# UNVEILING VARIED IMPACTS: A STUDY OF HOW THE COVID-19 PANDEMIC AND CONTAINMENT STRATEGIES HAVE SHAPED HOUSEHOLD FOOD SECURITY IN ETHIOPIA

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*Abstract:* The Covid-19 pandemic affects household food security through various channels. Multiple studies from different developing countries, including Africa, indicate that the pandemic's effects on food security differ among households, livelihoods, and economic sectors. This study aims to analyze the early-stage pandemic's trajectory and its differing impacts on food security in Ethiopia, considering household location, ownership of assets, livelihoods, and income sources. Key factors in this examination include the government's containment measures, such as travel restrictions within the country, curfews or lockdowns, and the closure of non-essential businesses. Using the World Bank's nationally representative harmonized panel data drawn from the high-frequency phone survey (HFPS), the study employs fixed effects regression. Results reveal that Covid-19 significantly affected overall food insecurity in Ethiopia, with a decreasing trend in food insecurity observed across survey rounds. In-country travel restrictions displayed a statistically significant and varied impact on households' likelihood of experiencing moderate/severe food insecurity. Households relying on rental income sources faced heightened food insecurity due to the pandemic. The study also identifies varying impacts between households receiving remittances or assistance and those without. This underscores the role of social protection in mitigating short-term food insecurity during the pandemic. Overall, the study concludes that mobility restrictions, land ownership, rental income, remittances, and assistance significantly contribute to the heterogeneity of the pandemic's effects on food security. Lastly, the paper emphasizes that these findings can inform short-term and medium-term policy responses by the Ethiopian government and international donor organizations.

*Key Words* - **Covid-19; pandemic; probability; impacts; food insecurity; heterogeneity; livelihood.**

## I. INTRODUCTION

The COVID-19 pandemic has caused significant disruptions to economies worldwide. Movement restrictions, both locally and internationally, have led to substantial changes in unemployment rates and gross domestic product (GDP). As the global pandemic persisted, disruptions in food supply chains gained considerable attention. Notably, both the World Bank and the Food and Agriculture Organization of the United Nations (FAO) have expressed concerns about the potential repercussions of COVID-19 on food security.

One of the most striking events during the period was the extremely diverse performance across countries in containing the pandemic and the economic outcomes that have ensued (Penas et al., 2022). Amare et al. (2020) indicated that the World Bank had forecasted that Covid-19 pandemic was highly likely to push more than 49 million people into extreme poverty in 2020 and beyond. Among this figure, greater than 45 percent of these people are in Sub-Saharan Africa, implying that the region would be hit hardest in terms of increased extreme poverty. The United Nations World Food Programme had estimated that the number of people globally facing acute food insecurity would almost double by the end of 2020 (about 135 million people before the crisis), due to income and remittance losses, and disruption of food systems associated with the pandemic (WFP, 2020a; WFP, 2020b).

Covid-19 could affect food security of households through different pathways. For instance, lockdowns and social distancing measures can adversely affect incomes by reducing economic and livelihood activities, which directly affect food security. Several studies in different countries show that the pandemic has had heterogeneous impacts on various livelihood options and sectors (Amare et al., 2020). Livelihoods and sectors that can operate on a remote basis with limited personal interactions or those functionally dependent on the internet are likely to be less affected, relative to those involving personal interactions (Abay et al., 2020). Similarly, some livelihood options and sectors are likely to experience a relatively higher disruption in economic activities. For instance, government-imposed mobility restrictions and shutdowns often disrupt supply chains, which may prove the

most challenging for small businesses with smaller stock. Thus, those households relying on non-farm business activities are likely to experience disproportionally higher impacts associated with disruptions in value chains caused by the pandemic and related mobility restrictions (Amare et al., 2020).

As soon as the first case of Covid-19 emerged in Ethiopia around mid-March 2020, the government took swift action to counter the pandemic's economic impact and curb its spread. Promptly following the initial case detections, a state of emergency was declared, accompanied by a comprehensive Covid-19 National Emergency Response Plan (NERP) to ensure a coordinated and all-encompassing approach to tackling the crisis. This encompassed measures such as border surveillance, contact tracing, establishment of dedicated quarantine facilities, provision of medical supplies and protective gear, and extensive awareness campaigns aimed at educating the public on managing the virus (Batana et al., 2021). Besides, to curb the pandemic's transmission, the government took various measures, like restricting travel within the country and internationally, limiting social gatherings, imposing curfews or lockdowns, shutting non-essential businesses, and closing schools and universities (Bundervoet et al., 2021)..

To alleviate the impact on individuals and businesses, authorities introduced several economic initiatives. These included increased healthcare spending, emergency food provisions for vulnerable populations, deferrals of tax and social security payments, and financial sector support through liquidity injections and forbearance extensions. COVID-19 has inflicted severe economic consequences on low- and middle-income nations. The steps taken by governments to prevent the virus's spread, such as lockdown orders, business closures, and social distancing mandates, led to job and income losses, particularly for those with limited coping strategies. Moreover, the pandemic exacerbated existing inequalities, disproportionately affecting already disadvantaged groups like women, youth, and low-skilled workers (Bundervoet et al., 2021). These lockdowns and restrictions are expected to disrupt food supply chains and community services, and social protection programs, which ultimately positively affect food prices. Decreased import of basic stuffs due to restriction of international travel could raise process and be an added financial burden that directly affects food security of households. Besides, national and state-level restrictions and lockdowns would affect food transportation within the country, with implications on food supply and thus on food prices (Amare et al., 2020). Obviously, this would bring significant repercussions on food insecurity in the country, particularly in poorer and vulnerable urban households.

One of the most salient features of the economic impacts of the pandemic and respective policy interventions is the asymmetry along several dimensions. The actions taken by agents and policymakers have resulted in very different economic effects across sectors and regions (Cerezo et al., 2021). Studies have revealed that the impacts of the Covid-19 pandemic on household incomes, food security and welfare have been uneven across space, gender, and livelihood options. It has been widely observed that the pandemic more severely affected urban households, many of whom are informal, self-employed, or casual workers, in many low- and medium-income countries (Batana et al 2012; Bundervoet et al 2021). Economic effects of such a pandemic disproportionately impact members of the society, depending on their socio-economic status, livelihood strategies, access to markets, etc. Thus, it is important to understand the household level impacts and support mechanisms that can be enhanced to ensure income smoothing (Kansiime et al., 2021).

In Ethiopia, Covid-19 has affected economic activity with significant adverse effects on employment, particularly at the onset of the pandemic (Batana et al., 2021). The same study has also shown the existence of spatial heterogeneity on impacts of Covid-19, in which households in large towns faced a higher chance of reduced labor incomes. The pace of recovery among female-headed households has been slow in terms of labor incomes, particularly in large towns. Self-employed households experienced severer income loss in earlier rounds, but they recovered fast in terms of the probability of further reducing labor incomes both in small and large towns. Also, poor households experienced severer income shocks in the early rounds, and those in larger towns still had a higher probability of income loss even in the future. The pandemic is likely to disproportionately exacerbate food insecurity in those areas or household with preexisting vulnerabilities to food security likely to be magnified. Impacts are expected to be most severe for poorer households in both rural and urban areas (Ravallion et al., 2020). Additionally, the impact of Covid-19 is also expected to vary across livelihood options, with those activities that require face-to-face interactions likely to experience a significant loss in demand (Abay et al., 2020; Amare et al., 2020). Furthermore, value chain disruptions may extend deeply into rural areas, affecting both input supply and output demand for farming households and affecting the income of those employed in both forward and backward agricultural value chains (Amare et al., 2020; Reardon et al., 2020a). Closure or disruption of informal food markets, where the poor obtain the majority of their food, may be more severe in extent and food security impacts (Devereux et al., 2020; Barrett, 2020).

Given the limited number of studies conducted in Ethiopia regarding the pandemic's effects, the available research mainly is focused on examining its impacts on household level total income, labor income, and to some extent its macroeconomic impacts. Additionally, there is a lack of understanding regarding the disparate impacts of the pandemic on Ethiopian households' food security. The unequal effects that come from the strategies taken to contain the spread of the pandemic in also remain understudied. It is against this backdrop that this study is motivated and aims to provide insight into this issue using household-level survey panel data. Specifically, the paper seeks to explore the trajectory of the Covid-19 pandemic's impact on Ethiopian households' food security. Additionally, it investigates the potential variations in the effects of Covid-19 containment measures on households' food security, along with different socioeconomic characteristics and geographic locations of households.

## II. REVIEW OF THE EMPIRICAL LITERATURE

Extensive research has delved into the multi-dimensional socio-economic impact of COVID-19, both within countries and across borders. Additionally, an expanding body of literature is actively exploring the interconnection between COVID-19 and facets such as food security, which are integral to sustainable development. For the purpose of substantiating the rational of making this study and also informing development of methodology for this study, a review of few empirical literatures on the impacts of the pandemic at international, regional and national level is conducted.

A study that spanned 1478 low-income adults in the United States (Wolfson & Leung, 2020) demonstrated that during the early stages of the pandemic, 44% experienced food insecurity, 36% achieved food security, and 20% faced marginal food security. Notably, the effects of COVID-19 were amplified among households already grappling with food insecurity and financial strain, with communities of color disproportionately affected. In Vermont State, USA, during the initial weeks of stay-at-home orders, Niles et al. (2020) examined food insecurity before and during COVID-19, revealing that 36% of new households were affected by food insecurity. This study also highlighted that individuals who lost their jobs were more likely to face food insecurity.

After India's nationwide lockdown, most recovery efforts prioritized economic aspects, leaving the education sector, even in the significant 250 billion dollar stimulus package, overlooked. This study examines the fallout of lockdown-related school closures for the urban and rural poor, particularly children who rely on school meals. Girls and disadvantaged children seem to face more severe impacts. The research also explores ways to strengthen existing social safety programs to mitigate these effects. Finally, it asserted that the impact of COVID-19 on food security and education would disproportionately impact girls and children from disadvantaged ethnic groups (Alvi & Gupta, 2020).

Beyond the health toll of COVID-19, its containment measures have hit both city and countryside hard. Sitko et al. (2022) examined how the pandemic affected rural life using data from 54 countries and survey evidence. They also consider how different food systems play into this. The findings are striking: about two-thirds of rural households in these countries saw income drop due to COVID-19, a number on par with urban areas. This shows that even though lockdowns hit cities more, the impact reached rural areas too. In places with traditional food systems, nearly 80% of rural homes saw total income loss. This hit different income sources too, with non-farm businesses, family farms, remittances, and wages all taking hits. The report provides a clear picture of how COVID-19 is affecting rural life, varying across countries and food systems, urging policymakers and the world to build a recovery that includes everyone.

Bundervoet and colleagues (2021) conducted a study examining the pandemic's immediate impact on households in developing countries. They gathered data from 34 nations, covering a vast population of 1.4 billion people. Their analysis looked at work cessation, income reduction, food insecurity, and disrupted learning, using complex statistical methods. They considered various factors like respondent details, household characteristics, and country-specific variables. Their findings were telling: on average, about 36% stopped working, over 64% faced income cuts, and nearly a third of children couldn't continue their education due to school closures. The loss of jobs and income also drove up household food insecurity. The study emphasized that the pandemic's effects were far-reaching and hit vulnerable groups particularly hard, including women, youth, and those with limited education. These uneven impacts could solidify inequality and hinder social progress, underscoring the need for policies that promote inclusive recovery and bolster resilience against future crises.

Liu et al. (2020) used data from China's household finance survey to investigate how Covid-19 impacted household consumption in China. They employed the ordinary least square (OLS) method and factored in various household and individual level variables to estimate the effects. Additionally, to account for inherent differences between regions like cultural environment, regional spending habits, and savings preferences, the study controlled for fixed effects at the city level. The findings pointed to a notable drop in household consumption during the outbreak. Further analysis of differences revealed that urban households experienced a significant decline in consumption due to the pandemic, while rural households were comparatively less affected. Interestingly, the use of mobile payment systems boosted consumption among urban households during the pandemic, whereas its effect on rural households was minimal.

Through a computable general equilibrium model-based simulation, Kabir et al. (2021) assesses the gender dimensions of the impact of Covid-19 on economic outcomes, that is, labor force participation, employment, wages, and earnings. Using the 2020 high-frequency phone survey in Chad, the study applied a probit model to determine if differences in binary outcomes between female and male-headed households. For household income reduction, it constructed binary variables for the decline in household income from any source and for each income source: wage employment, non-farm enterprise income, farm income, remittance. The findings show that the Covid-19 pandemic brings disproportionately higher negative impact on women in urban areas. The situation is potentially dire, especially in service sectors, where most women are employed in urban areas. Moreover, the pandemic has notably impacted the households' income from enterprises and suggests that this negative impact is more prevalent for female-headed households. Although male-and female-headed households are using common coping strategies during the pandemic, female-headed households in rural and urban areas have been more reliant on aid from family and friends and less reliant on savings, credit, or the sale of assets.

Consolazio et al. (2021) assessed the role of five area level indicators in shaping the risk of contagion in the provinces of Milan and Lodi (Lombardy, Italy), namely: educational disadvantage, unemployment, housing crowding, mobility, and population density. Data on Covid-19 patients from the Integrated Data warehouse were used and matched with aggregate-level data from the National Institute of Statistics. Multilevel logistic regression models were used to estimate the association between the census block-level predictors and Covid-19 infection, independently of age, sex, country of birth, and preexisting health conditions. All the variables were significantly associated with the outcome, with different effects before and after the lockdown and according to the province of residence. This suggests a pattern of socioeconomic inequalities in the outbreak, which should be taken into account in the eventuality of future epidemics to contain their spread and its related disparities.

Bloem & Farris (2022) have conducted a review of findings from the emerging microeconomic literature on observed changes in food insecurity associated with the Covid-19 pandemic. To do so, the paper focuses on studies in low- and middle-income countries that include household survey data measuring food insecurity collected both before and after the onset of the Covid-19 pandemic. Initially, it focuses on several studies—seven from countries in Sub-Saharan Africa and one from India—that estimate immediate changes in food insecurity associated with the Covid-19 pandemic. Next, it reviews subsequent analysis studying longer term changes in food insecurity associated with the Covid-19 pandemic. The review finds that most, but not all, studies find evidence of increasing food insecurity amid the Covid-19 pandemic, and increased food insecurity appears to be associated with pandemic-related disruptions in food markets and earned income. Despite evidence of pandemic-related disruptions across all studies, there is evidence of resilience, at least in terms of food security, among some subpopulations.

Employing a computable general equilibrium model with observed shifts in key indicators like unemployment, trade, oil prices, and production from September 2020, Beckman et al. (2021) assessed the impact in low- and middle-income countries, including the sub-Saharan African countries. These estimations, encompassing changes in gross domestic product (GDP) and food prices, are then input into the International Food Security Assessment model. The findings spotlight significant trends: COVID-19 lockdowns correlate with a 7.2 percent global GDP contraction and a 9 percent decrease in grain prices, ultimately leading to a considerable 27.8 percent surge (equivalent to 211 million people) in food-insecure individuals in 2020. To offer a comprehensive outlook, a sensitivity analysis is conducted, encompassing a spectrum of potential COVID-19 impacts. This dual approach provides a nuanced understanding of the pandemic's effects.

In the same vein, Udmale et al. (2020) brought attention to key players in the global food balance, examined the potential ramifications of COVID-19 on worldwide food availability, and considered SDG-2 (zero hunger). Their research identified the most susceptible regions to cereal supply disruptions as developing countries, specifically fifteen from Africa, followed by ten from Latin America, six from Oceania, and four from Asia. The study concludes that the ongoing pandemic is likely to trigger temporary food insecurity in these vulnerable nations. The impacts on food security (SDG-2) could persist due to a dual effect of economic slowdown and increased poverty, which could restrict access to food beyond 2020. Ultimately, the study underscored heightened risks of transitory food insecurity for 15 African countries, 4 Asian countries, 10 Latin American countries, 6 countries in Oceania, and other developing nations

Focusing on Africa, Shupler et al. (2020) discovered that during the lockdown, 88% of the respondents from a Kenyan informal settlement were food insecure while a survey of 600 Ethiopian households conducted by de Brauw et al. (2020) found that two-thirds of the respondents observed a decline in their source of income, with lower-income households experiencing the highest impact. A number of these households used their savings to cushion food consumption; hence, food insecurity was not alarming.

In South Africa, Arndt et al. (2020) discovered that households relying on labor income and with lower education levels were more susceptible to food insecurity. As vaccines remained elusive, the primary tool against the pandemic's impact was physical distancing, meant to curb contagion by reducing social and economic interactions. However, policymakers must weigh the health benefits of strong distancing measures like lockdowns against their economic costs, especially for low-income and food-insecure families. In South Africa, such measures carried significant economic burdens and disproportionately affected those with limited education, endangering their food security. Nonetheless, government transfer payments helped cushion the blow for low-income households. This underscores the importance of robust transfer policies to aid vulnerable households during unforeseen crises like Covid-19, benefiting public health, income distribution, and food security.

Inegbedion (2020) whose study examined the implication of the lockdown induced by COVID-19 on food security using a cross-sectional survey elicited via social media found that the pandemic adversely affected transportation, security, and farm labour which may undermine the production of food and accelerate food insecurity in Nigeria.

Again, Kansiime et al. (2021) assessed implications of Covid-19 pandemic on household income and food security in two East African countries (Kenya and Uganda). The authors have collected data using an online questionnaire via Google forms, sent to respondents through social networks and email. Since the two countries have been affected by Covid-19 in varying degrees, and the containment measures put in place varied, with anticipated differences in effects on food and nutritional outcomes. The responses were obtained from 313 and 129 people in Kenya and Uganda respectively, making a total of 442 respondents. Analytically, food security was measured using the Food Insecurity Experience Scale (FIES), and fitted probit model so as to estimate the factors determining whether a respondent's source of income has been affected by the Covid-19 crisis and whether food and nutrition outcomes have worsened during the pandemic. Results show that more than two-third of the respondents experienced income shocks. Food security & dietary quality worsened, as measured by the food insecurity experience scale and the frequency of consumption of nutritionally-rich foods. The probit regressions show that the income-poor households and those dependent on labour income were more vulnerable to income shock, and had poorer food consumption during the Covid-19 pandemic compared to other respondent categories. Farmers were less likely to experience worsened food security compared to other respondent categories who depended to a great extent on market sources for food. Conversely, membership in savings and loan groups was correlated with less likelihood of suffering income shocks and reduction in food consumption.

Furthermore, Bukari et al. (2021) examined the effect of Covid-19 on poverty and living standards of households in Ghana. The study further analyzed which class of persons within the income distributions has been mostly hit by the pandemic. Data on 3,905 households were obtained via concurrent online survey and telephone interviews. Multiple analytical approaches were employed: ordinary least squares, probit model and simultaneous quantile regressions. Results showed that Covid-19 had significantly increased the poverty levels of households while deteriorating living standards. The study also discovered that gender and locational heterogeneities exist regarding the impact of Covid-19 with females and rural dwellers mostly disadvantaged. However, simultaneous quantile regression result shows that in terms of overall household consumption, those in the middle and upper classes are profoundly affected compared to those in the lowest class.

On the other hand, a study by Amare et al. (2020) combines pre-pandemic face-to-face survey data with follow up phone surveys collected in April-May 2020 to quantify the overall and differential impacts of Covid-19 on household food security, labor market participation and local food prices in Nigeria. The study exploited spatial variation in exposure to Covid-19 related infections and lockdown measures along with temporal differences using a difference-in-difference approach. It found that those households exposed to higher Covid-19 cases or mobility lockdowns experience a significant increase in measures of food insecurity. Examining possible transmission channels for this effect, it indicated that Covid-19 significantly reduces labor market participation and increases food prices. Also, the study found that impacts differ by economic activities and households. These lockdown measures have smaller impacts on wage-related activities and farming activities. In terms of food security, households relying on non-farm businesses, poorer households, those with school-aged children, and those living in remote and conflicted-affected zones have experienced relatively larger deteriorations in food security.

Also, Josephson et al. (2020) provided some of the first evidence on the socioeconomic impacts of and responses to the pandemic among households and individuals in Sub-Saharan Africa. To do so, reduced-form econometric methods are applied to longitudinal household survey data from Ethiopia, Malawi, Nigeria, and Uganda—originating from the pre-Covid-19 face-to-face household surveys and from the novel phone surveys that have been conducted during the pandemic. It has indicated that around 256 million individuals, about 77 percent of the population in the four countries, were estimated to live in households that have lost income due to the pandemic. Secondly, attempts to cope with this loss were exacerbated by the inability to access medicine and staple foods among 20 to 25 percent of the households in each country. Finally, it has mentioned that food insecurity is disproportionately borne by households that were already impoverished prior to the pandemic.

Research underscores that Ethiopia is not exempt from the adverse repercussions of the pandemic on household income. To illustrate, based on high-frequency phone surveys, Wieser et al. (2020) reveal that approximately 55% of respondents in Ethiopia experienced a decrease (51%) or complete loss (4%) of income. Bundervoet and Finn (2020) emphasize that the pandemic and associated containment measures disproportionately affect urban dwellers, as their livelihoods often rely on sectors particularly

vulnerable to distancing policies and travel bans. These sectors, predominantly composed of informal businesses like small shops, roadside eateries, shoe-shiners, and casual laborers, experience heightened impacts.

Additionally, Batana et al. (2021) studied the existence of spatial heterogeneity in the impacts of the early days of the Covid-19 pandemic on urban household incomes in Ethiopia and Kinshasa, Democratic Republic of Congo. Combining new panel household surveys with spatial data, the fixed-effects regression analysis for Ethiopia finds that households in large and densely populated towns were more likely to lose their labor incomes in the early phase of the pandemic, and their recovery was slower than other households. Disadvantaged groups, such as female, low-skilled, self-employed, and poor, particularly suffered in those towns. In Kinshasa, labor income-mobility elasticities are higher among workers—particularly female and/or low-skilled workers—who live in areas that are located farther from the city core area or highly dense and precarious neighborhoods. The between- and within-city evidence from two Sub-Saharan African countries points to the spatial heterogeneity of Covid-19 impacts, implying the critical role of mobility and accessibility in urban agglomerations.

On the other hand, Hirvonen (2020) at IFPRI suggests that the pandemic has not led to unusually large increases in food prices. However, a case study in the vegetable sector suggests that price dynamics are highly context and crop specific, calling for more comprehensive price monitoring to identify food value chains and areas where food price increases may have been unusually rapid. Second, employment losses have concentrated on informal sector workers while redundancies in the formal sector have been less significant. Third, there is considerable uncertainty about the income, poverty, and food security implications of this crisis. While most households report income losses, the qualitative and subjective nature of these questions mean that the magnitudes of these losses are unknown. In Addis Ababa, less subjective food security measures indicate only small negative changes in household food and nutrition security. Finally, the report mentioned that limited access to mobile phones in rural areas results in imperfect and incomplete information on how this crisis has been affecting rural households in Ethiopia.

Beyene et al. (2020) used a comprehensive model to explore how Covid-19 might impact the economy. They considered factors like reduced labor participation, lower productivity, and increased trade costs within the country, as well as international trade disruptions, lower demand for exports, reduced imports, and drops in foreign investment and remittances. They looked at three scenarios: a normal baseline, a mild Covid-19 scenario, and a severe Covid-19 scenario. The pandemic is projected to affect various economic and social aspects, even in optimistic scenarios, impacting growth and employment significantly. Recovery might not fully restore GDP and welfare losses, especially in severe scenarios.

Finally, Asegie et al. (2021) explored into the impact of Covid-19 on the livelihoods of smallholder farm households in South Wollo and Oromia Administrative Zones, Ethiopia. They gathered data from 275 participants using interviews, key informants, and case studies between September and November 2020. They employed a mix of methods like descriptive statistics, binary logistic regression, and qualitative analysis to dissect the data. The study assessed how the pandemic influenced household livelihoods, with a focus on whether at least one livelihood activity was affected. They considered factors like age, gender, family size, education level, land ownership, irrigation use, oxen count, remittance access, market distance, and cooperative membership. The study found that the impact on lives and livelihoods varied based on geographical settings and the pre-pandemic activities of the target areas. The conclusion drawn was that the pandemic significantly disrupted all facets of livelihood strategies, with a particular impact on non-farm and off-farm activities among smallholder farmers.

In summary, the reviewed literature reveals a comprehensive exploration of the multifaceted impacts of the COVID-19 pandemic on various socio-economic aspects globally. Studies have underscored the disproportionate effects of the pandemic on vulnerable populations, particularly in terms of food security and livelihoods. Insights emerge from diverse geographical contexts showed that existing disparities were exacerbated, and marginalized communities faced severe food insecurity and financial strain. These impacts shown varied across various income sources, affecting non-farm businesses, family farms, remittances, and wages. Vulnerable groups, particularly women, youth, and those with limited education, experienced amplified negative effects. The literature also emphasizes the importance of strong transfer policies to aid low-income households during crises like COVID-19. The pandemic has brought impacts' notable spatial disparities, with urban and rural areas facing differing impacts. The research highlights the interconnectedness of various facets, from labor income to food prices, while also pointing to the challenges in obtaining accurate data in remote areas. Additionally, comprehensive modeling has projected long-term implications on economies, suggesting potential growth and welfare setbacks, even in relatively optimistic scenarios. Ultimately, the literature underscores the urgency of inclusive recovery strategies that address existing inequalities and strengthen resilience against future crises.

## III. DATA AND METHODOLOGY

### 3.1. Context and Data

Ethiopia's first Covid-19 research was observed in mid-March 2020. The country is among those African countries that experienced significant economic disruptions because of the pandemic. The Government of Ethiopia has put in place a range of measures to mitigate the economic impact of the Covid-19 pandemic, while aiming at containing transmission. Right after the first few cases of Covid-19 were detected, the government implemented a state of emergency, which remained in effect until September 2020, and adopted a comprehensive Covid-19 National Emergency Response Plan to ensure that efforts to fight the crisis are comprehensive and well-coordinated. Specifically, Ethiopia implemented surveillance at borders, conducted contact tracing, established designated quarantine facilities, ensured the supply of drugs and protective equipment, and embarked on several communication efforts to raise awareness on how to deal with the virus. Ethiopia's lockdown and mobility restrictions were mostly introduced by federal and state-level governments. Also, in order to mitigate impacts on people and firms, authorities announced several economic measures, including additional expenditure on healthcare, provision of emergency food to the vulnerable, tax and social security payment deferrals, and liquidity injections and extension of forbearance measures in the financial sector.

The measures taken by the federal and regional governments have restricted movement of residents and led to the closure of business operations, and closure of regional borders linking lockdown areas with the rest of the country. These lockdown and mobility restrictions are likely to disrupt major economic activities, including local businesses. Ethiopia is highly susceptible to income shocks and food insecurity associated with the spread of the pandemic. As the reports of the World Bank (2020) reveals, food prices are already soaring in the country, food supply chains (domestic and international) are being disrupted, informal sector

unemployment rates are likely to be increasing, and poor households are likely to be facing food shortages. All these effects are likely to increase food insecurity. The data collected by the World Bank (2020) indicated that the restrictions imposed by the government on people's movement and business operations in the early stage of the pandemic resulted in decrease in food and non-food consumption levels of households, which is considered as an impact on the consumption levels of household, and thus impact their food security situations. This is an indication of the fact that the pandemic has impacted the food security levels of Ethiopian households.

The empirical analysis in this study relies on a harmonized household phone surveys that have been collected since the outbreak of the Covid-19 pandemic in Ethiopia. The World Bank conducted a High Frequency Phone Survey (HFPS) of households to monitor the economic and social impacts of and responses to the Covid-19 pandemic on households, and thus inform interventions and policy responses (Wieser et al., 2020). The HFPS builds on the national longitudinal Ethiopia Socioeconomic Survey (ESS) that the Central Statistical Agency (CSA) carried out in 2019 in collaboration with the World Bank. The HFPS drew a subsample of the ESS sample that was representative of households with access to a working phone. It is conducted by calling a sample of households every three to four weeks for a total of 12 survey rounds, starting in April 2020. The survey questionnaire takes just 15 minutes, and covers topics such as knowledge of Covid-19 and mitigation measures, access to educational activities during school closures, employment dynamics, household income and livelihood, income loss and coping strategies, and assistance received.

From the HFPS of households, the World Bank has developed a harmonized dataset in order to create a comparable picture of how the pandemic affects the live of the poor around the world. Harmonized indicators help to track the impact of the pandemic and mitigating policies over time in a comparable manner. Since the outcome variable of this study, which is probability of being food insecure, is available only for five rounds (from round 2 – round 6) in the harmonized dataset for households in Ethiopia, the study uses a panel data extracted from these five rounds only. The main advantage of using panel data is that it enables us to deal with time-invariant and unobserved heterogeneity that would potentially cause bias in estimation results if it is not properly accounted for, or controlled or taken into consideration during the analysis.

Besides, the study exclusively focuses on household level characteristics as predictors and independent variables. Using the household's id and survey rounds as the main identifiers and following the required data management processes, a panel data of 14,506 observations has been organized and utilized for this study. The analysis includes data on total household food insecurity situation, and various households' socioeconomic characteristics and location variables.

Outcome variables: (food insecurity indicators): Food insecurity is measured using two separate, but not exclusive, variables on probability of food insecurity. They are the "probability of being moderately/severely food insecure >= 50%" and the "probability of being severely food insecure >= 50%". Each probability index takes binary values: 1 if "Yes" and 0 if "No". That means, if the probability of being food insecure is greater than or equal to 0.50 (>=50%), it takes 1 and 0 otherwise.

Key explanatory variables and predictors: Covid19 containment measures (restriction on in-country travel, curfew/lockdown and closure of non-essential businesses) are the key explanatory variables that are used as indicators by themselves in the model. Also, the independent variables for the study comprised of household level socioeconomic characteristics only. Additional indicator variables are sector/location of the household, ownership of land, ownership of livestock, and ownership of non-farm family business enterprises, sources of incomes such as wage employment, rental income, remittance and assistance. Since they have time trend across the five (5) survey rounds as presented in the harmonized data by the world Bank, variables such as household size, change in household head, adult equivalence are included in the estimation as time-variant household characteristics in order to control their effects, if any.

Moreover, to better understand the differential impacts of the pandemic on households' food insecurity situation, the study used baseline characteristics of households so as to disentangle those vulnerable households and livelihood activities. As the impacts of the pandemic are likely to vary across households, it aims to uncover the heterogeneous impacts of the pandemic on various groups of households, measured based on different dimensions of indicators. The variables for identifying the differential impacts are location (rural/urban), ownership of assets (land; livestock; non-farm family enterprises), livelihood activities (such as wage employment); and income sources (such as rental income; remittance; assistance).

Table 1: Descriptive results of key explanatory and indicator and outcome variables

| No. | Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| 1 | Restriction on in-country travel | 14,436 | .2195206 | .4139362 | 0 | 1 |
| 2 | Curfew/lockdown | 14,436 | .1364644 | .3432929 | 0 | 1 |
| 3 | Closure of non-essential business | 14,436 | .145816 | .3529339 | 0 | 1 |
| 4 | Urban | 14,506 | 1.707638 | 0.454863 | 1 | 2 |
| 5 | Land ownership | 14,506 | 0.240245 | 0.427247 | 0 | 1 |
| 6 | Non-farm family business | 14,506 | .2988419 | .4577661 | 0 | 1 |
| 7 | Livestock ownership | 14,506 | .359989 | .4800133 | 0 | 1 |
| 8 | Rental income | 14,506 | 0.091755 | 0.288689 | 0 | 1 |
| 9 | Received remittance | 14,506 | 0.172342 | 0.377691 | 0 | 1 |
| 10 | Received assistance | 14,506 | 0.057562 | 0.232922 | 0 | 1 |
| 11 | Wage employment | 14,506 | .3636426 | .4810641 | 0 | 1 |
| 12 | Household head changed | 14,506 | 0.002550 | 0.050441 | 0 | 1 |
| 13 | Household size | 14,506 | 4.370812 | 2.203917 | 1 | 14 |
| 14 | Adult equivalence in the household | 14,506 | 3.438585 | 1.756451 | 0.73 | 11.98 |
| 15 | Number of household members above 65 & below 15 years age | 14,506 | 1.700813 | 1.556243 | 0 | 9 |
| 16 | Probability of being moderately/ severely food insecure >= 50% | 14,506 | 0.303598 | 0.459827 | 0 | 1 |
| 17 | Probability of being severely food insecure >= 50% | 14,506 | 0.044395 | 0.205979 | 0 | 1 |

As mentioned earlier, the harmonized HFPS of households' data produced by the World Bank includes household characteristics of their baseline information applied from the national longitudinal Ethiopia Socioeconomic Survey (ESS) that the Central Statistical Agency (CSA) carried out in 2019 across the country. These data on household characteristics remain the same across all survey rounds. Only household size, adult equivalence and change in the household head vary across the rounds in the dataset. This makes the dataset more convenient and appropriate for analyzing heterogeneous or differential impacts of Covid-19 across the different groups of households.

Table 2 below presents a simple descriptive indicator (percentage) of the probability of food insecurity of households in all rounds in different groups of households. From the total, 30.36% of the households asked in all rounds (column 1) have reported that they have faced a moderately/severely food insecurity during the pandemic, while the remaining 69.64% (column 2) didn't face such food insecurity problem.

Table 2: Percentage of food insecurity probabilities by groups of households

| | | Probability of being moderately/severely food insecure (P >= 0.5) | |
|---|---|---|---|
| | | Yes  ( 1) | No   (2) |
| Rural/Urban | Rural | 11.43% | 17.81% |
| | Urban | 18.93% | 51.83% |
| Ownership of  land | Yes | 21.76% | 54.21% |
| | No | 8.60% | 15.43% |
| Ownership of livestock | Yes | 16.19% | 47.81% |
| | No | 14.17% | 21.83% |
| Ownership of non-farm family business | Yes | 8.87% | 21.50% |
| | No | 21.02% | 48.62% |
| Rental income | Yes | 28.60% | 62.23% |
| | No | 1.76% | 7.41% |
| Received remittance | Yes | 5.83% | 58.24% |
| | No | 24.53% | 11.40% |
| Received assistance | Yes | 27.55% | 66.70% |
| | No | 2.81% | 2.94% |
| Wage employment | Yes | 8.09% | 22.27% |
| | No | 28.27% | 41.37% |
| Restriction on in-country travel | Yes | 6.41% | 23.91% |
| | No | 15.54% | 54.12% |
| Lockdown/curfew | Yes | 4.69% | 25.64% |
| | No | 8.96% | 60.72% |
| Closure of non-essential businesses | Yes | 4.16% | 26.17% |
| | No | 10.43% | 59.25% |

Also, 11.43% and 18.93% of the total households surveyed in all rounds who have faced moderately/severely food insecurity are located in rural and urban areas, respectively (column 1). From the total number of households surveyed in all rounds (14,506), different proportions who faced moderately/severely food insecurity are presented in column 1 of table 2.

From the total households in all rounds, around 21.95%, 13.65%, and 14.58% of the households have mentioned that they have faced restriction on in-country travel, curfew, and closure of non-essential business, respectively. In contrast to this, majority of the households asked in all rounds, i.e. 78.05%, 86.35% and 85.42% of the households reported that they did not face restriction on in-country travel, curfew, and closure of non-essential business, respectively.

## 2.2. Empirical Method

Given the household level fixed effects, how has the trajectory of Covid-19 food insecurity impacts varied by containment measures, sector of households, ownership of assets, livelihood options and income sources of households in Ethiopia? Panel regression models are used to determine the dimensions/indicator variables along which food insecurity situations of households have differentially or heterogeneously been affected by the Covid-19 pandemic.

For such situations, the standard econometric methodology suggests the use of efficient panel data estimators, such as fixed effect and random effect estimators (Wooldridge, 2002). Fixed effect estimators control for unobserved time-invariant characteristics of households and account for within-household variations across time. Random effects model takes care of both within- and between-household variations. Though our principal objective is heterogeneity analysis and the empirical literature on the topic suggest the use of fixed effect estimators, the paper estimated both fixed and random effects and applied the Hausman test to identify whether the fixed effect or random effect estimators is better for the estimation.

The analytical model is described as

$$y_{it} = \alpha + \beta_1 r_t + \beta_2(r_t h_i) + \beta_3 x_{it} + \delta_i + \varepsilon_{it} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where, $y_{it}$ is a dummy variable for household i indicating the change in the probability of being moderately/severely food insecure (greater than or equal to 0.5) at round t since the previous survey round t-1; $r_t$ is a dummy indicator for the survey round; $h_i$ is indicator variable, which can be containment measures, sector, socioeconomic characteristic for household i,; $\delta_i$ is a household fixed effect. Since $h_i$ is a time-invariant variable (household characteristics), it is interacted with the round dummies. $\beta_2$ is the

parameter of interest, indicating how the probability of households' food insecurity varies by the time-invariant characteristics (heterogeneity parameter). In addition, those time-variant household characteristics are controlled in $x_{it}$.

In the next step, we estimate two-way fixed effects by interacting two indicators variables and thus create another new indicator variable so as to examine whether heterogeneity impact exists when the two variables are considered simultaneously. One form of such estimation is made by interacting containment measures with urban indicator to explore if the impacts of the three containment measures have differential impact on food security among rural and urban households.

This is expressed by the following notation

$$y_{it} = \alpha + \beta_1 r_t + \beta_2(r_t h_i) + \beta_3(r_t c_i) + \beta_4(r_t h_i c_i) + \beta_5 x_{it} + \delta_i + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

The coefficient of interest is $\beta_4$ which captures the impact of interaction between containment measures and urban households.

Finally, in order to check robustness of our estimates, we re-fit each model by some observations or variables from the sample. Firstly, we omit the data for Addis Ababa and estimate every model. Then, we drop the ti e-variant household characteristics ($\beta_5 x_{it}$) and estimate each model. Next, we compare these estimates with the original estimates to check for robustness.

## IV. RESULTS AND DISCUSSION

The nature of the data and main objective of the research imply that the fixed effects (FE) model is the appropriate model. The Hausman specification test also confirms that in all estimations the fixed effect model is better than the random effect model. So, the estimation results (coefficients and p-values) of the fixed effect model are used in the analysis and discussions below.

In this section, results on the impact of the pandemic on food security and associated heterogeneity factors are presented, corresponding to the model equations above. Estimation is made by interacting the round dummies with the time-invariant variables such as containment measures (travel restriction, curfew, closure), location of the households, ownership of land, livestock and non-farm family business, sources of income (rent, remittance or assistance), and livelihood activities (wage employment). It is worth to mention at this point that the parameter associated with the round dummy captures aggregate trends in food insecurity situation of Ethiopian households across the five survey rounds. It also captures aggregate potential differences in food insecurity situations across the survey rounds.

### 4.1 Impacts of Government's Responses

Initially, we estimate the empirical specification in equation (1) to quantify the implication of variations in responses to the pandemic. In this estimation, the containment measures are considered as indicator variables. We mainly focus on the mobility restrictions, lockdown measures and closure of non-essential businesses and hence generate an indicator variable for the measures. We then compare temporal evolutions in food security outcomes across households with and without the containment measures. The results are presented in table 3 below.

The findings indicate that when there are limitations on travel within a country and curfews/lockdowns are enforced at the state level, there is a higher chance of experiencing food insecurity from the fifth to the sixth round. Similarly, the interaction coefficient involving the shutdown of non-essential businesses and specific rounds shows significance during the fourth and fifth rounds. This suggests that the closure of non-essential businesses raises the likelihood of food insecurity among households in Ethiopia. Finally, we re-estimated the models by excluding time-variant household characteristics (column 4, 5 and 6 in Table 3), and by dropping the observations for Addis Ababa, the biggest city in Ethiopia, which is used to check if its exclusion sways away the results. In both cases, the results remain almost the same and thus are robust.

Table 3: Government responses and probability of being severely food insecure

| | Full Sample | | | Without household controls | | |
|---|---|---|---|---|---|---|
| | *Probability of being severely food insecure (P >= 50%)* | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| round 3 | .-1.244972 (0.000) | -1.209733 (0.000) | -1.264487 (0.000) | .0718991 (0.000) | -1.20274 (0.000) | -1.260099 (0.000) |
| round 4 | -1.541994 (0.000) | -1.448419 (0.000) | -1.615612 (0.000) | -1.525313 (0.000) | -1.425835 (0.000) | -1.609042 (0.000) |
| round 5 | -1.224418 (0.000) | -1.065079 (0.000) | -1.061888 (0.000) | -1.211038 (0.000) | -1.051957 (0.000) | -1.051267 (0.000) |
| round 6 | -1.328784 (0.000) | -1.241458 (0.000) | -1.218614 (0.000) | -1.327939 (0.000) | -1.237228 (0.000) | -1.218042 (0.000) |
| round 3*travel | .0262483 (0.941) | | | .0310876 (0.929) | | |
| round 4*travel | .1620033 (0.664) | | | .1784768 (0.632) | | |
| round 5*travel | .9398987* (0.006) | | | .9385458 (0.006) | | |
| round 6*travel | .4606033 (0.205) | | | .4745023 (0.191) | | |
| round 3*curfew | | -.0713252 (0.867) | | | -.0781803 (0.854) | |

| | | | | | |
|---|---|---|---|---|---|
| round 4*curfew | | -.2362286 (0.612) | | | -.2551341 (0.583) | |
| round 5*curfew | | .662784*** (0.103) | | | .6567044 (0.104) | |
| round 6*curfew | | .260838 (0.548) | | | .2630354 (0.544) | |
| round 3*closure | | | .2081027 (0.617) | | | .2192122 (0.596) |
| round 4*closure | | | .68812*** (0.098) | | | .7606778 (0.065) |
| round 5*closure | | | .66547*** (0.102) | | | .6658979 (0.100) |
| round 6*closure | | | .0718991 (0.875) | | | .0945024 (0.836 ) |
| Household FE | Yes | Yes | Yes | No | No | No |
| Obs. | 5,623 | 5,623 | 5,623 | 5,623 | 5,623 | 5,623 |

Note: *, ** and *** represent 1%, 5% and 10% levels of significance

Both Table 4 and Table 5 provided below display the parameter estimates for the round indicator variable in each case. Across most of the calculations, the coefficients associated with all the round indicators show negative values and are statistically significant, except for round 4 where it pertains to the likelihood of experiencing moderate to severe food insecurity. This indicates that the overall probability of households facing moderate to severe food insecurity tends to increase between round 3 and round 4 in Ethiopia, while it decreases during the other survey rounds. As a result, we can confidently state that households in Ethiopia have observed a decrease in food insecurity levels between round 2 (June 2020) and round 6 (late September 2020).

The impact of Covid-19 is likely to vary across households due to differences in underlying conditions of the households. Table 4 reports the results for the probability of households being moderately/severely food insecure (column 1-4) across various indicator variables. The interaction terms between dummy rounds and the indicator variables capture the temporal variation in the evolution of food insecurity associated with households' location/sectors, ownership of land, ownership of livestock, and ownership of non-farm family enterprises (table 4). The same estimation is also conducted along income sources (rental income, remittance, assistance) and livelihood source, wage employment (Table 5).

**4.2 Covid-19 Impacts across Location and Ownership of Assets**

The interaction terms between the survey rounds and rural (column 1), between round dummies and ownership of livestock and non-farm family enterprises are all statistically insignificant, indicating that there is no heterogeneity in the impacts of the pandemic on food insecurity. As the spread of the pandemic initiates and also spreads in urban areas, government responses, including mobility restrictions and lockdowns, were mostly intensified in urban areas and expected to affect urban residents more directly than rural households at least in the short term. This, however, is not the case in the context of Ethiopian households.

Ownership of land has positive and significant coefficients in round 5 and 6 (column 2, table 4) on the probability of being moderately/severely food insecure. The significant coefficient of ownership of land, in column 2 of table 4, presents unexpected results on the differential impact of the pandemic on food insecurity. It tells that those households who own land face increased probability of being moderately/severely food insecure between round 4 and round 5, and round 5 and round 6. In fact, it is whether the land is cultivated or not; whether the land is being used for the intended purpose that should determine the variation in food security, not just a simple ownership of the land. This result could also be understood as ownership of land serves as a proxy for the rural community, who are already in deteriorating food security situation exacerbated by the pandemic's containment measures as well. Whatsoever the reality is, the implication of ownership of land by households in Ethiopia could be a subject of further discussions and researches.

Moreover, ownership of livestock and its interaction with round dummies are each statistically insignificant. This suggests the absence of heterogeneity by ownership of livestock in the impacts of the Covid-19 pandemic in households' food security situation in Ethiopia.

Finally, in the last column table 4, the paper presents the interaction terms between round dummies and ownership of non-farm family businesses. Though the literature identifies ownership of non-farm family businesses as a potential factor that could bring differential impact of the pandemic on food security, this study finds a contrasting result that the variable is not a significant one to put in such heterogeneous impacts.

Table 4: Estimation results of FE models in Ethiopia for location and ownership heterogeneity

| | Probability of being moderately/severely food insecure (P >= 50%) | | | |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| round 3 | -0.1959 (0.159) | -0.1125 (0.251) | -0.1031 (0.340) | -.1711233 (0.087) |
| round 4 | 0.307** (0.032) | 0.3659* (0.000) | 0.409* (0.000) | .4689469 (0.000) |
| round 5 | -0.606* (0.000) | -0.664* (0.000) | -0.518* (0.000) | -.5148625 (0.000) |
| round 6 | -0.8244 (0.000) | -0.840* (0.000) | -0.650* (0.000) | -.7056107 (0.000) |
| rural*round 3 | 0.1292 (0.451) | | | |
| rural*round 4 | 0.1624 (0.353) | | | |
| rural*round 5 | 0.1075 (0.556) | | | |
| rural*round 6 | 0.1171 (0.532) | | | |
| round 3*land | | 0.0122 (0.947) | | |
| round 4*land | | 0.1795 (0.334) | | |
| round 5*land | | 0.469** (0.015) | | |

| | | | | |
|---|---|---|---|---|
| round 6*land | | *0.339*** (0.088)* | | |
| livestock*round 3 | | | *-0.0220 (0.895)* | |
| livestock*round 4 | | | *0.0144 (0.932)* | |
| livestock*round 5 | | | *-0.0379 (0.829)* | |
| livestock*round 6 | | | *-0.2367 (0.192)* | |
| nfe*round 3 | | | | *.199622(0.263)* |
| nfe*round 4 | | | | *-.1725839 (0.339)* |
| nfe*round 5 | | | | *-.0619466 (0.742)* |
| nfe*round 6 | | | | *-.1372542 (0.482)* |
| Household FE | Yes | Yes | Yes | Yes |
| Obs. | 5,658 | 5,658 | 5,658 | 5,658 |

Note: *, ** and *** represent 1%, 5% and 10% levels of significance.

**4.3 Covid-19 Impacts across Income Sources and Livelihood Activity**

In the next section, the study explores potentially heterogeneous impacts of the pandemic across households with varying livelihoods and income sources. Our analysis in this regard is also in line with several studies across the world suggesting that the pandemic has had heterogeneous impacts on different livelihood options and sectors (Amare et al., 2020). The availability of baseline data regarding household's socioeconomic characteristics allows estimating the impact of the pandemic across various socioeconomic groups and regions. In order to better understand possible differential impacts, the study utilizes the baseline characteristics of households. It would us to discern vulnerable households and income sources from their counterparts. So, the heterogonous impacts of the pandemic across households' income and livelihood sources such as rental income, remittance, assistance, and wage employment are estimated and the results are presented in table 5 below. Each of these variables is interacted with the round dummies to determine evolution of the food insecurity across the rounds vis-à-vis the differential impact of the pandemic across each group of households.

Column 1 presents the interaction results between round dummies and rental income of households. Thus, coefficients in round 3 (0.5817), round 4 (0.9418), and round 5 (0.8929) are positive and statistically significant at 10%, 1% and 5%, levels, respectively. This means that households who had rental income source previous to the onset of the pandemic have increased likelihood of being moderately/severely food insecure between round 2, round 3, round 4 and round 5 (between May and August 2020). This also suggests that the impact of the pandemic is significantly heterogeneous among households with and without rental income.

Rental income includes income from shop or store or house or car or truck or other vehicle. It also includes rental income from land or agricultural tools or transport animals. Therefore, businesses closure measure by the government and decrease in economic activity due to the direct impacts of the pandemic and also other government's containments measures could be attributed to this differential impact of the pandemic across rental income sources.

Table 5: Estimation results of FE models for heterogeneity by households' income sources

| | Probability of being moderately/severely food insecure (P >= 50%) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| round 3 | -0.146*** (0.091) | -0.062 (0.505) | -0.070 (0.418) | -.1014559 (0.309) |
| round 4 | 0.359* (0.000) | 0.385* (0.000) | 0.429* (0.000) | .4306635 (0.000) |
| round 5 | -0.586* (0.000) | -0.454* (0.000) | -0.451* (0.000) | -.5523385 (0.000) |
| round 6 | -0.752* (0.000) | -0.707* (0.000) | -0.696* (0.000) | -.8315111 (0.000) |
| round 3*rent | 0.5817*** (0.091) | | | |
| round 4*rent | 0.94185* (0.009) | | | |
| round 5*rent | 0.89286** (0.017) | | | |
| round 6*rent | 0.0501 (0.900) | | | |
| round 3*remit | | -0.253 (0.224) | | |
| round 4*remit | | 0.171 (0.427) | | |
| round 5*remit | | -0.428*** (0.055) | | |
| round 6*remit | | -0.215 (0.349) | | |
| round 3*assist | | | -0.585*** (0.056) | |
| round 4*assist | | | -0.253 (0.415) | |
| round 5*assist | | | -1.206* (0.001) | |
| round 6*assist | | | -0.736** (0.034) | |
| round 3*wage_emp | | | | -.0326948 (0.855) |
| round 4*wage_emp | | | | -.0510748 (0.777) |
| round 5*wage_emp | | | | .0587911 (0.753) |
| round 6*wage_emp | | | | .272986 (0.155) |
| Household FE | Yes | Yes | Yes | Yes |
| Obs. | 5,658 | 5,658 | 5,658 | 5,658 |

Note: *, ** and *** represent 1%, 5% and 10% levels of significance.

Secondly, the interaction term between round and remittance is negative and significant only in round 5 (-0.428 at 10%) which indicates that remittance had a role of decreasing probability of becoming food insecure in Ethiopia during the pandemic (column 2). Likewise, households who have been receiving assistance from the government before the onset of the pandemic have decreased chance of becoming moderately or severely food insecure in Ethiopia. The interaction between round dummies and assistance are negative and statistically significant and different from zero in round 3 (-0.585), round 5 (-1.206) and round 6 (-0.736) at 10%, 1% and 5%, respectively, levels of significance. So, households relying on remittance and assistance income are significantly not harmed by the pandemic.

Finally, column 4 (table 5) presents the differential impact of the pandemic across wage employment as an income source. And, the interaction coefficients between wage employment indicator and round dummies are mixed in sign and are insignificant in all rounds, which indicates that involvement in wage earning activities does not significantly differentiate the impacts of the pandemic on households' food insecurity situation. Wage employment's impact is mixed and insignificant.

Joint significance of the interactions between each indicator variable and the round dummy are tested and presented in table 6 above. The impact of Covid-19 on the probability of households being moderate/severe food insecure is heterogeneous between those households who own land, earn rental income, and receive remittance and assistance and those households who do not. So, we can deduce that the variables (land, rent, remit and assist) are heterogeneity indicator variables.

Among the containment measures, in-country mobility restriction is the only jointly significant indicator variable. Hence, the government's restriction on in-country travel has had a significant and heterogeneous impact on households' food insecurity during the pandemic period.

Table 6: Test of joint significance of interaction terms (heterogeneity indicator variables)

| No. | Interactions terms (*heterogeneity indicators*) | Probability of being moderately/ severely food insecure >= 0.5 | |
|---|---|---|---|
| | | Chi2(4) | Prob>chi2 |
| 1 | travel*round | 9.12*** | 0.0582 |
| 2 | curfew*round | 4.65 | 0.3250 |
| 3 | closure*round | 4.63 | 0.3276 |
| 4 | rural*round | 1.00 | 0.9099 |
| 5 | land*round | 8.72*** | 0.0685 |
| 6 | livestock*round | 2.36 | 0.6701 |
| 7 | nfe*round | 5.16 | 0.2716 |
| 8 | rent*round | 10.70** | 0.0302 |
| 9 | remit*round | 8.30*** | 0.0812 |
| 10 | assist*round | 13.47* | 0.0092 |
| 11 | wage_emp*round | 3.50 | 0.4782 |

(Source: own organization from STATA results)

## 4.4 Impacts of Containment Measures across Urban/Rural

At last, a model (eq. 2) is fitted to examine the differential impacts of government containment measures on food security among rural and urban households. The results are presented in table 7. Restriction on in-country travel in urban households is statistically significant between round 5 and round 6. Thus, restriction on in-country travel has brought a statistically significant differential impact on food security between urban and rural households in these rounds.

The other statistically significant containment indicator is the closure of non-essential businesses between round 3 and round 4, and round 4 and round 5. Its interaction coefficients with urban are statistically significant in round 4 and round 5, at 5% level of significance each. Thus, closure of non-essential business has affected more strongly rural households than urban households. It brought a differential impact on food security among urban and rural households.

Therefore, from the table we can deduce that urban households have lesser probability of being affected than their rural counterparts because of the in-country travel restrictions and closure of non-essential businesses in Ethiopia.

Table 7: Differential impacts of measures on food security across location of households

| | Probability of being moderately/severely food insecure (P >= 50%) | |
|---|---|---|
| | Coefficient | P>|z| |
| travel* urban *round 3 | -0.5489889 | (0.167) |
| travel* urban *round 4 | -0.4349969 | (0.282) |
| travel* urban *round 5 | -1.047096** | (0.014) |
| travel* urban *round 6 | -0.6029585 | (0.162) |
| curfew* urban *round 3 | -0.3817449 | (0.394) |
| curfew* urban *round 4 | -0.6499698 | (0.154) |
| curfew* urban *round 5 | -0.2971929 | (0.532) |
| curfew* urban *round 6 | 0.6558487 | (0.174) |
| closure* urban *round 3 | -0.6870287 | (0.132) |
| closure* urban *round 4 | -0.9730496** | (0.037) |
| closure* urban *round 5 | -1.115285** | (0.024) |
| closure* urban *round 6 | -0.286051 | (0.566) |
| Household FE | | Yes |
| Obs. | | 5,623 |

Note: *, ** and *** represent 1%, 5% and 10% levels of significance

**4.5 Checking Robustness of the Estimates**

To ensure the strength of our conclusions, we took extra steps. We assessed each model by using smaller groups of data and trying different approaches. Initially, we focused on fixed effect model variations, concentrating solely on households outside Addis Ababa. This involved excluding data from Addis Ababa and adjusting the model accordingly. This allowed us to determine whether our results were heavily influenced by households in Addis Ababa, which is significantly larger and distinct in many ways compared to other Ethiopian cities.

Additionally, we re-ran the fixed effect models by removing certain time-dependent controls related to household attributes, such as changes in household head, household size, and adult equivalence (see also Table 3). Our analysis indicates that our findings remained consistent even with these changes in the dataset and model setup. The results hardly shifted when we excluded Addis Ababa from the dataset or left out specific household attributes in the fixed effect model. In essence, our conclusions held steady across all scenarios. Hence, the fixed effect models utilized in our study were appropriately chosen and effectively applied.

# V. CONCLUSIONS AND IMPLICATIONS

The impact of Covid-19 on households' food security is influenced by various factors. Measures like mobility restrictions, lockdowns, and business closures can reduce incomes by limiting economic and livelihood activities, directly affecting households' ability to secure food. Research from developing nations, including Africa, reveals that the pandemic's effects on food security, livelihoods, and economic sectors are diverse. This study aims to examine how the initial phase of the Covid-19 pandemic affected food insecurity among Ethiopian households, considering containment measures, locations, asset ownership, livelihoods, and income sources. To do this, it uses comprehensive panel data from the HFPS-H and Ethiopia's national longitudinal Socioeconomic Survey (ESS).

The results of the fixed-effects regression indicate that Covid-19 significantly impacted food insecurity in Ethiopia. Between round 2 (June 2020) and round 6 (late September 2020), households experienced a decline in food insecurity. The joint significance test highlights specific indicators, such as travel restrictions within the country, land ownership, rental income, remittances, and assistance, as significant factors affecting how the early days of Covid-19 influenced overall food insecurity among Ethiopian households. Notably, among the various measures implemented by the Ethiopian government to curb Covid-19, restrictions on in-country mobility had a notable impact on food insecurity. This measure increased the likelihood of households facing moderate to severe food insecurity during the initial stages of the pandemic.

Although further research is needed to fully understand its effects, the ownership of land appears to play a significant role in determining how Covid-19 affects households' access to food. Additionally, households that relied on rental income before the pandemic are more likely to experience moderate to severe food insecurity between the second and fifth rounds of data collection (from May to August 2020). The presence of rental income also serves as an important factor in how Covid-19 impacts households' food security. This means that the pandemic's impact on food security varied significantly between households with and without rental income.

When examining the relationship between different rounds of data and remittances, the interaction term shows a negative and statistically significant impact only in the fifth round. Similarly, the interaction between round data and assistance is negative and statistically different from zero in the third, fifth, and sixth rounds. These factors also collectively contribute to the varying impact of Covid-19. These findings highlight the crucial role played by remittances and assistance income in safeguarding households from worsening food insecurity during the pandemic's short-term effects.

The findings can provide valuable insights for shaping short and medium-term policy actions and measures by both government entities at various levels and international donor organizations. To begin with, this research can guide the development of targeted approaches by pinpointing the households or individuals most heavily affected. Additionally, it could serve as a foundation for crafting policies related to safety nets and social protection, with the goal of mitigating the adverse effects of the pandemic.

In the immediate timeframe, it was crucial to offer direct assistance to these households, such as providing cash transfers and distributing food supplies. Looking ahead to the medium term, it could have been beneficial to enhance the resilience of marginalized groups and households to future shocks. This might involve improving their access to job opportunities and markets for both food and transactions. The key takeaway is that the country should have bolstered its social protection and rehabilitation efforts through safety net programs that can help those significantly affected households. Hence, the study underscores the importance of preparedness for unforeseen economic shocks in the future.

Finally, the scope of the analysis didn't allow for a distinction between the specific impacts of Covid-19 on solely urban or rural households. For instance, in larger and densely populated cities, people were less likely to travel due to the heightened risk of contagion and stricter mobility constraints imposed by lockdowns. This divergence in responses to Covid-19 could lead to differing impacts on urban households. Moreover, the analysis did not explore other potential avenues of differing pandemic effects. For instance, workers belonging to disadvantaged groups who had to commute from far-off places to their workplaces would likely be severely affected by mobility restrictions. Household members who lacked the option to work remotely and relied on travel for their self-employment might have faced heightened vulnerability to mobility-related disruptions and increased susceptibility to food insecurity.

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