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Assessing food insecurity in Latin America and the Caribbean using FAO's Food Insecurity Experience Scale

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ABSTRACT

The complexity of the operational concept and definition of food insecurity has complicated the study of the 'food insecure' and efforts to determine clear policy directions. Previous findings on the prevalence and severity of food insecurity are inconsistent and often depend on the measure used. To overcome limitations in food security measurement, the Food and Agriculture Organization of the United Nations developed the Food Insecurity Experience Scale, which is the first survey protocol to measure people's direct experience of food insecurity on a global scale. Using this new measure, our study contributes to the understanding of the food insecure by examining the determinants of food insecurity within and across countries in Latin America and the Caribbean (LAC). Using a series of multilevel linear models, we find the three determinants associated with the largest increase in the likelihood of experiencing food insecurity in LAC are: low levels of education, limited social capital, and living in a country with low GDP per capita. Results suggest the need to promote education of the most vulnerable, encourage social interactions that help build individuals' social capital, and adopt gender-sensitive programs. The results also suggest the need for a shift in policy from short-term strategies to long-term efforts that sustain household productive capacity and employment to promote sustained economic growth.

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1. Introduction

Food insecurity is an important topic among development economists and practitioners but there is no clear understanding of who and where the food insecure are and what they do to survive. While the prevalence of food insecurity over the last few decades has declined in general, and in Latin America and Caribbean (LAC) in particular, many have been left behind. The second United Nations Sustainable Development goal (SDG2) aims to "end hunger, achieve food security and improved nutrition" for all people by 2030.[1] To effectively target and design policy interventions to address food insecurity and to meet the targets laid out under SDG2 requires understanding who, where, and what of the food insecure. This is imperative since addressing the more difficult and chronic cases of food insecurity requires an improved understanding of the causes and consequences of food insecurity.

Food security exists "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meet their dietary needs and food preferences for an active and healthy life" (FAO, 2009, p. 1). While this definition has been widely accepted, defining a common metric that can measure the prevalence and severity of food insecurity across different countries, languages, and cultures has so far been lacking. The complexity of the concept has complicated the study of food insecurity and corresponding efforts to attain clear policy directions. Previous findings on the prevalence and severity of food insecurity using conventional model-based estimates of food insecurity are inconsistent, often depending on the specific measure used (Barrett, 2010; Klasen, 2008; Masset, 2011; Svedberg, 2002). Hence, our understanding of who the food insecure are is also inconsistent.

This inconsistent understanding is potentially changing due to the Food and Agriculture Organization's (FAO's) Voices of the Hungry (VoH) project. The VoH project has developed an experiential measure of food insecurity—the Food Insecurity Experience Scale (FIES)—with the aim of producing comparable annual estimates

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[1] See https://sustainabledevelopment.un.org/sdg2 particularly target 2.1.

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of food insecurity across most countries.[2] In 2014, FAO contracted Gallup, Inc. to collect data in all 149 countries covered by the Gallup World Poll (GWP) using the FIES. This generated the first globally comparable experiential measure of food insecurity. In combination with broader Gallup World Poll (GWP) data, it provides an opportunity for the first time to analyze individual food insecurity across most countries.

This paper details the results of using the FIES to examine food insecurity in LAC to identify the food insecure. This new understanding of the characteristics, circumstances, and locations of the food insecure contributes to building political will, designing effective policies, and targeting the most vulnerable (Ballard et al., 2013). In addition, if the characteristics of the food insecure are consistent across countries within LAC, the findings will provide further evidence of the validity and usefulness of the FIES as a measure of food insecurity across different contexts.

Substantial efforts have been underway within LAC for decades to reduce poverty and food insecurity. For example, in 2003 Brazil launched the *Fome Zero* (Zero Hunger) program to alleviate poverty, eliminate hunger, and improve the livelihoods of the poor (Melgar-Quinonez et al., 2008; Winters et al., 2015). *Fome Zero* brings together national and international governmental and non-governmental institutions to reduce food insecurity (Melgar-Quinonez et al., 2008). Building on this program, Brazil has now launched *Plan Brasil sem Miseria* (Plan Brazil Without Poverty), with the goal of eradicating extreme poverty (Winters et al., 2015). Mexico launched *Sin Hambre Cruzada Nacional* (National Crusade Against Hunger), also to eliminate hunger and malnutrition. Both Guatemala (*Pacto Hambre Cero)* and Nicaragua (*Programa Hambre Cero*) have programs aimed at establishing policies to ensure food security (Winters et al., 2015). Some of the success in reducing LAC's food insecurity in recent years is likely due to these ongoing efforts, but continued success requires careful analysis.

This paper is among the first to report cross-country comparable estimates and common determinants of food insecurity in LAC.[3] Fig. 1 shows significant regional variation within LAC in terms of the prevalence of food insecurity as measured by FIES. The Caribbean region experience more severe food insecurity (22.5%) in 2014, compared to Central America (9.5%), the Andean States (9.2%), or the Southern Cone (4.4%). Severe food insecurity was the highest in Haiti (67.4%), followed by Jamaica (17.8%), Honduras (16.9%), Bolivia (16.7%), and the lowest in Chile (2.4%).

To find the common determinants of food insecurity in LAC, we examine descriptive statistics and ran a series of multilevel linear models over 22 countries using information on demographic and socioeconomic characteristics. The three determinants associated with the biggest increase in the likelihood of experiencing food insecurity in LAC are: low levels of education, limited social capital, and living in a country with low GDP per capita. Our findings also confirm that it is possible to use self-reported experiential food security measures to document the incidence of food insecurity across diverse populations. These results confirm that, despite heterogeneity in populations, economic systems, cultural contexts, and labor markets; we can identify the characteristics of the typical food-insecure individual in LAC.

[2] The actual number of countries depends on the number of countries covered by the GWP in each given year. The FIES is based on a Rasch measurement model, where countries that ask food security questions (independent of GWP) that overlap with the FIES may have their food security scales equated to the FIES global standard. For more information, see (FAO, 2016).

[3] The first cross-country comparable estimates of food insecurity were reported in FAO (2016); found here: http://www.fao.org/3/a-i4830e.pdf.

2. Measuring food insecurity

In the early 1990s, ethnographic research in the United States revealed several stages households go through when living with hunger. Household hunger is initially characterized by worry about having enough food, followed by dietary changes to make available food last longer, and finally, a decrease in food consumption, first in adults followed by any children (Radimer et al., 1990, 1992). Further, research has shown that the experience of households living with hunger is consistent in developed and developing countries (Coates et al., 2006).[4] These earlier studies provide the foundation for the current understanding of food insecurity and the impetus for using experiential measures to capture the experiences and behaviors associated with food insecurity.

Many studies have validated experiential food insecurity scales in the United States, Canada, Mexico, and LAC over the past few decades (Coates et al., 2003; Frongillo and Nanama, 2006; Nord, 2012; Pérez-Escamilla et al., 2004). Experiential measures have captured cross-cultural aspects of food insecurity and proven their validity across global regions (Coates, 2013; Pérez-Escamilla, 2012). FAO selected the Prevalence of Undernourishment to monitor the Millennium Development Goal (MDG) of halving world hunger by 2015. The Prevalence of Undernourishment performed relatively well in this regard but as an aggregate measure, was unable to identify the characteristics of the food insecure, or determine where within a country they live (Ballard et al., 2013).

The Prevalence of Undernourishment often serves as a national proxy for food insecurity but requires strong assumptions about the distribution of food within a country, due to a lack of reliable survey data on household food consumption.[5] On the other hand, experiential measures of food insecurity, as a micro-level metric, offer insights into the determinants of food insecurity at the individual-, regional-, and international-levels. This allows a consistent representation of the characteristics and geographic distribution of the food insecure within and across countries (Ballard et al., 2013; Nord, 2014).

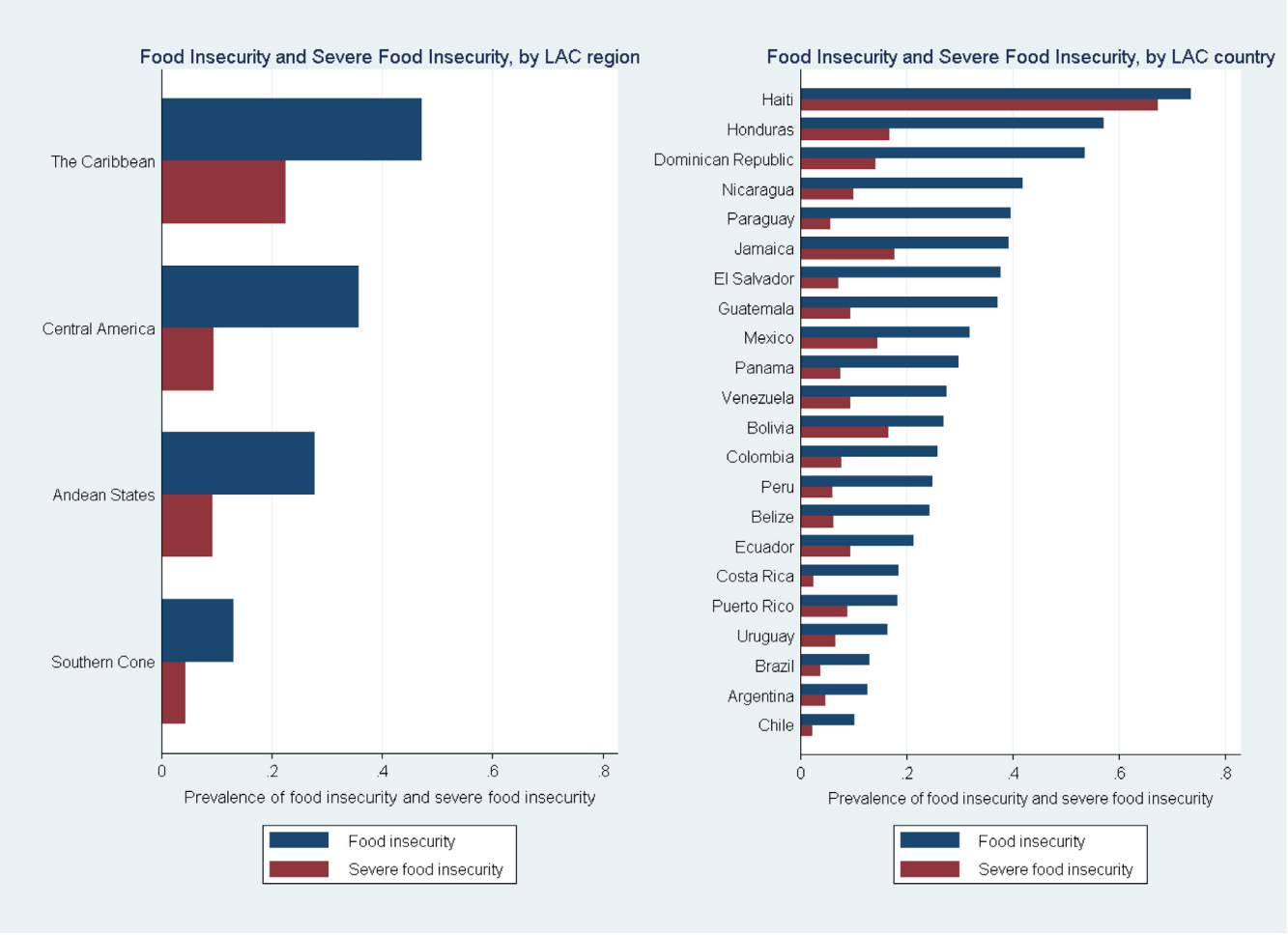
Previous research on experiential measures of food insecurity and hunger provide the conceptual construct on which FIES is built. In 1995, the United States implemented the U.S. Household Food Security Survey Module (US HFSSM) which captures the Radimer et al. (1990) latent construct of food insecurity (Bickel et al., 2000; Hamilton and Cook, 1997; Nord, 2003). In the early 2000s, several LAC countries began implementing their own experiential food security measures, eventually culminating in a LAC Food Security Scale called ELCSA (Escala Latinoamericana y Caribeña de Seguridad Alimentaria) (FAO, 2012; Pérez-Escamilla et al., 2007). Ballard et al. (2013) notes that both the US HFSSM and ELCSA have proven reliable across diverse cultural contexts after thorough testing and experimentation. Thus, FAO developed the FIES by following the approaches of US HFSSM and ELCSA, and adjusted the scale to be applied globally (Ballard et al., 2013). The FIES is the first survey protocol to measure people's direct experience of food insecurity at the individual level on a global scale.

3. Conceptual model: Food insecurity and its causes

To motivate our empirical analysis, we used Barrett's (2002) theoretical rational-choice model of food insecurity, which builds upon the Becker (1965) and Gronau (1976) household production model and includes food insecurity as an indicator of risk exposure. The model assumes that individuals maximize their utility by

[4] For a more comprehensive review of the evolution of food insecurity measurement, see Coates (2013), Jones et al. (2013), and Marques et al. (2015).

[5] For more information regarding the FAO Prevalence of Undernourishment methods see Cafiero (2014).



Source: Data source FAO/GWP 2014.

Fig. 1. Prevalence of Food Insecurity by Country and Region within LAC. Source: Data source FAO/GWP 2014.

choosing levels of consumption, physical well-being, savings, and physical activity, subject to their budget, time, and production constraints (Barrett, 2002). A person's utility is a function of consumption and physical well-being, where each period's well-being depends on the well-being in the previous period.[6] Using this conceptual model and the FIES measure, we looked for the common determinants of food insecurity and identified what is distinct about the food insecure in LAC.

Recent broad-based economic growth in developing countries (e.g., the BRIC nations) has contributed to most of the reduction in global food insecurity over the past few decades (Barrett, 2002; FAO, 2014). For example, increased economic growth and the success of the Zero Hunger program in Brazil resulted in a 25 percent decrease in the prevalence of hunger between 2004 and 2009, with most improvements occurring in the poorest regions (Kepple et al., 2012; Schmitz et al., 2011). Greater economic growth, improved political and institutional stability, and overall economic development reduced food insecurity rates in LAC (FAO, 2014; Winters et al., 2015).[7]

At the individual level, household income growth is essential to eliminating food insecurity. As a household's standard of living increases, the share of budgetary resources spent on food decreases (Banerjee and Duflo, 2008). For example, Banerjee and Duflo (2008) found that in rural areas of Guatemala, the budgetary share spent on food falls from 65 percent for the extremely poor—those living on less than $1 per day—to 13.5 percent for those living on $6–$10 per day. Higher levels of income allow individuals to not only afford more food, but also to purchase other goods associated with greater levels of health and well-being, such as health insurance and education (Barrett, 2002). Research has shown that cash transfer programs significantly improve people's health and well-being by increasing income and food access (Hoddinott and Wiesmann, 2008). Other studies indicate that income plays a vital role in ensuring an individual's ability to smooth consumption and withstand exogenous shocks to food access and markets (e.g., Webb and Reardon, 1992; Webb and Rogers, 2003).

Food insecurity is often seasonal and associated with "temporary unemployment, episodes of ill health, or other recurring adverse events" (Barrett, 2010, p. 827). For example, unemployment is often linked to business cycles, causing temporary food insecurity in low-skill households (Barrett, 2010). Radimer et al. (1990) and Radimer et al. (1992) show that food insecurity is a managed process where people are active in adjusting their behavior to mitigate risk. However, the ability of an individual to cope with episodes of food insecurity depends heavily on access to both

[6] For a more in-depth review of Barrett's model, see Gregory et al. (2015). For alternative conceptual models of food insecurity see Duffy and Zizza (2016), Caswell and Yaktine (2013), Gundersen and Oliveira (2001), Meyerhoefer and Yang (2011), and Ribar and Hamrick (2003).

[7] For a more comprehensive background investigation of the effective targeting of food insecurity in LAC see Winters et al. (2015).

labor and asset markets. Policies and programs directed at job training and public empowerment provide crucial skills, jobs, and income to the poor, allowing them to mitigate the risks of food insecurity and escape the liquidity trap.

Gender and intra-household dynamics can play a large role in how households mitigate food insecurity risks. For example, households have been shown to react differently to changes in income depending on the gender of the person in control of household resources (Quisumbing, 2003). The literature shows that women traditionally place more emphasis on family and child welfare, often leading to better educational and food-related outcomes (Smith and Haddad, 2000). When women have more bargaining power and a larger share of household expenditures, the share of household resources spent on food increases, leading to more but also higher-quality foods (Schmeer, 2005; Sraboni et al., 2014).

Rural populations and smallholder farmers make up most of the food insecure in developing countries and are key to improving global food insecurity (FAO et al., 2015). All else equal, a rural poor household may be better off than an urban one if the rural household is food self-sufficient and can grow, hunt, and gather food. Smallholder farmers in Rwanda who consume their own food outputs experience better health and nutrition status (Muller, 2009). However, smallholder farmers may also be more susceptible to exogenous economic and weather-related shocks, such as droughts and floods. Minot and Pelijor (2010) found that in Bhutan, household food self-sufficiency is negatively correlated with food security. This implies that household food self-sufficiency in rural populations generally reflects poor market access and the possible existence of a poverty trap. Addressing food insecurity in rural areas requires greater access to assets such as land, education, and infrastructure, all of which are important determinants of rural income (Winters et al., 2009).

Addressing food insecurity in urban areas requires improved income generation and productivity growth. In urban areas in developing countries, income is generated primarily through non-agricultural manufacturing and service industries. This places a premium on the acquisition of human capital and assets that allow individuals greater access to infrastructure and markets. However, the differences between rural and urban food security do not lie in income sources alone. The way rural and urban households purchase food and gain access to stores and markets is very different. Social protection policies that take this difference into account when improving access to nutrition, healthcare, and education will be more likely to improve the food security of the target population.

4. Data

Our analysis was designed to increase the understanding of the characteristics of the food insecure in LAC. The data comes from the 2014 wave of the Gallup World Poll (GWP), including FAO's FIES data. Since 2005, the GWP has conducted an annual survey of individuals age 15 years and older in over 150 countries. The GWP collects information on individual's labor force participation status, income, education, opinions, experiences, future aspirations, demographic characteristics, and country- and region-identifiers. In most countries, the GWP interviews 1000 individuals and is nationally representative.[8]

The FIES Survey Module (FIES-SM) was first included as a client module in the GWP in 2014, as part of the FAO's VoH project.[9] The FIES-SM measures the prevalence and severity of individuals' food insecurity. The survey is composed of eight questions designed to assess the adequacy of an individual's access to food. The questions focus on respondent's behaviors and experiences when they have had difficulty meeting their basic food needs over the previous 12 months (see Table A1 in Appendix A). Typical of other food insecurity surveys, the FIES-SM questions are asked in order of severity so that households can be grouped by their severity of food insecurity (Broussard and Tandon, 2016). To provide a basic understanding of the underlying data, Table A2 in Appendix A presents a correlation matrix of the individual items of the FIES-SM, illustrating the relationship between the questions. As would be expected there is a positive correlation between the individual items. Tables A3 and A4 shows the descriptive statistics of the item responses by LAC countries and regions. The data highlights how the results for items vary across the region.

4.1. Dependent variables

FAO methodology, based on Item Response Theory, measures the prevalence and severity of food insecurity based on the conditions and behaviors reported in response to the survey module at equal levels of severity across countries. Item Response Theory, or more specifically, the single-parameter logistic measurement model commonly known as the Rasch Model (Fischer and Molenaar, 2012; Rasch, 1960) is used to assess and combine individual responses in which the individual's severity of food insecurity is modelled as a latent trait—a characteristic not directly observable (Nord et al., 2016). Observable conditions assumed to be caused by the latent trait are elicited by the FIES-SM for constructing the measure. A Rasch scale (Rasch, 1960) is estimated for each country, and each country's scale is adjusted to a global reference scale. Provided the FIES data pass a statistical test of fit to the Rasch model's assumptions, we can determine an individual's food security status by summing the affirmed responses (i.e., the raw score). Classifications based on raw-scores are used in other experiential food insecurity measures, notably the US HFFSM and the ELCSA. The classification methods of these scales however, do not allow cross-country comparisons since the same raw score would not necessarily correspond to the same level of severity in different countries.

To ensure the measured severity of food insecurity is comparable across countries, FAO equated the food-insecurity scales for each country to a FIES Global Standard Scale (FIES-GSS).[10] FAO's equating procedure maintains cross-country comparability by creating two food-insecurity thresholds—moderate food insecurity and severe food insecurity—and adjusts these thresholds for each country. We use the FAO thresholds for categorizing our sample by severity of food insecurity. Thus, the measured severity of food insecurity, food-insecurity thresholds, and the food-insecurity prevalence rates are all equivalent and comparable across countries.

In our analyses, individuals are classified as having moderate or severe food insecurity if their raw score is equal to or above the moderate FIES-GSS threshold. Individuals are severely food insecure if their raw score is equal to or above the severe FIES-GSS threshold. Thus, we use two binary dependent variables representing moderate or severe food insecurity (1), and severe food insecu-

[8] The GWP typically interviews 1000 individuals per country, but increases the sample size per the population size of the country. For example, in 2014, 3000 and 5000 individuals were interviewed in India and China, respectively. Telephone interviews are conducted for medium- and high-income countries with at least 80 percent telephone coverage. Face-to-face interviews are administered in most developing countries.

[9] For more information, see http://www.fao.org/in-action/voices-of-the-hungry.

[10] For a more in-depth discussion for the equating methodology used by FAO to construct the FIES-GSS, see FAO (2016) and Nord et al. (2016).

rity (2).[11] For ease of interpretation, we refer to "moderate or severe food insecurity" simply as "food insecurity." The LAC country thresholds for moderate food insecurity were, on average, around 4 and the thresholds for severe food insecurity were, on average, around 7. Thus, individuals in LAC with food insecurity have typically eaten less than they thought they should at some time during the past year because they lacked sufficient resources for food, and at times, experienced more severe conditions like hunger. Similarly, those with severe food insecurity have typically gone a whole day without eating at some time in the past year, due to a lack of resources.

4.2. Explanatory variables

The primary explanatory variables for the analyses are common food insecurity determinants that include individual-, household-, and socioeconomic-characteristics. The GWP collects information on individuals and their households which we broke into five determinant categories—demographic, human capital, economic, social, connectivity, and macroeconomic and locational factors (Table 1). Most of the variables are self-explanatory but a few require definition.

Log Household Income is a continuous variable of the log of the individual's imputed household income.[12] The following are binary variables that equal one if the individual: feels education in their country is accessible to anyone, regardless of economic situation (*Education Access*); is satisfied with their ability to make friends (*Social Network*); feels they can count on friends and family in times of need (*Social Capital*); can count on relatives or friends living in another country (*Help Outside Country*); believes religion is an important part of the individual's daily life (*Religiosity*). We also include country-level variables (*Unemployment* and *Log GDP per capita*) from the World Bank's World Development Indicators.

4.3. Analysis sample

In 2014, the GWP interviewed 22,066 individuals in 24 LAC countries. We dropped observations for individuals that lack valid measures of food insecurity or those that have missing information on one or more of the control variables. The final sample was 17,260 individuals in 22 countries.[13] Table 1 presents the summary statistics as well as mean comparison tests of the covariates conditional on the individual's food security status.[14] Descriptive statistics show that the women experiencing food insecurity (57.3%) is statis-

Table 1
Means of analysis variables by food security status.

	Food security	Food insecurity	Severe food insecure
Female	0.501	0.573***	0.549
	(0.500)	(0.498)	(0.498)
Age	37.359	39.046**	39.225**
	(17.301)	(16.610)	(16.597)
Number of children	0.990	1.409***	1.492***
	(1.242)	(1.450)	(1.485)
Number of adults	3.418	3.476**	3.476
	(1.542)	(1.644)	(1.689)
Marital Status			
Single or Never Married	0.400	0.332***	0.349
	(0.490)	(0.471)	(0.477)
Married or Domestic partner	0.506	0.549**	0.504***
	(0.500)	(0.498)	(0.500)
Separated, Widowed, or Divorced	0.094	0.120***	0.147***
	(0.292)	(0.325)	(0.355)
Education Access	0.658	0.634***	0.620**
	(0.474)	(0.482)	(0.486)
Education			
Elementary education	0.281	0.519***	0.562***
	(0.450)	(0.500)	(0.496)
Secondary education	0.564	0.421***	0.401***
	(0.496)	(0.494)	(0.490)
College education	0.155	0.060***	0.037***
	(0.361)	(0.273)	(0.190)
Log Household Income (US$)	9.002	8.302***	8.074***
	(1.216)	(1.226)	(1.352)
Employment Status			
Full-time employment	0.412	0.349***	0.301***
	(0.492)	(0.477)	(0.459)
Part-time employment	0.131	0.178***	0.210***
	(0.338)	(0.383)	(0.408)
Unemployed	0.072	0.102***	0.124***
	(0.258)	(0.303)	(0.330)
Out of workforce	0.385	0.370***	0.365***
	(0.487)	(0.483)	(0.481)
Immigrant	0.020	0.024	0.020
	(0.139)	(0.153)	(0.140)
Social Network	0.829	0.778***	0.739***
	(0.376)	(0.416)	(0.439)
Social Capital	0.900	0.771***	0.715***
	(0.300)	(0.420)	(0.452)
Help Outside Country	0.504	0.477**	0.451***
	(0.500)	(0.500)	(0.498)
Religiosity	0.781	0.843***	0.838***
	(0.414)	(0.364)	(0.368)
Cell Phone	0.901	0.822***	0.797***
	(0.298)	(0.383)	(0.402)
Internet	0.492	0.202***	0.153***
	(0.500)	(0.402)	(0.360)
Public Transit	0.608	0.596	0.571
	(0.488)	(0.491)	(0.495)
Country Characteristics			
Unemployment Rate	6.778	6.765	6.740
	(3.085)	(3.639)	(3.590)
Log GDP Per Capita	8.427	8.113***	7.976***
	(0.680)	(0.761)	(0.939)
Rural or farm	0.555	0.666***	0.655***
	(0.497)	(0.472)	(0.476)
Number of Observations	11,838	5422	1778
Number of Countries	22	22	22

Note: Source FAO/GWP 2014. The variable *Food Insecurity* is composed of moderate food insecurity or severe food insecurity. We use the sample weights provided by Gallup to estimate all descriptive statistics and prevalence rates. Standard errors are in parenthesis.
*Food insecure category significantly different from the food secure category, at the 10 percent level.
*** Food insecure category significantly different from the food secure category, at the 1 percent level.
** Food insecure category significantly different from the food secure category, at the 5 percent level.

[11] We choose not to use count or ordinal versions of the dependent variables for the following reasons: First, to adopt a simple additive index (count measure) and exclude the thresholds would omit the comparability of the thresholds of food insecurity across countries. There would no longer exist a comparable estimate by excluding the categories of food insecurity. Second, FAO's VoH recommends the use of "moderate or severe" and "severe" categories of food insecurity, as the distinction between the "food secure" and "mild food insecure" classes are prone to error. This is due to the impossibility of precisely determining the probability of being "mild" food insecure for those reporting raw score zero. In some countries, most respondents have raw-score zero, so ignoring measurement error in that group may have large implications for prevalence estimation at the lowest raw-score thresholds. Thus, due to measurement error in the Rasch model creating the country thresholds, it is impossible in some countries to distinguish food secure individuals from individuals with mild food insecurity. For more details on probabilistic assignment of respondents to food security classes, see FAO (2016, section 6, pp. 17–19).

[12] Household income was equated across countries by converting the local currency to international dollars using the World Bank's PPP private consumption conversion factor. This measure relies on multiple imputation methodology to replace missing values.

[13] An analysis of the missing observations suggests that there is no systematic difference with respect to food security in those failing to answer questions. Only 19 observations were missing for the food security variables. Most missing values are from the social capital variables (friends, help form outside, etc.) and questions on education and number of children.

[14] We use the sample weights provided by Gallup to estimate all descriptive statistics and prevalence rates but do not use the weights in the regression analyses.

tically significantly higher than those who are food secure (50.1%). Individuals who experience severe food insecurity tend to be slightly older, poorer, have weaker social networks, and lower levels of social capital than the food secure. The descriptive statistics also show that individuals who experience severe food insecurity are more likely to be separated, widowed, or divorced.

5. Econometric method

An individual's food security can only be fully understood through multilevel analysis (Pérez-Escamilla and Segall-Corrêa, 2008). The GWP contains natural hierarchical or clustered data. The first and second levels consist of individual- and household-level characteristics and the within-country sub-regions where the respondent lives. The third level represents the country-level information obtained from the World Bank's World Development Indicators. To ignore these relationships risks overlooking the importance of cluster effects (sub-region and country), and may also render invalid many of the traditional statistical analysis techniques (Goldstein, 2011). For example, because of this clustering, the assumption that observations are independent and identically distributed is violated. Hence, hierarchical or multilevel models are the standard frameworks for clustered data in econometric analysis (Cameron and Trivedi, 2005; Goldstein, 2011; Gelman and Hill, 2007).

Following Cameron and Trivedi (2005) and Goldstein (2011),[15] our baseline multilevel model to estimate the probability of an individual being food insecure is given by:

$$Y_{irc} = X'_{irc}\beta + Z'_c\gamma + \upsilon_{ir} + \upsilon_i + \varepsilon_{irc} \quad (1)$$

where Y_{irc} is the probability of an individual being food insecure and *i, r,* and *c* are indices for individuals, within-country sub-regions, and countries, respectively. X'_{irc} consists of demographic and socioeconomic characteristics, $Z'_c\gamma$ contains country-level variables, υ_{ir} is the random effect at the second (sub-region) level, υ_i is the random effect at third (country) level, and ε_{irc} represents the unobserved individual heterogeneity. The level-three subscript *i* is present for both υ_{ir} and υ_i since we do not assume an equal sample size between the number of individuals inside each sub-region, and the number of sub-regions inside each country in LAC. The error termsυ_{ir},$\upsilon_i$and ε_{irc} enter the model at the sub-region-, country-, and individual-levels, respectively. We assumed these errors were distributed independently of each other and distributed as Gaussian with means of zero and variances ofσ^2_{ir} ,σ^2_i , and σ^2_{irc} (Cameron and Trivedi, 2005).

Our model of choice is the multilevel random intercept linear model, which is a variant of the class of multilevel models.[16] For a sensitivity check on the type of multilevel model used, we compare the results of the random intercept model with the results from a random coefficient model. We also compare results from the binary dependent variables with results from ordinal multilevel models using a categorical dependent variable. The results, which are found to be robust across model specifications, are presented in Appendix B.

6. Results and discussion

In this paper, we highlight the main results across the models to tell a complete story. Table 2 shows the results from the three-level linear model by food insecurity (column 1) and severe food insecurity (column 2). After testing the estimated coefficients, we find evidence that the covariates vary significantly by gender and rural/urban status. Thus, we also explored the heterogeneity of the determinants of food insecurity and severe food insecurity by gender (Table 3) and rural/urban status (Table 4). This information gives a more detailed and comprehensive picture of who the food insecure are within LAC and can help policymakers focus programs aimed at ameliorating food insecurity.

6.1. Demographic determinants of food insecurity

Gender. Overall, our analysis show that women, especially in rural areas—while not in the most dire straits (severely food insecure)—are more likely to experience food insecurity. Being female is associated with a 1.5-percentage point higher probability of experiencing food insecurity, compared to being male (column 1 of Table 2), although this is not statistically significant for severe food insecurity (column 2). Previous research has found that women's empowerment is positively associated with calorie availability and dietary diversity (Sraboni et al., 2014).

Where women live affects food insecurity. In rural areas (Table 4), being female is associated with a 3.1-percentage point higher probability of experiencing food insecurity. But in large cities, being female is associated with a 1.2-percentage point lower probability of experiencing food insecurity. This may be due to the availability of government and other institutional support in urban settings for women that are not available in rural areas.

Age. The likelihood of experiencing food insecurity and severe food insecurity increases with age but levels off with old age—the slope of age is zero at 90 years old for food insecurity and 94 years old for severe food insecurity (Table 2). This is most likely because those reaching older age have generally had opportunities that provide for a healthy life, but may also be because the amount of food one needs declines as you age.

Household composition. Generally, having a large number of children increases the likelihood of food insecurity while a large number of adults has little effect on food insecurity. Children depend fully on others for their food access, lead to lower labor market participation for their parents, and are highly susceptible to illness and injury (Barrett, 2002). Each additional child in the household is associated with a 2.8-percentage point higher probability of food insecurity (Table 2). The likelihood of severe food insecurity increases 1.0 percentage point. Having more children in the household appears to also increase food insecurity among women (Table 3) and in rural areas (Table 4).

Marital status. In LAC, married individuals are less likely to experience food insecurity or severe food insecurity. Separated, widowed, or divorced individuals had a 3.5-percentage point higher probability of food insecurity and a 3.0-percentage point greater likelihood of severe food insecurity, compared to those who are married. Being a single woman in LAC, compared to being married, is associated with a 1.7-percentage point higher probability of severe food insecurity, but is statistically insignificant for men (Table 3).

6.2. Human capital determinants of food insecurity

Education. Overall, the results clearly show that having access to education and obtaining an education beyond elementary school is a key determinant of food security. Human capital is essential to achieving and maintaining high labor productivity (Barrett, 2002). Educated individuals often possess more assets and have access to better infrastructure, providing opportunities for non-agricultural employment and reducing dependence on agricultural sources of income. Education access is associated with a 2.8-

[15] See Goldstein (2011), Gelman and Hill (2007), and Cameron and Trivedi (2005) for further discussions on multilevel models.

[16] The linear probability model for discrete choice is rigorously justified in Heckman and Snyder (1997).

Table 2
Coefficients and standard errors for the determinants of food insecurity and severe food insecurity.

	Food insecurity	Severe food insecurity
Female	0.015**	−0.002
	(0.007)	(0.005)
Age	0.008***	0.003***
	(0.001)	(0.001)
Age Squared	−0.000***	−0.000***
	(0.000)	(0.000)
Number of children	0.028***	0.010***
	(0.003)	(0.002)
Number of adults	0.002	−0.000
	(0.002)	(0.002)
Marital Status		
Single or Never Married	0.006	0.013**
	(0.008)	(0.005)
Separated, Widowed, or Divorced	0.035***	0.030***
	(0.010)	(0.007)
Education Access	−0.028***	−0.005
	(0.007)	(0.005)
Education		
Elementary education	0.159***	0.069***
	(0.012)	(0.008)
Secondary education	0.067***	0.012
	(0.011)	(0.007)
Log Household Income	−0.043***	−0.022***
	(0.003)	(0.002)
Employment Status		
Part-time employment	0.061***	0.040***
	(0.010)	(0.007)
Unemployed	0.060***	0.040***
	(0.012)	(0.009)
Out of workforce	−0.016**	−0.003
	(0.008)	(0.005)
Immigrant	0.076***	0.011
	(0.022)	(0.015)
Social Network	−0.033***	−0.015***
	(0.008)	(0.006)
Social Capital	−0.130***	−0.061***
	(0.009)	(0.006)
Help Outside Country	−0.014**	−0.006
	(0.007)	(0.005)
Religiosity	0.017*	0.012**
	(0.009)	(0.006)
Cell Phone	−0.040***	−0.021***
	(0.010)	(0.007)
Internet	−0.102***	−0.039***
	(0.008)	(0.005)
Public Transit	−0.030***	−0.008*
	(0.007)	(0.005)
Country Characteristics		
Unemployment Rate	0.013**	0.011*
	(0.006)	(0.006)
Log GDP Per Capita	−0.115***	−0.097***
	(0.025)	(0.025)
Rural or farm	0.005	−0.005
	(0.008)	(0.005)
Constant	1.482***	1.016***
	(0.196)	(0.192)
Error Components		
σ_1	0.078***	0.083***
	(0.014)	(0.014)
σ_2	0.110***	0.065***
	(0.006)	(0.004)
σ_3	0.403***	0.277***
	(0.002)	(0.002)
Log likelihood	−9060.958	−2541.855
Number of Observations	17,260	17,260
Number of Countries	22	22

Note: Source FAO/GWP 2014. The dependent variable *Food Insecurity* is composed of moderate food insecurity or severe food insecurity. Married, Four-year college education, Large city, Employed Full time are the omitted categories. Standard errors are in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

percentage point lower probability of experiencing food insecurity (Table 2).

The relationship between having low levels of education and food insecurity is significant across all model specifications and samples. Individuals with only elementary education were 15.9-percentage points more likely to experience food insecurity and 6.9-percentage more likely to experience severe food insecurity, compared to those with a college degree (Table 2). In addition, having only an elementary education consistently was the strongest determinant of food insecurity and severe food insecurity, across all model specifications and samples.

6.3. Economic determinants of food insecurity

Income. Higher household incomes lead to improved health, nutrition, and general well-being, resulting in a virtuous cycle that can eliminate food insecurity (Barrett, 2002). Likewise, low household incomes can create a vicious cycle that can make it difficult for households to escape food insecurity. A one-unit increase in log household income resulted in a 4.3-percentage point lower probability of experiencing food insecurity, and a 2.2-percentage point lower probability of experiencing severe food insecurity (Table 2). The magnitudes of the association between food insecurity and household income is also much larger for individuals in rural areas, compared to individuals in urban areas (Table 4).

Employment status. Being fully employed in LAC, increases the chances of being food secure. Unemployment increases the probability of food insecurity by 6.0 percentage points and severe food insecurity by 4.0 percentage points (Table 2). Part-time workers face similar likelihoods of being food insecure and severely food insecure. While part-time employment is consistently associated with a higher probability of experiencing food insecurity for both men and women, we find that for severe food insecurity, being unemployed is not statistically significant for men, compared to being employed full-time (Table 3).

6.4. Social determinants of food insecurity

Immigration. Immigration status is clearly linked to food insecurity, particularly in urban areas, likely because they are among the ranks of the poor. Having an immigrant status is associated with the fifth largest increase in the likelihood of experiencing food insecurity in LAC. Immigrants were 7.6-percentage points more likely to be food insecure (Table 2). In large cities, immigrants were 10.9-percentage points more likely to be food insecure (Table 4).

Social network and social capital. Social factors and the ability to rely on others is highly related to food security. Previous research indicates that stronger social networks and high levels of social capital are consistently associated with better health (Berkman et al., 2000; Cacioppo et al., 2006; Cohen and Janicki-Deverts, 2009). Social networks and social capital can provide the food insecure with private transfers in times of need that may help decrease the severity of food insecurity episodes. However, these transfers are often too small, uneven in coverage, and offer incomplete assistance to substantial subpopulations (Barrett, 2002). Having a strong social network in LAC lowers the probability of experiencing food insecurity by 3.3 percentage points (Table 2).

Individuals with high levels of social capital had a 13.0-percentage point lower probability of experiencing food insecurity, and a 6.1-percentage point lower probability of severe food insecurity (Table 2). Receiving help from outside an individual's country meant a 1.4-percentage point lower probability of experiencing food insecurity (Table 2).

Religion. Our results suggest that the food insecure, particularly among women, have a higher propensity to be religious. Religiosity is associated with a 1.7-percentage point higher probability of

Table 3
Coefficients and standard errors for food insecurity and severe food insecurity by gender.

	Female		Male	
	Food insecurity	Severe food insecurity	Food insecurity	Severe food insecurity
Age	0.008***	0.002**	0.008***	0.005***
	(0.001)	(0.001)	(0.002)	(0.001)
Age Squared	−0.000***	−0.000**	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Number of children	0.032***	0.011***	0.023***	0.011***
	(0.004)	(0.002)	(0.004)	(0.003)
Number of adults	0.003	−0.000	0.002	0.001
	(0.003)	(0.002)	(0.003)	(0.002)
Marital Status				
Single or Never Married	0.016	0.017**	−0.006	0.012
	(0.011)	(0.007)	(0.013)	(0.009)
Separated, Widowed, or Divorced	0.042***	0.031***	0.030*	0.035***
	(0.012)	(0.008)	(0.017)	(0.012)
Education Access	−0.019**	0.000	−0.041***	−0.012
	(0.009)	(0.006)	(0.011)	(0.007)
Education				
Elementary education	0.163***	0.066***	0.150***	0.074***
	(0.016)	(0.011)	(0.019)	(0.013)
Secondary education	0.074***	0.013	0.054***	0.011
	(0.014)	(0.010)	(0.017)	(0.011)
Log Household Income	−0.040***	−0.022***	−0.047***	−0.022***
	(0.004)	(0.003)	(0.004)	(0.003)
Employment Status				
Part-time employment	0.060***	0.037***	0.063***	0.045***
	(0.013)	(0.009)	(0.015)	(0.010)
Unemployed	0.067***	0.063***	0.053***	0.016
	(0.018)	(0.012)	(0.018)	(0.012)
Out of workforce	−0.012	−0.000	−0.026**	−0.006
	(0.010)	(0.007)	(0.013)	(0.009)
Immigrant	0.061**	0.020	0.092***	0.005
	(0.030)	(0.021)	(0.031)	(0.021)
Social Network	−0.028***	−0.014*	−0.040***	−0.018**
	(0.011)	(0.007)	(0.013)	(0.009)
Social Capital	−0.128***	−0.061***	−0.133***	−0.064***
	(0.012)	(0.008)	(0.014)	(0.009)
Help Outside Country	−0.014	−0.005	−0.012	−0.008
	(0.009)	(0.006)	(0.010)	(0.007)
Religiosity	0.015	0.022***	0.019	−0.001
	(0.012)	(0.008)	(0.012)	(0.008)
Cell Phone	−0.023*	−0.009	−0.063***	−0.037***
	(0.013)	(0.009)	(0.015)	(0.010)
Internet	−0.117***	−0.048***	−0.084***	−0.029***
	(0.010)	(0.007)	(0.012)	(0.008)
Public Transit	−0.033***	−0.009	−0.025**	−0.007
	(0.009)	(0.006)	(0.010)	(0.007)
Country Characteristics				
Unemployment Rate	0.012**	0.010*	0.015**	0.012**
	(0.006)	(0.006)	(0.006)	(0.006)
Log GDP Per Capita	−0.122***	−0.095***	−0.107***	−0.096***
	(0.025)	(0.025)	(0.027)	(0.024)
Rural or farm	0.010	−0.005	−0.002	−0.005
	(0.011)	(0.007)	(0.012)	(0.008)
Constant	1.502***	1.006***	1.498***	1.000***
	(0.199)	(0.194)	(0.212)	(0.190)
Error Components				
σ_u	0.076***	0.082***	0.081***	0.079***
	(0.015)	(0.014)	(0.016)	(0.014)
σ_e	0.109***	0.062***	0.108***	0.065***
	(0.008)	(0.005)	(0.008)	(0.006)
σ_i	0.405***	0.280***	0.399***	0.272***
	(0.003)	(0.002)	(0.003)	(0.002)
Log likelihood	5258.653	−1596.961	−3872.319	−1008.856
Number of Observations	9834	9834	7426	7426
Number of Countries	22	22	22	22

Note: Source FAO/GWP 2014. Dependent variables are binary variables representing food insecurity (moderate or severe) and severe food insecurity. Married, Four-year college education, Large city, Employed Full time, are the omitted categories. Estimates are reported as average marginal effects. Standard errors are in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 4
Coefficients and standard errors for food insecurity and severe food insecurity by location.

	Rural area		Urban area	
	Food insecurity	Severe food insecurity	Food insecurity	Severe food insecurity
Female	0.031**	0.009	0.006	−0.012*
	(0.015)	(0.011)	(0.011)	(0.007)
Age	0.014***	0.004**	0.008***	0.004***
	(0.002)	(0.002)	(0.002)	(0.001)
Age Squared	−0.000***	−0.000*	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Number of children	0.034***	0.017***	0.027***	0.010***
	(0.006)	(0.004)	(0.004)	(0.003)
Number of adults	−0.005	−0.005	0.004	0.005**
	(0.005)	(0.004)	(0.004)	(0.002)
Marital Status				
Single or Never Married	0.019	0.016	0.007	0.018**
	(0.018)	(0.013)	(0.013)	(0.009)
Separated, Widowed, or Divorced	0.034	0.038**	0.032**	0.045***
	(0.025)	(0.018)	(0.015)	(0.010)
Education Access	−0.045***	−0.015	−0.023**	−0.003
	(0.016)	(0.012)	(0.011)	(0.007)
Education				
Elementary education	0.131***	0.055**	0.136***	0.064***
	(0.033)	(0.023)	(0.018)	(0.012)
Secondary education	0.054*	0.008	0.070***	0.019*
	(0.032)	(0.022)	(0.015)	(0.010)
Log Household Income	−0.072***	−0.031***	−0.035***	−0.017***
	(0.007)	(0.005)	(0.004)	(0.003)
Employment Status				
Part-time employment	0.063***	0.046***	0.064***	0.038***
	(0.024)	(0.017)	(0.016)	(0.010)
Unemployed	0.073***	0.042**	0.044**	0.022
	(0.028)	(0.020)	(0.021)	(0.014)
Out of workforce	0.007	0.003	−0.015	0.003
	(0.018)	(0.013)	(0.013)	(0.009)
Immigrant	0.052	0.005	0.109***	0.033
	(0.048)	(0.034)	(0.035)	(0.024)
Social Network	−0.043**	−0.013	−0.033**	−0.016*
	(0.020)	(0.014)	(0.013)	(0.009)
Social Capital	−0.115***	−0.041***	−0.136***	−0.086***
	(0.020)	(0.014)	(0.015)	(0.010)
Help Outside Country	−0.005	−0.018	−0.005	0.007
	(0.016)	(0.011)	(0.011)	(0.007)
Religiosity	0.042**	0.009	0.018	0.023***
	(0.021)	(0.015)	(0.013)	(0.009)
Cell Phone	−0.026	−0.030**	−0.038**	0.001
	(0.020)	(0.014)	(0.017)	(0.012)
Internet	−0.106***	−0.018	−0.106***	−0.050***
	(0.021)	(0.015)	(0.011)	(0.008)
Public Transit	−0.021	0.004	−0.023**	−0.009
	(0.016)	(0.011)	(0.011)	(0.007)
Country Characteristics				
Unemployment Rate	0.009	0.010*	0.020***	0.005
	(0.007)	(0.006)	(0.006)	(0.004)
Log GDP Per Capita	−0.116***	−0.107***	−0.111***	−0.035**
	(0.032)	(0.026)	(0.025)	(0.016)
Constant	1.600***	1.135***	1.337***	0.455***
	(0.260)	(0.212)	(0.204)	(0.129)
Error Components				
σ_u	0.092***	0.081***	0.052***	0.031***
	(0.021)	(0.017)	(0.015)	(0.011)
σ_e	0.121***	0.078***	0.113***	0.071***
	(0.012)	(0.009)	(0.010)	(0.006)
σ_i	0.416***	0.297***	0.382***	0.258***
	(0.005)	(0.004)	(0.003)	(0.002)
Log likelihood	−2045.412	−825.451	−2923.780	−494.220
Number of Observations	3596	3596	6177	6177
Number of Countries	22	22	22	22

Note: Source FAO/GWP 2014. Dependent variables are binary variables representing food insecurity (moderate or severe) and severe food insecurity. Married, Four-year college education, Large city, Employed Full time, are the omitted categories. Estimates are reported as average marginal effects. Standard errors are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

experiencing food insecurity, and for severe food insecurity, a 1.2-percentage point higher probability (Table 2). Holding all other characteristics constant, women had a 2.2-percentage point higher probability of experiencing severe food insecurity. However, religiosity is not statistically significant for men (Table 3).

6.5. Connectivity and food insecurity

Cell phone and internet. Overall, the results point to the importance of connectivity for food insecurity in LAC. Those with both modern (cell phone and internet) and traditional (public transport) connections were more likely to be food secure. Individuals with a cell phone had a 4.0-percentage point lower probability of experiencing food insecurity, and a 2.1-percentage point lower probability of severe food insecurity (Table 2). Individuals with access to the internet had a 10.2-percentage point lower probability of food insecurity; 3.9-percentage points lower for severe food insecurity (Table 2).

Public transportation. Access to public transportation lowered the likelihood of food insecurity by 3.0 percentage points and severe food insecurity by 0.8 percentage points. For large cities, access to public transportation is associated with a 2.3-percentage point lower probability of experiencing food insecurity, but is not statistically significant for rural areas (Table 4).

6.6. Macroeconomic and locational determinants of food insecurity

Macroeconomic indicators and rural-urban residence. While controlling for other factors, rural-urban location does not play a strong role in food insecurity but macroeconomic factors, as measured by unemployment and GDP per capita clearly do. Improving macroeconomics conditions in LAC should greatly improve food security. A one-unit increase in the country's unemployment rate was associated with a 1.3-percentage point higher probability of experiencing food insecurity, and a 1.1-percentage point higher probability of severe food insecurity (Table 2). A one-unit increase in the country's log GDP per capita lowered the likelihood of food insecurity by 11.5 percentage points and severe food insecurity by 9.7 percentage points (Table 2).

7. Conclusions

Consistent and comprehensive information on food security across LAC has so far been lacking. The newly available FIES makes broad cross-country individual-level analysis possible for the first time. Using the FIES data in combination with broader Gallup World Poll data, we use multilevel models to analyze the determinants of food insecurity in LAC. The top three determinants associated with higher likelihoods of experiencing food insecurity in LAC are low levels of education, limited social capital, and living in a country with low GDP per capita. Our findings also confirm that it is possible to use self-reported experiential food security measures to document the incidence of food insecurity across diverse populations.

While our results do suggest the presence of strong correlations between our covariates and food insecurity, we do not attempt to control for potential endogeneity. Therefore, causality cannot be inferred. However, understanding these correlations is still crucial in understanding the characteristics of LAC's food insecure. Further work should extend the analyses here to address potential endogeneity.

Results suggest the need for a shift in policy from a focus on short-term strategies to long-term efforts that sustain household productive capacity and employment. Substantial efforts have been underway within LAC for decades to reduce poverty and food insecurity. Based on our results, macroeconomic factors, principally economic growth play a critical role in reducing food security. Hence promoting sustainable growth and improving macroeconomic conditions are critical. However, this is unlikely to be sufficient and must be complimented by targeted interventions. The key policies to address food insecurity in LAC are to expand programs for vulnerable individuals, invest in the education and skills of the food insecure, expand gender-sensitive interventions to address the challenges of food insecurity, and invest to expand social capital. It is also essential for policy makers to recognize the heterogeneity of the determinants of food insecurity across various aspects of individuals including their gender, location of their residence, and age.

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Appendix A. FAO Food Insecurity Experience Scale survey module

See Tables A1–A4.

Table A1
FAO Food Insecurity Experience Scale Survey Module (FIES-SM).

Q1. You were worried you would run out of food because of a lack of money or other resources?	Worried	(**Yes**/No)
Q2. You were unable to eat healthy and nutritious food because of a lack of money or other resources?	Healthy	(**Yes**/No)
Q3. You ate only a few kinds of foods because of a lack of money or other resources?	Fewfood	(**Yes**/No)
Q4. You had to skip a meal because there was not enough money or other resources to get food?	Skipped	(**Yes**/No)
Q5. You ate less than you thought you should because of a lack of money or other resources?	Ateless	(**Yes**/No)
Q6. Your household ran out of food because of a lack of money or other resources?	Runout	(**Yes**/No)
Q7. You were hungry but did not eat because there was not enough money or other resources for food?	Hungry	(**Yes**/No)
Q8. You went without eating for a whole day because of a lack of money or other resources?	Whlday	(**Yes**/No)

Note: Source FAO Voices of the Hungry. "Affirmative" responses are indicated in bold.

Table A2
Correlation matrix of the FIES-SM items.

FIES Items	Worried	Healthy	Fewfood	Skipped	Ateless	Runout	Hungry	Whlday
Worried	1.0000							
Healthy	0.7115	1.0000						
Fewfood	0.6973	0.7720	1.0000					
Skipped	0.5581	0.6028	0.6033	1.0000				
Ateless	0.6255	0.6581	0.6895	0.7181	1.0000			
Runout	0.5741	0.6006	0.6093	0.7122	0.7042	1.0000		
Hungry	0.5548	0.5918	0.6000	0.7292	0.7203	0.7638	1.0000	
Whlday	0.3687	0.3974	0.3919	0.5414	0.4802	0.5429	0.5725	1.0000

Note: Source FAO/GWP 2014.

Table A3
Countries in Regions and FIES-SM item responses.

Countries and Regions	Worried			Healthy			Fewfood			Skipped		
	Mean	SD	Count	Mean	SD	Count	Mean	SD	Count	Mean	SD	Count
Central America												
Belize	0.379	0.486	428	0.305	0.461	428	0.320	0.467	428	0.202	0.402	428
Costa Rica	0.308	0.462	888	0.262	0.440	889	0.295	0.456	886	0.122	0.327	889
El Salvador	0.563	0.496	925	0.496	0.500	923	0.516	0.500	923	0.272	0.445	924
Guatemala	0.545	0.498	933	0.455	0.498	934	0.491	0.500	935	0.277	0.448	935
Honduras	0.665	0.472	935	0.631	0.483	937	0.634	0.482	935	0.481	0.500	932
Mexico	0.434	0.496	800	0.386	0.487	801	0.367	0.482	798	0.261	0.439	797
Nicaragua	0.551	0.498	923	0.515	0.500	923	0.531	0.499	922	0.318	0.466	923
Panama	0.431	0.496	863	0.345	0.476	859	0.360	0.480	860	0.240	0.427	861
The Caribbean												
Dominican Republic	0.599	0.490	868	0.604	0.489	867	0.645	0.479	867	0.455	0.498	868
Haiti	0.677	0.469	308	0.654	0.476	302	0.694	0.462	300	0.742	0.438	293
Jamaica	0.522	0.500	399	0.495	0.501	399	0.558	0.497	400	0.489	0.501	399
Puerto Rico	0.277	0.448	378	0.218	0.413	378	0.222	0.416	378	0.161	0.368	377
South America												
Southern Cone												
Argentina	0.215	0.411	783	0.176	0.381	784	0.188	0.391	784	0.119	0.324	783
Brazil	0.206	0.404	891	0.185	0.389	891	0.210	0.408	891	0.105	0.307	891
Chile	0.172	0.377	805	0.169	0.375	805	0.157	0.364	804	0.076	0.264	806
Uruguay	0.226	0.419	821	0.211	0.408	820	0.243	0.429	821	0.137	0.344	820
Andean States												
Bolivia	0.424	0.494	896	0.328	0.470	896	0.362	0.481	895	0.229	0.421	896
Columbia	0.344	0.475	908	0.309	0.463	907	0.328	0.470	907	0.188	0.391	906
Ecuador	0.325	0.469	870	0.282	0.450	871	0.293	0.456	865	0.181	0.385	870
Paraguay	0.523	0.500	900	0.458	0.499	900	0.356	0.479	900	0.232	0.422	900
Peru	0.416	0.493	837	0.337	0.473	836	0.366	0.482	834	0.186	0.390	831
Venezuela	0.420	0.494	877	0.334	0.472	878	0.341	0.474	874	0.253	0.435	873
Total LAC	0.417	0.493	17,236	0.368	0.482	17,228	0.381	0.486	17,207	0.244	0.430	17,202

Note: Source FAO/GWP 2014. We use the sample weights provided by Gallup to estimate all descriptive statistics and prevalence rates.

Table A4
Countries in Regions and FIES-SM item responses.

Countries and Regions	Ateless			Runout			Hungry			Whlday		
	Mean	SD	Count	Mean	SD	Count	Mean	SD	Count	Mean	SD	Count
Central America												
Belize	0.214	0.411	428	0.199	0.400	425	0.175	0.380	429	0.105	0.307	429
Costa Rica	0.185	0.388	890	0.147	0.354	889	0.127	0.333	889	0.048	0.214	890
El Salvador	0.379	0.485	925	0.312	0.464	925	0.306	0.461	925	0.102	0.303	921
Guatemala	0.369	0.483	934	0.303	0.460	932	0.301	0.459	933	0.135	0.341	932
Honduras	0.548	0.498	932	0.517	0.500	931	0.478	0.500	937	0.225	0.418	936
Mexico	0.326	0.469	800	0.238	0.426	798	0.218	0.413	795	0.151	0.359	795
Nicaragua	0.402	0.491	924	0.358	0.480	923	0.334	0.472	918	0.153	0.360	924
Panama	0.294	0.456	856	0.286	0.452	860	0.247	0.432	860	0.119	0.324	860
The Caribbean												
Dominican Republic	0.540	0.499	868	0.472	0.500	868	0.456	0.498	868	0.183	0.387	868
Haiti	0.776	0.418	293	0.682	0.467	293	0.727	0.446	284	0.680	0.467	307
Jamaica	0.518	0.500	400	0.535	0.499	398	0.410	0.492	398	0.252	0.435	398
Puerto Rico	0.185	0.389	376	0.139	0.346	377	0.137	0.344	377	0.087	0.282	375

Table A4 (*continued*)

Countries and Regions	Ateless			Runout			Hungry			Whlday		
	Mean	SD	Count	Mean	SD	Count	Mean	SD	Count	Mean	SD	Count
South America												
Southern Cone												
Argentina	0.152	0.360	783	0.104	0.306	783	0.086	0.280	784	0.052	0.223	784
Brazil	0.145	0.352	891	0.080	0.271	891	0.075	0.263	891	0.061	0.240	891
Chile	0.103	0.304	805	0.077	0.267	804	0.070	0.256	805	0.038	0.190	776
Uruguay	0.164	0.371	819	0.120	0.325	821	0.106	0.309	820	0.071	0.257	820
Andean States												
Bolivia	0.289	0.453	893	0.213	0.410	896	0.252	0.435	895	0.190	0.393	895
Columbia	0.265	0.441	906	0.179	0.384	906	0.198	0.398	906	0.095	0.293	908
Ecuador	0.217	0.413	871	0.165	0.371	868	0.157	0.364	871	0.118	0.323	869
Paraguay	0.236	0.425	900	0.112	0.316	900	0.099	0.299	901	0.069	0.254	901
Peru	0.263	0.440	829	0.187	0.390	829	0.197	0.398	824	0.096	0.295	829
Venezuela	0.287	0.453	865	0.243	0.429	869	0.226	0.419	871	0.124	0.329	878
Total LAC	0.300	0.458	17,188	0.243	0.429	17,186	0.231	0.422	17,181	0.127	0.333	17,186

Note: Source FAO/GWP 2014. We use the sample weights provided by Gallup to estimate all descriptive statistics and prevalence rates.

Appendix B. Alternative identification strategies

This section explores alternative model specifications (Table B1). Columns 1 and 2 use food insecurity as the dependent variable, where column 1 presents the multilevel random intercept model present in the text, and column 2 presents a multilevel random coefficient model. Similarly, for columns 3 and 4, we use severe food insecurity as the dependent variable, and present the results from a multilevel random intercept model and a multilevel random coefficient model. Finally, column 5 uses a categorical dependent variable that represents the categories of food insecurity as food secure (0), mild food insecurity (1), moderate food insecurity (2), and severe food insecurity (3), with each respondent deterministically assigned to one of the four classes. We present the results of a three-level ordinal random intercept model (column 5).

The random coefficient model is subject to the same assumptions as the random intercept model described in the text, but allows both the intercept and a covariate to vary by country. This allows us to capture the potential heterogeneity of the coefficient

Table B1
Robustness check: Alternative model specifications.

	Food insecurity		Severe food insecurity		Three-level ordinal logistic model	Unconditional multilevel model
	Three-level linear model	Three-level linear model with random coefficient	Three-level linear model	Three-level linear model with random coefficient		
Female	0.015**	0.012*	−0.002	−0.003	0.066**	
	(0.007)	(0.007)	(0.005)	(0.005)	(0.033)	
Age	0.008***	0.008***	0.003***	0.003***	0.045***	
	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)	
Age Squared	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
Number of children	0.028***	0.028***	0.010***	0.010***	0.148***	
	(0.003)	(0.003)	(0.002)	(0.002)	(0.013)	
Number of adults	0.002	0.004*	−0.000	0.000	0.010	
	(0.002)	(0.002)	(0.002)	(0.002)	(0.011)	
Marital Status						
Single or Never Married	0.006	0.003	0.013**	0.013**	0.003	
	(0.008)	(0.008)	(0.005)	(0.005)	(0.039)	
Separated, Widowed, or Divorced	0.035***	0.031***	0.030***	0.027***	0.194***	
	(0.010)	(0.010)	(0.007)	(0.007)	(0.049)	
Education Access	−0.028***	−0.027***	−0.005	−0.004	−0.150***	
	(0.007)	(0.007)	(0.005)	(0.005)	(0.034)	
Education						
Elementary education	0.159***	0.134***	0.069***	0.058***	0.888***	
	(0.012)	(0.012)	(0.008)	(0.008)	(0.063)	
Secondary education	0.067***	0.055***	0.012	0.007	0.433***	
	(0.011)	(0.011)	(0.007)	(0.007)	(0.058)	
Log Household Income	−0.043***	−0.073***	−0.022***	−0.034***	−0.247***	
	(0.003)	(0.005)	(0.002)	(0.004)	(0.015)	
Employment Status						
Part-time employment	0.061***	0.054***	0.040***	0.036***	0.369***	
	(0.010)	(0.010)	(0.007)	(0.007)	(0.049)	
Unemployed	0.060***	0.052***	0.040***	0.037***	0.420***	
	(0.012)	(0.012)	(0.009)	(0.008)	(0.060)	
Out of workforce	−0.016**	−0.018**	−0.003	−0.003	−0.049	
	(0.008)	(0.008)	(0.005)	(0.005)	(0.039)	
Immigrant	0.076***	0.080***	0.011	0.013	0.332***	
	(0.022)	(0.021)	(0.015)	(0.015)	(0.106)	

(*continued on next page*)

Table B1 (*continued*)

	Food insecurity		Severe food insecurity		Three-level ordinal logistic model	Unconditional multilevel model
	Three-level linear model	Three-level linear model with random coefficient	Three-level linear model	Three-level linear model with random coefficient		
Social Network	−0.033***	−0.035***	−0.015***	−0.015***	−0.245***	
	(0.008)	(0.008)	(0.006)	(0.006)	(0.040)	
Social Capital	−0.130***	−0.127***	−0.061***	−0.059***	−0.586***	
	(0.009)	(0.009)	(0.006)	(0.006)	(0.044)	
Help Outside Country	−0.014**	−0.013*	−0.006	−0.006	−0.071**	
	(0.007)	(0.007)	(0.005)	(0.005)	(0.034)	
Religiosity	0.017*	0.016*	0.012**	0.011*	0.138***	
	(0.009)	(0.009)	(0.006)	(0.006)	(0.044)	
Cell Phone	−0.040***	−0.033***	−0.021***	−0.018***	−0.234***	
	(0.010)	(0.010)	(0.007)	(0.007)	(0.047)	
Internet	−0.102***	−0.093***	−0.039***	−0.037***	−0.598***	
	(0.008)	(0.008)	(0.005)	(0.005)	(0.038)	
Public Transit	−0.030***	−0.031***	−0.008*	−0.009*	−0.198***	
	(0.007)	(0.007)	(0.005)	(0.005)	(0.034)	
Country Characteristics						
Unemployment Rate	0.013**	0.014**	0.011*	0.011**	0.075**	
	(0.006)	(0.005)	(0.006)	(0.005)	(0.031)	
Log GDP Per Capita	−0.115***	−0.099***	−0.097***	−0.075***	−0.786***	
	(0.025)	(0.024)	(0.025)	(0.023)	(0.135)	
Rural or farm	0.005	0.000	−0.005	−0.011**	0.009	
	(0.008)	(0.008)	(0.005)	(0.005)	(0.041)	
Constant	1.482***	1.610***	1.016***	0.948***		0.329***
	(0.196)	(0.189)	(0.192)	(0.181)		(0.036)
Error Components						
σ_1	0.078***	0.072***	0.083***	0.076***	0.179***	0.027***
	(0.014)	(0.013)	(0.014)	(0.013)	(0.067)	(0.009)
σ_2	0.110***	0.053***	0.065***	0.040***	0.383***	0.015***
	(0.006)	(0.005)	(0.004)	(0.003)	(0.045)	(0.002)
σ_3	0.403***	0.399***	0.277***	0.274***		0.185***
	(0.002)	(0.002)	(0.002)	(0.001)		(0.002)
Log household income variance						
σ_2		0.521***		0.406***		
		(0.043)		(0.031)		
σ_3		0.095***		0.044***		
		(0.011)		(0.008)		
Log likelihood	−9060.958	−8977.680	−2541.855	−2440.525	−18675.611	−10047.797
Number of Observations	17,260	17,260	17,260	17,260	17,260	17,260
Number of Countries	22	22	22	22	22	22

Note: Source FAO/GWP 2014. Dependent variables are binary variables representing food insecurity (moderate or severe), severe food insecurity, and a categorical measure representing food secure (0), mild food insecurity (1), moderate food insecurity (2), and severe food insecurity (3). Married, Four-year college education, Large city, Employed Full time are the omitted categories. Coefficients for ordinal logistic models are presented in log odds. Standard errors are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

across countries. However, the random coefficient model is unnecessary if the heterogeneity is fully captured by the random intercept. Do to the high correlation between household income and food security, we use log household income as our random coefficient and allow it to vary by country.

Comparing the results for food security, severe food security, and the ordinal measures in Table B1, we find that the respective magnitudes and signs of the coefficients are consistent, signifying the robustness of our results. Column 7 presents the unconditional multilevel model which shows the variance components of each level. The food insecurity mean for LAC is 0.329 and the standard deviations are 0.27, 0.015, and 0.182 for the country, sub-region, and individual levels, respectively. This results in an intra-class correlation (ICC)[17] of 12% at the country level and 19% at the sub-region level. Thus, 12% of the variation in food insecurity can be attributed to country-level factors and 19% of the variation can be attributed to sub-region- and country-level factors. Thus, geographic variation attributes to the heterogeneity of individual-level food insecurity in LAC. These results justify our use of multilevel models but also signify to policy makers the importance of considering factors associated with food insecurity at different levels (Zhou and Yu, 2017). For example, focusing exclusively on macro-level growth alone would miss the important influence of factors at the sub-region and individual levels that are significantly associated with food insecurity in LAC.

[17] The ICC represents the ratio of the between-cluster variance to the total variance and reveals the proportion of the total variance in Y_{irc} that is accounted for by the clustering. For a three-level model, there are two ICCs. The first is the level-three ICC at the country level, the correlation between food insecurity in the same country. The second is the level-two ICC at the within-country sub-region level, the correlation between food insecurity in the same sub-region and country.

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