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**Article**

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# Do conditional cash transfers reduce household vulnerability? Evidence from PROGRESA-Oportunidades in the 2000s

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## Abstract

A number of researchers and policymakers have revealed the short- and medium-term impacts of conditional cash transfer (CCT) programs; however, accumulation of full-scale evaluations of their long-term impact is ongoing. To contribute to filling the gap, this study empirically examines the vulnerability of rural households in Mexico and how CCT has recently impacted them. Using two Mexican rural household panel datasets from the 2000s, I adopt Kurosaki's (2006) version of Townsend's (1994) risk-sharing model with instrumental variable methods, which enables a greater focus on household welfare decline. The empirical results confirm that CCT played a certain role in reducing household vulnerability in the 2000s; however considering the situation after the global crisis in 2008 and the exact mechanism through which this occurs remains subject to further examination.

*JEL classifications:* O12; D12; O54

*Keywords:* Consumption smoothing; Household vulnerability; PROGRESA-Oportunidades

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## 1. Introduction

In 1997, more than 20 years ago, the first conditional cash transfer (CCT) program, the Education, Health, and Nutrition Program (Programa de Educación, Salud y Alimentación: PROGRESA), was implemented in Mexico. A number of researchers have revealed the short- and medium-term impacts of CCT programs; however, a full-scale evaluation of their long-term impact has just recently begun (see [Parker and Todd, 2017](#) for a full review and [Kugler and Rojas, 2018](#) for the longest term assessment to date). Such studies are now greatly needed so that general conclusions can be drawn to achieve the objectives of reducing both current and future poverty in developing countries.

There is no doubt among researchers and policymakers that the ultimate goal of the CCT is to help poor and vulnerable households break the intergenerational transmission of poverty ([Araujo et al., 2016](#); [Molina-Millan et al., 2016](#)). To achieve this goal, CCT programs aim to alleviate current poverty, as well as reduce future poverty, by linking

*Abbreviations:* CCT, conditional cash transfer; IV, instrumental variable; CARA, constant absolute risk aversion; IPW, inverse probability weighting; LSDV, least squares dummy variable.

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monetary transfers to children's human capital investment (Parker and Vogl, 2018). Since the beginning of PROGRESA (hereafter referred to as 'PROGRESA-Oportunidades'<sup>1</sup>) in 1997, its performance on the latter objective of education, health, and nutrition components has been thoroughly studied in the literature. By contrast, we do not rely on the sufficient literature that focus on the former objectives of reducing "current" poverty, especially in the longer term. This study focuses exclusively on whether the first objective of "current" poverty reduction was met in the 2000s from the perspective of household consumption smoothing by applying Kurosaki's (2006) model that is originally based on Townsend's (1994) well-known risk-sharing framework<sup>2</sup> with robust instrumental variables.

With respect to poverty and vulnerability, it is widely recognized that the primary obstacle in consumption smoothing, particularly among poor farmers, is liquidity constraints, usually caused by market imperfections, as asserted by Bardhan and Udry (1999). The nonexistence or poor functioning of formal credit and/or insurance markets in rural areas is supplemented by various informal mechanisms among families, ethnic groups, or neighborhoods.<sup>3</sup> In this respect, Townsend (1994) proposes the risk-sharing model to jointly evaluate these informal mechanisms using a general equilibrium framework. Kurosaki (2006) modified the Townsend (1994) model to enable us to consider, above all, the different marginal effects of both positive and negative income shocks. This allows us to assume different degrees of vulnerability across households in a village according to household characteristics, even if the panel period is limited. In line with Townsend's (1994) and Kurosaki's (2006) models, this study assumes that the vulnerability of Mexican rural households arises from the inability to smooth consumption because of liquidity constraints.

This study uses the *Encuestas de Evaluación de los Hogares (ENCEL: Household Evaluation Surveys)* for 2003 and 2007 to evaluate PROGRESA-Oportunidades. The empirical results confirm the long-term consumption-smoothing effects of PROGRESA-Oportunidades in reducing household vulnerability and reveal that larger family size and landholdings can mitigate household vulnerability, whereas receiving remittances increases it. In addition, two-stage least squares (2SLS) regressions with instrumental variables (IVs) were conducted to deal with endogeneity and attrition problems. The results are consistent for all models estimated.

The structure of the remainder of this paper is as follows. Section 2 presents the literature review of the effects of PROGRESA-Oportunidades on household consumption smoothing. Section 3 describes the models and data used in this study. Section 4 examines the effects of PROGRESA-Oportunidades by applying Kurosaki's (2006) model with robustness checks, and Section 5 concludes the paper.

## 2. Consumption-smoothing effects of PROGRESA-Oportunidades in rural Mexico

Although most CCT studies concentrate on human capital development, several previous studies have examined the consumption-smoothing effects of PROGRESA-Oportunidades in rural Mexico. Skoufias (2007) conducted an empirical analysis of the risk insurance model using three rounds of ENCEL panel data for 1998–1999 and rejected full risk-sharing in all specifications. The effect of PROGRESA-Oportunidades on improving pre-existing risk-sharing within villages was statistically insignificant in all models, except a few cases of subsample regressions based on household characteristics. He attributes the insignificance to the short passage of time (1.5 years) after the program's implementation. He finds that the coefficients are insignificant and the signs of the coefficients of the interaction terms (effects of PROGRESA) are 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

<sup>1</sup> PROGRESA was renamed "Oportunidades" after the government change in 2000, and is now known as "Prospera."

<sup>2</sup> The most recent study, Kugler and Rojas (2018), which covered up to 17 years (from 1997 to 2015), confirms the phase-in effects of the CCT on education and employment (including wage and employment quality), but do not examine consumption smoothing effects. Also, it is worth mentioning that some cross-country analyses of the long-term effects of CCT programs have been conducted, such as Molina-Millan et al. (2016) for Mexico, Nicaragua and Colombia, Robles et al. (2017) for 16 Latin American countries, and Amarante and Brun (2018) for 8 Latin American countries.

<sup>3</sup> Dercon (2005) describes two strategies used by households exposed to income fluctuations to reduce the impact of shocks: risk management and risk-coping. Risk management is an ex ante strategy seeking income smoothing through diversification of income sources by combining different income-generating activities such as crop diversification. Risk coping is an ex post strategy that includes self-insurance (precautionary savings) and informal group-based risk-sharing.

insurance markets, which enables not only treated households but also non-treated households to reduce savings and increase consumption.

Attanasio et al. (2013) simulate the welfare consequences of the food price increases in the 2000s in Mexico using five rounds of ENCEL data (from 1998 to 2003). They show that CCT programs more effectively alleviate the problem of increased staple prices than other indirect policies, computing the effects of 50-peso transfers (the amount equivalent to the “energy subsidy” introduced by the government) and 5% price subsidies. However, they include only part of ENCEL 2003 by excluding the newly added 151 sample villages as an additional control group from the 2003 round. They argue that these 151 villages are systematically different from the original ones, and thus the sample would lead to considerable sample compositional change (this point is discussed in detail in Section 3.2). In addition, they do not use the entire ENCEL 2007 for the same reason, although it is the only round so far that covers the food price crisis period. As a result, they used eligibility status as of 2003 when estimating the effect of cash transfer on rural household consumption amid the food price increase (2003–2011). This implies that virtually all the eligible households in the sample used for their estimation received CCT transfers, which made it difficult to completely separate the effects of cash transfers without including any control groups. In addition, the assumption of 5% price subsidies seems to be arbitrary, which might question the validity of the effect of cash transfers.

This study deals with these shortcomings by 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 regression methods with more robust IVs.

### 3. Model and data

#### 3.1. Risk-sharing model with emphasis on welfare loss and different household characteristics<sup>4</sup>

Townsend (1994) suggests a general equilibrium model to jointly assess the effectiveness of various (mostly informal) insurance mechanisms in a community such as a village. The theoretical model is obtained by maximizing a village utility function, which is the sum of  $N$  households’ utility functions weighted by each household’s Pareto efficient weight ( $\lambda_i$ ), subject to a pooled village income.<sup>5</sup>

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

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

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  $\beta_i$  are the parameters to be estimated.

By taking the first differences, we obtain:

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

where  $\Delta c_{it}$  and  $\Delta y_{it}$  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  $t$ ,  $\Delta v_{it}$  is an i.i.d. error term with zero mean, and  $a_i$  and  $\beta_i$  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.<sup>6</sup> If the village achieves Pareto optimal risk-sharing, the changes in each household’s consumption,  $\Delta c_{it}$ , should respond only to the village-level shock,  $\Delta \bar{c}_t$ . Theoretically,  $\beta_i$  moves between 0 and 1.

In addition, Deaton (1992) and Kurosaki (2006, 2009) argue that the size of  $\beta_i$  shows the sensitivity of consumption to idiosyncratic income shocks. A relatively large positive value for  $\beta_i$  indicates that household  $i$  is less able to cope with such shocks. They call this  $\beta_i$  the “excess sensitivity parameter,” and Kurosaki (2006, 2009) insists that it can be used as a vulnerability measure. For the purposes of this study, this sensitivity parameter is defined as a reflection of “consumption-smoothing effects.”

<sup>4</sup> This section draws on Bardhan and Udry (1999) and Kurosaki (2006, 2009).

<sup>5</sup> See Uchiyama (2016) for a maximization process based on Townsend (1994) and Bardhan and Udry (1999).

<sup>6</sup> An alternative hypothesis implies a complete autarky or lack of risk-sharing mechanisms.

Ravallion and Chaudhuri's (1997) modification is generally applied to correct a downward bias for  $\beta_i$  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. In line with Kurosaki (2006) and Skoufias (2007), restrictions can be imposed 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:

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

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

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

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

According to Kurosaki (2006, 2009), a possible problem in using a specification such as Eq. (3) for a vulnerability analysis is that parameter  $\beta$  does not distinguish whether  $\Delta y_{it}$  is positive or negative. Parameter  $\beta$  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 effects of negative and positive income shocks 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.

Furthermore, Eq. (4) is based on the assumption of uniform time and risk preferences across households in a village because of the short panel period. Thus, the model only allows us to estimate the average degree of a village's vulnerability. 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 ( $\Delta y_i$ ) and household characteristics ( $X_i$ ), the model to be estimated becomes:

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

where  $d_i = 1$  if  $\Delta y_i < 0$ , and  $u_i$  is an i.i.d. error term with mean zero. The parameters  $\beta_1$  and  $\beta_2$  are the vectors that show the marginal effects of the negative and positive income shocks of a particular household characteristic  $X_i$ . Here, the vector  $X_i$  includes a constant. In this case, the parameter  $\beta_1$  shows the extent to which consumption changes when income marginally decreases if a household has a certain characteristic ( $X_i$ ) (or after controlling for aggregate village shocks ( $\alpha_v$ ) in case of a constant), and  $\beta_2$  shows the extent to which consumption varies when income marginally increases if a household has a certain characteristic ( $X_i$ ).

## 3.2. Panel data

### 3.2.1. Data

The ENCEL series consists of eight survey rounds from 1998 to 2007 that are public to date, and is well known for its randomization. The original full sample in spring 1998 comprises repeated observations for 24,000 rural households from 506 localities (villages) in seven states. Of the 506 localities, 320 were assigned to a treatment group (hereinafter Treatment 1998) and 186 to a control group (hereinafter Treatment 2000) at the start of the program in 1998.<sup>7</sup> Households denoted as control localities did not receive PROGRESA-Oportunidades benefits until 2000 (Skoufias, 2007). Using propensity score matching, a comparison group of 151 localities, not yet incorporated into the program, was selected as a new control group 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. The latest two rounds of ENCEL (2003 and 2007) used in this study are the richest datasets available to the public to date; however, they have not been fully utilized in the literature, given the dissolution of the original control groups (Treatment 2000). In sum, phase-in effects can be assessed using ENCEL 2003 and 2007 by taking advantage of three different groups: Treatment 1998 (original treatment villages where eligible households receive benefits from 1998),

<sup>7</sup> PROGRESA officially started in 1997, but the eligible households started to receive benefits in 1998 (Skoufias, 2007).

Treatment 2000 (original control villages where eligible households receive benefits from 2000), and Control 2003 (new control villages where eligible households receive benefits after the 2003 survey).

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 7988 households (23.6%) 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 for food consumption and 17,603 households for total consumption, accounting for another drop of about 28% of the sample. Finally, 12,394 households remain as a complete panel for the regression analyses, after the exclusion of households with zero or unreported income and outliers in the upper and lower 1% of the sample. [Table 1](#) presents the summary statistics and mean tests of attrition bias. The list of variables used in this study and the summary statistics of the three treatment/control groups are provided in [Appendix C](#).

### 3.2.2. Summary statistics and attrition bias

According to Column (D) of [Table 1](#), a significant drop in real per capita weekly consumption and income was observed between 2003 and 2007 (8.8 Mexican pesos for food alone, 10.8 pesos in total, and 6.3 pesos for income, on average). 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 ([Attanasio et al., 2013](#); [Uchiyama, 2017](#); [Valero-Gil and Valero, 2008](#); [Wood et al., 2009](#)).

As the statistics reveal, sample households in the most marginal regions of Mexico are representative of 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, justifying an examination of the consumption-smoothing hypothesis within [Townsend's \(1994\)](#) risk-sharing framework.

As shown in [Table 1](#), the sample size reduction explained above could lead to an attrition bias considering the possible non-randomness of the process. Taking this into account, inverse probability weighting (IPW) is applied 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 \(2016\)](#).

## 4. Empirical analyses

### 4.1. Regression results

[Table 2](#) shows the regression results for Eq. (5), which assesses the household type that is less (or more) vulnerable to idiosyncratic (especially negative) income shocks. Per capita weekly food consumption change and per capita weekly total consumption change are used as explained variables.<sup>8</sup> Models 1 (Food) and 2 (Total) show OLS results without household characteristics ( $X$ ). Least squares dummy variable (LSDV) estimation methods are applied to Models 3–6 to control for the village dummy and deal with the technical problems that arose when conducting bootstrap methods for the two-step IV estimation.<sup>9</sup>

$\beta_1$  and  $\beta_2$  represent the excess sensitivity parameters of negative and positive per capita income shocks, respectively, as discussed in Section 3.1. Also, different types of variables are used to estimate the effects of CCT on a household's consumption smoothing. *CCT03* is used in Models 3 and 5, which is a dummy variable that equals 1 if a household receives PROGRESA-Oportunidades in the initial period (2003). *Treatment 1998* and *2000* dummies, with Control 2003 as a base, are used in Models 4 and 6 to clarify the phase-in effect of PROGRESA-Oportunidades explained in Section 3.2 (whether longer exposure to PROGRESA-Oportunidades reduces household vulnerability).

<sup>8</sup> The models were also regressed with per capita consumption and income calculated using different specifications of adult equivalent scales based on [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 are available upon request.

<sup>9</sup> Bootstrap methods were used 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.

Table 1  
Summary statistics with mean test of attrition bias.

Variable	(A) Original sample in 2003 (unbalanced)	(B) 2003 sample remaining in 2007	(C) Balanced panel (with consumption)	(D) Balanced panel (for regression)
(PANEL A: consumption and income)				
<i>Cf.i, 2003</i>	–	–	93.69 (365.30)	71.12 *** (43.97)
<i>Ct.i, 2003</i>	–	–	112.22 (330.79)	90.74 *** (56.47)
<i>Cf.i, 2007</i>	–	–	73.07 (201.86)	62.30 *** (39.79)
<i>Ct.i, 2007</i>	–	–	94.36 (210.77)	80.24 *** (54.39)
<i>Y.i, 2003</i>	–	–	–	28.95 (43.76)
<i>Y.i, 2007</i>	–	–	–	22.69 (21.47)
(PANEL B: household characteristics (education))				
<i>no_education03 (a)</i>	0.28 (0.45)	0.25 *** (0.43)	0.24 (0.43)	0.24 (0.42)
<i>primary03 (a)</i>	0.61 (0.49)	0.64 (0.48)	0.64 (0.48)	0.65 *** (0.48)
<i>secondary03 (a)</i>	0.09 (0.28)	0.09 (0.29)	0.10 (0.30)	0.09 (0.29)
<i>highschool03 (a)</i>	0.012 (0.11)	0.012 (0.11)	0.013 (0.11)	0.011 (0.10)
<i>technical03 (a)</i>	0.007 (0.08)	0.007 (0.09)	0.007 (0.09)	0.007 (0.08)
<i>university03 (a)</i>	0.004 (0.06)	0.004 (0.06)	0.003 (0.06)	0.002 * (0.05)
(PANEL C: household characteristics (others))				
<i>total_member03</i>	4.91 (2.46)	5.16 *** (2.40)	5.15 (2.38)	5.25 *** (2.31)
<i>dependency_ratio03</i>	44.15 (26.43)	42.43 *** (24.55)	42.73 *** (24.49)	42.68 (23.85)
<i>female03 (a)</i>	0.14 (0.35)	0.12 *** (0.33)	0.12 (0.33)	0.10 *** (0.30)
<i>age03</i>	48.02 (16.31)	47.06 *** (15.29)	46.65 *** (15.32)	46.27 ** (14.62)
<i>married03 (a)</i>	0.82 (0.38)	0.85 *** (0.36)	0.86 (0.35)	0.88 *** (0.33)
<i>indigenous03 (a)</i>	0.32 (0.47)	0.32 (0.46)	0.30 *** (0.46)	0.31 *** (0.46)
<i>land_holding03 (a)</i>	0.64 (0.48)	0.65 (0.48)	0.64 * (0.48)	0.63 *** (0.48)
<i>total_land_ha03+</i>	4.33 (9.45)	4.35 (9.41)	4.43 ** (9.55)	4.73 *** (9.65)
<i>irrigation03+ (a)</i>	0.09 (0.29)	0.09 (0.29)	0.09 (0.29)	0.09 (0.29)
<i>remittance03 (a)</i>	0.29 (0.45)	0.27 *** (0.44)	0.27 (0.44)	0.26 *** (0.44)
<i>migration03 (a)</i>	0.32 (0.47)	0.33 *** (0.47)	0.33 (0.47)	0.32 (0.47)
<i>self-consumption03 (a)</i>	–	–	–	0.06 (0.24)
<i>CCT03 (a)</i>	0.52 (0.50)	0.54 (0.50)	0.53 (0.50)	0.59 *** (0.49)

Table 1 (Continued)

Variable	(A) Original sample in 2003 (unbalanced)	(B) 2003 sample remaining in 2007	(C) Balanced panel (with consumption)	(D) Balanced panel (for regression)
<i>CCT07 (a)</i>	– –	0.70 (0.46)	0.69 (0.46)	0.79 *** (0.41)
(PANEL D: states and treatment groups)				
<i>Treatment 1998 (a)</i>	0.49 (0.50)	0.48 (0.47)	0.47 (0.50)	0.48 (0.50)
<i>Treatment 2000 (a)</i>	0.32 (0.47)	0.33 * (0.39)	0.33 (0.47)	0.34 (0.47)
<i>Control 2003 (a)</i>	0.20 (0.40)	0.19 * (0.26)	0.19 (0.39)	0.19 (0.39)
<i>State12: Guerrero (a)</i>	0.08 (0.28)	0.07 *** (0.36)	0.09 *** (0.29)	0.08 *** (0.27)
<i>State13: Hidalgo (a)</i>	0.16 (0.37)	0.15 ** (0.34)	0.10 *** (0.31)	0.10 (0.31)
<i>State 16: Michoacán (a)</i>	0.13 (0.34)	0.13 (0.35)	0.17 *** (0.38)	0.17 (0.37)
<i>State 21: Puebla (a)</i>	0.14 (0.35)	0.14 (0.25)	0.14 (0.34)	0.15 (0.35)
<i>State 22: Querétaro (a)</i>	0.06 (0.24)	0.07 (0.36)	0.09 *** (0.28)	0.08 * (0.27)
<i>State 24: San Luis Potosí (a)</i>	0.15 (0.35)	0.15 (0.45)	0.16 *** (0.37)	0.16 (0.37)
<i>State 30: Veracruz (a)</i>	0.27 (0.45)	0.28 * (0.45)	0.24 *** (0.43)	0.26 *** (0.44)
<i>Sample Size</i>	33,888	25,899	18,763	12,394

Note: Standard deviations are in parentheses. Cf.i, Ct.i, and Y<sub>i</sub> 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 to the left (A and B, B and C, and C and D).

The number of observations for total consumption in column (D) is 11,483.

(a) Dummy variables.

+Percentages among those who hold land.

Column D is the sample after excluding households whose income is unreported or only partially reported and of the upper and lower 1% outliers from Column (C).

The self-consumption dummy is excluded for technical estimation reasons (it was estimated only for the regression, corresponding to (D)).

The estimates show that  $\beta_1$  is smaller than  $\beta_2$  in all models, which confirms that consumption smoothing is more effective (households are better insured) when dealing with negative shocks. This result is consistent with our intuition. As for the interaction terms of household characteristics with negative per capita 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.

The variables that have counter effects (i.e., reducing household vulnerability in the case of negative income changes) are mainly CCT (including the *Treatment 1998* and *2000* dummies), large family size (total number of household members), and marital status. It is noteworthy that CCT is robust to reducing household vulnerability against negative shocks, providing relief of 0.09 pesos for per capita food consumption (Model 3) and 0.08 pesos for per capita total consumption (Model 5) with every 1-peso decline in per capita income. In addition, the coefficients of *Treatment 1998* and *2000* dummies that capture the phase-in effect of PROGRESA-Oportunidades are negative for food (Model 4) and positive for total (Model 6), but insignificant in both models. The effect of large families and marriage can be explained by household economies of scale, which reduce per capita living costs.

On the contrary, receiving remittances increases household vulnerability when the household is hit by negative income shocks, as shown by its positive and significant coefficients, indicating that a per capita income drop of 1 peso induces a total per capita consumption decline of 0.11–0.14 pesos. This is quite counter-intuitive, but one possible interpretation is that a technical issue might have affected these results. Since consumption in this study is calculated



Table 2  
OLS and LSDV regression results for Eq. (5).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	OLS		LSDV			
	Food	Total	Food	Food	Total	Total
$d\Delta y_i$ ( $\beta_1$ )	0.13***	0.17***	0.44***	0.43***	0.54***	0.47***
$(1-d)\Delta y_i$ ( $\beta_2$ )	0.40***	0.50***	0.88***	0.94***	1.01***	1.06***
<b>Interaction with negative per capita income change (<math>d\Delta y_i</math>) (<math>\beta_1</math>)</b>						
<i>primary03</i>		−0.03	−0.03		0.03	0.04
<i>secondary03</i>		−0.04	−0.03		−0.05	−0.03
<i>highschool03</i>		−0.02	−0.01		−0.01	0.001
<i>technical03</i>		0.27*	0.30*		0.08	0.11
<i>university03</i>		0.12	0.14		0.40	0.44
<i>total_member03</i>		−0.02***	−0.03***		−0.04***	−0.05***
<i>depratio03</i>		−0.001	−0.001*		−0.001*	−0.002**
<i>female03</i>		−0.09	−0.10		−0.12	−0.12
<i>age03</i>		0.001	0.001		0.002	0.0018*
<i>married03</i>		−0.20***	−0.20***		−0.24***	−0.25***
<i>indigenous03</i>		0.02	0.01		0.03	0.02
<i>land_holding03</i>		−0.003	0.01		0.01	0.01
<i>remittance03</i>		0.11***	0.11***		0.13***	0.14***
<i>self-consumption03</i>		0.09	0.09		0.02	0.02
<i>CCT03</i>		−0.09***		−0.08**		
<i>Treatment 1998</i>			−0.05		0.02	
<i>Treatment 2000</i>			−0.04		0.01	
<b>Interaction with positive per capita income change (<math>(1-d)\Delta y_i</math>) (<math>\beta_2</math>)</b>						
<i>primary03</i>		−0.13*	−0.13*		−0.17**	−0.17**
<i>secondary03</i>		−0.30***	−0.30***		−0.27**	−0.26**
<i>highschool03</i>		−0.22	−0.24		−0.13	−0.17
<i>technical03</i>		−0.32***	−0.33***		0.13	0.11
<i>university03</i>		−0.88*	−0.92*		−0.18	−0.21
<i>total_member03</i>		−0.01	−0.01		−0.01	−0.01
<i>depratio03</i>		0.00	0.00		0.00	0.00
<i>female03</i>		−0.05	−0.05		−0.23	−0.23
<i>age03</i>		−0.01***	−0.01***		−0.01***	−0.01***
<i>married03</i>		0.02	0.03		0.05	0.05
<i>indigenous03</i>		0.10*	0.11**		0.02	0.04
<i>land_holding03</i>		0.15**	0.15**		0.09	0.09
<i>remittance03</i>		0.01	0.00		−0.09	−0.09
<i>self-consumption03</i>		−0.31***	−0.31***		−0.06	−0.06
<i>CCT03</i>		−0.01	0.01			
<i>Treatment 1998</i>			−0.04		0.03	
<i>Treatment 2000</i>			−0.12		−0.15	
<i>constant</i>			−11.38***		−12.86***	−12.86***
<i>village dummy</i>	<i>Yes</i>	<i>Yes</i>	<i>No</i>	<i>No</i>	<i>No</i>	<i>No</i>
No. of Obs.	12,394	11,483	12,349	12,349	11,442	11,442
R-squared	0.12	0.14	0.08	0.08	0.09	0.09
Wald chi <sup>2</sup>			891.20	827.70	852.35	855.15
Repetition			400	400	400	400

Note: \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$  based on robust standard errors (Models 1, 2) and bootstrap clustered standard errors (Models 3, 4, 5, 6).  $d\Delta y_i$  and  $(1-d)\Delta y_i$  stand for negative and positive changes in per capita income.

on a weekly basis, it would be difficult to believe that households generally rely on remittances for expenditures related to daily necessities (see [Appendix B](#) for details of how the consumption variables are calculated), considering the fact that remittances rarely arrive on a regular basis. In this regard, [Acosta et al. \(2008\)](#) reveal that remittance-recipient households in Latin America (including Mexico) increase expenditures on durable goods, housing, and human capital, none of which is included in the calculation of per capita weekly total consumption used in this study. [Mora Rivera](#)

and Arellano González (2017), by applying ENCEL data from 1998 to 2000, also indicate that rural households with higher probability of receiving remittances are more likely to spend in physical and human investments. In addition, De la Fuente (2008) uses the same ENCEL (1998–2000) and concludes that highly vulnerable households tend to be less likely to receive transfers. He attributes this result to an asymmetrical relationship between senders and receivers of remittances, which coincides with the argument of Fafchamps (2003), who suggests that at times, remittances do not serve as insurance during shocks because the money does not arrive on time. However, since its explicit role remains an unsolved issue, as Fafchamps (2003) argues, further discussion on the effect of remittances for households receiving CCT is required.

The results for the interactions with positive per capita income changes ( $X_i(1 - d_i)\Delta y_i$ ) are not as clear as those for negative per capita income changes. However, education is shown to enable households to achieve consumption smoothing because most of the coefficients have negative signs and their magnitudes are greater, especially for per capita total consumption, which is consistent with our intuition. Another interesting finding is that self-consumption serves to smooth per capita food consumption only when households experience income gains.

In contrast, landholdings tend to increase per capita consumption, which can be explained by the unexpected increase in per capita income due to the rise in food prices for landholders in the surveyed period. No CCT effects are observed for positive per capita consumption changes as the coefficients are all insignificant.<sup>10</sup>

#### 4.2. Regression results with instrumental variables

It should be reasonable to assume endogeneity to estimate Eq. (5), apart from possible attrition bias that is discussed in Section 4.3, by considering measurement errors in income and the possibility of omitted variable biases such as price levels. Thus, the explanatory variable should be replaced by fitted values using IVs in estimating Eq. (5). These variables are expected to correlate with income changes between 2003 and 2007 ( $\Delta y_i$ ) but not with the consumption variation in the same period.

First, changes in lagged income between 2001 and 2002 ( $\Delta y_i$ : 2001–02) are used as an instrument in the first stage, drawing on Ravallion and Chaudhuri (1997), who identify lagged income as the preferred instrument. Next is a migrant dummy (*migration03*) that equals 1 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 lagged income change as an instrument, which only captures the household head and spouse's retrospective income due to data limitations, as explained in Appendix B. Fafchamps (2003) mentions the possibility of remittances serving as a reliable income source rather than ex post insurance for consumption smoothing.<sup>11</sup> Moreover, as noted above, Acosta et al. (2008) argue that remittance-receiving households in Latin America are more likely to spend on durable goods than non-durables, including daily necessities. The per capita total consumption used in this study does not include any of these items, which is consistent with the assumption regarding the IVs that the migrant dummy is not correlated with weekly per capita consumption but is only related to weekly per capita income.<sup>12</sup>

Table 3 presents 2SLS estimation results for Eq. (5). The IV models not only show the same tendency but also offer better results than the OLS and LSDV models (Table 2) in terms of consistency with intuition. The 2SLS coefficients are much larger than the OLS coefficients for both food and total per capita consumption, which implies a downward bias for  $\beta$  owing to endogeneity, including measurement errors.<sup>13</sup> Now the phase-in effect of PROGRESA-Oportunidades

<sup>10</sup> However, CCT dummies for positive income changes are positive and significant for both food and total consumption in 2SLS, although there was no phase-in effect for positive consumption changes. These phenomena could be explained by the additional income that enables households to relax their budget constraints, relying on PROGRESA-Oportunidades as a regular income source. In addition, *indigenous* and *self-consumption* dummies become negative and significant especially for food consumption, indicating that these households tend to reduce consumption when experiencing positive income gains. This might suggest that those households are most vulnerable to poverty, and thus, prepare themselves for future shocks through precautionary savings or asset investments in good times. The full regression results are available upon request.

<sup>11</sup> Fafchamps (2003) argues 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)

<sup>12</sup> Further, the  $F$  statistics for the weak instrument tests are sufficiently large in absolute values to show the robustness of all models, as presented in Table 3.

<sup>13</sup> One can infer from the 2SLS regression results that the downward bias caused by measurement errors is greater than other possible biases, such as specification errors or omitted variables. Also, the reason why the coefficients of per capita income changes exceed 1, especially for positive income changes in Table 3, in contrast to the theory prediction of the risk-sharing model, is that the budget constraint of the Townsend (1994) -based

Table 3  
2SLS regression results for Eq. (5).

Variables	Model 1 Food	Model 2	Model 3	Model 4 Total	Model 5	Model 6
$d\Delta y_i$ ( $\beta_1$ )	0.12	1.21***	1.33***	0.73	2.02***	2.19***
$(1-d)\Delta y_i$ ( $\beta_2$ )	3.10***	2.83***	2.57***	3.20***	2.44***	2.15**
<b>Interaction with negative per capita income change (<math>d\Delta y_i</math>) (<math>\beta_1</math>)</b>						
<i>primary03</i>		0.04	0.05		0.04	0.05
<i>secondary03</i>		0.14	0.16		0.20	0.19
<i>highschool03</i>		-0.26	-0.23		-0.35	-0.27
<i>technical03</i>		0.26	0.27		0.36	0.40
<i>university03</i>		0.69	0.94		1.33	1.50
<i>total_member03</i>		-0.14***	-0.14***		-0.16***	-0.16***
<i>depratio03</i>		0.01***	0.01***		0.01***	0.01***
<i>female03</i>		0.06	0.09		0.04	0.07
<i>age03</i>		0.001	0.001		-0.003	-0.003
<i>married03</i>		-0.06	-0.04		-0.02	-0.01
<i>indigenous03</i>		-0.146*	-0.129*		-0.16	-0.14
<i>land_holding03</i>		-0.46***	-0.47***		-0.58***	-0.59***
<i>remittance03</i>		0.06	0.05		0.21**	0.20**
<i>self-consumption03</i>		-0.20**	-0.19**		-0.43***	-0.43***
<i>CCT03</i>		-0.20***			-0.26***	
<i>Treatment 1998</i>			-0.23**			-0.24*
<i>Treatment 2000</i>			-0.27**			-0.32**
<i>constant</i>	-77.66***	-35.95***	-34.44***	-42.10	-31.43***	-28.88***
<i>village dummy</i>	<i>Yes</i>	<i>No</i>	<i>No</i>	<i>Yes</i>	<i>No</i>	<i>No</i>
First stage of 2SLS						
(Dependent variable: $d\Delta y_i, 03-07$ )						
$\Delta y_i$ 01-02			-0.084**			-0.084**
<i>migrant03</i>			-7.552***			-7.301***
(Dependent variable: $(1-d)\Delta y_i, 03-07$ )						
$\Delta y_i$ 01-02			0.003			0.004
<i>migrant03</i>			-5.975***			-5.941***
No. of Obs.	12,394	12,349	12,349	11,483	11,442	11,442
Robust Durbin–Wu–Hausman test of endogeneity						
F statistics	310.05			307.33		
Chi <sup>2</sup>	155.33			153.89		
Weak instrument tests (F statistics)						
$d\Delta y_i$ (minus)	42.53			37.41		
$(1-d)\Delta y_i$ (plus)	196.54			176.81		
Repetition		400	400		400	400

Note: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$  based on robust standard errors (Models 1, 4) and bootstrap clustered standard errors (Models 2, 3, 5, 6).  $d\Delta y_i$  and  $(1-d)\Delta y_i$  stand for negative and positive changes in income.

The results of interaction terms with positive income change ( $\beta_2$ ) and first-stage regressions are available upon request.

is much clearer, indicating that belonging to a Treatment 1998 or Treatment 2000 village provides relief of 0.23–0.27 pesos for per capita food consumption and 0.25–0.32 pesos for per capita total consumption with every 1-peso decline in per capita income. In addition, *landholding* and *self-consumption* dummies become negative and significant, and

risk-sharing model is the sum of incomes within the village for simplicity. It is not feasible today to assume that a village has no storage or access to borrowing from outside the community. However, the estimated coefficients, especially in OLS (without household characteristics), are consistent with those of previous studies such as Deaton (1992), Kurosaki (2006) and Skoufias (2007). A model that eases village budget constraints should be applied in a future study.

Table 4  
Probit results of IPW models.

Variable	Model (a) Food	Model (b)	Model (c)	Model (d)	Model (e) Total	Model (f)	Model (g)	Model (h)
(Dependent variable: attrition = 1)								
Attrition	3.35***		3.55***		3.10***		3.13***	
primary03			−0.06**	0.04			−0.04	0.02
decondary03			−0.10*	0.06			−0.02	0.07*
highschool03			−0.09	0.02			−0.09	−0.03
technical03			0.19	0.18			0.07	0.1
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.	25,740	25,740	20,037	20,037	25,751	25,751	20,833	20,833
Likelihood ratio	9149.4	3240.3	7992.7	3259.2	7241.7	2509.4	6279.3	2699.3
Pseudo R <sup>2</sup>	0.3	0.11	0.36	0.5	0.22	0.08	0.25	0.11
Log likelihood	−10568.2	−13522.7	−7005.3	−9372	−12771	−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 models.

Income-related variables and the self-consumption dummy are excluded for technical reasons. However, they are included in the regression of robustness checks using the sample in Columns (C) and (D) of Table 1, whose coefficients are virtually zero and nonsignificant. The results are available upon request.

F tests reject the null hypothesis between Models (a) and (b), (c) and (d), (e) and (f), and (g) and (h).

thus serve to mitigate household vulnerability. Landholdings represent the importance of initial assets to cope with shocks as predicted by development theories.

Furthermore, the indigenous dummy becomes negative and significant at the 10% level for per capita food consumption, suggesting a stronger consumption-smoothing network for subsistence because of their history and culture. Again, the remittance dummy becomes positive, but significant only for per capita total consumption.

#### 4.3. Robustness checks

As discussed in Section 3.2.2, the regression results shown in Tables 2 and 3 might have some attrition bias; thus, the inverse probability weightings (IPW) expressed in Eq. (D2) in Appendix D are applied. I compare the “2003-sample households also present in 2007,” a balanced panel of 25,899 households without consumption or income variables that correspond 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, corresponding to Column (D) of Table 1.<sup>14</sup>

Table 4 shows the results of the probit model used to calculate the IPW. The results indicate that the factors that increase a household’s probability of attrition, when controlling for other characteristics, are large family (total\_member), age, indigenous, holding lands, receiving remittances, and receiving CCT. In comparison, households tend to stay in the sample if they have a higher dependency ratio, are female-headed, and are married; however, the

<sup>14</sup> I also compare the “balanced panel with complete information on consumption” (Column (C) of Table 1) with the Column (D) sample for a further robustness check. The results do not change despite the different sample attrition sizes. The details are available upon request.

Table 5  
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 (28.40%)	–	–	704 (3.80%)	6,030 (32.10%)
	Treatment 2000	–	3,350 (17.90%)	–	449 (2.40%)	3,799 (20.20%)
	Control 2003	–	–	133 (0.70%)	24 (0.10%)	157 (0.80%)
Not beneficiary in 2003		1,060 (5.60%)	1,179 (6.30%)	1,890 (10.10%)	4,648 (24.80%)	8,777 (46.80%)
Total		6,386 (34.00%)	4,529 (24.10%)	2,023 (10.80%)	5,825 (31.00%)	18,763 (100%)

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

effect of education in household attrition is not clear. The result of the second stage of the IPW regression is presented later in Table 6.

Furthermore, there might be some selection bias in the CCT dummy because eligible households can decide for themselves whether to participate in or exit from the program. Households unable to meet the CCT requirements are forced to exit from the program, which might also be attributed to specific characteristics of unaccomplished households. Table 5 shows the entry and exit information for households in PROGRESA-Oportunidades between 2003 and 2007, calculated from ENCEL. The table indicates that 72% of households, including non-eligible ones, did not change their status (the diagonal line: 28.4% + 17.9% + 0.7% + 24.8%). However, 6.2% of beneficiary households in Treatment 1998 and 2000 villages (3.8% + 2.4%) exited in 2007, while 11.9% of non-beneficiary households in these villages (5.6% + 6.3%) entered the program in 2007. New beneficiary households in the Control 2003 group that became entitled after the 2003 survey constituted 10.1% of households.

Taking these into consideration, I conduct 2SLS estimations of Eq. (5) by assuming that the CCT dummy is endogenous, but here the per capita income change is assumed to be exogenous. ENCEL-based poverty assessment scores and classification in 2007 (*eligibility*, both raw scores and dummy) are used as an instrument for the CCT dummy because the 2003 assessment is constrained by a number of missing data. However, 85% of the 2003 eligibility cases coincide in classification with those in 2007 (see Appendix F for details).

Table 6 shows the regression results of the robustness checks for Eq. (5). The results of both the second stage of the attrition-adjusted model (Models 1 and 2) and the IV model with the CCT dummy (*CCT03*) as endogenous (Models 3–6) are consistent with Table 3. All results in Table 6 are corrected to some extent for the upward bias in the results reported in Table 3, especially in the magnitude of the coefficients for negative and positive per capita income changes and for the interaction term with *CCT03*. The interaction term of negative per capita income change with *CCT03* is negative in all models as expected, but significant only for per capita total consumption change in the attrition-adjusted model (Model 2) and for per capita food consumption change in the IV models (Models 3 and 4).

## 5. Concluding remarks

This study examined the vulnerability of households in rural Mexico as well as the effects of the CCT program in the 2000s. Drawing on Kurosaki (2006), it considered the different marginal effects based on household characteristics, focusing more on negative income shocks. The results confirmed that the CCT is effective in rural Mexico in reducing household vulnerability to idiosyncratic income shocks. Besides the CCT, larger families, landholdings, and self-consumption can mitigate vulnerability. In contrast, the regression results show quite robustly that households receiving remittances become more vulnerable to shocks. While some possible explanations, such as the technical reasons in the sample data and the argument of Fafchamps (2003), were proposed, more evidence is needed to verify this explanation. However, the clear contribution of this study is that it confirmed robustly the positive (but not perfect) long-term

Table 6  
Regression results of the robustness checks for Eq. (5).

Variables	Model 1 Attrition adjusted model		Model 3	Model 4	Model 5	Model 6
	Food	Total	Food		Total	
$d\Delta y_i$ ( $\beta_1$ )	0.63	0.51***	0.43***	0.43***	0.47***	0.47***
$(1-d)\Delta y_i$ ( $\beta_2$ )	1.09	0.88**	0.86***	0.86***	0.99***	0.99***
<b>Interaction with negative per capita income change (<math>d\Delta y_i</math>) (<math>\beta_1</math>)</b>						
<i>primary03</i>	0.26	0.05	−0.03	−0.03	0.05	0.05
<i>secondary03</i>	0.35	0.00	−0.05	−0.05	−0.04	−0.04
<i>highschool03</i>	0.19	0.07	−0.02	−0.02	0.00	0.00
<i>technical03</i>	0.54	−0.07	0.30**	0.30**	0.05	0.05
<i>univ03</i>	0.18	0.21	0.01	0.01	0.28	0.28
<i>total_member03</i>	−0.05	−0.05***	−0.02***	−0.02***	−0.05***	−0.05***
<i>depratio03</i>	0.01	0.00	0.00	0.00	0.00	0.00
<i>female03</i>	0.07	−0.11	−0.09	−0.09	−0.13	−0.13
<i>age03</i>	0.00	0.00	0.00	0.00	0.00	0.00
<i>married03</i>	−0.91	−0.22**	−0.19***	−0.19***	−0.23***	−0.23***
<i>indigenous03</i>	−0.26	0.07	0.04	0.04	0.07	0.07
<i>land_dum03</i>	−0.01	0.06	0.03	0.03	0.03	0.03
<i>hhremmit03</i>	0.40**	0.09*	0.11***	0.11***	0.13***	0.13***
<i>selfcons_dum03</i>	0.21	0.08	0.09	0.09	0.03	0.03
<i>CCT_dum03</i>	−0.08	−0.13***	−0.12**	−0.12**	−0.07	−0.07
<i>constant</i>	−13.22	25.91***	−8.26***	−8.31***	26.10***	26.01***
Instrument	–	–	<i>Eligibility (score)</i>	<i>Eligibility (dummy)</i>	<i>Eligibility (score)</i>	<i>Eligibility (dummy)</i>
No. of Obs.	11,711	11,305	12,326	12,326	11,421	11,421
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 models.

The inverse probability weights in this table are calculated based on the results in Table 4.

The first-stage regression results of the IV model are in Appendix F and the full results of the second stage, including the interaction terms with positive per capita income change ( $\beta_2$ ), are available upon request.

consumption smoothing effects of PROGRESA-Oportunidades cash transfers on reducing household vulnerability amid the food price crisis in the 2000s.

On the other hand, 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, since 2003, food prices have constantly increased in tandem with the international food price crisis, which peaked in 2008 and 2011. An expanded sample should be further studied for a more precise consideration of the influence of price shocks and the global economic crisis in 2008, and to further enable robustness checks.

The mechanism through which the CCT program 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 a household's consumption behavior. If this happens, we will be able to assess how much these changes in household behavior related to consumption patterns contribute, together with the incentives in education and health, to the CCT's ultimate goal of breaking the intergenerational transmission of poverty. These inferences should be carefully examined with more detailed analyses of quantitative and qualitative evidence.

## Declaration of interest

None.

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## Appendix A.

See [Table A1](#).

## Appendix B. Variables

*Household real per capita food consumption:* First, a household’s weekly food consumption is constructed by summing up the reported amount of weekly food consumption of the interview week and the estimated weekly self-consumption. Then, the household’s weekly food consumption is divided by the number of household members to ascertain per capita weekly food consumption. In estimating self-consumption, the median state price of each item is calculated using each household’s reported weekly purchases and expenditure on the item. Then, the amount of reported self-consumption is multiplied by the estimated unit median price of the state. Per capita food consumption is deflated by the annual average food CPI.<sup>15</sup>

*Household real per capita total consumption:* A household’s real per capita total consumption is constructed 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 (including remittances), non-labor or irregular incomes, such as the sale 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 a migration dummy is used 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, the weekly total income is divided by the number of household members and deflated 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 for lagged household income changes because data for the newly added control group (Control 2003) are not available for the years prior to 2003.

<sup>15</sup> Banco de México Estadísticas (<http://www.banxico.org.mx/estadisticas/index.html>); June 2001 = 100.

Table A1  
Variable descriptions.

(PANEL A: Consumption and Income)	
<i>Cf<sub>i</sub></i>	Per capita real weekly food consumption
<i>Ct<sub>i</sub></i>	Per capita real weekly total consumption
$\Delta Cf_{i}$	Per capita real weekly food consumption change between 2003 and 2007
$\Delta Ct_{i}$	Per capita real weekly total consumption change between 2003 and 2007
<i>Y<sub>i</sub></i>	Per capita real weekly income
$\Delta Y_{i}$	Per capita real weekly income change between 2003 and 2007
$d\Delta Y_{i}$	Negative per capita real weekly income change between 2003 and 2007
$(1-d)\Delta Y_{i}$	Positive per capita real weekly income change between 2003 and 2007
(PANEL B: Household Characteristics (Education))	
<i>no_education03</i>	Takes 1 if the household head has never received education in her/his life as of 2003.
<i>primary03</i>	Takes 1 if the household head has ever enrolled in primary education as of 2003.
<i>secondary03</i>	Takes 1 if the household head has ever enrolled in secondary education as of 2003.
<i>highschool03</i>	Takes 1 if the household head has ever enrolled in high school as of 2003.
<i>technical03</i>	Takes 1 if the household head has ever enrolled in a technical or vocational school, including a teacher's college, as of 2003.
<i>university03</i>	Takes 1 if the household head has ever enrolled for university and higher education as of 2003.
(PANEL C: Household Characteristics (Others))	
<i>total_member03</i>	The total number of household members who live in the same house in 2003.
<i>depratio03</i>	The household's dependency ratio in 2003.
<i>female03</i>	Takes 1 if the household head is female in 2003.
<i>age03</i>	The age of the household head in 2003.
<i>married03</i>	Takes 1 if the household head is married in 2003.
<i>indigenous03</i>	Takes 1 if the household head speaks an indigenous language in 2003.
<i>land_holding03</i>	Takes 1 if the household cultivated land in 2003.
<i>total_land_ha03</i>	Total hectares of land the household cultivates in 2003.
<i>irrigation03</i>	Takes 1 if the household has access to irrigation for at least one of their plots in 2003.
<i>remittance03</i>	Takes 1 if the household receives personal cash/in kind transfers from domestic/foreign migrants in 2003.
<i>self-consumption03</i>	Takes 1 if the household has self-consumption during the interviewed week in 2003.
<i>CCT03</i>	Takes 1 if the households receive CCT benefits in 2003.
<i>CCT07</i>	Takes 1 if the households receive CCT benefits in 2007.
(PANEL D: States and Treatment Groups)	
<i>Treatment 1998</i>	Takes 1 if the household is within one of the villages where the CCT program started in 1998 (original treatment group).
<i>Treatment 2000</i>	Takes 1 if the household is within one of the villages where the CCT program started in 2000 (original control group).
<i>Control 2003</i>	Takes 1 if the household is within one of the villages newly added to the ENCEL survey in 2003 where the CCT program started by 2004 (new control group).
(PANEL E: Instruments)	
<i>attritratio</i>	Sample attrition ratio at the municipal level between 2003 and 2007, which is calculated separately for food and total consumption.
$\Delta Y_{i, 01-02}$	Per capita real weekly income change between 2001 and 2002
<i>migrant03</i>	Takes 1 if the household has members older than 15 years who lived away from home (domestic/foreign migrants) in 2003.
<i>eligibility (score)</i>	ENCEL-based poverty assessment score in 2007.
<i>eligibility (dummy)</i>	Takes 1 if the household is assessed as 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.

*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 in university and higher education programs (including those who graduated from university and have entered or graduated from the postgraduate level).



*Household demographic variables:* The total number of household members refers to 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 (non-labor force) to the number of household members aged 15–64 years (labor force).

## Appendix C.

See [Table C1](#).

Table C1  
Summary statistics and means test of treatment/control groups.

Variable	(1) All Sample (Mean)	(2) Treatment 1998 (Mean)	(3) Treatment 2000 (Mean)	(4) Control 2003 (Mean)
(PANEL A: Consumption and Income)				
<i>Cf.i, 2003</i>	71.12	70.87	68.93***	79.76***
<i>Ct.i, 2003</i>	90.74	89.14	88.53	102.38***
<i>Cf.i, 2007</i>	62.30	60.65	58.55***	73.08***
<i>Ct.i, 2007</i>	80.24	76.99	75.82	96.26***
<i>Y.i, 2003</i>	28.95	30.65	29.71	23.50***
<i>Y.i, 2007</i>	22.69	22.70	22.11	23.64*
(PANEL B: Household Characteristics (Education))				
<i>primary03</i>	0.65	0.64	0.66**	0.66*
<i>secondary03</i>	0.09	0.09	0.09	0.13***
<i>highschool03</i>	0.011	0.01	0.01	0.02***
<i>technical03</i>	0.007	0.008	0.005**	0.006
<i>university03</i>	0.002	0.002	0.002	0.004
(PANEL C: Household Characteristics (Others))				
<i>total_member03</i>	5.25	5.22	5.26	5.32**
<i>dependency_ratio03</i>	42.68	43.02	42.61	41.85***
<i>female03</i>	0.10	0.10	0.10	0.10
<i>age03</i>	46.27	46.33	46.27	46.24
<i>married03</i>	0.88	0.88	0.88	0.87
<i>indigenous03</i>	0.31	0.32	0.37***	0.15***
<i>land_holding03</i>	0.63	0.66	0.64**	0.51***
<i>total_land_ha03+</i>	4.73	2.88	2.77	2.64
<i>irrigation03+</i>	0.09	0.06	0.05***	0.07
<i>remittance03</i>	0.26	0.25	0.25	0.27
<i>migration03</i>	0.32	0.35	0.36*	0.20***
<i>self-consumption03</i>	0.06	0.06	0.06	0.06
<i>CCT03</i>	0.59	0.75	0.67***	0.05***
<i>CCT07</i>	0.79	0.81	0.81	0.68***
<i>eligibility03 (dummy)++</i>	0.88	0.89	0.89	0.79***
<i>eligibility03 (score)++</i>	2.13	2.23	2.18**	1.76***
<i>eligibility07 (dummy)++</i>	0.80	0.82	0.82	0.69***
<i>eligibility07 (score)++</i>	1.71	1.81	1.76***	1.35***
(PANEL D: States and Treatment Groups)				
<i>State12: Guerrero</i>	0.08	0.11	0.04	0.09
<i>State13: Hidalgo</i>	0.10	0.13	0.08	0.08
<i>State 16: Michoacán</i>	0.17	0.18	0.15	0.17
<i>State 21: Puebla</i>	0.15	0.16	0.15	0.10
<i>State 22: Querétaro</i>	0.08	0.06	0.08	0.13
<i>State 24: San Luis Potosí</i>	0.16	0.16	0.18	0.16
<i>State 30: Veracruz</i>	0.26	0.21	0.33	0.29
No. of Obs.	12,394	5,919	4,146	2,329

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

+Percentages among those who hold land.

++Takes 1 if a household is eligible for PROGRESA-Oportunidades (=poor). As the eligibility score is higher, a household is poorer.

### Appendix D. Inverse probability weighting 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  $\Delta c_i$  is the consumption change in household  $i$  and  $\Delta y_i$  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  $\Delta c_i$  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.

If we assume selection on observables, we can apply the IPW method ([Fitzgerald et al., 1998](#); [Wooldridge, 2002](#)):

$$f(\Delta c_i | \Delta y_i, X_i) = \int_z g(\Delta c_i, z | \Delta y_i, X_i, A_i = 0) w(z, \Delta y_i, X_i) dz \tag{D1}$$

where

$$w(z, \Delta y_i, X_i) = \left[ \frac{Pr(A_i = 0 | \Delta y_i, X_i, z)}{Pr(A_i = 0 | \Delta y_i, X_i)} \right]^{-1} \tag{D2}$$

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

### Appendix E.

See [Table E1](#).

Table E1  
Full results of the first stage of the 2SLS regressions for Eq. (5) ([Table 3](#)).

(Determinants of positive and negative income changes)				
Variable	Model 1	Model 2	Model 3	Model 4
	Food		Total	
	dΔy <sub>i</sub> (minus)	(1 - d)Δy <sub>i</sub> (plus)	dΔy <sub>i</sub> (minus)	(1 - d)Δy <sub>i</sub> (plus)
<i>Δy<sub>i</sub> 01-02</i>	-0.077**	0.001	-0.077**	0.003
<i>migrant03</i>	-2.284**	-3.792***	-2.003**	-3.728***
<i>primary03</i>	-3.189***	0.060	-3.458***	0.075
<i>secondary03</i>	-3.785***	0.899	-3.807**	0.919
<i>highschool03</i>	-15.99***	0.292	-15.29***	0.103
<i>technical03</i>	-13.82**	3.229	-14.44**	3.317
<i>university03</i>	-20.21**	1.290	-18.70**	1.954
<i>total_member03</i>	1.488***	-0.315***	1.538***	-0.293***
<i>depratio03</i>	0.079***	0.094***	0.072***	0.095***
<i>female03</i>	2.203	0.992	2.367	0.943
<i>age03</i>	-0.376***	-0.068***	-0.372***	-0.067***
<i>married03</i>	1.192	1.157*	1.466	1.333*
<i>indigenous03</i>	3.999**	0.381	3.976**	0.249
<i>land holding03</i>	-11.44***	-2.719***	-11.90***	-2.987***
<i>remittance03</i>	-3.060***	-1.528***	-2.929***	-1.530***
<i>CCT03</i>	-6.605***	-3.416***	-6.639***	-3.217***
<i>self-consumption03</i>	0.142	-0.438	0.117	-0.253
<i>constant</i>	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<sub>i</sub> 01–02 stands for household per capita income changes between 2001–2002.  
\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01 based on robust standard errors.

## Appendix F.

See Tables F1 and F2.

Table F1  
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%)

Source: Author's calculations based on ENCEL.

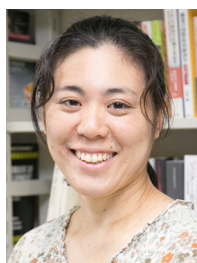
Table F2  
First-stage regression results of the IV model for robustness checks (Table 6).

Variable	Model 1 Food	Model 2 Food	Model 3 Total	Model 4 Total
<i>(Dependent variable: CCT03)</i>				
<i>eligibility (score)</i>	<b>-0.012**</b>		<b>-0.012**</b>	
<i>eligibility (dummy)</i>		<b>0.004</b>		<b>0.001</b>
<i>dΔy<sub>i</sub></i>	-0.0002***	-0.0002**	-0.0003***	-0.0002**
<i>(1 - d)Δy<sub>i</sub></i>	-0.001***	-0.001***	-0.001***	-0.001***
<i>primary03</i>	-0.016	-0.011	-0.015	-0.011
<i>secondary03</i>	-0.056***	-0.048***	-0.053***	-0.046**
<i>highschool03</i>	-0.138***	-0.126***	-0.133***	-0.122***
<i>technical03</i>	-0.197***	-0.183***	-0.205***	-0.192***
<i>university03</i>	-0.333***	-0.315***	-0.344***	-0.327***
<i>total_member03</i>	0.024***	0.024***	0.024***	0.023***
<i>depratio03</i>	0.001***	0.001***	0.001***	0.001***
<i>female03</i>	0.072***	0.074***	0.070***	0.072***
<i>age03</i>	0.001*	0.001**	0.001**	0.001**
<i>married03</i>	0.074***	0.077***	0.075***	0.078***
<i>indigenous03</i>	0.020	0.018	0.015	0.013
<i>land_holding03</i>	0.003	0.003	0.002	0.002
<i>remittance03</i>	0.020**	0.020**	0.021**	0.022***
<i>self_consumption03</i>	-0.014	-0.014	-0.006	-0.006
<i>constant</i>	-0.229***	-0.252***	-0.230***	-0.250***
No. of Obs.	12,326	12,326	11,421	11,421
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 models.

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