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Abstract

This study empirically examines the vulnerability of rural households in Mexico and the impact of the conditional cash transfer (CCT) programme on them. Using the two most recent Mexican rural household panel datasets (2003 and 2007), I adopt Townsend's (1994) model and Kurosaki's (2006) modified version with instrumental variable methods. The empirical results confirmed better risk-sharing functions in basic needs (food) and the effects of CCT, together with other factors such as larger family size, landholdings, and self-consumption, on reducing household vulnerability; however, the effects of remittances were somewhat opposite.

JEL Classification: O12, D12, O54

Keywords: consumption smoothing, household vulnerability, PROGRESA-Oportunidades

1. Introduction

People living in low-income countries, especially rural areas, face severe poverty and various risks, including natural disasters, diseases, accidents, death, unemployment, crop failure, property loss, disabilities, and market price changes, causing their incomes to fluctuate (Bardhan and Udry, 1999; Fafchamps, 2003). According to Fafchamps (2003), poor rural communities are subject to higher risks and are less able to deal with such risks.

Kamanou and Morduch (2005) argue that 'vulnerability' comprises three elements: (1) the pattern of possible shocks due to the loss of a job or bad harvest, (2) the strength of coping mechanisms or degree to which provisions are not in place to fully address shocks, and (3) the structural and behavioural ramifications of a decline in consumption, that is, whether such declines can result in temporary shortfalls for households or render them victims of a poverty trap. They indicate that the expected utility of risk-averse individuals or households declines with an increase in consumption variability (Kamanou and Morduch, 2005). This allows us to explore household vulnerability from a consumption-smoothing perspective.

Bardhan and Udry (1999) assert that the primary obstacle in consumption smoothing, particularly among poor farmers, is liquidity constraints, usually caused by market imperfections. The inexistence or poor functioning of formal credit and/or insurance markets in rural areas is supplemented by various informal mechanisms. Dercon (2005) describes two strategies used by households exposed to income fluctuations to reduce the impacts of shocks: risk management and risk-coping strategies. Risk management is an ex ante strategy seeking income smoothing through the diversification of income sources by combining different income-generating activities, including crop diversification, to reduce harvest risk, even if the crops have lower average yield. Risk coping is an ex post strategy that includes self-insurance (precautionary savings) and informal group-based risk sharing. For example, households accumulate assets in good years or organise various informal arrangements among families, ethnic groups, or neighbourhoods.

There has been growing interest in the empirical analysis of informal mechanisms and modelling of the sustainability and consequences of the arrangements previously listed. The most frequently cited study is Townsend's (1994) risk-sharing model.[1] He points out that by focusing on a single aspect of the strategies mentioned above, one might miss smoothing possibilities by another market or institution when examining risk management and coping mechanisms. To address this, he presents a general equilibrium framework that jointly evaluates all types of institutions. Following Townsend's (1994) views, I empirically examine the consumption-smoothing mechanisms of Mexican rural households.

I use Mexican rural household panel data for 2003 and 2007 called *Encuestas de Evaluación de los Hogares* (*ENCEL*: *Household Evaluation Surveys*), a comprehensive household survey conducted to evaluate the conditional cash transfer (CCT) programme. These are the latest datasets available and the richest in information; however, they have not been fully utilised in the literature, given the dissolution of the original control groups. I assume, in this paper, that vulnerability arises from the inability to smooth consumption because of liquidity constraints. First, I estimate a basic risk-sharing model to show that the full risk-sharing hypothesis is rejected in rural Mexico. I apply instrumental variable (IV) methods for all estimation models using two-stage least squares (2SLS) regressions and other robustness checks to deal with endogeneity and attrition. The results are consistent for both the OLS and the IV models. Simultaneously, I apply Kurosaki's (2006) modification to Townsend's (1994) model by considering the different marginal effects of both positive and negative income shocks. Kurosaki's model allows us to assume different degrees of vulnerability across households in a village according to household characteristics, even if the panel period is limited. The empirical results confirm the consumption-smoothing effects of the Mexican CCT in reducing household vulnerability and reveal that larger family size and landholdings can mitigate household vulnerability, whereas receiving remittances increases it.

The structure of this paper is as follows. Section 2 outlines the Mexican CCT programme and presents the literature review of the effects of the CCT on household consumption smoothing. Section 3 presents the models and data used in this study. Section 4 conducts empirical analyses to test the full risk-sharing hypothesis. Section 5 examines the effects of the CCT by applying Kurosaki's (2006) modified version. Section 6 concludes the paper.

2. Mexican CCT Programme and Discussion on Its Consumption-Smoothing Effects

2-1. Outline of PROGRESA-Oportunidades

The CCT programme was designed and implemented in Mexico in 1997 as a new targeted strategy for poverty reduction, and soon became widespread among other developing countries. The Mexican CCT, first named the Education, Health and Nutrition Programme (*Programa de Educación, Salud y Alimentación*: *PROGRESA*), started in seven pilot states in 1997. The original eligible households were randomly divided into treatment and control groups to enable a rigorous impact evaluation. Eligible households in the treatment and control villages started receiving benefits in 1998 and 2000, respectively. After 2000, the programme scaled up rapidly to cover all eligible households in all the municipalities over several years. The programme has two clear objectives: (1) to provide poor households with a minimum consumption floor (to reduce 'current' poverty) and (2) to encourage the accumulation of human capital by making the transfers conditional on education and health to break the vicious cycle that transmits poverty across generations (to reduce 'future' poverty) (Levy, 2006; Fiszbein and Schady, 2009).

The education component of PROGRESA is designed to increase school enrolment among young people with a requirement of greater than 85 per cent attendance to receive the scholarship. It is notable that a greater amount of scholarships are granted to girls who are more likely to drop out. For health and nutrition, the programme includes the distribution of nutritional supplements, education related to hygiene and nutrition, and monetary transfers for the purchase of food. Receipt of monetary transfers and nutritional supplements is tied to mandatory visits to public clinics for health care. The average monthly payment (received every two months) by a beneficiary family amounts to 20 per cent of the value of monthly consumption expenditures before the initiation of the programme (Skoufias, 2005). The transfers are made to mothers, who are expected to be most familiar with the resource allocation within their household. It has replaced all existing poverty programmes. Hereafter, I refer to the programme as 'PROGRESA-Oportunidades' because PROGRESA was renamed as 'Oportunidades' after the government change in 2000.

Since the education and health and nutrition components of PROGRESA-Oportunidades are thoroughly studied in the literature, this study focuses on the first objective of 'current' poverty reduction from the perspective of household consumption smoothing within Townsend's (1994) well-known risk-sharing framework. In addition, the pilot regions of PROGRESA-Oportunidades, the most marginal rural areas in Mexico, present typical characteristics of rural households in developing countries, as will be shown in Table 1 in Section 4. These facts confirm that examining a Mexican case within the risk-sharing framework will contribute to a further case study of household poverty and vulnerability of developing countries.

2-2. Consumption-Smoothing Effects of PROGRESA-Oportunidades in Rural Mexico

Although most CCT studies concentrate on human capital development, several previous studies examine the consumption-smoothing effects of PROGRESA-Oportunidades on rural Mexico. Skoufias (2007) conducts an empirical analysis of the risk insurance model using three rounds of ENCEL panel data for 1998–1999 and rejects full risk sharing in all specifications. The effect of PROGRESA-Oportunidades on improving pre-existing risk sharing within villages is not statistically significant in all models, except for a few cases of subsample regressions based on household characteristics. He attributes this to the short duration (1.5 years) after the programme's implementation. He finds that the coefficients are insignificant and that the sign of the coefficient of the interaction terms (effects of PROGRESA) is reversed (positive and insignificant) because of weak instruments.

Angelucci and De Giorgi (2009) confirm the indirect or spillover effect of PROGRESA-Oportunidades cash transfers on increasing the consumption of ineligible households in the same treatment village. They argue that the availability of additional liquidity in the network (through PROGRESA-Oportunidades) causes changes in the local credit and insurance markets, which enables not only treated households but also nontreated ones to reduce savings and increase consumption.

Attanasio et al. (2013) simulate the welfare consequences of the recent increase in food prices in Mexico using ENCEL data, showing that CCT programmes more effectively alleviate the problem of increased staple prices than other indirect policies, computing the effects of 50 peso transfers and 5 per cent price subsidies. However, they do not include data from ENCEL 2007 when estimating rural households' consumption patterns, thereby excluding the Control 2003 samples. Thus, the validity of their assumption must be examined.

I deal with the abovementioned shortcomings in applying the risk-sharing model to better identify the consumption-smoothing effects of PROGRESA-Oportunidades over the longer term, using updated ENCEL data covering 2007 and more sophisticated regression methods with robust IVs.

3. Model and Data

3-1. Model[2]

3-1-1. Risk-Sharing Model

Here, I briefly present Townsend's (1994) risk-sharing model. Townsend suggests a general equilibrium model to jointly assess the effectiveness of various (mostly informal) insurance mechanisms in a community, for example, a village. The theoretical model is obtained by maximising a village utility function, which is the sum of *N* households' utility functions weighted by each household's Pareto efficient weight (λ_i), subject to a pooled village income.[3]

The reduced form of the first-order condition using a constant absolute risk aversion (CARA) utility function is

$$c_{it} = b_i + a_i \bar{c}_t + \beta_i y_{it} + v_{it}, \qquad (1)$$

where $\bar{c}_t = \frac{1}{N}\sum_{j=1}^{N} c_{jt}$.

c_{it} and y_{it} are household *i*'s consumption and income levels at time *t*, respectively, v_{it} is an i.i.d. error term with zero mean, and a_i and β_i are the parameters to be estimated.

By taking the first differences, we obtain

$$\Delta c_{it} = a_i \Delta\bar{c}_t + \beta_i \Delta y_{it} + \Delta v_{it}, \qquad (2)$$

where Δc_{it} and Δy_{it} are household *i*'s consumption change and income change (or idiosyncratic shocks) at time *t*, respectively, $\Delta\bar{c}_t$ is the average consumption change at the village level at time *t*, Δv_{it} is an i.i.d. error term with zero mean, and a_i and β_i are the parameters to be estimated.

Full risk sharing can be achieved when the null hypothesis of $\beta_i = 0$ is accepted across all households within the village.[4] If the village achieves Pareto optimal risk sharing, the changes in each household's consumption Δc_{it} should respond only to the village-level shock, $\Delta\bar{c}_t$. Theoretically, β_i moves between 0 and 1. Deaton (1992) and Kurosaki (2006, 2009) argue that the size of β_i shows the sensitivity of consumption to idiosyncratic income shocks. A relatively large positive value for β_i indicates that household *i* is less able to cope with such shocks. They call this β_i the 'excess sensitivity parameter', and Kurosaki (2006, 2009) insists that it should be used as a vulnerability measure. I hereafter define this sensitivity parameter as a reflection of 'consumption-smoothing effects'.

We generally apply Ravallion and Chaudhuri's (1997) modification to correct a downward bias for β_i by replacing $a_i\Delta\bar{c}_t$ with the time village dummy, $\sum_t \delta_t D_t$, which can absorb all village-level aggregate shocks. We impose restrictions on the parameters $b_i = b, a_i = a,$ and $\beta_i = \beta, \forall i$ by assuming uniform time and risk preferences across households in the case of a short panel period, in line with the empirical models proposed by Kurosaki (2006) and Skoufias (2007):

$$\Delta c_{it} = \sum_t \delta_t D_t + \beta\Delta y_{it} + \Delta v_{it}. \qquad (3)$$

Since the panel data used in this study are for two periods, the estimation equation becomes a cross-section:

$$\Delta c_i = a_v + \beta\Delta y_i + u_i, \qquad (4)$$

where a_v is a village dummy and u_i is an i.i.d. error term with mean zero.

3-1-2. Model with Emphasis on Welfare Loss

According to Kurosaki (2006, 2009), a possible problem in using a specification such as equation (3) for a vulnerability analysis is that parameter β does not distinguish whether Δy_{it} is positive or negative. Parameter β in this case shows the extent to which a household needs to decrease its consumption level when hit by a negative income shock and the extent to which it can afford to increase its consumption level when it enjoys a certain income increase. Therefore, it is necessary to separate the marginal effect of negative income shocks from that of positive ones on consumption. Only the degree to which a household is forced to decrease consumption in response to negative income shocks should be regarded as vulnerability. Following Kurosaki (2006, 2009), I estimate a modified version of equation (4) in this study:

$$\Delta c_i = \alpha_v + \beta_1 d_i \Delta y_i + \beta_2 (1 - d_i) \Delta y_i + u_i, \qquad (5)$$

where $d_i = 1$ if $\Delta y_i < 0$ and u_i is an i.i.d. error term with mean zero. Parameter β_1 shows the extent to which consumption changes when income marginally decreases for a household after controlling for aggregate village shocks, α_v, and β_2 shows the extent to which consumption varies when income marginally increases.

Furthermore, equations (4) and (5) are based on the assumption of uniform time and risk preferences across households in a village in the case of a short panel period. Thus, the model only allows us to estimate the average degree of the vulnerability of a village. To overcome this shortcoming, Kurosaki (2006, 2009) suggests household characteristics (X_i) as determinants of different vulnerabilities across households, which enable us to estimate different excess sensitivity parameters for each household. By inserting interaction terms for income changes (Δy_i) and household characteristics (X_i), the model to be estimated becomes

$$\Delta c_i = \alpha_v + \beta_1 X_i d_i \Delta y_i + \beta_2 X_i (1 - d_i) \Delta y_i + u_i, \quad (6)$$

where $d_i = 1$ if $\Delta y_i < 0$, u_i is an i.i.d. error term with mean zero. Here, the parameters β_1 and β_2 are the vectors that show the marginal effects of the negative and positive income shocks of a particular household characteristic X_i. The vector X_i includes a constant here.

3-2. Panel Data

3-2-1. Data

This study adopts panel data from ENCEL. The survey is designed and periodically administered by the Social Development Secretary (*Secretaría de Desarrollo Social*) as an external evaluation of the 'randomised' CCT programme, whose data are available for 1997–2007.

The original full ENCEL sample comprises repeated observations for 24,000 households from 506 localities (villages) in seven states (Guerrero, Hidalgo, Michoacán, Puebla, Querétaro, San Luis Potosí, and Veracruz). Of the 506 localities, 320 were assigned to a treatment group (hereinafter Treatment 1998) and 186 to a control group (hereinafter Treatment 2000). Households denoted as control localities did not receive PROGRESA-Oportunidades benefits until 2000 (Skoufias, 2007). A comparison group of 151 localities, not yet incorporated into the programme, was selected as a new control group using propensity score matching for the seventh round of the survey in 2003 (hereinafter Control 2003) (Todd, 2004). This group's households were entitled to receive benefits only after the 2003 survey, thus becoming beneficiaries by 2004. By 2007, eight rounds were conducted in the most marginal rural areas, enabling researchers to utilise micro-panel data that spanned a longer timeframe. The summary statistics of the three treatment/control groups are provided in Appendix A.

I use rural samples of the two most recent rounds available: 2003 and 2007. ENCEL 2003 consists of 33,887 households and 205,306 individuals, and ENCEL 2007 comprises 25,899 households and 176,809 individuals from the seven sample states, indicating that 7,988 households (23.6 per cent) were dropped from the 2007 sample. From the 25,899 households in the 2007 sample, households whose consumption was not reported or reported as nil were excluded, leaving 18,763 households in the case of food consumption and 17,603 households for total consumption, accounting for another drop of about 28 per cent of the sample. Finally, 12,394 households remain as a complete panel for the regression analyses after households with zero or unreported income and outliers in the upper and lower 1 per cent of the sample were dropped.

3-2-2. Summary Statistics and Attrition Bias

Table 1 presents the summary statistics of all the variables used in this study. The manner in which the variables are created is summarised in Appendix B and the list of variables used in this paper is provided in Appendix C. Column (A) of Table 1 corresponds to the whole sample size of ENCEL 2003 and Column (B), to that of ENCEL 2007. Column (C) presents the sample data for households with positive consumption in both years and Column (D), the final balanced panel (12,394 households) for the regression, as explained in Subsection 3-2-1. According to Column (D) in Table 1, a significant drop in real consumption and income was observed between 2003 and 2007 (by 8.8 Mexican pesos for food alone, 10.8 pesos in total, and 6.3 pesos for income). This phenomenon can be attributed to the welfare loss in poor households owing to the increase in prices for international and domestic food during the period (Valero-Gil and Valero, 2008; Wood et al., 2009; Attanasio et al., 2013; Uchiyama, 2017).

With respect to household characteristics in the base year (2003), Column (A) of the table shows that 28 per cent of household heads received no education. Those with a primary education accounted for 61 per cent, while 9 per cent had a secondary education and only 2 per cent received a high school or higher education. The author's calculation based on the data reveals that more than half of the household heads who enrolled in primary school did not graduate, indicating a high dropout rate. Women headed 14 per cent of the households. About 32 per cent of the households were indigenous. About 52 per cent received benefits under PROGRESA-Oportunidades in 2003. This percentage increased to 70 in 2007 because by then, the Control 2003 households began receiving benefits. About 6 per cent of households reported self-consumption during the interview week (Column (D)). Approximately 64 per cent of households owned or cultivated 4.3 hectares of land on average, but the median farming household only owned or cultivated 2 hectares of land, indicating an unequal land distribution. Of those who owned or cultivated land in 2003, 9 per cent had full or partial irrigation. About 29 per cent of the households received personal transfers (domestic and/or foreign remittances) in cash or kind and 32 per cent had members older than 15 years who lived away from home (domestic and/or foreign migrants).

Highly marginal pilot villages (localities) were selected from the seven states in Mexico. The three treatment or control groups in Table 1 correspond to the aforementioned village categories.

As the statistics in Table 1 reveal, sample households in the most marginal regions in Mexico well represent the typical rural characteristics of a developing country: low education; high indigenous ratio; high ratio of farmers with small and rain-fed lands but unequal concentration of land among a small number of rich farmers; and relatively high dependency on migration. Also, Uchiyama (2017) reveals that more than 80 per cent of the households in this sample live below the rural food poverty line determined by the Mexican government. The low saving and debt ratios (2–3 per cent and 6.7 per cent, respectively) and clear decline in the debt ratio amid the food price crisis in this period are also noteworthy (Uchiyama, 2017). These facts clearly indicate the existence of severe liquidity constraints for households to cope with risks, which justifies an examination of the consumption-smoothing hypothesis within Townsend's (1994) risk-sharing framework.

As one can easily imagine, the sample size reduction in Table 1 could lead to an attrition bias considering the possible nonrandomness of the process. The table shows that half of the mean tests of variables related to household characteristics before and after the attritions are statistically different. Those households more likely to be dropped between 2003 and 2007 (Columns (A) and (B)) are those whose heads are uneducated, female, aged, and indigenous, and those with higher dependency ratios and remittances. By contrast, those likely to remain in the sample between 2003 and 2007 are bigger families, married, landholders, and CCT beneficiaries, and those who send domestic/foreign migrants. By comparing Columns (B) with (C), those unlikely to report their consumption are households whose heads are aged and indigenous, and those with land and CCT benefits.

Taking these into account, I apply the inverse probability weighting (IPW) method to deal with attrition bias based on Wooldridge (2002) and Fitzgerald et al. (1998). The details are provided in Appendix D. I use the attrition rate at the municipal level as an auxiliary variable based on Mina and Imai (2016).

TABLE 1

SUMMARY STATISTICS WITH MEAN TESTS OF ATTRITION BIAS

Variable	**(A) Original Sample in 2003 (unbalanced)**		**(B) 2003 Sample Remained in 2007**			**(C) Balanced Panel (with consumption)**			**(D) Balanced Panel (for regression)**		
(PANEL A: Consumption and Income)											
Cf_i, 2003	-	-	-	-		93.69	(365.30)		71.12	(43.97)	***
Ct_i, 2003	-	-	-	-		112.22	(330.79)		90.74	(56.47)	***
Cf_i, 2007	-	-	-	-		73.07	(201.86)		62.30	(39.79)	***
Ct_i, 2007	-	-	-	-		94.36	(210.77)		80.24	(54.39)	***
Y_i, 2003	-	-	-	-		-	-		28.95	(43.76)	
Y_i, 2007	-	-	-	-		-	-		22.69	(21.47)	
(PANEL B: Household Characteristics (Education))											
no education03 [(a)]	0.28	(0.45)	0.25	(0.43)	***	0.24	(0.43)		0.24	(0.42)	
primary03 [(a)]	0.61	(0.49)	0.64	(0.48)		0.64	(0.48)		0.65	(0.48)	***
secondary03 [(a)]	0.09	(0.28)	0.09	(0.29)		0.10	(0.30)		0.09	(0.29)	
highschool03 [(a)]	0.012	(0.11)	0.012	(0.11)		0.013	(0.11)		0.011	(0.10)	
technical03 [(a)]	0.007	(0.08)	0.007	(0.09)		0.007	(0.09)		0.007	(0.08)	
university03 [(a)]	0.004	(0.06)	0.004	(0.06)		0.003	(0.06)		0.002	(0.05)	*
(PANEL C: Household Characteristics (Others))											
total_member03	4.91	(2.46)	5.16	(2.40)	***	5.15	(2.38)		5.25	(2.31)	***
depratio03	44.15	(26.43)	42.43	(24.55)	***	42.73	(24.49)	***	42.68	(23.85)	
female03 [(a)]	0.14	(0.35)	0.12	(0.33)	***	0.12	(0.33)		0.10	(0.30)	***
age03	48.02	(16.31)	47.06	(15.29)	***	46.65	(15.32)	***	46.27	(14.62)	**
married03 [(a)]	0.82	(0.38)	0.85	(0.36)	***	0.86	(0.35)		0.88	(0.33)	***
indigenous03 [(a)]	0.32	(0.47)	0.32	(0.46)		0.30	(0.46)	***	0.31	(0.46)	***
land holding03 [(a)]	0.64	(0.48)	0.65	(0.48)		0.64	(0.48)	*	0.63	(0.48)	***
total_land_ha03 +	4.33	(9.45)	4.35	(9.41)		4.43	(9.55)	**	4.73	(9.65)	***
irrigation03 [(a)] +	0.09	(0.29)	0.09	(0.29)		0.09	(0.29)		0.09	(0.29)	
remittance03 [(a)]	0.29	(0.45)	0.27	(0.44)	***	0.27	(0.44)		0.26	(0.44)	***
migrant03 [(a)]	0.32	(0.47)	0.33	(0.47)	***	0.33	(0.47)		0.32	(0.47)	
self-consumption03 [(a)]	-	-	-	-		-	-		0.06	(0.24)	
CCT03 [(a)]	0.52	(0.50)	0.54	(0.50)		0.53	(0.50)		0.59	(0.49)	***
CCT07 [(a)]	-	-	0.70	(0.46)		0.69	(0.46)		0.79	(0.41)	***
(PANEL D: States and Treatment Groups)											
Treatment 1998 [(a)]	0.49	(0.50)	0.48	(0.47)		0.47	(0.50)		0.48	(0.50)	

Treatment 2000 [a]	0.32	(0.47)	0.33	(0.39)	*	0.33	(0.47)		0.34	(0.47)	
Control 2003 [a]	0.20	(0.40)	0.19	(0.26)	*	0.19	(0.39)		0.19	(0.39)	
State 12: Guerrero [a]	0.08	(0.28)	0.07	(0.36)	***	0.09	(0.29)	***	0.08	(0.27)	***
State 13: Hidalgo [a]	0.16	(0.37)	0.15	(0.34)	**	0.10	(0.31)	***	0.10	(0.31)	
State 16: Michoacán [a]	0.13	(0.34)	0.13	(0.35)		0.17	(0.38)	***	0.17	(0.37)	
State 21: Puebla [a]	0.14	(0.35)	0.14	(0.25)		0.14	(0.34)		0.15	(0.35)	
State 22: Querétaro [a]	0.06	(0.24)	0.07	(0.36)		0.09	(0.28)	***	0.08	(0.27)	*
State 24: San Luis Potosí [a]	0.15	(0.35)	0.15	(0.45)		0.16	(0.37)	***	0.16	(0.37)	
State 30: Veracruz [a]	0.27	(0.45)	0.28	(0.45)	*	0.24	(0.43)	***	0.26	(0.44)	***
Sample Size	33,888		25,899			18,763			12,394		

Note: Standard deviations are in parentheses. *Cf_i, Ct_i*, and *Y_i* stand for per capita weekly real food consumption, total consumption, and income, respectively.

* p < 0.1, ** p < 0.05, *** p < 0.01 based on t-tests with the column in the left (A and B, B and C, and C and D).

The number of observations for total consumption in column D is 11483.

[a] Dummy variables.

+ Percentages among those who hold land.

Column D is the sample after households whose income is unreported or only partially reported and upper and lower 1 per cent outliers are excluded from Column C.

Self-consumption dummy is excluded for technical reasons.

1

4. Empirical Analyses of the Risk-Sharing Model

4-1. Basic Model: Testing the Full Risk-Sharing Hypothesis

I assume endogeneity to estimate equation (4) apart from possible attrition bias by considering measurement errors and possible omitted variable biases such as price levels in income. Thus, the explanatory variable is replaced by fitted values using IVs. These variables are expected to correlate with income changes between 2003 and 2007 (Δy_i) but not with the consumption variation in the same period. First, I use changes in lagged income between 2001 and 2002 (Δy_i*: 2001-02*)[5] as an instrument in the first stage, drawing on Ravallion and Chaudhuri (1997), who identify lagged income as the most preferable instrument. Next is a migrant dummy (*migration03*), which takes the value of one if a household has a member who is older than 15 years of age and lives in another region or country in 2003. The migrant dummy allows for a robust regression result, given the weakness of the lagged income change as an instrument, which only captures part of a households' income as is explained in Appendix B. Fafchamps (2003) supports the possibility of remittances serving as a reliable income source rather than ex post insurance for consumption smoothing, arguing that 'given the cost of communicating with migrants and the difficulties and risks of transferring money across space in most developing countries, it may be more efficient for recipients to leave the timing of remittances to the discretion of migrants' (p. 39). Moreover, Acosta et al. (2008) reveal that remittance-recipient households in Latin America (including Mexico) increase expenditures on durable goods, housing, and human capital compared with nonrecipients. As described in Appendix B, the total consumption used in this paper does not include either of these items.[6] Food and total consumption are used as explained variables in all the models herein.

Table 2 presents the regression results for equation (4) for both the OLS and the 2SLS regressions for food and total consumption.[7] The OLS estimation coefficients for β are about

0.18 for food consumption and about 0.24 for total consumption, which is consistent with previous studies in significance and magnitude. This implies that real food and total consumption increase (decline) by about 0.18 and 0.24 pesos, respectively, when real income rises (declines) by 1 peso. The null hypothesis of full risk sharing is thus rejected at the 1 per cent level. It is noteworthy that the coefficients for food consumption are smaller than those for total consumption (the difference between the estimated coefficients are confirmed to be statistically significant by a t-test for OLS), which implies that food consumption is better insured than total consumption. This result is also consistent with most previous studies of developing countries.[8] In this respect, Skoufias (2007) explains that when household income increases, demand for nonfood items rises more than that for necessities (for example, food), and the opposite holds true in the case of a decrease in household income. The 2SLS coefficients are much larger than the OLS coefficients for both food and total consumption, which implies a downward bias for β owing to endogeneity, including measurement errors,[9] although both of them are estimated to be greater than one.

TABLE 2

REGRESSION RESULTS OF EQUATION (4)

Variable	Model (1) OLS	Model (2) 2SLS	Model (3) OLS	Model (4) 2SLS
	Food		Total	
β	0.18***	1.34***	0.24***	1.75***
	(0.01)	(0.11)	(0.02)	(0.15)
(t-value)[a]			*(2.46***)*	*(0.84)*
constant	-4.66	-26.47**	31.31***	0.47
	(8.25)	(11.38)	(10.56)	(15.81)
First stage of 2SLS				
(Dependent variable: *Δy_i,03-07)*				
Δy_i,01-02	-	-0.08**	-	-0.08**
hhmigrant_over15_dum03	-	-13.53***	-	-13.24***
constant	-	21.41***	-	23.08***
No. of Obs.	12,394	12,394	11,483	11,483
R-squared (OLS)	0.11	-	0.13	-
Chi2 (2SLS)	-	16541.5	-	111276
R-squared (first stage of 2SLS)	-	0.10	-	0.11
Robust Durbin–Wu–Hausman test of endogeneity				
F statistics	-	284.88	-	291.79
Chi2	-	311.06	-	312.91
Weak instrument tests				
F statistics	-	104.27	-	93.29

Note: Δy_i 01-02 stands for household real per capita income changes (2001–2002).

Robust standard errors are in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.

Village dummies are included in all the models.

[a] T-test of differences between the estimated *β* in food and total consumptions for OLS and 2SLS, separately.

4-2. Model with Emphasis on Welfare Decline

From this section, I shift the discussion to the modified risk-sharing model proposed by Kurosaki (2006), which assumes different marginal effects on negative or positive income shocks as well as those based on their household characteristics. Kurosaki (2006) argues that when focusing on household vulnerability issues, the modified risk-sharing model serves as a better approach than the basic model.

Table 3 shows the regression results for equation (5) presented in Section 3. The dependent variables are the change in household per capita food consumption for Models 1 and 2 and the change in household per capita total consumption for Models 3 and 4. The regression methods are OLS for Models 1 and 3 and 2SLS with IVs for Models 2 and 4. I use the same IVs as those in the previous regressions in Table 2.

The regression results indicate that the estimated coefficients for negative income shocks (β_1) are significantly smaller (closer to zero) than those for positive income shocks (β_2). This suggests that households are better insured for negative income shocks with village risk-sharing functions. The results also show that consumption smoothing could work better for basic needs such as food than for nonfood consumption because β_1 is smaller for food (Models 1 and 2) than for total consumption (Models 3 and 4). However, the t-values for the mean difference tests are not significant in three out of four cases this time. Furthermore, the results confirm the existence of a downward bias due to endogeneity since the estimated coefficients are larger in 2SLS (except for food in Model 2).

TABLE 3

REGRESSION RESULTS OF EQUATION (5)

Variable	Model (1) OLS	Model (2) 2SLS	Model (3) OLS	Model (4) 2SLS
	Food		Total	
dΔy_i (β₁)	0.13***	0.12	0.17***	0.73
	(0.03)	(0.29)	(0.04)	(0.40)
(t-value)[a]			*(0.78)*	*(1.26)*
(1-d)Δy_i (β₂)	0.40***	3.10***	0.50***	3.20***
	(0.02)	(0.41)	(0.02)	(0.53)
(t-value)[a]			*(3.922***)*	*(0.14)*
constant	-10.39	-77.66***	24.20**	(42.10)
	(8.32)	(20.68)	(10.84)	(18.83)
First stage of 2SLS				
(Dependent variable: *dΔy_i,03-07)*		**minus**		**Minus**
Δy_i 01-02	-	-0.08**	-	-0.08**
migrant03	-	-7.55***	-	-7.30***
constant	-	-4.61	-	-3.85
(Dependent variable: *(1-d)Δy_i,03-07)*		**plus**		**Plus**
Δy_i 01-02	-	0.003	-	0.004
migrant03	-	-5.98***	-	-5.94***
constant	-	26.02***	-	26.93***
No. of Obs.	12,394	12,394	11,483	11,483
R-squared (OLS)	0.12	-	0.14	-
R-squared (first stage of 2SLS)				
dΔy_i (minus)	-	0.09	-	0.10
(1-d)Δy_i (plus)	-	0.11	-	0.11
Robust Durbin–Wu–Hausman test of endogeneity				
F statistics	-	310.05	-	307.33
Chi2	-	155.33	-	153.89
Weak instrument tests (*F* statistics)				
dΔy_i (minus)	-	42.53	-	37.41
(1-d)Δy_i (plus)	-	196.54	-	176.81

Note: Δy_i 01-02 stands for household real per capita income changes (2001–2002).

Robust standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Village dummies are included in all the models.

[a] T-test of differences between the estimated β in food and total consumptions for OLS and 2SLS, separately.

4-3. Attrition Bias-Adjusted Regression of the Basic and Modified Models

As discussed in Section 3-2-2, the regression results in Tables 2 and 3 might have some attrition bias. Table 4 shows the regression results of equations (4) and (5) by applying the IPW method expressed in equation (D.2) in Appendix D. I compare the '2003-sample households also present in 2007', a balanced panel of 25,899 households without consumption or income variables corresponding to Column (B) of Table 1, with the 'balanced panel for regression', which consists of 12,394 households with complete information on consumption and income after outliers are dropped, which corresponds to Column (D) of Table 1.

The table shows similar results to those in Tables 2 and 3. The upward biases of the estimated β in the normal OLS (Tables 2 and 3) have been corrected. Attrition biases were greater for the change in food consumption in Models 1, 2, 5, and 6 compared with those for the change in total consumption in Models 3, 4, 7, and 8 because the latter present estimates similar to or slightly smaller in absolute values than those of the normal OLS.

I also compare the 'balanced panel with complete information on consumption' (Column (C) of Table 1) with the Column (D) sample mentioned above for a further robustness check. The results do not change despite the different sample attrition sizes. The details are provided in Appendix E.

TABLE 4

REGRESSION RESULTS OF EQUATIONS (5) AND (6) WITH IPWS

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	Food		Total		Food		Total	
β	0.09**		0.25***		0.06		0.19***	
dΔy_i (β1)		0.10*		0.18***		0.07		0.12***
(1-d)Δy_i (β2)		0.09*		0.51***		0.06***		0.45***
constant	-3.01***	-2.94**	31.09***	23.89***	-24.23	-24.22	31.63***	24.97***
household characteristics (X)	No	No	No	No	Yes	Yes	Yes	Yes
No. of Obs.	12394	12394	11441	11441	11711	11711	11305	11305
R-squared	0.06	0.06	0.13	0.13	0.06	0.06	0.16	0.17

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ based on weighted clustered standard errors.

Village dummies are included in all the models.

The IPWs in this table are calculated based on Samples (B) and (D) of Table 1.

The full results of these tables and the probit models to calculate the IPWs are in Appendix F.

5. Empirical Analyses of CCT Effects

5-1. Regression Results

Table 5 shows the regression results for equation (6), which assesses the household type that is less (or more) vulnerable to idiosyncratic (especially negative) income shocks. This time, I apply least squares dummy variable (LSDV) estimation methods to control for the village dummy to deal with the technical problems that arose when conducting bootstrap methods for the two-step IV estimation.[10] The regression results show that the tendency is the same for both the LSDV and the IV (2SLS) models. The IV models use the same IVs as the previous ones to correct the endogeneity problem. In addition, the IV models offer better results than the LSDV models in terms of consistency with the intuition. The first-stage IV regression results are provided in Appendix G.

The estimates show that β_1 is smaller than β_2 except for Model 8, which confirms the regression result in Table 3 that consumption smoothing is more effective (households are better insured) when dealing with negative shocks. As for the interaction terms of household characteristics with negative income changes ($X_i d_i \Delta y_i$), the negative coefficients indicate that the variable can reduce the corresponding household vulnerability by enabling consumption smoothing amid idiosyncratic income shocks. Education levels have almost no effect on reducing vulnerability (through consumption smoothing) since they are mostly insignificant, irrespective of the sign, especially for all the variables in the IV models.

The variables that have counter effects (reduce household vulnerability in the case of negative income changes) are mainly CCT (including the *Treatment 1998* and *2000* dummies), large family size, landholdings (significant only in IV), self-consumption (significant only in IV), and marital status (significant only in LSDV). Their coefficients are negative and significant. In the first place, it is noteworthy that the CCT in Models 1, 3, 5, and 7 is robust to reducing household vulnerability against negative shocks, providing a relief of 0.20 pesos for food (Model 4) and 0.26 pesos for total (Model 7) consumption with every 1-peso decline in income. In addition, I use the *Treatment 1998* and *2000* dummies instead of *CCT03,* with Control 2003 as a base, in Models 2, 4, 6, and 8 to clarify the phase-in effect of PROGRESA-Oportunidades explained in Section 2. The results indicate that longer exposure to PROGRESA-Oportunidades, compared with Control 2003, would reduce household vulnerability, especially in the IV models. Belonging to a Treatment 1998 or Treatment 2000 village provides a relief of 0.23–0.27 pesos for food (Model 4) and 0.25–0.32 pesos for total (Model 8) consumption with every 1-peso decline in income.

The effect of large families and marriage can be explained by household economies of scale, which reduce per capita living costs, while landholdings should imply the importance of initial assets to cope with shocks as development theories predict. One additional household member offsets the consumption decline (food and total) with an income drop of 1 peso by 0.14–0.16 pesos (IV models), 0.20–0.25 pesos (LSDV models) for being married, and 0.46–0.6 pesos (IV models) for landholders. Moreover, self-consumption offsets the consumption drop with an income decline of 1 peso by 0.20–0.43 pesos (IV models), which implies that the increasing vulnerability during 2003–2007 can be attributed to the food price increase in the same period. In addition, the indigenous dummy becomes negative and significant at the 10 per cent level in Models 3 and 4, which would suggest a stronger consumption-smoothing network for subsistence and a higher percentage of farmers among indigenous groups because of their history and culture.

On the contrary, receiving remittances increases household vulnerability when the household is hit by negative income shocks because their coefficients are positive and significant in most cases (except for Models 3 and 4). The results show that there is no effect on food consumption smoothing, while an income drop of 1 peso induces a total consumption decline of 0.20–0.21 pesos (Models 7 and 8). Accordingly, Fafchamps (2003) argues that sometimes remittances do not serve as insurance in times of shocks because the money does not arrive on time, although its explicit role remains an unsolved issue.

The results for the interactions with positive income changes ($X_i(1-d_i)\Delta y_i$) are not as clear as those for negative income changes. However, education tends to enable households to achieve consumption smoothing because most of the coefficients have negative signs and their magnitudes are greater, especially for total consumption, which is consistent with our intuition. Another important finding is that households with female heads, indigenous families, and those with self-consumption tend to reduce household consumption when they experience positive income gains. This suggests that these households are most vulnerable to poverty, and thus, prepare themselves for future shocks through precautionary savings or asset investments in good times.

By contrast, landholdings and receiving PROGRESA-Oportunidades tend to increase consumption this time. These phenomena can be explained by the unexpected increase in income owing to the rise in food prices for landholders and by the additional income that enables households to relax their budget constraints relying on PROGRESA-Oportunidades as a regular income source. There was no phase-in effect for positive consumption change as the coefficients of the *Treatment 1998* and *2000* dummies are all insignificant.

TABLE 5

LSDV REGRESSION RESULTS FOR EQUATION (6)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	LSDV	LSDV	IV	IV	LSDV	LSDV	IV	IV
		Food				Total		
dΔy_i (β1)	0.44***	0.43***	1.21***	1.33***	0.54***	0.47***	2.02***	2.19***
(1-d)Δy_i (β2)	0.88***	0.94***	2.83***	2.57***	1.01***	1.06***	2.44***	2.15**
				interaction with dΔy_i (β1)				
primary03	-0.03	-0.03	0.04	0.05	0.03	0.04	0.04	0.05
secondary03	-0.04	-0.03	0.14	0.16	-0.05	-0.03	0.20	0.19
highschool03	-0.02	-0.01	-0.26	-0.23	-0.01	0.001	-0.35	-0.27
technical03	0.27*	0.30*	0.26	0.27	0.08	0.11	0.36	0.40
university03	0.12	0.14	0.69	0.94	0.40	0.44	1.33	1.50
total_member03	-0.02***	-0.03***	-0.14***	-0.14***	-0.04***	-0.05***	-0.16***	-0.16***
depratio03	-0.001	-0.001*	0.01***	0.01***	-0.001*	-0.002**	0.01***	0.01***
female03	-0.09	-0.10	0.06	0.09	-0.12	-0.12	0.04	0.07
age03	0.001	0.001	0.001	0.001	0.002	0.002*	-0.003	-0.003
married03	-0.20***	-0.20***	-0.06	-0.04	-0.24***	-0.25***	-0.02	-0.01
indigenous03	0.02	0.01	-0.146*	-0.129*	0.03	0.02	-0.16	-0.14
land holding03	-0.003	0.01	-0.46***	-0.47***	0.01	0.01	-0.58***	-0.59***
remittance03	0.11***	0.11***	0.06	0.05	0.13***	0.14***	0.21**	0.20**
self-consumption03	0.09		-0.20**	-0.19**	0.02	0.02	-0.43***	-0.43***
CCT03	-0.09***	0.09	-0.20***		-0.08**		-0.26***	
Treatment 1998		-0.05		-0.23**		0.02		-0.24*
Treatment 2000		-0.04		-0.27**		0.01		-0.32**
				interaction with (1-d)Δy_i (β2)				
primary03	-0.13*	-0.13*	-0.17	-0.13	-0.17**	-0.17**	-0.27	-0.20
secondary03	-0.30***	-0.30***	-0.57**	-0.54**	-0.27**	-0.26**	-0.47	-0.43
highschool03	-0.22	-0.24	-0.48	-0.46	-0.13	-0.17	0.03	0.17
technical03	-0.32***	-0.33***	-1.02*	-1.02	0.13	0.11	0.74	0.80
university03	-0.88*	-0.92*	-0.66	-0.27	-0.18	-0.21	1.76	2.00

total_member03	-0.01	-0.01	0.03	0.02	-0.01	-0.01	0.03	0.02
depratio03	0.00	0.00	-0.007**	-0.007*	0.00	0.00	0.00	0.00
female03	-0.05	-0.05	-0.14	-0.04	-0.23	-0.23	-0.59	-0.49
age03	-0.01***	-0.01***	0.01	0.01	-0.01***	-0.01***	0.02*	0.02*
married03	0.02	0.03	0.04	0.15	0.05	0.05	0.01	0.12
indigenous03	0.10*	0.11**	-0.32**	-0.28*	0.02	0.04	-0.56***	-0.51**
land holding03	0.15**	0.15**	0.79***	0.81***	0.09	0.09	1.28***	1.31***
remittance03	0.01	0.00	0.03	0.02	-0.09	-0.09	0.14	0.14
self-consumption03	-0.31***	-0.31***	-0.55**	-0.51**	-0.06	-0.06	-0.43	-0.40
CCT03	-0.01		0.37***		0.01		0.40**	
Treatment 1998		-0.04		0.26		0.03		0.26
Treatment 2000		-0.12		-0.03		-0.15		-0.14
constant	-11.38***	-11.37***	-35.95***	-34.44***	-12.86***	-12.86***	-31.43***	-28.88***
No. of Obs.	12349	12349	12349	12349	11442	11442	11442	11442
R-squared	0.08	0.08	-		0.09	0.09	-	
Wald chi2	891.20	827.70	-		852.35	855.15	-	
Repetition	400	400	400	400	400	400	400	400

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ based on bootstrap clustered standard errors.

$d\Delta y\_i$ and $(1-d)\Delta y\_i$ stand for negative and positive changes in income.

5-2. Robustness Checks

The regression results of this section are also subject to possible attrition bias discussed in Sections 3 and 4. Furthermore, there might be some selection biases in the CCT dummy because eligible households decide themselves whether to participate in or exit the programme. Households that could not achieve the CCT requirements are forced to exit the programme, which could also be attributed to specific characteristics of unaccomplished households. Table 6 shows the entry and exit information for households in PROGRESA-Oportunidades between 2003 and 2007, calculated from ENCEL. The table indicates that 72 per cent of households, including noneligible ones, did not change their status (the diagonal line: 28.4%+17.9%+0.7%+24.8%). However, 6.2 per cent of beneficiary households in Treatment 1998 and 2000 villages (3.8%+2.4%) exited in 2007, while 11.9 per cent of nonbeneficiary households in these villages (5.6%+6.3%) entered the programme in 2007. New beneficiary households in the Control 2003 group that became entitled after the 2003 survey constituted 10.1 per cent of households.

Taking these into consideration, I conduct two-step estimations of equation (6) by assuming that the CCT dummy is endogenous, but the income change is assumed to be exogenous here. I use ENCEL-based poverty assessment scores and classification in 2007 (*eligibility,* both raw scores and dummy) as an instrument to the CCT dummy because the 2003 assessment is constrained by a number of missing data. However, 85 per cent of the 2003 eligibility cases coincide in classification with those in 2007 (see Appendix H for details).

TABLE 6

ENTRY AND EXIT OF SAMPLE HOUSEHOLDS IN PROGRESA-OPORTUNIDADES, 2003–2007

		Beneficiary in 2007			Not beneficiary in 2007	Total
		Treatment 1998	Treatment 2000	Control 2003		
Beneficiary in 2003	Treatment 1998	5,326 (28.4%)	-	-	704 (3.8%)	6,030 (32.1%)
	Treatment 2000	-	3,350 (17.9%)	-	449 (2.4%)	3,799 (20.2%)
	Control 2003	-	-	133 (0.7%)	24 (0.1%)	157 (0.8%)
Not beneficiary in 2003		1,060 (5.6%)	1,179 (6.3%)	1,890 (10.1%)	4,648 (24.8%)	8,777 (46.8%)
Total		6,386 (34.0%)	4,529 (24.1%)	2,023 (10.8%)	5,825 (31.0%)	18,763 (100%)

Source: Author's calculation based on ENCEL 2003 and 2007.

Table 7 shows the regression results of the robustness checks for equation (6). Both the attrition-adjusted (by IPW) model and the IV model with the CCT dummy (*CCT03)* as endogenous present results consistent with Table 5. Moreover, all the results in Table 7 are corrected to some extent for the upward bias in those reported in Table 5, especially in the magnitude of the coefficients for the negative and positive income changes and for the interaction term with *CCT03*. The interaction term of the negative income change with *CCT03* is negative in all the models as expected, but significant only for the total consumption change in the attrition-adjusted model (Model 2) and for the food consumption change in the IV models (Models 3 and 4).

TABLE 7

REGRESSION RESULTS OF THE ROBUSTNESS CHECKS FOR EQUATION (6)

Variable	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
	Attrition Adjusted Model		IV Model (Instrumented: *CCT03*)			
	Food	Total	Food		Total	
dΔy_i (β1)	0.63	0.51***	0.43***	0.43***	0.47***	0.47***
(1-d)Δy_i (β2)	1.09	0.88**	0.86***	0.86***	0.99***	0.99***
interaction with dΔy_i (β1)						
primary03	0.26	0.05	-0.03	-0.03	0.05	0.05
secondary03	0.35	0.00	-0.05	-0.05	-0.04	-0.04
highschool03	0.19	0.07	-0.02	-0.02	0.00	0.00
technical03	0.54	-0.07	0.30**	0.30**	0.05	0.05
university03	0.18	0.21	0.01	0.01	0.28	0.28
total_member03	-0.05	-0.05***	-0.02***	-0.02***	-0.05***	-0.05***
depratio03	0.01	0.00	0.00	0.00	0.00	0.00
female03	0.07	-0.11	-0.09	-0.09	-0.13	-0.13
age03	0.00	0.00	0.00	0.00	0.00	0.00
married03	-0.91	-0.22**	-0.19***	-0.19***	-0.23***	-0.23***
indigenous03	-0.26	0.07	0.04	0.04	0.07	0.07
land holding03	-0.01	0.06	0.03	0.03	0.03	0.03
remittance03	0.40**	0.09*	0.11***	0.11***	0.13***	0.13***
self-consumption03	0.21	0.08	0.09	0.09	0.03	0.03
CCT03	-0.08	-0.13***	-0.12**	-0.12**	-0.07	-0.07
constant	-13.22	25.91***	-8.26***	-8.31***	26.10***	26.01***
Instrument	-	-	*eligibility (score)*	*eligibility (dummy)*	*eligibility (score)*	*Eligibility (dummy)*
No. of Obs.	11711	11305	12326	12326	11421	11421
R-squared	0.06	0.15	0.13	0.13	0.15	0.15

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ based on clustered standard errors.

Village dummies are included in all the models.

The same IPWs as those of Models (6) and (8) in Table 4 are used for Models (1) and (2) in this table, respectively.

The first-stage regression results of the IV model are in Appendix I and the full results of the second stage, including the interaction terms with *(1-d)Δy_i*, are available upon request.

5. Concluding Remarks

This study examined the vulnerability of households in rural Mexico as well as the effects of the CCT programme. First, by drawing on Townsend's (1994) basic model, I revealed that existing risk sharing is incomplete but better insures basic needs. I modified the model according to Kurosaki (2006) to consider the different marginal effects based on household characteristics, focusing on negative income shocks, which allowed for the more accurate measurement of household vulnerability. The results confirmed that the CCT are effective in reducing household vulnerability to idiosyncratic income shocks in rural Mexico. Besides the CCT, larger families, landholdings, and self-consumption can mitigate vulnerability. Households receiving remittances become more vulnerable to shocks, which can be explained by Fafchamps' (2003) argument that remittances might not smooth consumption when faced by a shock because they do not arrive on time.

However, one should consider the possible downward rigidity of food demand when adopting risk-sharing models; vulnerable households living below subsistence levels cannot further decrease their consumption when hit by income shocks. Moreover, the mechanism through which the CCT programme reduces household vulnerability is yet to be clarified. Securing a minimum consumption floor, which is stated as one of the main objectives of CCTs, might gradually change the consumption behaviour of a household. However, these inferences should be carefully examined with more detailed analyses of quantitative and qualitative evidence.

This study was based on two-period cross-sectional panel data. However, ENCEL data have nine rounds in total, with the 10th survey conducted in 2011. Moreover, since 2003, food prices have constantly increased in tandem with the international food price crisis, which peaked in 2008 and 2011. The sample should thus be expanded to more than three periods for a more precise consideration of the influence of price shocks and the global economic crisis in 2008, when new data become available, and to further enable robustness checks.

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[1] Townsend (1994) uses 10-year panel data from the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) on three high-risk villages in the semi-arid tropics of southern India.

[2] This section draws on Bardhan and Udry (1999) and Kurosaki (2001, 2006, 2009).

[3] See Uchiyama (2016) for a maximisation process based on Townsend (1994), Bardhan and Udry (1999), and Kurosaki (2001).

[4] An alternative hypothesis implies a complete autarky or lack of risk-sharing mechanisms.

[5] Details of the income change for 2001–2002 are explained in Appendix A.

[6] Further, the *F* statistics for the weak instrument tests are sufficiently large in absolute values to show the robustness of all the models, as presented in the following tables.

[7] I also regressed the models with per capita consumption and income calculated using the different specifications of adult equivalent scales on the basis of Székely (2005), a study that contains reliable information on the determination of Mexican official poverty measures. The results showed no significant change in any of the specifications. All results can be available upon request.

[8] See, for example, Ravallion and Chaudhuri (1997), Kurosaki (2001, Tables 6–8), and Deaton (1992, Table 3).

[9] One can infer from the 2SLS regression results that the downward bias caused by measurement errors is greater than other possible biases, which can be attributed to specification errors or omitted variables.

[10] I used bootstrap methods here considering that any estimation errors in the first-stage estimators (including the IVs) are ignored in calculating the sequential two-step estimators, $\hat{\beta}_1$ and $\hat{\beta}_2$, when the OLS method is applied (Cameron and Trivedi, 2009). This problem is attributed to the fact that the distributions of $\hat{\beta}_1$ and $\hat{\beta}_2$ depend on those of the first-step estimators.

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APPENDIX A

TABLE A1

SUMMARY STATISTICS BY SUBGROUP

Variable	(1) Treatment 1998		(2) Treatment 2000			(3) Control 2003		
	Mean	Std. Dev.	Mean	Std. Dev.		Mean	Std. Dev.	
Cf_i, 2003	70.87	(45.64)	68.93	(43.53)	***	79.76	(48.18)	***
Ct_i, 2003	89.14	(58.96)	88.53	(87.88)		102.38	(80.41)	***
Cf_i, 2007	60.65	(39.19)	58.55	(37.01)	***	73.08	(44.23)	***
Ct_i, 2007	76.99	(52.33)	75.82	(51.50)		96.26	(61.40)	***
Y_i, 2003	30.65	(45.12)	29.71	(43.43)		23.50	(40.93)	***
Y_i, 2007	22.70	(21.55)	22.11	(20.16)		23.64	(23.43)	*
primary03	0.64	(0.48)	0.66	(0.48)	**	0.66	(0.47)	*
secondary03	0.09	(0.29)	0.09	(0.28)		0.13	(0.33)	***
highschool03	0.01	(0.10)	0.01	(0.10)		0.02	(0.13)	***
technical03	0.008	(0.09)	0.005	(0.07)	**	0.006	(0.08)	
university03	0.002	(0.04)	0.002	(0.05)		0.004	(0.06)	
total_member03	5.22	(2.33)	5.26	(2.33)		5.32	(2.28)	**
depratio03	43.02	(24.05)	42.61	(24.00)		41.85	(23.20)	***
female03	0.10	(0.30)	0.10	(0.30)		0.10	(0.30)	
age03	46.33	(14.60)	46.27	(14.67)		46.24	(14.58)	
married03	0.88	(0.33)	0.88	(0.33)		0.87	(0.33)	
indigenous03	0.32	(0.47)	0.37	(0.48)	***	0.15	(0.36)	***
land holding03	0.66	(0.47)	0.64	(0.48)	**	0.51	(0.50)	***
total_land_ha03	2.88	(8.28)	2.77	(7.13)		2.64	(7.50)	
remittance03	0.25	(0.43)	0.25	(0.44)		0.27	(0.44)	
CCT03	0.75	(0.43)	0.67	(0.47)	***	0.05	(0.22)	***
CCT07	0.81	(0.39)	0.81	(0.39)		0.68	(0.47)	***
self-consumption03	0.06	(0.25)	0.06	(0.25)		0.06	(0.24)	
migration03	0.35	(0.48)	0.36	(0.48)	*	0.20	(0.40)	***
No. of Obs.	5919		4146			2329		

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ based on t-tests compared with Treatment 1998.

APPENDIX B: Variables

Household real per capita food consumption: First, I construct each household's weekly food consumption by summing up the reported amount of weekly food consumption of the interview week, and the estimated weekly self-consumption. Then, I divide the household's weekly food consumption by the number of household members to ascertain per capita weekly food consumption. In estimating self-consumption, I first calculate the median state price of each item using each household's reported weekly purchase and the expenditure on the item. Then, I multiply the amount of reported self-consumption by the estimated unit median price of the state. Per capita food consumption is deflated by the annual average food CPI.[i]

Household real per capita total consumption: I construct a household's real per capita total consumption in the same manner as food consumption, using the reported weekly total consumption of food and nonfood items of the interview week. Per capita total consumption is deflated by the annual average general CPI. However, expenditures on transport, doctors, medicines, combustibles, cigarettes and alcohol, school materials, and other durable goods and extraordinary expenditures such as parties are all excluded because these types of information are collected separately in the survey.

Household real per capita income in 2003 and 2007: This includes all household members' wages, pensions, bonuses, monetary institutional transfers (including PROGRESA-Oportunidades), agricultural sales, and nonagricultural sales. It excludes personal transfers

[i] Banco de México Estadísticas (http://www.banxico.org.mx/estadisticas/index.html); June 2001 = 100.

(including remittances), nonlabour or irregular incomes, such as the sales of assets (for example, houses, cars, and home electronics), inheritance, lottery, gifts, and donations. Personal transfers are excluded considering the possibility that they might reflect ex post adjustments to shocks, as Skoufias (2007) argues, and because I use a migration dummy as an IV in the regressions. The reported units for each income source vary from daily, weekly, and monthly to annual. Thus, I estimate the weekly amounts of each income source and sum these up to estimate weekly household income. Then, I divide the weekly total income by the number of household members and deflate it by the annual average general CPI. Households that have any type of unreported income source are dropped from the sample.

Household real per capita income in 2001 and 2002: This consists of the sum of the household head's and spouse's retrospective weekly wage incomes divided by the number of household members, which is deflated by the average annual general CPI. The sum of the retrospective wage earnings of household heads and spouses are used as a proxy of lagged household income changes because data for the newly added control group (Control 2003) are not available for the years prior to 2003.

Education dummies: *Primary*, *secondary*, and *high school* refer to those who have enrolled in a primary, secondary, and high school, respectively, regardless of whether they graduated. *Technical* education refers to those who have enrolled in any technical or vocational school, including teacher's college. *University* education includes those who have enrolled for a university and higher education (including those who graduated from university and have entered into or graduated from the postgraduate level).

Household demographic variables: The total number of household members refers to the members who live in the same house. It excludes those who live separately for more than one year or whose stay is temporary, as well as the deceased. The dependency ratio is the proportion of household members under 14 years and over 65 years of age (nonlabour force) to the number of household members aged 15–64 years (labour force).

APPENDIX C

TABLE C1

VARIABLE DESCRIPTIONS

(PANEL A: Consumption and Income)	
Cf_i	Per capita real weekly food consumption
Ct_i	Per capita real weekly total consumption
ΔCf_i	Per capita real weekly food consumption change between 2003 and 2007
ΔCt_i	Per capita real weekly total consumption change between 2003 and 2007
Y_i	Per capita real weekly income
ΔY_i	Per capita real weekly income change between 2003 and 2007
dΔY_i	Negative per capita real weekly income change between 2003 and 2007
(1-d)ΔY_i	Positive per capita real weekly income change between 2003 and 2007
(PANEL B: Household Characteristics (Education))	
no education03	Takes 1 if the household head has never received education in her/his life as of 2003.
primary03	Takes 1 if the household head has ever enrolled in a primary education as of 2003.
secondary03	Takes 1 if the household head has ever enrolled in a secondary education as of 2003.
highschool03	Takes 1 if the household head has ever enrolled in a high school as of 2003.
technical03	Takes 1 if the household head has ever enrolled in a technical or vocational school, including a teacher's college, as of 2003.
university03	Takes 1 if the household head has ever enrolled for a university and higher education as of 2003.
(PANEL C: Household Characteristics (Others))	
total_member03	Represents the total number of household members who live in the same house in 2003.
depratio03	Represents the household's dependency ratio in 2003.
female03	Takes 1 if the household head is female in 2003.
age03	Represents the age of the household head in 2003.
married03	Takes 1 if the household head is married in 2003.
indigenous03	Takes 1 if the household head speaks indigenous language in 2003.
land holding03	Takes 1 if the household cultivated a land in 2003.
total_land_ha03	Total hectares of lands the household cultivates in 2003.
irrigation03	Takes 1 if the household has access to irrigation at least for one of their plots in 2003.
remittance03	Takes 1 if the household receives personal cash/in kind transfers from domestic/foreign migrants in 2003.
self-consumption03	Takes 1 if the household has self-consumption during the interviewed week in 2003.
CCT03	Takes 1 if the households receive CCT benefits in 2003.
CCT07	Takes 1 if the households receive CCT benefits in 2007.
(PANEL D: States and Treatment Groups)	
Treatment 1998	Takes 1 if the household lives in one of the villages where the CCT programme started in 1998 (original treatment group).
Treatment 2000	Takes 1 if the household lives in one of the villages where the CCT programme started in 2000 (original control group).

Control 2003	Takes 1 if the household lives in one of the villages newly added to the ENCEL survey in 2003 where the CCT programme started by 2004 (new control group).
(PANEL E: Instruments)	
attriratio	Sample attrition ratio at the municipal level between 2003 and 2007, which is calculated separately for food and total consumption.
ΔY_i, 01-02	Per capita real weekly income change between 2001 and 2002
migrant03	Takes 1 if the household has members older than 15 years who lived away from home (domestic/foreign migrants) in 2003.
eligibility (score)	ENCEL-based poverty assessment score in 2007.
eligibility (dummy)	Takes 1 if the household is assessed poor according to the ENCEL-based poverty assessment in 2007.

Note: Refer to Appendix B for further details on the construction of variables.

Source: Author’s elaboration.

APPENDIX D: IPW Method

According to Fitzgerald et al. (1998), we assume that the object of interest is the conditional population density $f(\Delta c_i|\Delta y_i,\ X_i)$, where Δc_i is the consumption change in household i and Δy_i and X_i are independent variables (household i's income change and characteristics). A_i is an attrition dummy equal to 1 if an observation is missing its Δc_i value because of attrition, and 0 otherwise (X_i is assumed to be observed for all in this case). I define the attrition function as the probability function $\Pr(A_i = 1|\ \Delta c_i, \Delta y_i,\ X_i, z)$, where z is an auxiliary variable assumed to be observable for all units.

In case we assume selection on observables, we can apply the IPW method (Fitzgerald et al., 1998; Wooldridge, 2002):

$$f(\Delta c_i|\Delta y_i,\ X_i) = \int_z \ g(\Delta c_i, z|\Delta y_i,\ X_i, A_i = 0) w(z.\Delta y_i,\ X_i) dz \qquad \text{(D.1)}$$

where

$$w(z.\Delta y_i,\ X_i) = \left[\frac{\Pr(A_i=0|\ \Delta y_i, X_i, z)}{\Pr(A_i=0|\ \Delta y_i, X_i)}\right]^{-1} \qquad \text{(D.2)}$$

$g(\Delta c_i, z|\Delta y_i,\ X_i, A_i = 0)$ denotes the conditional density function.

APPENDIX E

TABLE E1

REGRESSION RESULTS OF EQUATIONS (5) AND (6) WITH IPWS (II)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	Food		Total		Food		Total	
β	0.10**		0.25***		0.07		0.19***	
dΔy_i (β1)		0.07		0.19***		0.10		0.13***
(1-d)Δy_i (β2)		0.14*		0.51***		0.06***		0.44***
constant	5.80***	5.82***	31.06***	24.21***	26.04**	25.72**	30.29***	23.92***
household characteristics (X)	No	No	No	No	Yes	Yes	Yes	Yes
No. of Obs.	11717	11717	11312	11312	11668	11668	11273	11273
R-squared	0.06	0.06	0.13	0.13	0.06	0.06	0.16	0.17

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ based on weighted clustered standard errors. Village dummies are included in all the models.

The IPWs in this table are calculated based on Samples (C) and (D) of Table 1.

The full results of these tables and the probit models to calculate the IPWs are available upon request.

APPENDIX F

TABLE F1

FULL RESULTS OF TABLE 4

Variable	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
	Food		Total		Food		Total	
β	**0.095****		**0.245*****		**0.064**		**0.191*****	
dΔy_i (β1)		0.096*		0.177***		0.066		0.124***
(1-d)Δy_i (β2)		0.092*		0.511***		0.062***		0.449***
primary03					-23.23	-23.23	-3.85*	-4.039*
secondary03					-22.80	-22.80	-5.477*	-5.857*
highschool03					-21.88	-21.84	0.255	-1.400
technical03					-40.48*	-40.43*	7.225	4.668
university03					151.57	151.61	-1.711	-4.053
total_member03					1.645	1.641	2.383***	2.534***
depratio03					0.714	0.714	0.260***	0.236***
female03					41.51	41.51	-6.228	-6.109
age03					-0.500*	-0.500*	-0.444***	-0.445***
married03					26.04	26.04	3.098	3.071
indigenous03					-0.871	-0.873	0.824	0.983
land holding03					12.62	12.63	0.165	0.269
remittance03					-3.681	-3.687	-2.784*	-2.539
CCT03					-4.598	-4.598	3.536**	3.802**
constant	-3.01***	-2.94**	31.09***	23.89***	-24.23	-24.22	31.63***	24.97***
No. of Obs.	12394	12394	11441	11441	11711	11711	11305	11305
R-squared	0.064	0.064	0.126	0.132	0.062	0.062	0.161	0.167

Note: * p < 0.1, ** p < 0.05, *** p < 0.01 based on weighted clustered standard errors.

Village dummies are included in all the models.

TABLE F2

PROBIT RESULTS OF TABLE 4

Variable	Model (a)	Model (b)	Model (c)	Model (d)	Model (e)	Model (f)	Model (g)	Model (h)
			Food				Total	
				(Dependent Variable: Attrition=1)				
attriratio	3.35***		3.55***		3.10***		3.13***	
primary03			-0.06**	0.04			-0.04	0.02
secondary03			-0.10*	0.06			-0.02	0.07*
highschool03			-0.09	0.02			-0.09	-0.03
technical03			0.19	0.18			0.07	0.10
university03			0.31	0.28			0.061	0.09
total_member03			0.02***	0.02***			0.02***	0.02***
depratio03			-0.001**	-0.002***			-0.001**	-0.001***
female03			-0.06	-0.11**			-0.04	-0.05
age03			0.007***	0.008***			0.005***	0.007***
married03			-0.35***	-0.21***			-0.09**	-0.13***
indigenous03			0.02	0.23***			0.03	0.22***
land holding03			0.07**	0.04			0.06**	0.05**
remittance03			0.08***	0.01			0.07***	0.001
CCT03			0.25***	0.31***			0.15***	0.22***
constant	-0.61***	0.68***	-1.01***	-0.04	-0.65***	0.68***	-1.06***	0.03
No. of Obs.	25740	25740	20037	20037	25751	25751	20833	20833
Likelihood Ratio	9149.4	3240.3	7992.7	3259.2	7241.7	2509.4	6279.3	2699.3
Pseudo R2	0.30	0.11	0.36	0.5	0.22	0.08	0.25	0.11
Log likelihood	-10568.2	-13522.7	-7005.3	-9372.0	-12771.0	-15137.1	-9431.2	-11221.2
F test		2.81		2.42		2.87		2.31

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ based on clustered standard errors.
Village dummies are included in all the models.
Income-related variables and self-consumption dummy are excluded for technical reasons. However, they are included in the Appendix E model, whose coefficients are virtually zero and nonsignificant. The results are available upon request.
F tests rejected the null hypothesis between Models (a) and (b), (c) and (d), (e) and (f), and (g) and (h).

APPENDIX G

TABLE G1

FIRST STAGE OF THE 2SLS REGRESSIONS FOR EQUATION (6) (TABLE 5)

(Determinants of Positive and Negative Income Changes)

Variable	Model 1	Model 2	Model 3	Model 4
	Food		Total	
	dΔy_i (minus)	(1-d)Δy_i (plus)	dΔy_i (minus)	(1-d)Δy_i (plus)
Δy_i 01-02	**-0.077****	**0.001**	**-0.077****	**0.003**
hhmigrant_over15_dum03	**-2.284****	**-3.792*****	**-2.003****	**-3.728*****
primary03	-3.189***	0.060	-3.458***	0.075
secondary03	-3.785***	0.899	-3.807**	0.919
highschool03	-15.99***	0.292	-15.29***	0.103
technical03	-13.82**	3.229	-14.44**	3.317
university03	-20.21**	1.290	-18.70**	1.954
total_member03	1.488***	-0.315***	1.538***	-0.293***
depratio03	0.079***	0.094***	0.072***	0.095***
female03	2.203	0.992	2.367	0.943
age03	-0.376***	-0.068***	-0.372***	-0.067***
married03	1.192	1.157*	1.466	1.333*
indigenous03	3.999**	0.381	3.976**	0.249
land holding03	-11.44***	-2.719***	-11.90***	-2.987***
remittance03	-3.060***	-1.528***	-2.929***	-1.530***
CCT03	-6.605***	-3.416***	-6.639***	-3.217***
self-consumption03	0.142	-0.438	0.117	-0.253
constant	8.213*	26.94***	9.472**	27.54***
No. of Obs.	12,349	12,349	11,442	11,442
R-squared	0.139	0.137	0.147	0.140

Note: Δy_i 01-02 stands for household per capita income changes in 2001–2002.

Robust standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

APPENDIX H

TABLE H1

ENCEL-BASED ELIGIBILITY CLASSIFICATION IN 2003 AND 2007

		Eligibility in 2007		
		Nonpoor	Poor	Total
Eligibility in 2003	Nonpoor	614 (7.35%)	289 (3.46%)	903 (10.81%)
	Poor	930 (11.13%)	6,521 (78.06%)	7,451 (89.19%)
	Total	1,544 (18.48%)	6,810 (81.52%)	8,354 (100%)

Note: Author’s calculations based on ENCEL

APPENDIX I

TABLE I1

FIRST-STAGE REGRESSION RESULTS OF THE IV MODEL FOR THE ROBUSTNESS CHECKS (TABLE 7)

Variable	Model (1)	Model (2)	Model (3)	Model (4)
	Food	Food	Total	Total
	(Dependent Variable: CCT03)			
eligibility (score)	**-0.012****		**-0.012****	
eligibility (dummy)		**0.004**		**0.001**
dΔy_i	-0.0002***	-0.0002**	-0.0003***	-0.0002**
(1-d)Δy_i	-0.001***	-0.001***	-0.001***	-0.001***
primary03	-0.016	-0.011	-0.015	-0.011
secondary03	-0.056***	-0.048***	-0.053***	-0.046**
highschool03	-0.138***	-0.126***	-0.133***	-0.122***
technical03	-0.197***	-0.183***	-0.205***	-0.192***
university03	-0.333***	-0.315***	-0.344***	-0.327***
total_member03	0.024***	0.024***	0.024***	0.023***
depratio03	0.001***	0.001***	0.001***	0.001***
female03	0.072***	0.074***	0.070***	0.072***
age03	0.001*	0.001**	0.001**	0.001**
married03	0.074***	0.077***	0.075***	0.078***
indigenous03	0.020	0.018	0.015	0.013
land holding03	0.003	0.003	0.002	0.002
remittance03	0.020**	0.020**	0.021**	0.022***
self-consumption03	-0.014	-0.014	-0.006	-0.006
constant	-0.229***	-0.252***	-0.230***	-0.250***
No. of Obs.	12326	12326	11421	11421
R-squared	0.436	0.436	0.438	0.438

Note: * p < 0.1, ** p < 0.05, *** p < 0.01 based on clustered standard errors.

Village dummies are included in all the models.