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Food insecurity during the first year of the COVID-19 pandemic in four African countries☆

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ABSTRACT

We document trends in food security up to one full year after the onset of the COVID-19 pandemic in four African countries. Using household-level data collected by the World Bank, we highlight differences over time amid the pandemic, between rural and urban areas, and between female-headed and male-headed households within Burkina Faso, Ethiopia, Malawi, and Nigeria. We first observe a sharp increase in food insecurity during the early months of the pandemic with a subsequent gradual decline. Next, we find that food insecurity has increased more in rural areas than in urban areas relative to pre-pandemic data within each of these countries. Finally, we do not find a systematic difference in changes in food insecurity between female-headed and male-headed households. These trends complement previous microeconomic analysis studying short-term changes in food security associated with the pandemic and existing macroeconomic projections.

1. Introduction

The SARS-CoV-2 coronavirus (COVID-19) pandemic has led to widespread reductions in global food security, affecting vulnerable households in almost every country around the world. These adverse consequences are expected to continue through 2022, and possibly beyond, as new variants of the virus continue to spread. Moreover, although COVID-19 vaccines are widely available in high-income countries, to date, very few people in low-income countries are able to access these vaccines. Noted by Miguel and Mobarak (2021), as of August 2021, only 1.2 percent of people in Sub-Saharan Africa have been fully vaccinated against the COVID-19 virus. Thus, understanding the longer term socioeconomic consequences of this global health crisis is important for informing effective policy responses. Although short-term changes in food security associated with the onset of the pandemic are well-documented (Bloem and Farris, 2021; Josephson et al., 2021; Furbush et al., 2021), understanding and documenting longer term trends are exceedingly and increasingly relevant.

In this paper, we document longer term trends in food security in four countries in Sub-Saharan Africa, up to one full year after the onset of the COVID-19 pandemic. We use household-level survey data collected both before and during the pandemic, as part of the World Bank's Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) Initiative. These data provide valuable insight into changes in key socioeconomic indicators amid the pandemic in Sub-Saharan Africa. Upon the onset of the pandemic, in-person data collection was suspended and the World Bank supported implementation of phone surveys administered to a representative sub-set of the full study sample in each country. We use both the pre-pandemic face-to-face surveys and post-outbreak COVID-19 phone surveys to document trends in food security in Burkina Faso, Ethiopia, Malawi, and Nigeria. These data allow us to fully explore national-level trends over time, and also to examine sub-national dynamics in these trends across rural and urban areas and between female-headed and male-headed households.

We document three main findings. First, studying longitudinal trends during the COVID-19 pandemic, we find an initial spike in food insecurity in the early months of the pandemic followed by a gradual decline over time. To date, levels of each of our measures of food insecurity have not returned back to levels observed in the first month of

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the pandemic. Second, combining data collected during the pandemic with pre-pandemic data, we find that for most of our measures of food insecurity in most of the countries in our study, food insecurity increased more in rural areas than in urban areas. Finally, with the exception of Nigeria, we do not find any evidence of differences in changes in each of our measures of food insecurity between female-headed and male-headed households. In Nigeria, by contrast, we find that male-headed households experience larger adverse changes in food security during the pandemic relative to pre-pandemic levels.

Taken together, these findings inform two key lessons about the evolution of changes in food insecurity associated with the COVID-19 pandemic so far. First, although some analysis of short-term changes in food insecurity associated with the pandemic found evidence of larger adverse changes in urban areas than in rural areas (e.g., Adjognon et al., 2021a in Mali), this result appears not to hold when analyzing a longer time frame. This is consistent with an understanding of the spread of the coronavirus which first affected individuals in urban areas and then began to spread to rural areas. Second, these findings highlight the critical importance of taking into account local-level factors when assessing changes in food insecurity associated with the pandemic. Although we find some consistent results across each of the countries included in our study, we also find important exceptions that highlight the presence of critical heterogeneity across and within countries. This presence of heterogeneity motivates careful consideration of local-level factors when considering policy responses to pandemic-related disruptions that aim to support the food security of potentially vulnerable households.

Our analysis complements two strands of existing research on the COVID-19 pandemic and food security. First, in initial months of the pandemic, numerous studies set out to document short-term changes in food security.[2] In a review of this literature, Bloem and Farris (2021) note that the existing microeconomic literature finds conflicting evidence of how food security trends differ between rural and urban areas and by household-level socioeconomic status. Further, all of these existing studies are limited to documenting only short-term changes in food security associated with the onset of the pandemic. Second, existing macroeconomic projections estimate that in 2021 the number of food insecure people in the world will rise by 291 million people—an increase of roughly 30 percent (Baquedano et al., 2021).[3] Although these macroeconomic projections provide valuable insight into expected future changes in food security, supplementing these projections with analysis of household-level data helps triangulate a better understanding of global food security amid the pandemic, through facilitating sub-national analysis. We aim to (a) document longer term trends in food security across four African countries with household-level survey data and (b) use microeconometric analysis to investigate differences between rural and urban areas and between female-headed and male-headed households within these countries.

Our paper is most closely related to Mueller et al. (2021), Dasgupta and Robinson (2022), and Maredia et al. (2022) which each study food security trends in low- and middle-income countries during the COVID-19 pandemic.[4] In doing so, Mueller et al. (2021) show that knowledge of a person who is infected with COVID-19 is associated with food insecurity. In addition, Dasgupta and Robinson (2022) show that female-headed households and poorer households appear to have experienced the largest adverse changes in food insecurity during the COVID-19 pandemic. Finally, Maredia et al. (2022) show that changes in food security were correlated with the severity of pandemic-related lockdowns but were similar between rural and urban areas. Our work differs from Mueller et al. (2021), Dasgupta and Robinson (2022), and Maredia et al. (2022) in that we have the benefit of a pre-pandemic survey wave in which to compare reported trends in food security amid the COVID-19 pandemic. This is a critically important detail as food insecurity increased dramatically in the initial months of the pandemic, and therefore comparisons to pre-pandemic levels allow for analysis of changes in food insecurity associated with the onset of the COVID-19 pandemic.

The rest of this paper is organized as follows. In the next section, we introduce the World Bank's LSMS-ISA data as well as the COVID-19 phone survey data. In Section 3, we discuss our analytical approach and highlight its strengths and weaknesses in the current empirical setting. In Section 4, we report and discuss our main results. Finally, in Section 5, we conclude.

2. Study setting and data

To study changes in food security associated with the COVID-19 pandemic, we combine the World Bank supported Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) household survey data collected before the pandemic with household survey data collected via phone during the pandemic. The LSMS-ISA data collected before the pandemic comprise our baseline. We combine these data with LSMS-supported high frequency phone surveys that began in May 2020, using a sampling frame based on the pre-pandemic face-to-face surveys (WB, 2021a,b,c; NBS, 2021). The COVID-19 phone survey data provide us with detailed monthly panel survey data for households up to 15 months after the onset of the pandemic.

We specifically use data from Burkina Faso, Ethiopia, Malawi, and Nigeria. The selection of these countries is guided solely by the public availability of unit-record survey data immediately prior to the pandemic. Additional phone survey rounds are available for Chad, Djibouti, Georgia, India, Kenya, Mali, and Uganda. However, these COVID-19 phone surveys lack pre-pandemic data on food insecurity and are therefore not appropriate for use in the present study. Before we discuss these data in more detail, we provide a brief summary of each of the four countries in our study and highlight their response to and experience with the COVID-19 pandemic.

In response to the COVID-19 pandemic Burkina Faso closed schools, workplaces, restricted public gatherings, and issued a stay-at-home order from April through May 2020. Burkina Faso implemented a second stay-at-home order a year later, from April through May 2021. In Nigeria, most policy responses aiming to slow the spread of the COVID-19 virus were implemented at the state level and thus varied across the country. In general, state-level restrictions were in place from April through August 2020. Some Nigerian states re-implemented restrictions again between December 2020 and January 2021. Ethiopia implemented restrictions on school attendance, workplaces, and public gatherings from April through October 2020. Malawi implemented restrictions on school attendance and public gatherings in April 2020

[2] These include Abay et al. (2020) on rural Ethiopia; Adjognon et al. (2021a) on Mali; Aggarwal et al. (2020) on rural Liberia and Malawi; Amare et al. (2021) on Nigeria; Ceballos et al. (2020) on India; Josephson et al. (2021) on Ethiopia, Malawi, Nigeria, and Uganda; Kansiime et al. (2021) on Kenya and Uganda; Hirvonen et al. (2021) on Addis Ababa, Ethiopia; and Mahmud and Riley (2021) on rural Uganda.

[3] Similar macroeconomic projections are reported by the United Nations Food and Agriculture Organization (FAO, 2021) and the International Food Policy Research Institute (IFPRI, 2021). These macroeconomic projections do not specifically identify changes specifically due to the COVID-19 pandemic, but more generally project a combination of changes associated with the COVID-19 pandemic and other long-term macroeconomic factors.

[4] Specifically, Mueller et al. (2021) study Bangladesh, Kenya, and Nigeria from October 2020 through April 2021. Dasgupta and Robinson (2022) study Armenia, Cambodia, Chad, Djibouti, Ethiopia, Kenya, Malawi, Mali, Nigeria, South Africa, and Uganda and do not include "pre-pandemic" data in their analysis. Maredia et al. (2022) study Kenya, Zambia, Mali, Nigeria, and Senegal from September through November 2020.

and implemented a stay-at-home order in May 2020. Some of these restrictions were implemented again a year later from March through April 2021 (Ritchie et al., 2020). As of the end of June 2021, at the time of data collection for the last round of data COVID-19 phone survey data used in this study, each of the countries in this study reported numbers of positive COVID-19 cases and deaths related to contracting the COVID-19 virus. Burkina Faso reported 13,481 total cases and 168 total deaths, Nigeria reported 167,543 total cases and 2120 total deaths, Ethiopia reported 276,037 total cases and 4320 total deaths, and Malawi reported 35,897 total cases and 1194 total deaths (WHO, 2021).

The hungry season and socio-political events contemporaneous to the pandemic also provide important context for understanding the dynamics of responses and experiences to the pandemic. In Burkina Faso the hungry season extends from July to September for corn and millet planters, September to January for sorghum planters, and February for rice planters (IPAD, 2022a). In addition, during our study period Burkina Faso experienced a presidential and legislative election with associated security concerns (Reuters, 2020). In Nigeria the hungry season extends from June to September for corn, millet, peanut, rain-fed rice, and sorghum planters (IPAD, 2022d). Additionally, throughout the duration of our study Nigeria experienced violent events perpetrated by both state and non-state actors. In Ethiopia the hungry season for barley, corn, millet, sorghum, and wheat planters extends from June to November, and for cereal planters is in May (IPAD, 2022b). Further, after election delays in 2020 due to the COVID-19 pandemic, the Tigray region held their own referendum in September 2020 contrary to government demands. This created a crisis that led to an ongoing civil war, which has its own associated challenges on food security (Abay et al., 2022). Finally, in Malawi the hungry season extends from December to March for corn planters, January to May for rice planters and sorghum planters, and April to June for wheat planters (IPAD, 2022c). In addition, during the time period of the study, Malawi's 2019 presidential election was annulled by the Supreme Court of Malawi (Gondwe, 2020a). A new election was held in June 2020 where Lazarus Chakwera was declared the winner (Gondwe, 2020b).

2.1. Sampling design and survey weights

The sampling design for the COVID-19 phone surveys is based on the sampling design from the pre-pandemic LSMS-ISA surveys. These pre-pandemic surveys include the Burkina Faso Harmonized Living Conditions Household Survey (EHCVM) 2018/19, Ethiopia Socioeconomic Survey (ESS) 2018/19, Malawi Integrated Household Panel Survey (IHPS) 2019, and Nigeria General Household Survey (GHS) - Panel 2018/19. Each pre-pandemic survey sample is representative at the national, urban/rural, and regional level. These data are then paired with the phone survey data to form multi-wave panel datasets for each country. The existing work of Josephson et al. (2021) provides additional detail on the sampling frame and design.

Our empirical approach relies on longitudinal comparisons of household-level measures of food insecurity. Thus, we only include households in the analysis that are in the pre-pandemic sample and show up at least once in the COVID-19 phone survey sample. This provides us with a sample size of 2413 unique households in Burkina Faso, 3247 unique households in Ethiopia, 1726 unique households in Malawi, and 1950 unique households in Nigeria. Our total sample is thus 9066 unique households across the four countries. Following these households over time yields a total of 66,314 total observations, across each wave in our panel data set. On average, each household appears in our data seven times.

Attrition in the COVID-19 phone surveys results in two types of selection bias. The first is associated with not being able to connect with households in the pre-pandemic sample because they do not own a mobile phone or because the listed phone number is no longer active. The second is non-response associated with not being able to interview households selected for the COVID-19 phone survey.[5] Both of these issues result in an unbalanced panel, as not all households have mobile phones, not all mobile phone numbers are active, and not all respondents reliably answer their mobile phone. In the Supplemental Appendix, Figure A1 illustrates round-specific phone survey response rates. The presence of selection bias and non-response bias means that results based on the raw data likely underestimate real changes in food security amid the COVID-19 pandemic, because poorer households are both less likely than wealthier households to have phones and more likely to be vulnerable and experience food insecurity.[6]

In order to correct for bias driven by selection bias and non-response bias, we use sampling weights following Tillé (2006) and Himelein (2014). The phone survey sampling weights in each country build on the sampling weights for the corresponding pre-pandemic survey. These weights are calibrated to address the selection bias introduced from households not owning a mobile phone and non-response bias from not answering the phone. This latter issue is overwhelmingly due to non-working phone numbers or prospective respondents not answering calls, as opposed to refusals. To calculate sampling weights for the phone survey, we implement are series of steps as discussed in Josephson et al. (2021). Sampling weights are calculated for each round in the data based on the response and non-response rates for a given round. We then calculate the mean of a household's weight across all COVID-19 phone survey waves. We use this mean sampling weight to correct for bias in the COVID-19 phone survey data. Baseline data are weighted using the sampling weights that are provided by the World Bank with the publicly available data.

2.2. Food insecurity experience scale

The United Nations Food and Agriculture Organization (FAO) defines food security as existing, "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996, 2009). While this definition is widely accepted, there is considerable variation in the ways researchers attempt to measure food insecurity (Carletto et al., 2013). The eight question Food Insecurity Experience Scale (FIES) is the preferred measure of the FAO, while the U.S. Department of Agriculture (USDA) has a related 10 question measure of food insecurity used in surveys of households in the United States. Other studies use measures of dietary diversity as proxies for food insecurity, including the household dietary diversity score (HDDS) developed by FAO or the household species richness index (HSR) developed by Lachat et al. (2018). Bloem and Farris (2021) provide an overview of the different measures for food insecurity used in the existing microeconomic literature on changes in food security amid the COVID-19 pandemic in low- and middle-income countries.

We use the FIES as our measure of food insecurity and our primary outcome of interest. The FIES is an experience-based metric of food insecurity severity, which relies on individual's direct responses to questions about their household's experiences with access to adequate food (Ballard et al., 2013; Cafiero et al., 2018; Wambogo et al., 2018). The FIES is constructed based on responses to eight survey questions

[5] A related concern is potential bias due to systematic migration in our sample. Although this could lead to systematic attrition in our data, previous analysis using the data we use in this paper for a larger set of countries finds that a very small share of households migrate during the pandemic (Josephson et al., 2021).

[6] Household income is a common leading indicator for experiencing food insecurity. Analysis of household food security in the United States shows that low-income households are more likely to report experiencing food insecurity (Coleman-Jensen et al., 2021). Additionally, macroeconomic projections use changes in household income, aggregated to the national level, to project the prevalence of food insecurity (IFPRI, 2021).

Country	Pre-COVID	2020 Apr	2020 May	2020 Jun	2020 Jul	2020 Aug	2020 Sep	2020 Oct	2020 Nov	2020 Dec	2021 Jan	2021 Feb	2021 Mar	2021 Apr	2021 May	2021 Jun
Burkina Faso	2018/19					■		■	■	■	■	■		■		■
Ethiopia	2019	■	■	■		■	■	■								
Malawi	2019/20			■	■	■			■	■	■		■	■		■
Nigeria	2018/19		■	■		■			■							

Fig. 1. Rounds in which food security module was included. *Note*: Timeline shows, by country, in which month the phone-survey included the food security module containing the FIES questions.

about a respondent's experience in various domains of food insecurity at the household level. A general summary of these eight survey questions include the following[7]:

- FS1: Household members have been worried that they will not have enough to eat because of a lack of money or other resources?
- FS2: Household members have been worried that they cannot eat nutritious foods because of lack of money or other resources?
- FS3: Household members had to eat always the same thing because of lack of money or other resources?
- FS4: Household members had to skip a meal because of lack of money or other resources?
- FS5: Household members had to eat less than they should because of lack of money or other resources?
- FS6: Household members found nothing to eat at home because of lack of money or other resources?
- FS7: Household members have been hungry but did not eat because of lack of money or other resources?
- FS8: Household members have not eaten all day because of lack of money or other resources?

The FIES is designed to facilitate comparisons of food insecurity experienced by people in different contexts and across national and sub-national populations.

While the FIES is designed to allow for comparison of food insecurity in different contexts, we face several challenges in making such comparisons. First, in the COVID-19 phone surveys, all eight FIES questions were asked in each country and all questions have a reference period of the last 30 days. However, not every round of the COVID-19 survey in a country included the food security module. This means that there are gaps in the round-to-round data on food insecurity (see Fig. 1). Second, the pre-pandemic surveys includes inconsistencies in what FIES questions were included in the food security module, how the questions were phrased, and the reference period. For example, in Burkina Faso, the same eight questions were asked in the pre-pandemic survey and COVID-19 surveys, but the reference period differed. In the pre-pandemic survey, the reference period for all eight questions is the previous 12 months. This was so that the measurement could capture the seasonal nature of food insecurity for agricultural households.[8] In the COVID-19 phone surveys, the reference period is the previous 30 days, as survey rounds occurred roughly 30 days apart. Additionally, in Malawi, FS3 and FS8 are not included in the pre-pandemic survey. Ultimately, only in Nigeria were all eight FIES questions phrased in exactly the same way and had the same recall period for the pre-pandemic survey and COVID-19 phone surveys. Supplemental Appendix Tables A1 through A4 provide full details on the phrasing and reference period for each survey question in each country. Differences also persist in other measures that we use to supplement our analysis. In Ethiopia and Malawi, pre-pandemic surveys asked questions about the *number of days* in the past week a household member had done a particular activity (e.g., how many times did you skip a meal). In COVID-19 phone surveys, the questions are all binary indicators, asking *if in the past 30 days* a household member had ever done a particular activity (e.g., did you skip a meal).

To address these inconsistencies, our primary outcome of interest is a standardized measure of the raw FIES score. For each household in each country in each round we count up the number of affirmative answers to the FIES questions.[9] We standardize this variable using the survey weights, such that the variable has a weighted mean of zero and a weighted standard deviation of one. We do this by country for the pre-pandemic surveys. For the COVID-19 phone survey data, we standardize by country across all survey rounds, as the questions and reference period were the same throughout all COVID-19 phone survey waves.

We adopt this approach for three reasons. First, because the survey data are collected in different months in each country this standardization helps to avoid bias driven by seasonality and allows for comparisons of deviations from the pre-pandemic mean and the mean of the variables after the onset of the pandemic within each country. Second, because the baseline food security indicator questions were asked in different ways and with different reference periods, the standardization helps to avoid bias driven by these differences and allows for comparison between pre-pandemic and COVID-19 phone survey data within a country. Third, the standardization process allows for easier interpretation of our estimated coefficients in terms of standard deviations instead of a unitless score. Nevertheless, and to serve as a robustness check, we present our core results using an alternative standardization procedure that standardizes pre-pandemic and post-outbreak data together in Figures A3 and A4 in the Supplemental Appendix.

In addition to the weighted standardized FIES score, we use the food insecurity severity classifications developed by Cafiero et al. (2018). Following Adjognon et al. (2021a), we define "mild food insecurity" with a raw FIES score greater than zero, "moderate food insecurity" with a raw FIES score greater than three, and "severe food insecurity" with a raw FIES score greater than seven (i.e., answering affirmatively to each of the eight FIES questions). Our classification of moderate and severe food insecurity is closely related to that used by Smith et al. (2017) to measure food insecurity globally and with Josephson et al. (2021) and Furbush et al. (2021) to measure the changes in food insecurity amid the initial months of the COVID-19 pandemic. In order to ensure measures of food security are comparable across countries and time, Smith et al. (2017), Josephson et al. (2021), and Furbush et al. (2021) use a Rasch model which aims to correct for heterogeneity that may influence responses to the FIES questions. In our study, as questions and reference periods differ, we lack the symmetry necessary to correctly implement the Rasch model. So, instead, we uses our weighted standardization to facilitate cross-country and cross-round comparisons. Thus, we report results for four measures of food

[7] It is important to note that the specific wording of each of these questions varies across countries and across surveys within countries. We list the specific survey questions for the pre-pandemic LSMS survey data and the post-outbreak COVID-19 phone survey data for each country in the Supplemental Appendix.

[8] In Ethiopia and Malawi, by contrast, the pre-COVID survey asked about food insecurity using a seven day reference period. This was done to shorten the recall period and capture more precise information.

[9] For pre-pandemic questions in Ethiopia and Malawi that asked about the *number of days* we simply code any non-zero value as a one.

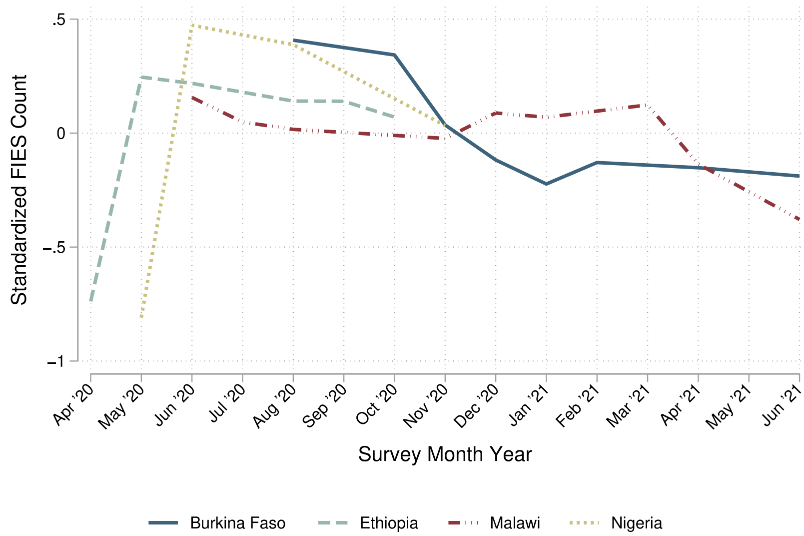

Fig. 2. Changes in standardized raw FIES score over time. *Note*: The figure presents the mean of the standardized raw FIES score by country and wave. This standardization procedure ensures that for each country the FIES variable has a mean of zero and a standard deviation of one within the data collected after the onset of the pandemic. Therefore, values below zero indicate that food insecurity (as measured via the FIES) is low relative to other months in the data collected after the onset of the pandemic in each country. All values are computed using survey weights. Not all countries had survey data collection in the same month and not all surveys asked questions about food insecurity. As a result, there are gaps in the time series in each country.

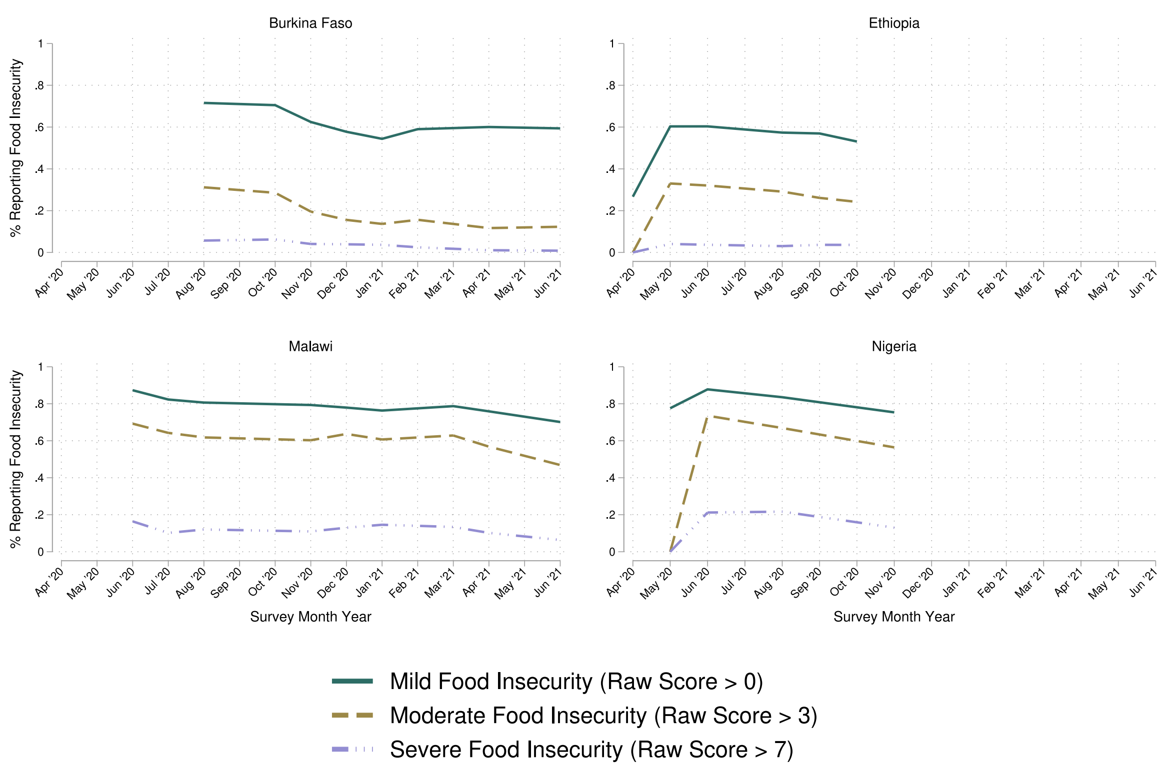

Fig. 3. Changes in food insecurity by country over time. *Note*: The figure presents the mean of three different measures of food insecurity: Mild Food Insecurity (Raw Score > 0), Moderate Food Insecurity (Raw Score > 3), and Severe Food Insecurity (Raw Score > 7), by country and wave. All values are computed using survey weights. Not all countries had survey data collection in the same month and not all surveys asked questions about food insecurity. As a result, there are gaps in the time series in each country.

security. First we use the weighted standardized raw FIES score. The other three indicators we use are binary measures for if the household experiences (i) mild, (ii) moderate, or (iii) severe food insecurity.

3. Estimation strategy

To estimate the relationship between COVID-19, food security, and household characteristics we use a difference-in-differences regression estimation approach. This analytical approach aims to estimate differences in food insecurity trends, measured in the pre-pandemic data and the COVID-19 phone surveys, between different types of households. We specifically investigate differences between (i) households in urban areas and households in rural areas, and (ii) female-headed households and male-headed households. We emphasize that this estimation strategy does not calculate a credible estimate of the causal effect of the COVID-19 pandemic on food insecurity. Our goal is more modest, but nevertheless informative, as this approach estimates changes in our four measures of food insecurity between rural and urban within countries and between female-headed and male-households.

We estimate a simple difference-in-difference specification that compares differences in food insecurity before and after the onset of the pandemic between urban households and rural households, and between female-headed and male-headed households, respectively. Specifically we estimate a linear regression that includes an indicator for survey waves collected after the onset of the COVID-19 pandemic and either an indicator for urban (relative to rural) households or an indicator for female- (relative to male-) headed households.

$$y_{it} = \alpha + \beta \mathbb{H}_i + \delta COVID_t + \gamma \left(\mathbb{H}_i \times COVID_t \right) + \pi_t + \epsilon_{it}, \quad (1)$$

In Eq. (1), y_{it} is our outcome variable measuring food insecurity for household i in time t, $\mathbb{H}_i$ is a time-invariant binary indicator for either an urban household or a female-headed household, $COVID_t$ is a binary indicator for if the survey wave is from the COVID-19 phone survey collected after the onset of the pandemic, π_t is a survey wave fixed effect, and ϵ_{it} is an error term. Our coefficient of interest is γ, which estimates the differential change in food insecurity amid the COVID-19 pandemic between rural and urban households or between female-headed and male-headed households. We also include a set of dummy variables (not shown in Eq. (1)) to control for if a household did not answer all eight FIES questions, for any reason. This allows us to compare outcomes for a household that may have answered only a subset of the FIES questions to other households who answered the same subset of questions. We estimate regressions for each country separately. All standard errors are clustered at the household-level and all regressions include sampling weights.

Again, we emphasize that this estimation approach does not calculate a credible estimate of the causal effect of the COVID-19 pandemic. In order to interpret our estimates in this way we would require the identifying assumption of parallel counterfactual trends in latent food security between households in urban versus rural areas or between female- versus male-headed households in the absence of the pandemic. This parallel counterfactual trends assumption cannot be tested and may not hold in the context of our data. A variety of forms of unobserved heterogeneity beyond rural and urban locations or female-headed and male-headed households limit our ability to claim credible causal identification of our coefficient estimates. The analysis should be interpreted as describing heterogeneity in changes in food insecurity within each country associated with the COVID-19 pandemic.

This descriptive analysis is important for several reasons. First, the geographic distribution of COVID-19 related disruptions change as the pandemic persists. Therefore, our analysis helps inform an understanding of what areas, within countries, are households most vulnerable to food insecurity amid the pandemic. For example, analyzing data from the initial months of the pandemic in Mali, Adjognon et al. (2021a) find that Mali's urban areas experienced an increase in food insecurity while Mali's rural areas experienced no change, on average. As discussed by Bloem and Farris (2021), however, it may be that this trend changes in the longer term as the pandemic and pandemic-related disruptions begin to extend into rural areas. Second, the experience of vulnerable households may change and evolve as the pandemic continues. Reviewing the existing microeconomic literature, Bloem and Farris (2021) find that the poorest and most vulnerable households did not consistently experience the largest adverse changes in food insecurity. Thus, we proxy for household vulnerability by estimating changes in food insecurity amid the pandemic between female-headed and male-households (Buvinić and Gupta, 1997).

4. Results

We report four sets of results. First, we report longitudinal trends in our measures of food insecurity during the COVID-19 pandemic in Burkina Faso, Ethiopia, Malawi, and Nigeria. These figures provide insight into household food insecurity amid the pandemic. Second, combining pre-pandemic data with data collected during the pandemic, we report regression results that investigate differential changes in food insecurity associated with the onset of the pandemic between rural and urban areas. Third, with the same estimation approach, we document differential changes in food insecurity associated with the onset of the pandemic between female-headed and male-headed households. Finally, we examine intertemporal heterogeneity in the differential trends between rural and urban areas, by reporting estimates from an event study regression specification. Taken together, these regression results describe how measures of food insecurity changed within countries relative to before the onset of the pandemic.

4.1. Longitudinal trends amid the COVID-19 pandemic

We first discuss longitudinal trends in food insecurity amid the COVID-19 pandemic from April 2020 until June 2021, using data from the COVID-19 phone surveys. As previously discussed, there is variation in the beginning and end of the COVID-19 survey waves for each country. This is because, as presented in Fig. 1, not every country is included the FIES module in every month. Nevertheless, these results describe how our four measures of food insecurity changed amid the pandemic in the four countries.

Fig. 2 plots the mean standardized raw FIES score by country and survey wave for the COVID-19 phone survey data. In general, we see an initial spike in food insecurity in the first few months after the onset of the pandemic, then in subsequent months the mean standardized raw FIES scores begin to decline. In particular, the trends for Nigeria and Ethiopia show a dramatic increase in raw FIES score between the first and second waves of the COVID-19 phone survey. This is followed by a slow decline back towards the mean over subsequent waves. Malawi, by contrast, begins with an above average raw FIES score. It is important to note, however, the first wave to include questions about food insecurity for Malawi was in June of 2020, so this trend may be driven by the timing of these questions relative to the onset of the pandemic. After June of 2020, the raw FIES score in Malawi decreases slightly but holds relatively steadily until a notable decrease starting March 2021. In Burkina Faso, we also initially observe an above average raw FIES score. Again, it is important to note that the first survey wave in Burkina Faso to include questions about food insecurity began many months after the onset of the pandemic. In subsequent months, Burkina Faso experienced declines in food insecurity relative to August of 2020. The steepest decline occurred between October of 2020 to November of 2020.

Fig. 3 plots our three additional measures of food insecurity (e.g., mild, moderate, and severe) for each country between April of 2020 and June of 2021. In Burkina Faso, roughly 70 percent of households experienced mild food insecurity in August of 2020. The share of households experiencing mild food insecurity decreases from October of 2020 through January of 2021 where it reaches the low of roughly 55 percent before rising slightly and persisting at that level through June 2021. The share of households reporting moderate food insecurity in Burkina Faso begins at around 30 percent in August of 2020 and follows a similar trend as mild food insecurity, declining to a low of 15 percent in January before leveling at roughly 20 percent through the end of June of 2021. In contrast, the number of households reporting severe food insecurity remained fairly stable throughout the study period. In August of 2020, less than 10 percent of people reported severe food insecurity though that rate fell by only a few percentage points by June of 2021.

In Ethiopia, where we only have data through October of 2020, we observe an initial spike in the number of households reporting mild and moderate food insecurity. In April of 2020 the rate of mild food insecurity was roughly 30 percent and the rate of moderate food insecurity is close to zero. One month later, in May, roughly 60 percent of households report mild food insecurity and 30 percent of household report moderate food insecurity. In subsequent months, rates

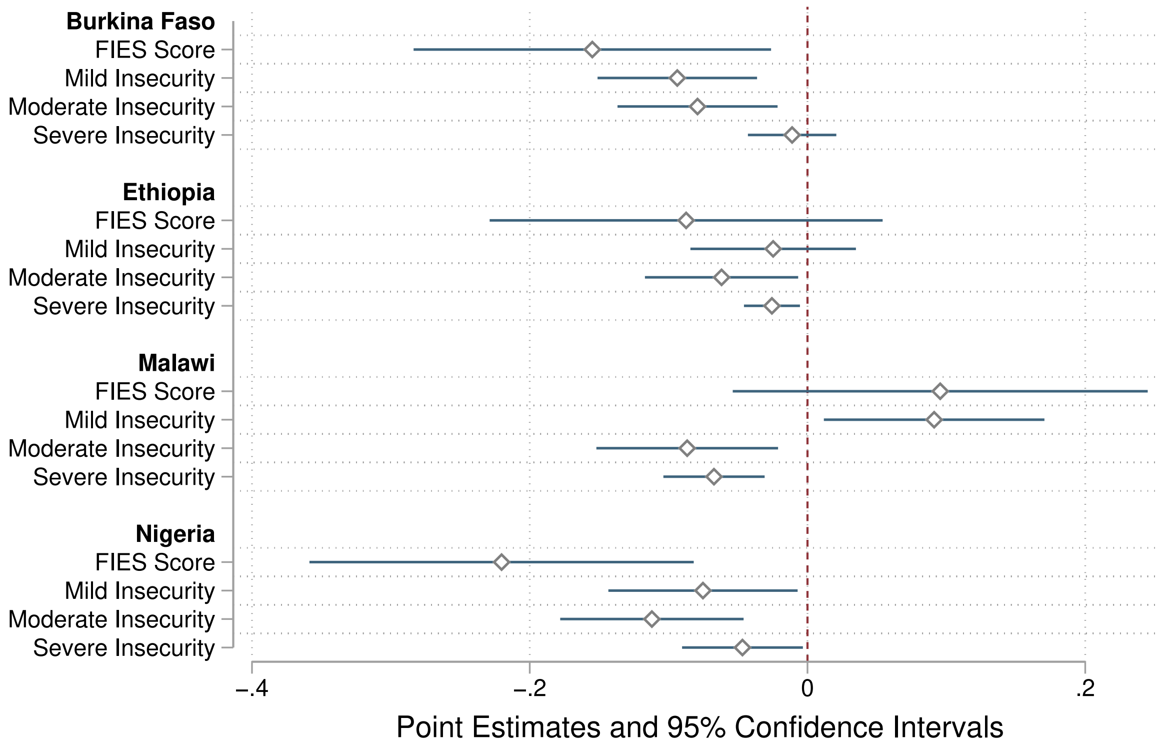

Fig. 4. Urban–rural differences in changes in food insecurity. *Note*: This figure reports coefficients and 95% confidence intervals when estimating differences between urban and rural households before and during the pandemic. When the coefficient is positive, this implies that households in urban areas experienced a larger increase in the given measure of food insecurity, since before the pandemic, relative to rural households. When the coefficient estimate is negative, this implies that households in rural areas experienced a larger increase in food insecurity. This analysis uses FIES data from before and after the COVID-19 outbreak.

of both mild and moderate food insecurity slowly decline but remain persistently higher than in April of 2020. By contrast, the rate of severe food insecurity remains largely unchanged from April through October of 2020.

In Nigeria, we observe a pattern in trends that is similar to those in Ethiopia. In particular, we see an initial spike in mild and moderate food insecurity that slowly declines in subsequent months. More specifically, the share of households reporting mild food insecurity is just under 80 percent in May of 2020. This rate increased to just under 90 percent in June and eventually declined through November of 2020. Similarly, the percent of households reporting moderate food insecurity increased from just above zero in May to over 70 percent in June of 2020. In subsequent months the share of households reporting moderate food insecurity slowly declined but remained relatively high – above 60 percent of households – through November of 2020. Finally, the portion of households reporting severe food insecurity started close to zero in May and increased to roughly 20 percent in June, where this rate remained steady through November of 2020.

Finally, in Malawi we observe trends similar to those in Burkina Faso. In the first wave from June of 2020, roughly 80 percent of households report mild food insecurity. This rate declines only slightly through June of 2021. Similarly, roughly 70 percent of households report moderate food insecurity in June of 2020. This rate declines modestly again by June 2021 to roughly 60 percent of households. Finally, the share of households reporting severe food insecurity is fairly steady – at roughly 20 percent of households – through the study period.

The longitudinal trend analysis highlights two clear findings. First, in Ethiopia and Nigeria, where we have data in the early months of the pandemic, we observe sharp increases in the percent of households reporting some level of food insecurity. Second, in all countries we observe gradual declines in the percent of households reporting some level of food insecurity in the months after the initial onset of the COVID-19 pandemic. However, we find no evidence to suggest that rates of food insecurity have fallen back to the levels observed in the first month of the pandemic.

4.2. Differences between rural and urban areas

We now turn to discussing results from our regression analysis. By combining pre-pandemic data with data collected during the pandemic, this estimation approach allows us to describe how trends in food insecurity, dating back to before the pandemic, change within countries. We begin by discussing differences between rural and urban households. In a review of the microeconomic literature studying short-term changes in food insecurity associated with the pandemic, Bloem and Farris (2021) find conflicting evidence on differential changes in food insecurity between rural and urban areas. On the one hand, Adjognon et al. (2021a) finds that adverse changes in food insecurity were much larger in Mali's urban areas than in rural areas. On the other hand, Amare et al. (2021) did not find any difference in changes in food insecurity between urban and rural areas in Nigeria. We explore differences in changes in food insecurity associated with the pandemic between rural and urban areas in Burkina Faso, Ethiopia, Malawi, and Nigeria one year after the onset of the pandemic.

Before we discuss how changes in food insecurity associated with the COVID-19 pandemic differ between rural and urban areas, it is useful to document the more general average changes associated with the pandemic. Tables A5 through A8 in the Online Appendix report results from Eq. (1) in tabular form for each measure of food insecurity. The coefficient on the $COVID_t$ binary variable estimates the average change in a given measure of food insecurity associated with the COVID-19 pandemic within each of the four countries in our study. Table A6 reports results on the binary indicator of mild food insecurity. In each of the four countries, we find that on average mild food insecurity increased within the timeframe of our study. We find similar results for both moderate (Table A7) and severe (Table A8) food insecurity, which on average is increasing in Ethiopia, Malawi, and Nigeria during the

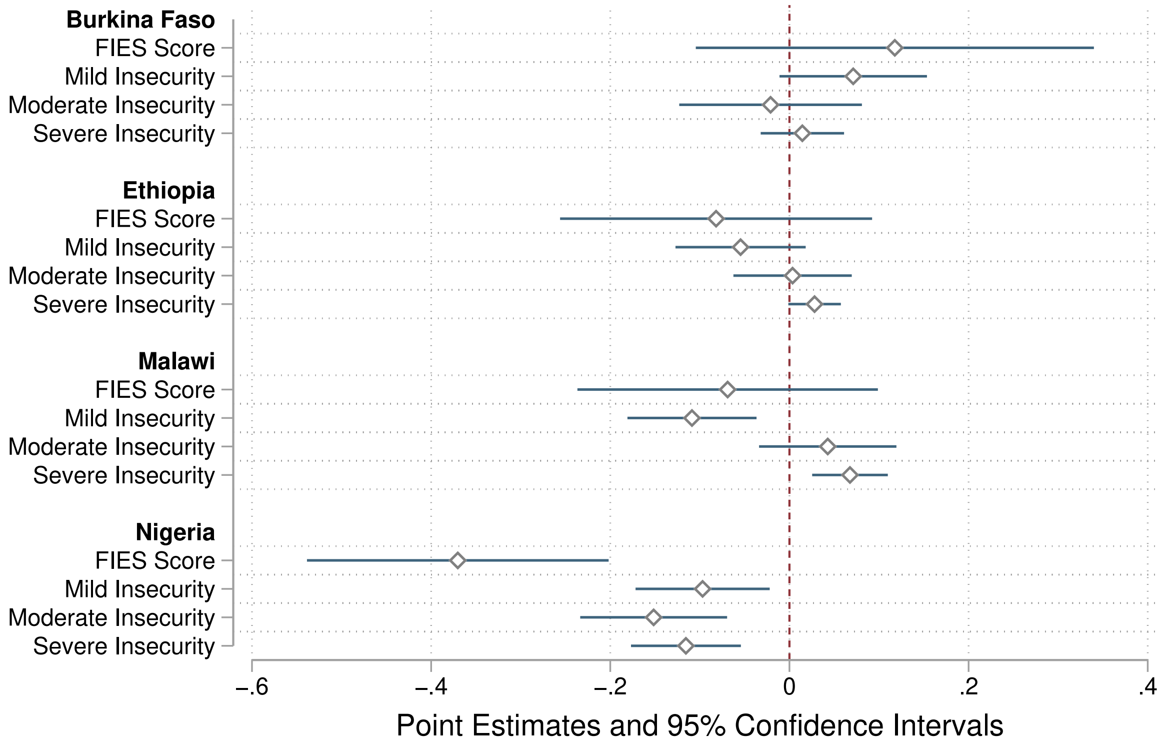

Fig. 5. Female-Male headed household differences in changes in food insecurity. *Note*: This figure reports coefficients and 95% confidence intervals when estimating differences between female-headed and male-headed households before and during the pandemic. When the coefficient is positive, this implies that female-headed households experienced a larger increase in the given measure of food insecurity since before the pandemic, relative to male-headed households. When the coefficient estimate is negative, the implies that male-headed households experienced a larger increase in food insecurity. This analysis uses FIES data from before and after the COVID-19 outbreak.

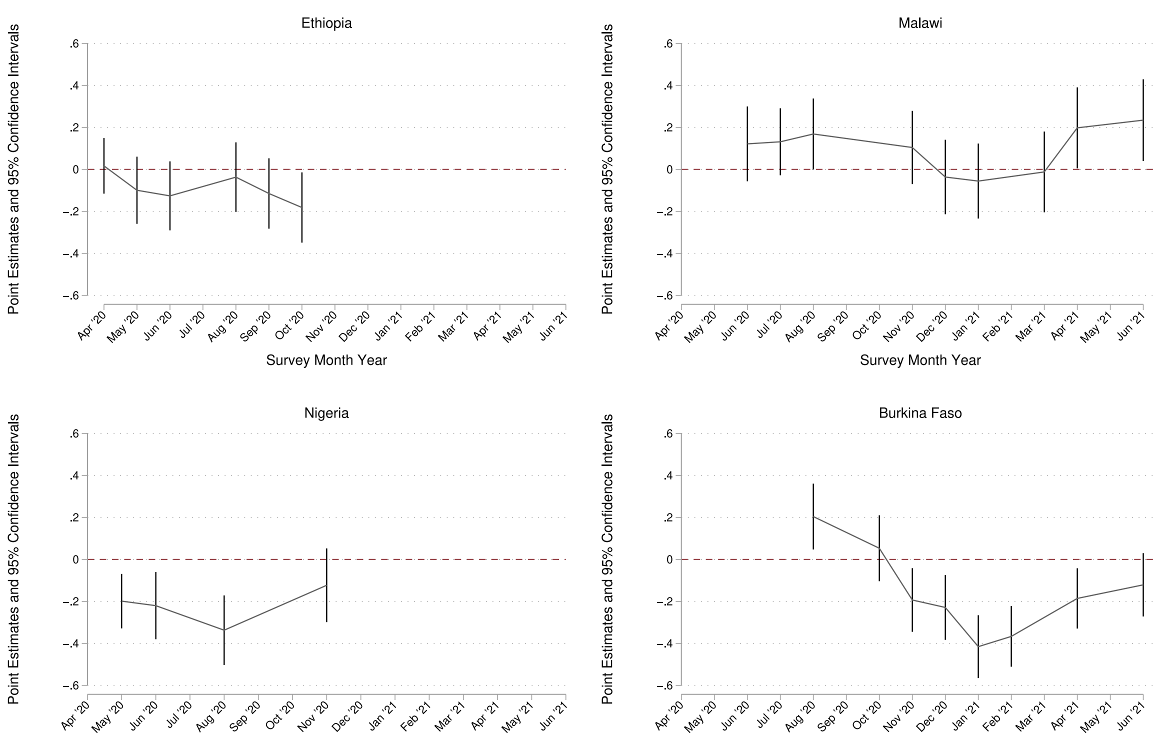

Fig. 6. Event study—Urban–rural differences in food insecurity. *Note*: This figure disaggregates estimates of differential trends in food insecurity, as measured with the standardized raw FIES score, by country and wave. When the coefficient is positive, this implies that households in urban areas experienced a larger increase in the given measure of food insecurity, since before the pandemic, relative to rural households. When the coefficient estimate is negative, this implies that households in rural areas experienced a larger increase in food insecurity. This analysis uses FIES data from before and after the COVID-19 outbreak.

timeframe of our study. Burkina Faso is the only exception, which may be due to the fact that we do not observe data for Burkina Faso in the early months of the pandemic (e.g., April through August 2020).

Fig. 4 reports estimates of differences in trends in food insecurity between urban and rural areas. When this estimate is positive, households in urban areas experience a larger increase in the given measure of food insecurity relative to rural households. When this coefficient estimate is negative, the opposite is true. Given that the rate of food insecurity tends to be on average higher in rural areas than in urban areas in many countries around the world (Adjognon et al., 2021b), a negative coefficient in Fig. 4 suggests that the rural–urban gap in food insecurity increased amid the first year of the COVID-19 pandemic. With a few exceptions, Fig. 4 shows that most coefficients are negative. This implies that for most measures of food insecurity in most of the countries in our study, food insecurity increased more in rural areas relative to urban areas since the onset of the pandemic. This general longer term trend, coupled with the previous findings by Adjognon et al. (2021a), follows the changing dynamics of the spread of the coronavirus within countries, around the world. For example, in the United States, pandemic-related disruptions first spread quickly in major metropolitan areas before spreading to rural areas. In these rural areas the consequences were often more deeply disruptive in the longer term than in urban areas (McGranahan and Dobis, 2021).

We find that in Burkina Faso, Ethiopia, and Nigeria the estimated coefficient on each of our measures of food insecurity indicate that food insecurity increases more in rural areas than in urban areas during the COVID-19 pandemic. In addition, most of these estimated coefficients are statistically significant at conventional levels, meaning that we can reasonably rule out no difference in changes between rural and urban households. The exception is Malawi, where using the raw FIES score and a binary indicator of mild food insecurity are both positive, though the estimated coefficient is only statistically significant at conventional levels for mild food insecurity. These results highlight important heterogeneity in changes in food insecurity between rural and urban households amid the pandemic that can persist even one year after its onset.

In the Supplemental Appendix, we show sets of supporting information. The top panel of Figure A2 shows the share of urban respondents relative to rural respondents was stable over the entire study period. This supports the idea that the estimates reported in Fig. 4 are not biased from differential attrition of households between rural and urban areas.

4.3. Differences between female-headed and male-headed households

Our analysis next considers differential changes in food insecurity between female-headed and male-headed households. Again, we perform this analysis by combining pre-pandemic data with data collected during the pandemic. As discussed by Buvinić and Gupta (1997), the vast majority of available evidence shows that female-headed households are more vulnerable and at risk of experience poverty. Therefore, it may be that female-headed households experience larger adverse changes in food insecurity amid the COVID-19 pandemic. In a review of the microeconomic literature studying short-term changes in food insecurity associated with the pandemic, Bloem and Farris (2021) find inconclusive evidence on differential changes by socioeconomic status. Part of the explanation for these ambiguous results is that, at least in the short-term, pandemic-related disruptions seem to have more deeply influenced the lives of those who are more tightly connected to international markets. These individuals and households may be relatively well-off, and thus, in the short-term more vulnerable households may not have experienced the most dramatic adverse changes in food security.

Again before we discuss how changes in food insecurity associated with the COVID-19 pandemic differ between female-headed and male-headed households, it is useful to document the more general average changes associated with the pandemic. Tables A5 through A8 in the Online Appendix report results from Eq. (1) in tabular form for each measure of food insecurity. As discussed above, the coefficient on the $COVID_t$ binary variable estimates the average change in a given measure of food insecurity associated with the COVID-19 pandemic within each of the four countries in our study. Each of our binary variables representing mild, moderate, and severe food insecurity show that on average food insecurity increased within the timeframe of our study in Ethiopia, Malawi, and Nigeria. As discussed above, Burkina Faso is the only exception, which may be due to the fact that we do not observe data for Burkina Faso in the early months of the pandemic (e.g., April through August 2020).

Fig. 5 reports estimates of differences in trends in food insecurity between female-headed and male-headed households. When this estimate is positive, female-headed households experienced a larger increase in the given measure of food insecurity relative to male-headed households. When the estimate is negative, the opposite is true. In general, Fig. 5 shows that most coefficients are centered around zero and are not statistically significant. This implies that for most cases and by most measures, there is no noticeable difference in changes in food insecurity associated with the pandemic between female-headed and male-headed households.

In particular, in Burkina Faso and Ethiopia all of the estimated coefficients of the differential change in food insecurity amid the COVID-19 pandemic between female-headed and male-headed households are not statistically significant at conventional levels. In Malawi, we see conflicting results depending on the measure of food insecurity. Both the raw FIES score and the binary measure of moderate food insecurity are not statistically significant. However, the binary measure of mild food insecurity is negative (indicating a larger adverse change for male-headed households) and the binary measure of severe food insecurity is positive (indicating a larger adverse change for female-headed households). Finally, in Nigeria, the estimated coefficients on each measure of food insecurity are negative and indicate larger adverse changes in food insecurity for male-headed households. Taken together, these results highlight the ambiguity in differentiating the socioeconomic consequences of the pandemic by socioeconomic status. On the one hand, poorer households may be less able to protect themselves from adverse changes in their food security status than wealthier households. But on the other hand, wealthier households may be more connected with pandemic-related disruptions at the global-level and thus at greater risk of adverse consequences due to the pandemic.

In the Supplemental Appendix, we again show sets of supporting information. The bottom panel of Figure A2 shows the share of female-headed households relative to male-headed households was stable over the entire study period. This supports the idea that the estimates reported in Fig. 4 are not biased from differential attrition between female-headed households and male-headed households.

4.4. Intertemporal heterogeneity

In our final set of results, we investigate intertemporal heterogeneity. In the regression results reported and discussed so far, we average all of the data collected during the pandemic together. Although this allows for a straightforward analytical approach it obscures potential heterogeneity over time. In this section, we present results from an event study regression specification that disaggregates estimates of sub-national differences in changes in food insecurity associated with the COVID-19 pandemic. Fig. 6 illustrates the event study results for differences between urban and rural households using the standardized raw FIES score as the outcome of interest.

We see in Fig. 4 for Ethiopia that with the onset of the pandemic, the FIES score increased more in rural areas than in urban areas on average, but that this estimate was not statistically significant at conventional levels. Fig. 6 shows similar results for the initial survey waves administered during the pandemic. However, by October 2020, the last wave of data from Ethiopia, the estimated difference in the trend of food insecurity relative to prior to the pandemic between urban and rural areas is statistically significant. Food insecurity for rural households increased more in October than it did for urban households, relative to pre-pandemic levels. These findings enrich existing analysis of short-term changes in food insecurity associated with the pandemic in Ethiopia by Abay et al. (2020) and Hirvonen et al. (2021). Studying a sample of rural households in Ethiopia, Abay et al. (2020) finds evidence of increasing food insecurity in the initial months of the pandemic. By contrast, studying a sample of urban households in Ethiopia, Hirvonen et al. (2021) finds no evidence of changes in food insecurity in the initial months of the pandemic.

In Malawi, we see in Fig. 4 that the FIES score increased more in urban areas than in rural areas on average in association with the pandemic. Similar to the estimate for Ethiopia, this estimate was not statistically significant at conventional levels. In Fig. 6, although the coefficient is positive in the initial months of the pandemic, indicating a larger increase in food insecurity in urban areas than in rural areas, estimates became negative at the beginning of 2021, before finally becoming positive in May and June of 2021. Despite most of these estimates being statistically insignificant at conventional levels, the results highlight the importance of investigating intertemporal heterogeneity as in some months food insecurity increased more in urban areas while in others food insecurity increased more in rural areas.

For Nigeria, we see in Fig. 4 that the FIES score increased more in rural areas than in urban areas on average in association with the pandemic. Fig. 6 shows that the estimate is negative and statistically significant in the early survey waves, implying that food insecurity increased more in rural areas than in urban areas at least through August 2020. These results contrast with those estimated by Amare et al. (2021). It is important to briefly discuss key methodological differences that likely lead to these different results. The analysis of Amare et al. (2021) relies on only a single post-pandemic round of data and uses only three of the eight FIES questions. Further, the authors seek to use state-level COVID-19 case number to try and determine if there are difference in food security outcomes between rural and urban households. Amare et al. (2021) do not find evidence of heterogeneous changes in that first month. Our analysis is more straightforward in that we do not aim to estimate exposure to COVID-19 disruptions as case reporting is prone to irreconcilable measurement error.

Finally, in Burkina Faso, we see in Fig. 4 that the FIES score increased more in rural areas than in urban areas in association with the pandemic and that this estimate is statistically significant at conventional levels. In Fig. 6, this estimate varies over time and highlights critical heterogeneity. In August of 2020, food insecurity increased more in urban areas than in rural areas but in subsequent months this difference shifted. By November food insecurity had increased more in rural areas. This difference persists through June of 2021 and is consistent with the idea that although pandemic-related disruptions may have been strongest initially in urban areas, over time pandemic-related disruptions spread to rural areas (McGranahan and Dobis, 2021).

We focus our discussion in the main manuscript on the event study results disaggregating urban–rural differences over time using the FIES score as a measure of food insecurity. In the Supplemental Appendix, we show event study results for each of our other measures of food insecurity (e.g., binary measures indicating mild, moderate, and severe food insecurity). We also disaggregate differences between female- and male-headed households. As shown in Fig. 5, difference in food security between female- and male-headed households are rarely statistically significant at conventional levels, even when disaggreagted over time.

5. Conclusion

We document trends in food security up to one year after the onset of the COVID-19 pandemic in Burkina Faso, Ethiopia, Malawi, and Nigeria using household-level panel data collected as part of the World Bank's LSMS-ISA program. Our analysis complements both the existing microeconomic literature that studies short-term changes in food insecurity associated with the COVID-19 pandemic (Bloem and Farris, 2021) and existing macroeconomic projections based on expected changes of national level income, prices, and food supply (Baquedano et al., 2021).

We document three main findings. First, we observe an initial spike in food insecurity in the early months of the pandemic followed by a gradual decline that has not returned back to levels observed in the first month of the pandemic. Second, in general, we find that food insecurity increased more in rural areas relative to urban areas. Finally, we do not find any evidence of systematic differences in changes in our measures of food insecurity between female-headed and male-headed households. One exception is in Nigeria, where by contrast we find that male-headed households experience larger adverse changes in food insecurity. Each of these findings highlight the critical importance of taking into account local-level factors when assessing changes in food insecurity associated with the pandemic.

The goal of this paper is to document changes in food security during the first year of the COVID-19 pandemic in four African countries. This is a modest but important goal. Future research could focus on understanding what factors drive the changes in food security that we document in this paper. We do not have access to the necessary data to investigate what factors drive, for example, the initial spike in food insecurity in the first summer of the pandemic or why food insecurity has increased more in rural areas than in urban areas. These represent important questions that require detailed data on COVID-19 case counts, sub-national data on food prices and food supply, household-level data on income, and national level data on imports.

The analysis in this paper is nevertheless important because the adverse consequences of the COVID-19 pandemic are expected to continue into 2022, and possibly beyond, as new variants of the virus emerge and continue to spread the illness. Moreover, although COVID-19 vaccines have become widely available in high-income countries, to date, very few people in low-income countries are able to access these vaccines. Therefore, understanding the longer-term socioeconomic consequences of this global health crisis can help to inform policy responses. Although short-term changes in food security associated with the onset of the pandemic are well-documented (Bloem and Farris, 2021; Josephson et al., 2021), understanding and documenting longer term trends are exceedingly and increasingly relevant.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.foodpol.2022.102306. Replication code and data associated with this article can be found at https://doi.org/10.5281/zenodo.6773380.

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