Food and Agriculture Organization of the United Nations

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Background paper for *The State of Food Security and Nutrition in the World 2019*

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The State of Food Security and Nutrition in the World 2019

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Abstract

Despite relatively high economic growth rates in many developing countries in the last two decades, income inequality has remained high and even increased. This has important policy implications for achieving reductions in food insecurity. As evidence from this paper suggests, high-income inequality undercuts the benefits of economic growth in reducing food insecurity. This paper uses the 2014 Gallup World Poll (GWP) dataset on a sample of 75 low- and middle-income countries for which cross-country comparable measures of individual food insecurity based on the Food Insecurity Experience Scale (FIES) are available. By means of a three-level linear probability model that controls for the presence of individual and household (first level), country (second level) and the macro-region (third level), we assess the macro-economic effects of economic growth and income inequality on individual food insecurity. Results show that increases in gross domestic product (GDP) per capita are concurrent with declines in individual food insecurity, both in terms of *severe food insecurity* (people running out of food and experiencing hunger) and *moderate or severe food insecurity* (also including people who face uncertainties about their ability to obtain food and have to compromise on the quality and/or quantity of food consumed). Specifically, a 10 percent increase in GDP per capita is associated with a 4–7 percent decrease in individual food insecurity. However, the effect of living in a country with high-income inequality significantly undercuts the positive effect of economic growth on individual food security. Individuals living in countries with a high Gini index have on average a 33 percentage point higher probability of experiencing severe food insecurity and a 42 percentage points higher probability of moderate or severe food insecurity. The findings suggest that by tackling income inequality, economic growth can become a force for reducing food insecurity in low- and middle-income countries.

Keywords: food security, economic growth, income inequality, Food Insecurity Experience Scale (FIES), developing countries.

JEL codes: I31, I32, E25, O15, O47, O57.

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1 Introduction

Although many low- and middle-income countries are among the world's fastest growing economies in recent years, most still have the highest burden of hunger and food insecurity. It is estimated that more than 2 billion people are moderately or severely food insecure, meaning that they struggle to access sufficient and nutritious food because of lack of money or resources. Most of these people, more than 90 percent, live in low-and middle-countries (FAO *et al.*, 2019). Individual food insecurity is a complex phenomenon that is not only determined by individual and household socio-economic characteristics but also by country-specific factors, particularly the pace and pattern of economic growth and the degree of income inequality.

While it is well acknowledged that macro-economic factors can be critical in affecting food security, few studies have analyzed the association between country-level macro-economic variables and the individual probability of food insecurity or child undernutrition using multilevel statistical models. Subramanyam *et al.* (2011) find a statistically insignificant association between economic growth and child undernutrition (underweight, stunting and wasting) across Indian states, whereas Harttgen, Klasen and Vollmer (2013) point to a significant but small and inverse relationship in sub-Saharan countries. Smith, Kassa and Winters (2017) and Smith, Rabbitt and Coleman-Jensen (2017) analyze the effect of macroeconomic variables (GDP and unemployment) on food insecurity for a sample of high- and low-income countries available in the Gallup World Poll (GWP) dataset as well as for Latin American countries only. They find heterogeneity in the determinants of food insecurity across different rankings of economic development. In particular, they find that the largest increase in the likelihood of experiencing food insecurity is associated with low levels of education, low social network and social capital, low household income and unemployment. The analysis focused on Latin America shows that living in countries with low GDP per capita is also a significant determinant of food insecurity.

We move from this last piece of work to see how income inequality and GDP per capita, analyzed alone and through their interacted effect, determine the probability of individual food insecurity in low- and middle-income countries. We use the 2014 Gallup World Poll (GWP) dataset on a sample of 75 low- and middle-income countries to collect individual and household socio-economic information, and we merge it with two country-level characteristics: GDP per capita and the Gini index of income inequality. Following the approach of Smith, Kassa and Winters (2017) and Smith, Rabbitt and Coleman-Jensen (2017), we build a unique dataset containing information at different levels of disaggregation that comprise individual, household and country level variables. We exploit the richness of the data collected to bring two main innovative elements into the analysis.

First, we start from the assumption that individual food insecurity is a complex phenomenon that is not only determined by individual and households socio-economic characteristics but also by country specific factors that directly shape the extent to which people have access to food. Additionally, we also control for macro-region unobserved characteristics that may be at play in determining individual food insecurity. We thus use a three-level linear probability model to analyze the determinants of individual food insecurity, as this class of models is found to better suit the structure of our dataset.

Second, we exploit unique features of the experienced-based Food Insecurity Experience Scale (FIES) that we use as our dependent variable: it measures access to food security at the individual level, it is self-reported and it is directly comparable across countries. In the present

analysis, two FIES variables are used – one indicating *severe food insecurity*, the other indicating moderate or severe *food insecurity*. By relying on cross-country comparability, we are able to find key economic determinants of food insecurity that are common to low- and middle-income countries, with a particular focus on the contribution of GDP and income inequality.

Our results bring two important considerations. First, this paper provides an important validation for the use of the FIES for analysing food security in the context of low and middle-income countries. Second, our estimations point to an association in the range of 4–7 percent between GDP per capita and food insecurity (severe, and moderate or severe). The results show that individuals living in countries with a high Gini index have on average a 33 percentage point higher probability of experiencing severe food insecurity and a 42 percentage points higher probability of moderate or severe food insecurity. Importantly, the results also indicate that high-income inequality works to undercut the contribution of per capita GDP in reducing individual food insecurity, both in terms of severe and moderate or severe food insecurity.

2 Background

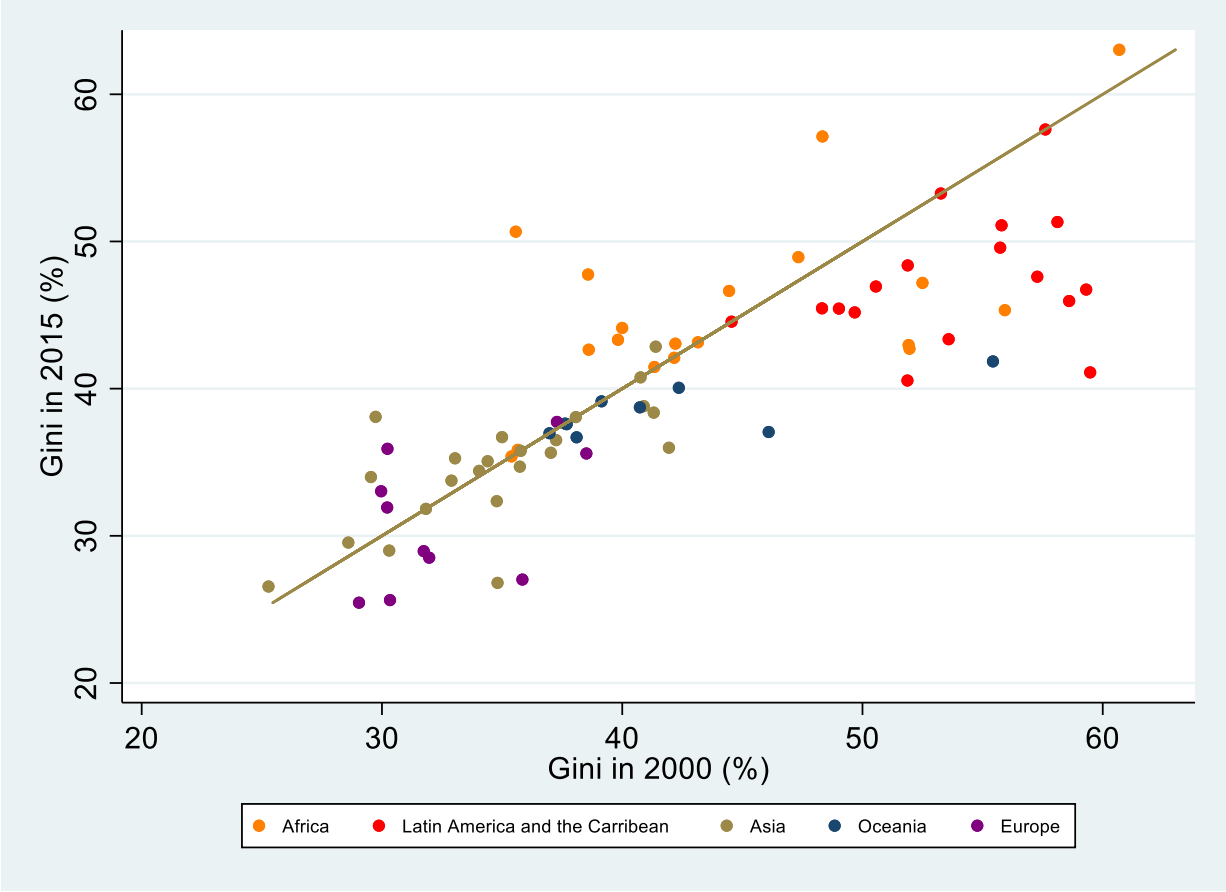
Income inequality is a defining issue of our time. It is also a cause of entrenched uncertainty and vulnerability (World Bank, 2018). A country experiences income inequality when not every member of its population gets exactly the same share of the income the economy is generating. Although the world has made remarkable progress in reducing extreme poverty, income inequality remains high. This means that most of the reduction in poverty has been achieved through increased economic growth, not through reductions in income inequality, as poverty reduction can occur through higher average growth, a narrowing in income inequality, or a combination of the two.

In the last two decades many low-income and middle-income countries have exhibited relatively high GDP growth rates that generally translated into increased economic development. For example, since 2000, 34 countries rose from a status of a low-income country (LIC) to a middle-income country (MIC) because their national economy grew in terms gross national income (GNI) per capita (World Bank, 2020a). Despite this economic growth, however, income inequality has remained high and even increased in many low- and middle-income countries. In Figure 1, countries above the line have seen an increase in income inequality from 2000 to 2015, whereas those below the line have seen a reduction. Between years 2000–2015, income inequality has increased for 33 percent of the countries shown in Figure 1, and the great majority of these countries (73 percent) are classified as middle-income. Furthermore, several countries in Africa and Asia – the regions with the highest levels of food insecurity, have seen large increases in income inequality in the last fifteen years.

Persistent and high levels of income inequality have important policy implications for achieving reductions in food insecurity. These involve pro-poor growth strategies to reduce hunger and food insecurity, as well as direct investments targeted to the most food insecure. For instance, the quality of policies and institutions is a critical element for directly ensuring food and nutrition security (Mary, Saravia-Matus and Gomez y Paloma, 2018). Several nutrition studies show that the most effective way for economic growth to reduce child stunting is to enhance the role of intermediary factors such as sanitation, governance, nutrition programs, growth in food production and infrastructures, and education. Moreover, promoting economic growth that increases the income of the poorest and improves the quality of these intermediary inputs is likely to have a positive effect on stunting (Mcgovern *et al.*, 2017).

If economic growth is associated with high or rising income inequality, the poorest may not capture the benefits of increased national income and can continue to face uncertainty in access to food or be forced to compromise on the quality and/or quantity of food they consume. With limited income and resources, the poorest are often forced to make difficult choices between basic essential expenditures, which can lead to uncertainty and compromise their access to food, such as skipping meals, buying less nutritious foods, or going a day without food. New measures of food insecurity that go beyond just measuring severe forms of hunger, show that more moderate forms of food insecurity is a significant problem (FAO *et al.*, 2019). Globally, the prevalence of moderate or severe food insecurity affects more than 26 percent of the world population, and for some regions rates are even higher, reaching 34 percent (Southern Asia) and 57 percent (sub-Sharan Africa). This is further confirmed by new measures of poverty that show that billions of people still struggle to meet basic needs, including access to food, basic health and education (World Bank, 2020a).

Figure 1. Persistent and high-income inequality in low- and middle-income countries



Source: Authors' own elaborations based on World Development Indicators (WDI) (World Bank, 2020a).

Part of the explanation for this crisis in access to food can be attributed to persistent and high levels of income inequality. Evidence suggests that high and increasing income equality works to undercut the benefits of economic growth for the poorest (Carmignani, 2013; Kanbur, 2016; Mary, Saravia-Matus and Gomez y Paloma, 2018; World Bank, 2016). When there is both economic growth and high or increasing income inequality, the expected effect on the risk of food insecurity depends on the strength of each opposing factor, as the effect of economic growth is positive, while that of increasing inequality is negative. For this reason, empirical evidence is needed to shed light on the interaction of these relationship.

A country experiences income inequality when not every member of its population gets exactly the same share of the income the economy is generating. Income inequality shapes the way growth translates into higher or lower human development. Income inequality causes structural problems that can lead to threaten economic growth, food security, poverty and social unrest. Various economic, social, and political factors operating within an economy influence the distribution of income in that economy. These factors are important particularly in developing countries, which are not only confronted with income distribution problems, but face very low per capita incomes and declining food consumption (Karmakar and Sarkar, 2013). An earlier literature was conducted on the relationship between income distribution and food consumption prior to the 1980s, arguing that moving toward a more equitable income distribution is expected to lead to a substantial increase in consumer expenditures for food. An early work of FAO argues

that a shift in the structure of income distribution, with more rapid income growth for low (high) income strata than for high (low), would generally lead to a greater increase (decrease) in food consumption (FAO, 1972; Zheng and Henneberry, 2010).

Changes in the distribution of income across countries affect the rate of growth of food demand and food consumption especially for the poor (Cirera and Masset, 2010). A distribution-neutral income growth pattern is expected to increase food demand by a larger amount than would an income growth which is skewed in favour of high-income households (Zheng and Henneberry, 2010). Some studies have focused on specific countries and found a statistically significant and negative association between income inequality and the levels of nutritional status. An adverse effect of state income inequality was found in India on both the risk of being underweight as well as on pre-overweight, overweight and obesity (Subramanian, Kawachi and Smith, 2007). A deleterious effect of economic inequality was also found on child stunting in Ecuador (Larrea and Kawachi, 2005) and on self-reported health in Chile (Subramanian *et al.*, 2003).

The effect of economic growth and income inequality on poverty has been extensively analyzed and shows the crucial role of income inequality in transforming economic growth into poverty changes.[1] Specifically, while sustained economic growth is one of the most critical factors in alleviating poverty, the rate at which poverty shrinks as economic growth accelerates, depends on both the initial level of income inequality and changes in income inequality over time (Nallari and Griffith, 2011).[2] Studies show that high levels of income inequality hampers the ability of economic growth to reduce poverty – in fact, it is a barrier. High initial levels of inequality limit the effectiveness of economic growth in reducing poverty while growing income inequality increases poverty directly for a given level of growth. Fosu (2017) shows that lower-inequality and higher-income countries exhibit greater abilities to transform a given economic growth rate to poverty reduction. Income inequality has also been shown to reduce the impact of future economic growth on poverty reduction (Ravallion, 2001). Bourguignon (2003) found that a fall in income inequality, as measured by a Gini index change from 0.55 to 0.45, would cause poverty to drop by more than 15 percentage points in ten years, but it would take 30 years to achieve the same reduction in poverty if inequality remains unchanged.

Although the mediating effect of income inequality on economic growth has been extensively analyzed on poverty, there is limited empirical evidence on nutritional and health outcomes, and no evidence exists on the effect on food security. Pickett *et al.* (2005) find that income inequality is positively correlated with obesity and diabetes mortality in developed countries, after controlling for gross national per capita income. Ward and Viner (2017) focus on the impact of income inequality and national wealth on child and adolescent mortality in low- and middle-income countries and find that the Gini index (and GDP) are positively (negatively) associated with all-cause and communicable disease mortality in both sexes across all age groups.

While there are few empirical studies on the effect of income inequality on child nutrition, there is extensive evidence that economic growth is negatively associated with child stunting, that is the higher the economic growth, the lower the child stunting. The empirical evidence is unambiguous on this negative relationship, however, the magnitude of the relationship

[1] See Bourguignon (2003); Epaulard (2003); Fosu (2009, 2017); Kalwij and Verschoor (2007); Lopez (2004); Ravallion (2001); World Bank (2006a, 2006b, 2016, 2020b).

[2] In addition to the initial level of income inequality, the pattern of economic growth and whether growth is concentrated in areas where poor people live plays an important role at which poverty shrinks as growth accelerates.

continues to be highly debated (Alderman *et al.*, 2014; Vollmer *et al.*, 2014). A number of studies have shown that a 10 percent rise in GDP leads to a 6 to 7 percent reduction in stunting whereas other studies have found only a very small or no link.[3] A recent review of evidence across studies finds that once estimates from the different studies are rescaled for comparability, the impact of a 10 percent increase in GDP per capita is in the range of a 0.7-2.2 percent reduction in child stunting for short term impacts of economic growth (Bershteyn *et al.*, 2015; Mcgovern *et al.*, 2017).

On the other hand, in the long-run (25- to 30-year period), the impact of GDP per capita on child stunting is larger, at around 6 percent (Haddad *et al.*, 2003; Mcgovern *et al.*, 2017; Smith and Haddad, 2015). However, if the reverse causal effect of child stunting on economic growth is accounted for, the long-run effects of economic growth on child stunting are much lower. For example, Mary, Saravia-Matus and Gomez y Paloma (2018) find that accounting for reverse causality, the impact of a 10 percent increase in GDP per capita on child stunting is reduced from 3.6 percent to 2.7 percent. Despite the continuing debate on the magnitude of the effects, there appears to be general agreement that while economic growth contributes to improvements in child nutrition, it does so only modestly and is not sufficient to accelerate reductions in child nutrition, at least in the short-run.

In contrast, there is very little empirical evidence on the effect of economic growth and income inequality on food insecurity. This lack of empirical evidence is partially due to the lack of common comparable cross-country food security measures and data. Empirical analysis is increasingly possible, however, given the development of a globally comparable food insecurity measures based on the Food Insecurity Experience Scale (FIES) and newly available FIES cross-country panel data (FAO *et al.*, 2019).

While no study to date has examined the effect of income inequality on food insecurity, two recent studies have analysed the effect of economic growth, as measured by GDP per capita, using this newly available data set. Both studies find that increases in economic growth are concurrent with declines in individual food security. In the study focusing on the comparisons across countries in Latin America and the Caribbean, Smith, Kassa and Winters (2017) find that a 10 percent increase in a country's GDP per capita lowered the likelihood of moderate or severe food insecurity by 1.15 percentage points and severe food insecurity by 0.97 percentage points. In the global analysis of 134 countries, also find the same negative relationship, but with a smaller effect and with statistically significant results only for low- and high-income countries. Although these studies do not analyze the effect of income inequality on food insecurity, they provide the first empirical evidence of the relationship between economic growth and individual food insecurity.

Following this literature and moving from the hypothesis that income inequality is an important mediating factor, this study sets out to empirically test if GDP per capita and income inequality are significant determinants of food insecurity by using of a sample of 75 low- and middle-income countries for which available data at individual, household and country level would permit reasonably comprehensive country comparative analysis.

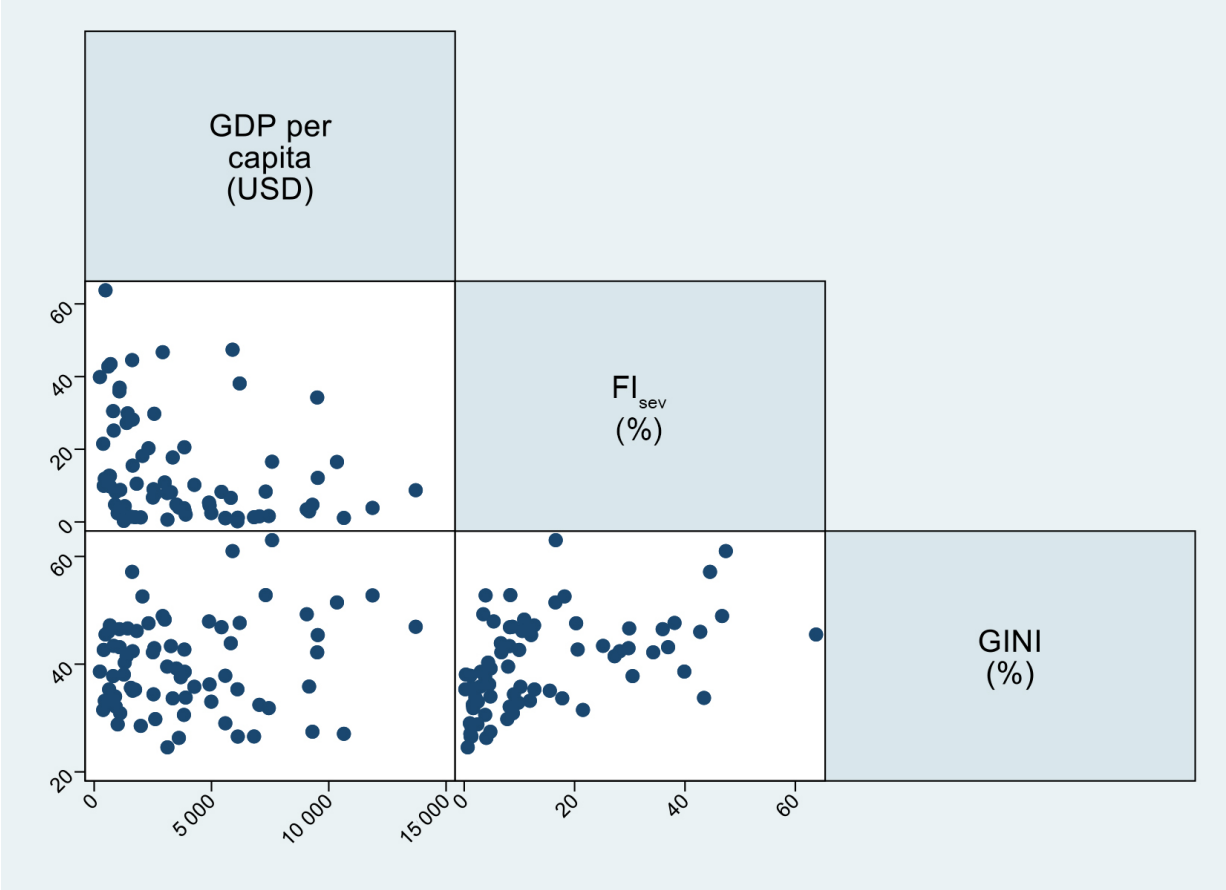
As highlighted by the scatterplot matrices in Figure 2, food insecurity as measured by both FI_{sev} and $FI_{mod+sev}$, shows a negative nonlinear correlation with GDP per capita, and a positive relationship with the Gini index. In addition, Pearson's correlation coefficients, all statistically

[3] For a recent review of some of the literature, see Mary, Saravia-Matus and Gomez y Paloma (2018).

significant at the 5 percent level or better, show that GDP per capita is negatively correlated with both severe food insecurity (-0.30) and moderate or severe food insecurity (-0.40), whereas the Gini index of income inequality shows positive correlation with both FI_{sev} (0.48) and $FI_{mod+sev}$ (0.51).[4] Therefore, in this paper we want to test if income inequality undercuts the ability of individuals to access adequate and nutritious food, and either attenuate or cancel out the positive effects of GDP on decreases in food insecurity.

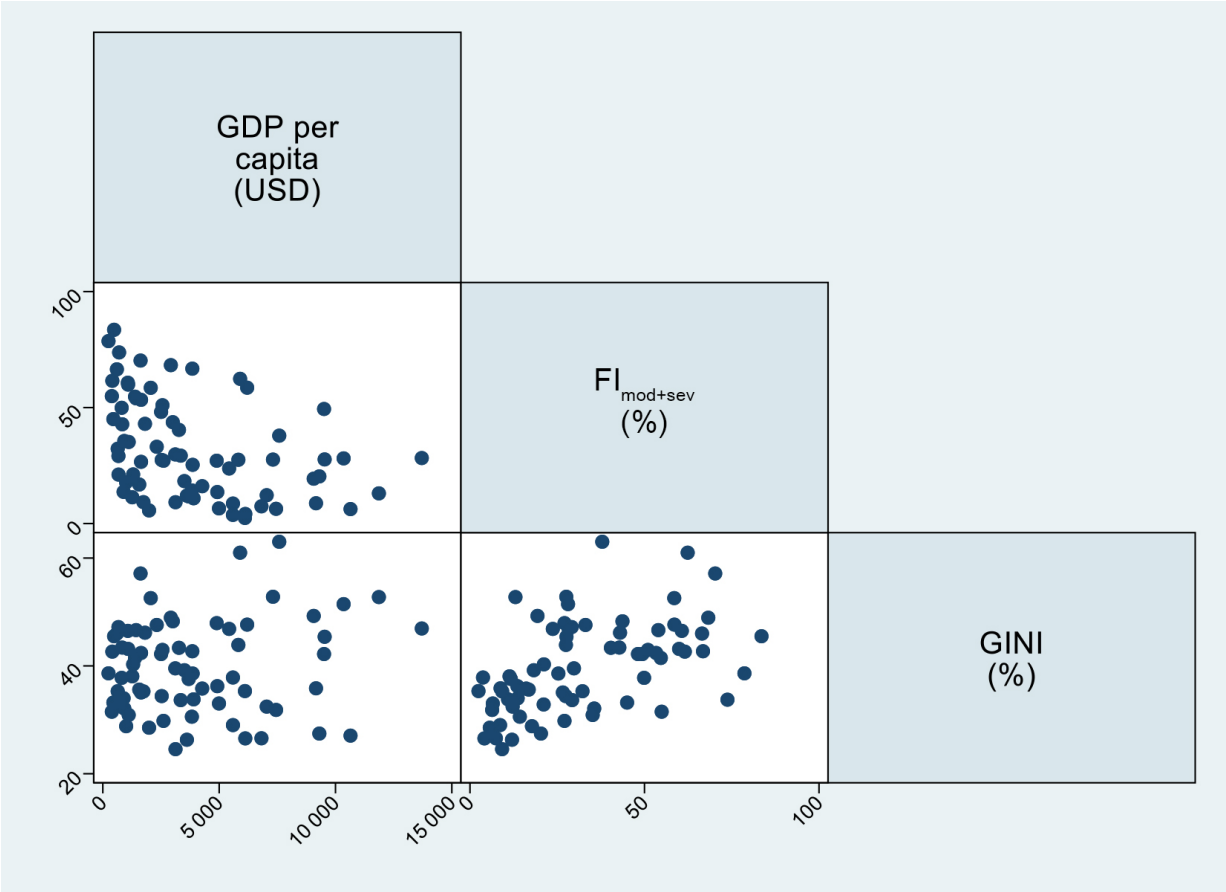
Figure 2. Correlations matrices between GDP per capita, food insecurity and income inequality

a. Severe food insecurity (FI_{sev})



[4] Similar results on country-level measures of the $FI_{mod+sev}$, where Spearman rank correlations coefficients, significant at the p=0.01 level, show that GDP per capita is strongly and negatively correlated with food insecurity (-0.82), and income inequality strongly and positively correlated with food insecurity (0.62), see FAO *et al.* (2019).

b. Moderate or severe food insecurity ($FI_{mod+sev}$)



Notes: The figure presents scatterplot matrices of correlations between severe (FI_{sev}) and moderate or severe food insecurity ($FI_{mod+sev}$), GDP per capita, and the Gini index of income inequality. The figure shows a negative and significant correlation between GDP per capita and both measures of food insecurity, and a positive and significant relationship between food insecurity and income inequality. No statistically significant association is found between GDP per capita and the Gini index.

Source: Authors' own elaborations.

In analyzing income inequality and GDP per capita, one may argue that these two variables are endogenous and highly correlated to each other, and that their inclusion as regressors in our model specifications may lead to biased estimated coefficients. We thus run several statistical tests and show that the Gini index and the GDP per capita do not report a statistically significant association in absolute terms, as can be seen from scatterplots in Figure 2 and from Pearson's coefficients. In fact, the Gini index and GDP per capita share a positive but statistically insignificant coefficient (0.14), indicating that the degree of inequality in income distribution across low- and middle-income countries is not systematically correlated with their level of economic development. Furthermore, when running the analysis of variance (ANOVA), we find no statistically significant differences in the level of the Gini index across the three groups of low-, lower-middle- and upper-middle-income countries. The Bartlett's test confirms that the variances of the Gini index across the three groups of countries are not unequal in a statistical sense. Therefore, including the Gini index in the equation along with GDP per capita does not raise problems of multicollinearity.

As mentioned above, the growth-poverty nexus has been extensively analyzed to show the crucial role of income inequality in transforming economic growth into poverty changes (Bourguignon, 2003). In addition, there is evidence that food security is highly correlated with poverty, for instance, poverty and self-assessed hunger share a strong and significant correlation in the range of 0.71–0.75 (Headey, 2013; FAO *et al*., 2019). In fact, extreme poverty was originally defined in relation to income levels required to access a minimum daily caloric intake.

3 Data and methodology

3.1 Conceptual model

Following Smith, Rabbitt and Coleman-Jensen (2017) and Gregory *et al.* (2013), we used Barrett (2002) theoretical rational-choice model of individual behaviour to inform our empirical analysis of the effects economic growth and income inequality on individual food insecurity. The model builds on the household model of Becker (1965)[5] and Gronau (1977) and the health production function framework of the household production model of Grossman (1972) to include household nutrition and food security.[6] Food security falls out of the model as an indicator of risk exposure. Importantly, the model formally captures the complex interactions among many different variables which are both endogenous and exogenous to the individual, thus allowing for the examination of the effects of macro-economic factors on individual food security. Individual food security in the model is defined as the marginal probability, at any specific time, of falling in any of the three states or classes of food security of progressive severity: i) near-optimal food security; ii) avoidance of permanent impairment of food security; and iii) survival food security. In the current period where food security is observable (directly or indirectly), food security is a binary variable equal to zero or one – either a person is currently food secure or not.

From Barrett's model we can consider how macro-economic factors, such as economic growth and changes in national income inequality, should affect individual and household food insecurity. The effect of growth in gross national product on food security comes primarily from increased individual and household resources. In principal, economic growth brings increased employment and income opportunities and reductions in poverty, which in turn work to expand individuals and households budget sets and relax their resource constraints. This should allow people to access more food and reduce the incidence of uncertainty and hardships in acquiring adequate quantities and quality of foods, thus reducing the probability of food insecurity.

Similarly, decreases in national income inequality presume that the share of national income is more evenly shared. Where high-income inequality is defined as skewed to those who are better-off, the effect of decreasing income inequality would bring improved incomes for those at the bottom end of the scale. The effect of a decrease in national income inequality on food security, like economic growth, would come through increased household's resources that expand budget sets and relax resource constraints, and in turn improved access to food, both in quantity and quality.

When there is both economic growth and increasing inequality the expected effect on the risk of individual food insecurity depends on the strength of each opposing factor, as theoretically the effect of economic growth is positive, while that of increasing income inequality is negative. In this case empirical analysis is needed to shed light on the interaction of these relationships. We utilize this framework to motivate our empirical analysis of the relationship between economic growth, income inequality and the interaction of the two. The recent availability of a global database containing measures of individual food insecurity reflecting a person's actual

[5] The model also includes important contributions from by Chavas (2000); Dasgupta (1993); Glomm and Palumbo (1993).

[6] For other empirical studies that have used this approach see (Gregory, Rabbitt and Ribar, 2013; Smith, Kassa and Winters, 2017; Smith, Rabbitt and Coleman-Jensen, 2017).

behaviour and experience of access to food considering their resource or budgetary constraints provides an important opportunity to explore these relationships using large nationally representative samples across many countries.

Barrett's model also identifies several other structural characteristics that increase the risk or probability of individual food insecurity and which more generally inform the determinants of individual food security. Labour is a primary factor in production-based entitlement and the one of most important item exchange for trade-based entitlements. As such low and unstable labour productivity is a proximate cause and risk to food insecurity. Individuals also are at increased risk of hardship if they face adverse terms of trade, for example in the form of either low wages for the work they perform, limited or irregular employment opportunities or high prices for the goods and services they purchase. There are also increased risks to food insecurity if individuals or the households to which they belong have low levels of assets and savings. This is risk is made worse when they have limited opportunities to borrow or receive support. Weak or limited access to social or public support systems thus also increases the risk food insecurity as it lessens the ability to smooth consumption over time. In our empirical analysis we include elements of these factors to both control for explanatory variations and to provide empirical evidence of the expected relationships.

3.2 Data

To assess the association between GDP per capita, income inequality and individual food insecurity, we construct a unique dataset containing information at different levels of disaggregation that comprise individual, household and country level variables. The analysis uses Gallup World Poll (GWP) data for 75 low- and middle-income countries in year 2014, including FAO Food Insecurity Experience Scale (FIES) data.

High-income countries are excluded given the focus of the analysis on the effects of macro-economic factors in countries with the highest burden of food insecurity in the world. In 2014, the GWP interviewed 99,138 individuals in 92 low- and middle-income countries. Observations were dropped where there was either missing country-level data or individual data on any of the indicators of interest. Starting from this sample, five countries were omitted given information on Gini index was unavailable; nine countries dropped due to missing information in at least one of the eight questions on food insecurity, and additional three countries were dropped from the sample since they do not provide information on two or more individual-level control characteristics. The final sample was 77 472 adults in 75 low- and middle-income countries in 2014. The sample size for each country varies depending on the size of the country populations. For the list of countries included in the analysis see Annex 3.

The GWP collects data on individuals aged 15 years or older in more than 150 countries on a semi-annual, annual and biennial frequency that is determined on a country-by-country basis. Survey data is nationally representative after weighting, with a typical sample size of at least 1 000 individuals per country, with larger samples for more populous countries. For example, in 2014, 3 000 individuals were sampled in India, and 5 000 individuals in China. Samples are probability based, and the coverage includes the entire country in both rural and urban areas. Interviews are conducted either face-to-face or by telephone. Surveys are administered through face-to-face interview in much of Latin America, Africa, Asia, Eastern and Central Europe and the former Soviet Republics, using an area frame design in randomly selected households.

Surveys conducted by telephone are done in medium and high-income countries only when there is at least 80 percent of national telephone coverage.[7]

The GWP consists of a set of core questions asked in all countries, plus additional region-specific questions. Information collected from individuals includes demographic characteristics (e.g. gender, age, and marital status), educational attainment, labour force participation, opinions, experiences, habits, as well as information on a few household-level characteristics, namely, household income, household size and living conditions. The majority of the questions can be answered with yes/no responses.

Since 2014, the FAO Food Insecurity Experience Scale Survey Module (FIES-SM) has been included in the GWP questionnaire, providing an opportunity to investigate the determinants and consequences of food insecurity across geographic and cultural contexts. The data collected through FIES-SM of the GWP surveys are used to compute a measure of severity of the food insecurity status for each respondent, focusing on conditions that reflect limited access to food. The FIES was developed by FAO to be a new global standard for measuring food insecurity, based on people´s self-reported experiences facing constraints in accessing food.

Information provided in the GWP data is complemented with country-level information on income inequality and GDP per capita that is taken from the World Bank World Development Indicators database (World Bank, 2020a) and the United Nations National Accounts Main Aggregates Database, respectively (United Nations, 2019).

Dependent variables

For the purposes of this analysis we utilize two binary measures of individual's severity of food insecurity based on the FIES, collected through the GWP and estimated by FAO.[8] The first measure is *severe food insecurity* (FI_{sev}), including people who have typically run out of food, experienced hunger and, at worst, gone a day or days without eating (FAO *et al.*, 2019). Severe food insecurity estimates are found to be more sensitive to short-term factors affecting people's direct experiences in accessing food. The second measure is *moderate or severe food insecurity* ($FI_{mod+sev}$) based on the FIES. This measure includes *severe food insecurity* (FI_{sev}), but goes beyond hunger to include *moderate food insecurity* (FI_{mod}). People facing *moderate food insecurity* may not have run out of food or gone hungry, but face uncertainties about their ability to obtain food, and have been forced to compromise on the quality and/or quantity of the food they consume. Both the indicators are measures of access to food. Moderate food insecurity thus refers to a lack of consistent access to food, which diminishes dietary quality, disrupts normal eating patterns, and can have negative consequences for nutrition, health and well-being (FAO *et al.*, 2019).

In this analysis we use individual Pearson's probabilities that FAO computes separately for severe and moderate or severe food insecurity. Thus, two food insecurity dummy variables are created – one denoting severe and the other moderate or severe food insecurity. The dummy

[7] The GWP methodology documentation can be found at: www.gallup.com/poll/105226/world-poll-methodology.aspx. GWP country data set details, including the methodology of each country data set, collection dates, languages, mode of interviewing, sample exclusions and margin of error can be found at: www.gallup.com/file/services/177797/World_Poll_Dataset_Details_052920.pdf

[8] FAO's data are public goods, and the organization follows a policy of open data. For this reason, FIES data collected in the GWP and six demographic variables is publicly available for a large number of countries through a new microdata dissemination portal (FAO, 2018).

variables are equal to one when individual probabilities fall above the threshold of 0.5, and they equal zero otherwise. Following Smith, Kassa and Winters (2017) and Smith, Rabbitt and Coleman-Jensen (2017), we also create alternative food insecurity measures that we use to further test the validity of our analysis.[9] In particular, by summing up the number of affirmed food insecurity responses a raw score is determined ranging from 0 to 8. Individuals are then classified as being moderate or severe food insecure if their raw score is equal or greater than the moderate country-specific FIES Global Standard Scale (FIES-GSS)[10] thresholds, and are severely food insecure if their raw score is equal or above the severe FIES-GSS thresholds.

Independent variables

The explanatory variables for the analyses are the common determinants of individual food security, as defined by the theoretical model, including two macro-economic variables that are the focus of this paper: GDP per capita and income inequality. In addition, individual and household explanatory variables include demographic (age, gender, marital status, household size, place of resident), social (social capital, social network), and socio-economic characteristics (household income, status of individual employment, household income).

Demographic variables of age, gender, household's size and marital status are self-explanatory. Place of residence distinguishes between whether a person lives in a rural area or on a farm, small town, suburban area or large city. To capture the elements of an individual's social support or social capital two binary variables (yes or no) are used: social networks and social capital. Social network is a dummy variable indicating whether or not the individual respondent is satisfied with their ability to make friends while the social capital dummy variable captures if individuals feel they can count on relatives or friends in times of need.

The annual household income is a continuous variable of the log of the individual's imputed household income. It is equated across countries by converting from local currency to International Dollars (ID) using the most recent World Bank's purchasing power parity (PPP) ratios (2014 for many countries) and deflated based on consumer price index (CPI) of USD for years 2009–2015, thus making all years in 2016 USD comparable.

GDP per capita is measured at constant 2010 prices (USD) and is drawn from the United Nations National Accounts Main Aggregates Database (United Nations, 2019). The Gini index from the World Development Indicators is used to measure the extent to which the distribution of income among individuals or households within a country deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality. A binary variable is created to identify countries according to their level of income inequality (low vs. high). Countries reporting a relatively higher income inequality are those with the Gini index falling above the median sample value of 35 percent, whereas countries with lower-income inequality are those with the Gini index above or equal to this threshold. In what follows, to ease the discussion of the results, we call countries as having high- or low-income inequality, depending whether the Gini index falls below or above the median threshold. For a full description of all independent variables see Annex 2.

[9] Results are available upon request.

[10] For the methodology used by FAO to construct the FIES-GSS, see FAO (2016).

3.3 Analysis sample and descriptive statistics

Table 1 shows the average prevalence of the food insecurity variables, with standard errors reported in parenthesis, for the complete sample of low- and middle-income countries (column 1) as well as by degree of income inequality, i.e. countries with low (column 2) and high (column 3) income inequality as defined by the Gini index.

Descriptive statistics of the dependent variables show that in 2014, 30 percent of the individuals experienced *moderate or severe food insecurity* ($FI_{mod+sev}$), and 14 percent experienced *severe food insecurity* (FI_{sev}) (Table 1, column 1). More importantly, the percentage of people with food insecurity is higher in countries with a high level of income inequality than those with a lower level, as attested by the statistically significant difference in means between the two groups. The prevalence of severe food insecurity is on average three times higher in countries with high-income inequality (20 percent) compared with countries with low-income inequality (7 percent).[11] The same pattern follows for the prevalence of moderate or severe food insecurity that is more than double (43 percent) in countries with high-income inequality compared with countries with low-income inequality (18 percent). The high difference in the prevalence of food insecurity between these two groups justifies the choice of running separate model specifications for individual living in low vs. high-income inequality.

Table 1. Descriptive statistics for the dependent variables: complete sample and by low- and high-income inequality

	All (1)	Low Gini index (2)	High Gini index (3)
Severe food insecurity (FI_{sev})	0.137	0.068***	0.206***
	(0.344)	(0.0012)	(0.002)
Moderate or severe food insecurity ($FI_{mod+sev}$)	0.306	0.179***	0.433***
	(0.461)	(0.002)	(0.002)
Number of observations	77 472	38 781	38 691

Notes: Unweighted means of 2014 Gallup data, with standard errors reported in parentheses.

Source: Authors' own elaborations.

[11] The difference between the means of countries with low Gini index and countries with high Gini index in 2014 are statistically significant at 1 percent level.

Table 2. Descriptive statistics for the independent variables: complete sample and by low- and high-income inequality

	All sample (1)		Countries with low Gini index (2)		Countries with high Gini index (3)	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Female	0.520	0.122	0.526	0.111	0.514	0.132
Age	39.269	4.864	40.746	5.220	37.977	4.180
Number of adults in the households	3.069	0.614	3.247	0.722	2.913	0.455
Number of children in the households	1.349	0.717	1.258	0.884	1.427	0.530
Married (reference group)	0.500	0.167	0.612	0.095	0.401	0.153
Single or never marries	0.302	0.108	0.249	0.087	0.349	0.104
Separated, widowed, or divorced	0.129	0.060	0.127	0.071	0.132	0.050
Resides in a large city (reference group)	0.263	0.164	0.292	0.161	0.239	0.165
Reside in rural area or on a farm	0.327	0.192	0.343	0.198	0.313	0.189
Reside in small town	0.337	0.146	0.298	0.144	0.372	0.141
Reside in suburban area	0.067	0.081	0.066	0.092	0.068	0.070
Social capital	0.769	0.105	0.772	0.098	0.766	0.112
Social network	0.711	0.135	0.667	0.158	0.750	0.098
Annual household income	9 179.881	5 662.822	11 755.580	6 682.674	6 990.535	3 396.526
Employee, full-time (reference group)	0.202	0.089	0.229	0.108	0.178	0.060
Self-employed, full-time	0.172	0.099	0.159	0.115	0.183	0.083
Employed part-time	0.165	0.073	0.140	0.074	0.188	0.065
Unemployed	0.074	0.038	0.061	0.039	0.086	0.033
Out of labour force	0.387	0.097	0.412	0.105	0.365	0.085
GDP per capita (USD 2010)	3 878.2	3 159.7	3 716.340	2 804.664	4 019.734	3 470.042
Gini index	0.395	0.098	0.317	0.057	0.464	0.071
Low-income countries	0.227	0.421	0.229	0.426	0.225	0.423
Lower-middle-income countries	0.400	0.493	0.371	0.490	0.425	0.501
Upper-middle-income countries	0.373	0.487	0.400	0.497	0.350	0.483
Number of observations	77 472		38 781		38 691	

Source: Authors' own elaborations based on 2014 Gallup data (Gallup, 2014).

Descriptive statistics of mean and standard deviation values of the key independent variables (Table 2) highlight that the average household income is higher in countries with a low vs. a high Gini index. It suggests that the household income distribution is highly skewed in favour of higher-income strata, making it more difficult for the poor to have access to the national wealth produced in the country. In fact, although the level of GDP per capita is slightly higher in countries with a high Gini index, households living in countries with lower inequality have on average 75 percent higher annual incomes than households in countries with high-income inequality. Regarding the geographical distribution, most of the households with higher-income inequality live in lower-middle-income countries (42.5 percent), whereas countries with a lower inequality are more concentrated in upper-middle-income countries (40 percent).

A larger importance of social network is found across countries with high Gini index, suggesting that relying on informal networks possibly acts as a substitute for a lack of adequate government support and/or access to markets and services. It is interesting to notice that, independently of the level of income inequality, most of the sampled individuals are out of the labour force, suggesting that low- and middle-income countries are characterized by a large diffusion of the informal sector for employment opportunities.

3.4 Econometric methods

Individual food security is best understood through multilevel analysis, as an individual's food security has a hierarchical or clustered structure. For example, an individual's experience of food security tends to be more correlated with the food security situation of the household in which they live, as opposed to individuals chosen at random from the population at large. Individual food insecurity is also further nested within groupings based on socio-economic characteristics, for example poor households and lower-income countries. Because of the clustering, the assumption that observations are independent and identically distributed is violated.

We therefore use a hierarchical or multilevel model for the econometric analysis. To disregard these multi-level relationships risks overlooking the cluster effects, may lead to an underestimation of the standard errors of the coefficient leading to an overestimation of the statistical significance, and can render invalid traditional statistical analysis techniques (Buxton, 2008; Cameron and Trivedi, 2005; Goldstein, 2010). The multi-level model is the standard framework for quantitative analysis when the problem under investigation has a multilevel structure and when the research question is particularly focused on variability and heterogeneity and not just over average values. By extending the basic regression model to account for correlated response, the multi-level model facilitates the incorporation of data at different levels of aggregation and allows to model individual behaviour within contexts and allow relationships to vary over contexts (Buxton, 2008; Cameron and Trivedi, 2005; Gelman and Hill, 2007; Goldstein, 2010; Jones and Duncan, 1998).

Following Smith, Kassa and Winters (2017) and Smith, Rabbitt and Coleman-Jensen (2017) we use a multilevel random intercept linear model, which is a variant of the class of multilevel models, to account for dependence in hierarchically nested data. We employ this multilevel linear probability model to empirically study the effect of country-level macro-economic factors, specifically GDP per capita and income inequality, on individual food insecurity. The model is a three-level linear probability model that allows for the presence of individual and household (first level), as well as the country (second level) and the macro-region (third level) where the

respondent lives. The choice of the macro-region as a third level is justified by an attempt to isolate unobservable factors that may be at play at the aggregate level and that could be possibly transmitted at the more disaggregated level of individual's experience of food insecurity.

Our underlying multilevel linear model to estimate the probably of an individual being food insecure is defined as:

$$Y_{icr} = X_{icr}\,\beta + Z_c\,y + v_{ic} + v_i + \varepsilon_{icr} \qquad (1)$$

where Y_{icr} is the probability of an individual of being food insecure and i, c, and r, are indices for individuals, countries, and macro-regions, respectively. X_{icr} consists of demographic and socioeconomic characteristics; Z_c *y* contains country-level variables, specifically log of GDP per capita and Gini index, v_{ic} is the random effect at the second (country) level, v_i is the random effect at third (macro-region) level, and e_{icr} represents the unobserved individual heterogeneity. Since we do not assume an equal sample size between the number of individuals inside each country, and the number of countries inside each macro-region, the level-three subscript *i* is present for both v_{ic} and v_i. The error terms, v_{ic}, v_i , and e_{icr}, enter the model at the country-, macro-region-, and individual-level, respectively. We assume these errors are distributed independently of each other and they are distributed as Gaussian with means of zero and variances of σ_{ic}^2, σ_i^2, and σ_{icr}^2.

4 Results

In this study, we do not attempt to control for potential endogeneity and causality cannot be inferred from the results without strong assumptions. However, results do suggest the presence of strong associations between the covariates of interest, specifically per capita GDP, income inequality, and food insecurity.

Table 3 presents the results of the three-level linear probability model for both severe (column 1) and moderate or severe food insecurity (column 4) for the pooled sample of low- and middle-income countries. To test the existence of possible non-linear effects of income inequality on food insecurity, we use the median value of the Gini index (35 percent) to divide the sample by low and high levels of country income inequality. These results are reported for severe food insecurity (columns 2–3) and moderate or severe food insecurity (columns 5–6).

Table 3. Coefficients and standard errors of the probability of experiencing moderate or severe food insecurity by low- and high-income inequality in 2014

Variables	Severe food insecurity (FI_{sev})			Moderate or severe food insecurity ($FI_{mod+sev}$)		
	All	Low Gini index	High Gini index	All	Low Gini index	High Gini index
	(1)	(2)	(3)	(4)	(5)	(6)
Demographic characteristics						
Female	0.00223	0.00598**	-0.00267	0.0113***	0.0133***	0.00777
	(0.00236)	(0.00256)	(0.00395)	(0.00302)	(0.0037)	(0.00476)
Age	0.000526***	0.000156*	0.000979***	0.000889***	0.000259*	0.00155***
	(0.00008)	(0.00009)	(0.000134)	(0.000105)	(0.000134)	(0.000162)
Number of adults in households	0.00122	0.000704	0.00107	0.00448***	0.00497***	0.00364**
	(0.000785)	(0.000868)	(0.0013)	(0.00101)	(0.00126)	(0.00156)
Number of children in households	0.0119***	0.0105***	0.0128***	0.0206***	0.0186***	0.0219***
	(0.000815)	(0.000923)	(0.00131)	(0.00104)	(0.00134)	(0.00158)
Single or never married vs. married (reference)	0.00142	-0.00308	0.00651	-0.00419	-0.0132**	0.00268
	(0.003)	(0.00356)	(0.00467)	(0.00385)	(0.00518)	(0.00564)
Separated, widowed or divorced vs. married (reference)	0.0225***	0.0138***	0.0323***	0.0278***	0.0345***	0.0233***
	(0.00367)	(0.00411)	(0.00598)	(0.0047)	(0.00597)	(0.00721)
Rural areas or farms vs. large city (reference)	0.0026	0.00309	0.00562	0.00821**	-0.00467	0.0283***
	(0.00321)	(0.00366)	(0.00563)	(0.00411)	(0.00488)	(0.00678)
Small town vs. large city (reference)	-0.00234	-0.00552	0.0028	-0.00486	-0.0121**	0.00643
	(0.00303)	(0.00337)	(0.005)	(0.00389)	(0.0049)	(0.00603)
Suburban area vs. large city (reference)	0.00448	0.00551	0.00826	0.0159**	0.0168**	0.0240**
	(0.00503)	(0.00545)	(0.00848)	(0.00645)	(0.00791)	(0.0102)

Variables	Severe food insecurity (FI_{sev})			Moderate or severe food insecurity ($FI_{mod+sev}$)		
	All	Low Gini index	High Gini index	All	Low Gini index	High Gini index
	(1)	(2)	(3)	(4)	(5)	(6)
Social capital characteristics						
Social capital (Yes D=1)	-0.0770***	-0.0517***	-0.103***	-0.112***	-0.0953***	-0.129***
	(0.00268)	(0.00288)	(0.00453)	(0.00343)	(0.00418)	(0.00546)
Social network (Yes D=1)	-0.0388***	-0.0311***	-0.0487***	-0.0547***	-0.0610***	-0.0503***
	(0.0026)	(0.00282)	(0.00433)	(0.00333)	(0.0041)	(0.00522)
Economic characteristics						
Annual household income (log)	-0.0629***	-0.0341***	-0.0828***	-0.111***	-0.0855***	-0.129***
	(0.00133)	(0.0016)	(0.00206	(0.00171	(0.00232)	(0.00248)
Self-employed, full-time vs. employed full-time (reference)	-0.0168***	-0.0100**	-0.0199***	-0.0137***	-0.0195***	-0.00327
	(0.00371)	(0.00401)	(0.00626)	(0.00476)	(0.00583)	(0.00755)
Employed, part-time vs. employed full-time (reference)	-0.00127	0.000144	-0.00129	0.0115**	0.00959	0.0171**
	(0.00378)	(0.00423)	(0.00621)	(0.00484)	(0.00614)	(0.00749)
Unemployed vs. employed full-time (reference)	0.0435***	0.0308***	0.0540***	0.0738***	0.0540***	0.0927***
	(0.00489)	(0.00574)	(0.00776)	(0.00627)	(0.00833)	(0.00936)
Out of the labour force vs. employed full-time (reference)	-0.00635**	0.00174	-0.00985*	-0.00512	0.000308	-0.00536
	(0.00317)	(0.00334)	(0.00552)	(0.00407)	(0.00485)	(0.00665)
Country characteristics						
Per capita GDP (log)	-0.0633***	-0.002	-0.120***	-0.218***	-0.0902***	0.0708***
	(0.0114)	(0.012)	(0.0129)	(0.0146)	(0.0174)	(0.0155)
Gini index	1.668***			1.952***		
	(0.0646)			(0.0828)		
Constant	0.622***	0.377***	1.901***	2.175***	1.671***	1.103***
	(0.0792)	(0.0954)	(0.1)	(0.102)	(0.139)	(0.121)
AIC	35 037.03			73 527.65		
BIC	35 907.25			74 397.87		
Observations	77 472	38 781	38 691	77 472	38 781	38 691
Number of countries	75	35	40	75	35	40

Note: Standard errors are reported in parenthesis, with the following significance values: *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' own elaborations based on 2014 Gallup data.

4.1 Effect of economic growth on individual food insecurity

The results in Table 3 show that increases in GDP per capita are concurrent with declines in individual food insecurity, both in terms of people running out of food and experiencing hunger (*severe food insecurity*) and people facing uncertainties about their ability to obtain food and having to compromise on the quality and/or quantity of the food they consume food (*moderate or severe food insecurity*). However, the positive effect of economic growth on individual food insecurity, is highest for moderate or severe food insecurity as compared to severe.

A 10 percent increase in GDP per capita is associated with a 0.6 percentage point decrease in severe food insecurity, while the decrease is more than double in magnitude in correspondence to moderate or severe food insecurity, featuring a 2.1 percentage point decline (Table 2, columns 1 and 4). These results are similar to findings from Smith, Rabbitt and Coleman-Jensen (2017), although our analysis focuses on a different set of countries.[12]

Our estimations point to an association in the range of 4-7 percent between GDP per capita and food insecurity (severe, and moderate or severe).[13] That is, a 10 percent increase in GDP per capita is associated with a decrease in individual food insecurity in the range of 4–7 percent. These results are higher than the short-term association between economic growth and child stunting recently found by the nutrition literature, where a 10 percent increase in GDP per capita is associated with a decrease in child stunting in the range of 0–2 percent (Mcgovern et al., 2017). This weaker association with child nutrition outcomes could be anticipated as outcomes are determined by a number of underlying factors, not only individual and household food insecurity, but also the quality of care for children and women, health services and the health environment.

4.2 Effect of income inequality on individual food insecurity

Our results indicate that inequalities in income distribution increase the likelihood of individual food insecurity, both in terms of severe and moderate or severe food insecurity. A 10 percent increase in income inequality as measured by the Gini index of a country, is associated with a 16.7 percentage point higher probability of experiencing severe food insecurity and 19.5 percentage point higher probability of experiencing severe or moderate food insecurity (Table 3, columns 1 and 4).

[12] Smith, Rabbitt and Coleman-Jensen (2017) estimate that a 10 percent increase in GDP per capita is associated with a 0.4 percentage point decrease in moderate or severe food insecurity considering low-, middle- and high-income countries, and with a 2.7 percentage point lower probability considering low-income countries only. Given the different composition of our sample where high-income countries are excluded from the analysis, our results are aligned with Smith's results. Smith, Kassa and Winters (2017) show that a 10 percent increase in the GDP per capita in Latin America lowered the likelihood of moderate or severe food insecurity by 1.15 percentage points, and severe food insecurity by 0.97 percentage points.

[13] The estimated association between GDP per capita and food insecurity expressed in percentage is obtained by using information in Tables 1 and 2. On average, 13.7 percent of people are severely food insecure (Table 1) and a 10 percent increase in GDP per capita is associated with a 0.599 percentage point reduction in severe food insecurity (Table 2, column 1). Therefore, by rescaling these results we obtain that a 10 percent increase in GDP per capita is associated with a 4.6 percent decrease in severe food insecurity (0.633/13.7*100). The same criterion applies to moderate or severe food insecurity, showing an average decrease of 7.1 percent (2.18/30.6*100).

A 10 percent increase in GDP per capita in countries with a low Gini index has a zero average effect in reducing severe food insecurity, whereas it is associated with a 1.2 percentage point reduction for individuals in countries with high inequality (Table 3, columns 2 and 3). Furthermore, the results also show that high-income inequality works to undercut the contribution of per capita GDP to reductions in moderate or severe food insecurity (Table 3, columns 5 and 6). While GDP per capita is associated with a decrease in the likelihood of experiencing moderate or severe food insecurity for countries with a low-income inequality (Table 3, column 5), this association reverses its sign in presence of high-income inequality (Table 3, column 6).

It means that a 10 percent increase in GDP per capita in associated with 0.7 percentage point higher food insecurity in countries with high-income inequality. This result should be further investigated, as it may be related to the way the data are nested within groups. Specifically, the choice of macro-region as a third level in the hierarchical structure of the data helps addressing the problems associated with dependencies between macro-region characteristics and individual's food insecurity. While this approach controls for heterogeneity within macro-region, it may mask within-country heterogeneity that plays a key role in determining the extent of a country's income inequality. In fact, the spatial dimension and the distribution of peoples in a country may have a strong influence on the phenomenon of income inequality that, for instance, varies to a high extent across densely populated urban centres and rural areas.[14] In this perspective, accounting for group effects at the level of a country's sub-regions could highlight different results. This may be done by clustering individuals and households within a different hierarchy that also considers sub-regions as well as countries and macro-regions in order to account for within-country heterogeneity. Exploring this issue warrants further investigation.

To further explore the heterogeneity of the income inequality effect on food insecurity, we used the same model as in Table 3 and replaced the continuous Gini index variable with a dummy variable indicating high-income inequality. The variable equals 1 for countries with a high Gini index, defined above the median threshold of 35 percent, and equals zero otherwise.

From this model specification we find that individuals living in countries with a high Gini index have on average a 33 percentage point higher probability of experiencing severe food insecurity (Table 4, column 1), and a 42 percentage points higher probability of moderate or severe food insecurity, holding other things constant (Table 4, column 2). In addition, income inequality increases the likelihood of severe food insecurity, and this effect is 20 percent higher for low-income countries compared with middle-income countries (Table 4, column 2). In fact, if a 10 percent increase in Gini leads to 16.5 percentage point higher probability of severe food insecurity in middle-income countries (Table 4, column 3), the same increase leads to 19.7 (16.5+3.2) percentage point higher probability of severe food insecurity in low-income countries. Similarly, but to a greater extent, higher-income inequality increases moderate or severe food insecurity by 29 percent more in low-income countries compared to middle-income countries (Table 4, column 4).

[14] Similarly, residential segregation between socio-economic groups has grown in the last decades and this is likely to lead to different degrees of income inequality in a country (Fujita and Maloutas, 2012; Tammaru *et al.*, 2020).

Table 4. Estimation of the probability of experiencing severe and moderate or severe food insecurity for countries with high-income inequality and a low level of income

Variables	Severe food insecurity (FI_{sev}) (1)	Moderate or severe food insecurity ($FI_{mod+sev}$) (2)	Severe food insecurity (FI_{sev}) (3)	Moderate or severe food insecurity ($FI_{mod+sev}$) (4)
Countries with Gini index higher than 0.35 (dummy=1)	0.330***	0.418***		
	(0.0148)	(0.0177)		
Gini index (continuous variable)			1.659***	1.873***
			(0.0638)	(0.0818)
Gini in low-income countries (interaction term)			0.324***	0.541***
			(0.0343)	(0.0439)
Constant	0.446***	2.149***	0.0925	1.350***
	(0.0849)	(0.102)	(0.116)	(0.148)

Note: This table only reports the key estimated coefficients for the association between food insecurity and country income inequality (Gini index). Columns 1 and 2 report the estimated association between food insecurity and income inequality expressed as a dummy variable (columns 1 and 2); columns 3 and 4 report the estimated differentials in the association between food insecurity and income inequality in low- vs. middle-income countries. The model specifications include the same estimated control variables (demographic, socio-economic and social capital and country-level characteristics) shown in Table 3 but they are not reported here to ease the presentation of the results. Standard errors are reported in parenthesis, with the following significance values: *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' own elaboration.

4.3 Other determinants of individual food insecurity

While the above analysis shows that macro- economic factors, specifically GDP increases and income inequality, have micro-level effects on individual food insecurity, there are a number of other basic structural characteristics at the individual and household level that increase the risk or probability of individual food insecurity and which more generally inform the determinants of individual food security. Although this is not the focus of this study, given the study is among the first to analyze individual food insecurity across all low- and middle-income countries it is important to review the results in some detail to contribute to better understanding on the commonalities across countries in different cultural contexts.

Our findings are largely consistent with empirical studies that use GWP FIES data (Broussard, 2019; Smith, Kassa and Winters, 2017; Smith, Rabbitt and Coleman-Jensen, 2017), as well as previous research using more limited data. Results indicate that age, number of children in the household, being separated, widowed or divorced, and being unemployed, increases the probability of individual food insecurity, both severe and severe or moderate (Table 3). In addition, for moderate or severe food insecurity, residing in a rural area or farm, the number of adults in households, and whether the individual is a female, also show statistically significant and positive coefficients. However, the magnitude of the coefficients for these variables are relatively small, ranging between 0.08 and 0.1 percentage points. This can partly be explained by the fact that the coefficients capture the average values in food insecurity across all countries, and this may hide regional and within-country variations. For example, a recent study using

GWP FIES data to analyze the gender differences in individual food insecurity found that the magnitude of the gender gap in individual food insecurity varies across regions (Broussard, 2019).

The characteristics associated with the largest marginal effects on lowering the probability of an individual food insecurity are those that more directly define an individual's budget and resource constraints, namely the level of household income, full-time employment and whether a person has access to social support when their resources are constrained (Table 3, columns 1 and 2). This is instructive as it shows a consistency across low- and middle-income countries in different cultural contexts.

Results of our study confirm the importance of access to social capital as having the largest marginal effect on lowering the probability of individual food insecurity (Table 3, columns 1 and 4). Our results indicate that both social capital (whether or not the individual feels that they can count on relatives or friends in times of need) and social networks (the ability of whether or not an individual is satisfied with their ability to make friends) are statistically significant and decrease the probability of an individual experiencing food insecurity. However, the marginal effect of social capital in decreasing food insecurity is almost double compared to the marginal effect of social network. Compared to individuals with no access, individuals having access to social capital have 11.2 and 7.7 percentage point lower probability of experiencing moderate or severe food insecurity and of experiencing severe food insecurity, respectively. Individuals with access to social networks experience 5.4 percentage points lower probability of moderate or severe food insecurity, and 3.8 percentage point lower probability of severe food insecurity with respect to individuals who cannot rely on social network.

Individuals are at increased risk of hardship if they face limited or irregular employment opportunities or have low income. In countries with high levels of income inequality, increases in household income are highly correlated with a reduction in severe food insecurity, and this effect is almost three times higher than that of lower-income inequality. A 10 percent increase in household income is associated with a 0.8 or 0.3 percentage point lower likelihood of severe food insecurity in countries with high or low-income inequality, respectively (Table 3, columns 2 and 3). The findings are the same for moderate or severe food insecurity but with a greater magnitude. A 10 percent increase in household income is associated with a 1.3 or 0.8 percentage point lower likelihood of moderate or severe food insecurity in countries with, respectively, high or low-income inequality (Table 3, columns 5 and 6). As expected, being unemployed increases the probability of both measures of food insecurity, compared to those who are employed full-time (Table 3, columns 1–6). Moreover, where income inequality is high, these effects are magnified (Table 3, columns 3 and 6). Self-employed individuals experience lower food insecurity compared to full-time employed workers, while being a part-time employer increases the likelihood of moderate or severe food insecurity especially in countries with high-income inequality.

5 Conclusions and policy implications

Our results bring two important considerations. First, this paper provides an important validation for the use of the FIES for analysing food security in the context of low and middle-income countries. Second, our estimations point to an association in the range of 4–7 percent between GDP per capita and food insecurity (severe, and moderate or severe). These results are higher than the short-term association between economic growth and child stunting recently found by the nutrition literature. However, when we introduce income inequality, we find evidence that increases in GDP per capita are associated with significantly higher improvements in food security in the presence of low-income inequality. With high-income inequality in a country, improvements remain significant but small.

Table 5 summarizes the results to facilitate the discussion of implications for policy. As shown above, the average association between GDP per capita and food insecurity (Table 3 above) is in the range of 4–7 percent (Table 5, columns 1–2). Specifically, a 10 percent increase in GDP per capita is associated with the highest decrease in magnitude for moderate or severe food insecurity (-7.1 percent), followed by severe food insecurity (-4.6 percent). When we disentangle the GDP-food insecurity association by the level of income inequality we find more nuanced results. A 10 percent increase in GDP is associated with the highest decrease in moderate or severe food insecurity in countries with low-income inequality (-5 percent) while the sign of this association is even reversed for high-income inequality countries, suggesting a 1.6 percent increase in moderate or severe food insecurity (Table 5, column 2).

Table 5. Estimated average decrease in food security associated with a 10 percent increase in GDP per capita in low- and middle-income countries, by income inequality

	Severe food insecurity (FI_{sev}) (1)	Moderate or severe food insecurity ($FI_{mod+sev}$) (2)
All countries	-4.6%	-7.1%
Low-income inequality	–	-5.0%
High-income inequality	-5.8%	1.6%

Notes: The table shows average expected change in food insecurity associated with a 10 percent increase in GDP per capita. In order to compute these expected changes, estimated GDP-food insecurity elasticities estimated in Table 3 were used along with means reported in Table 1. The expected change in severe food insecurity is not reported for low-income inequality countries, since the estimated coefficient of this association is not significant in a statistical sense (see Table 3).

Source: Authors' own elaboration.

The findings suggest that in low- and middle-income countries economic growth alone is not sufficient to reduce food insecurity unless income inequality is tackled. More importantly, this evidence indicates that by tackling income inequality, economic growth can be a force for reducing food insecurity. Therefore, it needs to be a priority along national food security policies.

Significant challenges remain to ensure food insecurity for all, and an important one is to address persistent and high-income inequality – even in the face of achievements in poverty reduction. There is no silver bullet for tackling economic inequality: the interconnections

between different areas mean that a package of interventions is required, with each policy step reinforcing the next. Inequality, however, is not inevitable, and rising inequality is not an inescapable outcome.

There are many pathways to reducing inequality, from narrowing gaps in income generation opportunities to narrowing the potential for inequalities in human capital development before the inequalities emerge, smoothing consumption among the most deprived, and redistribution in favour of the poor. This includes interventions disproportionately benefiting the poorest in low- and middle-income countries during periods of crisis.

For countries with high, and persistent income inequality, economic growth per se does not help vulnerable groups to escape from food insecurity unless interventions and investments are targeted to reach these peoples and increase their socio-economic opportunities. This involves reducing inequalities and removing structural constraints to making a living. For example, this can include connecting vulnerable small-scale producers and family farmers to markets through rural infrastructure development and improved services, generating employment, improving access to finance, expanding social protection and ensuring access to natural resources for the poorest. For instance, many economists have emphasized the importance of economic growth in conjunction with specific investments that increase the productivity of the agriculture sector and promote human capital development (Karmakar and Sarkar, 2013). Investing in these areas should stimulate economic growth and raise the incomes of the poor relatively faster than other income groups. It will also lead to the reduction of poverty and increase access to food, thereby reducing the main cause of chronic undernutrition (United States Department of Agriculture, 1997)

If economic growth is associated with high or rising income inequality, the poorest will continue to struggle to capture the benefits of increased national income and will continue to face uncertainty in access to food or be forced to compromise on the quality and/or quantity of food they consume. To address food insecurity, countries need to invest to reduce economic vulnerabilities and inequalities. This requires balancing a set of policies and investments to achieve an inclusive structural transformation, while also fostering poverty reduction and more egalitarian societies. To ensure that structural transformation is pro-poor and inclusive requires integrating food security and nutrition concerns into poverty reduction efforts, while ensuring that reducing gender inequalities and social exclusion of population groups is either the means to, or outcome of, improved food security and nutrition. Short- and medium-term policies should aim at achieving a pro-poor and inclusive transformation, but this will not be possible by focusing only on economic growth.

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Annexes

Annex 1. FAO Food Insecurity Experience Scale Survey Module (FIES-SM) questions

The eight questions in the food insecurity experience scale are the following.

During the last 12 months, because of a lack of money or other resources was there a time when:

1) You were worried you would run out of food?
2) You were unable to eat healthy and nutritious food?
3) You ate only a few kinds of foods?
4) You had to skip a meal?
5) You ate less than you thought you should?
6) Your household ran out of food?
7) You were hungry but did not eat because there was not enough money or other resources for food?
8) You went without eating for a whole day because of a lack of money or other resources?

Annex 2. Description of independent variables

1. Demographic characteristics from the Gallup World Poll (GWP) survey

Age: Age in years.

Education:

- **Elementary:** Completed elementary education or less (up to eight years of basic education).
- **Secondary:** Completed some secondary education up to three years tertiary education (nine to 15 years of education).
- **Tertiary:** Completed four years of education beyond "high school" and/or received a four-year college degree.

Marital status: married, divorced or single.

Employment:

- **Employed full time for an employer**
  A respondent is considered employed full time for an employer if he or she is employed by an employer and if he or she works for this employer for at least 30 hours per week.
- **Employed full time for self**
  Respondents are considered employed full time for themselves if they are self-employed and if they work for at least 30 hours per week.
- **Employed part time, do not want to work full time**
  Respondents who work either for an employer or themselves and do not work more than 30 hours per week at either job are categorized as employed part time. Additionally, when asked, these respondents indicated that they do not want to work more than 30 hours per week.
- **Employed part time, want to work full time**
  Respondents who work either for an employer or themselves and do not work more than 30 hours per week at either job are categorized as employed part time. Additionally, when asked, these respondents indicated that they do want to work more than 30 hours per week.
- **Unemployed**
  A respondent is unemployed if he/she reports not being employed in the last seven days, either for an employer or for himself or herself. The respondent must also report actively looking for a job in the past four weeks AND being able to begin work in the last four weeks.
- **Out of the workforce**
  Respondents who are out of the workforce were not employed within the last seven days, either for an employer or for themselves, are not looking for work, AND/OR are not available to start work. Respondents may be full-time students, retired, disabled or homemakers; however, some respondents will not fall into any of these scenarios.

Residence: Individual's place of residency is defined as either rural (or farm), small town, suburban or large city.

2. Social support characteristics – GWP survey

- **Social network**
  Social network is a binary variable (yes or no) of whether or not the individual is satisfied with their ability to make friends.
- **Social capital**
  Social capital is a binary variable (yes or no) of whether or not the individual feels that they can count on relatives or friends in times of need.

3. Socio-economic characteristics – GWP survey

- **Household income**
  Household income is a continuous variable of individuals household's imputed income. It is equated across countries by converting from local currency to International Dollars (ID) using the most recent World Bank's purchasing power parity (PPP) ratios (2014 for many countries) based on the 2011 International Comparison Program (ICP). Annual household income in international dollars (ID) is calculated using the World Bank's PPP private consumption conversion factor. In addition, PPP rates have been deflated based on CPI of USD for years 2009–2015, thus making all years in 2016 USD comparable. The household income measure relies on multiple imputation methodology to replace missing values.
- **Relative household per capita income level – per capita income quintiles**
  Household income in international dollars divided by household's size is used to calculate Household Per Capita Annual. Then respondents are divided into five groups of equal size. This provides a measure of respondent wealth that is relative to other respondents in that country. This variable provides a look at wealth within a given country with the following divisions:

  1 | Poorest 20 percent

  2 | 21– 40 percent

  3 | 41– 60 percent

  4 | 61– 80 percent

  5 | Richest 20 percent

4. Macro-economic indicators: World Bank database

- **GDP per capita**
  GDP per capita is measured at constant 2010 prices and expressed in USD drawn from the United Nations National Accounts Main Aggregates Database (United Nations, 2019).

- **Income inequality**
  Income inequality is measured by the Gini index from the World Bank 2014, World Development Indicators (World Bank, 2020b). The Gini index measures the extent to which the distribution of income or consumption expenditure among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality. Two binary variables are also created to identify countries with low and high levels of income inequality, where a low Gini index is a country where the index is lower than the median sample value of .35, and a high Gini is a country where the index is above this number.

Annex 3. List of countries/areas included in the sample analysis (2014)

Angola, Armenia, Azerbaijan, Bangladesh, Belarus, Benin, Bolivia (Plurinational State of), Bosnia and Herzegovina, Brazil, Burkina Faso, Burundi, Cameroon, China, Colombia, the Congo, Costa Rica, Côte d'Ivoire, the Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Gabon, Georgia, Ghana, Guatemala, Guinea, Honduras, India, Indonesia, Jamaica, Jordan, Kazakhstan, Kenya, Kosovo, Kyrgyzstan, Lebanon, Malawi, Mauritania, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Myanmar, Namibia, Nepal, Nicaragua, the Niger, Nigeria, North Macedonia, Pakistan, Palestine, Panama, Paraguay, Peru, the Philippines, the Republic of Moldova, Romania, Rwanda, Senegal, Serbia, South Africa, Sri Lanka, Tajikistan, Thailand, Togo, Tunisia, Ukraine, the United Republic of Tanzania, Uzbekistan, Venezuela (Bolivarian Republic of), Viet Nam, Zambia and Zimbabwe.

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