Determinants of Household Food Insecurity in Mexico

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ABSTRACT

Using a national household survey and a newly established food security scale, socio-demographic factors affecting the level of household food insecurity in Mexico were identified. Households more likely to be food insecure include those with younger, less-educated household heads, headed by single, widowed or divorced women, with disabled household members, with native language speakers, with children, as well as rural and lower-income households. The model was also estimated for the rural and lower-income subpopulation, finding that low levels of education, native language speakers, and number of kids are factors associated with higher levels of food insecurity.

Key words: Food security scale, Household food insecurity, Mexico.

JEL Classification: D10, D60

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Introduction

The importance of food security has been addressed nationally and internationally. Food security is defined as the situation when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO 1996).

At a global level, the number of people suffering from hunger and poverty exceeds one billion, which represents one-seventh of the world's population (FAO 2009). As for the situation in Mexico, in 2010 the proportion of population that suffered from any level of food insecurity was 44.3%. In particular, 19.5% of the Mexican population reported experiencing very low food insecurity, 14.0% moderate food insecurity, and 10.8% severe food insecurity. In terms of the number of persons, 49.9 million people in Mexico were experiencing some degree of food insecurity in 2010 (CONEVAL 2011a). In 2008, the proportion of Mexican population under moderate food insecurity and severe food insecurity was 12.8% and 8.9%, respectively. This means that the two most severe levels of food insecurity in Mexico increased from 2008 to 2010 (CONEVAL 2011a).

Food security is an essential dimension of household welfare and an important subject whether viewed globally, within a nation, a state, or in local communities (Bickel et al. 2000). Negative consequences of food insecurity have been documented extensively. Ramsey et al. (2011) found that children in food-insecure households may be at risk of poor health, developmental or behavioral problems. Likewise, Jyoti, Fronjillo, and Jones (2005) provide strong empirical evidence that food insecurity is linked to nutritional and non-nutritional

developmental consequences for children, in particular, academic performance and social skills are found to be affected by food insecurity. Cook et al. (2006) found that household food insecurity is positively associated with fair/poor health and hospitalizations in young children. Moreover, Carmichael et al. (2007) suggest that increased risks of certain birth defects may be included among the negative consequences of food insecurity.

Food insecurity is one of the most important public health challenges and reducing food insecurity and its associated consequences requires an understanding of the determinants of food insecurity (Gundersen and Garasky 2012). Despite the fact that food insecurity and hunger are consequences of constrained financial resources, traditional income and poverty measures do not provide clear information about food security. Evidence supported by analysis of food security data indicates that many low-income households seem to be food secure, while a small proportion of non-poor households appear to be food insecure (Bickel et al. 2000). Likely reasons for such differences include variations in household decisions about how to handle competing demands for limited resources, as well as geographic patterns of relative costs and availability of food and other basic necessities. In other words, the food security measure provides independent, more specific information on this dimension of welfare than the measure that can be inferred from using only income data (Bickel et al. 2000). In the case that food insecurity was completely determined by other measures of constrained resources, poverty for example, establishing a measurement of food insecurity would be irrelevant (Gundersen 2008). However, research has shown that income-based measures and other measures of well-being are not necessarily highly correlated with food insecurity and hunger (Gundersen 2008).

As pointed out by Bickel et al. (2000), monitoring food security can be useful to identify and understand this basic welfare aspect and to recognize population subgroups or regions with particularly severe conditions. Therefore, determining the food security status of the households comprising the community can provide a tool for assessment and planning of governmental programs and policies aimed to enhance food security and reduce hunger.

The main objective of this research is to identify social-demographic factors that determine the level of food insecurity in Mexico. In other words, vulnerable groups in terms of food security are to be identified. This is achieved through the use of the newly established Mexican Food Security Scale (EMSA, Spanish acronym) and a nationally representative dataset containing detailed household- and individual-level information. A clear understanding of the factors that determine food insecurity can improve the design of future agricultural and development policies aimed to promote household food security and child nutrition in Mexico. Despite the demonstrated validity of the food security scale, there is no available study that has utilized food security scales to identify the socio-demographic factors that determine household food (in)security in Mexico and this study will bridge the gap in the existing literature.

This paper is organized as follows. The next section provides a background information and literature review on household food security and the use of food security scales. Following the description of the data, the quantitative methods used to obtain food security estimates at the household level are presented. Next, empirical results are presented and discussed. The final section contains the conclusions.

Background and Literature Review

During the last decade a renewed interest in the concept of food insecurity at the household level has emerged (González et al. 2008). Interest in household food insecurity within scientific and policy groups has motivated efforts to develop methods to measure it. As recent experience suggests, household food insecurity and its severity can be measured/captured through simple and short questionnaires, allowing collecting valuable information with low cost and low respondent burden (González et al. 2008).

The literature has established socioeconomic and demographic factors associated with food insecurity in the United States. Among the groups of people that are found more likely to be food insecure are: households headed by an African American person, Hispanic households, a non-married person, a divorced or separated person, a renter, younger persons, and less educated persons. Moreover, households with children are more likely to be food insecure than households without children. In previous studies, the aforementioned characteristics are generally positively associated with food insecurity (Gundersen, Kreider, and Pepper 2011). However, these authors also recognize that an important factor is the amount of money available to a household, which in some cases is included in estimation methods as income normalized by the poverty line. Similarly, Hager et al. (2010) reports that in the United States, black or Hispanic households with single parents, young children, and incomes below the federal poverty line were identified to have increased risk for food insecurity in 2008.

Bickel et al. (2000) observe that the terms food insecurity and hunger refer to conditions resulting from financial resource constraints. In other words, the measurement procedure is concerned only with food insecurity and hunger that occur because the household does not have

enough resources or money to buy food. That is, this measure rules out the fact of experiencing hunger “voluntarily” in situations such as dieting, fasting and not having time to eat .

Food security scale methodology has been successfully applied in the United States to measure household food security and can be applicable in other settings, with appropriate linguistic and cultural conversions, reflecting the characteristic patterns of perception and response within the sampled population (Bickel et al. 2000).

As for the performance of this type of measures of food insecurity in developing countries, Melgar-Quiñonez et al. (2006) examined the association between food insecurity, determined by a modified version of the U.S. Household Food Security Survey Module, and total daily per capita consumption -measured as household expenditures- in Bolivia, Burkina Faso, and the Philippines. Daily per capita food expenditure, which represented over 60% of the total household consumption, as well as expenditures on specific food groups correlated with food insecurity both as a continuous Food Insecurity Score and as a tri-categorical food insecurity status variable. Regression analysis was executed adjusting for social and demographic covariates. Food secure households have significantly higher total daily per capita food expenditures as well as expenditures on animal source foods, vegetables, and fats and oils than moderately and severely food-insecure households. The authors concluded that the results offer evidence that the U.S. Household Food Security Survey Module is able to discriminate between households at different levels of food insecurity status in diverse developing world settings. They also emphasize that the food insecurity scale is a practical and cost-effective approach whose results correlate well to expenditure estimates, making this scale a good option for practitioners.

González et al. (2008) developed a 14-item questionnaire to measure household food insecurity in urban Costa Rica. They conclude that the adapted questionnaire is a valid measurement of household food insecurity. Further, they observe that this is a simple and quick method to apply in a household setting.

Related to a validation of the scale in Mexico, Melgar-Quiñonez et al. (2005) conducted a study to validate a version of the Food Security Survey (FSS), used by the U.S. Department of Agriculture, in communities located in Sierra de Manantlán, Jalisco –western Mexico-. The FSS was modified to fit the Mexican context. Namely, the questionnaire was translated to Spanish and the questions were reworded in a way that they were unambiguously understood by locals. Moreover, the authors recorded a 24-hour diet recall as nutritional assessment in every interviewed household; this metric was compared to the food security survey outcome. The modified FSS was validated in correlation with a household food inventory and the household dietary variety. They found that food insecurity was associated with low dietary variety. In particular, food insecurity was inversely correlated with the number of food items in the household, animal source foods, dairy products, fruits, and vegetables. The authors concluded that the FSS is a useful tool for monitoring food insecurity in rural regions of Jalisco, Mexico.

Moreover, Pérez-Escamilla, Paras, and Hromi-Fiedler (2008) tested the validity of the Latin American and Caribbean Food Security Scale (ELCSA) in a representative public opinion survey in the state of Guanajuato, Mexico. ELCSA was applied in Spanish, contained 16 items and used a reference period of 3 months. Authors conclude that using a food security scale, such as ELCSA is a valid tool for assessing household food insecurity in Mexico.

Likewise, Pérez-Escamilla et al. (2004) validated a food security scale in Brazil. They also reported that food security is strongly associated with the likelihood of daily consumption of fruit, non-root/tuber vegetables, and meat. In other words, the authors found a negative association between food insecurity and the probability of daily consumption of fruits, vegetables and animal protein.

Other studies that have successfully validated the household food security scale, as a measure to identify the actual magnitude and severity of food security, include: Álvarez et al. (2006) that conducted a study in Antioquia, Colombia; as well as Gulliford, Mahabir, and Rocke (2004) that studied food security in a Caribbean community, among others.

One of the few studies on the subject that used food expenditures data and food security in Mexico is Carrasco, Peinador, and Aparicio (2010). Following the hypothesis that households with higher degree of food insecurity are expected to have less varied diets than food secure households they conducted a correspondence analysis, finding a slight association between food security and a more varied diet, measured through food expenditure in households.

The problem of food security is multifactorial. In Mexican households, food insecurity should be understood as a problem of 1) food availability, 2) food access, and 3) food consumption (CONEVAL 2010). As for food availability, according to FAO data, between 2003 and 2005 there was adequate food availability in Mexico. That is, the minimum requirements for the Mexican population was of 1,850 kilocalories per capita per day, while the food supply reached 3,270 kilocalories per capita per day (CONEVAL 2010). However, in terms of food access 18.2% of the Mexican population had income below the food poverty line in 2008, which means that they did not have enough income to buy a representative basic food basket

(CONEVAL 2010). Finally, in terms of food consumption, in 2008 only a small proportion of rural households had a diversified diet, according to health recommendations. This problem is much more severe in indigenous households in rural communities (CONEVAL 2010).

However, food security is not synonymous with a good nutritional status. That is, food security is a necessary but not a sufficient condition for nutritional security. Nutrition security requires not only that food is available and affordable, but it also should be consumed in an adequate quality and variety, be prepared properly in a hygienic environment, and consumed by a healthy body (CONEVAL 2010). In this research, the concept of nutrition security is not discussed further. The focus is on food security and its socioeconomic determinants.

Data

The data used in this study come from the Module of Socioeconomic Conditions Module (MCS 2010) of the National Household Income and Expenditure Survey (ENIGH, Spanish acronym) collected from August 21st to November 28, 2010. This is a nationally representative dataset that provides detailed household- and individual-level information. The MCS 2010 offers nationwide results, for urban and rural population in every State. The total sample consists of more than 60,000 households. The ENIGH is the only official nationally representative data in Mexico that contains data on food security and food expenditures at the household level. The MCS 2010 is a joint effort between two Mexican Institutions: the National Institute of Statistics and Geography (INEGI) and the National Council for Evaluation of Social Development Policy (CONEVAL). The objective of this joint effort was to provide a statistical overview of variables needed for the multidimensional measurement of poverty, which was stipulated by the Law on Social Development.

It is worth noting that since 2008, the survey has undergone a series of changes. Among these is the inclusion of Mexican Food Security Scale (EMSA, Spanish acronym), an instrument which addresses the dimension of access to food, which is useful for the new poverty estimates in the country. The scale is constructed from a battery of twelve questions that consider the quality and adequacy of food through the reporting of experiences of the population. The EMSA measures the degree of household food insecurity and is the instrument to measure the lack of access to food. This newly implemented scale is used in this research.

The set of food security questions included in the MSC 2010 survey can be combined – following the official methodology of CONEVAL (2011b) - into a single overall measure called the Mexican Food Security Scale (EMSA). This is a scale that measures, using a single numerical value, the level of food insecurity experienced by a household. That is, the dependent variable in the model can have four different levels of food security that are defined following the criteria specified in the EMSA. CONEVAL validated EMSA as a reliable instrument to measure food security at the national and state level in Mexico (Carrasco, Peinador, and Aparicio 2010).

Technically, the distinction between the levels of food insecurity is constructed after distinguishing between households with adults only and those with children under 18. In the first case, the scale uses values between zero and six, whereas in the second case, it uses values between zero and twelve. This is because for households with children six additional questions about the experience of food shortage or hunger are asked. Once this distinction is performed, the scale identifies four breakpoints: 1) *food security* (no affirmative answers to any of the food insecurity/hunger questions); 2) *very low food insecurity* (one or two positive answers in households without children, and one to three affirmative answers in households with children);

3) *moderate food insecurity* (three to four positive answers in households without children, and four to seven in homes with minors); and 4) *severe food insecurity* (five or six affirmative responses for households without children, and eight to twelve positive answers in the case of households with children).

All of the food security questions in the EMSA have two common characteristics. Each question includes a phrase such as "due to lack of money or resources" to assure that the reported hunger experience or food unavailability condition occurred because of household financial/resource limitations. It is important to notice that the term "resources" imply the possibility of obtaining or producing the food for the household without the need to use money. This opens up the possibility of obtaining food from own production and/or subsistence farming, something very common especially in rural communities across Mexico. Moreover, each question asks explicitly about circumstances that occurred during the past 3 months.

Model

Since the order in the four categories of food security scale matters, the model used to obtain the estimates is an ordered probit model, which can briefly be described, for each individual *i*, as:

$$y_i^* = \mathbf{x_i}\boldsymbol{\beta} + \varepsilon_i \quad (1)$$

where y_i^* is a latent variable that can take on four values corresponding to four levels of food security in the EMSA, $\mathbf{x}_i$ represents a set of socio-demographic covariates, and ε_i is a random error. Following the notation used by Long and Freese (2006), the latent variable y^*, that ranges from $-\infty$ to ∞, is divided into J ordinal categories, such that:

$$y_i = m \text{ if } \tau_{m-1} \leq y_i^* < \tau_m \text{ for } m = 1 \text{ to } J = 4$$

The cutoff points τ_1 through τ_{J-1} are unknown parameters to be estimated. It is assumed that $\tau_0 = -\infty$ and $\tau_J = \infty$.

The four categories in the EMSA are: 1= Food Security, 2= Very Low Food Insecurity, 3=Moderate Food Insecurity, and 4=Severe Food Insecurity. The observed food security categories are related to the latent variable as follows:

$$y_i = \begin{cases} 1 \text{ if } \tau_0 = -\infty \leq y_i^* < \tau_1 \\ 2 \text{ if } \tau_1 \leq y_i^* < \tau_2 \\ 3 \text{ if } \tau_2 \leq y_i^* < \tau_3 \\ 4 \text{ if } \tau_3 \leq y_i^* < \tau_4 = \infty \end{cases}$$

Estimation of cutoff points τ_1 through τ_{J-1}, along with estimation of the vector $\boldsymbol{\beta}$ in equation (1) is estimated by maximum likelihood.

After the maximum likelihood estimates are obtained, marginal effects are calculated. A marginal effect is defined as the partial derivative of y with respect to x_k. For nonlinear models, such as ordered probit, the value of the marginal effect depends on the particular values of all the covariates (Long and Freese 2006). Marginal effects are obtained at the mean values of the explanatory variables and the estimation is performed using Stata.

As for the explanatory variables, the vector of covariates, $\mathbf{x}_i$, is divided into three types of social-demographic characteristics: 1) household head characteristics, 2) household characteristics, and 3) community and regional variables. Regional refers to a group of states according to socioeconomic indicators (INEGI 2012). Definition and descriptive statistics of explanatory variables are presented in Table 1.

Results and Discussion

The final sample size after accounting for relevant demographic variables and the variables needed to calculate the household food security is 61,467 households. Every observation (household) in this nationally representative sample is weighted according to the complex sampling design (INEGI 2011). Sampling weights are provided in the dataset and used to obtain summary statistics and estimates.

Table 1 shows the weighted summary statistics of demographic variables for the whole sample, as well as for the four different levels of food security status. From the 2010 sample, 59.4% of the households are food secure, 18.5% have very low food insecurity, 12.1% of the Mexican households have moderate food insecurity, whereas 10.1% report severe food insecurity. The proportions of food security status presented here slightly differ from proportions presented in the introductory section of this document. The reason is that in the introduction the proportion term refers to total population (sum of individuals), while in this section it refers to proportion of total number of households.

The poverty lines mentioned in Table 1 are as officially defined by CONEVAL, Mexican Institution in charge of this task. Poverty lines are measured in monthly per capita income, adjusted monthly by the consumer price index, and classified for rural and urban households. The food poverty line is a monetary measure of the resources needed to buy a representative food basket in Mexico. For the last quarter of 2010, the food poverty line was MX$797.29 for a rural household, and MX$1,074.28 for an urban household. Likewise, the assets poverty line is defined as the income needed to afford food, education, health, clothing, housing and transportation. The

assets poverty line was MX$1,446.76 for a rural household, and MX$2,155.43 for an urban household during the last quarter of 2010.

In terms of household income levels, 16% of the total households in the sample have income below the food poverty line (lower income), 27% have income above the food poverty line but below the assets poverty line (low income), 31% of households are classified as middle income, and the remaining 26% of households have higher income. Interestingly, 9% of the households that are food secure are households with incomes below the food poverty line (lower income), whereas 22% of the households that are food secure with income below the asset poverty line. It is clear that, even though they are correlated, food security and poverty are two different dimensions of welfare.

Table 1. Variable Names, Definitions, and Descriptive Statistics Related to Food Security Levels

				Food Insecurity		
Variable	Definition	All Obs.	Food Security	Very Low	Moderate	Severe
Proportion of Households		1.00	0.59	0.18	0.12	0.10
Household Head Characteristics						
Age<=30	Dummy variable, 1 if household head's age is <=30, 0 otherwise.	0.14	0.13	0.15	0.15	0.14
Age 31-45	Dummy variable, 1 if household head's is age >=31 and <=45, 0 otherwise.	0.35	0.35	0.34	0.41	0.35
Age 46-60	Dummy variable, 1 if household head's is age >=46 and <=60, 0 otherwise.	0.29	0.30	0.28	0.27	0.29
Age >=61	Dummy variable, 1 if household head's is age >=61, 0 otherwise.	0.21	0.22	0.22	0.17	0.21
Male	Dummy variable, 1 if household head's gender is male, 0 otherwise.	0.76	0.77	0.78	0.76	0.71
Female	Dummy variable, 1 if household head's gender is female, 0 otherwise.	0.24	0.23	0.22	0.24	0.29
No Formal education	Dummy variable, 1 if household head has no formal education, 0 otherwise.	0.09	0.06	0.11	0.12	0.18
Elementary	Dummy variable, 1 if household head has elementary school as maximum level of formal education, 0 otherwise.	0.37	0.32	0.44	0.47	0.47
Secondary	Dummy variable, 1 if household head has high school as maximum level of formal education, 0 otherwise.	0.27	0.27	0.29	0.28	0.26
High School	Dummy variable, 1 if household head has junior high school as maximum level of formal education, 0 otherwise.	0.12	0.15	0.10	0.08	0.07
College	Dummy variable, 1 if household head has college or graduate school as formal education, 0 otherwise.	0.15	0.21	0.07	0.04	0.03
Household Characteristics						
"SWD" Mother	Dummy variable, 1 if household is headed by a single, widowed or divorced mother, 0 otherwise.	0.20	0.19	0.18	0.19	0.24
Disabled Person	Dummy variable, 1 if there is at least one disabled household member, 0 otherwise.	0.16	0.12	0.18	0.23	0.24
Indigenous background	Dummy variable, 1 if there is at least one household member that speaks a native language, 0 otherwise.	0.09	0.06	0.11	0.14	0.15

Table 1. Continued.

Variable	Definition	All Obs.	Food Security	Food Insecurity		
				Very Low	Moderate	Severe
Lower Income	Dummy variable, 1 if household income is below the food poverty line, 0 otherwise.	0.16	0.09	0.22	0.30	0.34
Low Income	Dummy variable, 1 if household income is above the food poverty line but below the assets poverty line, 0 otherwise.	0.27	0.22	0.35	0.36	0.34
Middle Income	Dummy variable, 1 if household income is higher than the assets poverty line but lower than twice the assets poverty line, 0 otherwise.	0.31	0.32	0.31	0.27	0.23
Higher Income	Dummy variable, 1 if household income is higher than twice the assets poverty line, 0 otherwise.	0.26	0.37	0.12	0.07	0.09
Social Program Participant	Dummy variable, 1 if household receives benefits from a conditional cash transfer program *(Oportunidades* or *Apoyo Alimentario*), 0 otherwise.	0.18	0.11	0.25	0.30	0.30
Agricultural Household	Dummy variable, 1 if at least 1/4 of household's income comes from agricultural activities, 0 otherwise.	0.02	0.02	0.03	0.02	0.02
Unitary Household	Dummy variable, 1 if (household head=1 and spouse=0 and children=0 and relatives=0 and no relatives=0) , 0 otherwise.	0.10	0.11	0.06	0.06	0.13
Traditional Household	Dummy variable, 1 if (household head=1 and (spouse>0 or children>0) and relatives=0 and no relatives=0) , 0 otherwise.	0.66	0.67	0.67	0.66	0.61
Extended Household	Dummy variable, 1 if (household head=1 and (spouse>0 or children>0 or relatives>0) and no relatives=0) , 0 otherwise.	0.23	0.21	0.26	0.28	0.25
Composite Household	Dummy variable, 1 if (household head=1 and (spouse>0 or children>0 or relatives>0) and no relatives>0) , 0 otherwise.	0.01	0.01	0.01	0.01	0.01
Co-resident Household	Dummy variable, 1 if (household head=1 and spouse=0 and children=0 and relatives=0 and no relatives>0) , 0 otherwise.	0.00	0.01	0.00	0.00	0.00
Kids 0	Dummy variable, 1 if there are no kids (<18 y old), 0 otherwise.	0.36	0.42	0.29	0.20	0.35
Kids 1	Dummy variable, 1 if there is 1 kid, 0 otherwise.	0.22	0.22	0.24	0.22	0.15
Kids 2	Dummy variable, 1 if there are 2 children, 0 otherwise.	0.22	0.21	0.24	0.27	0.19
Kids 3	Dummy variable, 1 if there are 3 children, 0 otherwise.	0.13	0.10	0.15	0.19	0.16
Kids 4	Dummy variable, 1 if there are 4 children, 0 otherwise.	0.04	0.03	0.05	0.07	0.08
Kids >4	Dummy variable, 1 if there are more than 4 children, 0 otherwise.	0.03	0.01	0.03	0.05	0.07

Table 1. Continued.

Variable		All Obs.	Food Security	Food Insecurity: Very Low	Food Insecurity: Moderate	Food Insecurity: Severe
Community and Regional Variables						
Large City	Dummy variable, 1 if the household is located in a city with more than 100,000 inhabitants, 0 otherwise.	0.51	0.58	0.40	0.40	0.40
Medium City	Dummy variable, 1 if the household is located in a city with population between 15,000 and 99,999 inhabitants, 0 otherwise.	0.15	0.15	0.15	0.14	0.14
Small City	Dummy variable, 1 if the household is located in a city with population between 2,500 and 14,999 inhabitants, 0 otherwise.	0.14	0.12	0.16	0.16	0.16
Rural Community	Dummy variable, 1 if the household is located in a city with less than 2,500 inhabitants, 0 otherwise.	0.21	0.16	0.28	0.29	0.31
Region 1	Dummy variable, 1 if the household is in Socioeconomic Region 1 (Chiapas, Guerrero, and Oaxaca), 0 otherwise.	0.10	0.07	0.14	0.14	0.12
Region 2	Dummy variable, 1 if the household is in Socioeconomic Region 2 (Campeche, Hidalgo, Puebla, San Luis Potosi, Tabasco, and Veracruz), 0 otherwise.	0.19	0.17	0.22	0.22	0.23
Region 3	Dummy variable, 1 if the household is in Socioeconomic Region 3 (Durango, Guanajuato, Michoacán, Tlaxcala, and Zacatecas), 0 otherwise.	0.12	0.12	0.12	0.12	0.12
Region 4	Dummy variable, 1 if the household is in Socioeconomic Region 4 (Colima, Estado de Mexico, Morelos, Nayarit, Queretaro, Quintana Roo, Sinaloa, and Yucatan), 0 otherwise.	0.23	0.22	0.25	0.27	0.24
Region 5	Dummy variable, 1 if the household is in Socioeconomic Region 5 (Baja California, Baja California Sur, Chihuahua, Sonora, and Tamaulipas), 0 otherwise.	0.13	0.15	0.09	0.08	0.11
Region 6	Dummy variable, 1 if the household is in Socioeconomic Region 6 (Aguascalientes, Coahuila, Jalisco, and Nuevo Leon), 0 otherwise.	0.14	0.15	0.13	0.11	0.12
Region 7	Dummy variable, 1 if the household is in Socioeconomic Region 7 (Mexico City), 0 otherwise.	0.09	0.11	0.06	0.05	0.06

Weighted summary statistics reported. Sample size: 61,467 households.

Coefficient estimates and p-values from the ordered probit model, as well as marginal effects for the four levels of food security are reported in Table 2. Given the complex design of the sample, weighted data should be used for estimation (INEGI 2011). Discussion focuses on marginal effects (post-estimation) since coefficients from ordered probit do not have a direct interpretation.

The marginal effects for variable *Age>=61* indicate that these households are 10.8 percentage points more likely to be food secure than those with household head younger than 30 years old, which is the omitted category. This result may suggest that, on average, as age of household head increases she/he gets more experience in managing the resources in the household and, possible, more experience at work may represent higher disposable income, reducing the probability of the household to be food insecure. Moreover, the probability of having children at this age is expected to be very low, which implies less family members.

Turning to gender of household head, once all other covariates are controlled for, a male-headed household is 2.5 percentage points more likely to be food secure than a female-headed household.

In terms of education level of the household head, all variables related to a level of formal education have positive marginal effects for the food security category compared to the omitted category *No formal education*. That is, a household headed by a person that has elementary school as maximum level of formal education is 8.2 percentage points more likely to be food secure than a household headed by a person with no formal education. This marginal effect is 12.6, 20.2, and 28.4 percentage points for the variables *Secondary*, *High School* and *College*, respectively. This result suggests that education is an important variable that affects the probability of a favorable food security status. On the other hand, negative marginal effects were obtained for each of the

three categories of food insecurity in terms of education levels. In particular, a household headed by a person with high school education is 9.5 percentage points less likely to be severe food insecure than a household headed by a person with no formal education.

A household with a family member that is disabled is 10.7 percentage points less likely to be food secure, compared to a household that does not share this characteristic. Likewise, the probability of being food secure for a household where native language is 3.7 percentage points lower than that for a non-indigenous household. This finding is consistent with conclusions in previous studies such as Oseguera-Parra (2010), who found that urban and mestizo –non-indigenous- women perceive less food insecurity compared to rural and indigenous women.

Regarding variables related to income the omitted variable was *Lower income*, thus the marginal effects of *Low income*, *Middle income*, and *Higher income* are compared to that category. It turns out that all marginal effects are positive for food security and negative for each of the categories of food insecurity. This implies that, as expected, income is an important determinant of food security. As a particular example, *Middle income* households are 17.8 percentage points more likely to be food secure than those household in the reference category (*Lower income*), and they are also 5.4 percentage points less likely to be moderate food insecure. Similarly, *Low income* households are 4.0 percentage points less likely to be under severe food insecurity than those households in the reference category.

An *Agricultural household* is 5.7 percentage points more likely to be food secure than a type of household that is not considered under this definition. Recall that, for modeling purposes, it is considered an agricultural household if the income from agricultural activities is at least ¼ of total household income. Moreover, an agricultural household is 2.7 percentage points less likely

to suffer severe food insecurity. This result makes intuitive sense, since a household that receives income from agricultural activities may be more likely to also produce food for own consumption.

Marginal effects for household types are positive in the food security column. That is, *Traditional households* and *Extended households* are more likely to be food secure than *Unitary households*. This could be because in a non-unitary household there may be more persons receiving income and they can achieve some economies of scale in terms of food consumption. Also, in a non-unitary household there may be a person in charge of preparing food, which may represent a way to take better advantage of the food resources at hand.

Variables related to number of children in the household have negative marginal effects as for food security is concerned. That is, when compared to the omitted category, *No kids*, households with two kids, three kids, four kids and more than four kids are 2.4, 4.9, 7.6, and 11.4 percentage points, respectively, less likely to be food secure. As expected the marginal effects are positive for each of the food insecurity categories, meaning that the probability of being food insecure is higher for households with kids. These probabilities increase monotonically with the number of kids in the household (See Table 2).

Table 2. Regression Coefficients and Marginal Effects (Robust Estimation)

		Marginal Effects			
			Food Insecurity		
Variable	Coefficients	Food Security	Very Low	Moderate	Severe
Age 31-45	-0.056	0.019	-0.004	-0.006	-0.009
Age 46-60	-0.076	0.025	-0.006	-0.008	-0.012
Age >=61	-0.324***	0.108***	-0.024***	-0.033***	-0.051***
Male	-0.074**	0.025**	-0.006**	-0.007**	-0.011**
Elementary	-0.246***	0.082***	-0.019***	-0.025***	-0.038***
Secondary	-0.379***	0.126***	-0.029***	-0.038***	-0.059***
High School	-0.608***	0.202***	-0.046***	-0.062***	-0.095***
College	-0.853***	0.284***	-0.064***	-0.087***	-0.133***
"SWD" Mother	0.065*	-0.022*	0.005*	0.007*	0.010*
Disable Person	0.320***	-0.107***	0.024***	0.033***	0.050***
Native Language	0.110***	-0.037***	0.008***	0.011***	0.017***
Low Income	-0.255***	0.085***	-0.019***	-0.026***	-0.04***
Middle Income	-0.536***	0.178***	-0.040***	-0.054***	-0.083***
Higher Income	-1.062***	0.354***	-0.080***	-0.108***	-0.166***
Agricultural HH	-0.17***	0.057***	-0.013***	-0.017***	-0.027***
Traditional HH	-0.283***	0.094***	-0.021***	-0.029***	-0.044***
Extended HH	-0.318***	0.106***	-0.024***	-0.032***	-0.050***
Composite HH	-0.046	0.015	-0.003	-0.005	-0.007
Co-resident HH	-0.207	0.069	-0.016	-0.021	-0.032
Kids 1	0.041	-0.014	0.003	0.004	0.006
Kids 2	0.072**	-0.024**	0.005**	0.007**	0.011**
Kids 3	0.146***	-0.049***	0.011***	0.015***	0.023***
Kids 4	0.227***	-0.076***	0.017***	0.023***	0.035***
Kids >4	0.344***	-0.114***	0.026***	0.035***	0.054***
Large City	-0.075***	0.025***	-0.006***	-0.008***	-0.012***
Medium City	-0.125***	0.042***	-0.009***	-0.013***	-0.019***
Small City	-0.084***	0.028***	-0.006***	-0.008***	-0.013***
Region 1	0.126***	-0.042***	0.009***	0.013***	0.020***
Region 2	0.133***	-0.044***	0.010***	0.013***	0.021***
Region 3	-0.004	0.001	-0.0003	-0.0004	-0.001
Region 4	0.216***	-0.072***	0.016***	0.022***	0.034***
Region 5	-0.060	0.020	-0.005	-0.006	-0.009
Region 6	0.076**	-0.025**	0.006**	0.008**	0.012**

Sample size: 61,467 households. HH=Household. "SDW"=Single, Divorced or Widowed.
*p<.1, **p<.05, ***p<.01

Households that live in rural communities appear to be more vulnerable than those living in larger communities/cities. Namely, controlling for variables related to household head characteristics and household composition, households that live in large cities are 2.5 percentage points more likely to be food secure than those living in rural communities (omitted category). This marginal effect is even greater, 4.2 and 2.8 percentage points, for households living in medium and small cities, respectively. This result may be related to the level of isolation, since there are rural communities that do suffer from lack of access to development opportunities (jobs, education, health care, etc.). Since poverty and food insecurity is a relevant problem in rural communities, a more detailed analysis is provided below. That is, determinants of food insecurity are analyzed in below for this particular population group.

Finally, in terms of geographic regions, in average households in *Region3* and *Region5* are, respectively, 0.1 and 2.0 percentage points more likely to be food secure than those in *Region7*. Conversely, households in *Region1*, *Region2*, *Region4* and *Region6* are more likely to be food insecure than the households in *Region7*, which is Mexico City.

Focusing on an important vulnerable population subgroup, which consists of rural households with incomes below the food poverty line (*Lower income*), the regression analysis is performed using a sample of 4,343 households that meet these two aspects (rural and *Lower income*).

Level of formal education of household head is an important determinant of food security in rural areas. As shown in Table 3, the marginal effects of all levels of education are positive and highly significant for food security and for very low food insecurity, levels that represent the two best categories in the food security scale. Education may be important to food security not only because it is usually correlated with income, but also because it may have a positive impact on

how the resources in the household are managed. On this matter, Gundersen and Garasky (2012) found that households with greater financial management abilities are less likely to be food insecure. This finding holds even for households with incomes <200% of the poverty line in the United States. These findings suggest that improving households' financial management skills has the potential to reduce food insecurity. It would be worth to explore if the same outcome holds for Mexican households and if that is the case, implementing training programs would help families to achieve food security.

Households that have disabled persons have increased probability of being moderate food insecure (2.6 percentage points) and severe food insecure (7.4 percentage points) compared to households in the alternative category. This is not a surprising result since taking care of a disabled person increases household expenses.

Native language is a variable that have negative marginal effects for food security (-5.6 percentage points) and for very low food insecurity (-0.7 percentage points). This means that the probability of a household, where at least one member speaks a native language, to be food secure is significantly lower compared to households that do not share the native language characteristic. It is worth noticing that even in the rural-lower income subpopulation group the households with strong indigenous background are more likely (vulnerable) to be food insecure.

The marginal effects of participating in a social program, households that receive income from one of two government programs, *Oportunidades* or *Apoyo Alimentario*, are not statistically significant. This variable is only included in the estimation for the rural-lower income subpopulation group since the objective of the program is to reach households that live under poverty conditions. An alternative model specification (not reported) without including the variable for social program participation was estimated, finding that the estimates and marginal

effects of the rest of the variables are practically unaffected when dropping such variable that could be considered as endogenous.

Estimation of a formal treatment effect of social program participation on food security is out of the scope of this research and it is left as an opportunity for future work. However, there is evidence in the literature that social program participation helps households to achieve better food security status. In particular, Ruiz-Arranz et al. (2002) analyze the impact on food security of two conditional cash transfer programs, *Oportunidades* (previously known as *Progresa*) and *Procampo*. Whereas *Oportunidades* is a transfer program aimed to help households through food consumption and the development of human capital, *Procampo* is an agricultural production program. The authors found that both programs boost total food consumption, and caloric intake in similar proportions. Moreover, both programs increase food diversity. However, households that were *Procampo* recipients that also receive *Oportunidades*, were more likely to have a more varied diet than households that receive benefits from *Procampo* only. The authors conclude that access to information on nutrition and health that accompanies *Oportunidades* has a positive effect on food diversity. That is, education and training provided to women seem to affect positively the way resources in the household are spent. Nevertheless, Torres Salcido (2010) suggests that certain vulnerable population has not yet received benefits from social programs in Mexico. Among the reasons for this exclusion, the author cites adverse ethnic characteristics, isolation of rural communities and lack of information.

Back to the description of results, agricultural households have increased probabilities to have a positive food security status. That is, an agricultural household in rural areas is 8.3 percentage points more likely to be food secure than a non-agricultural household. The definition of agricultural household is the same as in previous sections. Most agricultural households are

eligible to receive benefits from *Procampo* and arguably are more likely to be better off than other households. Sadoulet, de Janvry, and Davis (2001) analyzed *Procampo* program in Mexico, finding that cash transfer programs can create multiplier effects, particularly when household recipients invest the money they receive to generate further incomes. The authors also find that these multipliers are higher for households with medium and large farms, low numbers of adults in the household, and households with nonindigenous backgrounds. Furthermore, they point out that opportunities are enhanced when recipient households have also access to technical assistance.

As for the number of children in the household, the marginal effects on food security of having one, two, three, four and more than four kids are -5.8, -8.6, -8.7, -12.2 and -18.3 percentage points, respectively. That is, households with kids are less likely to be food secure than households without children. Unsurprisingly, the probability of a household to have food security decreases as the number of kids in the household increase.

Common factors from the discussion above include: 1) education is an important determinant of food security, even in lower income households; 2) population with strong indigenous background, usually living in isolated communities, seem to be a vulnerable population segment in terms of food insecurity.

Table 3. Regression Coefficients and Marginal Effects for Lower Income Households in Rural Communities

		Marginal Effects			
			Food Insecurity		
Variable	Coefficients	Food Security	Very Low	Moderate	Severe
Age 31-45	-0.038	0.013	0.002	-0.004	-0.011
Age 46-60	0.108	-0.036	-0.005	0.011	0.030
Age >=61	0.075	-0.025	-0.003	0.008	0.021
Male	-0.044	0.015	0.002	-0.004	-0.012
Elementary	-0.300***	0.101***	0.013***	-0.030***	-0.085***
Secondary	-0.347***	0.117***	0.015***	-0.035***	-0.098***
High School	-0.666***	0.225***	0.029***	-0.066***	-0.188***
College	-0.794*	0.268*	0.035*	-0.079*	-0.224*
Disable Person	0.262***	-0.089***	-0.011***	0.026***	0.074***
Native Language	0.166***	-0.056***	-0.007***	0.017***	0.047***
Social PP	-0.037	0.013	0.002	-0.004	-0.011
Agricultural HH	-0.246***	0.083***	0.011***	-0.025***	-0.069***
Traditional HH	0.199	-0.067	-0.009	0.020	0.056
Extended HH	-0.015	0.005	0.001	-0.001	-0.004
Composite HH	0.400	-0.135	-0.017	0.040	0.113
Co-resident HH	-1.032*	0.349*	0.045*	-0.103*	-0.291*
Kids 1	0.17**	-0.058**	-0.007**	0.017**	0.048**
Kids 2	0.256***	-0.086***	-0.011***	0.026***	0.072***
Kids 3	0.257***	-0.087***	-0.011***	0.026***	0.073***
Kids 4	0.361***	-0.122***	-0.016***	0.036***	0.102***
Kids >4	0.541***	-0.183***	-0.024***	0.054***	0.153***

Sample size: 4,343 households. HH=Household. Social PP=Social Program participation.

*p<.1, **p<.05, ***p<.01

Conclusions

The increase of food insecurity in Mexico has obvious policy implications and relevance. In this study we investigate how demographic variables are related to food security and to different degrees of food insecurity using a nationally representative data and a newly developed food security scale. The estimation was conducted using an ordered probit model for the total population first, and then for a subgroup of rural lower income households. We found that households with younger, less-educated household heads were more likely to suffer food insecurity. Other groups that were found to be vulnerable in terms of food insecurity include households headed by a single, widow or divorced mother, households with disabled family members, households with strong indigenous background, rural households, low income families, non-agricultural households and households with children.

Since households in rural areas and with income below the food poverty line were found to be a vulnerable group, estimation for this subgroup was conducted separately. Vulnerable groups in rural, lower income subgroup still include households with strong agricultural background (*Native language*), households with disabled family members and households with a large number of children. It seems that is necessary not only to implement policies that will bring the benefits of cash transfer social programs to the residents of isolated rural communities but also to implement/strengthen complementary public policies to support sustainable local food production and rural development.

We found that the level of education is yet an important determinant of food security even among lower income families in rural areas. Education may be important to food security not only because it is usually correlated with income, but also because it may have a positive impact on how the resources in the household are managed. Gundersen and Garasky (2012) suggest that

improving households' financial management skills has the potential to reduce food insecurity in the United States. If the same outcome will hold for Mexican households, implementing training programs would help families to improve food security.

Within the rural and lower income subpopulation, a variable related to favorable food security status is whether or not the household is an *agricultural household*. Sadoulet, de Janvry, and Davis (2001) analyzed the *Procampo* program in Mexico, finding that cash transfer programs can create multiplier effects. They also point out that opportunities are enhanced when recipient households have also access to technical assistance. Hence, education (technical training) seems to play an important role to achieve food security in agricultural households as well.

As for opportunities for future research, one way to expand the present work is to evaluate social program participation using food security as dependent variable. This could be done by using formal treatment effect methods and correcting for endogenous program participation. Future research can also include the estimation of household food security determinants for particular geographic regions or demographic subgroups of interest, which may have the potential to identify relevant variables to help the design of development programs.

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