maintenance and reproduction), annual hours reported in table 1, panel a, show urban individuals to be at 67.1% (1288 hours) of the 1920-hours work potential and rural individuals at 47.3% (909 hours). Looking at the high season, urban workers work 28.1 hours per week and rural workers 24.6. Urban workers are thus still only at 70.2% of a 40 hour week, and rural workers at 61.5%. Hence, a deficit in work opportunities applies to both urban and rural workers, and exists throughout the year. It is this large and pervasive urban work deficit that limits the possibility of using rural-urban migration as a major instrument for poverty reduction (Evidence Action 2014). Solving the deficit in work opportunities, basically through labor-intensive aggregate economic growth, remains the key issue for large scale poverty reduction in Malawi.

Given this large deficit, what is the importance of seasonality in rural households labor calendars in their opportunities to work? Since full employment as defined above is completely out of reach, we propose to consider the current high-season urban workload as the benchmark employment for rural adults throughout the year. Using the numbers reported in column 2 of table 1, we see that the high-season urban workload is 28.05 hours a week per adult, which amounts to a benchmark of 1459 annual hours for the year. We then define the peak deficit as the annualized difference between the high season work load in rural areas and this potential maximum. Since the high-season rural work load is 24.61 hours a week, the peak deficit accounts for 3.44 hours a week, for an annual deficit of 179 hours. In other words, this is the 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 seasonal deficit is then 67% of the total deficit. Beyond addressing the high-season deficit for urban and rural workers, the seasonality of rural labor calendars is indeed a big issue. Finding ways of smoothing rural labor calendars through agricultural and rural transformations is thus a key policy problem in addressing rural poverty. This is what we explore in the following two sections.

Agricultural and rural activities associated with smoother labor calendars

We now explore the reasons behind the seasonality in labor demand that rural household 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 eventually counter-cyclical and associated with smoother labor calendars.

Constructing agricultural labor calendars

The third contribution of this paper is methodological concerning data needs to construct the agricultural dimension of labor calendars. These crop calendars allow us to better understand the extreme 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. 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.[19] [20]

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

[19] For the construction of these graphs, we drop households for whom the reference season in the agricultural module was 2008/2009 season.

[20] Maize and intercropped maize is the main crop grown in Malawi followed by tobacco and groundnuts. Table A3 in the appendix gives the average acreage planted per household for the main crops.

in the agricultural modules of farm surveys. This approach could thus easily be applied to other 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 household plot calendars are constructed using two key pieces of information reported in the agricultural questionnaire for the plot: the timing of planting and harvest activities as well as the amount of household labor that was applied to the plot.

Respondents are asked about the timing of planting and harvesting. Using this information, for each plot j we estimate the duration in weeks D_j^p, beginning date p_j^b, and end date p_j^e of planting activities on the plot [21] as well as the duration in weeks D_j^h, beginning date h_j^b, and end date h_j^e of harvest activities[22] and 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.[23]

For each of these three activities (planting, growing and harvesting), respondents are also asked about household labor,[24] reporting the number of weeks, the days per week and the hours per day each household member was engaged on the plot. We can thus calculate L_j^a, the total amount of

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

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

[23]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.

[24]In order to build a representative calendar of labor demand by crop we use the 69.4% of plots that rely solely on household labor. We exclude households that engage in hiring and exchanging labor as non-household labor is not disaggregated by task and is measured in days rather than hours, making comparisons to household labor difficult. We verified that while these households typically farm fewer acres, their crop composition is broadly comparable to that of households hiring and exchanging labor. Estimates of the timing of farming activities and the labor hours required for each task and crop using this subset consisting of 10,253 plots farmed by 6,260 households should thus be generalizable to the full sample.

household labor hours applied by n household members to the plot j for activity a, adjusted for plot size, as

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

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

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

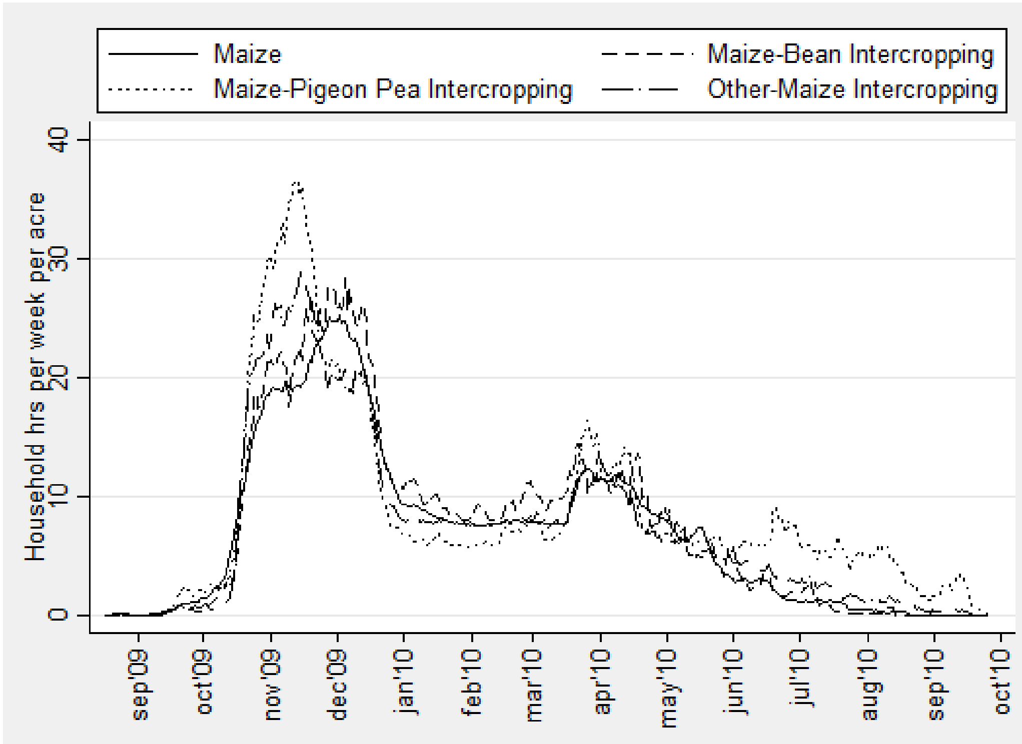
For each plot we can then assign l_j^a, to each day of the calendar year in which the household is engaged in activity a. This defines ℓ_{dj}, the acreage adjusted weekly labor hour demanded for the week of day d on plot j, such that

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

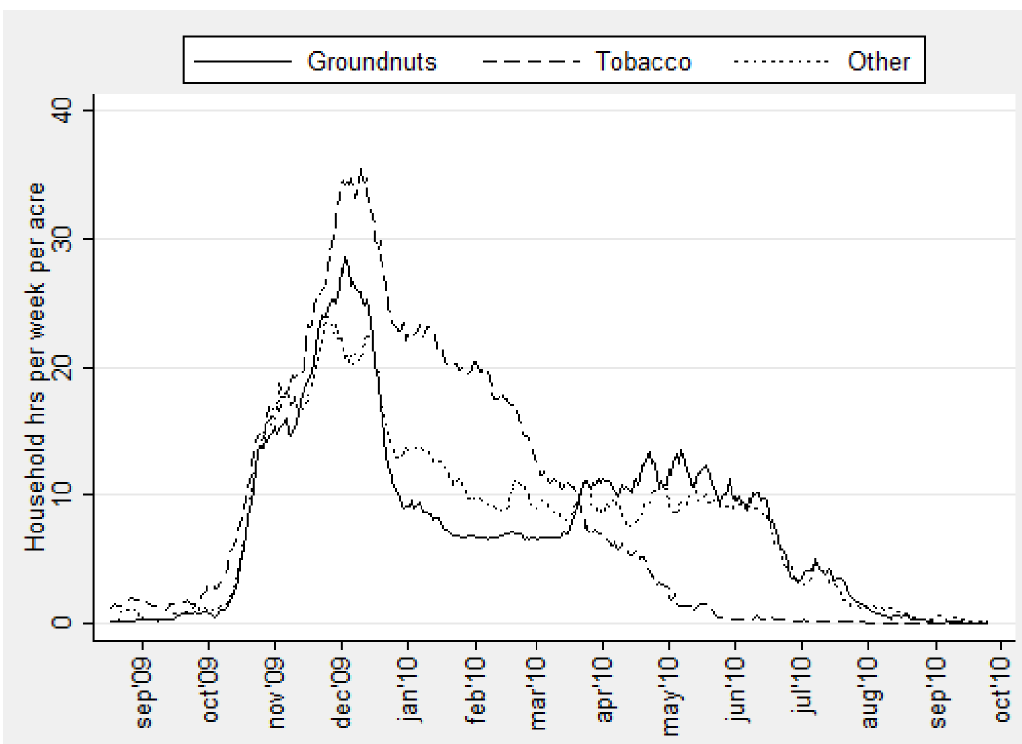
We then calculate the average number of hours $\bar{\ell}_d$ for each day of the agricultural season to generate a representative calendar for a one acre plot of that crop. Estimated labor calendars are plotted in figures 5a and 5b for the most common crops and intercropped combinations.[25]

We see that the November-December planting period is the peak of labor demand. Maize

[25] 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.



(a) Maize and intercropped maize



(b) Non-maize

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

and intercropped maize account for over 70% of the acreage of the typical household farm,[26] thus the timing of maize planting and harvest as illustrated in figure 5a governs the fluctuation in the labor demand calendar of the typical households. The other commonly grown crops, tobacco and groundnuts, also compete for labor hours during the same high demand planting season. Labor demand at harvest time is much lower and exhibits more dispersion between different crops. Peak harvesting for maize happens in April. Plots that are intercropped with pigeon-peas continue to require labor inputs until the late pigeon-peas harvest in July and August. As seen in figure 5b groundnut harvesting is more labor intensive than the maize harvest but still does not require a substantial labor input as compared to planting activities.[27] 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.[28] 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.

For each household h, [29] we can then re-weight the plot level labor calendar ℓ_{dj} by the acres of plot j and sum across the household's J plots to generate $\mathcal{L}_{dh}$, the weekly agricultural labor hours demanded for household h in the week of day d. Thus for each day, we calculate

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

From these daily household labor calendars, we then calculate the average number of hours across households, $\bar{\mathcal{L}}_d$, for each day of the agricultural season to generate a representative calendar for household agricultural labor demand, plotted in figure 6.

The agricultural labor demand calendar generated with this procedure covers the 2009/2010

[26] See appendix A3.

[27] See appendix table A4 for total labor demand estimates for each activity by crop.

[28] See appendix table A4.

[29] 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.

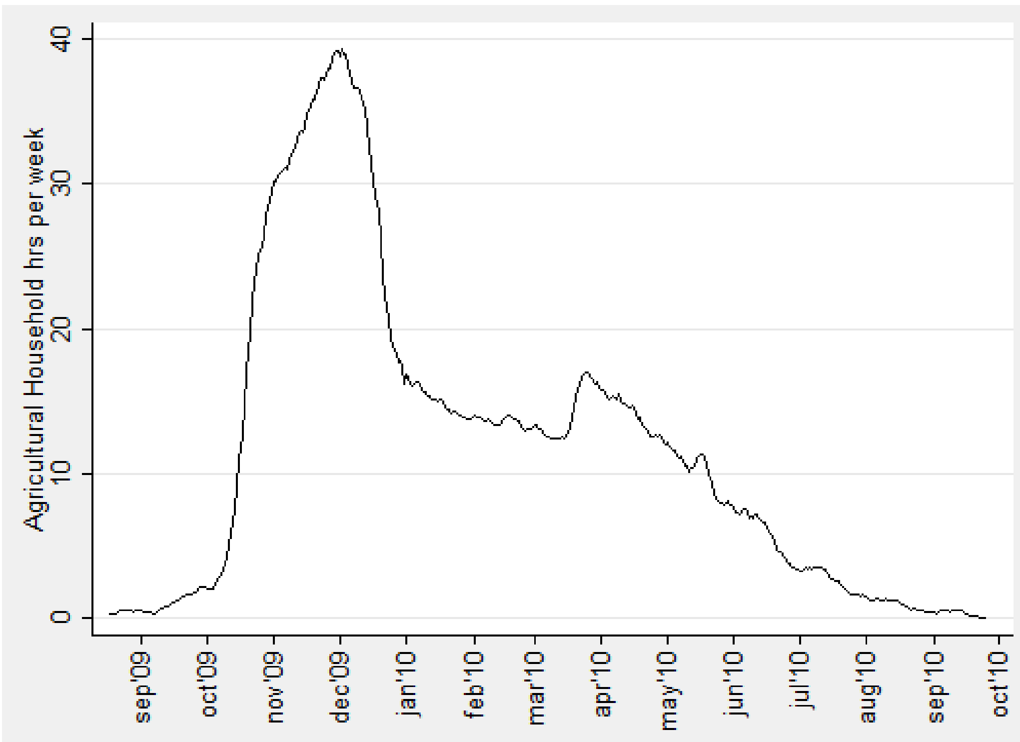


Figure 6. Estimated household agricultural labor demand per week for farming households using the retrospective agricultural questionnaire

agricultural season (rather than the 2010/2011 survey season) and relies on retrospective recalls of significant agricultural dates and labor requirements. Nonetheless, this calendar is consistent with the labor hours in agriculture reported in figure 2a.[30] Figure 6 shows a sharply concentrated labor calendar, particularly at planting time. These concentrated labor demands in agriculture are at the origin of the high seasonality in rural households' labor calendars. 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.

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.[31] While we are able to control for a 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

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

[31] 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.

manner, which agricultural and rural activities are associated with smoother rural labor calendars.[32]

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 reports total annual hours worked, high and low season weekly hours worked, and SD and CV of hours worked across months of the year for households that do and do not participate in these activities. Panel 3a focuses on smoothing of the agricultural work calendar, and uses the sample consisting of the 9,389 rural households (93.5% of all rural households) that are directly engaged in agriculture by cultivating a plot of land and/or owning livestock. We use this grid of indicators to assess the contributions of livestock, tobacco, crop diversity, farm area, irrigation, and use of non-family labor to smoothing the agricultural labor calendar. In Panel 3b, we look at activities that are beyond agricultural on-farm work: engagement in paid work and employment in non-farm enterprises, using the full sample of all rural households.

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 working hours for households that own livestock compared to those that do not. We see that households that raise livestock have higher household work hours throughout the year, with no seasonal effect, except possibly during the harvesting period. This

[32] 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.

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 supply of cultivating 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**	1.23**	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	0.87	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***	2.10***	1.49	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	0.96	1.25*	0.92	0.92
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		1.07 *	0.93	1.00	0.81	0.76
Panel 3b: Non-Farm labor supply of 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***	1.63***	0.94	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***	1.39***	1.20	0.94

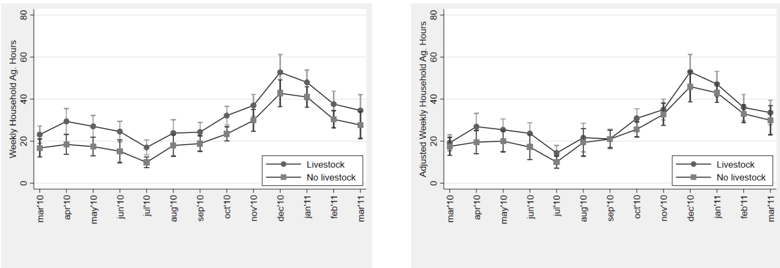
Note: Sample in panel a consists of rural households that report cultivating a plot or owning livestock. Sample in panel b consists of all rural households. Household crops are considered more diversified if they report planting three or more crops and less if they report planting a single crop. Household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

is reflected in a 33% higher total hours worked (16% with controls) and almost no difference in SD (table 3). By adding to 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 in Bangladesh to smooth their labor supply over the year.

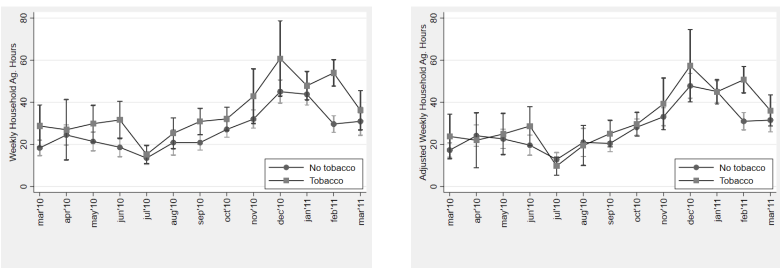
Tobacco. Most of the tobacco in Malawi is cultivated by smallholder farmers (Lea and Hanmer 2009). As observed by Orr (2000) and by Xia and Deininger (2019), tobacco is highly labor intensive, especially at harvest time. Comparing hours worked in households that grow tobacco compared to those that do not shows that tobacco is associated with household 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 harvest season of tobacco 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 diversification. Here we compare households with three or more crops to households planting only one crop. In general one expects crop diversity to smooth the agricultural calendar. Yet here, as with the case of tobacco, the seasonal patterns of rain implies that planting of all crops happens at the same time, and hence multiple crops correlates with substantially more work but no relief from seasonality of labor demand.

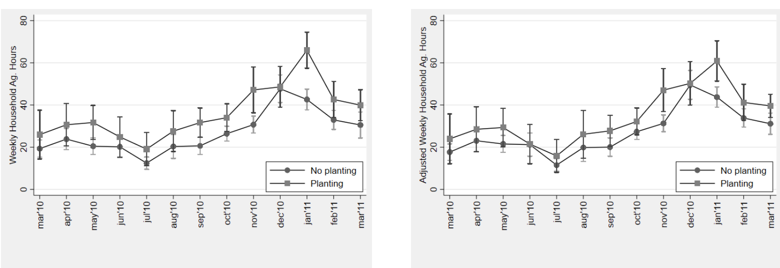
Irrigation and dry season cultivation. We compare household labor hours for households that report planting a plot in the previous year's dry season. This is generally done with bucket irrigation. The choice to irrigate is correlated with higher labor demand not only in the dry period, but also during the wet season, suggesting that it is associated with a more intensive use of land and a shift in the



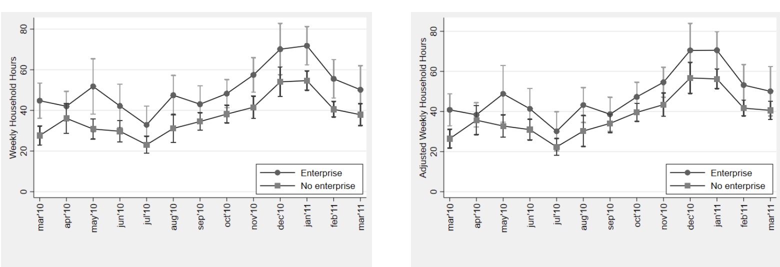
(a) **Household hours in agriculture by ownership of livestock (without and with controls)**



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



(c) **Total household hours by dry season planting (without and with controls)**



(d) **Total household hours by presence of household enterprise (without and with controls)**

Figure 7. Labor supply by household activities

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 would be consistent with the correlation we observe here.

Use of hired labor. The last two comparisons look at the use of non-family labor in periods of high labor demand. Only 25% of the households ever hire labor. Among those that do hire labor, they hire on average 16 days of labor per year, although the distribution has a long tail with 1% of the households hiring more than 60 days. These numbers are small relative to annual work, although they are certainly critical at particular times of the year. We see very little difference in family labor between households that hire and those that do not hire labor.

Use of exchange labor. The contrast between the roles of exchange labor and hired labor is interesting. Labor exchange is a within season arrangement between households. Typically, instead of having a short very intense few days of work on your own field, you get neighbors to come and help you and then go on to help them. This helps spread each household's work over a longer period of time if there is some heterogeneity in the exact timing of the operation, or if the operation is for technical reason difficult to spread over more days. The CV of monthly hours worked in agriculture is 34% lower for household that use labor exchange (24% with controls) and is mainly due to spreading labor rather than adding any labor.

Work as Paid Labor. Participation in the labor market is associated with a large 37% increase in annual hours worked (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.

Household Enterprises. Figure 7d compares reported hours worked by rural households that run a household enterprise to those that do not. Most of the households that run an enterprise are engaged in retail or trade selling consumer products or services. With the exception of some basket weaving, brick making, mat weaving, and tailors there is very little manufacturing of non-perishable goods. Household enterprises increase work hours throughout the year by an average 36% (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).

In conclusion, raising livestock and to a lesser extent using irrigation that allows intensification of agriculture or more crop diversification is correlated with a lower variability in hours worked across months, and this is mostly due to higher labor use throughout the year. 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

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 not different from 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 individual consumption in rural areas is labor calendars that offer much lower off-peak work opportunities to rural households, 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, rural-urban labor migration–the typical urban-based structural transformation–would not offer a solution to reducing differentially high rural poverty. For that reason, we explore which of the diverse activities in agriculture and income opportunities in the labor market and the rural non-farm economy are associated with smoother labor calendars.

Smoother labor calendars are associated with a variety of instruments including 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 instruments to fill in labor calendars. Instead, a comprehensive agenda focusing on all available instruments, 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 effective policy option for growth and poverty reduction.

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Appendix

A1 Balance of survey timing

The IHS3 sample was designed to provide nationally-representative estimates of consumption expenditures and poverty for each quarter. Subsamples of EA's for each quarter of the IHS3 data collection were selected from the full sample systematically with equal probability. Within each quarter, EA's were randomly allocated to each month such that households reporting consumption information throughout the year were evenly spread.[1] Though designed to be temporally representative at the quarter level, funding and fuel shortage related disruptions midway through the

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

fieldwork led to a degree of imbalance in the number of households covered. To evaluate how this might affect balance in the sample, in table A1 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 columns report the f-statistic for a joint significance test for quarters (column 1) and months (column 2), with the p-value of the f-test reported in parenthesis. 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 are answering with regards to planting that would have happened close to a year ago. The imbalance in reporting that the household operated a household enterprise in the past month is more difficult to explain. To check how these imbalances may affect our analysis of seasonality, we estimate the following,

$$L_i = \sum_{n=2}^{13} \alpha_{1n} Month_i + \alpha_2 Cov_i + \sum_{m=2}^{13} \alpha_{3m} Month_i * Cov_i + \epsilon_i. \tag{1}$$

Results are reported in table A2. An additional control for the dry season of reference is included for when looking at dry season planting. A joint significance these on the α_{3m} interaction coefficients cannot reject that they are jointly insignificant for both enterprise ownership and dry season planting, alleviating concerns that the imbalance is driving seasonality differences in labor supply.

Table A1: Balance of Survey Timing

Variable	Quarters	Months
Area planted in the past rainy season*	.41	.98
	(.749)	(.467)
Household grew tobacco in past rainy season*	1.03	.84
	(.377)	(.595)
Household reports planting in the past dry season*	3.5	1.58
	(.015)	(.1)
Household reports operating an enterprise in past 12 months	2.26	3.11
	(.08)	(0)
Distance to urban area	.72	.62
	(.543)	(.812)
Distance to daily market	1.78	1
	(.15)	(.443)
Distance to paved road	.94	1.43
	(.423)	(.153)
Reported value of home	2.04	1.48
	(.107)	(.136)
Household has electricity	.99	1.44
	(.395)	(.148)
Household has it's own toilet	1.12	.56
	(.339)	(.861)
Household owns a stock corral	.78	.83
	(.507)	(.61)
Household owns a chicken house	1.7	1.96
	(.166)	(.029)

Note: Sample consists of all households. Values report the F-statistic of a test for the joint significance of the survey quarters in column 1 and months in column 2. P-values for the F-tests are reported in parentheses. Regressions marked with a * control for season of reference.

Table A2: Controlling for covariate imbalance

	Total household labor hours				
Apr. '10	6.191	6.857	6.041	8.512*	6.347
	(3.732)	(3.567)	(3.801)	(3.966)	(3.874)
May '10	2.000	3.041	1.838	3.400	1.835
	(3.591)	(3.362)	(3.625)	(3.383)	(3.801)
Jun. '10	-1.576	0.217	-1.730	1.216	-1.510
	(3.780)	(3.576)	(3.837)	(3.613)	(4.109)
Jul. '10	-3.638	-2.970	-3.950	-2.790	-2.965
	(3.782)	(3.591)	(3.857)	(3.109)	(4.074)
Aug. '10	4.583	5.444	4.224	4.425	4.302
	(4.014)	(3.750)	(4.081)	(3.804)	(4.177)
Sep. '10	5.800	6.596*	5.571	8.069**	6.053
	(3.205)	(3.020)	(3.292)	(3.112)	(3.614)
Oct. '10	7.184*	8.241**	6.901*	10.11**	7.293*
	(3.116)	(2.963)	(3.161)	(3.133)	(3.252)
Nov. '10	11.17**	11.93***	10.79**	12.98***	9.972**
	(3.484)	(3.359)	(3.536)	(3.519)	(3.728)
Dec. '10	21.76***	22.83***	21.32***	23.80***	21.22***
	(4.079)	(4.006)	(4.175)	(4.067)	(4.403)
Jan. '11	23.36***	25.04***	22.89***	26.33***	21.74***
	(3.300)	(3.140)	(3.449)	(3.277)	(3.629)
Feb. '11	8.906**	11.11***	8.401**	12.34***	8.295*
	(3.063)	(2.944)	(3.243)	(2.983)	(3.453)
Mar. '11	6.916	8.933*	6.330	9.620**	6.134
	(3.576)	(3.468)	(3.723)	(3.484)	(3.971)
Household enterprise		16.65***		19.93***	
		(1.416)		(4.451)	
Dry season planting			5.831***		5.555
			(1.612)		(6.247)
2010 dry season			2.121		2.002
			(1.498)		(1.474)
Apr. '10 x Covariate				-6.850	-2.653
				(7.266)	(9.609)
May '10 x Covariate				-0.774	0.112
				(6.947)	(7.938)
Jun. '10 x Covariate				-4.173	-1.659
				(7.190)	(8.676)
Jul. '10 x Covariate				-0.216	-6.908
				(7.646)	(7.998)
Aug. '10 x Covariate				5.641	-0.497
				(6.577)	(8.731)
Sep. '10 x Covariate				-6.131	-4.804
				(5.839)	(7.704)
Oct. '10 x Covariate				-8.367	-2.222
				(5.601)	(7.559)
Nov. '10 x Covariate				-4.137	6.354
				(5.794)	(8.498)
Dec. '10 x Covariate				-3.834	1.412
				(6.939)	(8.245)
Jan. '11 x Covariate				-5.914	18.08*
				(5.804)	(7.928)
Feb. '11 x Covariate				-6.105	2.066
				(5.797)	(7.934)
Mar. '11 x Covariate				-2.053	2.980
				(6.780)	(8.825)
Observations	12266	12266	12262	12266	12262

Note: Sample consists of all households. A joint f-test on the interaction terms in column 3 gives F(12,756)=0.7 and a p-value of 0.757. A joint f-test on the interaction terms in column 5 gives F(12,756)=1.54 and a p-value of 0.105. We cannot reject the null that these coefficients are jointly 0.

Table A3: 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 A4: Mean Labor Hours per Acre, by Crop

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

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

Table A5: 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	4.72	4.43
	Median	5.00	5.00	4.00
Household working-age individuals not in school	Mean	2.02	1.91	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, land area is calculated using self-reported plot size winsorized at 5pct.

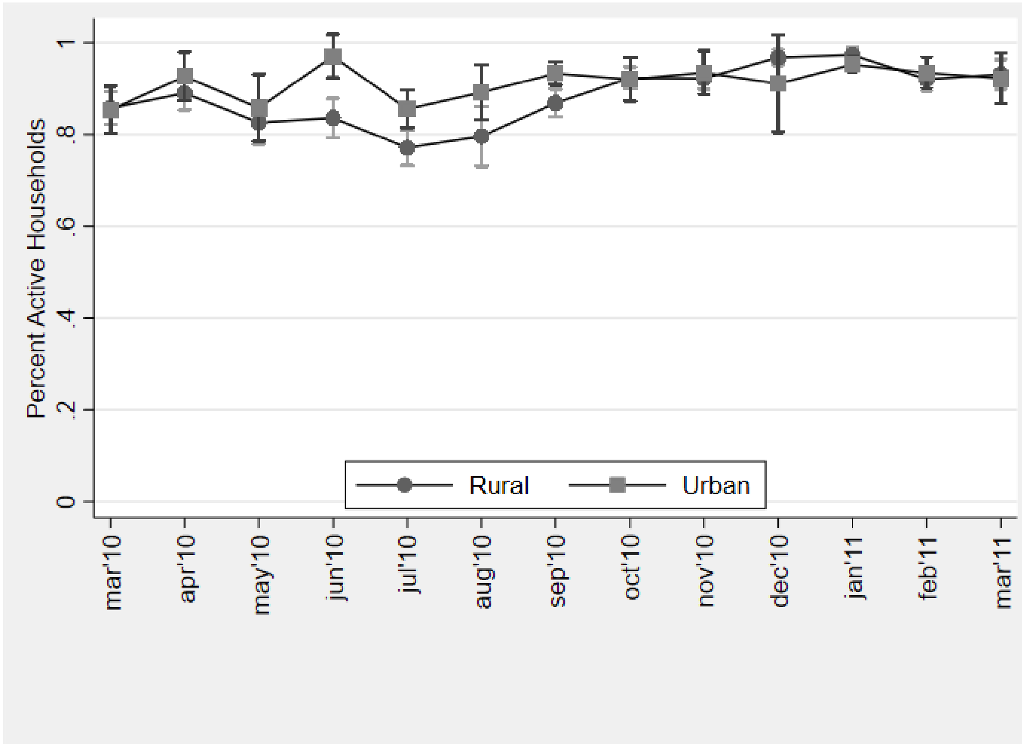
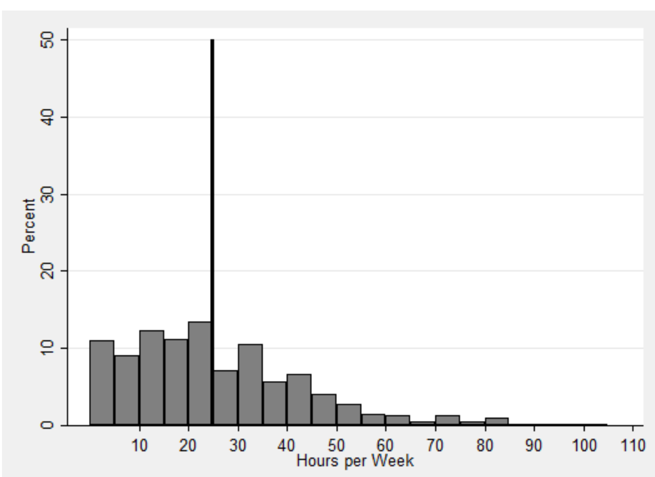
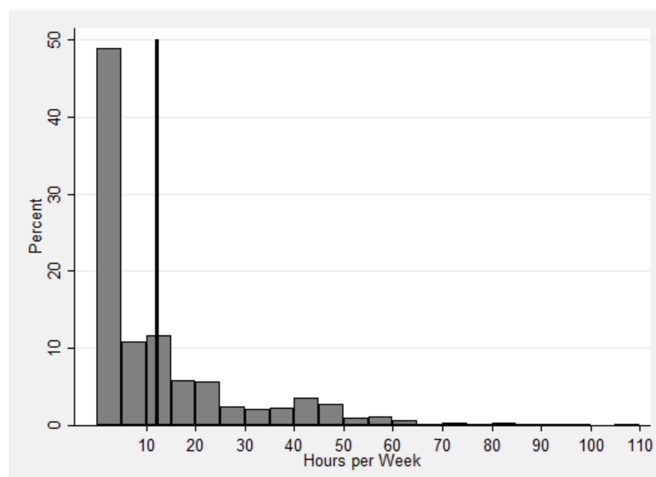


Figure A1. Percent of active households last week

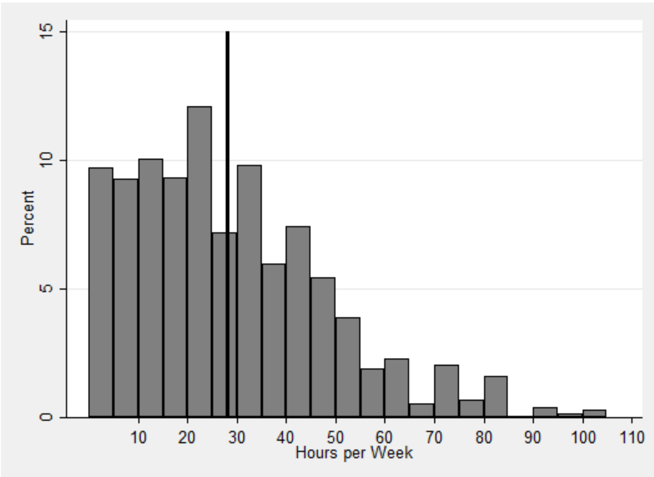


(a) High season (Dec-Jan)

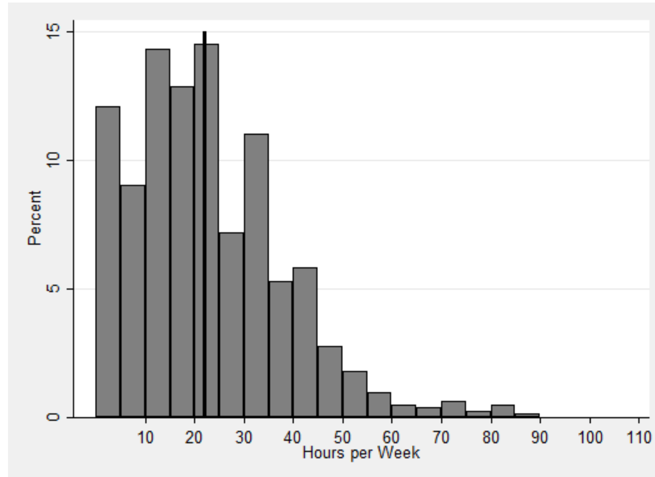


(b) Low season (Jul-Aug)

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

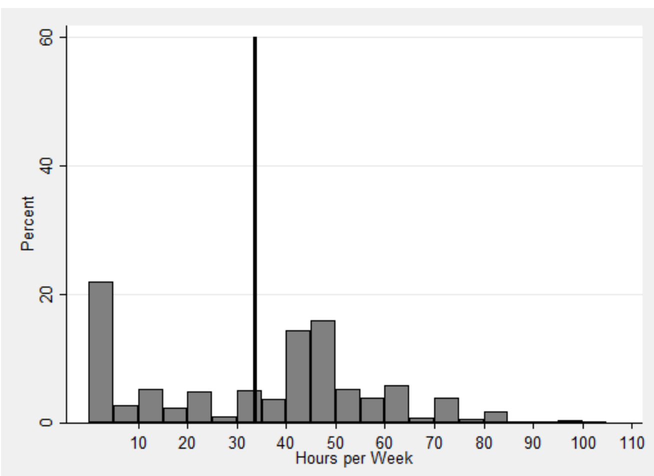


(a) Rural men (Dec-Jan)

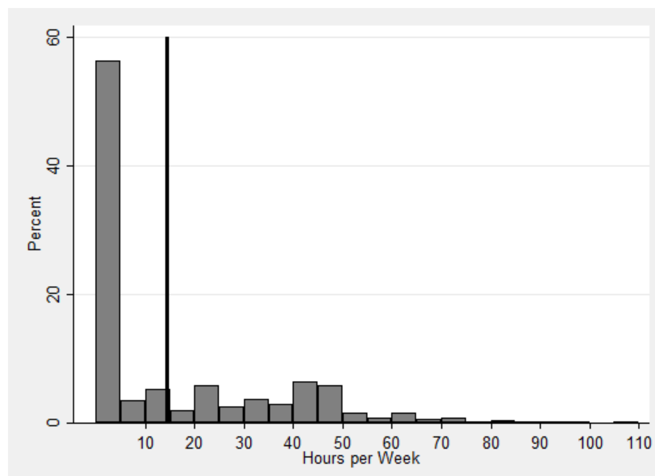


(b) Rural women (Dec-Jan)

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



(a) Urban men



(b) Urban women

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

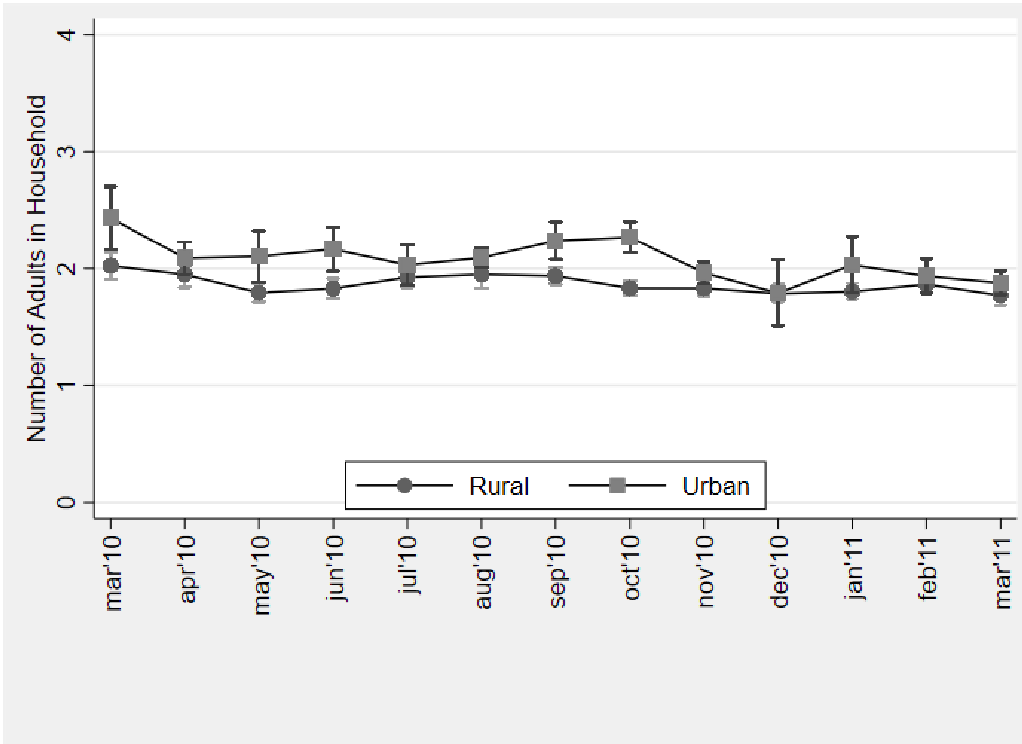


Figure A5. Working age adults

Table A6: Labor Supplied by Households, 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 (%)
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

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

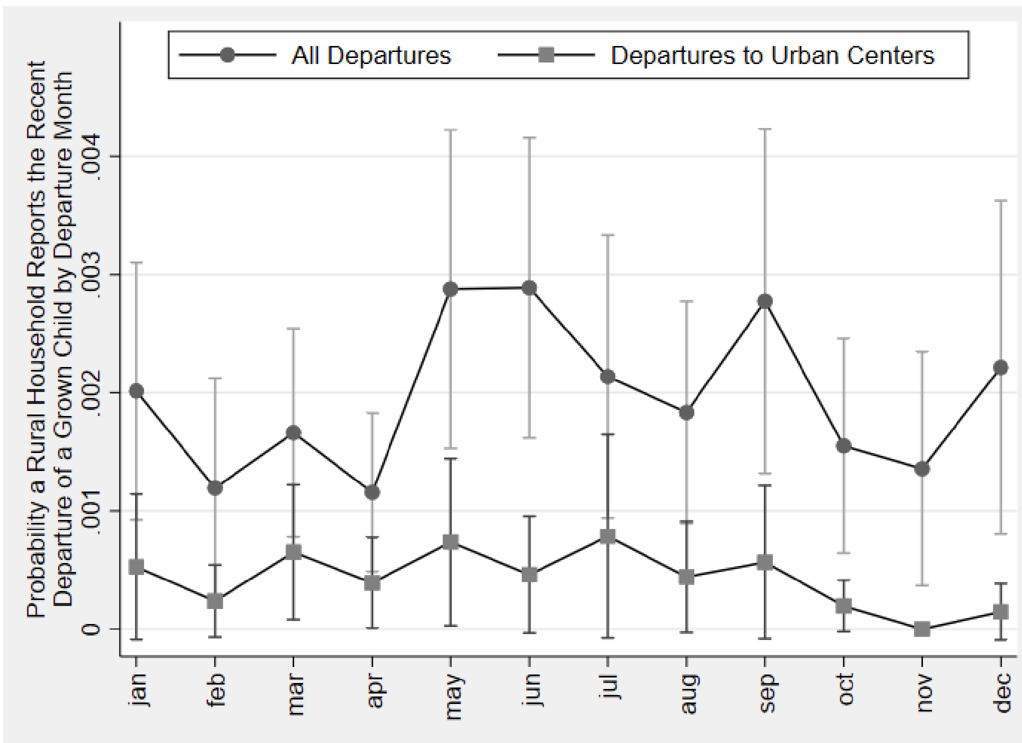
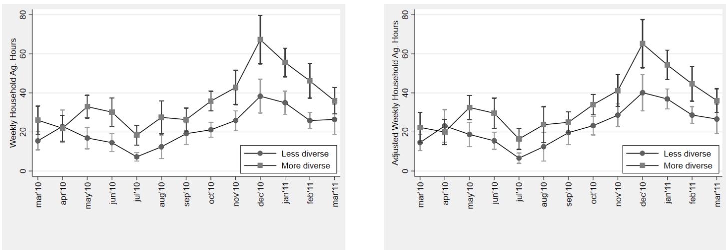


Figure A6. Probability rural households report the departure of an adult child by departure month

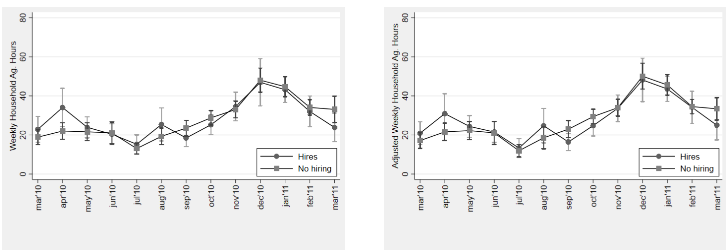
Table A7: Labor Engagement of Individuals, Rural vs. Urban: 2004, 2010, and 2016

	Contrast	Obs	Mean % active	High sea. % active	Low sea. % active	Standard deviation	Coeff. of variation (%)
Rural vs. urban, 2010	2010 Rural	18,699.00	0.79	0.93	0.64	0.10	13.08
	2010 Urban	4,625.00	0.64	0.67	0.61	0.05	8.58
	2010 Rural/urban		1.23***	1.39***	1.05	2.00	1.52
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	56,412.00	0.75	0.87	0.62	0.09	12.42
	Pooled urban	12,163.00	0.64	0.67	0.63	0.04	6.08
	Pooled rural/urban		1.17***	1.30***	0.98	2.25	2.04

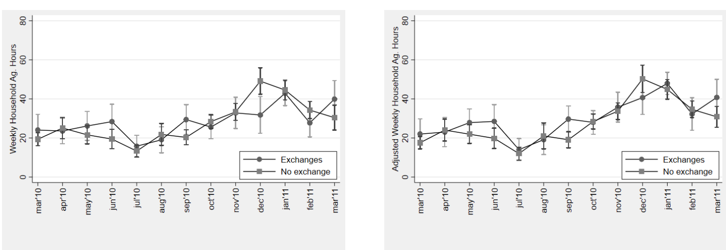
Note: Sample consists of working age individuals who are not in school. High season is December and January, low season is July and August.



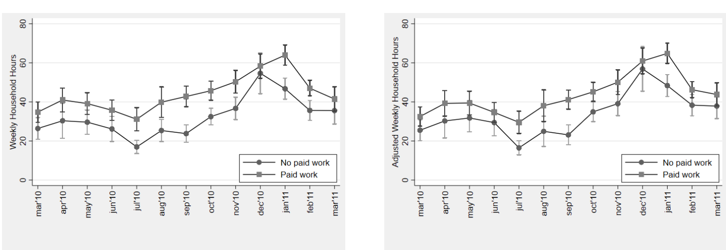
(a) Household hours in agriculture by crop diversity (without and with controls)



(b) Total household hours by labor hiring (without and with controls)



(c) Total household hours by labor exchange (without and with controls)



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

Figure A7. Labor supply by household activities