Quantifying the food insecurity needs from price escalations among Mexican households

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Abstract

Price shocks create and exacerbate poverty. Being able to proactively predict their effect, instead of waiting for households to fall into poverty to then try to assist them, may greatly reduce the severity of the shock's damage. However, understanding shock severity and being able to target those households most likely to be disrupted, requires a level of data oftentimes unavailable in the developing world. This manuscript uses the Mexican National Household Survey of Incomes and Expenditure to quantify the household income needs resulting from the recent food price spikes. We estimate a complete food demand system that accounts for the substitution effects across food items to accurately calculate the cost of a poverty alleviation policy tailored to the recent price escalation caused by the COVID-19 pandemic. Our findings reveal that in 2021, the price of food increased such that Mexican households require an additional 9% increase in their food budgets to keep a level of welfare like that of the beginning of the year. Demographic comparisons reveal that households led by women require additional monetary aid regardless of geographic location. We find that the cost of proactively alleviating the anticipated poverty effects in México caused by the recent price escalation to be $48.6 billion pesos ($2.4 billion dollars). Because of the high price tag, we group Mexican states by the level of income compensation required to distribute to each family and propose an efficient allocation of transfer payments to reduce the cost of poverty alleviation.

JEL codes: C31, D12, I32, Q18
Keywords: Consumer behavior, food price escalation, food systems, poverty, poverty alleviation.

1. Introduction

The Government of México (GOM) is a leader in attempting to alleviate poverty through cash transfers. They have a long history of anti-poverty measures (Yashine, 2009). The primary example being the Progresa program, which recently evolved into the Benito Juarez scholarship program.[1] Progresa started in 1997 and is one of the first large-scale Cash Conditional Transfer (CCT) programs most studied because of its large importance in the region, and that recipients are randomized (Rossel, Antia and Mazi, 2022). Progresa, by design, is responsive. The program first identifies households in need and then distributes aid to them. A concern with responsive poverty alleviation programs is the period of time between the household falling into poverty and when it receives aid. A large body of research has demonstrated that poverty negatively effects households. Victora *et al* (2022) shows the linkage between childhood poverty and negative health and human capital outcomes. Khullar and Chokshi (2018) provide a broad overview of the relationship between poverty and morbidity and mortality. In this study, we take a different approach. First, we identify Mexican households vulnerable to food price increases, simulate the poverty effects of these increases, and then we propose a cash transfer amount to alleviate the estimated poverty effects. We implement our methodology on the recent food price escalations caused by the COVID-19 pandemic. We calculate that the cost of alleviating the poverty effects in Mexico caused by the recent price escalation to be $48.6 billion pesos ($2.4 billion dollars).

The United States is an exemplary case where datasets are readily available to assess aid needs among different sectors of the population promptly. Using the Feeding America's Map the Meal Gap, Gundersen *et al.* (2020) project that food insecurity rates among children will double that of the average population. In addition, Ahn and Norwood (2020) use internet surveys to identify that households with children will experience the highest increase in food insecurity rates because of the COVID-19 pandemic. The latter two approaches employ household data to identify households in need, but recent developments exploit inter-state food flows to develop a general equilibrium model that simulates food price distortions coming from hypothetical events (e.g., severe drought conditions) affecting the food system in the U.S. (Nava, Ridley and Dall'Erba, 2022). Using their extensive existing data, U.S. authorities have pro-actively implemented anti-poverty measures in anticipation of COVID-related price shocks. These measures had different degrees of targeting, at the household level for stimulus payments and at the child level for tax

[1] This program is better known now as POP (Progresa-Oportunidades-Prospera).

credits. Recent research is already demonstrating poverty reductions (Béland et al, 2022) and food security improvements (Shafer et al, 2022) based on these proactive measures.

When it comes to developing countries where datasets of food vulnerability are often not available, different approaches are required to achieve a similar level of proactivity as in the U.S. (McBride *et al.*, 2021). Yujun *et al.* (2021) propose using machine learning algorithms with data on prices, assets, and weather to predict food insecurity in different regions of the world. In a similar study, Christensen, Wagner and Langhals (2021) employ Artificial Intelligence (AI) methodologies to classify communities by their level of food insecurity. Awojobi (2022) provides a systemic overview of cash transfer programs and their positive household effects through reducing poverty and improving children's health.

This manuscript contributes to these recent efforts to study the food security implications of events that affect food expenditure. We propose using ENIGH to calculate the cost of a poverty alleviation policy tailored to the recent price escalation caused by COVID-19. ENIGH has several advantages. ENIGH is a bi-annual household expenditure survey that includes a large array of food and other expenditure categories, so estimates can be revised every two years to assess the model's reliability. ENIGH also reports quantities of the goods bought, so prices can be imputed following recent methodological treatments (i.e., addressing the unit-value endogeneity). Using estimation techniques such as the one proposed in this paper, simulations can be performed to assess the level of need from hypothetical price escalations in monetary values, so stakeholders can calculate the amount of aid needed. Finally, ENIGH also collects demographic characteristics from surveyed households that better identify populations in need. In this manuscript, demographic comparisons reveal that households led by women require additional monetary aid to cope with the recent price escalations regardless of geographic location.

2. National Household Survey of Expenditures and Incomes

We utilize the most recent ENIGH collected by the Mexican National Institute of Statistics and Geography (INEGI) in 2020. Despite that ENIGH is not longitudinal, the survey data have been utilized in several demand estimations to evaluate policy (Colchero *et al.*, 2015a), study poverty effects (Wood, Nelson, and Nogueira, 2012), and advance methodologies (Nava and Dong, 2022). Following Wood, Nelson and Nogueira's (2012) work, we aggregate ENIGH food items by relying on the concepts of weak separability and two-stage budgeting for the construction of our basket of six composite goods (Deaton and Muellbauer, 1980). Our aggregation includes a corn tortilla composite good, a cereal composite good that accounts for all cereal items including maize and rice, a meat composite good that accounts for all raw meat, a dairy composite good, a composite good to account for fruits and vegetables, and another category that includes a variety of goods such as cooking oil and food-away from home.

Table 1 below describes our food basket across several budget bins that reflect households' incomes and other households' characteristics. The budget bins include households in the bottom three quartiles, between the 75th and 90th percentiles, and the top decile. Biweekly expenditure on food ranges from $17.65 dollars among the poorest households to $59.26 among the richest households. ENIGH requires two additional corrections regarding composite prices and expenditure endogeneity that are often neglected in empirical applications. First, unit values, i.e., the ratio of expenditure to quantity, are employed as a proxy for composite prices. The employment of unit values to proxy prices carries endogeneity concerns since unit values reflect household preferences and composite prices (Zhen et al., 2014). We address the quality/price issue with a simple two-step structural decomposition of unit values proposed in Capacci and Mazzocchi

Table 1: Descriptive statistics

	Food budget bins				
	[Min, 25%]	(25%, 50%]	(50%, 75%]	(75%, 90%]	(90%, Max]
Budget	353.13	564.42	736.04	935.41	1,185.15
Shares					
Tortilla	0.13	0.12	0.11	0.09	0.08
	(0.16)	(0.13)	(0.12)	(0.11)	(0.11)
Cereal	0.13	0.09	1.10	0.09	0.09
	(0.14)	(0.10)	(0.10)	(0.09)	(0.09)
Meat	0.18	0.22	0.23	0.24	0.23
	(0.18)	(0.17)	(0.17)	(0.17)	(0.17)
Dairy	0.09	0.09	0.10	0.09	0.09
	(0.12)	(0.10)	(0.10)	(0.09)	(0.09)
Fruits and Vegetables	0.14	0.13	0.13	0.12	0.12
	(0.12)	(0.12)	(0.11)	(0.10)	(0.11)
Other	0.33	0.33	0.34	0.36	0.39
	(0.23)	(0.23)	(0.22)	(0.23)	(0.24)
Prices					
Tortilla	17.11	17.15	17.27	17.40	17.40
	(2.32)	(2.20)	(2.12)	(2.06)	(2.06)
Cereal	44.36	45.26	46.31	47.00	47.41
	(7.41)	(7.11)	(6.80)	(6.54)	(6.37)
Meat	70.75	71.38	72.23	72.76	73.04
	(8.23)	(7.86)	(7.81)	(7.68)	(7.88)
Dairy	44.55	44.82	45.01	45.16	45.28
	(9.16)	(8.48)	(8.13)	(7.63)	(7.31)

Fruits and Vegetables	27.17	27.34	27.65	27.96	28.27
	(3.88)	(3.78)	(3.72)	(3.58)	(3.72)
Other	39.78	41.29	42.91	44.08	44.82
	(9.75)	(9.39)	(9.20)	(8.97)	(8.98)
Demographic controls					
Sex	1.41	1.31	1.25	1.21	1.17
	(0.49)	(0.46)	(0.43)	(0.41)	(0.38)
Age	58.89	49.52	47.72	47.91	50.02
	(16.77)	(16.14)	(14.44)	(13.28)	(12.55)
Education	3.99	5.28	6.06	6.88	7.68
	(2.05)	(2.19)	(2.29)	(2.44)	(2.60)
Household size	2.17	3.25	3.96	4.54	5.41
	(1.14)	(1.33)	(1.44)	(1.65)	(2.31)
Observations	21,624	21,625	21,625	12,975	8,650

Prices are in 2017 Mexican pesos. Expenditures represent a total of two weeks.

(2011) that has been recently reported in other empirical demand estimations (see, for example, Caro *et al.,* 2017). Empirical analyses of food demand typically focus on the second stage of a two-step household's budgeting process implied by standard microeconomics theory. While the approach is common in the literature, the total expenditure variable could be endogenous and biased model estimates (LeFrance, 1993). To address this issue, we run an auxiliary regression of the total food expenditure against household income and demographics and then use the predicted total food expenditure from the auxiliary regression in our final estimation (Dhar, Chavas, and Gould, 2003).

3. Methods

Substitution effects are a natural behavioral response that consumers use to cope with product price increases. Thus, an appropriate model to target populations in need must reflect substitutability and complementarity across goods to accurately reflect consumer responses to simulated price changes. The Cournot and Engel aggregations mathematically account for such behavior. The Almost Ideal Demand (AID) system of Deaton and Muellbauer (1980) is the first model that estimates elasticities consistent with the behavior described by Cournot and Engel aggregations:[2]

$$\ln e(p,u) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j + u\beta_0 \prod_i p_i^{\beta_i + \boldsymbol{\theta}_i' \mathbf{z}}, \qquad (1)$$

[2] We consider the quadratic AIDS of Banks, Blundell and Lewbel (1997), but our basket of goods does not reflect quadratic Engel curves.

where u is the level of utility, p_i is the composite price for the i^{th} composite good, and the vector $\boldsymbol{z}$ includes demographic characteristics. Following the microeconomics concept of duality, e.g., $\ln e(p,u) = w$, where w is total food expenditure, and $u = V(p,u)$, we can obtain the consumer's indirect utility function:

$$V(p,w) = \frac{(\ln w - (\alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j))}{\beta_0 \prod_i p_i^{\beta_i + \boldsymbol{\theta}_i' \boldsymbol{z}}}. \qquad (2)$$

The estimable AID system of six equations can then be recovered from the indirect utility function using Roy's identity:

$$s_i(p,w) = \alpha_i + \sum_j \gamma_{ij} \ln p_j + (\beta_i + \boldsymbol{\theta}_i' \boldsymbol{z})(\ln w - (\alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j)) \;\; \forall \; i \in \{1, \dots, 6\} \qquad (3)$$

where $s_i(p,w)$ is a budget share equation such that $\sum_i s_i(p,w) = 1$ for all household observations in our data, e.g., Table 1. To ensure that our system of equations reflects the Cournot and Engel, the following additional econometric adjustments on the distribution of the parameters are implemented *a-priori* our NLSUR estimation:

$$\sum_i \alpha_i = 1, \quad \sum_i \beta_i = 0, \quad \sum_j \gamma_{ij} = 0, \quad \sum_i \theta_i = 0, \text{ and } \quad \gamma_{ij} = \gamma_{ji} \quad \forall i,j.$$

The above constraints are for homogeneity, adding up, and symmetry. In the appendix, we show how we estimate and calculate elasticities using the system of equations described here.

Using 2021 as a reference, Mexican households experienced significant price escalations. Accounting for price increase heterogeneity and the substitution effects described in the previous section allows us to study poverty effects and propose efficient policy responses accurately. Thus, welfare calculations consider the observed price increases in 2021 as reported by INEGI: the price of tortilla increased by 16.59%, the price of cereal increased by 6.84%, the price of meat increased by 9.66%, the price of dairy increased by 5.78%, the price of fruits and vegetables increased by 21.46%, and the price of our other category increased by 4.93%. Using equation (1), we can derive a Compensated Variation (CV) given by

$$cv(p^0, p^1, w) = w - e(p^1, u^0),$$

where p^0 and p^1 are 2020 and 2021 prices, respectively (Wood, Nelson, and Nogueira, 2012).

4. Results

The income compensation required to lift Mexican households to their beginning-of-the-year level of welfare is $53.24 per family every two weeks. ENIGH reports a total of 33,814,132 households in México. Thus, public officials would need to spend $48.6 billion pesos ($2.4 billion dollars) for one year if they attempted to alleviate all of the poverty effects of the recent food price increases. Because this is a substantial amount of money, we evaluate two alternative policy responses that reach most Mexican households for a lower price tag.

This paper explores two alternative approaches to food price poverty alleviation. In our first approach, we consider geographic locations as the target variable for determining the cost of alleviation per state based on their level of food insecurity and the criteria to allocate aid. This initial estimation can be beneficial for both a top-down federal government program, or individual state-level programs, where the former could try to maximize the amount of recipients given a budget constraint, and the latter could identify the amount of aid required within its political borders. In our second approach, we review household demographic characteristics to assess the provision of targeted aid, and propose an allocation based on the demographic characteristics (e.g., urban vs. rural and female vs. male dimensions). Considering demographic characteristics can help to further narrow down households with the most need for aid, and existing evidence in the U.S. indicates that poverty and food insecurity are dependent on demographic factors (Gundersen *et al.*, 2020; Gundersen and Ziliak, 2022; Landry *et al.*, 2022).

Our initial analysis focuses on a geographic approach to proactively preventing poverty relating to increasing food prices. We use our previously described formulation to simulate the repercussions from food price increases across each state and determine the amount of money the Government of Mexico would need to distribute per state to alleviate the anticipated poverty. Figure 1 presents a geographic view of the poverty effects caused by the recent food price escalations across Mexico. Our analysis reveals substantial geographic heterogeneity in the level of income compensation required to lift Mexican households to their pre-price escalation period.

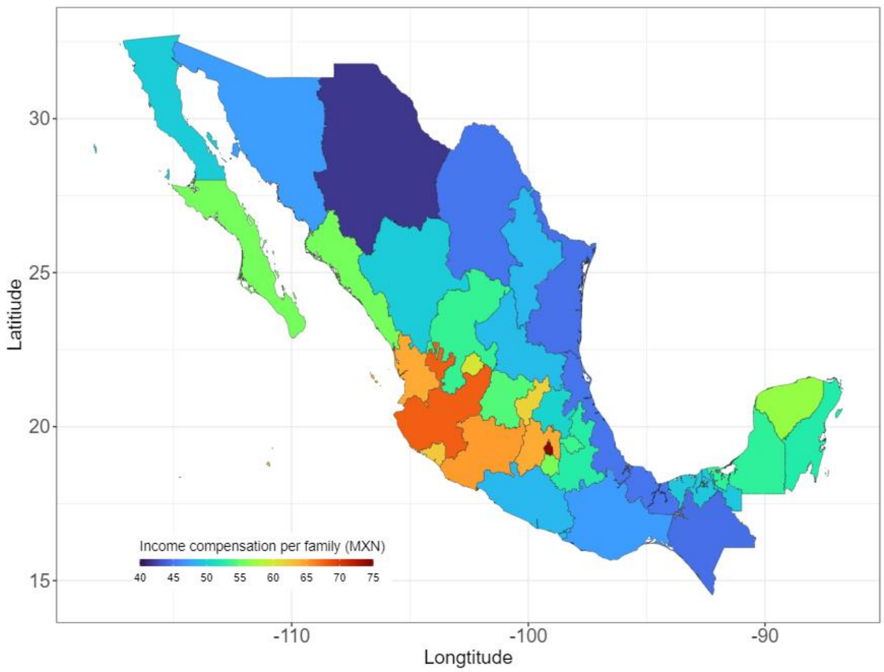

Figure 1: Spatial distribution of income compensation per family in México

Differentials in the cost of food and household preferences drive the income compensation heterogeneity. Specifically, Figure 1 distinguishes Mexican states that require the least income compensation, where limited spending can bring the most effectiveness, and where a policy evaluation would be the costliest. For example, the state of Chihuahua requires between $40.70 and $42.74 pesos per family every two weeks, being the state with the lowest amount of need. A proactive food poverty alleviation policy for the state of Chihuahua requires an annual price tag of $1.20 billion pesos ($62.17 million dollars).

In contrast, a policy for Michoacán with a similar number of households as Chihuahua has a price tag of $2.17 billion pesos ($108.32 million dollars). The proactive policy cost in Michoacán is almost double the cost of the policy in Chihuahua. Noticeably, poor states mostly located in the Southern part of the country require relatively lower amounts of income compensation when compared to wealthier states in the West-Center part of the country. For instance, the state of Chiapas, arguably the poorest in México, requires between $43.20 and $45.94 pesos per family every two weeks. Proactive income compensation in Chiapas would cost $1.53 billion pesos ($76.9 million dollars) over a year, which is 29% lower than what families in the state of Michoacán would need.

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Calculations in Figure 1 demonstrate two paths to effectively tackle the poverty effects raised by the recent price escalation in 2021. On the one hand, policymakers can allocate resources first to states that require the least income compensation (such as Chihuahua, Chiapas, and Tamaulipas) and move to the states that require the most income compensation (México City and the states of Jalisco and Michoacán). Such an approach is optimal since, given a budget constraint, policymakers would reach the most households. On the other hand, a bottom-top approach would have a similar optimal allocation if low income households are chosen initially. Most states that require the least income compensation are in the country's southern parts, where arguably the poorest families are located.

Even though our calculations in Figure 1 are a comprehensive effort to direct policy efforts to alleviate the poverty effects caused by recent price escalations, our calculations ignore demographic factors that shape poverty effects within each state. Figure 2 fills this gap by calculating the welfare implications across combinations of income status (poor vs. non-poor), location characteristics (rural vs. urban), and whether a female leads the households or not. Figure 2 reveals that households led by females are more severely impacted by the recent food price escalation than their male counterparts. Figure 2, however, presents a downward trend. The more urban the location and the poorer the family, the less income compensation the female-led household requires. In contrast to our previous recommendations based on Figure 1, Figure 2 does not suggest an allocation of resources based on demographic characteristics. Instead, Figure 2 reveals a clear heterogeneity in needs based on preferences and characteristics.

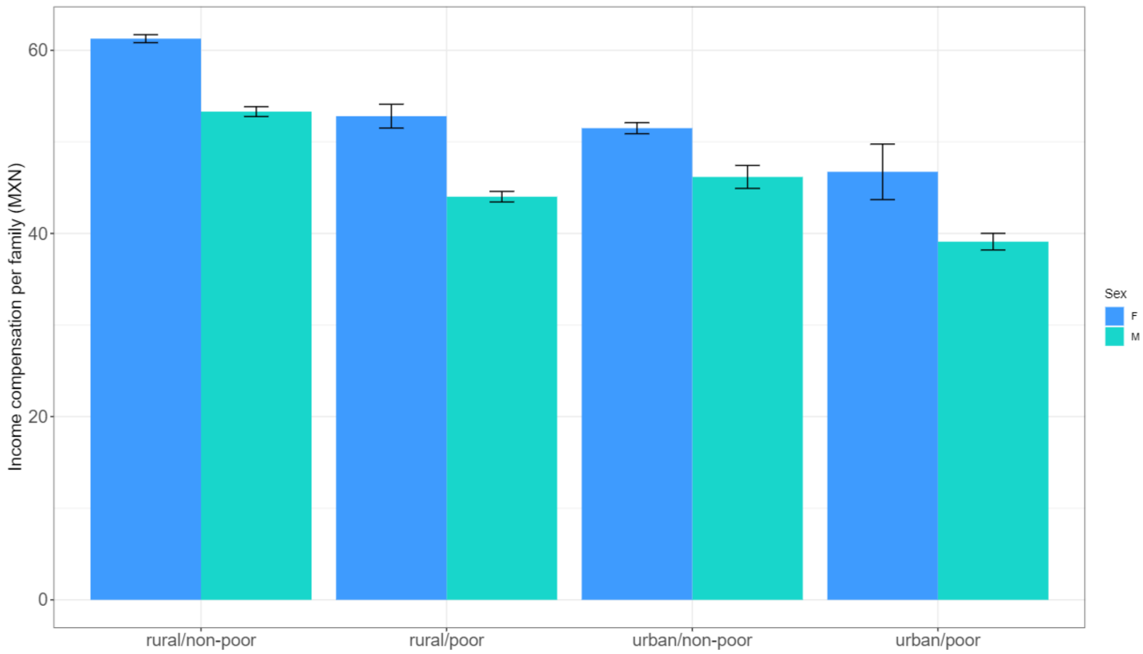

Figure 2: Demographic distribution of compensating variation

Who is most affected by food price increases is not theoretically obvious. Engel's Law clearly demonstrates that as household income increases, the income allocations to food decrease as a percentage of the household's overall budget. But oftentimes absolute amount of income spent on food continues to rise in conjunction with increasing household income. Our analysis indicates that non-poor households are more affected by the recent price increases, and there appears to be an urban/non-urban divide in our welfare calculations. The poor/non-poor and urban/non-urban dimensions were first considered by Wood, Nelson and Nogueira (2012), where the authors found that the welfare effects for non-poor households are higher than those for poor households. Our results reveal an ambiguous difference in welfare effects between rural and urban households, with rural households possibly off-setting some of the consumer side losses from increased food prices with increases in production sales value or diminishing the influence of these food price increases by on-farm consumption. The difference in welfare effects between rural and urban households is not statistically significant in our study or Wood, Nelson and Nogueira (2012).

Therefore, Figure 2 suggests that public policy in Mexico should target the vulnerable population in the country by considering household characteristics such as the sex of the household head, the income level , and location characteristics. For instance, Figure 2 suggests that female-led households require additional monetary needs than male-led households.

5. Concluding remarks

A concern with responsive poverty alleviation programs is the period of time between the household falling into poverty and when it receives aid. While the U.S. is an exemplary case where datasets are readily available to assess aid needs among different sectors of the population promptly, developing countries where datasets of food vulnerability are often not available, different approaches are required to achieve a similar level of proactivity as in the U.S. Using ENIGH to calculate the cost of a poverty alleviation policy tailored to the recent price escalation caused by COVID-19, our paper demonstrates multiple approaches governments might take to target vulnerable households and diminish the negative impacts of shocks on households.

To proactively address food vulnerability from price escalations among different sectors of the population in México, we couple the ENIGH survey with an AID system to evaluate possible approaches to alleviation. We demonstrate an application by simulating the recent price escalations caused by the COVID-19 epidemic on the Mexican population. We calculate that the cost of alleviating the poverty effects caused by the recent price escalation is $48.6 billion pesos ($2.4 billion dollars) for one year. Demographic comparisons reveal that households led by women require an additional monetary need to cope with the recent price increases regardless of whether the household is in an urban or rural area. Our structural approach is thus able to identify the population in need and propose a poverty alleviation package per household. Using the ENIGH survey allows us to re-calibrate our estimates every two years. Due to current advances in computing power, our methodology can be automated. Stakeholders and the research community (via open-source tools) can benefit from our proposed tool.

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Appendix

Estimating the system of equations described in our methods section requires an ad-hoc function program to be evaluated using Stata software's NLSUR command. Our program drops the sixth equation in equation (3) to avoid a singular error covariance matrix. The parameters of the dropped equation can be recovered following the parametric restrictions discussed in our methodological section. Table A1 describes our estimation procedure's estimated parameters and their standard errors. Parameter estimates, by themselves, lack a direct interpretation, so Table A1 provides diagnostics for our fitting procedure. Finally, we employ the estimated parameters to recover Hicksian and budget elasticities (Table A2).

Similarly, we employ the estimated parameters in Table A2 in our post-estimation calculation of Compensated Variation (CV) discussed in the methods section. All our calculations are obtained using the average values described in Table 1. All standard errors in our post-estimation exercises are obtained using 50 bootstrap replications. Marshallian elasticities are not reported since they are not relevant in our welfare analyses.

Our focus on the Hicksian elasticities responds to our interest in studying Mexican households' mitigating behavior when an additional income stream is considered, e.g., governmental transfer payment that compensates for a rise in prices. Hicksian elasticities show price effects after compensating the income that allows consumers to keep their level of welfare before the price change. The attenuation of Hicksian own-price elasticities with respect to their Marshallian counterparts demonstrates that the former lacks income effects. While Hicksian own-price elasticities can only be negative, their cross-price counterparts can be either positive or negative depending on whether the good is a complement or substitute of the good whose price changes. Thus, the magnitude of the cross-price elasticities shows the substitution level after compensating the consumer with additional income. Income compensation implies that budget elasticities largely determine welfare effects, as shown by the Slutsky equation in elasticities:

$$\eta_{ij} = \eta_{ij}^{*} - \eta_i s_i$$

where η_{ij} is the Marshallian elasticity, η_{ij}^{*} is the Hicksian elasticity, and η_i is the budget elasticity.

Table A1: Estimated parameters

Parameter	Estimate	Parameter	Estimate	Parameter	Estimate
α_1	-0.00960	γ_{22}	0.02172	θ_{21}	0.02630
	(0.0059)		(0.0033)		(0.0009)
α_2	0.12572	γ_{23}	-0.07071	θ_{22}	0.01014
	(0.0046)		(0.0028)		(0.0008)
α_3	0.28329	γ_{24}	0.01231	θ_{23}	0.03207
	(0.0068)		(0.0017)		(0.0011)
α_4	0.03365	γ_{25}	0.05274	θ_{24}	0.00835
	(0.0037)		(0.0024)		(0.0007)
α_5	0.00526	γ_{33}	0.03613	θ_{25}	0.01205
	(0.0047)		(0.0044)		(0.0008)
β_1	-0.05354	γ_{34}	0.00359	θ_{31}	0.00208
	(0.0026)		(0.0022)		(0.0001)
β_2	-0.06149	γ_{35}	0.05383	θ_{32}	0.00117
	(0.0025)		(0.0027)		(0.0001)
β_3	0.07709	γ_{44}	-0.01170	θ_{33}	-0.00082
	(0.0036)		(0.0018)		(0.0001)
β_4	-0.00334	γ_{45}	0.01856	θ_{34}	-0.00095
	(0.0023)		(0.0018)		(0.0001)
β_5	0.06300	γ_{55}	0.02611	θ_{35}	-0.00095
	(0.0025)		(0.0036)		(0.0001)
γ_{11}	0.00251	θ_{11}	-0.00631	θ_{41}	0.00054
	(0.0039)		(0.0006)		(0.0004)
γ_{12}	0.04506	θ_{12}	0.00495	θ_{42}	0.00147
	(0.0027)		(0.0005)		(0.0003)
γ_{13}	-0.01515	θ_{13}	-0.01450	θ_{42}	-0.00305
	(0.0030)		(0.0008)		(0.0005)
γ_{14}	-0.02603	θ_{14}	-0.00265	θ_{43}	-0.00398
	(0.0019)		(0.0005)		(0.0003)
γ_{15}	-0.06677	θ_{15}	-0.01998	θ_{44}	-0.00330
	(0.0028)		(0.0005)		(0.0004)

Standard errors in parentheses.

The Slutsky equation also demonstrates the interdependence between price and budget elasticities and the behavior depicted by the Cournot and Engel aggregation, demonstrating the need to estimate a complete demand system to accurately study poverty effects (Lewbel and Pendakur, 2009).

Table A2 describes the complete set of price elasticities that determine the magnitudes in our welfare calculations discussed in the next section. Focusing initially on the budget elasticities, Table A2 indicates that our "Other" category, representing about a third of households' consumption, can potentially lead to our conclusions in the next section. However, the price of the items in our other category only increased by 4.9%. The second-largest budget elasticity, meat, is of concern since the price of meat increased by 9.7% in 2021, and its budget elasticity is 1.13. About a fifth of Mexican households' food expenditure goes to meat. Therefore, poverty effects will largely be driven by the meat price increase. Finally, the price of fruits and vegetables and tortillas increased the most in 2021 by 21.5% and 16.6%, respectively. Fruits and vegetables, and tortillas are inferior goods, as their budget elasticities are lower than 1. This observation was first noted by Wood, Nelson and Nogueira (2012) and indicated the status of tortilla as a staple food. By themselves, staple goods should not determine the level of income compensation required to lift households to their original levels of welfare, but in our application, they will since they represent the highest price increases.

Table A2 also sheds light on Mexican households' substitution effects across foods in response to the recent price escalation. Focusing on meat price effects, the 9.7% price increase reduces Mexican households' meat consumption by about 6% but increases their dairy consumption and the other category, whose price increases were lower at 5.8% and 4.9%, respectively. Cross-price elasticities with respect to the price of meat also indicate that Mexican households reduce their cereal consumption by about 2%. While our elasticities indicate that higher meat prices can increase the consumption of tortillas and fruits and vegetables, these substitution effects are likely attenuated by their relatively large price increases, demonstrating the intricated substitution effects that shape our welfare analyses discussed in the next section. For example, the large price increases observed in the tortilla staple will increase cereal consumption by about 9% and the other category by about 12%, but the price of cereal only increased by 6.8%. Having provided insights into the determinants of the welfare effects with a discussion of the Hicksian and budget elasticities, the next section focuses on the poverty effects caused by the recent price escalation and offers a bottom-top policy recommendation and insights into the heterogeneity of the poverty effects.

Table A2: Budget and Hicksian elasticities

	Price						
With respect to	Tortilla	Cereal	Meat	Dairy	Fruits and vegetables	Other	Budget
Quantity							
Tortilla	-0.5255	0.4777	0.1153	-0.1657	-0.4996	0.5978	0.4887
	(0.0012)	(0.0016)	(0.0004)	(0.0013)	(0.0020)	(0.0013)	(0.0020)
Cereal	0.4897	-0.7130	-0.4227	0.1957	0.6107	-0.1603	0.7070
	(0.0014)	(0.0004)	(0.0024)	(0.0004)	(0.0018)	(0.0017)	(0.0010)
Meat	0.0577	-0.2086	-0.6254	0.1147	0.3826	0.2790	1.1269
	(0.0005)	(0.0010)	(0.0002)	(0.0004)	(0.0008)	(0.0009)	(0.0004)
Dairy	-0.1960	0.2253	0.2688	-1.0407	0.3222	0.4204	0.8179
	(0.0011)	(0.0005)	(0.0006)	(0.0007)	(0.0007)	(0.0009)	(0.0007)
Fruits and vegetables	-0.4228	0.5039	0.6412	0.2308	-0.6740	-0.2791	0.8746
	(0.0013)	(0.0014)	(0.0014)	(0.0006)	(0.0002)	(0.0019)	(0.0004)
Other	0.1913	-0.0497	0.1756	0.1136	-0.1053	-0.3256	1.2709
	(0.0008)	(0.0005)	(0.0007)	(0.0004)	(0.0005)	(0.0003)	(0.0008)

Standard errors in parentheses were obtained with 50 bootstrap replications.