Are Disaster Funds Enough to Smooth Consumption?

Juan Enrique Huerta-Wong * Julieth Santamaria †

Adan Silverio Murillo‡

June 23, 2017

Abstract

Natural disasters worldwide have increased considerably as a consequence of climate change, and empirical evidence has found that individuals decrease their levels of consumption when facing a natural disaster. While countries can rely on loans and aid from international community when facing a natural disaster, one alternative is to use disaster funds and catastrophe bonds. Mexico was the first developing country to use disaster funds and catastrophe bonds through the Fund for Natural Disasters (FONDEN). The FONDEN provides food to households and resources for the reconstruction of infrastructure. De Janvry, Del Valle, and Sadoulet (2016) find evidence that this program increases local economic activity between 2 and 4 percent in the year following the disaster. Yet, can FONDEN smooth the consumption of the families affected? To answer this question, we analyze data for Hurricane Earl in Puebla, Mexico, where FONDEN resources were implemented. Using a difference-in-difference strategy, we find a decrease in consumption, including beans, which is an essential staple good for Mexican families. It is possible that the consumption of families would have been more affected without the FONDEN; yet, the resources of FONDEN were not enough to smooth families' consumption.

Keywords: Natural Disasters, Consumption, Prices

JEL: I14, I24, Q546.

*UPAEP, Centro de Investigación e Inteligencia Económica. E-mail: `juan.huerta@upaep.mx`

†University of Minnesota, Department of Applied Economics, PhD Student. E-mail: `santa098@umn.edu`

‡University of Minnesota, Department of Applied Economics, PhD Candidate. E-mail: `silve346@umn.edu`

1 Introduction

Natural disasters worldwide have increased considerably since the 1970s, affecting on average over 200 million people every year (Leaning and Guha-Sapir, 2013). Natural disasters may greatly reduce children's human capital accumulation by affecting prices, assets, and the consumption of families. Yet, the impact of natural disasters on consumption is widely debated. While economic theory predicts that individuals can maintain their levels of consumption against income shocks,[1] there is evidence that this is not always the case when facing a natural disaster (Kazianga and Udry, 2006).

What kind of public policies can be implemented to protect families' consumption from a natural disaster? One possibility is through the use of insurance. In particular, governments can use disaster funds, i.e. save resources ex-ante for post-disaster use (De Janvry, Del Valle and Sadoulet, 2016) or use catastrophe (CAT) bonds to insure against the consequences of a natural disaster (Borensztein, Cavallo, and Jeanne, 2017). To the best of our knowledge, Mexico was the first developing country to use disaster funds and catastrophe bonds through the Fund for Natural Disasters (FONDEN). FONDEN resources are used to provide immediately supplies of food, medicines, cleaning supplies and toiletries to the households affected, and also provides resources for the reconstruction of housing and public infrastructure affected. De Janvry, et al. (2016) find evidence that FONDEN increases local economic activity between 2 and 4 percent in the year following the disaster. Thus, this program can be an important factor mitigating the

[1] Under the assumptions that insurance and/or credit markets function well.

effects of natural disasters in the medium term.

But, can FONDEN smooth the consumption of families affected by a natural disaster in the short term? To answer this question, we exploit the occurrence of Hurricane Earl, which had a large impact on the state of Puebla, Mexico, in 2016. This disaster happened unexpectedly in areas that do not usually experience hurricanes. Survey data were collected from municipalities within the state of Puebla that are comparable in terms of their ranking in the Human Development Index.[2] Huachinango and Tlaola are treatment municipalities (affected by the hurricane and received resources through the FONDEN) while Palmar de Bravo and Juan C. Bonilla are the comparison municipalities. We use a difference-in-differences estimation procedure to test the hypothesis that the use of FONDEN can protect families' consumption when they are affected by a hurricane. We find that the quantity consumed of key food items diminishes. In particular, of the 12 items analyzed, we observe a decrease in the consumption of beans, lemons, sugar, beef, and chicken.

A large body of literature has analyzed the effects of negative income shocks on households' behavior. This literature was initially motivated by the neoclassical life cycle model, also known as the permanent income hypothesis, which suggests that individuals tend to smooth their consumption over their lifetime by saving when they have income surpluses and dis-saving during hard times (Modigliani and Brumberg, 1954). However,

[2]The Human Development Index is a composite statistic of life expectancy, education, and percapita income, which is used to rank countries regarding human development.

the literature has also found that precautionary saving is very rare, particularly for uneducated households and individuals in the lower tail of the income distribution (Bernheim and Scholz, 1993; Browning and Lusardi, 1996). After natural disasters occur, households react in different ways to smooth their consumption and recover from the loss. For example, families can choose to sell assets in order to smooth their consumption, or they may reduce their present consumption in order to keep their assets. Hoddinott (2006) finds evidence that poorer households tend to smooth their assets rather than smooth their consumption. Consistent with this, Fafchamps, Udry, and Czkas (1998) find that households in West Africa do not sell assets after a severe drought. Their hypothesis is that households choose to protect their productive investment because the low market price prevailing at the time of the sale would not compensate for the loss.

This paper contributes to the recent literature on the use of disasters funds, providing evidence that a natural disaster fund (FONDEN) is not always sufficient to protect families' consumption (at least in the short run). In addition, the results provide no evidence that the hurricane affected families differently depending on their wealth. These results imply the need to review the way in which FONDEN is operating:

i. It is necessary to analyze whether the quantity and periodicity with which food is distributed is the most appropriate. According to the Mexican government, about 2,196 families were affected by Hurricane Earl. The government reported that food baskets were distributed as follows: 1,200 in August 7th; 1,200 in August 11th; and 2,196 in

August 26th. This reflects that not all the affected families were served and that the periodicity of delivery of food was not regular.

iii. It is important to establish mechanisms of accountability and transparency. The survey includes a question regarding whether families received help from natural disasters. Of the 327 families surveyed (14% of the total families affected), only 6 families reported receiving government support as a consequence of the natural disaster. Some possible explanations are: a) the families are underreporting the aid received from the government in order to continue receiving benefits; b) the families surveyed are part of the group that did not receive help from the government; or c) it is possible that these families did not receive support from the government. In order to know how the support is granted, it is necessary that FONDEN report a list of the families served. This will generate transparency and avoid possible situations of corruption in the delivery of food to the affected families.

The remainder of this paper proceeds as follows. First, we describe the geographical location and impact of Hurricane Earl on Puebla and we explain in more detail the FONDEN program. We then describe the data, present descriptive statistics, and explain the identification strategy. Finally, we describe the results and give some insights about their policy implications.

2 Background

Mexico is among the 30 countries that are most exposed to two types of natural disasters: hurricanes and earthquakes. The population that is most vulnerable to these natural disasters represents around 27% of the country (INEGI, 2013). A natural disaster can greatly reduce human capital accumulation and, as a consequence, decrease the possibility of social mobility. Its first effect is through income, which clearly has the potential to affect consumption and education. While economic theory predicts that individuals can maintain their levels of consumption against temporary income shocks, there is evidence that this is not always the case (Kazianga and Udry, 2006). On the other hand, other studies have found that natural disasters affect students' school attendance (Jensen 2000, Cameron and Worswick 2001). One consensus from these studies is that families who are affected most are less likely to have insurance coverage (formal or informal), and are relatively poor.

2.1 The Fund for Natural Disasters (FONDEN)

In response to the vulnerability of Mexico to natural disasters, the Mexican Government established the Fondo de Prevención de Desastres Naturales (Fund for Natural Disasters Prevention, FOPREDEN) and the Fondo de Desastres Naturales (Fund for Natural Disasters, FONDEN). FOPREDEN is a program intended to generate actions for the *prevention* and reduction of risks due to natural disasters. FONDEN is a financial in-

strument by which the Mexican government allocates resources ex-ante for post-disaster *immediate attention* to the population affected and for *reconstruction* of the damaged infrastructure. FONDEN is composed of two main instruments: the Emergency Relief Fund and the Reconstruction Program. The former serves the population immediately by supplying food, medicines, cleaning supplies and toiletries, and the latter provides resources for the reconstruction of affected housing and public infrastructure. For the fiscal year 2016, FOPREDEN received $358,718,014 pesos (US$19,928,778) and FONDEN received $8,035,987,256 pesos (US$446,443,736). If this funding is insufficient, additional resources can be transferred from other federal programs.

2.2 Hurricane Earl in Puebla

Hurricane Earl was the deadliest Atlantic Hurricane to hit Mexico since Hurricane Stan in 2005. It started on August 2 and dissipated on August 6 of 2016. According to media reports, 54 individuals died, of which 41 were from the state of Puebla. This number exceeds the 33 deaths for Mexico as a whole reported for all 10 hurricanes that occurred in 2014 and 2015. According to the Global Catastrophe Recap (2016), the damage associated with Earl is estimated to be US$132 million.

Given the gravity of the hurricane, the Mexican government declared a state of emergency in three municipalities of Puebla: Huachinango, Tlaola, and Xicotepec. According to information provided by the Mexican government, 8,784 individuals were affected

(around 2,000 families). The government distributed "despensas" (a food basket containing sugar, rice, beans, oil, corn, coffee, cookies, tuna, sardines, among other supplies) as follows: 1,200 in August 7th, 1,200 in August 11th, and 2,196 in August 26th. The total cost spent on food was $1,603,382 pesos (US$ 89,076). Finally, according to the media, the Mexican government received US$200,000 from the Inter-American Development Bank to purchase food for the families affected.[3]

3 Data

To analyze the effects of Hurricane Earl, we use a unique dataset that was collected in affected municipalities in Puebla after the disaster took place. The data are part of Mexico's Survey of Social Mobility in Disaster Zones (SSMDZ). The survey selects locations that were affected in the current year, but were not affected by a hurricane or other natural disaster in the previous four years. In addition, the survey includes a comparison group that was neither affected by the current natural disaster nor by any other natural disaster in the last four years. The comparison group should be located close to the affected area, and should have a Human Development Index that is similar to those of the affected municipalities before the natural disaster took place. The SSMDZ data contain information on two affected municipalities: Tlaola and Huauchinango. Data were also

[3]In addition, the government spent: $764,208 pesos (US$42,456) on 8,784 blankets, $2,304,851 pesos (US$128,047) on 8,784 mats, $524,775 pesos (US$29,154) on 5,592 toiletries kits, $384,906 pesos (US$21,383) on 2,196 sets of cleaning supplies, $552,960 (US$30,720) on 76,800 bottles of water, and $8,836,211 pesos (US$490,900) on medicines.

collected from two municipalities that are used as controls: Palmar de Bravo and Juan C. Bonilla.[4]

Table 1 displays descriptive statistics regarding the number of members in the household and the possession of assets. As mentioned before, the treatment and comparison groups were selected to ensure that the municipalities were as similar as possible in terms of their location and the Human Development Index. However, the table displays baseline differences between the treatment group and the comparison group. In particular, Table 1 shows that, previous to the shock, households in the comparison group tend to have more assets than households affected by the hurricane.

Regarding consumption and prices, the survey contains information about 12 items: corn tortillas, beans, tomatoes, lemons, bananas, sugar, beef, chicken, eggs, milk, alcohol, and cigarettes. All individuals were asked the following question about consumption before the hurricane: did your household consume (item) in (month)? If the individuals answered yes, then they were asked information about the quantity consumed and the price. Finally, similar questions were asked of the individuals regarding consumption and prices after the hurricane. The hurricane affected the treatment group municipalities from August 2 to August 6, 2016. The survey was implemented in September 2016, and the respondents were also asked to recall information about prices and consumption from the month of July 2016.

[4]Puebla was founded on December 21, 1823 and consists of a total of 217 municipalities.

The response rates regarding consumption and prices before the hurricane Earl are presented in first Column of Table 2. Regarding the question about consuming a particular product ("Did your household consume...?"), the percentage of households with no response (i.e. did not answer the question) ranges from 1.8% for sugar to 2.7% for beans. From those individuals who answered that they did consume such items, almost all the individuals responded with the quantity that they consumed (see Column 4 in Table 2).[5]

Table 3 presents the rates of consumption of these goods before the hurricane, separately for "treatment" and "control" municipalities, and we can observe important differences in the patterns of consumption. For example, 75% of the households in the treatment localities reported consuming corn tortillas, compared to 91% for the control group. Another example is the consumption of alcohol, where 24% of the households in the treatment group reported consuming alcohol, while the percentage is only 14% in the control group. Table 4 presents the quantities[6] consumed in the treatment and control groups. Depending on the item, some goods are consumed more in the treatment group

[5]These high rates of response can be explained by important changes to the instrument used to collect the information. For example, a similar survey collected information in the aftermath of the Hurricane Odile, which affected the state of Baja California Sur. This hurricane affected that area between September 10 and September 24, 2014. The survey was implemented during June of 2015, and the people surveyed were asked to recall information regarding the month of August 2014. Of the people who answered positively consumption, almost half of them were not able to respond the quantity consumed. So, it is clear that the time period for which the people were asked to recall information matters. Another potential explanation could be the length of the questionnaire. In the case of the survey collected for Hurricane Earl, it was decided to shorten the questionnaire. For example, when the individuals surveyed answer the consumption module, they have were asked 153 questions in the case of the Hurricane Odile, but only 82 questions in the case of the Hurricane Earl.

[6]Unconditional on positive consumption.

while others are consumed more in the control group. For example, the control group consumes an average of 6.98 kg of corn tortilla per week per household vs 4.32 kg in the treatment group; however, for sugar, the control group consumes 1.92 kg vs 2.57 kg in the treatment group. Finally, Table 5 presents information regarding prices. In general, the families in the treatment group report higher prices than those in the control group; yet, there are some exceptions, such as alcohol or cigarettes.

4 Empirical Strategy

The objective of this paper is to examine whether the FONDEN resources are sufficient to smooth the consumption of the families affected by the Hurricane Earl in Puebla, Mexico. Ideally, we would like to calculate the effects of the FONDEN on consumption by comparing the actual outcome with the outcome in the absence of the shock. Because this is impossible, we have to rely on the construction of a proper counterfactual. Since Hurricane Earl's trajectory was exogenous, households spared by the storm constitute a natural control group. Hence, the approach is to compare the changes in the outcome of interest in the localities directly hit by Hurricane Earl and where the FONDEN resources were used to the changes that occurred in the control group localities.

We use a difference-in-differences (DID) approach to examine the effect on household consumption, assets, and prices:

$$Y_{it} = \beta_0 + \beta_1 After_t + \beta_2 Hurricane_i + \beta_3 \left(After_t * Hurricane_i\right) + X_i\theta_i + e_{it}$$

where Y_{it} is the outcome of interest for household i at time t. We look at various types of outcomes such as consumption and prices of a basket of goods that is relevant for the Mexican context; $After_t$ takes the value of 1 in the period after the shock; $Hurricane_i$ takes the value of 1 in the municipalities affected by the natural disaster and zero otherwise; X_i is a set of control variables. Notice that the coefficient of interest is β_3. It estimates the *combined* effect that the hurricane and the implementation of FONDEN have in the treated municipalities compared to the control group. More specifically, without FONDEN we expect $\beta_3 < 0$, but we want to see whether, with FONDEN, $\beta_3 = 0$. To identify the causal effect, the above difference-in-differences (DID) estimator must satisfies the following:

1. The additive structure imposed is correct.

2. $cov(e_{it}, After_t * Hurricane_i) = 0$.

The last assumption is known as the *parallel-trend* assumption, and it means that the outcome variables of the treatment and comparison groups followed the same trend over time before the hurricane took place. In other words, the unobserved characteristics that create a gap between measured treatment and control outcomes are assumed to be time invariant. Given that we only have two data points, we cannot test this hypothesis. However, these municipalities are located close to each other and they are all

located in the State of Puebla. Therefore, we think that it is likely that in absence of the hurricane, the outcomes of interest for the four municipalities followed a similar trend.

Although a natural disaster is unexpected and non-manipulable by construction, the initial conditions of the families are likely to influence the subsequent consumption path. For example, it is possible that wealthy families recover faster from the hurricane using their savings or other assets to smooth their consumption. For this reason, we include an additional robustness check using a Kernel propensity matching technique combined with a DID. We use the predicted probability of being affected by the hurricane (the propensity score) to match the control municipalities. The propensity score is estimated using a probit model where the initial conditions are the assets holding of the families in the period before the hurricane. The average impact can be written as:

$$DD_i = (Y_{i2}^T - Yi1^T) - \sum_{j \in C} w(i,j)(Y_{j2}^C - Y_{j1}^C)$$

where w(i,j) is the weight using a Kernel matching in which all non-participants are used as comparison communes and weights are assigned according to a kernel function of the predicted propensity score.

Another potential source of endogeneity bias could be characteristics of the municipalities that might affect consumption outcomes. For example, economic opportunities might result in different consumption outcomes across the municipalities, even in the absence of the hurricane. Thus, as a robustness check, we will conduct a fixed effects

regression at the municipality level.

5 Results

We analyze the effects on quantities consumed and prices of the following goods: corn tortillas, beans, tomatoes, lemons, bananas, sugar, beef, chicken, eggs, milk, alcohol, and cigarettes. Table 6, Column 3, presents estimates of the impact on consumption decisions (a *dummy* variable for the question "Did your household consume...?"). The estimates show that the hurricane affected negatively, and statistically significantly, the consumption of beans (-0.14), lemons (-0.06), sugar (-0.04), beef (-0.02) and chicken (-0.02). Column 5 presents the results regarding the quantities consumed, where significantly negative impacts are found only for beans (-.288). Regarding prices, they decrease for all the items analyzed except cigarettes, and these decreases are statistically significant for all items except sugar and milk (Column 7). In particular, a statistically significant decrease is observed in the prices of the following items: tortillas (-0.94 or 9.5%), beans (-1.91 or 7.3%), tomatoes (-3.52 or 26.3%), lemons (-1.68 or 14.5%), bananas (-1.33 or 13.8%), beef (-4.86 or 8.8%), chicken (-4.34 or 9.9%), and eggs (-1.09 or 5.8%).[7]

As a robustness check, we use a kernel propensity matching to identify a sample of

[7]Finally a joint test was conducted for consumption, quantities consumed, and prices. We reject the null hypothesis that the effect of the hurricane on consumption and quantities consumed is not statistically significant at the 5 and 10 percent level, respectively. For prices, we reject the null hypothesis of no effect of the hurricane at the 5 percent level.

households in the comparison group that had asset holdings similar to those of the households in the treatment group before the hurricane took place. Table A1 (Appendix) show the balancing test before and after the matching. There are many significant differences in asset holdings for the unmatched sample. This is also in line with the descriptive statistics provided in Table 1, which pointed out some differences between households in the treatment and the comparison groups. After the matching is implemented, most of the differences between the matched sample of the treatment and control groups are no longer significant. And even for those variables for which there are still differences such as DVD, water heater, cellphone, and piped water, there is a large reduction in the gap after the matching.

The results of the DID using the matched sample are displayed in Table 7. As compared to the basic specification in Table 6, the effects on consumption of beans, lemon, sugar, beef, and chicken remain significant and are even slightly larger. On quantities consumed, there is still a negative effect of the hurricane on the quantity consumed of beans, and we also find a negative and significant effect on the quantity of lemons. Finally, the effect of the hurricane on prices remains negative for most of the products except for sugar and milk, neither of which were significant in the basic specification. Thus, we find the same results even after implementing the propensity score matching.[8]

[8] A joint test was conducted for consumption, quantities consumed, and prices. We reject the null hypothesis that the effect of the hurricane on consumption and quantities consumed is not statistically significant at the 5 and 10 percent level, respectively. For prices, we reject the null hypothesis of no effect of the hurricane at the 5 percent level.

To confirm the results presented above regarding consumption and prices, we decided to use municipality fixed effects. The idea is to capture characteristics of the municipalities that might affect our variables of interest even in the absence of the Hurricane and the resources of FONDEN, such as the population of the villages, economic development, and institutional efforts to prevent natural disasters. Table 8 reproduces Table 6 using municipality fixed effects. We do not observe substantial changes with respect the results presented in Tables 6 and 7.[9]

It is possible that the changes in consumption reflect only substitution effects, so that it is possible that aggregate household consumption was not affected. To analyze this possibility, the consumption of the twelve items was aggregated, i.e. we generate a new variable, which adds the dummy variables regarding consumption, and which maximum value is twelve. The result is presented in Table 9, Column 1, and we still observe a decrease in consumption that is statistically significant (-0.302). Column 2 presents the aggregate consumption results that exclude alcohol and cigarettes. The results continue to be statistically significant, and a slight increase is observed (-0.314). Finally, column 3 presents the result when we add the quantities consumed excluding alcohol and cigarettes.[10] it is observed a decrease in the quantity consumed that is statistically significant (-0.581)

[9]A joint test was conducted for consumption, quantities consumed, and prices. We reject the null hypothesis that the effect of the hurricane on consumption and quantities consumed is not statistically significant at the 5 and 10 percent level, respectively. For prices, we reject the null hypothesis of no effect of the hurricane at the 5 percent level.

[10]For the case of milk, it is assumed that 1kg= 1 liter.

There is evidence that natural disasters can affect families differently depending on their levels of wealth (Carter and Lybbert, 2012). In order to verify this hypothesis, using the information regarding the sixteen assets captured in the survey, we generate an index of wealth using principal component analysis. This index goes from -3.16 (less assets) to 6.68 (more assets). Then we estimate the following model using difference-in-differences estimation:

$$Y_{it} = \beta_0 + \beta_1 After_t + \beta_2 Hurricane_i + \beta_3 Wealth_{0i} + \beta_4 After_t Hurricane_i +$$
$$\beta_5 After_t Wealth_{0i} + \beta_6 Hurricane_i Wealth_{0i} + \beta_7 After_t Hurricane_i Wealth_{0i} + X_i\theta_i + e_{it}$$

where Y is the variable of interest (consumption); *After* is a dummy variable that takes the value of 1 after the shock; $Hurricane_i$ is a dummy variable that takes the value of 1 for the affected areas, and zero otherwise; $Wealth_{0i}$ is a variable that measures the wealth of the families before the hurricane; and X is a group of control variables. In this specification our coefficient of interest is β_7.

Table 10 presents results regarding the probability of consuming and the quantity consumed when the wealth of the families previous to the hurricane is taken into account. Column 3 presents the results when the consumption is analyzed. For the twelve items analyzed, we observe a statistically significant effect (0.029) only for the consumption of beef. Given that the sign of the effect is positive, it implies that households with low levels of assets were more affected. The results regarding the quantities consumed are

presented in Column 5. In this case, the only coefficient that is statistically significant at the 10% level is associated with the consumption of chicken: -0.048. The negative sign of the effect implies that households with high level of assets were most affected. Finally, we conducted a joint test, and we were not able to reject the null hypothesis of no effect of different levels of wealth on consumption and quantities consumed. Thus, it appears that the original level of wealth did not affect the decrease observed in the households consumption, i.e. we do not find evidence of heterogeneity.

Although families received support from FONDEN and there was a drop in prices, these factors were not enough to smooth the consumption of households affected by the hurricane. In addition, we do not find evidence that the hurricane affected families differently depending on their wealth. Regarding the decrease observed in prices, it is possible a consequence of an important decrease in income that affected the demand for food. Yet, other potential hypotheses are plausible, such as, that markets are not well integrated or the families sold at a lower price the items included in the "despensa" (for example, it could be the case of products that families do not like), causing a drop in prices.

6 Conclusion

This paper analyzes the ability of a disaster fund program (FONDEN) to smooth the consumption of families affected by Hurricane Earl in Puebla, Mexico. In particular, the analysis examines quantities consumed and prices for the following goods: corn tortillas, beans, tomatoes, lemons, bananas, sugar, beef, chicken, eggs, milk, alcohol, and cigarettes. The results show a decrease in the consumption of five of the twelve goods analyzed, including beans, which is an essential staple good for Mexican families. In addition, estimates of the effect on prices are negative, but this decrease in prices was not enough to maintain the consumption of the families.

The Fund for Natural Disasters (FONDEN) program provides food to families affected and supports the reconstruction of the infrastructure in the affected areas. In addition, the Mexican Government received US$200,000 from the Inter-American Development Bank to purchase food for the affected families. Yet, our results indicate that this aid was not enough to protect the consumption of families who were affected. De Janvry, et al. (2016) find evidence that this program (FONDEN) increases local economic activity between 2 and 4 percent in the year following the disaster. Thus, this program can be an important factor mitigating the effects of natural disaster in the medium term. Yet, it is necessary that the program review whether the quantity, quality, and periodicity with which food is distributed are the most appropriate. Improving these factors potentially can help to smooth the consumption of families affected in the short term.

7 References

Baird, S., J. Friedman, and N. Schady (2011): Aggregate Income Shocks and Infant Mortality in the Developing World," *Review of Economics and Statistics*, 93(3), 847-856.

Banerjee, A., E. Duflo, G. Postel-Vinay, and T. Watts (2010): "Long-Run Health Impacts of Income Shocks: Wine and Phylloxera in Nineteenth-Century France," *Review of Economics and Statistics*, 92(4), 714-728.

Barro, R. J. (2009): "Rare Disasters, Asset Prices, and Welfare Costs," *The American Economic Review*, 99(1), 243-264.

Beegle, K., R. H. Dehejia, and R. Gatti (2006): "Child labor and agricultural shocks," *Journal of Development economics*, 81(1), 80-96.

Bernheim, B. D., and J. K. Scholz (1993): "Private Saving and Public Policy," *Tax Policy and the Economy*, 7, 73-110.

Borensztein, E., Cavallo, E. and O. Jeanne (2017). "The Welfare Gains from Macro-Insurance against Natural Disasters," *Journal of Development Economics*, 124, 142-156.

Browning, M., and A. Lusardi (1996): "Household Saving: Micro Theories and Micro Facts," *Journal of Economic Literature*, 34(4), 1797-1855.

Cameron, L. and Worswick, C. (2001). "Education Expenditure Responses to Crop Loss in Indonesia: A Gender Bias," *Economic Development and Cultural Change*, 49(2), 351-363.

Carter, M. and T. Lybbert (2012):"Consumption versus Asset Smoothing: Testing the Implications of Poverty in Burkina Faso," *Journal of Development Economics*, 99, pp. 255-264.

Cavallo, E., and I. Noy (2011): "Natural disasters and the economy: a survey," *International Review of Environmental and Resource Economics*, 5(1), 63-102.

Cavallo, A., Cavallo, E., and R. Rigobon (2014): "Prices and Supply Disruptions During Natural Disasters." *Review of Income and Wealth*, 60, 449-471.

Cortés, D., J. Santamaría, and J. F. Vargas (2016): "Economic shocks and crime: Evidence from the crash of Ponzi schemes," *Journal of Economic Behavior & Organization*, 131, 263-275.

De Janvry, A., Del Valle, A. and E. Sadoulet (2016): "Insuring Growth: The Impact of Disaster Funds on Economic Reconstruction in Mexico," World Bank, Policy Reserach Working Paper.

Dube, O., and J. F. Vargas (2013): "Commodity price shocks and civil conflicts Evidence from Colombia," *The Review of Economic Studies*, 80(4), 1384-1421.

Fafchamps, M., C. Udry, and K. Czukas (1998): "Drought and saving in West Africa: are livestock a buffer stock?," *Journal of Development Economics*, 55(2), 273- 305.

Foster, A. D. (1995): "Prices, credit markets and child growth in low-income rural areas," *The Economic Journal*, pp. 551-570.

Global Catastrophe Recap (2016). Report 2016. Aon Benfield Analytics. London.

Guarcello, L., F. Mealli, and F. C. Rosati (2010): "Household vulnerability and child labor: the e˙ect of shocks, credit rationing, and insurance," *Journal of Population Economics*, 23(1), 169-198.

Hoddinott, J. (2006): "Shocks and their consequences across and within households in Rural Zimbabwe," *The Journal of Development Studies*, 42(2), 301-321.

INEGI (2013):"Dia Internacional Para la Reducción de Desastres Naturales." México.

Jacoby, H. G., and E. Skoufias (1997): "Risk, financial markets, and human capital in a developing country," *The Review of Economic Studies*, 64(3), 311-335.

Jensen, R. (2000): "Agricultural Volatility and Investments in Children," *The American Economic Review*, 90(2), 399-404.

Kahn, M. E. (2005): "The death toll from natural disasters: the role of income, geography, and institutions," *Review of economics and statistics*, 87(2), 271-284.

Kazianga, H. and Udry, C. (2006): "Consumption Smoothing? Livestock, Insurance, and Drought in Rural Burkina Faso", *Journal of Development Economics*, 79 (2), pp. 413-446.

Klomp, J. (2017): "Flooded with debt," *Journal of International Money and Finance*, 73, 93-103.

Kochar, A. (1995): "Explaining Household Vulnerability to Idiosyncratic Income Shocks," *The American Economic Review*, 85(2), 159-164.

Leaning, J. and D. Guha-Sapir (2013): "Natural Disasters, Armed Conflict, and Public Health," *The New England Journal of Medicine*, 369, pp. 1836-1842.

Modigliani, F., and R. Brumberg (1954): "Utility analysis and the consumption function: An interpretation of cross-section data," Post Keynesian Economics, Ruthers University Press, New Jersey.

Neumayer, E., and T. Plumper (2007): "The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981 to 2002," *Annals of the Association of American Geographers*, 97(3), 551-566.

PEF (2016). *Presupuesto de Egresos de la Federación para el Ejercicio Fiscal 2017.* Gobierno de México.

Pelling, M. (2003): "The vulnerability of cities: natural disasters and social resilience. Earthscan.

Sedesol (2016):"*Comunicado 245. Sedesol ha emprendido acciones de apoyo a la población en los estados de Puebla, Quintana Roo y Veracruz, las entidades más afectadas por la tormenta Earl.*" Sedesol.

Skoufias, E. (2003): "Economic Crises and Natural Disasters: Coping Strategies and Policy Implications," *World Development*, 31(7), 1087-1102.

UNICEF (2016). "Mexico Earl Tropical Storm Situation Report 8."

World Bank (2012). FONDEN: Mexicos Natural Disaster Fund- A review.

8 Tables

Table 1: Descriptive Statistics Assets: Puebla

Variables	Treatment	Control	Difference
Number of members of the HH	4.67	4.09	0.58***
Computer	0.02	0.28	−0.26***
Stove	0.44	0.95	−0.51***
Washing machine	0.04	0.54	−0.50***
Refrigerator	0.26	0.74	−0.48***
DVD	0.23	0.40	−0.17***
TV	0.55	0.89	−0.34***
Water heater	0.16	0.44	−0.28***
Cellphone	0.30	0.66	−0.36***
Microwave	0.02	0.20	−0.18***
Toaster	0.00	0.12	−0.12***
Internet	0.01	0.25	−0.24***
Piped water	0.85	0.56	0.29***
Toilet inside hh	0.71	0.86	−0.15***
Electricity	0.98	0.99	−0.01
Landline	0.21	0.32	−0.11***
Cable TV	0.17	0.22	−0.05*
Car	0.05	0.28	−0.23***
Number of observations	328	334	

Note: Tlaola and Huauchinango are treatment municipalities while Palmar de Bravo and Juan C. Bonilla form the comparison group. Clustered standard errors at the street level.

Source: Survey of Social Mobility in Disaster Zones.

*** p<0.01, ** p<0.05, * p<0.1

Table 2: Percentage of Pre-Hurricane Responses Regarding Consumption (Puebla)

	Did your household consume...?			How much...?
	No answer (%)	No (%)	Yes (%)	Answer (%)
Corn tortilla	1.9	8.5	89.5	100.0
Bean	2.7	10.9	86.3	100.0
Tomato	1.8	1.6	96.5	100.0
Lemon	2.5	23.3	74.1	99.6
Banana	2.3	19.0	78.7	100.0
Sugar	1.8	3.4	94.8	99.7
Beef	2.1	24.4	73.5	99.6
Chicken	1.9	7.9	90.1	99.8
Eggs	2.1	10.9	86.9	99.7
Milk	2.3	28.4	69.3	99.8
Alcohol	1.9	90.9	7.2	93.8
Cigarettes	1.9	95.4	2.7	100.0

Note: Data combined for treatment and control group.

*** p <0.01, ** p <0.05, *p <0.1

Table 3: Descriptive Statistics Consumption: Puebla (Pre-Hurricane)

Variables	Treatment	Control	Difference
Corn tortilla	0.75	0.91	−0.16***
Bean	0.89	0.88	0.01
Tomato	0.99	0.98	−0.01
Lemon	0.63	0.75	−0.12***
Banana	0.90	0.80	0.10***
Sugar	0.99	0.96	0.03**
Beef	0.96	0.75	0.21***
Chicken	0.96	0.91	0.04***
Eggs	0.92	0.88	0.04**
Milk	0.70	0.69	0.01
Alcohol	0.24	0.14	0.10***
Cigarettes	0.01	0.03	0.02**

Note: Tlaola and Huauchinango are treatment municipalities while Palmar de Bravo and Juan C. Bonilla form the comparison group. Clustered standard errors at the street level.

Source: Survey of Social Mobility in Disaster Zones

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Descriptive Statistics Quantities Consumed per Household: Puebla (Pre-Hurricane)

Variables	Treatment	Control	Difference
Corn tortilla	4.32	6.98	-2.66^{***}
Bean	1.40	1.83	-0.43^{***}
Tomato	1.87	2.84	-0.97^{***}
Lemon	0.71	1.29	-0.58^{***}
Banana	2.02	1.75	0.27^{**}
Sugar	2.57	1.92	0.65^{***}
Beef	1.09	1.09	0.00
Chicken	1.20	1.59	-0.39^{***}
Eggs	1.16	1.41	-0.25^{**}
Milk	1.54	3.76	-2.21^{***}
Alcohol	0.16	0.08	0.08^{***}
Cigarettes	0.01	0.06	-0.05^{**}

Note: Tlaola and Huauchinango are treatment municipalities while Palmar de Bravo and Juan C. Bonilla form the comparison group. Clustered standard errors at the street level.

Source: Survey of Social Mobility in Disaster Zones

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Descriptive Statistics Prices: Puebla (Pre-Hurricane)

Variables	Treatment	Control	Difference
Corn tortilla	9.89	8.99	0.90^{***}
Bean	25.91	19.37	6.54^{***}
Tomato	13.32	10.71	2.61^{***}
Lemon	11.47	9.10	2.37^{***}
Banana	9.59	8.31	1.27^{***}
Sugar	19.04	14.08	4.95^{**}
Beef	54.74	66.87	-12.13^{***}
Chicken	43.70	43.10	0.59
Eggs	18.92	20.78	-1.85^{**}
Milk	13.08	11.00	2.08^{***}
Alcohol	9.06	15.83	-6.77^{***}
Cigarettes	31.50	44.63	-13.13^{*}

Note: Chicahuaxtla (Tlaola) and Xaltepec (Huauchinango) are treatment municipalities while Palmar de Bravo and Juan C. Bonilla form the comparison group. Clustered standard errors at the street level.

Source: Survey of Social Mobility in Disaster Zones.

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Difference-in-Difference Estimates of the Impact of the Hurricane on Food Consumption and Prices

	Consumption		Quantity		Price	
Variables	Mean	Estimate	Mean	Quantity	Mean	Price
Tortillas	0.739	−0.003	4.752	−0.030	9.908	−0.944***
	0.439	(0.005)	5.323	(0.068)	0.871	(0.104)
Beans	0.902	−0.140***	1.514	−0.288***	25.927	−1.911***
	0.298	(0.023)	2.129	(0.099)	9.041	(0.523)
Tomatoes	0.995	−0.003	2.098	−0.009	13.374	−3.520***
	0.068	(0.005)	1.771	(0.041)	4.388	(0.435)
Lemon	0.650	−0.056***	0.770	−0.068	11.574	−1.689***
	0.477	(0.018)	1.006	(0.044)	6.367	(0.432)
Plantain	0.917	−0.020	2.096	−0.075	9.572	−1.336***
	0.275	(0.013)	1.310	(0.056)	3.496	(0.330)
Sugar	0.996	−0.040**	2.776	−0.183	18.959	−0.533
	0.063	(0.017)	2.564	(0.130)	8.075	(0.404)
Alcohol	0.240	0.011	0.164	−0.009	9.247	−12.739*
	0.427	(0.030)	0.384	(0.028)	7.496	(6.748)
Cigarretts	0.005	0.006	0.005	0.006	31.500	15.636**
	0.072	(0.008)	0.072	(0.031)	6.949	(5.661)
Beef	0.974	−0.023**	1.141	0.023	55.195	−4.867***
	0.160	(0.012)	0.568	(0.032)	11.519	(0.901)
Chicken	0.974	−0.018**	1.254	0.025	43.832	−4.340***
	0.158	(0.009)	0.646	(0.031)	6.734	(0.606)
Eggs	0.951	−0.003	1.276	−0.025	18.917	−1.098***
	0.216	(0.017)	1.023	(0.034)	5.362	(0.339)
Milk	0.707	−0.001	1.664	−0.028	13.262	−0.173
	0.455	(0.013)	1.901	(0.069)	6.703	(0.198)

Note: Clustered standard errors displayed in parenthesis at the street level. The table displays for each outcome the mean outcome for the treatment group before the hurricane, and the interaction term between the treatment and the after dummy. The sample size for consumption ranges from 1,291 for milk to 1,307 for tortillas. In the case of the quantities, it ranges from 1,287 for alcohol to 1,308 for tomatoes. Finally, in the case of prices, it ranges from 889 for lemons to 1,306 for beef, with the exceptions of alcohol (164) and cigarettes (22).

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Matching Difference-in-Difference Estimates of the Impact of the Hurricane on Food Consumption and Prices

	Consumption		Quantity		Price	
Variables	Mean	Estimate	Mean	Quantity	Mean	Price
Tortillas	0.739	−0.008	4.752	−0.067	9.908	−0.852***
	0.439	(0.009)	5.323	(0.092)	0.871	(0.106)
Beans	0.902	−0.153***	1.514	−0.298**	25.927	−1.355**
	0.298	(0.027)	2.129	(0.124)	9.041	(0.562)
Tomatoes	0.995	−0.002	2.098	−0.016	13.374	−3.139***
	0.068	(0.007)	1.771	(0.043)	4.388	(0.541)
Lemon	0.650	−0.058***	0.770	−0.094**	11.574	−0.932**
	0.477	(0.015)	1.006	(0.039)	6.367	(0.446)
Plantain	0.917	−0.025	2.096	−0.063	9.572	−1.016***
	0.275	(0.015)	1.310	(0.051)	3.496	(0.376)
Sugar	0.996	−0.044***	2.776	−0.219	18.959	−0.022
	0.063	(0.016)	2.564	(0.144)	8.075	(0.487)
Alcohol	0.240	−0.005	0.164	−0.004	9.247	−10.081*
	0.427	(0.031)	0.384	(0.028)	7.496	(5.266)
Cigarretts	0.005	0.010	0.005	0.015	31.500	20.836***
	0.072	(0.009)	0.072	(0.012)	6.949	(6.495)
Beef	0.974	−0.032**	1.141	0.004	55.195	−4.311***
	0.160	(0.015)	0.568	(0.031)	11.519	(1.270)
Chicken	0.974	−0.023**	1.254	0.016	43.832	−4.169***
	0.158	(0.011)	0.646	(0.034)	6.734	(0.740)
Eggs	0.951	−0.008	1.276	−0.010	18.917	−1.596***
	0.216	(0.014)	1.023	(0.037)	5.362	(0.496)
Milk	0.707	−0.009	1.664	−0.039	13.262	0.006
	0.455	(0.013)	1.901	(0.085)	6.703	(0.284)

Note: Clustered standard errors displayed in parenthesis. The table displays for each outcome the mean outcome for the treatment group before the hurricane, and the interaction term between the treatment and the after dummy. The difference-in-differences estimator include fixed effects at the street level. The sample size for consumption ranges from 1,291 for milk to 1,307 for tortillas. In the case of the quantities, it ranges from 1,287 for alcohol to 1,308 for tomatoes. Finally, in the case of prices, it ranges from 889 for lemons to 1,306 for beef, with the exceptions of alcohol (164) and cigarettes (22).

*** p<0.01, ** p<0.05, * p<0.1

Table 8: Municipality Fixed Effect Estimates of the Impact of the Hurricane on Food Consumption and Prices

	Consumption		Quantity		Price	
Variables	Mean	Estimate	Mean	Quantity	Mean	Price
Tortillas	0.739	−0.003	4.752	−0.032	9.908	−0.944***
	0.439	(0.005)	5.323	(0.068)	0.871	(0.105)
Beans	0.902	−0.140***	1.514	−0.293***	25.927	−2.080***
	0.298	(0.023)	2.129	(0.099)	9.041	(0.496)
Tomatoes	0.995	−0.003	2.098	−0.009	13.374	−3.531***
	0.068	(0.005)	1.771	(0.041)	4.388	(0.436)
Lemon	0.650	−0.057***	0.770	−0.068	11.574	−1.742***
	0.477	(0.018)	1.006	(0.045)	6.367	(0.434)
Plantain	0.917	−0.020	2.096	−0.073	9.572	−1.331***
	0.275	(0.013)	1.310	(0.056)	3.496	(0.329)
Sugar	0.996	−0.040**	2.776	−0.185	18.959	−0.483
	0.063	(0.017)	2.564	(0.131)	8.075	(0.401)
Alcohol	0.240	0.011	0.164	−0.009	9.247	−12.264*
	0.427	(0.031)	0.384	(0.028)	7.496	(6.674)
Cigarretts	0.005	0.006	0.005	0.006	31.500	15.804**
	0.072	(0.008)	0.072	(0.031)	6.949	(5.871)
Beef	0.974	−0.024**	1.141	0.022	55.195	−4.837***
	0.160	(0.012)	0.568	(0.032)	11.519	(0.898)
Chicken	0.974	−0.018**	1.254	0.025	43.832	−4.336***
	0.158	(0.009)	0.646	(0.031)	6.734	(0.603)
Eggs	0.951	−0.002	1.276	−0.024	18.917	−1.096***
	0.216	(0.017)	1.023	(0.034)	5.362	(0.339)
Milk	0.707	−0.003	1.664	−0.030	13.262	−0.170
	0.455	(0.013)	1.901	(0.071)	6.703	(0.196)

Note: Clustered standard errors displayed in parenthesis at the street level. The table displays for each outcome the mean outcome for the treatment group before the hurricane, and the interaction term between the treatment and the after dummy. The estimator include fixed effects at the municipality level. The sample size for consumption ranges from 1,291 for milk to 1,307 for tortillas. In the case of the quantities, it ranges from 1,287 for alcohol to 1,308 for tomatoes. Finally, in the case of prices, it ranges from 889 for lemons to 1,306 for beef, with the exceptions of alcohol (164) and cigarettes (22).

*** p<0.01, ** p<0.05, * p<0.1

Table 9: Difference-in-Difference Estimates on Aggregated Consumption

Variables	(1) Total Consumption	(2) Consumption w/o Alcohol and Cigarettes	(3) Quantity w/o Alcohol and Cigarettes
After	-0.153***	-0.021	-0.164
	(0.044)	(0.034)	(0.138)
Treatment	0.705*	0.562	-6.275***
	(0.401)	(0.363)	(0.996)
After*Treatment	-0.302***	-0.314***	-0.581**
	(0.071)	(0.063)	(0.264)
Constant	9.576***	9.510***	24.049***
	(0.022)	(0.017)	(0.780)
Observations	1,324	1,324	1,324
R-squared	0.184	0.187	0.075

Note: Clustered standard errors displayed in parenthesis at the street level. For the case of milk, it is assumed that 1kg= 1 liter.
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Heterogenous Estimates on Food Consumption

	Consumption		Quantity	
Variables	Mean	Estimate	Mean	Quantity
Tortillas	0.748	0.032	4.322	0.013
	0.435	(0.021)	4.980	(0.181)
Beans	0.899	0.014	1.401	0.033
	0.302	(0.025)	2.024	(0.056)
Tomatoes	0.994	0.003	1.873	−0.053
	0.078	(0.004)	1.524	(0.047)
Lemon	0.635	−0.034	0.710	0.036
	0.482	(0.021)	0.908	(0.037)
Plantain	0.908	0.019	2.029	−0.056
	0.290	(0.013)	1.317	(0.050)
Sugar	0.994	0.016	2.571	0.065
	0.078	(0.014)	2.365	(0.046)
Alcohol	0.240	−0.010	0.162	−0.029
	0.428	(0.018)	0.381	(0.025)
Cigarrettes	0.006	−0.006	0.006	−0.026
	0.078	(0.004)	0.078	(0.021)
Beef	0.966	0.029**	1.097	−0.002
	0.181	(0.012)	0.577	(0.047)
Chicken	0.966	0.005	1.200	−0.048*
	0.181	(0.009)	0.640	(0.029)
Eggs	0.929	0.009	1.164	−0.035
	0.256	(0.013)	0.908	(0.028)
Milk	0.693	−0.003	1.548	−0.072
	0.462	(0.019)	1.792	(0.079)

Note: Clustered standard errors displayed in parenthesis at the street level. The table displays for each outcome the mean outcome for the treatment group before the hurricane, and the interaction term between the treatment, the after dummy, and index of wealth. The sample size for consumption ranges from 1,291 for milk to 1,307 for tortillas. In the case of the quantities, it ranges from 1,287 for alcohol to 1,308 for tomatoes.

*** p<0.01, ** p<0.05, * p<0.1

9 Appendix

Table A1: Balancing Test Before and After the Matching

Covariates		Treatment	Control	$p > \|t\|$
Computer	Unmatched	0.018	0.281	0.000
	Matched	0.018	0.019	0.933
Stove	Unmatched	0.443	0.949	0.000
	Matched	0.442	0.391	0.193
Washing machine	Unmatched	0.043	0.536	0.000
	Matched	0.043	0.050	0.655
Refrigerator	Unmatched	0.257	0.740	0.000
	Matched	0.258	0.241	0.631
DVD	Unmatched	0.232	0.401	0.000
	Matched	0.233	0.137	0.002
TV	Unmatched	0.554	0.892	0.000
	Matched	0.555	0.605	0.202
Water heater	Unmatched	0.162	0.443	0.000
	Matched	0.163	0.257	0.003
Cellphone	Unmatched	0.303	0.665	0.000
	Matched	0.304	0.232	0.037
Microwave	Unmatched	0.024	0.201	0.000
	Matched	0.025	0.019	0.656
Toaster	Unmatched	0.003	0.120	0.000
	Matched	0.003	0.005	0.731
Internet	Unmatched	0.009	0.251	0.000
	Matched	0.009	0.007	0.749
Piped water	Unmatched	0.847	0.563	0.000
	Matched	0.847	0.797	0.097
Toilet inside hh	Unmatched	0.713	0.862	0.000
	Matched	0.712	0.809	0.004
Electricity	Unmatched	0.982	0.988	0.503
	Matched	0.982	0.979	0.803
Landline	Unmatched	0.208	0.320	0.001
	Matched	0.209	0.141	0.023
Cable TV	Unmatched	0.168	0.225	0.069
	Matched	0.169	0.214	0.138