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The Impact of Remittances on Food Insecurity Evidence from Mexico

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The Impact of Remittances on Food Insecurity
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Abstract

Literature has provided evidence that remittances have an impact on (economic) development and quality of life in developing countries. However, little is known about how income from remittances is perceived and used in relation to food consumption and, more specifically, its effect on food insecurity. Using data from CONEVAL's 2013 and 2015 Rural Households Surveys (ENCHOR) we estimate ordered probit regressions with instrumental variables in order to assess the impact of both international and internal remittances on food insecurity of households in rural Mexico. Our findings show that both kinds of remittances have significant effects on the food insecurity. International remittances appear to reduce food insecurity more than internal remittances, although not enough to make remittance-receiving households food secure. The findings suggest that remittances as a household strategy are not sufficient to ameliorate the precarious food insecurity of poor households in rural Mexico. Therefore, remittances should be considered as a complementary step to reduce food insecurity levels, but should not replace the government's responsibility for solving this problem.

JEL Classification: D12, O15, F24, C31, C36
Keywords: Remittances; Food security; Rural households; Ordered probit; Instrumental variables; Mexico.

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1 Introduction

The number of international migrants has tripled in the last 50 years, and figures show that this phenomenon has experienced significant growth since the mid-1980s. As a result, in 2015 the share of the world's population living outside their countries of birth was 3.3% (United Nations, 2017). Similarly, international remittances have been growing steadily – driven by the development of new information technologies and the increasing affordability of financial services – to such degree that they have quickly become the second largest source of external financing for developing countries, second only to foreign direct investment (World Bank, 2017). According to the World Bank, in 2015 developing countries received remittances amounting to US $431.5 billion, which tripled the official development assistance for that same year (World Bank, 2016). Such monetary flows sent back home by migrant workers are critical for economic development, especially for some low- and middle-income countries (Piteli et al., 2019; Lim and Basnet, 2017; Taylor and Castelhano, 2016; Yang, 2011; Adams, 2011).

Recently, the increase in international remittances has motivated social researchers to study the impact that they might have on home and host countries (Azizi, 2018; Manic, 2017; Borjas, 2015). Academic research has documented the impact of remittances on the economic development of migrant-sending countries, and a common objective in several of these studies is establishing whether these remittances influence migrant families' well-being (Bhattacharya et al., 2018; Mohanty et al., 2014; Adams 2011). Previous research has shown the effects of remittances on different development subjects such as poverty, inequality, health, and education (Berloffa and Giunti, 2019; Mora-Rivera and Morales-Gutiérrez, 2018; Amuedo-Dorantes and Pozo, 2010; Acosta et al., 2008; Hildebrandt and McKenzie, 2005; Cox-Edwards and Ureta, 2003). In addition, literature has analyzed the link between remittances and household consumption and investment (Manic, 2017; Mora-Rivera and Arellano-González, 2016; Adams and Cuecuecha, 2013; Yang, 2008).

Although the relationship between remittances and development has been widely reported, few studies address the nexus between remittances and food security. Indeed, Crush and Caesar (2018) emphasize that the relation between remittances, migration, and food security has been rather absent from the international food security agenda, and that only a handful of studies have examined this issue (Crush and Caesar, 2018, 2017; Crush, 2013; Lacroix, 2011). Most of the current work focuses on African and Asian countries (Sulemana et al., 2019; Mabrouk and Mekni, 2018; Choithani, 2017; Hussain et al., 2016; Musemwa et al., 2015; Generoso, 2015; Sharma, 2012), and little attention has been paid to the impact of these financial transfers on Latin America's food insecurity (Thomas-Hope, 2017). In particular, we are not aware of any study that examines directly this relationship in Mexican households.

Therefore, the objective of this paper is to evaluate the effect of remittances on food insecurity in rural Mexico. To achieve this goal, we aim to answer two questions: In first instance, we want to know if received remittances help rural Mexican households to relieve food insecurity, and,

secondly, we want to understand if there is a differential impact on food insecurity according to different types of remittances, in particular, between international versus internal remittances. This distinction is relevant since the existing literature regarding the effects of remittances on indicators of national development has centered on the impact of international remittances (Taylor and Castelhano, 2016; Adams, 2011) and almost ignores the potential effects of internal remittances. Nevertheless, internal migration is an extremely important phenomenon in terms of volume and its social and economic consequences, a fact that should not be neglected, especially because these domestic migration flows reflect the inherent inequalities of Mexico, a nation marked by enormous contrasts (Arends-Kuenning et al., 2019; Jones et al., 2019; Reyes et al., 2017).

The answers to these questions contribute to different branches of the literature on the remittances-food consumption nexus. First, Mexico is by far the top recipient of international remittances in Latin America, and the fourth globally (World Bank, 2016). Due to the high levels of poverty prevailing in Mexico's rural sector, food insecurity and malnutrition have persistently risen (Vilar-Compte et al., 2015; Shamah-Levy et al., 2014). In this context, the inflow of international transfers can affect remittance-receiving households by increasing their income and, as a consequence, indirectly decreasing food insecurity levels (Crush and Caesar, 2018; Regmi and Paudel, 2017).

Second, although efforts have been made to analyze food security concerns in Mexico (Magaña-Lemus et al., 2016; Villagómez-Ornelas et al., 2014; Van Gameren and Urbina-Hinojosa, 2018), no studies have evaluated the potential positive effects of remittances on food insecurity in vulnerable households, particularly those located in rural areas. As we mentioned above, several studies have shown the positive impacts of remittances on poverty reduction and human capital in rural Mexico (Mora-Rivera and Arellano-González, 2016; De la Fuente, 2010; Taylor et al., 2008). Nevertheless, they do not explore how these transfers may contribute to solving the high levels of food insecurity that many inhabitants of rural communities experience.

Third, while previous works have analyzed the link between food insecurity and international remittances (Regmi and Paudel, 2017; Sharma, 2012), this paper broadens the scope as it also considers internal remittances, and explores the possible existence of differentiated effects on food insecurity attributed to the origin of remittances. The latter originates from the fact that previous studies indicate that internal and international migrants differ in their selection processes and characteristics (Villarreal, 2016; Mora and Taylor, 2006). In addition, there is evidence that the total number of internal migrants is considerably higher than the number of international migrants (UNDP, 2009); as a result, many more households receive internal remittances rather than international remittances (Mora-Rivera et al., 2019). Therefore, it is worthwhile to identify if the effect of remittances, differentiating by its origin, leads to contrasting results on food security.

Fourth, the analysis contributes to the policy discussion in Mexico. The previous administration started a "Crusade Against Hunger" policy to combat food deprivation and extreme poverty simultaneously, but evaluations of the impact of the policy have been limited. In this regard, our results allow us to suggest policy measures aimed at promoting development in remittance-receiving communities by taking advantage of the potential of remittances to increase food security in rural households. Until now, these policies in rural Mexico have been very limited and sparse. Thus, understanding the possible impact of remittances on food security is crucial given the current global concern on poverty and malnutrition, and the interest in health and wellbeing in developing countries like Mexico.

The present paper uses ordered probit regressions to analyze the impact of internal and international remittances on food insecurity. This analysis presents the obvious challenge of the endogeneity of remittances (Azizi, 2018; Adams, 2011). To address this concern, we employ an instrumental variable (IV) approach that consistently estimates the impact of remittances on food insecurity. To implement this methodology, we use CONEVAL's (Mexico's National Council for the Evaluation of Social Development Policy) 2013 and 2015 Rural Households Surveys (ENCHOR). These surveys include household characteristics, individuals' socioeconomic features, diverse income sources, expenses, and the information needed to estimate food security levels (CONEVAL, 2015). The questionnaire was essentially the same for both years, but with newly drawn household samples. As a result, we cannot benefit from a panel aspect but can only pool both cross-sections.

Overall, the main findings show that a higher propensity to receive remittances reduces food insecurity in rural Mexican households. Moreover, the impact of remittances received from abroad (almost exclusively from the US) appears to be stronger than the impact of remittances from other parts of Mexico, which indicates that the effects of remittances on food insecurity, although of similar magnitude, are related to their origin (internal versus international). When considering the endogeneity of remittances, the impact of international remittances raises the share of food secure households by 30.65 percentage points (pp) and almost eradicates severe food insecurity. Importantly, internal remittances also strongly increase the share of food secure households by 19.10 pp and the change in the number of severe food insecure households is significant, although not as strong as the impact associated with international remittances.

The remainder of this paper is organized as follows. The next section reviews the relevant literature on the relationship between remittances and food security. Data and empirical methodology are presented in Section 3 and 4, respectively, while Section 5 reports and discusses the main findings. Finally, the conclusions are drawn along with policy recommendations and potential research avenues.

2 Literature Review

The positive impact of remittances on the economy of developing countries has been widely investigated and has gradually obtained recognition (Taylor and Castelhano, 2016; Yang, 2011). A vast academic literature provides evidence that remittances have a positive effect on various aspects of development and quality of life: poverty (Mora-Rivera and Morales-Gutiérrez, 2018; Taylor et al., 2008; Adams and Page, 2005), health (Gustafsson, 2018; Hildebrandt and McKenzie, 2005), inequality (Agwu et al., 2018; Acosta et al., 2008; Barham and Boucher, 1998), natural resources (López-Feldman and Chávez, 2017; Li and Zhou, 2015), nutrition (Isoto and Kraybill, 2017), education (Amuedo-Dorantes and Pozo, 2010; Cox-Edwards and Ureta, 2003), and food security (Crush and Caesar, 2018; Regmi and Paudel, 2017; Sharma, 2012; Lacroix, 2011). Previous studies have shown the potential of remittances for improving the well-being of remittance-receiving households thanks to their effect on income and consumption (Akçay and Karasoy, 2017; Lazarte-Alcala et al., 2014). Overall, it is widely accepted that remittances affect consumption patterns in several ways, with a positive effect on health, education, durable goods, and physical capital investments (Manic, 2017; Mora-Rivera and Arellano-González, 2016). Particularly relevant for our analysis is that remittances can directly and indirectly impact the household's income, and thereby improve nutritional variety and quality (Generoso, 2015; Crush, 2013).

The literature on remittances offers some theoretical reasons to explain the expected impact of remittances on food expenditures and food security. First, they can relax budget constraints and smooth consumption patterns (Taylor et al., 2003; Stark, 1995), and second, enhance savings and investment, making remittance-receiving households self-sufficient (Yang, 2008; Cox and Jimenez, 1992; Lucas and Stark, 1985). Third, remittances provide insurance against economic shocks and emergency needs (Gubert, 2002; Poirine, 1997; Stark and Levhari, 1982), while the migration experience can increase the knowledge and awareness necessary to improve the human capital and health of relatives who stay behind in home countries (Cox-Edwards and Ureta, 2003; Stark, 1991; Stark and Lucas, 1988; Djajić, 1986**).** In spite of these theoretical postulates, the empirical evidence regarding the effects of remittances associated with food security is not conclusive, and determining if such impacts are positive, negative, or null is an empirical task that can fade, depending on the context and period under analysis. Our research intends to contribute key elements to the prevailing discussion on the topic.

2.1 Empirical Evidence of Remittances' Impacts on Food Security

Despite the perceivable connection between remittances and food security, few empirical studies have addressed this issue (Crush and Caesar, 2018; Regmi and Paudel, 2017). Exceptions are the pioneering works that explored the topic in African and Asian countries. For example, Crush and Pendleton (2009) for five countries in southern Africa, and Lacroix (2011) for seven countries of

the British Commonwealth (ranging in size from India to Jamaica and Tonga) respectively argued that remittances have a significant potential for improving food security in poor rural communities because a substantial proportion of these funds is used to purchase food. In the case of Nepal, Pyakuryal et al. (2010) pointed out that international remittances have become a core aspect in promoting food security and reducing poverty. In the same vein, Sharma (2012), based on a survey carried out in a small village in Nepal, investigated the effects of migration on farm production and on household-level food security. His results indicate that even though migration is negatively affecting farm production, remittances are helping to reduce food insecurity levels. Recently, new research on African countries has found further evidence of the positive effects of remittances on food security. By employing panel data from 1990-2013 for a set of countries in Africa, Mabrouk and Mekni (2018) have pointed out that remittances play a fundamental role in improving the food security of African households. Sulemana et al. (2019) have confirmed this finding for the case of Sub-Saharan African countries, stating that receiving international remittances is positively associated with increases in food security; yet even more important is the frequency these remittances are received.

Although research in this field is increasing, some academics have pointed out that topics such as migration and remittances have been absent from the international food security agenda (Crush and Caesar, 2018; Crush, 2013). In fact, there appears to be a disconnection between international migration, remittances, and food security—three central agendas for global development (FAO et al., 2018; UN General Assembly, 2015; Griggs et al., 2013). However, a recent special issue of *International Migration* dedicated a section to empirical studies analyzing this relationship, which has contributed to bridge the gap. The goal of this special issue was to alert migration scholars to the importance of food security as a core element of the migration-development relationship (Crush and Caesar, 2017). These articles are grounded in empirical research using both quantitative and qualitative methodologies that explore several dimensions of the migration, remittances, and food security triad. However, none of these studies addresses this relationship for the Mexican case.

Notwithstanding the above, there is no consensus among scholars on the effects that remittances have on food security in migrants' countries of origin. On one hand, some argue that the cash flow of remittances promotes and improves food security in these countries, especially in rural areas, mainly inhabited by poor people (Ogunniyi et al., 2020; Mahapatro et al., 2017; Moniruzzaman, 2016; Zezza et al., 2011; Pyakuryal et al., 2010; Crush and Pendleton, 2009). On the other hand, some assert that remittances are like a "curse" with negative effects because they increase dependency, weaken institutional capacity, and rarely promote food security (Weiler et al., 2017; Kuuire et al., 2013; Karamba et al., 2011).

Among the studies that have identified the positive effects of remittances in reducing food insecurity is the work by Zezza et al. (2011), which argues that migration can reduce malnutrition and food insecurity through international remittances. Furthermore, they consider that these money transfers are a key component in the livelihood strategies of poor people living

in developing countries. In a recent work, Ogunniyi et al. (2020) used panel data analysis (dynamic and static econometric models) to study the dynamics of remittances and food security in African countries. Their main findings show that an increase in these transfers positively affects food and nutritional security. Meanwhile, the research by Mahapatro et al. (2017) in India, and Moniruzzaman (2016) in Bangladesh follows the same line of work. In the first case, a propensity score matching technique is employed to estimate the impact of remittances on food security. They found that remittance- and non-remittance-receiving households in India spend a similar proportion of their budget on food; however, at the margin, remittance-receivers' overall expenditure on food was significantly higher. Thus, their study shows that these cash inflows enhance households' well-being. The second study found that remittance-receiving families are more food secure than non-receiving ones. In other words, remittances improve dietary diversity and allow households to cope with shocks that threaten their food security status.

On the opposing end, Karamba et al. (2011) pointed out that migration does not impact the total food per capita—the only exception are highly migratory regions in Ghana. Yet, in general their results indicate that migration creates a shift toward the consumption of less nutritious food categories. More recent results for the same country show that poor rural households have increased their dependence on food remittances. This comprises a not so positive strategy to cope with chronic food insecurity (Kuuire et al., 2013). Using a qualitative methodology, Weiler et al. (2017) analyzed Canada's Seasonal Agricultural Worker Program. They point out that remittances partially contribute to improving food security and also highlight the need to promote policies that reduce food insecurity and promote food sovereignty for both residents and immigrants in Canada.

In addition to the studies mentioned above, some studies found that non-farm income (obtained through remittances) reduces food insecurity in rural households because of its potential to increase food production (Atuoye et al., 2017; Moniruzzaman, 2016; Nguyen and Winters, 2011; Babatunde and Qaim, 2010). Atuoye et al.'s (2017) research on Ghana, and Babatunde and Qaim's (2010) work on Nigeria, found evidence that non-farm income, in the form of remittances, positively impacts food security and nutrition. The results also show that this money contributes to higher food production. Similarly, using panel data from the Vietnam Household Living Standard Survey, Nguyen and Winters (2011) demonstrated that short-term migration is a strategy for households to maintain food security. Their results suggest the need to implement policies that facilitate short-term migration flows as well as remittance transfers.

2.2 The Mexican Context Regarding Food Insecurity

In Mexico's case, the vast literature on remittances has focused on studying their impact on various aspects of the country's economic development (Aysa-Lastra, 2019; Taylor et al., 2008; López-Córdova, 2005). Several studies have focused on the influence of remittances on spending patterns in Mexican households (Mora-Rivera and Arellano-González, 2016; Airola, 2007;

Zarate-Hoyos, 2004) and investigated how remittances influence the allocation of expenses to different expenditure categories. Using data from the National Household Income and Expenditure Survey (ENIGH), Zarate-Hoyos (2004) point out that consumption patterns in remittance-receiving households are modified when receiving these transfers. Mora-Rivera and Arellano-González (2016) confirm these findings and highlight that remittances modify spending on categories that positively impact the well-being of receiving households. On the other hand, some studies analyze the impact on spending categories linked to health and nutrition indicators but they came to inconclusive evidence regarding the effects of remittances. For example, Amuedo-Dorantes and Pozo (2011) conclude that remittance-receiving households significantly increase their health expenditures compared to those who do not receive these resources. Although Riosmena et al. (2012) find little proof that remittances improve Mexican households' nutritional conditions, Creighton et al. (2011) show that children aged 3 to 15 years living in remittance-receiving homes increase their probability of being overweight or obese. Despite the significant impact of remittances on various well-being categories and indicators reported by several studies, few papers have discussed their potential impact on severe issues such as those related to nutrition and food insecurity, a problem that persists in a large portion of households in Mexico, and which is exacerbated for those located in rural areas.

There are many studies that have addressed the prevalence of food insecurity problems in Mexico. Regarding the determinants of food insecurity, Mundo-Rosas et al. (2013, 2018) present descriptive analyses based on data from the National Health and Nutrition Surveys (ENSANUT) of 2012 and 2016. They encounter that in rural areas about a third of the households were classified as moderately or severely food insecure while in urban areas only a quarter of the households were classified as such. Their analysis is limited to bivariate relations, showing that food insecurity correlates with several poverty-related variables. A multivariate analysis by Magaña-Lemus et al., 2016), using data from the ENIGH of 2010, finds that households with younger, single, female and less-educated household heads are more likely to be food insecure, as are indigenous and lower-income households and households with more children. They also find that rural households are more likely to suffer from food insecurity, while an analysis specifically for households in rural areas maintains the relevance of most of the variables found relevant at the national level. Migration and remittances are not addressed in their work, however. Case studies such as Appendini and Quijada (2016) focus on consumption strategies and food security in rural households, and emphasize the role of small-scale maize production as a food policy in the analyzed communities while acknowledging the importance of migration for the households' income.

Regarding the impact of remittances on food security, evidence for Mexico is much more limited; only a few studies have analyzed how both phenomena might tie in together. Using the ENSANUT 2012, with the objective to analyze the determinants of both overweight/obesity and food security, Van Gameren and Urbina-Hinojosa (2018) control for but do not find any significant effect of remittances on either of the outcomes of their interest. An important

difference from the paper at hand is that their data is nationally representative, while our focus is on households in small rural communities. Vilar-Compte et al. (2015) use the ENIGH to investigate the determinants of food security using similar explanatory variables as Van Gameren and Urbina-Hinojosa (2018), such as population density, income quintiles, household size, level of education and gender of the household head, access to social security and socialized health insurance (*Seguro Popular*), receiving public cash transfers (*Oportunidades* and *70 y más*), agricultural self-consumption, and receiving remittances as explanatory variables. They discover that receiving remittances comes with lower levels of food insecurity, just as agricultural self-consumption seems to protect households against food insecurity. Also their data is nationally representative. Both Vilar-Compte et al. (2015) and Van Gameren and Urbina-Hinojosa (2018) employ binary indicators for the urban characteristics of the household's place of residence and encounter that (semi-)rural households are more likely to report food insecurity. Neither takes into account that the relations between the relevant variables may be different in urban and rural zones, and, importantly, neither is especially interested in the relation between remittances and food security. Moreover, neither considers that migration and remittances may be an endogenous strategy related to the food insecurity situation witnessed by households.

3 Data

The data used to carry out this research are taken from the CONEVAL Rural Households Survey (ENCHOR 2013 and 2015). The fundamental objective of that survey was to evaluate the performance of the National Crusade Against Hunger (Crusade),[1] gathering information regarding the periods November 2012 to October 2013 and November 2014 to October 2015 in localities with 500 to 2,499 inhabitants. A total of 12,874 people in 2,530 households from 111 localities were surveyed in the first wave, of which 58 belong to the set of Crusade locations and 53 to the set of non-Crusade localities. The sample design and selection allow obtaining representative results at a national level for the 400 municipalities of the Crusade and for the non-Crusade rural municipalities of the country. For the second wave, 10,842 persons in 2,400 households from 120 localities were interviewed, equally divided between Crusade and non-Crusade localities.[2]

The questionnaires asked for information at the individual and household level on social and economic conditions, including agricultural properties, activities and production, non-agricultural business activities, wealth, credits, and incomes derived from labor and non-labor

[1] The National Crusade Against Hunger is a strategy coordinated by the federal government that seeks to overcome simultaneous conditions of food deprivation and extreme poverty, a situation that was experienced by about 7.4 million people distributed throughout the country in 2010 (CONEVAL, 2017).

[2] The microdata of the ENCHOR can be accessed via http://www.coneval.org.mx/Paginas/Busqueda.aspx?k=enchor.

activities including income from remittances, and, particularly relevant for our analysis, on the household's access to food.

3.1 The Measurement of Food Insecurity

The level of food insecurity in households interviewed for the ENCHOR is measured using a set of six questions regarding the availability of food and meals for adults in the household, and, in households with persons under 18 years old, another set of six questions regarding the availability of food and meals for individuals under age 18 (Table 1). The questions included in the Mexican Food Security scale (EMSA) used for the ENCHOR are inspired by the 18-question USDA food security scale[3] and the 15-question Latin American and Caribbean Food Security scale (ELCSA).[4,5] Villagómez-Ornelas et al. (2014:S7) indicate that the questions regarding whether the households worried about running out of food, or lacked access to healthy and balanced foods, were excluded from the EMSA despite forming part of the ELCSA, because the questions (for adults and for under-18s) did not pass the validity tests of statistically consistent scales.

Table 1 Questions about Food Insecurity in ENCHOR-2013 and 2015 [a]

In the past three months, due to a lack of money or resources, have you or any adult in your household …	
1	had access to a limited variety of foods?
2	skipped breakfast, lunch, or dinner?
3	eaten less than you thought you should eat?
4	run out of food?
5	felt hungry, but did not eat?
6	eaten only once a day or not eaten for a whole day?
IF NO MINORS UNDER AGE 18 LIVE IN THE HOUSEHOLD, END THE SURVEY.	
In the past three months, due to a lack of money or resources, has any minor under age 18 in your household...	
7	had access to a limited variety of foods?
8	eaten less than you thought he or she should eat?
9	been served less food?
10	felt hungry, but did not eat?
11	gone to bed hungry?
12	eaten only once a day or not eaten for a whole day?

(a) Possible responses for each question: Yes or No

Source: Questionnaires of ENCHOR 2013 and 2015: SECTION 17. ACCESS TO FOOD IN HOUSEHOLD. Translation from Spanish to English based on translations in Pérez-Escamilla et al. (2009) for the ELCSA scale.

[3] See https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement.aspx. An important difference between this scale and EMSA or ELCSA is that the USDA asks for the experiences during the last 12 months while the Latin-American scales ask about the last 3 months.

[4] See FAO (2012) and INSP (2013). See also https://inddex.nutrition.tufts.edu/data4diets/indicator/latin-american-and-caribbean-food-security-scale-elcsa.

[5] The same 12 questions forming the EMSA are included in the ENIGH of 2008.

Each of the 12 questions could be answered affirmatively, indicating a problem, or negatively, indicating that the addressed (negative) situation did not occur. Counting the number of affirmative replies provides a measure of the level of food insecurity in the household, obviously treating household with and without under-18s differently, given the different numbers of questions asked (Table 2).

Table 2 Severity Classification used in CONEVAL Reports [a]

	Households with Under-18s	Households without Under-18s
Security	0	0
Mild insecurity	1 – 3	1 – 2
Moderate insecurity	4 – 7	3 – 4
Severe insecurity	8 – 12	5 – 6

(a) Number of affirmative responses on the questions of the EMSA scale shown in Table 1 (CONEVAL 2010:26)

Table 3 shows that, by applying the EMSA scale to rural households in localities with 500 to 2,499 inhabitants, in 2013 about one-sixth of the households should be considered as severely food insecure, indicating that, due to a lack of money, at least one person in the household felt hungry but could not eat, or was forced to skip one or more meals. In 2015, one-tenth of the households were classified as severely food insecure. On the other hand, in both years just over half of the households is considered to be food secure. Although the proportion of food secure households is slightly smaller in localities that were targeted by the Crusade Against Hunger policy, this does not result in a larger share of severely food insecure households but is mainly reflected by higher numbers of mildly and moderately food insecure households.

Table 3 Severity of Food Insecurity in Rural Households [a]

	Number of households	%	(Crusade)	(non-Crusade)
2013				
Security	1,863,237	50.73	44.62	53.94
Mild insecurity	744,913	20.28	24.35	18.14
Moderate insecurity	471,897	12.85	15.95	11.22
Severe insecurity	593,091	16.15	15.08	16.71
Total	3,673,139	100	34.47	65.53
2015				
Security	1,848,338	51.54	48.92	52.92
Mild insecurity	901,823	25.15	25.58	24.92
Moderate insecurity	464,329	12.95	14.75	12.00
Severe insecurity	371,814	10.37	10.75	10.17
Total	3,586,305			

(a) Scores on the EMSA scale, households in rural areas (<2,500 inhabitants)
Source: Authors' calculations based on ENCHOR 2013 and 2015. The numbers for 2013 reproduce CONEVAL (2015: p.152, Table 28).

3.2 Information Regarding Migration and Remittances

Crucial for our analysis is the information regarding migratory flows in general and the remittances sent by the migrants in particular. The ENCHOR questionnaires contain a set of questions in which, for each household member, labor experiences outside the locality during the 12 months before the survey date are registered. Everyone living in the respondent's house as well as all the children of the household head and their spouse not living in the same house is considered to be a household member.

For each household member that stated to have worked outside the locality of origin, questions about the value of the remittances sent by the migrants were asked, while differentiating between work in Mexico and work in the US. In particular, questions regarding three types of remittances were asked: (1) money sent or brought for investments such as savings, purchase of animals, house or business for the migrant him/herself; (2) money sent or brought for the household; and (3) the value of the things that were sent or brought such as clothes and electronic devices.

For our analysis, we group the three types of remittances together, and distinguish only between internal and international remittances. Moreover, given the wide variation in the monetary values received as well as incomplete information regarding the precise monetary value of the remittances, the analysis will focus on the reception of remittances irrespective of the monetary amount. Hence, for each household we construct three binary indicators: having received remittances from within Mexico, from outside Mexico (essentially, from the US), and an indicator that combines the two previous indicators: having received remittances either from within or from outside Mexico.

Table 4 shows that the share of households reporting members working elsewhere, during at least one month in the previous 12 months, dropped from 25.2% in 2013 to 16.1% in 2015; in both years, about three-quarters of those report members working within Mexico and about one quarter report international migrants (with rather few households reporting both types).[6] Not all migrant-sending households receive remittances from their members working elsewhere. Table 4 shows that in 2013 only about 14.2% of the households received remittances, a number that dropped to 6.2% in 2015.[7] Especially for households with members working elsewhere in

[6] The rather large reduction in the number of households sending migrants (and also receiving remittances) is consistent with the locality-level migration reports (see Table 6). For the estimation of the model parameters (see the following sections), it seems to have minor consequences: we cannot reject the hypothesis that parameters in both years are equal.

[7] The shares are 16.0% and 8.5%, respectively, if missings are considered as a positive amount of remittances. At individual level, for each household member with a migration history, the monetary value of the remittances sent home was asked, with the instruction to reply '0' if no remittances had been sent and '888' if the amount was not known. This may suggest that a 'missing' should be considered as a positive amount, but we cannot rule out that not only the amount is unknown by the respondent – who may be a different person than the migrant themselves – but also that it is unknown whether remittances have been sent at all. Aggregation to the household level largely

Mexico, the share receiving remittances is rather low; international migrants seem to be more inclined to send remittances.

Table 4 Descriptive Statistics, Migration and Remittances, Past 12 Months

	2013	***2015***
National		
At least one HH member working in another town	0.195	0.124
Remittances sent or brought (missings: no) [a]	0.096	0.036
Remittances sent or brought (missings: yes)	0.108	0.054
International		
At least one HH member working in the US	0.079	0.048
Remittances sent or brought (missings: no)	0.053	0.028
Remittances sent or brought (missings: yes)	0.060	0.034
Total		
At least one HH member working elsewhere	0.252	0.161
Remittances sent or brought (missings: no)	0.142	0.062
Remittances sent or brought (missings: yes)	0.160	0.085
Number of households	2530	2400

(a) The rows "missings: no" treat incomplete information as if no remittances had been received, while the rows "missings: yes" assume that unreported but positive amounts of remittances were received. See footnote 7.
Source: Authors' calculations based on ENCHOR-2013 and 2015.

3.3 Other Relevant Information

Whilst we are primarily interested in understanding the impact of remittances on food insecurity, we have to account for confounding factors that help to explain the observed food insecurity levels. In order to do so, in the analysis we will account for household-level sociodemographic and economic information, as well as several for locality-level indicators. In particular, we account for the gender and age of the household head – about 19% female, on average 49 years old (Table 5) – as well as the marital status and household composition (number of persons aged under 12, between 12 and 65, and over 65, living in the household during at least one of the last 12 months). Other sociodemographic information included as determinants for food insecurity are an indicator of indigenous roots of the household head, the highest level of education attained by an adult female household member, and the (self-reported) health status of the household head – factors of known relevance for food preparation capabilities. About 20% of the households report speaking an indigenous language, while educational levels are relatively equally spread over the four categories (Table 5). The economic situation of the household has also been shown to be a crucial determinant of food insecurity. Therefore we include information regarding the household head's labor status, whether the household benefits from government programs, makes use of formal or informal credits, owns land as indicators of the household's well-being, along with several dwelling characteristics and the household's consumptive

resolves the problem because one positive amount is sufficient to guarantee a 'yes', but as Table 4 shows, not for all household the issue is resolved.

expenditures. Moreover, we control for determinants of the general (economic) development of the locality, such as the number of natural disasters that have hit the locality,[8] the availability of informal credit services, and the number of schools in the locality.[9]

Table 5 Descriptive Statistics of Explanatory Variables (Household Heads) [a]

	2013		***2015***	
	mean	st.dev.	mean	st.dev.
Female	0.192	0.394	0.194	0.396
Age	49.65	16.49	49.37	15.77
Married / cohabiting	0.804	0.397	0.787	0.409
Househ. comp.: No. of children 0-11	0.973	1.154	0.805	1.029
Househ. comp.: No. of persons aged 12 - 65	2.799	1.639	2.904	1.699
Househ. comp.: No. of elderly (65 or older)	0.344	0.645	0.288	0.592
Speaks indigenous language	0.198	0.399	0.230	0.421
Educ.Fem.: incompl, prim. [REF.CAT.]	0.198	0.399	0.229	0.420
Educ.Fem.: primary	0.214	0.410	0.238	0.426
Educ.Fem.: lower secondary	0.285	0.451	0.244	0.430
Educ.Fem.: more than lower secondary	0.303	0.460	0.282	0.450
Health status: good [REF.CAT.]	0.583	0.493	0.670	0.470
Health status: regular	0.342	0.474	0.276	0.447
Health status: poor	0.075	0.264	0.054	0.225
Working locally, agricultural activ.	0.307	0.461	0.321	0.467
Working locally, non-agricult. activ.	0.311	0.463	0.313	0.464
Income from government program(s)	0.498	0.500	0.413	0.492
Formal credit received	0.062	0.240	0.048	0.214
Informal credit received	0.025	0.157	0.021	0.144
Household owns land, plots	0.300	0.458	0.357	0.479
Size of land, plots (Ha.)	0.00013	0.00078	0.00218	0.01169
House: number of romos	2.804	1.449	2.786	1.334
House: outside bathroom	0.349	0.477	0.309	0.462
House: no piped water	0.211	0.408	0.166	0.372
House: firewood used for cooking	0.264	0.441	0.316	0.465
Monthly total cons. exp. (1000 pesos)	4.165	3.755	4.892	4.466
Loc.: Number of natural disasters	3.552	1.773	2.025	1.725
Loc.: Informal credits available	0.521	0.500	0.283	0.451
Loc.: No. of elementary schools	1.270	0.660	1.077	0.439
Loc.: No. of lower-secondary schools	0.756	0.487	0.799	0.453
Loc.: No. of higher-secondary schools	0.308	0.462	0.311	0.475

Source: Authors' calculations based on ENCHOR 2013 and 2015.

[8] Drought, heavy rain or flooding, severe freeze, pests or plagues, earthquake, hurricane or storms, heavy hail storm, fire, polluted water.

[9] An indicator 'locality targeted by the Crusade Against Hunger policy' had no explanatory power and is therefore not included in the analysis.

4 Methodology

In order to identify the impact of receiving remittances on food insecurity, we have to be aware that causality may run in both directions, in the same way that relations between remittances and poverty, labor supply, and human capital are endogenous (Azizi, 2018; Adams, 2011). In particular, not only are the remittances expected to have an impact on food security – the remittances can be used to purchase food and thereby reduce food insecurity – but also we can expect that food-insecure households may be willing to let members go elsewhere in search of increased resources, which would imply a positive correlation between food insecurity and remittances. The data show the cumulative outcome of the two opposing effects. Our challenge is to disentangle the two effects, and identify the impact of remittances on food insecurity.

We resume to instrumental variable techniques for the identification of the impact of remittances on food insecurity: techniques that take into account that the migration decision and therefore the reception of remittances by the household is endogenous with regard to the food security status. Key for the validity of this approach is that we have (exogenous) variables that are strongly correlated with the endogenous variable of interest (the reception of remittances), but that do not have a direct effect on the household's food security status. Variables that typically qualify as instrumental variables are formed by information at a higher aggregate level, in this case, locality-level information. In our case, in particular, information on general migration rates in the localities or municipalities at hand can be expected to explain the migration and more precisely remittance-receiving within individual households, while we may expect that the aggregate migration flows have no direct impact on the food insecurity of individual households.[10]

Information regarding migration flows is available from the ENCHOR survey and from the *National Population Council* (CONAPO). The ENCHOR questionnaire asks, from a knowledgeable informant in each locality, if there are people born in the locality who are now living in the US or in other parts of Mexico. This gives rise to two binary migration indicators at locality level, but does not give information about the number or share of migrants. Much more detail is provided by the Migration Intensity Index published by CONAPO, an index that, for each municipality in Mexico, measures the intensity of international migration combining information about remittances, migrants living in the US, circular and return migrants.[11] Similarly, based on the Census of 2010, CONAPO provides a matrix with the origins and destinations of inhabitants of each municipality in 2005 and 2010.[12] We use this matrix to calculate, for each municipality in our database, the share of inhabitants in 2005 who five years

[10] Note that locality-level information that directly affects overall poverty levels may be expected to affect individual households' poverty and food insecurity, and hence do not constitute valid instrumental variables; instead, as discussed in the previous section, such variables are directly included in the models.

[11] Available from http://omi.gob.mx/es/OMI/Datos_Abiertos, "Por municipio 2010" (downloaded 29 Oct 2018). See https://www.gob.mx/conapo/documentos/indice-absoluto-de-intensidad-migratoria and CONAPO (2014) for details about the construction of the index.

[12] See http://www.conapo.gob.mx/es/CONAPO/Descargas, "Matriz intermunicipal 2010" (accessed 22 Apr 2019).

later were reported to be living in another municipality. This approximates the migration out of a municipality to other places in Mexico, and thus the probability that remittances will be sent to the municipality of origin.[13] Table 6 shows the descriptive statistics of the proposed instrumental variables. Interestingly, the share of localities with people living elsewhere dropped between 2013 and 2015; for the CONAPO-based indices such temporal variation is not visible because they are based on the same underlying information (and only differ because different municipalities are surveyed in the two years).

Table 6 Descriptive Statistics of Instrumental Variables [a]

		2013			***2015***	
	no. obs.	mean	st.dev.	no. obs.	mean	st.dev.
Migration Intensity Index 2010	2530	3.395	3.238	2400	3.520	3.152
Share migration to other municipalities	2530	0.078	0.193	2400	0.072	0.177
People from locality now living in the US [b]	2530	0.838	0.369	2400	0.750	0.433
People from locality now living elsewhere in Mexico [b]	2530	0.809	0.393	2400	0.644	0.479

(a) Municipality and locality-level information.
(b) Binary indicator at locality level.
Source: Authors' calculations based on ENCHOR-2013 and 2015 and on CONAPO publications.

4.1 Empirical framework

Although in principle, the estimation of an instrumental variable model is rather standard, our dependent variable and our endogenous variable imply that we are in a non-standard situation. Our dependent variable, food insecurity, is measured on a four-point scale, instead of a continuous variable. Moreover, the distances between the four values are rather arbitrarily determined, suggesting we need a model appropriate for an ordered dependent variable. Regarding the endogenous variable, reception of remittances, we saw in the previous section that it a binary variable (constructed as remittances being received or not), where the standard IV model is designed for a continuous endogenous variable. In the specification of the first stage equation, which explains remittances using all (included and excluded) instruments, we may want to account for the binary nature of the endogenous variable.

For these reasons, we specify the likelihood function of a model that accounts for the respective ordered and binary nature of the main variables. Essentially, the model consists of two equations. The first describes the relation of prime interest and connects the observed level of food insecurity (FI_{it}) to the binary remittances indicator (R_{it}) and a vector of other determinants of the food insecurity level ($\boldsymbol{X}_{it}$) through the use of a latent continuous variable FI^*_{it} that can be interpreted as the propensity to be food insecure:

$$FI^*_{it} = \delta R_{it} + \boldsymbol{\alpha}' \boldsymbol{X}_{it} + \varepsilon_{it}, \quad (1)$$

[13] Note that we do not know if the out-migration considered complete households, or individuals who may later send remittances back home. Moreover, inflow from or outflow to other countries is not reflected in the matrix.

with

$$FI_{it} = k \quad \text{if} \quad m_{k-1} \leq FI^{*}_{it} < m_k \quad \text{for } k=1, 2, 3, 4$$

where the values of the cut-off points m_k (k=1, 2, 3) have to be estimated along with the parameter of interest δ and the vector of parameters $\boldsymbol{\alpha}$ while $m_0 = -\infty$ and $m_4 = \infty$. In a similar fashion, the second equation links the binary remittance reception to the same vector of determinants of food insecurity as well as the vector of instrumental variables $\boldsymbol{Z}_{it}$ through the use of a latent continuous variable R^{*}_{it}:

$$R^{*}_{it} = \boldsymbol{\beta}' \boldsymbol{X}_{it} + \boldsymbol{\gamma}' \boldsymbol{Z}_{it} + \eta_{it}, \tag{2}$$

with

$$R_{it} = 0 \quad \text{if} \quad R^{*}_{it} < 0 \text{ (no remittances received)}$$

$$= 1 \quad \text{if} \quad R^{*}_{it} \geq 0 \text{ (household receives remittances).}$$

where the cut-off point is normalized to 0. This gives rise to the following straightforwardly specified loglikelihood function:

$$\log L = \sum_{t=2013}^{2015} \sum_{i=1}^{N_i} \sum_{k=1}^{4} \sum_{r=0}^{1} D_{it,kp} \log Pr\,[FI_{it} = k, R_{it} = \mathrm{r}], \tag{3}$$

where $D_{it,kr}$=1 if FI_{it}=k and R_{it}=r, y $D_{it,kr}$=0 otherwise, and Pr[FI_{it}=k, R_{it}=r] is the probability that household i (observed in year t) registers a food insecurity level equal to k (with k=1, 2, 3, 4) and remittance reception r (with r = 0 or 1). Assuming a standard bivariate normal distribution for the error terms ε_{it} and η_{it} implies that we can estimate the model with recent versions of the user-written Stata command `cmp` (Roodman, 2011).

Given the model estimates, following Zhang et al. (2009) and Stabridis and Van Gameren (2018) we can calculate predicted probabilities for each level of food insecurity and remittance reception, and we can use these to mimic treatment effects of remittances on food insecurity:

$$Effect_{Remitt.-on-Food\ insec.\ level\ k} = \hat{P}(FI = k \,|R = 1; \boldsymbol{X}) - \hat{P}(FI = k \,|R = 0\,; \boldsymbol{X}), \tag{4}$$

with

$$\hat{P}(FI = k \,|R = 1; \boldsymbol{X}) = \frac{\hat{P}(FI = k, R = 1; \boldsymbol{X})}{\sum_{r=0,1} \hat{P}(FI = k, R = r; \boldsymbol{X})}$$

$$\hat{P}(FI = k \,|R = 0; \boldsymbol{X}) = \frac{\hat{P}(FI = k, R = 0; \boldsymbol{X})}{\sum_{r=0,1} \hat{P}(FI = k, R = r; \boldsymbol{X})}$$

for k=1, 2, 3, 4; that is, for the four different levels of food insecurity that are distinguished, and for receiving (depending on the model that is used, internal, international, or any kind of) remittances (R=1) or not receiving them (R=0). Probabilities are calculated for each observation

in the sample using the actually observed values of other characteristics $\boldsymbol{X}$ and then averaging them over all observations.

5 Results

As indicated in Section 3.2, we estimate the model presented in the previous section separately for remittances received from the US and for those from other parts of Mexico, as well as for the total (receiving remittances, regardless of origin).[14]

Before we discuss the results and the implications of the estimation of the models specified by equations (1) and (2), we briefly review the quality and the validity of the instrumental variables. Given that exact tests of the IVs in that model are not straightforward to calculate, we present and discuss indicative tests obtained from a standard IV/2SLS model, under the assumption that if these tests suggest the (in)validity of the IVs then we can expect the same (in)validity in the correctly specified model. Table 7 shows the results of the tests. The relevant CONAPO measurements are used to identify international, internal, and total remittances, respectively, while the locality-level binary indicator of international migration is also included; its internal counterpart did not add to the strength of the identification.[15] The IVs are significant in the explanation of the reception of remittances: the underidentification tests are clearly passed. The overidentification test suggests that the IVs are valid as instruments, that is, that they can be excluded from the main equation. The hypothesis of weak instruments is clearly rejected for international remittances, while for internal and total remittances the rejection is slightly less strong. The final test in Table 7 rejects the exogeneity of remittances; although for internal remittances only the rejection is on the margin. Taken together, we conclude that the use of IV technique is necessary, and that the proposed IVs are valid.

The results of the estimation of the model stipulated by equations 1 and 2, using the likelihood function in equation 3 and the instruments analyzed in Table 7, are shown in Table 8. The main results show that receiving remittances (or more precisely, a higher propensity to receive remittances) in a household reduces food insecurity. The impact of remittances received from the US appears to be larger than the impact of remittances from other parts of Mexico, while the impact of the combined indicator is in between the two origin-specific indicators.

[14] We estimate the model both considering missings as not having received remittances (shown in this Section) as well under the assumption that they stand for unreported but positive amounts of remittances (see Appendix B).
[15] Also frequently used identifying variables such as distance to the US border and access to the railway network were found to be invalid; they appear to approximate poverty and directly explain food insecurity.

Table 7 Indicative Instrumental Variable Tests

	International	Internal	Total
Instrumental variables [a]c			
Migration Intensity Index 2010	yes	no	yes
Share migration to other municipalities	no	yes	yes
People from locality now living in the US	yes	yes	yes
Underidentification test (F test of excluded instruments)	19.872	15.546	18.208
H_0: instruments are jointly irrelevant in first stage	0.0000	0.0000	0.0000
Overidentification test (Hansen J statistic)	0.452	0.902	1.240
H_0: exclusion restrictions of instruments are valid	0.5013	0.3422	0.5378
Underidentification test (Kleibergen-Paap rk LM Statistic)	37.863	30.779	53.638
H_0: model is underidentified, instruments are not good	0.0000	0.0000	0.0000
Weak identification test (Cragg-Donald Wald F statistic)	40.865	12.403	17.796
H_0:weakly identified system	[b]	[b]	[c]
Endogeneity test of endogenous regressors	5.548	2.598	5.952
H_0: variables can be considered as exogenous	0.0185	0.1070	0.0147

(a) Other explanatory variables as in Table 5.
(b) Stock-Yogo weak ID test critical values: 10% maximal IV size 19.93, 15% maximal IV size 11.59
(c) Stock-Yogo weak ID test critical values: 5% maximal IV relative bias 13.91, 10% maximal IV relative bias 9.08. 10% maximal IV size 22.30, 15% maximal IV size 12.83

The other variables used in the explanation of the reported food security level largely behave in accordance with the literature: variables that serve as poverty or deprivation indicators increase the observed food insecurity. This includes variables related to the household size (where we find that mainly children and working-age adults but not the number of elderly matter), low levels of education, worse health status of the household head, a head working locally in agricultural activities, receiving support from government programs, and making use of credits come with increased levels of food insecurity. On the other hand, land ownership, living in a house with more rooms, and with a toilet, indicate a better living status and that gets reflected in reduced levels of food insecurity, while absence of electricity and usage of firewood for cooking coincide with higher levels of food insecurity. Worth mentioning is the relevance of having an indigenous background, a variable commonly found as an indicator of a more food-insecure situation. In our sample of rural households, such an effect is found when we analyze the internal remittances but not when (only) the international remittances are considered. This suggests that indigenous households with members in the US better manage to benefit from the remittances and overcome the drawbacks often observed for those with indigenous roots.

Also regarding the determinants of receiving remittances we see the patterns that commonly arise in the literature, although there are interesting differences between the probabilities of receiving internal or international remittances. For example, the age and marital status of the household head matter primarily for international remittances but do not explain the probability of receiving internal remittances. A larger number of young children increases internal remittances but does not predict international ones, while a larger number of working-age household members reduces international remittances without affecting internal ones. Higher levels of education increase remittance reception (with a more pronounced effect on international

remittances), while speaking an indigenous language increases the probability to receive internal remittances. A household head working locally, either in agricultural or non-agricultural activities, reduces the probability that other household members have migrated and sent remittances, again with a more pronounced effect on international remittances. Interesting is the quasi-irrelevance of the poverty and deprivation indicators for the reception of international remittances, while they are important (in the same direction as their influence on food insecurity) for the propensity to receive internal remittances: poorer economic conditions lead to more internal migrants and remittances.

Important to note is that various factors explain both the food security level as well as the propensity to receive (internal and international) remittances. This suggests that the decisions should not be seen and analyzed in isolation (as in Appendix Table A.1 where hardly any relevance of remittances for food security is found). In contrast, an integrated explanatory model as estimated in Table 8 is necessary in order to better understand the joint phenomena of food security and remittances.

Table 8 IV Models for Food Insecurity and Remittances

	International		Internal		Total	
	Food Insec.	Remitt.	Food Insec.	Remitt.	Food Insec.	Remitt.
Remittances from the US	-0.967***					
	(0.290)					
Remittances from elsewhere in Mexico			-0.562**			
			(0.283)			
Remittances received (from US or Mexico)					-0.831***	
					(0.210)	
Female	0.079	0.038	0.070	-0.007	0.075	0.039
	(0.071)	(0.126)	(0.071)	(0.113)	(0.070)	(0.097)
Age	0.010	0.031**	0.006	-0.013	0.008	0.008
	(0.007)	(0.016)	(0.007)	(0.012)	(0.007)	(0.011)
Age squared	-0.000	-0.000*	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Married / cohabiting	-0.102	0.396***	-0.130*	0.120	-0.099	0.260***
	(0.071)	(0.133)	(0.070)	(0.115)	(0.070)	(0.099)
Househ. comp.: No. of children 0-11	0.070***	-0.050	0.079***	0.072**	0.078***	0.033
	(0.018)	(0.043)	(0.018)	(0.030)	(0.018)	(0.027)
Househ. comp.: No. of persons aged 12 - 65	0.051***	-0.102***	0.061***	0.020	0.053***	-0.029
	(0.014)	(0.030)	(0.014)	(0.022)	(0.014)	(0.020)
Househ. comp.: No. of elderly (65 or older)	0.046	-0.119	0.046	-0.088	0.041	-0.087
	(0.047)	(0.096)	(0.047)	(0.082)	(0.047)	(0.069)
Speaks indigenous language	0.044	0.166	0.065	0.287***	0.075	0.285***
	(0.052)	(0.116)	(0.054)	(0.093)	(0.053)	(0.084)
Educ.Fem.: primary, incompl. lower sec.	-0.069	0.293**	-0.079	0.173*	-0.059	0.208**
	(0.054)	(0.137)	(0.054)	(0.097)	(0.054)	(0.087)
Educ.Fem.: complete lower secondary	-0.153***	0.461***	-0.172***	0.252**	-0.139**	0.314***
	(0.054)	(0.132)	(0.054)	(0.099)	(0.055)	(0.087)
Educ.Fem.: (some) upper secondary or more	-0.212***	0.520***	-0.237***	0.239**	-0.198***	0.352***
	(0.058)	(0.132)	(0.057)	(0.103)	(0.058)	(0.090)
Health status: regular	0.223***	0.090	0.213***	0.042	0.216***	0.056
	(0.040)	(0.089)	(0.040)	(0.070)	(0.040)	(0.061)
Health status: por	0.335***	-0.089	0.357***	0.212*	0.349***	0.094
	(0.073)	(0.160)	(0.074)	(0.128)	(0.072)	(0.112)
Working locally, agricultural activ.	0.163***	-0.461***	0.177***	-0.246***	0.142***	-0.326***
	(0.042)	(0.108)	(0.042)	(0.078)	(0.044)	(0.069)

Working locally, non-agricult. activ.	0.092**	-0.720***	0.122***	-0.302***	0.066	-0.501***
	(0.046)	(0.122)	(0.044)	(0.083)	(0.048)	(0.074)
Income from government program(s)	0.097**	0.021	0.103**	0.119	0.107***	0.074
	(0.040)	(0.089)	(0.040)	(0.076)	(0.040)	(0.066)
Household received formal credit	0.178**	0.005	0.164**	-0.161	0.159**	-0.079
	(0.076)	(0.165)	(0.076)	(0.159)	(0.075)	(0.128)
Household received informal credit	0.301***	-0.050	0.306***	0.160	0.318***	0.169
	(0.095)	(0.240)	(0.095)	(0.184)	(0.098)	(0.168)
Household owns land, plots	-0.089**	0.067	-0.078*	0.216***	-0.068	0.183***
	(0.044)	(0.096)	(0.044)	(0.075)	(0.044)	(0.067)
Size of land, plots (10,000 Ha.)	-14.409**	17.435	-15.665***	-17.821**	-16.258***	-16.325**
	(5.642)	(24.385)	(5.640)	(8.618)	(5.528)	(7.554)
Size of land, plots (10,000 Ha.) squared	99.770*	-432.788	110.127**	143.730***	114.635**	128.719**
	(53.492)	(360.728)	(52.444)	(49.828)	(51.655)	(52.343)
House: number of rooms	-0.082***	0.021	-0.083***	0.014	-0.080***	0.014
	(0.016)	(0.029)	(0.016)	(0.025)	(0.016)	(0.022)
House: outside bathroom	0.154***	-0.235**	0.179***	0.193***	0.174***	0.065
	(0.042)	(0.098)	(0.042)	(0.074)	(0.042)	(0.065)
House: no piped water	-0.061	0.230**	-0.056	0.137*	-0.040	0.186***
	(0.044)	(0.106)	(0.046)	(0.072)	(0.045)	(0.067)
House: firewood used for cooking	0.279***	-0.143	0.301***	0.124	0.291***	0.057
	(0.047)	(0.110)	(0.046)	(0.078)	(0.046)	(0.071)
State: BC, BCS, Son, Chih	0.158	0.034	0.091	-0.321*	0.075	-0.322**
	(0.115)	(0.231)	(0.122)	(0.170)	(0.119)	(0.154)
State: Sin, Dur	-0.192*	-0.079	-0.267**	-0.895***	-0.299**	-0.751***
	(0.111)	(0.241)	(0.121)	(0.176)	(0.117)	(0.174)
State: Coah, N.L., Tamps	0.865***	-0.380	0.795***	-1.163***	0.727***	-1.042***
	(0.110)	(0.304)	(0.124)	(0.215)	(0.121)	(0.187)
State: Jal, Col, Nay	0.336***	0.377**	0.208*	-0.407**	0.228**	-0.220
	(0.102)	(0.187)	(0.107)	(0.158)	(0.101)	(0.135)
State: Guerr, Mich	0.586***	0.329*	0.464***	-0.715***	0.458***	-0.426***
	(0.078)	(0.172)	(0.092)	(0.135)	(0.083)	(0.115)
State: Zac, Ags, SLP	0.623***	-0.172	0.505***	-1.011***	0.491***	-0.753***
	(0.086)	(0.201)	(0.103)	(0.180)	(0.094)	(0.141)
State: Guan, Quer	0.005	0.087	-0.127	-0.949***	-0.114	-0.552***
	(0.083)	(0.183)	(0.095)	(0.151)	(0.084)	(0.121)
State: Hgo	0.547***	-0.245	0.450***	-0.490***	0.430***	-0.600***
	(0.105)	(0.265)	(0.116)	(0.178)	(0.111)	(0.178)
State: Pue, Tlax, Mor	0.033	-0.183	-0.012	-0.316***	-0.029	-0.352***
	(0.081)	(0.218)	(0.086)	(0.111)	(0.083)	(0.113)
State: Ver	0.134*	-0.160	0.106	-0.226**	0.086	-0.237**
	(0.077)	(0.214)	(0.080)	(0.110)	(0.079)	(0.105)
State: Tab	0.614***	-	0.561***	-1.595***	0.490***	-1.429***
	(0.092)		(0.107)	(0.448)	(0.105)	(0.415)
State: Oax	0.059	-0.405**	-0.032	-0.914***	-0.070	-0.897***
	(0.086)	(0.201)	(0.101)	(0.149)	(0.093)	(0.138)
State: Chis	0.055	-0.286	-0.048	-1.341***	-0.096	-1.176***
	(0.097)	(0.334)	(0.114)	(0.272)	(0.107)	(0.220)
State: Camp, Yuc, QRoo	-0.033	-0.211	-0.107	-0.648**	-0.150	-0.558**
	(0.140)	(0.433)	(0.148)	(0.265)	(0.142)	(0.246)
Monthly total cons. exp. (1,000 pesos)	-0.048***	0.013	-0.049***	-0.002	-0.047***	0.004
	(0.009)	(0.010)	(0.009)	(0.012)	(0.009)	(0.009)
Loc.: Number of natural disasters	0.018*	0.018	0.017*	0.002	0.015	-0.002
	(0.010)	(0.025)	(0.010)	(0.020)	(0.010)	(0.017)
Loc.: Informal credits available	-0.088**	0.056	-0.070*	0.160**	-0.058	0.154**
	(0.039)	(0.089)	(0.041)	(0.068)	(0.040)	(0.061)
Loc.: No. of elementary schools	-0.092**	0.005	-0.100**	-0.060	-0.092**	-0.022
	(0.040)	(0.079)	(0.040)	(0.074)	(0.040)	(0.062)
Loc.: No. of lower-secondary schools	-0.060	0.034	-0.064	0.001	-0.060	0.016
	(0.041)	(0.100)	(0.041)	(0.074)	(0.041)	(0.066)
Loc.: No. of higher-secondary schools	-0.246***	-0.165	-0.238***	0.001	-0.246***	-0.085
	(0.046)	(0.114)	(0.046)	(0.091)	(0.046)	(0.078)

Migration Intensity Index 2010		0.092***				0.047***
		(0.015)				(0.011)
Share migration to other municipalities				0.984**		0.681
				(0.449)		(0.436)
People from locality now living in the US		0.270*		0.359***		0.354***
		(0.140)		(0.088)		(0.081)
Observation from 2015	-0.094**	-0.311***	-0.097**	-0.374***	-0.129***	-0.388***
	(0.041)	(0.094)	(0.042)	(0.074)	(0.043)	(0.065)
Constant		-3.283***		-1.431***		-1.746***
		(0.510)		(0.365)		(0.329)
Cut-off point 1 (m_1)	0.210		0.067		0.064	
	(0.201)		(0.206)		(0.202)	
Cut-off point 2 (m_2)	0.888***		0.746***		0.730***	
	(0.201)		(0.208)		(0.205)	
Cut-off point 3 (m_3)	1.417***		1.276***		1.251***	
	(0.202)		(0.211)		(0.207)	
Correlation between food insec. and remitt.	0.431***		0.309**		0.432***	
	(0.147)		(0.145)		(0.115)	
Observations	4,863		4,863		4,863	
Chi2 Test	1174		1182		1309	
p-value Chi2	0		0		0	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table 9 shows the predicted probabilities of each of the four food insecurity levels (see Eq. 4), based on an ordered probit model considering remittances as exogenous (estimates shown in Appendix Table A.1) in Columns 1-3 and those based on the preferred model that considers remittances as endogenous (shown in Table 8) in Columns 4-6.

If remittances were exogenous (refuted by the test results in Table 7), than the impact on food insecurity would be significant but small for international remittances. The number of food secure households would increase 6.09 percentage points (pp) from 50.90% to 56.99%, while the number of severely food insecure households drops from 13.46% to 10.42% (–3.04 pp). For internal remittances, essentially no effect is found: the changes are even smaller.

However, the picture changes when we account for the fact that migration decisions, and more precisely the sending of remittances, are endogenous decisions. The impact of international remittances is much stronger, raising the share of food secure households by 30.65pp, while also it almost eradicates severe food insecurity (a decrease from 14.27% to 2.69% of the households). Importantly, internal remittances also strongly increase the share of food secure households when we account for the endogeneity of remittance-sending decisions: a change from 49.81% to 68.92% of the households being food secure implies an increase of 19.10 pp. The change in the number of severe food insecure households is also substantial, although not as strong as when international remittances are received.

Table 9 Probabilities of Food Insecurity Levels, Treatment Effects

		Exogenous			Endogenous		
		without remitt.	with remitt.	difference (treatm. eff.)	without remitt.	with remitt.	difference (treatm. eff.)
International remittances							
Security	prob.	0.5090	0.5699	0.0609	0.4972	0.8037	0.3065
	st.dev.	0.1855	0.1832	0.0099	0.1810	0.1311	0.0661
Mild insecurity	prob.	0.2269	0.2136	-0.0133	0.2277	0.1239	-0.1037
	st.dev.	0.0454	0.0527	0.0145	0.0424	0.0640	0.0502
Moderate insecurity	prob.	0.1295	0.1123	-0.0172	0.1325	0.0455	-0.0870
	st.dev.	0.0521	0.0530	0.0059	0.0500	0.0368	0.0246
Severe insecurity	prob.	0.1346	0.1042	-0.0304	0.1427	0.0269	-0.1158
	st.dev.	0.1083	0.0921	0.0170	0.1090	0.0339	0.0770
Internal remittances							
Security	prob.	0.5120	0.5048	-0.0071	0.4981	0.6892	0.1910
	st.dev.	0.1860	0.1860	0.0011	0.1851	0.1668	0.0348
Mild insecurity	prob.	0.2261	0.2273	0.0013	0.2265	0.1739	-0.0526
	st.dev.	0.0459	0.0450	0.0018	0.0435	0.0636	0.0397
Moderate insecurity	prob.	0.1287	0.1306	0.0020	0.1321	0.0779	-0.0542
	st.dev.	0.0523	0.0521	0.0008	0.0510	0.0486	0.0162
Severe insecurity	prob.	0.1333	0.1372	0.0039	0.1432	0.0590	-0.0842
	st.dev.	0.1081	0.1100	0.0020	0.1122	0.0623	0.0517
Total remittances							
Security	prob.	0.5092	0.5311	0.0219	0.4808	0.7557	0.2749
	st.dev.	0.1859	0.1855	0.0035	0.1805	0.1463	0.0523
Mild insecurity	prob.	0.2267	0.2224	-0.0043	0.2268	0.1452	-0.0816
	st.dev.	0.0455	0.0481	0.0054	0.0398	0.0638	0.0499
Moderate insecurity	prob.	0.1295	0.1234	-0.0061	0.1362	0.0591	-0.0771
	st.dev.	0.0522	0.0527	0.0023	0.0482	0.0417	0.0212
Severe insecurity	prob.	0.1347	0.1232	-0.0115	0.1563	0.0401	-0.1162
	st.dev.	0.1086	0.1028	0.0062	0.1149	0.0456	0.0714

Weighted averages of the probabilities that were calculated for all households in the sample using their observed characteristics while setting remittances equal to 0 or 1 in the columns headed with or without remittances, respectively. The difference can be interpreted as the "treatment effect" of remittances.

The difference between the estimates considering remittances as exogenous and the estimates accounting for the fact that remittances are endogenous is large, especially when internal remittances are considered. This suggests that there is an important migration selection effect that implies that households that were more likely to benefit from migration (those already relatively better-off regarding food security), were more likely to send migrants and receive remittances, which helped to reduce food insecurity. Not separating the effect of background characteristics on the explanation of the migration and remittance decision from their effects on food security hides the impact remittances have on food insecurity. We observe that several variables, for example, low educational level of the women in the household, reduce the reception of remittances but are also directly associated with higher poverty, and through that channel with higher food insecurity. Their combined effect (in the exogenous model) suggests that remittances hardly help to resolve food insecurity. However, separating the effects on the two outcomes indicates that if a decision to migrate is taken, the remittances help to lighten the food insecurity issues in the households at hand. Taken together, our results suggest that food

insecurity could be further relieved if more households could benefit from the reception of remittances.

6 Conclusions

The high levels of food insecurity recorded by a large section of Mexico's rural households can be attributed to various factors: low wages, underdeveloped (labor and financial) markets, strong dependency on farming activities, and the lack of infrastructure typical of this sector. In spite of the above, remittance reception has allowed these households to overcome some of these limitations, and it is an activity that has increased in the last few decades.

These monetary resources are a vital source of income for receiving households as they provide sufficient liquidity to cover a variety of expenses, from educational services to the purchase of simple grocery items (food). In this study we showed evidence that remittances represent one of the most important sources of income for rural households, especially to counteract their food insecurity problems.

We employed an instrumental variable ordered probit regression to identify the impact of remittances on food insecurity for a sample of Mexican rural households taken in 2013 and 2015. Controlling for the endogeneity of remittances, we find that the impact of internal and international remittances is to reduce food insecurity, an effect that is statistically significant. Findings in this research also show that remittances decrease food insecurity in all its levels and increase the proportion of households with food security living in Mexico's rural sector. When distinguishing between the effects by remittance type (internal versus international), we observed that the impact of international remittances is greater than that attributed to internal remittances. These results are statistically reliable and imply that remittances make rural Mexican households more food secure; moreover, we identified that internal remittances significantly reduce the number of severe food-insecure households, and, even more importantly, international remittances almost eradicate severe food insecurity.

The above indicates that remittances are an essential element in improving food insecurity issues faced by a large part of Mexico's rural households. Despite the encouraging nature of these results, we want to emphasize that remittances should not be seen as a replacement for the obligations that the government has in eradicating the food insecurity and poverty experienced by a large number of Mexico's rural households.

According to the results of this study, remittances should be recognized and utilized as a key element of food security programs in developing countries. In order to increase the positive externalities of remittances, it would be recommendable to promote public policy measures aimed at decreasing the transaction costs associated with sending remittances. In addition, it would be desirable to encourage the creation of public programs to ensure the spending of remittances on higher-quality and more nutritious foods. These actions could fortify the positive

effects that remittances have on food security in countries like Mexico, some of the main recipients of international remittances.

Although this study provides statistically reliable evidence, it should be noted that some limitations prevail. Firstly, it would be highly desirable that information employed in this analysis would consist of panel data. However, as mentioned before, the limitations of databases available in Mexico hinder this task. Currently, no data can be obtained which would enable us to follow up on the same households over different time points and thus to extract more consistent conclusions regarding the dynamic between remittances and their effects on food insecurity. Secondly, by taking the analysis to a regional level we believe we could include elements that would enable us to identify the heterogeneity typical of remittance reception in the Mexican territory, a task that we intend to conduct in a future study in order to add elements that confirm or check out the results of this study. Nevertheless, neither of these limitations reduces the value of our findings. They do, however, point to the fact that this analysis is not exhaustive and that it could be strengthened by including alternative methodological approaches and, above all, those which use novel data with the purpose to improve these results.

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APPENDIX A. Estimations Considering Remittances as Exogenous

Table A.1 presents the results of the ordered probit regressions explaining food insecurity by the reception of remittances, considering the latter as an exogenous determinant. In contrast with the results shown in Table 8 where remittances are treated as an endogenous factor, a significant effect is reported only for international remittances while internal remittances show a small and insignificant but counterintuitive positive effect. Their combination is negative but insignificant, suggesting total remittances have no effect on food insecurity, but also suggesting that differentiation between internal and international remittances is crucial.

Table A.1 Food Insecurity and Remittances [a]

	International	Internal	Total
Remittances from the US	-0.173*		
	(0.097)		
Remittances from elsewhere in Mexico		0.020	
		(0.071)	
Remittances received (from US or Mexico)			-0.062
			(0.060)
Female	0.075	0.074	0.074
	(0.071)	(0.071)	(0.071)
Age	0.007	0.007	0.007
	(0.007)	(0.007)	(0.007)
Age squared	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Married / cohabiting	-0.130*	-0.135*	-0.133*
	(0.070)	(0.071)	(0.070)
Househ. comp.: No. of children 0-11	0.073***	0.073***	0.074***
	(0.018)	(0.018)	(0.018)
Househ. comp.: No. of persons aged 12 - 65	0.059***	0.060***	0.060***
	(0.014)	(0.014)	(0.014)
Househ. comp.: No. of elderly (65 or older)	0.051	0.052	0.051
	(0.047)	(0.047)	(0.047)
Speaks indigenous language	0.043	0.042	0.045
	(0.053)	(0.053)	(0.053)
Educ.Fem.: primary, incompl. lower sec.	-0.087	-0.090*	-0.088
	(0.054)	(0.054)	(0.054)
Educ.Fem.: complete lower secondary	-0.185***	-0.191***	-0.187***
	(0.053)	(0.053)	(0.053)
Educ.Fem.: (some) upper secondary or more	-0.247***	-0.253***	-0.250***
	(0.056)	(0.056)	(0.056)
Health status: regular	0.217***	0.214***	0.215***
	(0.040)	(0.040)	(0.040)
Health status: poor	0.345***	0.346***	0.347***
	(0.074)	(0.075)	(0.074)
Working locally, agricultural activ.	0.192***	0.198***	0.194***
	(0.040)	(0.040)	(0.040)
Working locally, non-agricult. activ.	0.138***	0.146***	0.141***
	(0.043)	(0.042)	(0.043)
Income from government program(s)	0.095**	0.094**	0.096**
	(0.040)	(0.040)	(0.040)
Household received formal credit	0.179**	0.179**	0.177**
	(0.076)	(0.077)	(0.076)
Household received informal credit	0.297***	0.295***	0.297***
	(0.093)	(0.092)	(0.092)
Household ownsland, plots	-0.095**	-0.097**	-0.095**
	(0.044)	(0.044)	(0.044)
Size of land, plots (10,000 Ha.)	-14.320**	-14.218**	-14.441**
	(5.698)	(5.704)	(5.699)

Size of land, plots (10,000 Ha.) squared	99.526*	98.895*	100.383*
	(53.742)	(53.775)	(53.708)
House: number of rooms	-0.086***	-0.086***	-0.086***
	(0.016)	(0.016)	(0.016)
House: outside bathroom	0.164***	0.165***	0.167***
	(0.042)	(0.042)	(0.042)
House: no piped water	-0.072	-0.074*	-0.072
	(0.044)	(0.044)	(0.044)
House: firewood used for cooking	0.294***	0.295***	0.296***
	(0.046)	(0.046)	(0.046)
State: BC, BCS, Son, Chih	0.147	0.149	0.140
	(0.116)	(0.117)	(0.117)
State: Sin, Dur	-0.192*	-0.188*	-0.199*
	(0.112)	(0.113)	(0.113)
State: Coah, N.L., Tamps	0.894***	0.900***	0.886***
	(0.110)	(0.111)	(0.111)
State: Jal, Col, Nay	0.278***	0.268***	0.263***
	(0.100)	(0.100)	(0.100)
State: Guerr, Mich	0.555***	0.549***	0.541***
	(0.078)	(0.078)	(0.078)
State: Zac, Ags, SLP	0.604***	0.602***	0.592***
	(0.086)	(0.087)	(0.087)
State: Guan, Quer	-0.036	-0.040	-0.049
	(0.081)	(0.082)	(0.082)
State: Hgo	0.529***	0.527***	0.518***
	(0.107)	(0.107)	(0.107)
State: Pue, Tlax, Mor	0.034	0.037	0.030
	(0.082)	(0.083)	(0.082)
State: Ver	0.140*	0.142*	0.137*
	(0.078)	(0.078)	(0.078)
State: Tab	0.647***	0.655***	0.641***
	(0.092)	(0.093)	(0.093)
State: Oax	0.060	0.064	0.050
	(0.086)	(0.087)	(0.087)
State: Chis	0.058	0.061	0.046
	(0.097)	(0.099)	(0.098)
State: Camp, Yuc, QRoo	-0.023	-0.017	-0.031
	(0.142)	(0.143)	(0.142)
Monthly total cons. exp. (1000 pesos)	-0.049***	-0.049***	-0.049***
	(0.009)	(0.009)	(0.009)
Loc.: Number of natural disasters	0.019*	0.019*	0.019*
	(0.010)	(0.010)	(0.010)
Loc.: Informal credits available	-0.090**	-0.091**	-0.088**
	(0.039)	(0.040)	(0.039)
Loc.: No. of elementary schools	-0.098**	-0.100**	-0.099**
	(0.040)	(0.040)	(0.040)
Loc.: No. of lower-secondary schools	-0.063	-0.063	-0.063
	(0.041)	(0.041)	(0.041)
Loc.: No. of higher-secondary schools	-0.240***	-0.238***	-0.239***
	(0.046)	(0.046)	(0.046)
Observation from 2015	-0.073*	-0.068*	-0.074*
	(0.040)	(0.040)	(0.040)
Cut-off point 1 (m_1)	0.171	0.164	0.154
	(0.201)	(0.201)	(0.201)
Cut-off point 2 (m_2)	0.857***	0.851***	0.840***
	(0.201)	(0.201)	(0.201)
Cut-off point 3 (m_3)	1.394***	1.386***	1.377***
	(0.202)	(0.202)	(0.202)
Observations	4,863	4,863	4,863
Chi2 Test	793.9	793.9	791.8
p-value Chi2	0	0	0

(a) Ordered probit models, considering remittances exogenous.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

APPENDIX B. Estimations Considering missings as Receiving Remittances

In the body of the text we addressed that for individual migrants who responded 'unknown' to the question regarding the monetary value of their remittances, we have interpreted the response as not having send remittances at all. However we can equally well argue that remittances have been send but that the precise monetary value is unknown. In this Appendix we follow that approach, and show that the outcomes are largely insensitive for the assumption that is made.

Table B.1 presents the indicative IV tests when considering missings as positive remittances. The tests are generally slightly stronger than the results shown in Table 7, and confirm the need to consider remittances as endogenous variables.

Table B.1 Indicative Instrumental Variable Tests

	International	National	Total
Instrumental variables [a]c			
Migration Intensity Index 2010	yes	no	yes
Share migration to other municipalities	no	yes	yes
People from locality now living in the US	yes	yes	yes
Underidentification test (F test of excluded instruments)	21.802	15.967	19.296
H_0: instruments are jointly irrelevant in first stage	0.0000	0.0000	0.0000
Overidentification test (Hansen J statistic)	0.092	0.738	1.853
H_0: exclusion restrictions of instruments are valid	0.7612	0.3902	0.3960
Underidentification test (Kleibergen-Paap rk LM Statistic)	42.233	31.592	56.782
H_0: model is underidentified, instruments are not good	0.0000	0.0000	0.0000
Weak identification test (Cragg-Donald Wald F statistic)	34.633	13.657	17.567
H_0: weakly identified system	[b]	[b]	[c]
Endogeneity test of endogenous regressors	5.627	2.838	5.291
H_0:variables can be considered as exogenous	0.0177	0.0921	0.0214

(a) Other explanatory variables as in Table 5.
(b) Stock-Yogo weak ID test critical values: 10% maximal IV size 19.93, 15% maximal IV size 11.59
(c) Stock-Yogo weak ID test critical values: 5% maximal IV relative bias 13.91, 10% maximal IV relative bias 9.08. 10% maximal IV size 22.30, 15% maximal IV size 12.83

Table B.2 presents the estimations of the model formed by equations (1) and (2) while treating unreported monetary values as positive remittances. The results are rather similar to those reported in Table 8, although the main results – the impact of remittances on food insecurity – seem slightly weaker but in the same order of magnitude.

Table B.2 IV Models for Food Insecurity and Remittances

	International		Internal		Total	
	Food Insec.	Remitt.	Food Insec.	Remitt.	Food Insec.	Remitt.
Remittances from the US	-0.896***					
	(0.291)					
Remittances from elsewhere in Mexico			-0.538**			
			(0.260)			
Remittances received (from US or Mexico)					-0.697***	
					(0.209)	

Female	0.079	0.032	0.071	-0.008	0.075	0.034
	(0.071)	(0.118)	(0.071)	(0.103)	(0.071)	(0.093)
Age	0.010	0.037**	0.006	-0.016	0.008	0.005
	(0.007)	(0.015)	(0.007)	(0.011)	(0.007)	(0.010)
Age squared	-0.000	-0.000**	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Married / cohabiting	-0.106	0.335***	-0.128*	0.105	-0.105	0.228**
	(0.071)	(0.124)	(0.070)	(0.104)	(0.070)	(0.093)
Househ. comp.: No. of children 0-11	0.071***	-0.026	0.078***	0.066**	0.078***	0.038
	(0.018)	(0.040)	(0.018)	(0.028)	(0.018)	(0.026)
Househ. comp.: No. of persons aged 12 - 65	0.052***	-0.092***	0.062***	0.033	0.056***	-0.013
	(0.014)	(0.029)	(0.014)	(0.021)	(0.014)	(0.020)
Househ. comp.: No. of elderly (65 or older)	0.045	-0.116	0.050	-0.026	0.046	-0.045
	(0.047)	(0.091)	(0.047)	(0.074)	(0.048)	(0.066)
Speaks indigenous language	0.043	0.132	0.071	0.333***	0.077	0.313***
	(0.052)	(0.116)	(0.054)	(0.085)	(0.053)	(0.079)
Educ.Fem.: primary, incompl. lower sec.	-0.066	0.327**	-0.083	0.078	-0.067	0.154*
	(0.054)	(0.133)	(0.053)	(0.093)	(0.054)	(0.085)
Educ.Fem.: complete lower secondary	-0.150***	0.504***	-0.169***	0.222**	-0.140**	0.319***
	(0.054)	(0.131)	(0.055)	(0.094)	(0.056)	(0.085)
Educ.Fem.: (some) upper secondary or more	-0.212***	0.519***	-0.231***	0.256***	-0.197***	0.366***
	(0.058)	(0.133)	(0.058)	(0.099)	(0.059)	(0.088)
Health status: regular	0.227***	0.128	0.217***	0.086	0.222***	0.096
	(0.040)	(0.085)	(0.040)	(0.065)	(0.040)	(0.059)
Health status: poor	0.335***	-0.113	0.356***	0.186	0.346***	0.065
	(0.074)	(0.154)	(0.074)	(0.118)	(0.073)	(0.106)
Working locally, agricultural activ.	0.164***	-0.451***	0.175***	-0.245***	0.149***	-0.328***
	(0.043)	(0.103)	(0.042)	(0.072)	(0.044)	(0.065)
Working locally, non-agricult. activ.	0.093**	-0.706***	0.124***	-0.230***	0.079*	-0.447***
	(0.046)	(0.116)	(0.044)	(0.076)	(0.048)	(0.070)
Income from government program(s)	0.097**	0.014	0.108***	0.156**	0.109***	0.091
	(0.040)	(0.084)	(0.040)	(0.069)	(0.040)	(0.062)
Household received formal credit	0.181**	0.020	0.164**	-0.138	0.166**	-0.054
	(0.077)	(0.168)	(0.076)	(0.139)	(0.075)	(0.121)
Household received informal credit	0.316***	0.080	0.296***	0.016	0.317***	0.141
	(0.097)	(0.215)	(0.094)	(0.178)	(0.098)	(0.161)
Household owns land, plots	-0.087**	0.089	-0.080*	0.165**	-0.071	0.168***
	(0.044)	(0.091)	(0.044)	(0.070)	(0.044)	(0.063)
Size of land, plots (10,000 Ha.)	-13.947**	18.322	-15.081***	-8.448	-15.414***	-8.882
	(5.627)	(17.644)	(5.564)	(7.113)	(5.503)	(6.890)
Size of land, plots (10,000 Ha.) squared	96.259*	-304.915	106.149**	75.587	108.469**	74.950
	(53.520)	(233.522)	(52.261)	(53.121)	(51.963)	(56.503)
House: number of rooms	-0.083***	0.016	-0.082***	0.037	-0.080***	0.025
	(0.016)	(0.028)	(0.016)	(0.023)	(0.016)	(0.021)
House: outside bathroom	0.150***	-0.266***	0.180***	0.204***	0.171***	0.065
	(0.042)	(0.096)	(0.042)	(0.070)	(0.042)	(0.063)
House: no piped water	-0.057	0.280***	-0.061	0.093	-0.046	0.168***
	(0.044)	(0.104)	(0.045)	(0.068)	(0.045)	(0.065)
House: firewood used for cooking	0.280***	-0.132	0.297***	0.076	0.289***	0.020
	(0.047)	(0.108)	(0.046)	(0.075)	(0.046)	(0.069)
State: BC, BCS, Son, Chih	0.155	0.053	0.093	-0.356**	0.084	-0.335**
	(0.116)	(0.232)	(0.121)	(0.169)	(0.119)	(0.152)
State: Sin, Dur	-0.178	0.114	-0.250**	-0.632***	-0.251**	-0.469***
	(0.112)	(0.220)	(0.119)	(0.169)	(0.116)	(0.154)
State: Coah, N.L., Tamps	0.874***	-0.195	0.794***	-1.146***	0.757***	-0.949***
	(0.110)	(0.269)	(0.123)	(0.203)	(0.120)	(0.177)
State: Jal, Col, Nay	0.351***	0.599***	0.216**	-0.320**	0.253**	-0.045

	(0.103)	(0.186)	(0.105)	(0.151)	(0.100)	(0.130)
State: Guerr, Mich	0.586***	0.392**	0.472***	-0.619***	0.483***	-0.329***
	(0.078)	(0.175)	(0.089)	(0.127)	(0.082)	(0.113)
State: Zac, Ags, SLP	0.636***	0.067	0.513***	-0.818***	0.524***	-0.543***
	(0.086)	(0.194)	(0.100)	(0.154)	(0.092)	(0.132)
State: Guan, Quer	0.013	0.283	-0.109	-0.627***	-0.078	-0.312***
	(0.084)	(0.180)	(0.090)	(0.129)	(0.083)	(0.116)
State: Hgo	0.556***	-0.013	0.448***	-0.564***	0.451***	-0.486***
	(0.106)	(0.260)	(0.116)	(0.177)	(0.110)	(0.172)
State: Pue, Tlax, Mor	0.039	-0.020	0.001	-0.197*	-0.000	-0.189*
	(0.081)	(0.208)	(0.084)	(0.105)	(0.082)	(0.108)
State: Ver	0.139*	-0.043	0.116	-0.139	0.110	-0.137
	(0.077)	(0.208)	(0.079)	(0.107)	(0.079)	(0.104)
State: Tab = o,	0.617***	-	0.567***	-0.955**	0.521***	-0.897**
	(0.092)		(0.105)	(0.445)	(0.104)	(0.393)
State: Oax	0.060	-0.335*	-0.018	-0.737***	-0.036	-0.739***
	(0.086)	(0.200)	(0.096)	(0.134)	(0.092)	(0.129)
State: Chis	0.060	-0.243	-0.041	-1.151***	-0.064	-1.023***
	(0.097)	(0.332)	(0.111)	(0.220)	(0.106)	(0.195)
State: Camp, Yuc, QRoo	-0.033	-0.198	-0.111	-0.709***	-0.139	-0.631**
	(0.140)	(0.434)	(0.148)	(0.262)	(0.143)	(0.247)
Monthly total cons. exp. (1000 pesos)	-0.047***	0.018*	-0.049***	-0.013	-0.048***	-0.001
	(0.009)	(0.010)	(0.009)	(0.012)	(0.009)	(0.009)
Loc.: Number of natural disasters	0.019*	0.016	0.017*	-0.002	0.016	-0.003
	(0.010)	(0.023)	(0.010)	(0.018)	(0.010)	(0.016)
Loc.: Informal credits available	-0.084**	0.058	-0.071*	0.146**	-0.062	0.144**
	(0.039)	(0.086)	(0.041)	(0.064)	(0.040)	(0.059)
Loc.: No. of elementary schools	-0.095**	-0.005	-0.101**	-0.041	-0.096**	-0.005
	(0.040)	(0.076)	(0.040)	(0.067)	(0.040)	(0.059)
Loc.: No. of lower-secondary schools	-0.057	0.082	-0.061	0.026	-0.056	0.040
	(0.041)	(0.094)	(0.041)	(0.071)	(0.041)	(0.064)
Loc.: No. of higher-secondary schools	-0.246***	-0.154	-0.241***	-0.083	-0.249***	-0.123*
	(0.046)	(0.106)	(0.046)	(0.081)	(0.046)	(0.073)
Migration Intensity Index 2010		0.076***				0.032***
		(0.015)				(0.010)
Share migration to other municipalities				0.410		0.227
				(0.457)		(0.409)
People from locality now living in the US		0.393***		0.355***		0.398***
		(0.140)		(0.084)		(0.079)
Observation from 2015	-0.091**	-0.243***	-0.092**	-0.254***	-0.114***	-0.291***
	(0.040)	(0.091)	(0.041)	(0.069)	(0.042)	(0.063)
Constant		-3.652***		-1.477***		-1.852***
		(0.489)		(0.340)		(0.313)
Cut-off point 1 (m_1)	0.224		0.077		0.097	
	(0.201)		(0.204)		(0.201)	
Cut-off point 2 (m_2)	0.904***		0.754***		0.768***	
	(0.201)		(0.206)		(0.203)	
Cut-off point 3 (m_3)	1.434***		1.284***		1.292***	
	(0.202)		(0.208)		(0.205)	
Correlation between food insec. and remitt.	0.371**		0.308**		0.362***	
	(0.152)		(0.136)		(0.116)	
Observations	4,863		4,863		4,863	
Chi2 Test	1196		1179		1287	
p-value Chi2	0		0		0	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table B.3 shows the predicted probabilities and treatment effects, with results that are largely comparable to the ones presented in Table 9 when missings were considered as not having received remittances. In particular, the finding that – after accounting for endogeneity – international remittances strongly increase the probability of food security and almost eradicate severe insecurity is maintained.

Table B.3 Probabilities of Food Insecurity Levels, Treatment Effects

		Exogenous			Endogenous		
		without remitt.	with remitt.	difference (treatm. eff.)	without remitt.	with remitt.	difference (treatm. eff.)
International remittances							
Security	prob.	0.5078	0.5841	0.0763	0.4960	0.7849	0.2889
	st.dev.	0.1852	0.1819	0.0125	0.1811	0.1377	0.0599
Mild insecurity	prob.	0.2273	0.2100	-0.0173	0.2284	0.1334	-0.0950
	st.dev.	0.0452	0.0544	0.0180	0.0424	0.0649	0.0495
Moderate insecurity	prob.	0.1299	0.1082	-0.0216	0.1330	0.0506	-0.0823
	st.dev.	0.0520	0.0529	0.0073	0.0502	0.0391	0.0231
Severe insecurity	prob.	0.1350	0.0976	-0.0374	0.1426	0.0310	-0.1116
	st.dev.	0.1084	0.0881	0.0212	0.1091	0.0378	0.0732
Internal remittances							
Security	prob.	0.5126	0.4987	-0.0139	0.4959	0.6797	0.1838
	st.dev.	0.1860	0.1861	0.0022	0.1843	0.1679	0.0327
Mild insecurity	prob.	0.2259	0.2284	0.0025	0.2267	0.1774	-0.0493
	st.dev.	0.0459	0.0444	0.0035	0.0430	0.0626	0.0385
Moderate insecurity	prob.	0.1285	0.1323	0.0038	0.1327	0.0806	-0.0521
	st.dev.	0.0523	0.0519	0.0015	0.0506	0.0489	0.0156
Severe insecurity	prob.	0.1330	0.1406	0.0076	0.1447	0.0623	-0.0824
	st.dev.	0.1079	0.1117	0.0040	0.1122	0.0643	0.0497
Total remittances							
Security	prob.	0.5089	0.5293	0.0204	0.4806	0.7166	0.2360
	st.dev.	0.1858	0.1855	0.0033	0.1805	0.1565	0.0420
Mild insecurity	prob.	0.2267	0.2228	-0.0039	0.2282	0.1625	-0.0656
	st.dev.	0.0455	0.0479	0.0051	0.0401	0.0632	0.0460
Moderate insecurity	prob.	0.1295	0.1239	-0.0057	0.1366	0.0701	-0.0665
	st.dev.	0.0522	0.0527	0.0021	0.0487	0.0452	0.0187
Severe insecurity	prob.	0.1348	0.1240	-0.0108	0.1546	0.0508	-0.1038
	st.dev.	0.1086	0.1032	0.0058	0.1141	0.0542	0.0620

Weighted averages of the probabilities that were calculated for all households in the sample using their observed characteristics while setting remittances equal to 0 or 1 in the columns headed with or without remittances, respectively. The difference can be interpreted as the "treatment effect" of remittances.