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Structural Transformation in Rural Ghana: The Trends and Drivers

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ABSTRACT

Structural transformation in rural spaces in developing economies remains elusive. Although the agricultural sector in Africa has often been viewed as a critical sector with the potential to provide productive employment to spur sustained growth, the sector is yet to experience the much-needed boost required to propel the transformation of rural areas. Ghana's extensive historical data makes it ideal for understanding transformation within developing country contexts. Using various waves of the Ghana Living Standard Surveys (GLSS) covering a period of close to three decades, the explores the trends, and drivers of transformation in rural Ghana. We further explore the role of general-purpose technologies - electricity and mobile phone coverage - in the transformation trajectory of rural Ghana. Our findings point to a modest decline in the share of labour in the agricultural sector with heterogeneity at the regional levels, suggesting that although some rural transformation has taken place, it is not to the extent that may have previously been perceived. Furthermore, we note a predominant presence of young individuals (both male and female) leading the transition away from agricultural-related activities, accompanied by a noticeable rise in higher education's association with the agricultural sector. We also observe growing labour shares in the services sector, while labour share in manufacturing declines over time. Our analyses suggest that access to electricity has been key to the transformation of rural spaces in Ghana by enabling the transition from farming to non-farm employment.

Key words: rural transformation, electricity, mobile phone coverage, Ghana
JEL Classifications: O1,011,012,014

EXECUTIVE SUMMARY

Although the trajectory of structural transformation in most African countries is atypical of the experiences of the developed economies, the pattern of rural transformation may be peculiar to countries on the Africa continent including Ghana. However, since there is a dearth of knowledge surrounding the patterns and drivers of such transformation in Ghana, it is imperative to examine the patterns, trends, enablers, and constraints of rural transformation; and further investigate the drivers of rural transformation in Ghana to inform policy.

Using 5 waves of the Ghana Living Standards Survey – waves III, IV, V, VI, VII – the study explores the patterns and trends of structural rural transformation by employing the descriptive methods. Further, the study uses the Linear Probability Model to examine the effects of access to electricity and mobile networks on rural transformation in Ghana.

The study measures rural transformation both at the household and individual levels and finds that the share of agricultural households over the three-decade period has been declining from 60.07% in 1991/1992 to 48.19% in 2016/2017. At the rural level however, although agricultural household shares declined, the declines were moderate. From 80.03% in 1991/1992, it declined to about 72.67% by 2016/2017. Differences in the declining agricultural labour shares are more apparent at the regional level. Other differences highlighted are based on gender, age and education of the household head. We find that the shift from agricultural related activities is dominated by the youth for both male and female. In addition, we find strong evidence that access to general-purpose technologies is positively associated in the transformation of rural areas in Ghana. Specifically, we found that households' access to grid electricity is associated with a 23.3 percentage point decline in the likelihood of anybody in the household participating in agriculture in rural Ghana.

In conclusion, we note that general-purpose technologies such as electricity play a significant role in labour's movement out of agricultural activities within rural spaces in Ghana. Also, the effects of electrification on transformation are differentiated based on the gender, age and educational level of the household head as well as the poverty status of the household in rural localities in Ghana.

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ACRONYMS AND ABBREVIATIONS

AS	Ashanti Region
BA	Brong-Ahafo
CR	Central Region
EA	Enumeration Area
ER	Eastern Region
GAR	Greater Accra Region
GLSS	Ghana Living Standard Survey
GSMA	Global System for Mobile Survey
GSS	Ghana Statistical Service
ICT	Information and Communication Technology
LPM	Linear Probability Model
NR	Northern Region
SHEP	Self-Help Electrification Program
SSA	Sub-Saharan Africa
UW	Upper West
UE	Upper East
VR	Volta Region
WR	Western Region
2G	Second Generation
3G	Third Generation

I. Introduction

Farming remains the main source of livelihood, particularly for those who live in the rural areas in many sub-Sahara African (SSA) countries. The agricultural sector for many African economies is also the largest employer of the labour force, which is projected to remain so in the next decade (Yeboah and Jayne 2018). According to Ghana's Statistical Service, the recent census shows that the agricultural sector employs about 61.4% of the labour force in rural areas, which is also characterised by limited opportunities for engaging in non-farm wage employment (GSS, 2021). This characterisation of rural areas in Ghana indicates the nature of the country's structural transformation trajectory. The typical path of structural transformation witnessed by numerous economies has not been the case for Ghana (Osei and Jedwab 2013). Ghana's rapid urbanisation which is currently at 58%, according to World Bank (2021) data, has not been accompanied by an industrial revolution (Jedwab, 2013) and its related marked improvements in agricultural technologies, farming arrangements, mechanisation, and agricultural productivity (the Green Revolution). This pattern of structural transformation that is being observed is not peculiar to Ghana, as evidence from other African countries show similar trends (see Diao, McMillan, and Rodrik, 2019).

While Ghana's high urbanisation rate has not been driven by a revolution in the agricultural sector and a labour-intensive manufacturing sector, increased urban growth has been associated with rapid growth in the services sector (Diao et al., 2019). Again, Ghana's urbanisation has been characterised not only by large cities but also by the growth of small cities and towns which present opportunities for rural- urban migration and a shift from farm employment to the non-farm economy. Between 2000 and 2010, Diao et al. (2019) provide evidence to show a sizable movement of households in agriculture to the rural nonfarm economy in areas with proximity to smaller cities and towns. Overall, the significant decline in subsistence agriculture and increasing urbanisation -which is characterised by declines in agricultural employment - are all indicative of transformation of rural spaces in Ghana.

In framing the tenets of transformation of Africa, Losch (2016), Filmer et al., (2014) and Ameyaw (2015) have maintained that the agricultural sector remains a critical sector which has the potential to provide productive employment to spur sustained growth. On one hand, the agricultural sector is yet to experience the much-needed growth required to spur the transformation of the rural areas on the continent because of the myriad challenges it faces. On the other hand, there is some evidence over a space of six to ten years which presents proof of profound farm-level transformation in relation to farm size, crop production and marketed output levels by farm size (see Jayne et al. 2019). There is also evidence of increased farmer participation in agricultural factor markets including land, labour, farm inputs and mechanisation (Chamberlin and Ricker-Gilbert, 2016 and Deininger et al., 2017). Moreover, Tschirely et al. (2015) and Reardon (2015) note that the increasing rate of urbanisation in most countries in SSA is associated with increased demand for food from the rural areas This creates new opportunities not only in farming but also increased food processing and other off-farm small-scale employment (Jayne et al., 2018), particularly for what Gollin et al. (2016) describe as 'production cities' where the increasing rate of urbanisation is associated with the workers involved in tradable

services and in industrial sectors such as manufacturing. Cumulatively, these changes suggest that rural areas in SSA are undergoing some form of transformation even though the nature of the transformation may not be even across the continent.

While there is a limited number of studies that explain the rural transformation in Ghana, a few provide some anecdotal evidence on the patterns, drivers and constraints of rural transformation. For instance, Ghebru et al. (2018), Kosec et al. (2018), Bezu & Holden (2014) and Bezu & Barrett (2012) maintain that agricultural labour allocations are determined by access to farmlands. Similarly, Ghebru et al., (2018) noted that improved access to land increases labour participation in the agricultural sector. Furthermore, binding credit constraints not only restrict farmers from hiring labour (Lovo, 2012; Sagbo, 2019), but also prevents farm households or individuals from taking up off-farm activities which is critical for structural transformation (Ellis, 2000).

In addition to access to the traditional factors of production such as land (i.e., land tenure) and capital (access to finance), general purpose technologies (access to electricity and mobile phone coverage) may play a critical role in the transformation of rural economies. General purpose technology and innovation such as electricity have been shown to serve as a catalyst in labour reallocation away from labour intensive activities (see Dinkelman, 2011). As demonstrated in the development economics literature, improved access to electricity not only increases industrial and agricultural productivity as shown by Fisher-Vanden et al., (2015) and Allcott et al., (2016) but also facilitates the entry and exit of firms (Kassem, 2018). The positive effects of electrification on employment and household income have also been documented by Chakravorty et al., (2014) and Mensah (2018). Other studies, including Assunção et al., (2018) have also highlighted the positive effects of electrification on agricultural productivity and Gaggl et al. (2021) provide evidence on the critical role that electrification plays in the structural transformation using historical panel data. Similarly, the emergence and growth of the Information and Communication Technology (ICT), also viewed as a general-purpose technology, has been recognized as an important enabler of structural transformation (see Kaila, 2017; Kaila and Tarp, 2019). This is because these technologies provide new opportunities for employment and entrepreneurship and therefore influences structural transformation indirectly. Kaila and Tarp (2019) note that, the arrival of internet significantly increased agricultural productivity through improved access to information and markets in rural Vietnam.

While these studies have demonstrated that general purpose technologies have positive effects on various development outcomes, our understanding of how these technologies interface with the structure of economies is rather limited (Perez-Sebastian et al., 2020). Specifically, there is paucity of studies that have examined the relationship between rural structural transformation and electrification (and other general-purpose technologies) within the sub-Saharan Africa context.

To provide an enhanced understanding and a more nuanced narrative of the patterns, drivers and constraints for effective policy making, we aim to complement Ripoll et al. (2017) and Diao et al. (2019) by considering a wider set of measures of rural transformation and potential drivers including

access to general purpose technologies such as electricity and mobile phone coverage. We also conduct a more disaggregated analysis of the patterns and trends of rural transformation in Ghana covering a period of almost three decades. This is key to identifying heterogeneities in rural transformation in Ghana.

Our study builds on and contributes to the rural structural transformation literature in two main ways. First, the paper provides a description of the nature of transformation in rural Ghana by employing a repeated cross-section of nationally representative data over a twenty-seven-year period. This description complements the existing narrative in this context in the literature which is often provided at the national level and therefore not nuanced enough to inform effective policy making. This description at the micro level also provides an opportunity to further interrogate the narrative about rural structural transformation in Ghana's context, which more often than not has been portrayed to be drastic. Secondly, based on the recent empirical evidence that general purpose technologies such as electrification and ICT are critical for agricultural productivity and labour allocations, we estimate the effects of access to electricity and mobile networks. We test the hypothesis that increased access to such technologies opens the rural economy and serves as a catalyst for change in the structure of the rural economy. Although we do not make causal claims in this paper, findings from the study are critical in understanding the interactions between general-purpose technologies and structural transformation in rural spaces in Ghana.

Using measures of rural transformation both at the household and individual levels, our findings show a declining share of agricultural households over the three-decade period from 60.07% in 1991/1992 to 48.19% in 2016/2017. At the rural level however, although agricultural household shares declined, the declines were moderate. From 80.03% in 1991/1992, it declined to about 72.67% by 2016/2017. Differences in the declining agricultural labour shares are more apparent at the regional level. Other differences highlighted are based on gender, age and education of the household head. We find that the shift from agricultural related activities is dominated by the youth for both male and female. In addition, we find strong evidence that access to general-purpose technologies is positively associated in the transformation of rural areas in Ghana. Specifically, we found that households' access to grid electricity is associated with a 23.3 percentage point decline in the likelihood of anybody in the household participating in agriculture in rural Ghana.

We focus on electrification to explore the potential channels through which electrification can lead to the transformation of rural spaces. Results suggest that increased access to electrification in rural areas is associated with increased household ownership of household productivity enhancing tools as well as equipment that allow households to diversify their livelihoods. Estimates from the Linear Probability Model (LPM) show positive and significant associations between electrification and participation in non-farm businesses suggesting that the decline in agricultural labour shares in rural spaces is potentially due to household movement into the non-farm sector.

The remainder of the paper structured as follows. The next section discusses the data sources and how they are combined for the analysis. This section also describes the key variables of interest. The patterns and trends of transformation are discussed in section three. The empirical strategy is explained in section four and the results are presented in section five. Section six concludes.

II. Data Description

The study employs data from the third to the seventh waves of the Ghana Living Standards Survey (GLSS III, IV, V, VI and VII). The GLSS is a nationwide individual and household level survey that collects detailed information on demographic, social, and economic variables that include employment and household agriculture. The GLSS remains the most comprehensive source of household-level data in Ghana in terms of coverage and scope. The sampling frame for the surveys are people living in private households[1] in Ghana and are usually divided into primary and secondary sampling units. Enumeration areas (EAs) are defined as the primary sampling unit and households within each EA constitute the secondary sampling unit. The EAs are stratified based on the population in each of the ten administrative regions[2]. The surveys for GLSS III, IV, V, VI and VI were conducted in 1991/92, 1998/99, 2005/06, 2012/13 and 2016/17 respectively and the corresponding number of households sampled were 4552, 5998, 8687, 16772 and 14009 respectively. Thus, by observing the trends in rural transformation over this time frame, we cover a period of 27 years, long enough to sufficiently examine trends in rural transformation in Ghana as well as the drivers and constraints.

In addition to the GLSS, this study complements household level data with spatial data on mobile telecommunication service coverage in Ghana sourced from Collins Bartholomew.[3] The mobile coverage data is compiled using data provided by national mobile service operators under the Global System for Mobile Communications Association (GSMA) as well as open-source data on cell phone towers. For our study, cell network coverage measures the share of persons living in an area with access to cell phone coverage. We limit our analysis to second generation (2G) access which basically supports voice calls and text messages as access to third generation (3G) shows up only in GLSS7[4]. This data has been used in previous studies examining the role of mobile telecommunication technology in several countries (see Mensah et al., 2022, Mensah, 2021, Manacorda and Tesei, 2020).

[1] Private households are defined in GLSS as excluding institutional populations such as schools and hospitals.
[2] At the time of each of the five rounds of the GLSS survey used in this study, Ghana had ten administrative regions. Currently, the country has sixteen administrative regions following a recent internal boundary re-demarcation.
[3] https://www.collinsbartholomew.com/mobile-coverage-maps/
[4] Third generation access was deployed in 2006 in Africa.

Key variables of interest

Measures of rural transformation

Agricultural households and individuals: Following Liu et al. (2020), we define a household as an agricultural household – or a household engaged in agriculture – if at least one member of the household aged 15 years and above had worked in agriculture (including forestry and aquaculture) during the past 12 months. This variable is measured at the household level. Thus, the variable indicates the proportion of total households that identify agriculture as a main occupation for at least one member of the household. In addition to this variable, the study also uses the share of individual agricultural workers as a proportion of the total employed persons. This variable, measured at the individual level gives a sense of how much of the working population are engaged in agriculture and is used as an alternative measure of rural transformation. These two measures give an indication of labour shares between agricultural and non-agricultural economic activities and provide information on the nature of economic activities engaged in by the labour force. Using these variables, this study is able to determine the trajectory of rural transformation in Ghana over time.

Access to electricity

Share of households with access to electricity: The study calculates the share of households per cluster or enumeration area who have access to the national electricity grid. This variable gives a measure of the proportion of the population who can connect their homes to the national grid electricity within each cluster. This variable is used as an explanatory variable in the econometric analysis to examine its role either as an enabler or constraint to rural transformation.

Access to telecommunication service

Share of households with access to mobile telecommunication services: Using spatial data, this variable captures the proportion of residents who have a supply of mobile telecommunication service and can therefore connect to the service should they provide themselves with a mobile phone and a sim card. In our analysis we limit ourselves to data on second generation (2G) cell network coverage in Ghana at the 0.10x0.10 (≈ 11km * 11km) grid cell level. In other words, the share of households who are within range of a mobile service signal. The variable gives a sense of the extent of mobile service coverage over time and also functions as an explanatory variable in assessing the enablers or constraints to rural transformation in Ghana. Additionally, we measure the actual number of mobile service subscriptions per 100 people.

III. Patterns and Trends in Rural Transformation in Ghana

Figure 1 shows the share of households engaged in agriculture as a proportion of total households at the national, urban and rural levels. Nationally, a decreasing trend in the share of agricultural households is observed from 1991 to 2017. The shares which stood at 60.07% in 1991/92, decreased to 58.32% in 1998/99, decreased further to 55.1% in 2005/06, to 50.95% in 2012/13 and then to

48.19 in 2016/17. This shows a clear and consistently decreasing share of agricultural households over the nearly three-decade period. Specific to rural households, the agricultural shares which stood at 80.03% in 1991/92 decreased to 78.34% in 1998/99 but increased to 80.89% in 2005/06 before resuming the decline to 76.56% in 2012/13. The share further dropped to 72.67% in 2016/17. Thus, for rural households over the twenty-seven-year period, the share of households involved in agriculture declined. This trend is visible at the regional rural levels as well. Figures 2 and 3 show the shares of agricultural households at regional levels for all 10 regions[5]. This is similar to observations made in Vietnam, where a declining trend in agriculture households was observed between 1992 and 2016 (Liu et al., 2020).

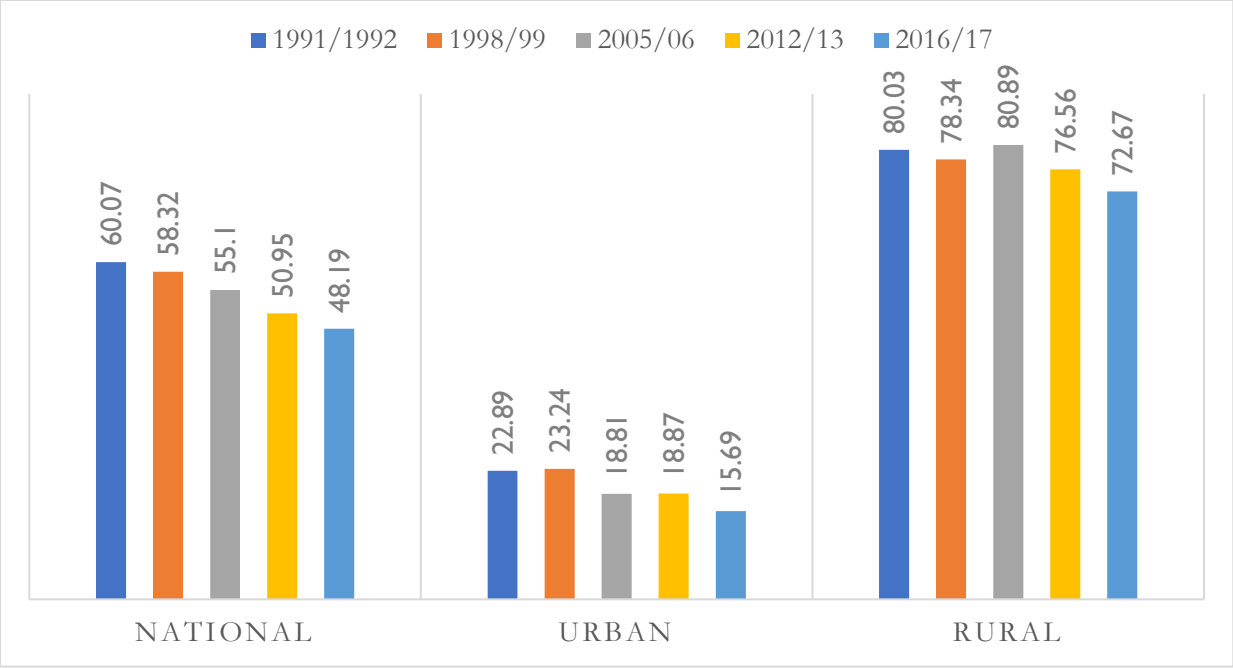

Figure 1: Share of household engaged in agriculture
Source: Based on Authors' calculations from GLSS 3, 4, 5, 6 & 7

[5] Figure 3 drops the Greater Accra Region (GA) from the chart. The GA is the region where the national capital is located. It is a highly urbanized region with a disproportionately low level of agricultural activity and is thus, an outlier.

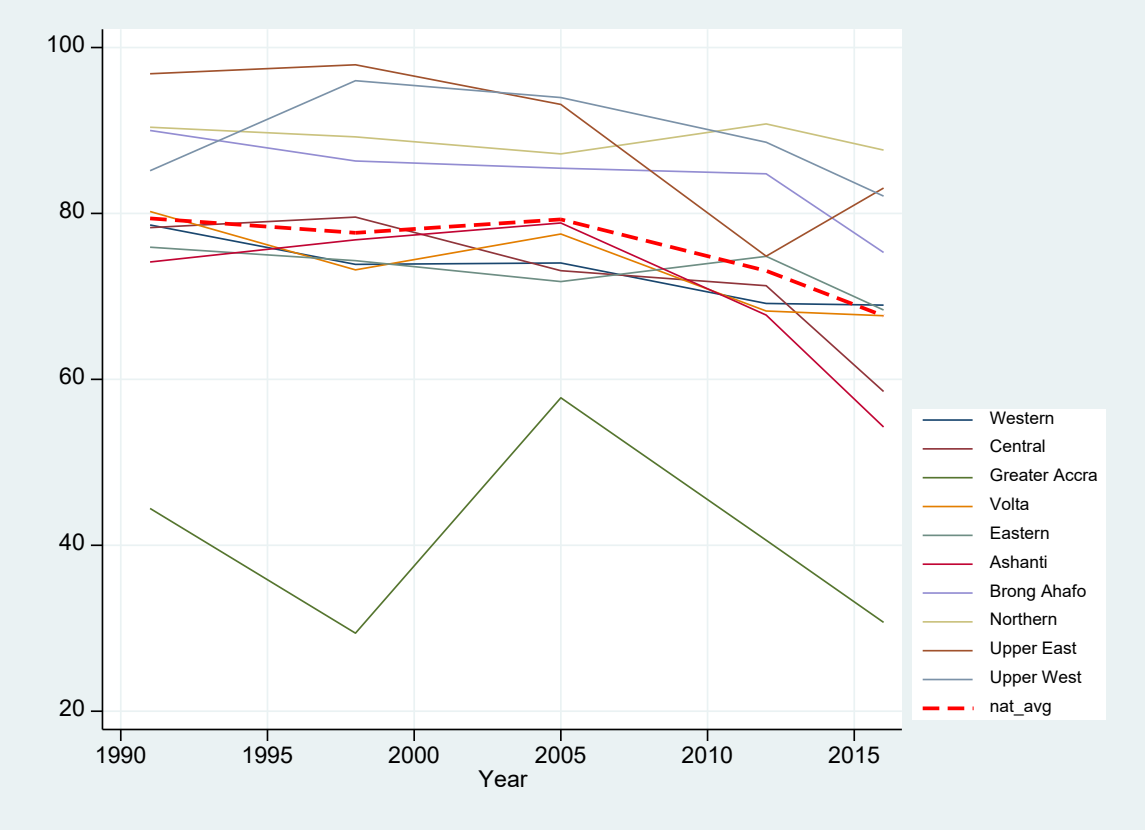

Figure 2: Share of rural households engaged in agriculture by administrative region
Source: Based on Authors' calculations from GLSS 3, 4, 5, 6 & 7

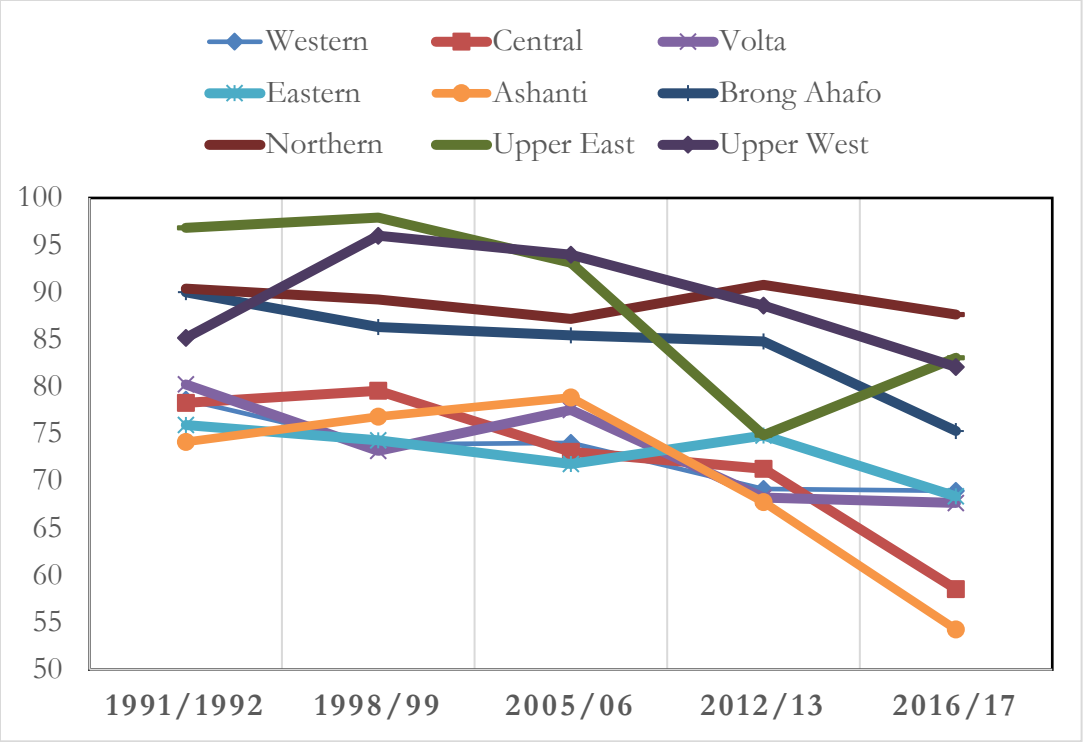

Figure 3: Share of rural households engaged in agriculture by administrative region (without GA)

Source: Based on Authors' calculations from GLSS 3, 4, 5, 6 & 7

Trends in rural employment by economic sector

Given the declining trends observed in agricultural jobs, it is important to observe what is happening to jobs in other sectors of the economy over time to understand where the movement away from agriculture is heading for rural residents. We classify individuals into different economic activities based on industry classification – agriculture, industry (without manufacturing), manufacturing, and services. The shares are displayed in Figure 4.

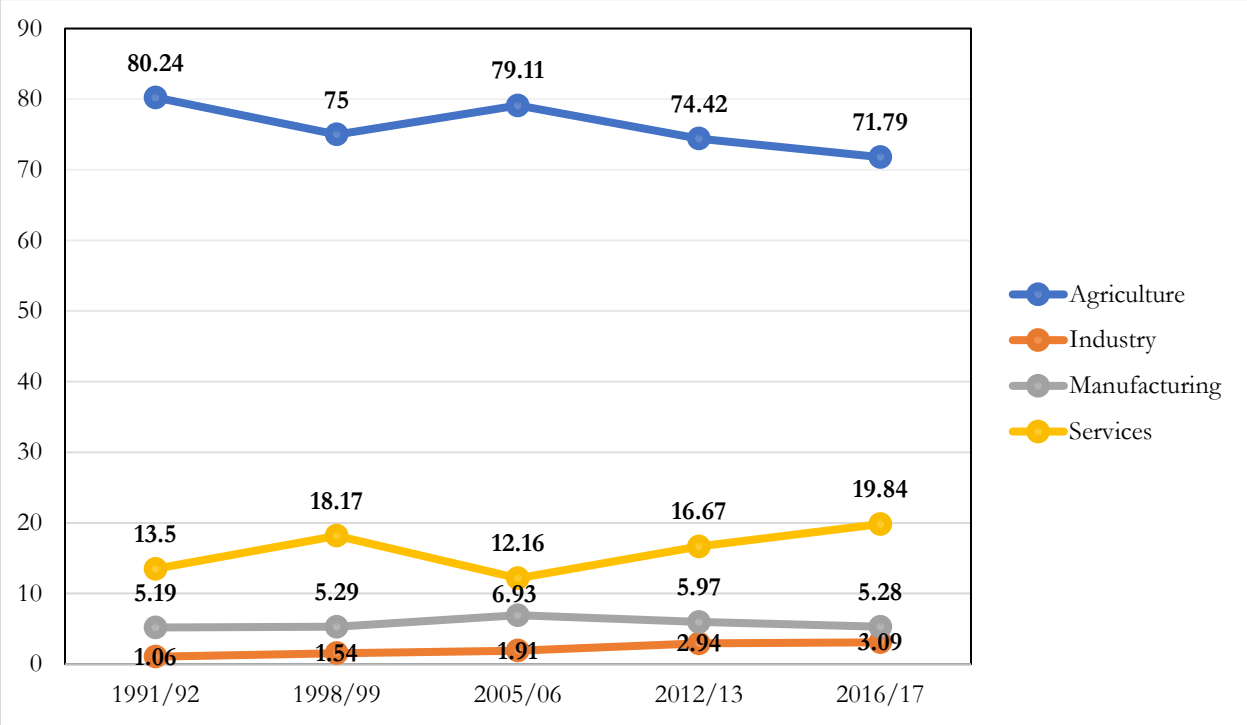

Figure 4: Distribution of individual rural workers by economic sector
Source: Authors' calculations based on GLSS 3, 4, 5, 6 & 7

Figure 4 shows the distribution of rural individual workers by economic sector. Over the period, it is observed that the share of individuals in agriculture declined by nearly 10 percentage points while the share of individuals in industry increased by 2 percentage points from 1.06% to 3.09% and the share of individuals in the services increased by over 6 percentage points from 13.5% to 19.84%. The share of individuals in manufacturing was relatively stable over the period beginning the period at 5.19% and ending the period at 5.28% peaking at 6.93% around 2005/06. The implication is that there is a growing importance of services as an employer even in rural areas. A similar observation is made for the industry sector. The importance of manufacturing as an employer in rural areas, however, has not seen significant growth over the period. This trend is somewhat reflected at the national level and is thus consistent with the narrative by Osei and Jedwab (2013) which describes Ghana's structural transformation as one that has leap-frogged the manufacturing sector. The growth of labour shares in the services sector particularly in the rural areas may have been facilitated by the increased growth in

small cities and towns as shown by Diao et al, (2019) which may induce labour migration and shift from agricultural work to other non-farm work, particularly in the informal sector. Taken together, the trends suggest that labour is moving from the agricultural sector into the services sector in which informality is pervasive and the scale of operations is micro to small and characterised by low productivity. Thus, the observed rural transformation is not characterised by industrialisation.

Trends in rural employment by age and gender groups

We further explore trends in rural transformation by age and gender groups. Figure 5 shows the trends in rural employment by age group. Panel A shows the trends for agricultural jobs while panel B shows the trends for non-agricultural jobs.

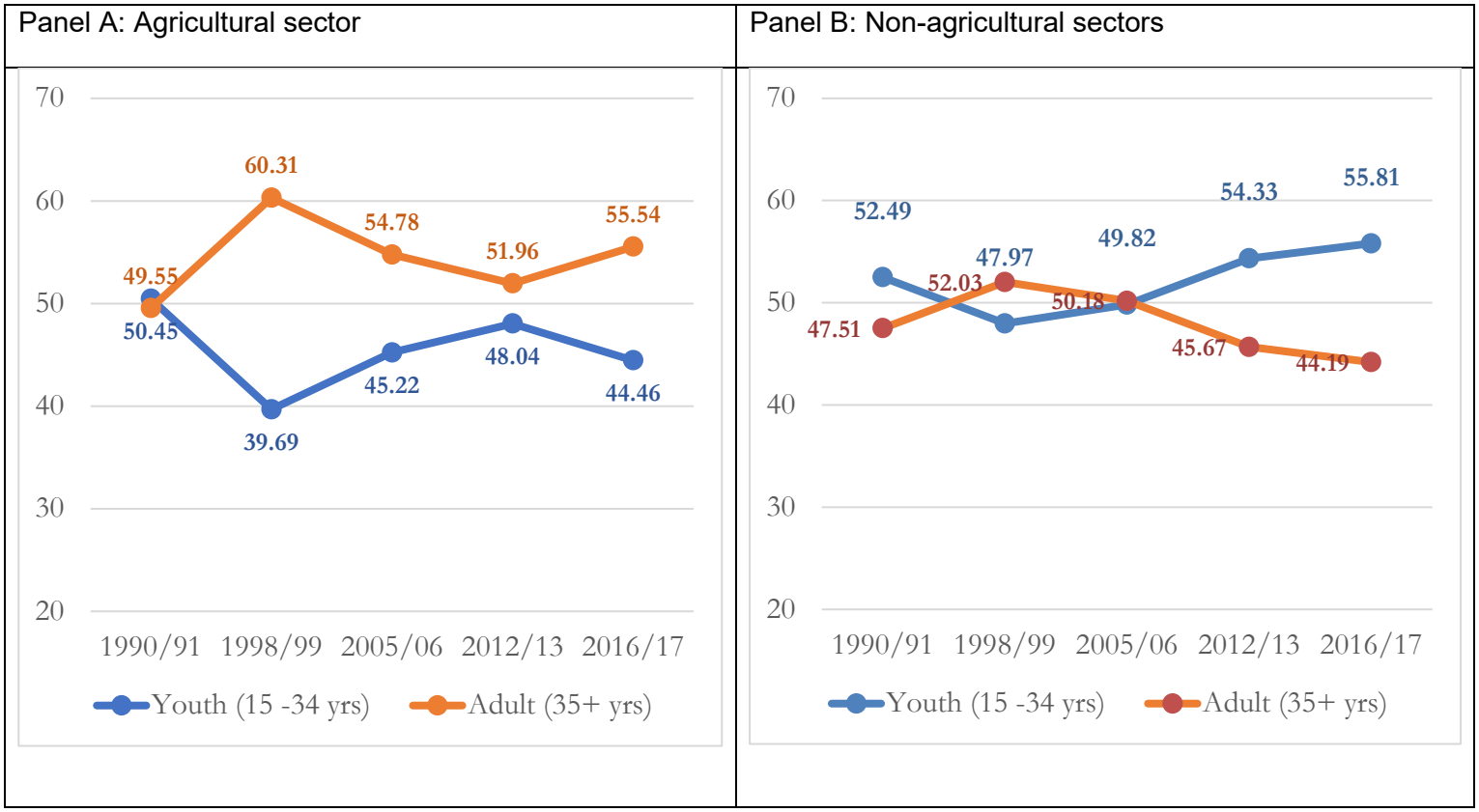

Figure 5: Share of individual rural workers by age group

Source: Based on Authors' calculations from GLSS 3, 4, 5, 6 & 7

It is observed that agricultural jobs are dominated by adults while non-agricultural jobs have seen shifts between youth and adults in terms of dominance over time probably due to retention and exit of youth, based on the types of jobs available in non-agricultural sectors in rural areas at specific points in time. In the agricultural sector, the initial drastic decline between 1991/92 and 1998/99 was followed by a sustained recovery until 2012/13 after which a decline in youth participation in agriculture followed. In non-agricultural sectors, recent years have seen a greater absorption of young people; a trend which could be arising from the evolution of informal service sector jobs and the

ability of young people to learn new skills easier to be able to fit into new service sector jobs that become available in rural areas. Furthermore, young people have more opportunities for higher education now than before, and with higher education, are more likely to move from agricultural jobs into non-agricultural jobs (Young, 2013; Hicks et al., 2017).

With respect to gender, Figure 6 shows that in the agricultural sector, there has been a shift in the gender composition from being female dominated to being male dominated over the period. The earlier years beginning 1991/92 had females dominating in the sector but that has been reversed post-2005/06 with males slightly dominating in terms of gender composition in agriculture. In non-agricultural sectors, however, female dominance remains despite a decline in the composition of females and a corresponding increase in the share of males after 2005/06.

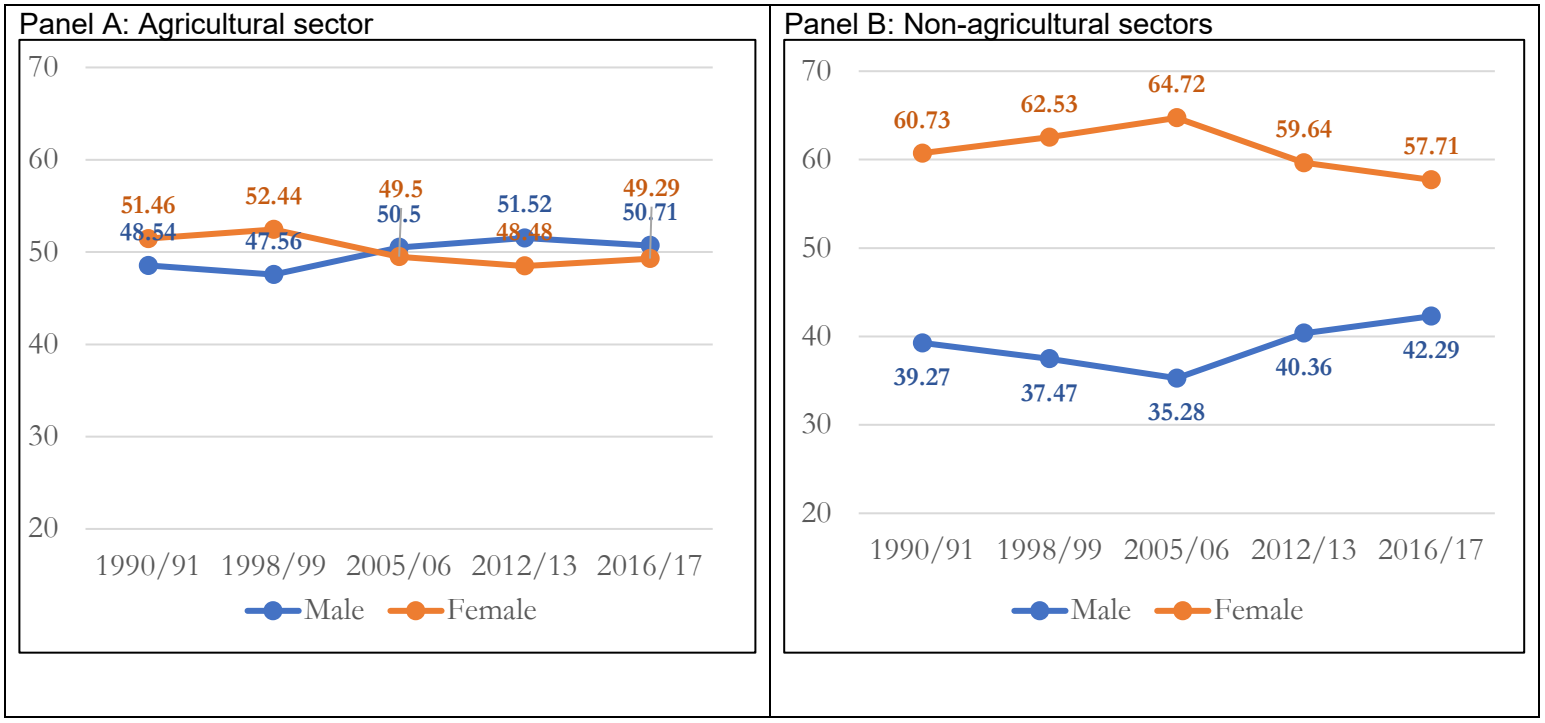

Figure 6: Shares of individual rural workers by gender
Source: Authors' calculations based on the GLSS 3, 4, 5, 6, & 7

Trends in rural employment by educational level

Figure 7 shows the trends in rural employment by educational level. Agriculture is dominated by persons with less than primary education even though the share has declined considerably within the latter half of the period of analysis. While lower levels of education generally seem to be associated with a declining participation in agriculture, basic, secondary and tertiary levels of education appear to have seen marginal increases in their shares in agricultural sector jobs over the period under consideration. In the case of non-agricultural sector jobs, lower levels of education have experienced declining shares over the period while higher levels (secondary and tertiary) have seen steady increases

in their shares. The share of individuals with basic education engaged in non-agricultural sector jobs has been fairly constant over the period.

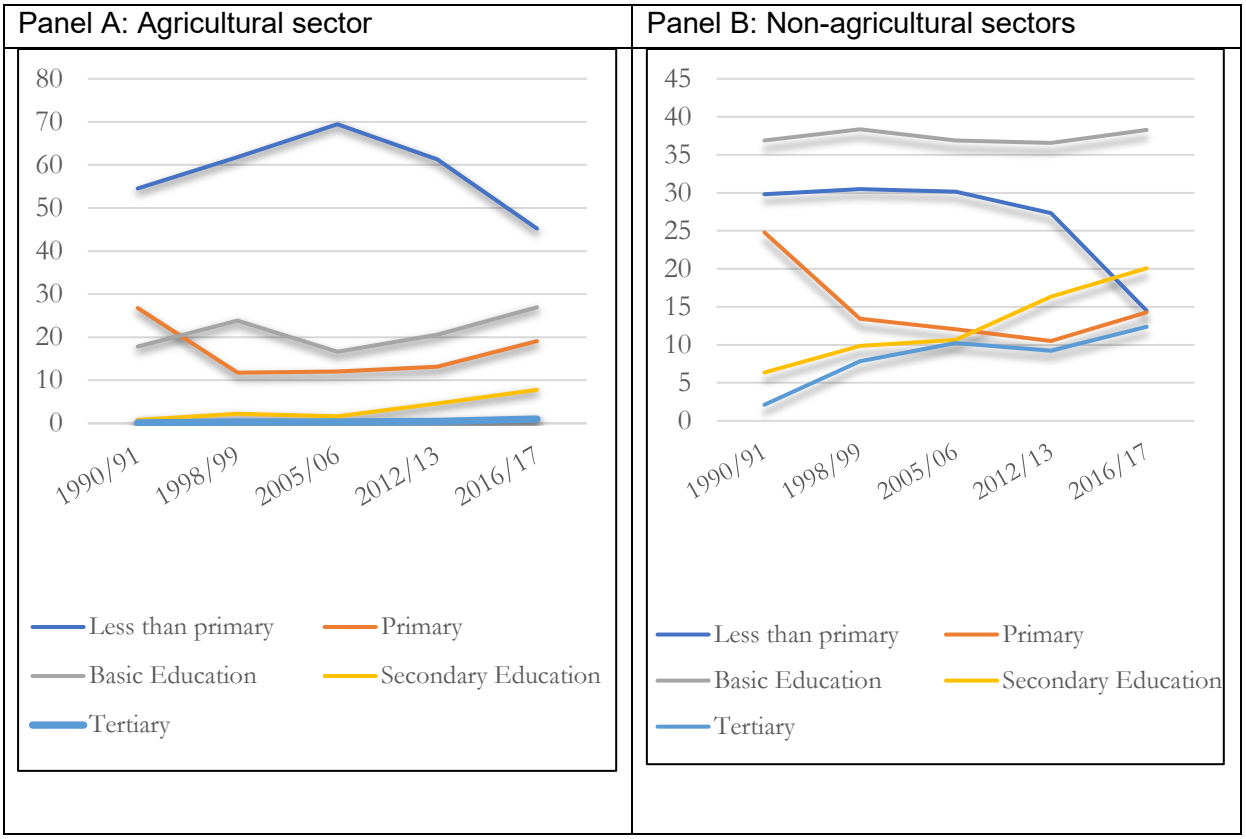

Figure 7: Share of individual rural workers by level of education

Source: Source: Based on Authors' calculations from GLSS 3, 4, 5, 6 & 7

Trends in access to electricity

Table 1 shows that the proportion of households across the country who had connected to the national grid electricity rose from 28.53% in 1991 to 72.14% in 2017. Among rural households, the shares increased from 7.57% in 1991 to 58.02% in 2017. Furthermore, we show the proportion of rural households with access to the national electricity grid per cluster/enumeration area between 1991 to 2017 in Figure 8 (i.e., those who could connect to the national grid). It shows that in 1991, no rural household in four regions – the Brong Ahafo, Northern, Upper East and Upper West – had access to the national grid, while between 10% - 20% of rural households in five regions: Volta, Eastern, Western, Central, and Greater Accra regions had access to the national electricity grid. In the Ashanti region, the proportion stood at between 20% - 40%. Over time, however, the situation improved as more rural households got connected to the national grid. By 2017, the Upper East region was the only region with electricity access via the national grid available to only 20% - 40% of rural households. In the Central and Greater Accra Regions, between 80% - 100% of all rural households had access to the national electricity grid. The trends show marked improvement in access to electricity by households across the survey period, which is associated inversely with the share of agricultural

households over time. These trends may be attributed more broadly to the National Electrification Scheme and particularly to the rural electrification programs implemented by the government of Ghana such as the Self-Help Electrification Program (SHEP). The SHEP made it possible for communities to complement government efforts by providing logistical support themselves to ensure that their communities were connected to the national grid earlier than they would have been if the government single-handedly shouldered the full responsibility (Kemausuor and Ackom, 2017). This move accelerated the rate at which previously unelectrified communities gained access to electricity through the national grid and is partly responsible for the steep rise in access to electricity especially in rural areas. The rising trend in household access to electricity is evident at the regional levels with all regions recording increases in the share of households with access to electricity across the survey years (see Table 1).

Table 1: Share of Households with access to electricity

Electricity access	1991/92	1998/99	2005/06	2012/13	2016/17
Access to electricity- national	28.53	39.20	45.88	60.85	72.14
Access to electricity- rural	7.57	17.08	22.59	39.84	58.02
By Region					
Western	22.50	49.30	52.04	72.06	79.86
Central	19.22	31.00	42.96	68.89	84.14
Greater Accra	79.08	81.72	80.75	87.34	93.28
Volta	10.26	27.93	30.69	60.27	73.88
Eastern	20.92	31.88	38.73	59.10	68.32
Ashanti	41.00	45.75	60.29	81.26	87.38
Brong Ahafo	16.56	27.59	44.28	57.93	69.73
Northern	8.58	10.83	28.55	39.37	59.55
Upper East	0.00	0.00	13.67	28.37	44.20
Upper West	0.53	4.23	11.00	38.63	57.57

Source: Authors' construct from GLSS 4, 5, 6, & 7

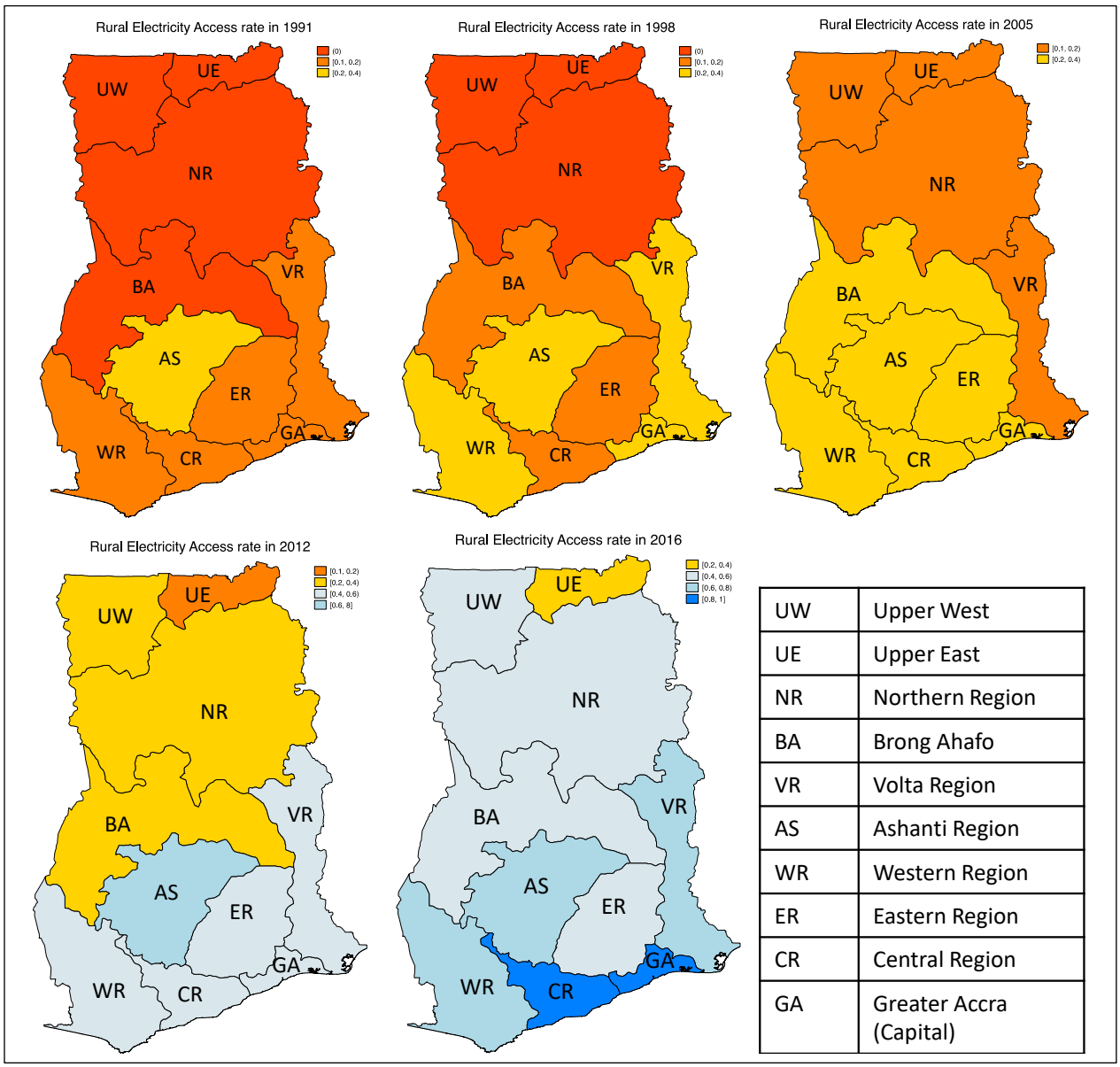

Figure 8: Proportion of households with access to the national electricity grid (1991-2017)

Source: Authors' construct from GLSS 3, 4, 5, 6, &7

Trends in mobile phone coverage

In Table 2, we report the share of households who are within the range of a mobile cellular signal and are able to connect to a mobile phone service whether they have actually subscribed or not as well as the actual cellular subscriptions per 100 people. The data shows a clear upward trend in both coverage and subscription. Over a two-decade period, mobile phone coverage increased significantly from 8% of households in 1998/99 to about 90 percent of households in 2017. Similarly, mobile phone subscriptions increased to over 100 percent within the same period suggesting that there were more than one subscription per person on average.

Table 2: Mobile Phone Network Coverage and Mobile phone penetration

	1998/99	2005/06	2012/13	2016/17
National				
Mobile phone coverage	0.08	0.22	0.59	0.90
Mobile phone penetration	0	13	99	134
By Region (mobile network coverage)				
Western	0	0.36	0.68	0.93
Central	0.01	0.64	0.83	0.97
Greater Accra	0.70	0.94	1.0	1.0
Volta	0	0.48	0.73	0.95
Eastern	0	0.55	0.90	0.98
Ashanti	0.31	0.64	0.90	0.97
Brong Ahafo	0	0.23	0.72	0.92
Northern	0	0.11	0.58	0.92
Upper East	0	0.31	0.75	0.98
Upper West	0	0.06	0.65	0.90

Note: Mobile phone access was only available from 1998

Source: Authors' construction from data provided by national mobile service operators under the Global System for Mobile Communications Association (GSMA) as well as open-source data on cell phone towers.

When this general-purpose technology is considered alongside the share of agricultural households within the same period, we find a clear inverse relationship between the two. The diverging trends we see between mobile phone coverage and shares of agricultural households over time is suggestive of the role access to mobile phone coverage may have in the rural transformation trajectory. At the beginning of the series, we find a high heterogeneity in mobile coverage across regions with more urbanised regions such as Greater Accra and Ashanti regions recording a larger share of households with access to mobile networks. Over time, however, we note that for all the ten regions, mobile phone network coverage is close to 100 percent.

In summary, Ghana has experienced a decreasing trend in agricultural households over a period of 27 years. This trend is also seen in the share of individuals engaged in agriculture. Further analysis showed

that while there appears to be movement of rural dwellers away from agriculture, an increasing trend in the share of individuals engaged largely in the services sector is observed. Disaggregated analysis by age group, gender and educational level further revealed that adults have dominated the agricultural sector over the period while females have dominated non-agricultural sectors. In recent years, the share of individuals with higher education (secondary and tertiary) engaged in agriculture is increasing even though the agricultural sector is dominated by persons with lower levels of education. Regarding general purpose technologies, there has been a consistent increase in access to rural electrification over the period and an even more rapid spread of national cell phone coverage. The next section seeks to test empirically whether these general-purpose technologies have significant associations with the nature of the rural transformation observed in Ghana.

Potential Pathways from general purpose technologies to Rural Structural Transformation

Khandker et al., (2013) provides a conceptual framework that shows the possible mechanisms through which technologies such as the electrification can affect households' livelihood and welfare. It is important to note that the interconnections of the different elements within this conceptual framework suggest that the mechanisms are also interrelated.

As a starting point, connection to the grid facilitates the ownership of a broad range of productivity enhancing and time saving equipment and appliances including irrigation equipment, food preparation appliances such as blenders and food preservation equipment such as refrigerators. These appliances, according to Khandker et al., (2013) releases labour to other productive activities. Ownership of some appliances such as blenders that facilitates more efficient cooking and food preservation appliances including fridges and freezers increases the likelihood of households venturing in nonfarm enterprises. Appliances such as video equipment and television provide opportunities for non-farm businesses. In addition, access to electric bulbs can increase the number of hours that businesses get to operate in rural areas which ultimately increases household incomes.

In addition, access to electrification improves learning and schooling outcomes through increased study time and enhanced access to knowledge and information regarding learning materials, schooling options and information regarding better income opportunities which ultimately increases labour market outcomes outside of the agricultural sector.

In the current study however, due to data limitations, we only focus on the non-farm enterprise channel where we first explore how electricity by making possible household ownership of appliances including video equipment and television, and fridges and freezers facilitates household's engagement in non-farm enterprises which then reduces their involvement in agricultural activities. Given the interrelatedness of the pathways, we only aim to highlight the potential channels without assigning causal claims regarding the mechanisms through which electrification spurs the transformation of rural areas.

IV. Empirical Estimation

We run a series of empirical estimations following the specification spelled out in equation 1. The dependent variable Y_{igy} is a dummy variable that takes on the value 1 for an agricultural household *i* living in grid *g* at year *y* and zero otherwise. GPT_{gy} represents a vector of community infrastructure including the two main general-purpose technologies namely cell phone coverage (captured at the grid cell level) and electricity access, also at the community level. The vector of relevant household characteristics is represented by X_{igy}. To account for community level characteristics and year specific characteristics, we include grid cell fixed effects (α_g) as well year fixed effects (B_y). A full description of the variables is provided in Table A1 in the appendix.

$$Y_{igy} = \alpha_g + \beta_1 X_i + \beta_2 GPT_{gy} + \alpha_y + \varepsilon_{igy} \qquad (1)$$

Although our dependent variables assume binary value, we apply linear probability models to sufficiently capture the grid cell fixed effects and facilitate interpretation. Our preference for the LPM over the conventional logit or probit models that are widely applied in the literature for binary dependent variables is the advantage that LPMs offer particularly in dealing with fixed effects as noted by Angrist and Pischke (2009). As noted by Green (2002) and applied by Bellemare (2015), implementing fixed effects within a non-linear framework introduces biases. Given that controlling for grid level fixed effects accurately capture the unobserved heterogeneity across different localities over time, we opt for the LPM. In addition, coefficients from the LPM estimations can directly be interpreted as changes in probabilities.

To explore the heterogeneous effects of the general-purpose technologies, we estimate another set of regressions by interacting the technology variable GPT_{gy} with a set of household level variables (H_{iy}). Particularly we examine if the effect of the general-purpose technologies is differentiated based on several categories. Based on data availability, we consider the gender of the household head, the age of the household head (whether the head is considered youth (15-35), the education level of the household head, the socio-economic status of the household and whether the household owns family land. Similar to equation 1, the heterogeneous estimations include grid cell and year fixed effects. The heterogenous effects are represented by equation 2 as follows:

$$Y_i = \alpha_g + \beta_1 X_i + \beta_2 GPT_{gy} + \beta_3 H_i + \beta \ \ H_i * GPT_{gy} + \alpha_y + \varepsilon_{igy} \qquad (2)$$

V. Results

Table 3 shows the results of the estimated relationship between the general-purpose technologies (i.e. access to electricity and mobile phone coverage) and structural transformation in rural Ghana. The results in the first two columns suggest that access to electricity is associated with the exit of households from agricultural activities (interestingly, Table A1 in the appendix also shows that access

to electricity is observed to be associated with similar exit in urban Ghana). Particularly, households' access to grid electricity is associated with a 23.3 percentage point decline in the likelihood of anybody in the household participating in agriculture. It is possible that access to electricity may have opened up opportunities for households to be engaged in small-scale manufacturing, food processing, or service industries that are often engendered by reliable access to energy. Also, the improved access to information through media and information can challenge social norms on traditional agricultural activities and shift aspirations towards non-agricultural related activity.

The estimations further show that the characteristics of the household head and attributes of the family are important influencers of structural transformation. On the one hand, households with the head being female, youth (15 – 35 years) and possessing at least basic education were less likely to be engaged in agriculture. On the other hand, however, ownership of a family land by the household and being a poor family were positively associated with the likelihood of the household engaging in agriculture.

Table 3: Effects of general-purpose technologies on household participation in agriculture at the rural level

Dep var: = 1 if Agricultural household, = 0 otherwise	(1)	(2)	(3)	(4)
Electricity access	-0.303***	-0.233***		
	(0.025)	(0.022)		
Cell phone reception			-0.122**	-0.064
			(0.048)	(0.041)
Female head		-0.125***		-0.136***
		(0.006)		(0.007)
Youth		-0.083***		-0.083***
		(0.006)		(0.006)
Basic education & above		-0.098***		-0.114***
		(0.006)		(0.007)
Family land		0.230***		0.232***
		(0.011)		(0.011)
Poor		0.089***		0.101***
		(0.007)		(0.008)
Constant	0.885***	0.795***	0.846***	0.749***
	(0.010)	(0.011)	(0.031)	(0.027)
Observations	25,821	25,821	25,821	25,821
Adjusted R-squared	0.221	0.328	0.192	0.311

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level.
Source: Estimations cover GLSS 4, GLSS 5, GLSS 6, GLSS 7 (1998/99 – 2016/17)

Columns 3 and 4 focus on the effect of mobile phone coverage on households' movement out of the agriculture sector. While mobile phone coverage on its own appears to be associated with movements of households out of agricultural activities, after controlling for other relevant household and community level characteristics, this influence is lost. This result suggests that mobile phone coverage is not that important for structural transformation in rural spaces. In urban spaces however, households' access to cell phone coverage is associated with a reduced likelihood of engaging in agricultural activity by 14.4 percentage points as the advantages conferred by cell phone such as access to information on opportunities outside agriculture, the possibility of using mobile phones to generate alternative income streams and mobility and flexibility may encourage shifts away from traditional agricultural activities (see Table A1 in the appendix). We therefore explore the heterogenous effects only for electricity access in rural spaces (See Table 4).

In Table 4, columns 1 and 2 are the base models with no controls and controls respectively. Columns 3 to 7 include the interactions terms that are used to capture heterogeneous effects of electricity access in rural households. The coefficients show a consistent negative and significant effect of electricity access on households' engagement in agricultural activities. In model 3 where we consider the gender of the family head, the results show that in communities with access to electricity, households with female heads are associated with reduced likelihood of being in agricultural activities compared to those with male heads. Such households are about 4.5 percentage points less likely to participate in agricultural activities. In column 4, we observe that households with heads that are youth (15-35 years) and who have access to electricity are associated with a 16.5 percentage points decrease in the probability of being engaged in agricultural activities compared to households with heads who are adults. We also report a negative and significant effect of households with heads who have at least basic education and have access to electricity. Such households are associated with a 10-percentage point decline in the probability of engaging in agricultural activities compared to households with heads who have less than basic education. In columns 6 we note that electricity access is associated with a 14 percentage point increase in the probability of poor households engaging in agriculture compared to non-poor households Similarly in column 7, households with access to family land are 33 percentage points more likely to engage in agriculture with expansion in electricity access compared to households without family land.

Potential Mechanisms

Due to limitations with our data, we only explore the non-farm enterprise channel discussed earlier. For households to move out of agricultural activities, we argue that access to electricity provides an opportunity for households to purchase efficient cooking appliances as well as appliances that allow them to prepare food easily and preserve the food. Ownership of such appliances including blenders, fridges and freezers enable households to venture into the food processing and related activities in rural spaces. Similarly, ownership of video equipment and televisions made possible by households' access to the grid presents various opportunities for households to operate non-farm activities.

We show in Table 5 trends in household ownership of various electricity-powered home equipment between 1998 and 2017 in rural spaces. We observe from the table that there has been a consistent increase in the ownership of television, food processors/ blender as well as food preservation equipment such as fridges and freezers in rural areas in Ghana. Over the period, the proportion of household's who own television increased almost 20-fold from 1.68 % to 32.79%. Households that own fridges and freezers almost doubled over the period and there was also a steady increase in the households that own food processors. Over a period of ten years, mobile phone ownership increased significantly from 5.21% to 84.75%. The increase in such tools create opportunities for the households who own them to operate in the non-farm sector of the rural economy.

Table 4: Estimations of Heterogeneous Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep var: = 1 if Agricultural household, = 0 otherwise							
Electricity access	-0.303***	-0.233***	-0.221***	-0.188***	-0.194***	-0.282***	-0.416***
	(0.025)	(0.022)	(0.023)	(0.021)	(0.022)	(0.024)	(0.027)
Female head		-0.125***	-0.106***	-0.126***	-0.126***	-0.125***	-0.122***
		(0.006)	(0.009)	(0.006)	(0.006)	(0.006)	(0.006)
Youth		-0.083***	-0.083***	-0.020***	-0.083***	-0.082***	-0.077***
		(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)
Basic education & above		-0.098***	-0.099***	-0.097***	-0.056***	-0.096***	-0.095***
		(0.006)	(0.006)	(0.006)	(0.008)	(0.006)	(0.006)
Family land		0.230***	0.230***	0.226***	0.229***	0.228***	0.093***
		(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.011)
Poor		0.089***	0.089***	0.089***	0.089***	0.040***	0.085***
		(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.007)
Female head*electricity access			-0.045***				
			(0.016)				
Youth*electricity access				-0.163***			
				(0.016)			
Basic education & above*electricity access					-0.097***		
					(0.015)		
Poor*electricity access						0.140***	
						(0.018)	
Family land*electricity access							0.330***
							(0.022)
Observations	25,821	25,821	25,821	25,821	25,821	25,821	25,821
Adjusted R-squared	0.221	0.328	0.328	0.333	0.330	0.331	0.346

Notes: Robust Clustered Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level.

Source: Estimations cover GLSS 4, GLSS 5, GLSS 6, GLSS 7 (1998/99 – 2016/17)

Table 5: Proportion of households that own electrical equipment in rural spaces

Year	1998/1999	2005/2006	2012/2013	2016/2017
Television	1.68	12.32	28.47	32.79
Fridge/ freezer	7.44	6.30	12.14	12.78
Food processor/ blender		0.12	2.05	2.80
Mobile phone		5.21	67.47	84.75

Source: Authors' construct from GLSS 4, 5, 6 & 7

The trends in ownerships of electric appliances together with the results from the regression analysis in Table 6 provides evidence to support the argument advanced earlier. The trend analysis shows an increasing move toward ownership of all the appliances, and the coefficients indicate a positive and significant association between electricity access and a household member being in a non-farm enterprise in rural Ghana. Electric grid access increases the probability of operating a non-farm enterprise by about 14%. The increasing trend over time suggests that electricity facilitates the ownership of relevant appliances which then increases the likelihood of operating of such businesses in rural areas.

Table 6: Electricity access and non-farm enterprise

Dependent Variable: A member of household is engaged in non-farm enterprise	
Electricity access	0.140***
	(0.021)
Female head	0.029***
	(0.007)
Youth	-0.025***
	(0.007)
Primary	0.067***
	(0.010)
Basic	0.110***
	(0.009)
Secondary and above	0.039***
	(0.013)
Non poor	0.031***
	(0.008)
Observations	25,636
Adjusted R-squared	0.111

Notes: Robust Clustered Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the grid level.

Source: Estimations cover GLSS 4, GLSS 5, GLSS 6, GLSS 7 (1998/99 – 2016/17)

VI. Conclusion

Using five[6] waves of a nationally representative repeated cross-section spanning a period of almost three decades, we show the patterns and trends of structural transformation in rural areas in Ghana. The paper also examines the role of general-purpose technologies on structural transformation in rural areas by combining household survey data with administrative data on mobile phone coverage.

Our findings point to a modest decline in the share of labour in the agricultural sector, suggesting that some rural transformation has taken place, but not to the extent that may have previously been perceived. We further observe high levels of heterogeneity at the regional level. Additionally, we observe that young people (both male and female) dominate the shift from agricultural- related activities and a growing trend of higher education being associated with the agricultural sector. In understanding where labour is moving to, we observe increasing shares of labour in the services sector and although labour share in manufacturing shows a declining trend.

Considering both individual and household level measures of structural transformation, the trend analysis shows that while the decline in the proportion of agricultural households may seem dramatic at the national level, we find only moderate declines in agricultural households in rural areas in Ghana. This suggests that some structural transformation may have taken place in rural areas, but not as dramatically as may have been previously perceived. Furthermore, we note that young people appear to be driving the observed structural transformation occurring in rural spaces. In these spaces we note the agricultural sector is associated with a labour pool that has increasing educational levels. The high percentages of agricultural households in rural areas in Ghana confirms the prevailing understanding that agriculture still dominates in rural spaces in the country. Taken together, both the dominance of young people driving structural transformation and the increasing prevalence of educated labour associated with the agricultural sector in the rural areas present an opportunity for the sector to increase its efficiency and output. This could potentially spur growth in the manufacturing sector which can then facilitate a robust path the structural transformation.

Evidence from our estimations shows a strong correlation between household electricity access and movement of labour out of agricultural activities within rural spaces in Ghana. The analyses also highlight the differentiated effects of electrification on transformation in rural localities in Ghana. Specifically, effects are differentiated based on the gender, age, and educational level of the household head as well as the poverty status of the household.

While we mention the various channels through which electrification can facilitate the structural transformation of rural spaces, we focused only on the non-farm enterprise pathway in our paper due to data limitations. Our findings suggest that with the increased ownership of labour-saving appliances and food preservation equipment, households are presented with opportunities to diversify their

[6] Five rounds of the GLSS were used for the trend analysis while four rounds of the data were used for the regression analysis.

activities away from agriculture. The regression analysis does indeed present evidence to support the view that electrification significantly increases the likelihood of households' operating non-farm businesses in rural areas in Ghana.

The current study provides a general understanding of the patterns, trends of structural transformation, and the enablers and constraints focusing on general purpose technologies. Future studies can build on this evidence to explore the effects of other general-purpose technologies such as mobile phone coverage. Since mobile phones operates more at the individual level it is possible they can therefore allow more pathways to be explored to better understand the main mechanisms through which such technologies facilitate the structural transformation of rural spaces.

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Appendix

Table A1: Description of variables

VARIABLES	Definition
Dependent variable(s)	
Agricultural household	Dummy variable that takes on value 1 if at least one person in the household aged 15 years and above has been engaged in agriculture in the last 12 months, 0 otherwise. Agricultural employment classification is based on the industry classification.
Non-farm enterprise	A dummy variable that takes on the value of 1 if any member of the household is self-employed outside of agriculture or operated their own business/ trade, and 0 otherwise.
Household level variables	
Youth	A dummy variable taking on a value 1 for household head classified as youth if aged 15 – 35 years, 0 otherwise.
Female head	Dummy variable with value 1 if household is female headed and 0 otherwise.
Education	Education of household head is used in two forms. First in which basic education level and above is compared with less than basic education. Second, primary, basic, secondary and tertiary levels are compared with less than primary.
Family land	If a member of the family owned an agricultural land in the last 12 months. Dummy variable takes on a value of 1 if such is present, and 0 otherwise
Poor	A dummy variable that takes on the value 1 if the household is poor, and 0 otherwise
Community level variables	
Access to electricity	Proportion of households with access to national electricity grid per cluster/ enumeration area
Cell phone access	Cell phone reception per cluster. Cell network coverage measures the share of persons living in an area with access to cell phone coverage. The analysis is limited to second generation (2G) which supports voice calls and text messages.

Table A2: Effects of general-purpose technologies on household participation in agriculture at the urban level

Dep var: = 1 if agricultural household, = 0 otherwise	(1)	(2)	(3)	(4)
Electricity access	-0.576***	-0.376***		
	(0.056)	(0.042)		
Cell phone reception			-0.195***	-0.144***
			(0.038)	(0.029)
Female head		-0.071***		-0.072***
		(0.009)		(0.009)
Youth		-0.050***		-0.048***
		(0.008)		(0.007)
Basic education & above		-0.090***		-0.100***
		(0.009)		(0.010)
Family land		0.362***		0.376***
		(0.014)		(0.015)
Poor		0.128***		0.142***
		(0.014)		(0.015)
Constant	0.677***	0.535***	0.355***	0.342***
	(0.047)	(0.038)	(0.033)	(0.028)
Observations	18,642	18,642	18,642	18,642
Adjusted R-squared	0.260	0.400	0.234	0.390