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Welfare effects of changed prices
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Welfare effects of changed prices
The "Tortilla Crisis" revisited*

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Abstract

This study uses a comprehensive framework to quantify the welfare changes of rural and non-rural households in Mexico associated with the food price crisis of 2007. The total change in welfare is decomposed into five contributors. I find that income effects, i.e. changes through profits and wages, negatively affected welfare. Substitution effects played an important role in maintaining welfare levels after a price shocks, households substantially substituted out of goods that showed a strong increase in their price. Though food price increases led to a significant welfare loss, part of it was compensated through the decrease of the price of other commodities such as health and personal care, transportation, and leisure. Hence, particularly in non-rural areas, the sole use of food commodities to analyze welfare changes leads to markedly different results than using the complete range of all goods consumed. Overall both poor households in rural as well as non-rural areas experienced a net welfare loss, but the effect was stronger for poor rural households thus among the poorest of the poor.

Keywords: welfare changes, prices, poverty
JEL classification: D31, I31, I32, O15

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1 Introduction

In the last 20 years the incidence and scope of temporary food prices shocks around the world has increased (Swinnen and Squicciarini, 2012; Wood et al., 2012; Hoyos and Medvedev, 2009). Between 2008 and 2010 Mexico experienced two tremendous increases of maize prices due to increased demand, population growth, low past investment, geopolitical concerns, droughts in other parts of the world as well an increased interest in biofuels (Wood et al., 2012; Baffes and Dennis, 2013; Piesse and Thirtle, 2009; Robles and Torero, 2010; Dyer and Taylor, 2011). People took the streets and protested against the governments' inability to control the loss of purchasing power, particularly among the urban poor[1]. But Mexico (and maize), were not the only ones affected: world prices for milk powder, wheat and rice increased substantially (Ivanic and Martin, 2008) and countries like Vietnam and India tried to curb exports to ensure sufficient internal supply (Ferreira et al., 2013).

These price shocks raised policy concerns regarding poverty (Wood et al., 2012; Ferreira et al., 2013; Ivanic and Martin, 2008) as well as food security (Swinnen and Squicciarini, 2012; Cohen and Garrett, 2010; Harttgen and Klasen, 2012). Theoretically, such price shocks have important distributional effects to which Governments may want to react through appropriate targeted interventions. Yet, teasing out these distributional consequences in detail is far from straightforward because price increases do not only affect the consumption side but also the income side whenever households' income directly or indirectly depends on the production of these goods. Moreover, households can react to price changes by adjusting their consumption, production and labor supply. Most of the existing literature ignores the complexity of such price changes and focuses solely on the consumption side and on first order effects, though there are some notable exceptions which will be discussed below.

In this paper we use a series of cross-sectional household surveys with detailed information

[1]For example: `http://www.elmundo.es/mundodinero/2007/01/31/economia/1170261989.html`

about households' consumption patterns and income sources by product group in conjunction with detailed price data collected over several years at 46 price stations distributed all over Mexico to calculate the net welfare effects associated with observed price shocks in general and food price changes in particular. Moreover, we decompose these net effects into its various contributing factors. This is the first study that analyses the welfare effects of food price inflation in Mexico in such detail and hence provides valuable insights regarding the design and targeting of policies to mitigate the distributional consequences of such shocks. Moreover, this paper contributes to the methodological discussion on how to account for differential inflation in welfare analyses.

A plethora of previous empirical studies have analyzed the distributional impact of food price changes. Besides methodological differences[2] these studies differ in their scope. Furthermore, the welfare effects of price changes are most likely highly context specific, depending on income and expenditure profiles in each country (Harttgen and Klasen, 2012; Akter and Basher, 2014).

The focus of some studies is on simulating the effects on welfare of a price change, for example because of a change in the taxation regime (Porto, 2006, 2008) or by imputing price changes and simulating the response (Ivanic and Martin, 2008; Hoyos and Medvedev, 2009; Vu and Glewwe, 2011). According to Akter and Basher (2014), results obtained in this manner should be interpreted carefully because they do not have data on, or ignore, adjustments in expenditures and income of the households. This can lead to overestimating the effects of price changes.

Other studies do not rely on simulation, but estimate only the first order expenditure effects, i.e. welfare effects that arise from unadjusted changes in expenditures. The advantages of this approach are twofold: first, household expenditure data is more readily available than income

[2] Araar and Verme (2016) and de Janvry and Sadoulet (2009) offer an excellent summary on this point.

data and so the welfare assessment can be performed shortly after the price increase (Friedman and Levinsohn, 2002) and second, it is argued that a distinction between production and consumption is only necessary if both react to different price signals. For example Deaton (1989) reasons that Thai subsistence farmers posses large shares of auto-consumption in goods with low added value, thus observing equal pricing for consumption and production. Furthermore, urban households are not likely producers; income effects in this case are probably minimal and can be ignored for certain purposes (Hoyos and Medvedev, 2009). Nevertheless, these analyses are limited to a specific group and do not offer comprehensive results.

Studies that include the adjustment of expenditures due to a change in prices, i.e. the second order expenditure effect, also known as substitution effects, are, for example, Robles and Torero (2010) for a set of four Latin American countries and Friedman and Levinsohn (2002) for Indonesia. Both studies conclude that the inclusion of substitution effects substantially influences the magnitude of the estimated welfare change by accounting for the expenditure adjustments of the households. Robles and Torero (2010) find that not including substitution effects would overestimate the welfare loss induced by a price increase by 7 to 12 percent.

Finally, studies more akin to ours are those that include first and second order effects, both in income and in expenditures. Examples are Jacoby (2013) for India and Ferreira et al. (2013) for Brazil[3]. Although these studies are limited to the analysis of food prices, they find that including income responses provides more differentiated welfare effects. Particularly, it appears that poor households seem to benefit from the price increase.

Several studies have looked into the welfare effects of price changes in Mexico. Valero-Gil and Valero (2008) concentrate on changes in consumption patterns due to increases in prices of

[3]Akter and Basher (2014) measure the effect on welfare of a price increase in Bangladesh its subsequent economic response. This approach is not comparable to ours because unlike us, they assume that the economic response was not simultaneous

staples and find a moderate poverty rate increase. They also identify certain food staples for which they argue price controls would achieve the largest welfare effects. Porto (2008) proposes a methodology that includes responses on the income and the expenditure sides. He simulates different price increase scenarios and for each computes "consumption" and "income" effects. The first is a compound of the first and second order responses in expenditure, the second refers to agricultural wages. He finds that an income effect *can* ameliorate the (negative) impact of a price increase but that this will depend on the size of the observed price changes and the goods for which the price increases. Dyer and Taylor (2011) also use a simulation to assess the effect of corn price increases on corn production and the respective labor supply and conclude that even in rural areas, there are large discrepancies in the distribution of gains and losses. Chávez Martín del Campo et al. (2008) simulate three different price increases for two types of commodity groups: cereals and all goods. They conclude that the expenditures of poor individuals, be it in rural or non-rural areas, are hit harder by price increases than non-poor ones because their food expenditure shares are relatively larger; thus food price increases have a negative poverty effect, i.e. they increase and exacerbate poverty. Nonetheless, the authors also include the second order expenditure effect to account for substitution and found that the rural poor in particular are able to offset a part of the negative expenditure effect. In a further methodological step, Wood et al. (2012), found that including an income effect, i.e. computing the compensating variation, in necessary since the magnitude of the welfare effect changes significantly. According to their simulation results, the inclusion of the first order expenditure effects overestimates and that of second order expenditure effects, one that includes only the own-price elasticities, underestimates the welfare change.

These studies typically rely on simulations, unit values (ratio of expenditures for an item with respect to overall expenditures) instead of prices, or on a limited set of goods to estimate welfare impacts. We estimate the compensating variation for rural and non-rural households using official prices for food and non-food items as well as including wage and non-wage

income.

We find that most of the positive welfare changes observed stem from a positive expenditure effect rooted in changes in the prices of non-food items. Furthermore, in times of high food inflation, as was $2008-2010$ most of welfare losses can be attributed to changes in food prices. Moreover, the inclusion of both the income as well as the substitution effects considerably changes the magnitude of the welfare change. Finally, while the welfare losses appear to be similar in both rural and non-rural areas, the poverty impact in non-rural ones is larger.

2 Concept

Changes in prices cause changes in welfare by affecting both income and expenditures.

The size and direction of a change in expenditures due to a change in prices can be broken down into the income and the substitution effects. The income effect arises due to the changes in the purchasing power and the substitution effect due to changes in the relative prices between goods. For example, a consumer facing an increased price for beef may purchase less beef than before (income effect). Simultaneously, the price of chicken meat relative the price of beef will be lower and the consumer may substitute some of his beef by more chicken meat (substitution effect). The empirical analysis of the substitution effect requires of the corresponding direct and cross price-elasticities.

Moreover, the magnitude of the welfare effect will depend on the size of the relative expenditure share in total expenditures of the commodity in question. Obviously, changes in prices of goods whose relative expenditure shares are relatively small will have a comparatively small impact on welfare as opposed to price changes of goods whose relative expenditure share is large.

The effects of a price change in a good on the income of a household will depend on the characteristics of its dependent employment as well as on its position as a net producer or consumer if the income generating activity is an independent one.

For dependent income generating activities, the changes in marginal returns to labor triggered by a price change can, for the production of the good in question, lead to changes in the hours worked or lead to new employment of previously unemployed members or both. Depending on the characteristics of the labor market, a price change in one good can also lead to changes in the production, and thus employment, in other goods (Jacoby, 2013).

For independent income generating activities, the standard net producer/net consumer

argumentation applies: if the household is a net producer then the increased prices in that good will lead to higher welfare and vice versa (for example, Deaton (1989)).

In the end, the reaction of the labor market to price changes is outside the scope of this study; relevant for the assessment of welfare presented here are the relative changes in income that, empirically, will amount to changes in income across time periods.

We differentiate between two income categories, that of wage and that of business income, for two reasons. First, wage income constitutes a substantial part of non-rural total income, while business income plays a larger role in rural areas[4]. Second, we argue that the response time to a price change between both income types can vary. In both cases, a composite measure of income would conceal any particular effects.

A third income sources to consider is transfer income. Transfer income does not have a direct link to a price change, but Governments may try to compensate households for a serious loss in purchasing power. Thus, the change in transfer income is attributed to the price changes, although the link is not as straightforward is with the other two types of income. For this reason we include changes in the transfer income without directly linking them to a price change.

The impact a change in price p_i of a commodity, i on household welfare can be described by the overall (proportional) change in money-metric household welfare (de Janvry and Sadoulet, 2008; Jacoby, 2013; Robles and Torero, 2010; Ferreira et al., 2013), b_h [5]:

$$\mathrm{d}b_h = \frac{\Delta y_h}{y_h} - \frac{\Delta E_h}{E_h} \tag{1}$$

Where $\frac{\Delta y_h}{y_h}$ stands for relative changes in income and $\frac{\Delta E_h}{E_h}$ for relative changes in expenditure

[4]Descriptive statistics to both can be found in Section 3

[5]Welfare defined as the amount of money needed to maintain a constant level of utility (Slesnick, 1998)

in a household h.

These are the two main contributors to welfare, the next step consists in formulating expressions for both that can be estimated empirically.

The household minimum expenditure necessary to achieve an utility level U is defined as $E_h(\mathbf{p}, U)$ where $\mathbf{p}$ is the vector of prices for goods: $i = 1 \dots n$. The compensating variation (CV) is a measure of the income change a household needs to realize the utility level achieved in the setting prior to a price change. We can approximate the CV with a second order Taylor expansion with respect to the price of these minimum expenditures $E_h(\mathbf{p}, U)$ where, $\mathbf{p}^0$ stands for the price in time period 0. Additionally, such an expansion will allow to account for substitution behavior, as will be explained later[6].

$$E_h(\mathbf{p}, U) \approx E_h(\mathbf{p}^0, U) + \left[\frac{\partial E(\mathbf{p}^0, U)}{\partial \mathbf{p}}\right]' d\mathbf{p} + \frac{1}{2} d\mathbf{p} \left[\frac{\partial^2 E(\mathbf{p}^0, U)}{\partial^2 \mathbf{p}}\right]' d\mathbf{p} \tag{2}$$

Rearranging (2) yields:

$$\Delta E_h(\mathbf{p}, U) \approx \left[\frac{\partial E(\mathbf{p}^0, U)}{\partial \mathbf{p}}\right]' d\mathbf{p} + \frac{1}{2} d\mathbf{p} \left[\frac{\partial^2 E(\mathbf{p}^0, U)}{\partial^2 \mathbf{p}}\right]' d\mathbf{p} \tag{3}$$

In (3) $\frac{\partial E(\mathbf{p}^0, U)}{\partial \mathbf{p}}$ is a vector and $\frac{\partial^2 E(\mathbf{p}^0), U}{\partial^2 \mathbf{p}}$ is a matrix. Using Shepard's Lemma one can restate $\frac{\partial E(\mathbf{p}, U)}{\partial p}$ as the Hicksian compensated demand, $h(\mathbf{p}^0, U)$. Rewrite (3) as:

$$\Delta E_h(\mathbf{p}, U) \approx \left[h(\mathbf{p}^0, U)\right]' d\mathbf{p} + \frac{1}{2} d\mathbf{p} \left[\frac{\partial h(\mathbf{p}^0, U)}{\partial \mathbf{p}}\right]' d\mathbf{p} \tag{4}$$

Equation (4), the compensating variation, can be expressed as a fraction of total expenditures, E. By simultaneously using proportional price changes we achieve an expression with

[6] Friedman and Levinsohn (2002); Vu and Glewwe (2011); Robles and Torero (2010); Ferreira et al. (2013) develop similar expressions for the CV.

expenditure shares and elasticities. For this, we define two square matrices $\mathbf{H} \equiv diag(h(\mathbf{p}, U))$ and $\mathbf{P} \equiv diag(\mathbf{p})$ such that:

$$\mathbf{H} = \begin{bmatrix} h(p_1, U) & \dots & \dots & 0 \\ 0 & h(p_2, U) & \dots & 0 \\ \vdots & \dots & \ddots & \vdots \\ 0 & 0 & \dots & h(p_n, U) \end{bmatrix} \text{ and } \mathbf{P} = \begin{bmatrix} p_1 & \dots & \dots & 0 \\ 0 & p_2 & \dots & 0 \\ \vdots & \dots & \ddots & \vdots \\ 0 & 0 & \dots & p_n \end{bmatrix}$$

Using these matrices, we can rewrite (4) as:

$$\frac{\Delta E_h(\mathbf{p}, U)}{E_h} \approx \frac{1}{E_h} \left[h(\mathbf{p}^0, U)\right]' d\mathbf{p}\ \mathbf{P}\mathbf{P}^{-1} + \frac{1}{E_h}\frac{1}{2} d\mathbf{p}\ \mathbf{P}\mathbf{P}^{-1} \left[\frac{\partial h(\mathbf{p}^0, U)}{\partial \mathbf{p}} \mathbf{H}\mathbf{H}^{-1}\right]' d\mathbf{p}\ \mathbf{P}\mathbf{P}^{-1}$$

Rearrange to obtain an expression with expenditure shares and elasticities:

$$\frac{\Delta E_h}{E_h} \approx [\omega]' \left[\frac{d\mathbf{p}}{\mathbf{p}}\right] + \frac{1}{2} \left[\frac{d\mathbf{p}}{\mathbf{p}}\right]' [\mathbf{\Omega\Gamma}]' \left[\frac{d\mathbf{p}}{\mathbf{p}}\right] \tag{5}$$

In Equation (5) $\left[\frac{d\mathbf{p}}{\mathbf{p}}\right]$ is a vector of proportional price changes,

$$\omega = \begin{bmatrix} \frac{h(p_1,U)p_1}{E} \\ \frac{h(p_2,U)p_2}{E} \\ \vdots \\ \frac{h(p_n,U)p_n}{E} \end{bmatrix}$$

is the vector of expenditure shares,

$$\mathbf{\Omega} \equiv diag(\omega)$$

and

$$\mathbf{\Gamma} = \begin{bmatrix} \frac{\partial h_1}{\partial p_1}\frac{p_1}{h_1} & \cdots & \frac{\partial h_1}{\partial p_n}\frac{p_n}{h_1} \\ \vdots & \ddots & \vdots \\ \frac{\partial h_n}{\partial p_1}\frac{p_1}{h_n} & \cdots & \frac{\partial h_n}{\partial p_n}\frac{p_1}{h_n} \end{bmatrix} = \begin{bmatrix} \epsilon_{11} & \cdots & \epsilon_{1n} \\ \vdots & \ddots & \vdots \\ \epsilon_{n1} & \cdots & \epsilon_{nn} \end{bmatrix}$$

is the elasticity matrix where the elements of the main diagonal are the own-price elasticities and those of the off-diagonal the cross-price elasticities.

The following expression restates the CV as a sum:

$$\begin{aligned} \frac{\Delta E_h}{E_h} &\approx \sum_{i=1}^{n} \omega_i \frac{\Delta p_i}{p_i} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \omega_i \epsilon_{ij} \frac{\Delta p_i}{p_i}\frac{\Delta p_j}{p_j} \\ &\approx \sum_{i=1}^{n} \omega_i \frac{\Delta p_i}{p_i} + \frac{1}{2}\sum_{i=1}^{n} \omega_i \sum_{j=1}^{n} \epsilon_{ij} \frac{\Delta p_i}{p_i}\frac{\Delta p_j}{p_j} \end{aligned} \tag{6}$$

The first term includes expenditure shares for goods i, ω_i. It measures the direct change in expenditures caused by a proportional price change in good i. The second term accounts for substitution by including the own and cross-price elasticities, ϵ_{ij}. Thus, the expression for the CV developed here accounts for the income and the substitution effects introduced earlier.

The first term on the right of (1),$\frac{\Delta y_h}{y_h}$, relates to the income of the household. Income can be split up into wage income, business income and transfers.

Proportional changes in household income, $\frac{\Delta y_h}{y_h}$, can be decomposed according to the sources of changes in income. Thus, the term $\frac{\Delta y_h}{y_h}$ in (1) is:

$$\frac{\Delta y_h}{y_h} = \sum_{i=1}^{n}\sum_{q=1}^{Q} \frac{\Delta v_{q,i}}{y_h}\frac{\Delta p_i}{p_i} + \sum_{i=1}^{n} \frac{\Delta \theta_i}{y_h}\frac{\Delta p_i}{p_i} + \frac{\Delta \tau}{y_h} \tag{7}$$

The first term corresponds to the change in wage income v of an individual q earned in the

production of a good i in the household h that has Q members. The second one corresponds to the total business income θ earned in the household in the production of good i. The third and final term represents state transfers, τ.

Rewrite (1) using both (6) and (7):

$$\begin{aligned} \mathrm{d}b_h = & \sum_{i=1}^{n}\sum_{q=1}^{Q}\frac{\Delta v_{q,i}}{y_h}\frac{\Delta p_i}{p_i} + \sum_{i=1}^{n}\frac{\Delta\theta_i}{y_h}\frac{\Delta p_i}{p_i} + \frac{\Delta\tau}{y_h} \\ & - \sum_{i=1}^{n}\omega_i\frac{\Delta p_i}{p_i} - \frac{1}{2}\sum_{i=1}^{n}\omega_i\sum_{j=1}^{n}\epsilon_{ij}\frac{\Delta p_i}{p_i}\frac{\Delta p_j}{p_j} \end{aligned} \tag{8}$$

As in Ferreira et al. (2013) and Porto (2008), Equation (8) captures different effects of changes in prices on household welfare:

1. A wage income effect: $\rho_v = \sum_{i=1}^{n}\sum_{q=1}^{Q}\frac{\Delta v_{q,i}}{y_h}\frac{\Delta p_i}{p_i}$
2. A business income effect: $\rho_\theta = \sum_{i=1}^{n}\frac{\Delta\theta_i}{y_h}\frac{\Delta p_i}{p_i}$
3. A transfer effect: $\rho_t = \frac{\Delta\tau}{y_h}$
4. An expenditure effect: $\rho_e = \sum_{i=1}^{n}\omega_i\frac{\Delta p_i}{p_i}$
5. A substitution effect: $\rho_s = \frac{1}{2}\sum_{i=1}^{n}\omega_i\sum_{j=1}^{n}\epsilon_{ij}\frac{\Delta p_i}{p_i}\frac{\Delta p_j}{p_j}$

The net effect then being: $db_h = \rho_v + \rho_\theta + \rho_t - \rho_e - \rho_s$

In practice, each income effect can be further decomposed into commodity group components, for example food and non-food items.

The first four components can be estimated using expenditure and income information extracted from several waves of the ENIGH and official price data. For the estimation of the fifth component, the substitution effect, we first estimate the necessary price elasticities.

Details to the estimation procedure are given below in Section 3.

3 Data and empirical strategy

This study relies on five waves of a nationally representative household survey providing data on income and expenditures and on an extensive and detailed set of officially levied monthly prices.

3.1 Prices

Unit values are used widely instead of prices when prices are not available are defined as the ratio of expenditure to units bought. Instead of unit values we use prices. This approach has two benefits.

Unit prices generated from household data contain in itself the quality decisions made by the households. To the extent to which higher prices mirror higher quality, when richer households purchase higher quality goods they also pay a higher price than poorer households buying the same, albeit lower quality, goods. Thus, increases in the unit values does not necessarily represent increases in prices but can stem from a changes in the quality decision of a household. If this quality decision arises due to an increased income, then we would observe an association between positive changes in unit values and positive changes in income. Thus, increases in unit values will not accurately represent changes in quantity demanded (McKelvey, 2011; Deaton, 1988)[7]. On the other hand, unit values cannot be produced if the household does not report the consumption of a good or if the amount consumed is not reported. This implies that the unit values have to be imputed, usually by making assumptions on the consumption level in a household (Dybczak et al., 2010). By using detailed information about prices there is no need for any assumptions regarding the price level, the consumption patterns or the separability of preferences (Vu and Glewwe, 2011).

[7] Although here is no correction for quality substitution between commodity groups.

Prices are obtained from the DOF[8] for different geographical points, so called *price stations*. A Consumer Price Index (CPI) is computed for every point using official weights for the various items that constitute the underlying consumption basket. Lastly, to each municipality prices are assigned according to its geographical location. These procedures are described next.

Prices for 314[9] items are levied monthly by the Banco de México (Banxico)[10] in 46 different municipalities. These *price stations* were selected to be nationally representative by the responsible organization. Table A1 lists these price stations. Municipalities are second level administrative divisions, the next one being the locality. In Figure 2 municipalities are delimited by black lines.

Using these prices and the weights from the consumer basket from June 2002, I calculate the CPI for every price station using January 2004 as a base. With this CPI we deflate income and prices and can work with real values (de Janvry and Sadoulet, 2008) while simultaneously considering regional price evolution differences.

Figure 1 relates the mean CPI level and its standard deviation. The largest increase as well as the highest decline both occurred in mid-2008. The large variation in CPI illustrates the divergence in prices for the various commodities at different price stations.

[8] Spanish for *Diario Oficial de la Federación*

[9] In three cities (México D.F., Guadalajara, and Monterrey) a 315th price is levied, that for the subway or the electric transportation system

[10] In June 2011 this task was reassigned to the INEGI

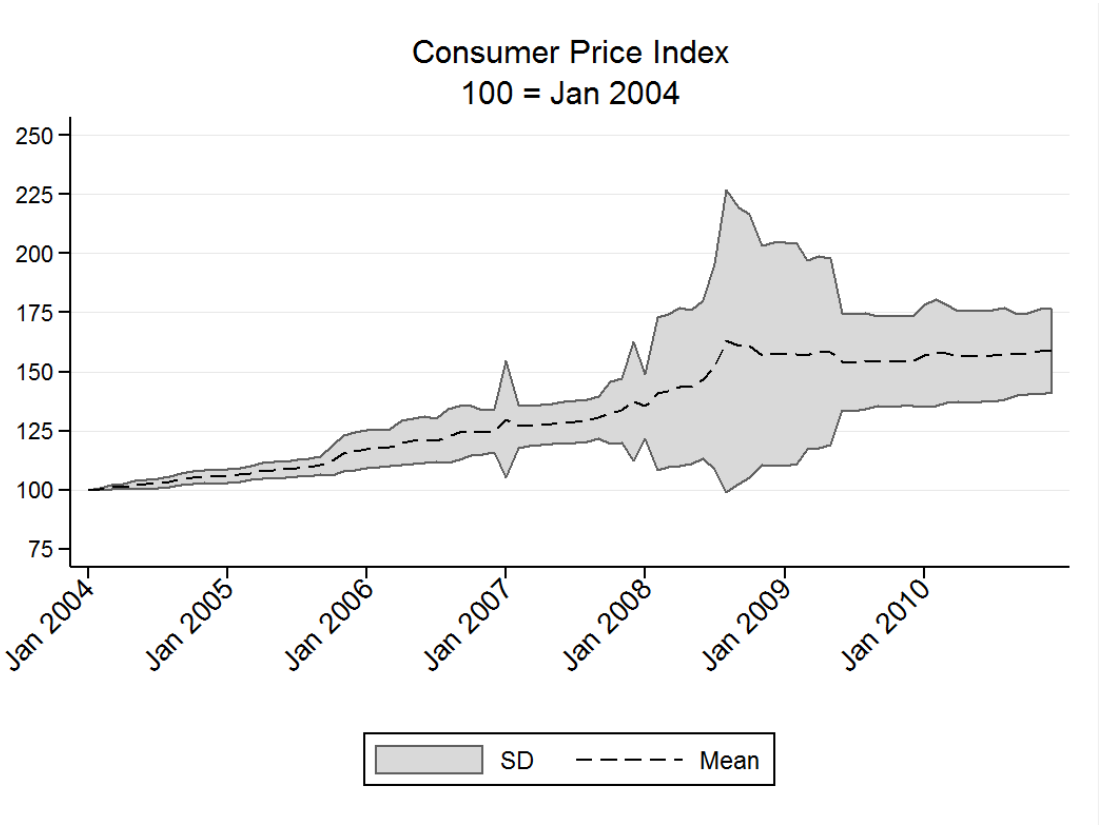
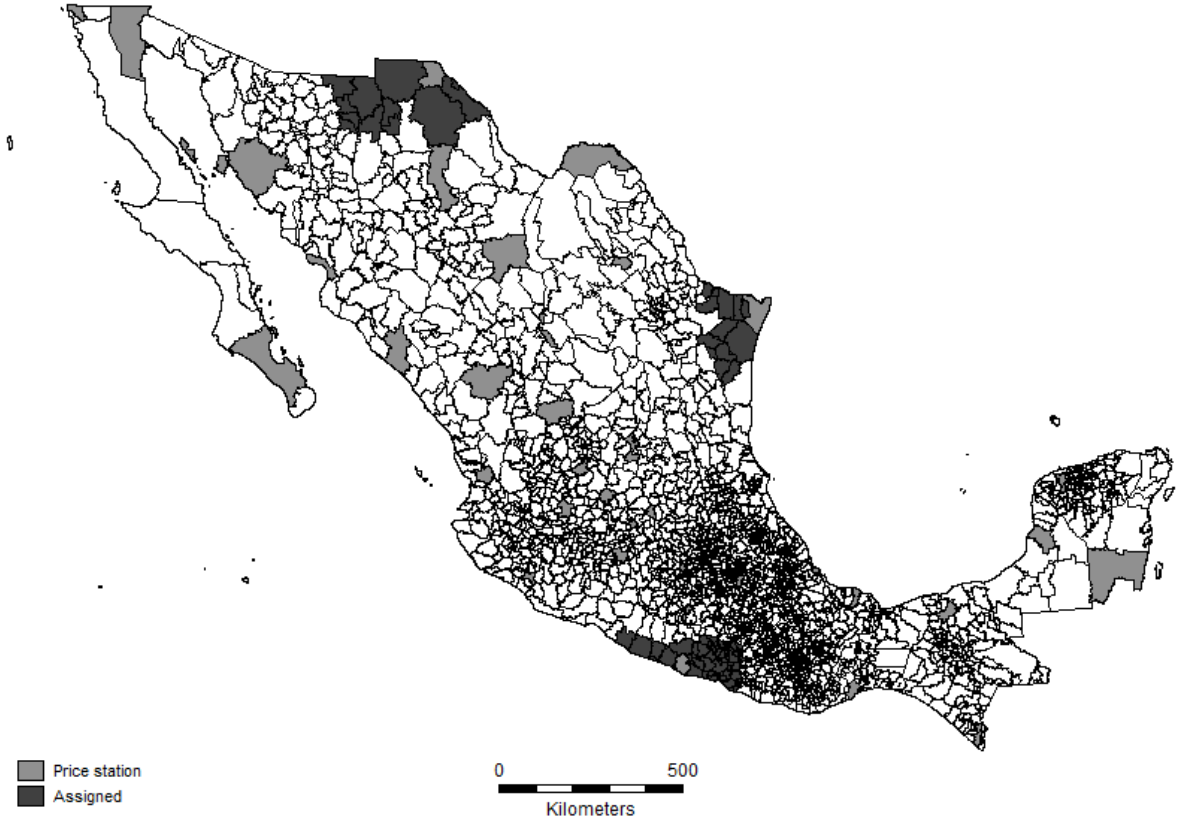


Figure 1: CPI

Every municipality in the country was unambiguously assigned to the closest price station by geodesic distance between the centroids of both municipalities. Figure 2 visualizes this procedure for three selected price stations. The prices and CPI from the price station are imputed on the assigned municipalities.

Figure 2: Selected price stations and municipality assignment



Shown here for selected price stations: Juárez (in the North), Heroica Matomoros (in the East) and Acapulco de Juárez (in the West)

Prices and households' income and expenditures are reported at different aggregation levels. On the expenditure side, prices levied and expenditure items in the household surveys match according to an official key (Banco de México, 2011), though at a higher level of aggregation than the orginal price data. On the income side prices and income sources can be matched using the industrial classification[11] of the workplace of each individual as well as the Mexican Classification of Occupations[12] and the National System of Classification of Occupations[13], though again at a higher level of aggregation the the original price data. Aggregation levels for the income and the expenditure side are different and thus subsequently combined into a

[11] Given by the North American Industrial Classification System, 'SCIAN' by its initials in Spanish
[12] Clasificación Méxicana de Ocupaciones, 'CMO' by its initials in Spanish
[13] Sistema Nacional de Clasificación de Ocupaciones, 'SINCO' by its initials in Spanish

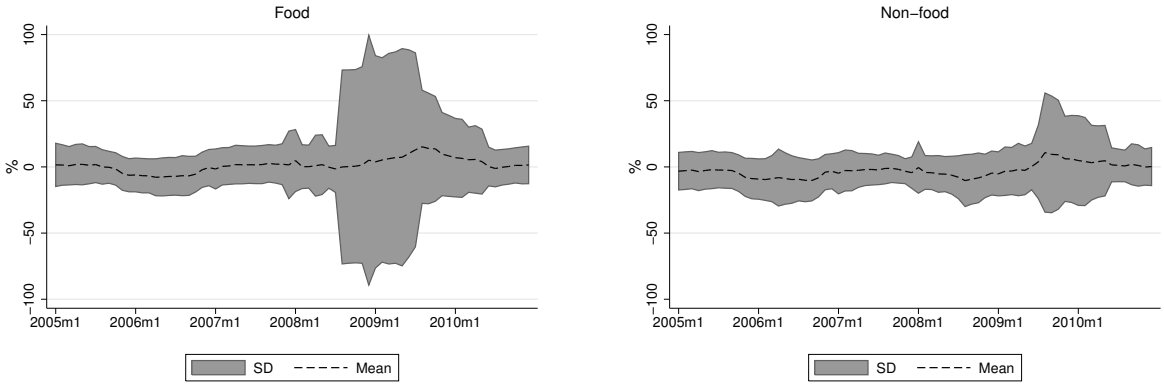
harmonized aggregation level which yields 20 *commodity groups* which can be grouped into food and non-food groups as is shown in Table 1.

Table 1: Food and non-food groups

Food	Non-food
Tortillas, bread, cereals and similar	Clothing, shoes and accessories
Maize and beans	Housing
Meats and fish	Furniture and household appliances
Milk and milk products	Health and personal care
Eggs	Transportation
Fruits	Education
Vegetables and greens	Leisure
Bottled fruits and legumes	Other services
Seasonings, sugar, oils and fats	
Beverages, incl. coffee	
Candy, chocolates and tobacco	
Food cooked outside of home	

Figure 3 reports country-wide mean percentage changes in relative real prices for food and non-food groups with their respective standard deviations. This figure exemplifies why the term "Tortilla Crisis" is actually a misnomer, as it refers to only one item.

Figure 3: 12-month growth rates in real prices



There are two spikles in food prices on the left panel in Figure 3: one at the end of 2007 and one in the middle of 2008. Although the average growth rate is positive, the standard

deviation around the spikes is sizeable, a reflection of regional differences in price changes as well as differences in price growth rates among food groups. Unlike cereals and other grains, growth rates for meat declined. Table 2 reports mean 12-month growth rates of real food prices as well as their mean standard deviations.

Table 2: 12-months growth rates in real food prices

	2004-2005		2005-2006		2006-2007		2007-2008		2008-2009		2009-2010	
Commodity group	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Tortilla, bread, cereal and similar	-4.0	8.5	-18.7	9.9	3.6	10.1	3.1	15.8	8.7	28.8	2.7	18.4
Maize and beans	8.2	21.4	1.9	17.0	3.8	17.1	7.0	21.2	25.5	35.9	-0.8	24.2
Meat and fish	-0.9	9.3	-8.4	8.9	-1.4	21.8	-5.5	14.9	8.5	31.1	2.4	19.9
Milk and milk products	-1.1	7.7	-5.0	10.3	9.3	133.9	3.7	18.3	3.6	28.1	1.9	19.0
Eggs	-8.0	16.5	0.8	22.4	14.1	17.9	8.8	30.9	8.6	28.9	-7.2	18.6
Fruits	0.2	8.2	-0.8	9.2	2.7	8.9	-5.2	15.7	4.5	28.8	4.6	18.4
Vegetables and greens	5.9	15.2	-10.7	13.2	0.7	11.1	-6.0	15.8	6.4	30.2	9.2	22.4
Bottled fruits and legumes	-1.6	10.0	-6.3	10.2	-0.1	15.7	11.3	144.1	32.6	197.8	2.1	24.0
Seasonings, sugar, oils and fats	-2.3	17.4	-7.8	13.8	-6.7	21.0	4.8	92.2	5.3	44.7	1.6	21.6
Beverages, incl. coffee	-1.3	9.7	-7.5	8.4	-3.5	10.2	-3.5	14.3	2.1	15.2	5.4	11.2
Candy, chocolates and tobacco	5.9	19.6	-2.9	15.8	0.3	15.5	-1.4	20.0	3.1	29.9	7.0	21.4
Food cooked outside of home	-3.1	8.2	-5.3	8.0	-1.0	9.8	-3.8	14.9	4.5	29.1	2.3	19.1

Source: Banxico, author's calculations

The most drastic price increases are found between the years of $2007-2008$ and $2008-2009$, with 12-month growth rates between 20% and 60%. The large standard deviations in Figure 3 are partly explained by very large standard deviations in single commodity groups, which are a result of price differences among the price stations and reflect regional disparities.

Because the welfare effect will depend on the relative change in prices as well as on the relative change in income and expenditures for each commodity group[14], welfare will evolve differently for households that experienced the same price changes but differ in their income and expenditure patterns. Thus, for the analysis changes between points in time of the variables of interest need to be observed.

Whereas the assessment relies on relative changes between points in time the household data consists of repeated cross-section. Hence, it is not possible to perform the analysis at the household level.

[14]as outlined in Section 2

3.2 Unit of analysis

Approximately 60% of all municipalities surveyed appear in subsequent waves, with 199 municipalities being surveyed in every wave over the time period considered. The analysis is performed for changes in the same municipality between two survey waves. Specifically, the comparison is made at per capita municipality changes in income and expenditure at every centile and decile of per capita expenditure. Using per capita expenditures ensures comparability with the relevant literature mentioned above (e.g.: Ferreira et al. (2013); Robles and Torero (2010)).

One concern that arises when analyzing municipality level changes is alterations in the composition of the municipality that might drive the results, for example a changed migration pattern. In Mexico, internal and external migration are relatively low. According to the National Council for Population[15] between the years of 2005 and 2010 only around 1% of the population emigrated abroad and around 6% migrated to a different municipality[16]. A large share of migration occurs to municipalities at the borders and touristic areas Anzaldo et al. (2008); Sobrino (2010). Nonetheless, I do not observe households across time and so, cannot observe migration patterns. To limit the effect that migration could have over time on the income and expenditure profiles, the analysis occurs between subsequent survey waves and not, for example, between the years before and after the price change. First, because price changes occur as a continuum and the setting of a precise date for the beginning of the price increase would be arbitrary by any means, and second, by observing such a short time period the changes for influences of migration on the municipality income and expenditure characteristics are hopefully minimized.

Another important dimension is the rural/non-rural divide. According to the INEGI, a locality

[15] CONAPO by its initials in Spanish

[16] 3% out of the federal state and 3% within the federal state

is rural if it has 2500 inhabitants or fewer. Each municipality is composed of a number of localities. Using the information on the rural status of the locality I can determine the median rural status of a municipality. Table 3 lists the total number of municipalities that where surveyed in subsequent waves by location.

Table 3: Number of municipalities

Waves	Rural	Non-rural
2004-2005	201	302
2005-2006	233	339
2006-2008	220	309
2008-2010	245	381

Source: ENIGH

Price stations are by choice of the incumbent agency municipalities with at least 20000 inhabitants (Banco de México, 2013), thus no price station accurately reflects the price dynamics in rural areas. Nevertheless, the differentiation between rural and non-rural municipalities is relevant as income and expenditure profiles are clearly different.

3.3 Household surveys

3.3.1 Income

Household data come from a biannual survey, the National Household Survey on Income and Expenditures[17] provided by the Mexican Statistical Office[18] for the years $2004 - 2006$, 2008, and 2010[19]. This is a nationally representative cross-sectional household survey that interviews between 20875 and 27665 households in over 900 different municipalities in each wave and contains information on the socio-demographic characteristics of households and its members, as well as detailed income and expenditure information.

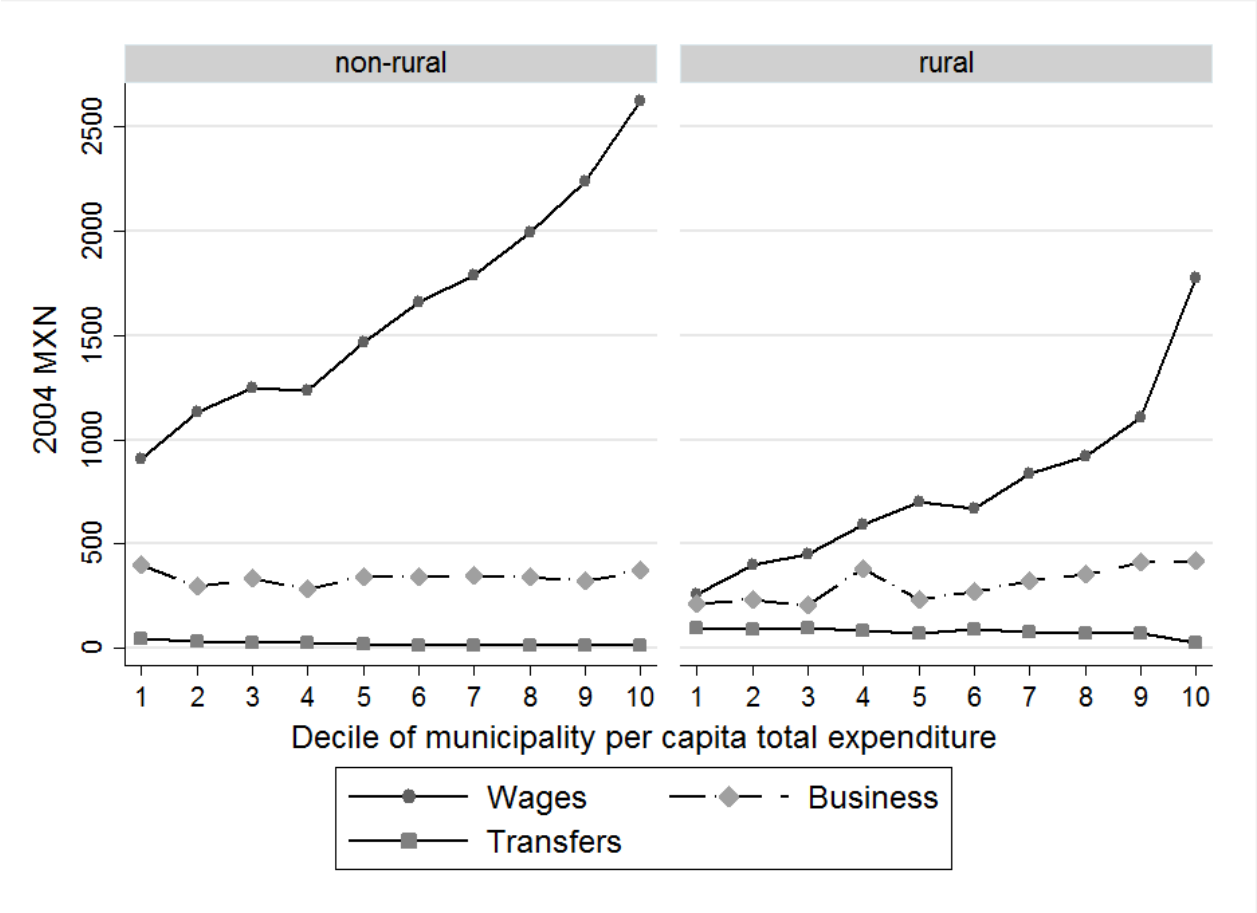
[17]ENIGH by its initials in Spanish.
[18]INEGI by its initials in Spanish.
[19]2005 was an extracurricular year

Estimation of the wage, business and transfer income effects along the lines shown in Section 2 requires that household income is reported by types and source. Using information on the sector of activity and the occupation of the individual[20], income earned by any member of the household can be classified as either wage income, business income or transfer income. The last one refers to the widespread and ample governmental transfer programs in Mexico. The first two income types can be further assigned to the commodity group in which they were earned. The final steps involve deflating the income with the CPI (see Section 3.1) and trimming the data by eliminating households in the first and last percentiles in the total income and total expenditure distributions. Then we generate municipality level weighted means as well as real relative changes in income.

Figure 4 shows the mean per capita income levels pooled for all years by income category. Overall income levels are higher in non-rural areas, although the speed at which income increases across deciles is higher in rural ones.

[20]Using the SCIAN, CMO, and SINCO detailed before

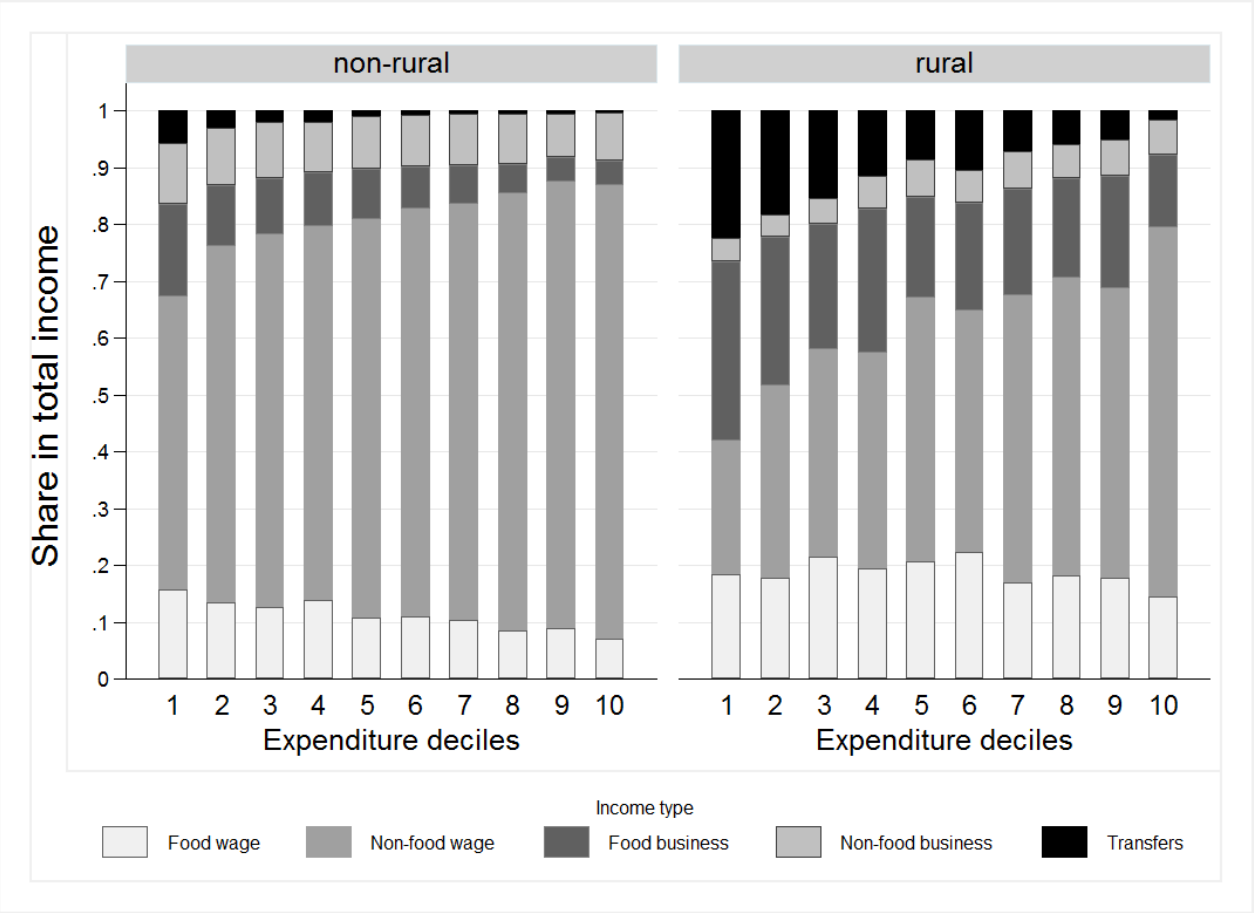
Figure 4: Mean per capita income levels



Notes: A locality has a rural status if it has 2500 inhabitants or less.

To further illustrate the differences between rural and non-rural municipalities and to further motivate our use of wage and business income, Figure 5 presents the mean income share for each income type. In addition we disaggregate the income types by their source: food and non-food. The role of agricultural businesses is larger in rural than in non-rural areas, therefore, food business income plays a larger role in rural areas. Furthermore, transfer income is particularly important at lower deciles, but much more so in rural areas. Because transfer income is awarded in part due to economic status, these higher shares in the income constitution are exemplary of the poverty situation in rural areas.

Figure 5: Income composition by food and non-food



Notes: Income shares computed for the ENIGH 2004 – 2006, 2008 and 2010 waves. A locality has a rural status if it has 2500 inhabitants or less.

Income composition differs markedly between rural areas and their counterparts. Whereas the major component of income in non-rural areas are wages, with more than 65% in all deciles, in rural areas the components appear more balanced. Nonetheless, we observe the save trend with respect to the income composition in both areas: at higher deciles, most income is wage income, particularly of the non-food kind.

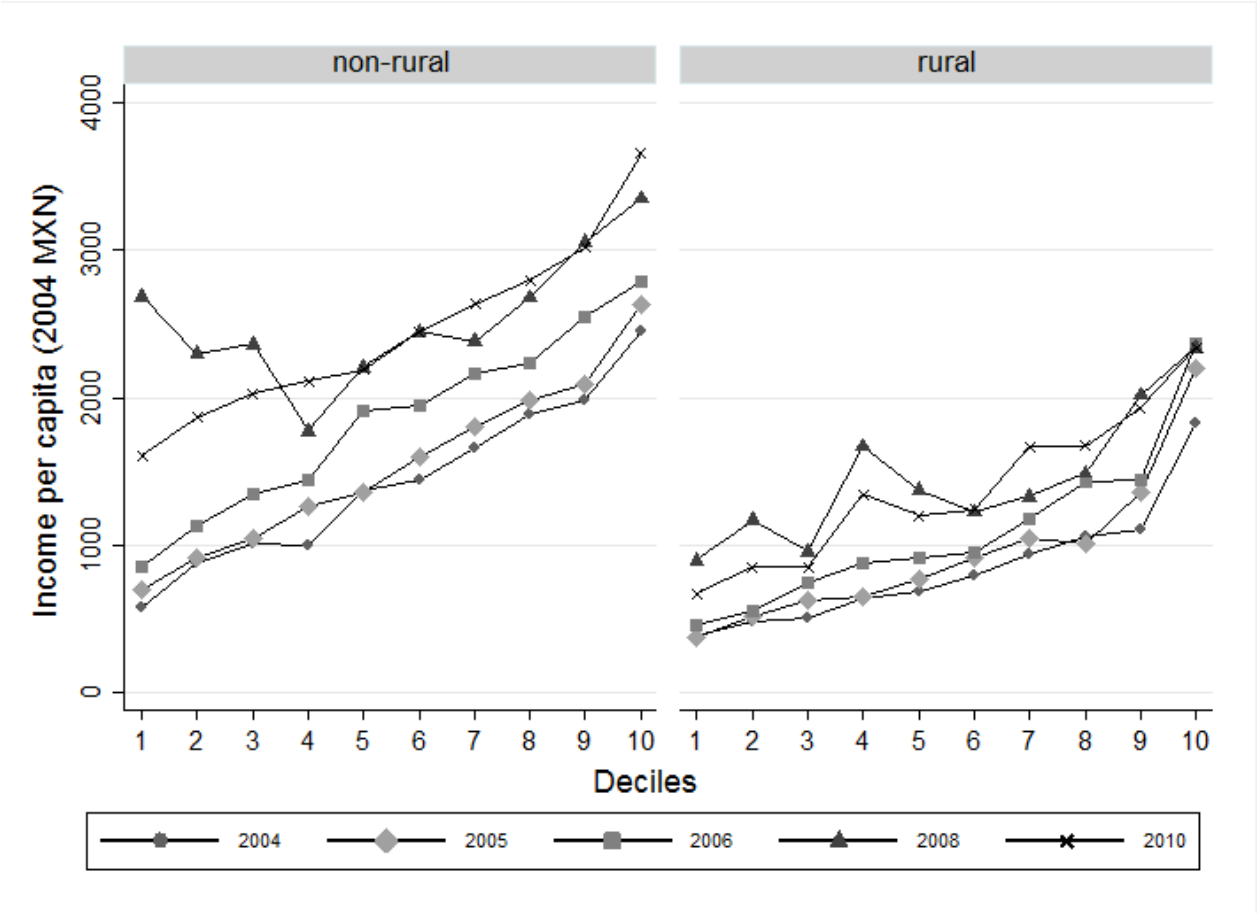
Figure 6 illustrates the mean per capita income level across deciles for every survey wave. To put these reported income levels into perspective, the mean rural and non-rural poverty lines in 2004 were 1004.3 MXN per capita and 1637.1 MXN per capita respectively[21]. In the rural

[21]Official SEDESOL values for July 2004, deflated with the CPI presented in this section.

setting this translates into an average poverty headcount of approximately 40 %, while in non-rural areas this figure reaches around 20 %.

Despite, it is clear that in both settings average per capita income *increased* in all deciles between 2006 and 2008 and between 2008 and 2010.

Figure 6: Decile mean per capita income levels



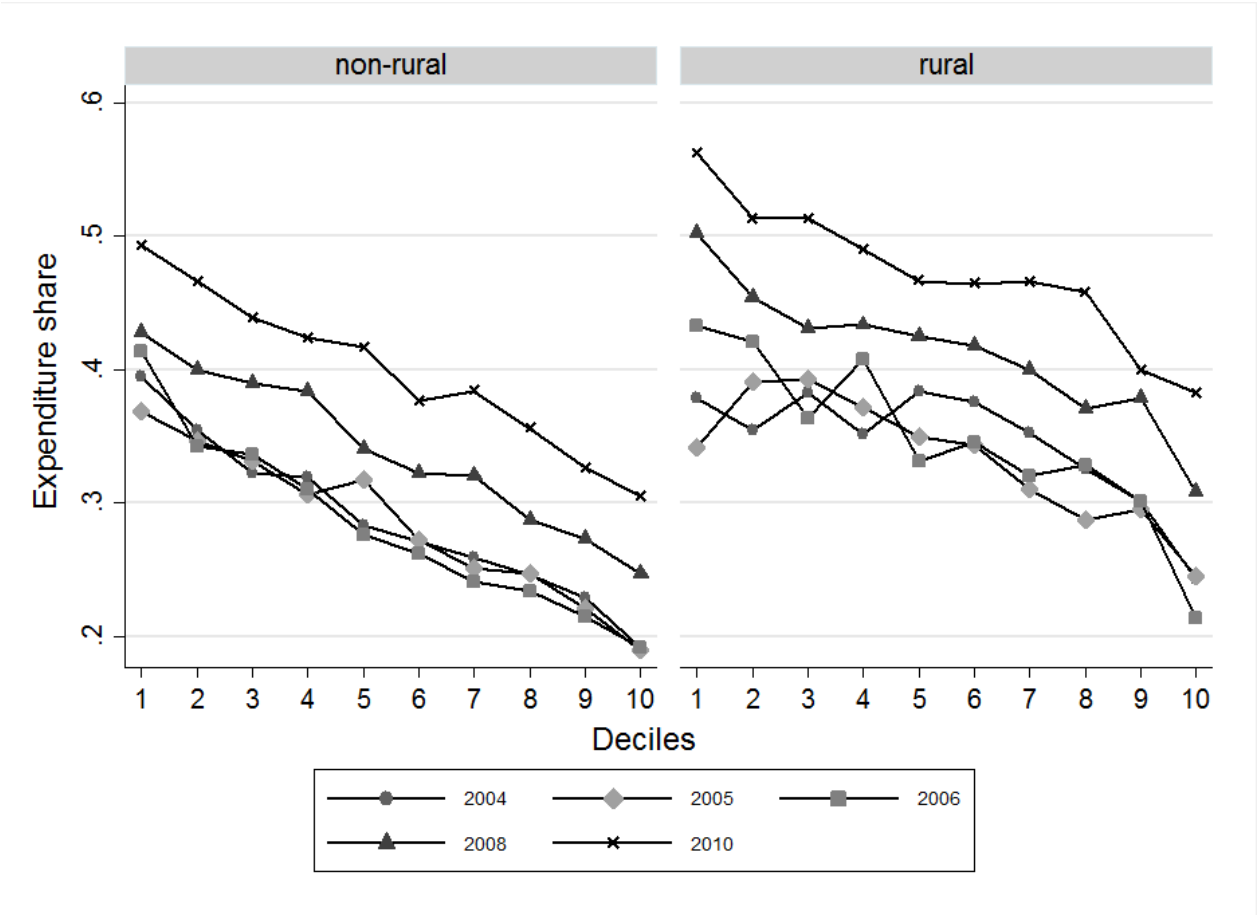
Notes: A locality has a rural status if it has 2500 inhabitants or less.

3.3.2 Expenditures

Per capita food and non-food expenditure levels (Figures A1 and A2) as well as per capita food and non-food expenditure shares (Figures 7 and 8) display the expected behavior: food (non-food) expenditure shares decline (increase) with increasing deciles while food (non-food)

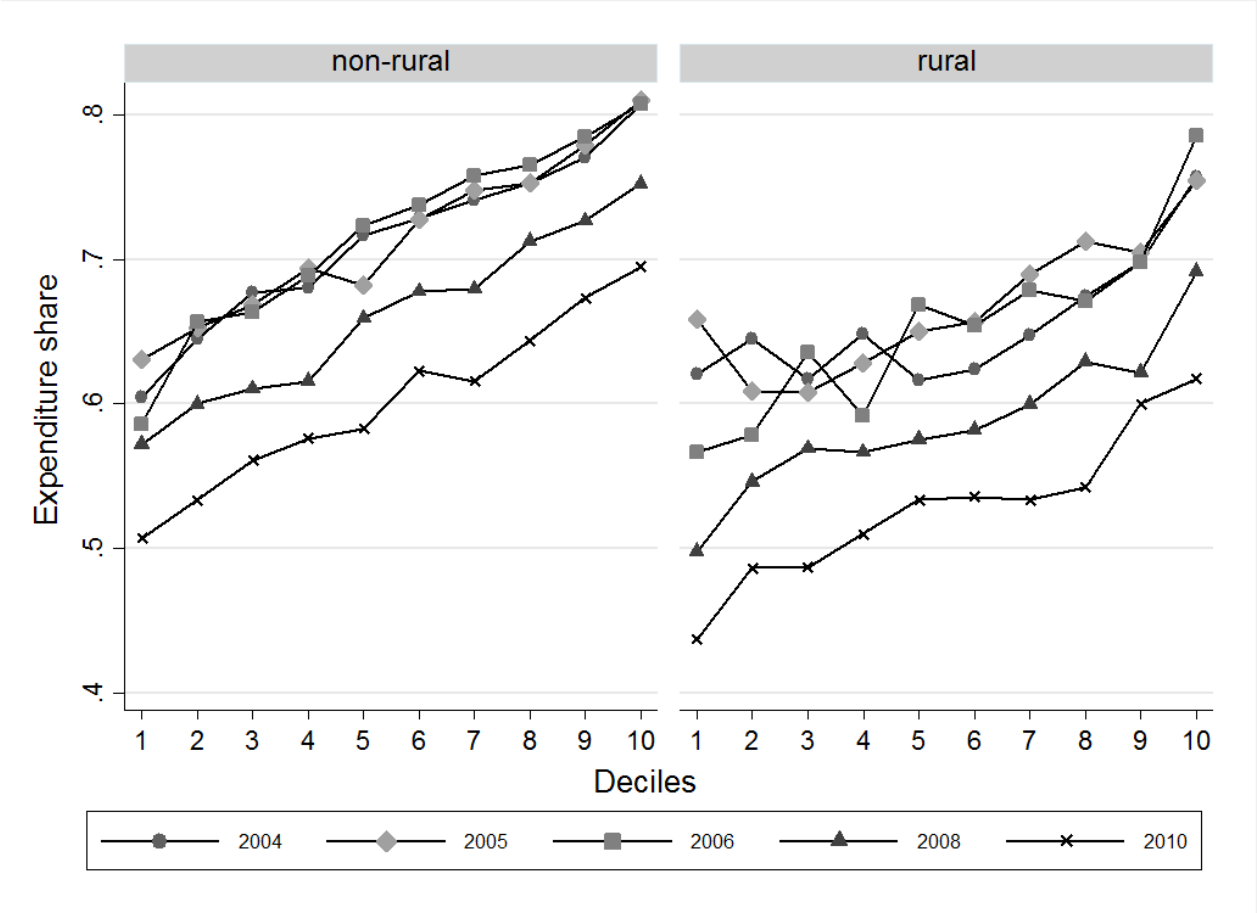
expenditures increase (decrease) over the deciles.

Figure 7: Food expenditure shares



Notes: Deciles were computed separately for rural and non-rural municipalities.

Figure 8: Non-food expenditure shares



Notes: Deciles were computed separately for rural and non-rural municipalities.

The increases in the expenditure share for food in the years 2008 and 2010, which are mirrored by declines in the non-food shares, follows from the decline in overall expenditures caused by the decline in non-food expenditures in that same time period. Particularly interesting is that real food expenditures remained largely unchanged during the observed time period indicating that food expenditures are largely unresponsive to inflation. To sustain unchanged expenditure levels despite the inflation, households either spend less on other goods, which would explain the lower levels of expenditures in non-food items, or sustain the consumption through a higher income, or both. This last argument is consistent with the higher income presented in Figure 6 above.

A cursory analysis would imply a positive effect of the price changes on welfare: incomes increased while total expenditures decreased. Nonetheless, it is not clear if the income increases are sufficient to compensate the for the price increases or how the decline in non-food expenditures affects welfare. Furthermore, the changes in income and expenditure presented above vary for each decile and by rural and non-rural setting.

Overall, the net welfare effect will depend on the changes in prices, income and expenditures. To further account for possible substitution effects, we compute the price and cross-price elasticities of the 20 commodity groups.

3.4 Elasticities

The compensated own- and cross-price elasticities which are needed to estimate the substitution effect -ρ_s- are derived from Hicksian demand functions which are in turn obtained from the estimation of a quadratic almost ideal demand system (QUAIDS). This system, proposed by Banks et al. (1997), allows for non linearities in the Engel curves by including a quadratic term in the expenditure share equation[22]. The reason for choosing this demand system lies in following similar studies and generating comparable results, albeit, according to Araar and Verme (2016), the choice of demand system appears to be of minor relevance for the results.

We estimated a QUAIDS controlling for rural status of the household and number of residents and obtained a full set of compensated own- and cross-price elasticities for every single commodity group in every household in every wave. These elasticities were aggregated at the municipality level in the same fashion as the income and expenditure data detailed before.

[22]See Section A.1 for the estimated system.

Table 4: Compensated price elasticities

Commodity group	Tortilla, bread, cereal, others	Maize and beans	Meat and fish	Milk and milk products	Eggs	Fruits	Vegetables and greens	Bottled fruits and legumes	Seasonings, sugar, oils and fats
Tortilla, bread, cereal, others	-1.093	0.171	-0.027	0.263	-0.033	0.387	0.354	0.038	0.194
Maize and beans	0.526	-1.615	-0.506	1.299	-0.014	-0.112	-0.147	-0.001	-0.303
Meat and fish	-0.016	-0.098	-1.295	0.208	-0.028	-0.013	-0.253	-0.033	0.162
Milk and milk products	0.422	0.635	0.477	-0.297	0.008	0.327	0.370	0.019	0.106
Eggs	-0.082	-0.001	-0.111	0.003	-0.659	-0.316	-0.708	0.111	-0.008
Fruits	1.295	-0.114	-0.031	0.737	-0.329	-0.077	-0.222	-0.106	-0.089
Vegetables and greens	0.653	-0.101	-0.658	0.438	-0.406	-0.120	-1.895	0.377	-0.032
Bottled fruits and legumes	0.188	0.012	-0.177	0.075	0.176	-0.144	1.065	-0.929	0.033
Seasonings, sugar, oils and fats	0.633	-0.318	0.825	0.243	-0.009	-0.093	-0.055	0.007	-1.288
Beverages	0.478	0.111	0.792	-0.225	0.217	-0.456	0.465	-0.050	-0.280
Candy, chocolates and tobacco	0.084	-0.238	0.474	-0.002	0.472	0.089	0.976	0.151	-0.287
Food cooked out.	-0.239	0.060	1.194	-0.628	0.052	0.043	0.536	-0.135	0.246
Clothing, shoes and acc.	0.034	-0.053	-0.195	0.375	-0.034	0.096	-0.015	-0.003	-0.017
Housing	-0.193	-0.055	0.147	0.071	-0.000	0.047	0.024	0.024	-0.022
Furniture and house. app.	0.224	0.098	-0.014	-0.432	0.230	-0.146	0.045	0.039	0.064
Health and personal care	-0.081	-0.007	0.113	-0.009	-0.011	-0.001	-0.016	-0.002	0.029
Transportation	-0.061	0.126	0.187	-0.439	0.068	-0.143	0.084	-0.059	0.083
Education	-0.002	0.107	0.466	-0.370	0.070	0.099	0.299	-0.074	-0.059
Leisure	-0.008	-0.265	-0.251	0.542	-0.322	-0.347	-0.751	0.104	-0.326
Other services	0.522	-0.161	-1.824	0.233	-0.168	0.220	0.120	0.160	-0.009

Table 4: Compensated price elasticities (continued)

Commodity group	Beverages	Candy, chocolates and tobacco	Food cooked out.	Clothing, shoes and acc.	Housing	Furniture and house. app.	Health and personal care	Transportation	Education	Leisure	Other services
Tortilla, bread, cereal, others	0.283	0.006	-0.178	0.024	-0.367	0.233	-0.175	-0.091	-0.039	-0.027	0.078
Maize and beans	0.159	-0.153	0.108	-0.100	-0.309	0.336	-0.040	0.727	0.334	-0.133	-0.058
Meat and fish	0.291	0.057	0.496	-0.120	0.199	-0.008	0.131	0.244	0.303	-0.051	-0.179
Milk and milk products	-0.193	-0.004	-0.642	0.586	0.207	-0.673	-0.020	-1.021	-0.541	0.186	0.057
Eggs	0.368	0.277	0.126	-0.071	0.042	0.694	-0.021	0.405	0.225	-0.211	-0.067
Fruits	-0.812	0.039	0.082	0.346	0.319	-0.482	0.015	-0.705	0.297	-0.265	0.111
Vegetables and greens	0.423	0.309	0.582	-0.023	0.029	0.064	-0.058	0.216	0.482	-0.320	0.038
Bottled fruits and legumes	-0.115	0.138	-0.420	0.015	0.292	0.234	0.035	-0.378	-0.318	0.102	0.119
Seasonings, sugar, oils and fats	-0.519	-0.186	0.532	-0.021	-0.124	0.242	0.180	0.427	-0.199	-0.262	-0.014
Beverages	-1.038	-0.065	-0.332	-0.028	-0.070	0.230	0.311	0.404	-0.614	0.227	-0.076
Candy, chocolates and tobacco	-0.177	-1.230	-0.094	-0.055	0.169	0.047	0.125	-0.494	-0.432	0.214	0.211
Food cooked out.	-0.253	-0.026	-1.128	0.319	-0.494	0.134	0.294	0.057	0.135	-0.039	-0.118
Clothing, shoes and acc.	-0.027	-0.018	0.175	-1.040	0.214	-0.001	0.096	0.171	0.102	0.132	0.007
Housing	-0.033	0.011	-0.220	0.127	-0.332	-0.116	0.214	0.109	0.066	0.096	0.039
Furniture and house. app.	0.123	0.004	0.072	0.014	-0.183	-0.933	0.046	0.585	-0.053	0.085	0.135
Health and personal care	0.102	0.011	0.095	0.080	0.258	0.031	-1.062	0.366	0.018	0.077	0.013
Transportation	0.122	-0.063	-0.009	0.120	0.112	0.366	0.352	-1.147	0.166	0.084	0.056
Education	-0.344	-0.088	0.077	0.149	0.134	-0.047	0.029	0.339	-0.805	-0.034	0.058
Leisure	0.562	0.170	-0.065	0.576	0.677	0.275	0.514	0.565	-0.210	-1.334	-0.096
Other services	-0.312	0.272	-0.599	0.088	0.470	0.944	0.135	0.636	0.354	-0.148	-0.924

Source: ENIGH 2004 – 2006, 2008 and 2010, author's calculations

Table 4 summarizes the compensated own- and cross-price elasticities for all years without distinction between rural and non-rural households. The commodity groups are listed both vertically and horizontally. Row elements react to a change in the price in the column elements (Poi, 2012). Thus the diagonal elements correspond to the own-price elasticities. For example, the own-price elasticity of the group "Tortilla, bread, cereal and similar" is -1.093: the

demand for this group will recede by 1.093% when the price for the same increases by 1%. Similarly, if the price for "Maize and beans" increases by 1% the demand for "Tortilla, bread, cereal and similar" will increase by 0.171%.

Overall the estimated elasticities are within a reasonable range, with no overly large values, and possess no unexpected signs. For example, own-price elasticities are always negative. As for the cross-price elasticities, the signs vary depending on whether in the data those goods are complements or substitutes.

We estimate the substitution effect, ρ_s described in Section 2, using such an elasticity matrix for every municipality for those years at the beginning of an inter-wave comparison. Hence, no elasticities are estimated for the year 2010.

The next section presents the results of an estimation of the five effects described in Section 2.

4 Results

The five effects identified in Section 2 are estimated using local polynomial regressions (Friedman and Levinsohn, 2002; Porto, 2006)[23] at every percentile of real per capita expenditure. Results are presented at the decile mean and for two different situations: overall price changes and changes in food prices, first as nationwide changes and then disaggregated for rural and non-rural areas.

4.1 Effects on welfare of changed overall prices

4.1.1 General effects

The estimated effects are reported as percentages of initial per capita expenditures for all municipalities, without distinguishing between rural and urban ones. For the first two years these are the subsequent years, afterwards the comparison occurs biennially. Results for the for periods $2006 - 2008$ and $2008 - 2010$, i.e. those with the sharpest price changes, are reported in Figures 9 and 10. Results for the time periods $2004 - 2005$ and $2005 - 2006$ can be found in the Appendix.

[23] Ferreira et al. (2013) use a similar approach

Figure 9: Net effect due to overall price changes, 2006-2008

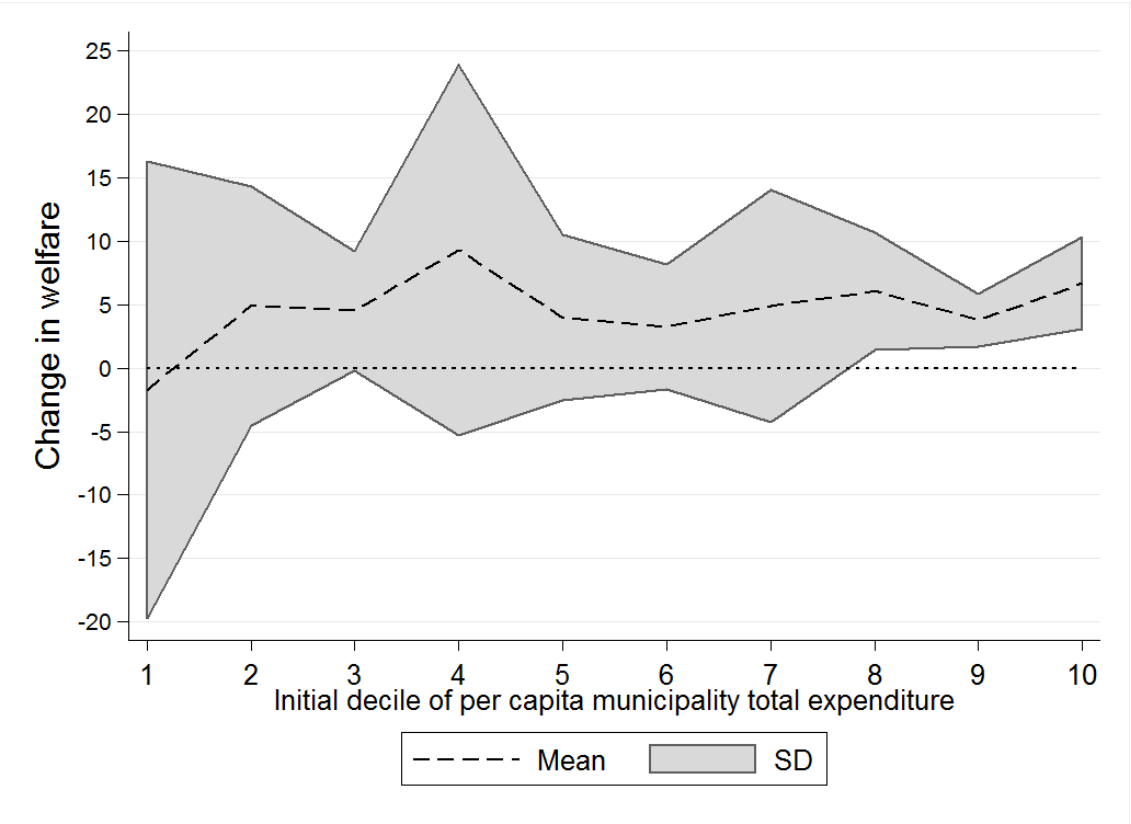
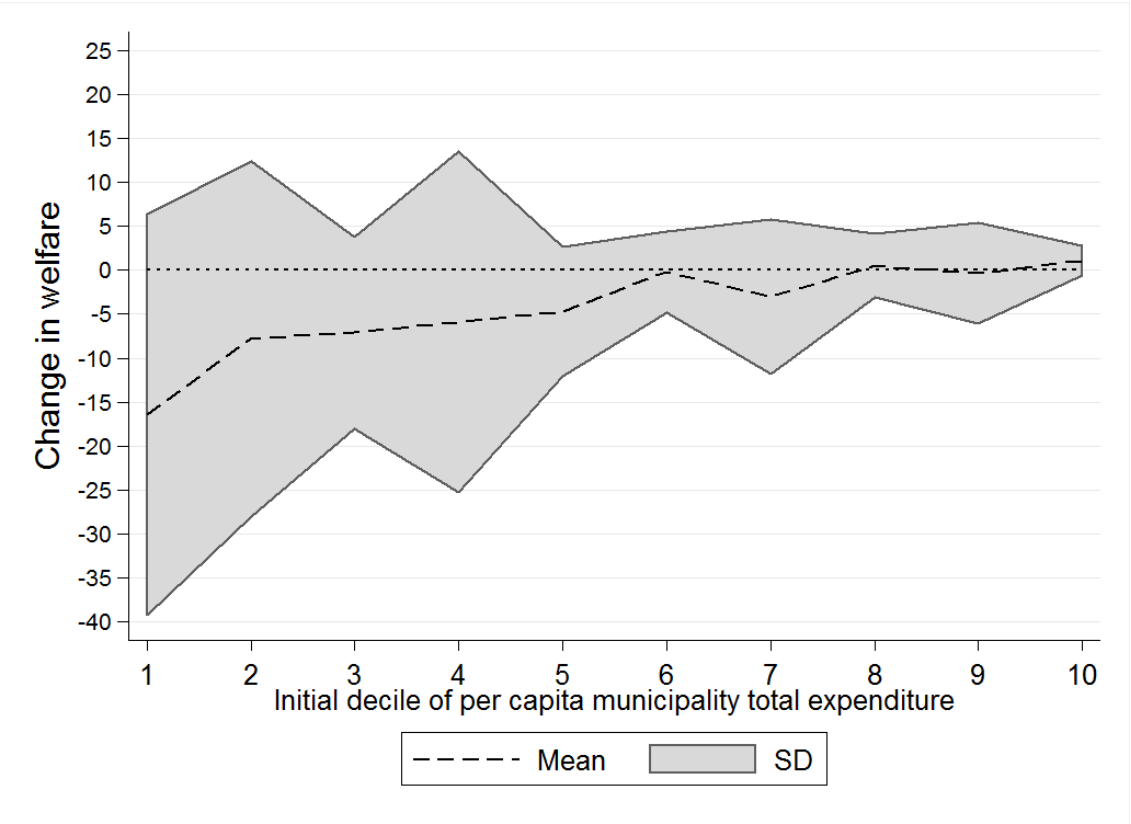


Figure 10: Net effect due to overall price changes, 2008-2010



Percentage changes in initial income due to the price increase are reported on the vertical axis. Negative (positive) values convey the percentage of income in the initial period that should be added (substracted) in that percentile to income in the comparison period to achieve the initial welfare level. For example, a household in the first decile in 2006 would need on average 101.25% of its 2006 income to achieve in 2008 the same level of welfare as in 2006 because this percentile's percentage changes in initial income is of about -1.25%. A welfare change of zero percent means that negative and positive changes balance themselves out and not necessarily that there was no change at all.

Figure 9 plots the mean changes between 2006 and 2008 as well as its standard deviation. The mean line in Figure 9 lies above the zero line for all deciles, indicating that, on average, there were no net losses, with the fourth decile having the largest mean gains. Yet, the plot of the

standard deviation shows that at least within the first seven deciles there were some losses. As opposed to that, the Figure 10 shows net mean losses across all deciles for the time between 2008 and 2010 except for the three richest deciles that display an an average net change of zero. Losses, indicted by the spread of the standard deviation into the negatives, are larger and more predominant that any gains during this time period. The spread of the welfare changes tightens around zero at the upper end of the expenditure distribution but is very wide at its lower end. For example, in the first decile a household would need on average approximately 115% of its 2008 income to achieve in 2010 the same level of utility as in 2008; but the welfare changes in that same decile stretches from positive 5% to negative 40%. An explanation for this very wide spread might be the pooling of rural and non-rural municipalities. Because both types have different income compositions as well as average income levels, results might be counterintuitive. Particularly in the first deciles do average income per capita differ markedly. For the year 2010 average income per capita in the first decile in rural areas amounted to 1000 Mexican Pesos, in non-rural areas 1500; a 50% difference.

Before exploring rural and non-rural differences in the next Section, I turn to the composition of the welfare change. Tables 5 and 6 present the composition of the mean net effects depicted in Figures 9 and 10 above. In the columns are those effects outlined in Section 2. The first three columns relate changes in welfare to changes in the following income sources: wage income, business income and transfer income. Next are changes due to changes in expenditures and substitution followed by the net effect. Tables for the periods $2004 - 2005$ and $20005 - 2006$ can be found in the Appendix.

Table 5: Breakdown of the overall effect for $2006 - 2008$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-2.05	-2.23	-0.51	2.42	0.65	-1.72
2	-1.43	-2.88	2.78	5.73	0.67	4.87
3	-0.86	-1.48	1.59	4.54	0.70	4.50
4	-2.03	0.40	0.41	10.09	0.47	9.30
5	-1.54	-1.63	0.34	6.25	0.59	3.97
6	-1.81	-0.51	-0.32	5.40	0.48	3.24
7	-0.09	-2.12	-0.06	6.68	0.47	4.87
8	-2.01	-0.58	-0.13	8.23	0.55	6.06
9	-1.48	-0.61	-0.02	5.39	0.49	3.77
10	-1.78	0.02	0.05	8.00	0.38	6.66

Source: ENIGH, Banxico, author's calculations

Table 6: Breakdown of the overall effect for $2008 - 2010$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.79	-4.17	3.06	-16.19	1.70	-16.40
2	-1.00	-2.71	-0.85	-4.39	1.09	-7.77
3	-0.02	0.09	-0.01	-8.01	0.87	-7.08
4	0.46	-1.08	1.27	-7.25	0.74	-5.87
5	-1.45	-0.40	-1.21	-2.34	0.70	-4.69
6	-0.71	0.31	-0.75	0.29	0.69	-0.17
7	-1.30	0.04	0.60	-2.91	0.53	-3.03
8	-0.85	-0.10	0.13	0.62	0.70	0.50
9	-0.94	-0.60	0.07	0.67	0.48	-0.33
10	0.08	0.00	0.06	0.65	0.32	1.11

Source: ENIGH, Banxico, author's calculations

Both the expenditure and the substitution effects enter Equation 8 with a negative sign. Welfare is defined as the monetary amount needed to maintain a certain utility level; an estimated positive expenditure or substitution effect relates to us the percentage of initial income that would be needed to be spend in order to maintain a given level of utility, thus a positive expenditure or substitution effect diminishes welfare. A positive substitution effect though, would only happen if the own- or cross-price elasticities were positive, and that is

never the case in the data. Hence, the substitution effect always affects welfare positively. In the Tables that report the breakdown of each effect both the expenditure and the substitution effects are accounted for with the sign with which they contribute to the welfare change.

Between $2006 - 2008$ most deciles experienced small average net gains, which are in part due to welfare gains because of the expenditure and the substitution effects offsetting the losses incurred due to negative changes in both wage and business income. Thus, in this first time period, changes in welfare came from modest negative changes in income and large enough changes in expenditures.

This is not at all the case in the next period, where the losses, specially in the lower deciles. Both the substitution and the transfer effects, although substantial, are too small to offset the combined negative effects of the negative income effects and large expenditure effects. The expenditure effect is large, regressive and dominates the evolution of the net effect.

4.1.2 Rural and non-rural effects

The distinction between rural and non-rural areas is important beyond determining the size of a community. As Ferreira et al. (2013) state, different labor markets and accessibility to commodity groups can lead to different welfare effects. An indication that both income and expenditure profiles are different was provided above.

Figures 11 and 12 depict the welfare changes for the years $2006 - 2008$ and $2008 - 2010$ separately for rural and non-rural areas.

Figure 11: Net effect due to overall price changes, 2006-2008

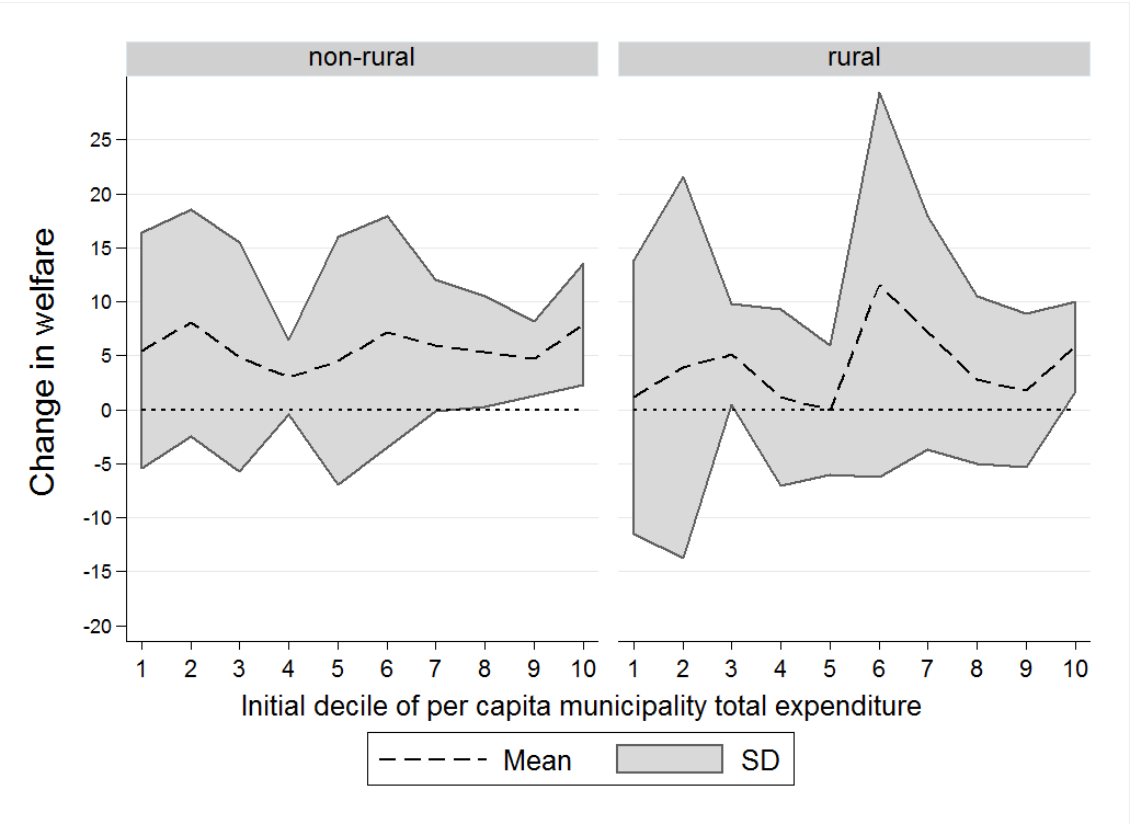
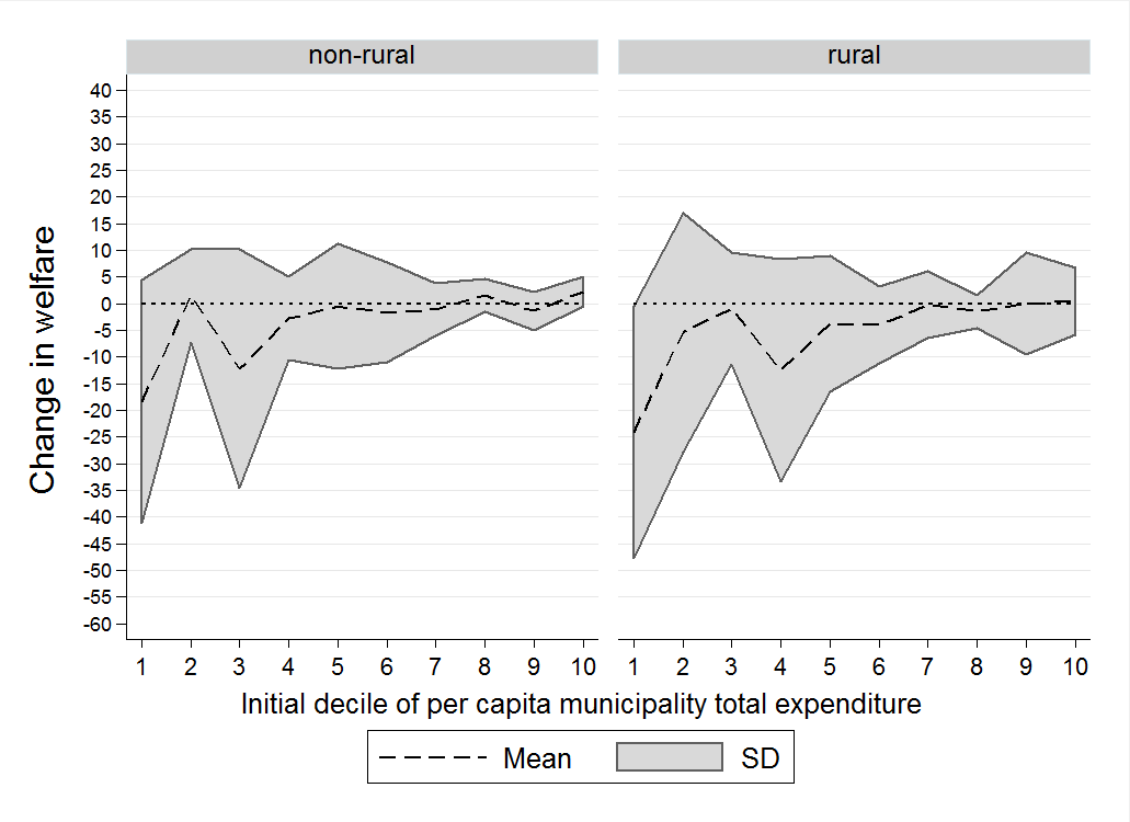


Figure 12: Net effect due to overall price changes, 2008-2010



Splitting the analysis into rural and non-rural areas reveals differences that were not visible before. In the $2006-2008$ period, non-rural areas experienced no negative welfare changes on average: the mean line is always in the positive range. While this is also the case for rural areas, the effects in this case are lower for middle income deciles. It becomes clear that the lumping together the two different areas actually overstates the losses, particularly in the lower deciles.

In contrast in the $2008-2010$ period, welfare changes turn into the negatives and the behavior of the mean as well as the standard deviation is less smooth than in the pooled analysis.

Table 7: Breakdown of net effect in the non-rural setting $2006 - 2008$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-1.55	-3.62	2.33	7.92	0.61	5.48
2	-0.73	-0.24	1.34	7.21	0.53	8.05
3	-1.64	-1.44	1.13	6.24	0.84	4.90
4	-0.89	-0.66	0.43	3.55	0.55	2.98
5	-0.79	-1.63	0.09	6.50	0.33	4.50
6	-0.31	-1.41	0.29	8.04	0.61	7.18
7	-1.75	0.06	-0.47	7.70	0.44	5.98
8	-2.39	-1.62	-0.04	8.89	0.54	5.38
9	-1.23	-0.46	0.17	5.58	0.65	4.70
10	-1.47	0.28	-0.04	8.88	0.29	7.94

Source: ENIGH, Banxico, author's calculations

Table 8: Breakdown of net effect in the rural setting $2006 - 2008$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-2.68	-3.40	5.29	2.03	0.66	1.18
2	0.01	0.01	-4.46	6.84	0.69	3.93
3	-0.64	0.17	4.04	1.86	1.09	5.10
4	-1.41	-2.31	-1.37	4.88	0.71	1.16
5	-3.38	-0.27	0.18	2.24	1.00	-0.02
6	-0.22	-0.08	1.45	10.44	0.63	11.58
7	-0.46	0.09	-0.63	7.22	0.40	7.15
8	-2.24	-0.13	-1.57	4.96	0.49	2.76
9	-1.35	-0.88	-2.46	5.03	0.66	1.79
10	-1.18	-0.05	0.15	6.33	0.71	5.85

Source: ENIGH, Banxico, author's calculations

Tables 7 and 8 provide the breakdown of the net effect into its components for the period $2006 - 2008$ and allow us to pinpoint the effect driving the behavior of the mean curve.

In line with the results obtained for whole country, both rural and non-rural areas display positive welfare changes that stem from the expenditure effect, although, on average, these are larger in non-rural areas. This effect is the driver of the positive welfare changes in the non-rural setting because it is large enough to offset the negative wage and business income

effects. This is only partly the case in rural areas, where the expenditure effect is not always large enough to offset the (mostly) negative income. In both cases the net effect is driven by the expenditure effect.

Table 9: Breakdown of net effect in the non-rural setting $2008 - 2010$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	1.91	-2.52	-0.15	-20.65	1.81	-18.33
2	2.86	-0.94	-0.11	-0.32	0.26	1.57
3	-0.68	-0.63	0.09	-11.66	0.69	-12.19
4	-1.57	-1.27	-0.61	-0.31	0.99	-2.73
5	-1.16	-0.01	0.47	-0.38	0.55	-0.54
6	-1.21	0.23	0.17	-1.45	0.62	-1.66
7	-1.46	-0.05	0.12	-0.45	0.74	-1.10
8	-0.93	-0.53	0.03	2.45	0.54	1.56
9	-0.21	0.00	-0.12	-1.32	0.27	-1.38
10	-0.01	-0.02	0.17	1.74	0.36	2.24

Source: ENIGH, Banxico, author's calculations

Table 10: Breakdown of net effect in the rural setting $2008 - 2010$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	0.78	-6.64	1.22	-20.58	2.06	-24.08
2	-1.83	-1.07	1.04	-4.10	0.28	-5.41
3	-1.74	-1.40	0.15	1.31	0.86	-0.87
4	-2.14	-1.29	-0.78	-10.68	0.96	-12.45
5	1.53	0.14	0.55	-6.99	1.24	-3.78
6	-1.68	-0.55	-2.88	-1.76	0.86	-3.97
7	-1.54	0.48	-1.74	1.20	0.66	-0.21
8	-1.38	-0.76	-2.31	1.06	0.86	-1.47
9	-0.20	-0.02	-0.20	-0.16	0.45	-0.02
10	1.21	-0.21	0.77	-1.55	0.60	0.46

Source: ENIGH, Banxico, author's calculations

The mean welfare change during $2008 - 2010$ for both settings is negative: there are almost no positive effects of wage or business income, and only minor positive effects stemming from the transfers. Unlike the previous two-year period where expenditures actually had a

positive effect, in this period expenditures had a principally negative effect on welfare that is never fully counteracted by the substitution effects. Nonetheless, the inclusion of other effects besides the expenditure effect matters for the magnitude of the net welfare affect and provides a more nuanced picture of the components of welfare change.

As reported in Section 3.1, the largest price increase observed during the crisis was for foodstuff. The next section presents a welfare analysis that concentrates on changes of foodstuff prices alone.

4.2 Effects on welfare of changed foodstuff prices

4.2.1 General effects

The aim in this section is to compute the welfare changes accounting for changes in food prices alone.

The main advantage of considering changes in food prices separately from changes in all prices is that it allows us to see how close, or far, both measures are to one another. Because complete data on consumption and expenditures profiles as well as on the respective prices is rarely available, it is common to use only food prices. In a high (food)-inflation environment, as are some of the time periods considered in this study , measures of welfare change could be decisively different when food prices are used as opposed to when all prices are considered because expenditure and income shares associated with food items vary across deciles and between rural and non-rural areas. This feature of any welfare analysis and its consequences has to be considered, particularly if the aim is to device efficient and well-targeted interventions.

For the welfare analysis which only considers food price changes, price changes in non-foodstuff commodity groups[24] are set to zero and Equation (8) is estimated again, thus replicating the

[24]See Table 1

approach taken in the literature by studies that concentrate solely on the impact of foodstuff prices (e.g. Ferreira et al. (2013); Friedman and Levinsohn (2002)).

Any income source that is not related to a food item as well as any expenditures in non-food and substitution between food and non-food items is not taken into account. Thus the only effect that remains unchanged from the previous Section is the transfer effect, which enters the welfare equation without any relationship to a price change.

As in Section above, results for the years $2006-2008$ and $2008-2010$ are presented below, both overall and disaggregated for non-rural and rural areas. Results for the years $2004-2005$ and $2005-2006$ can be found in the Appendix.

Figure 13: Net effect due to food price changes, 2006-2008

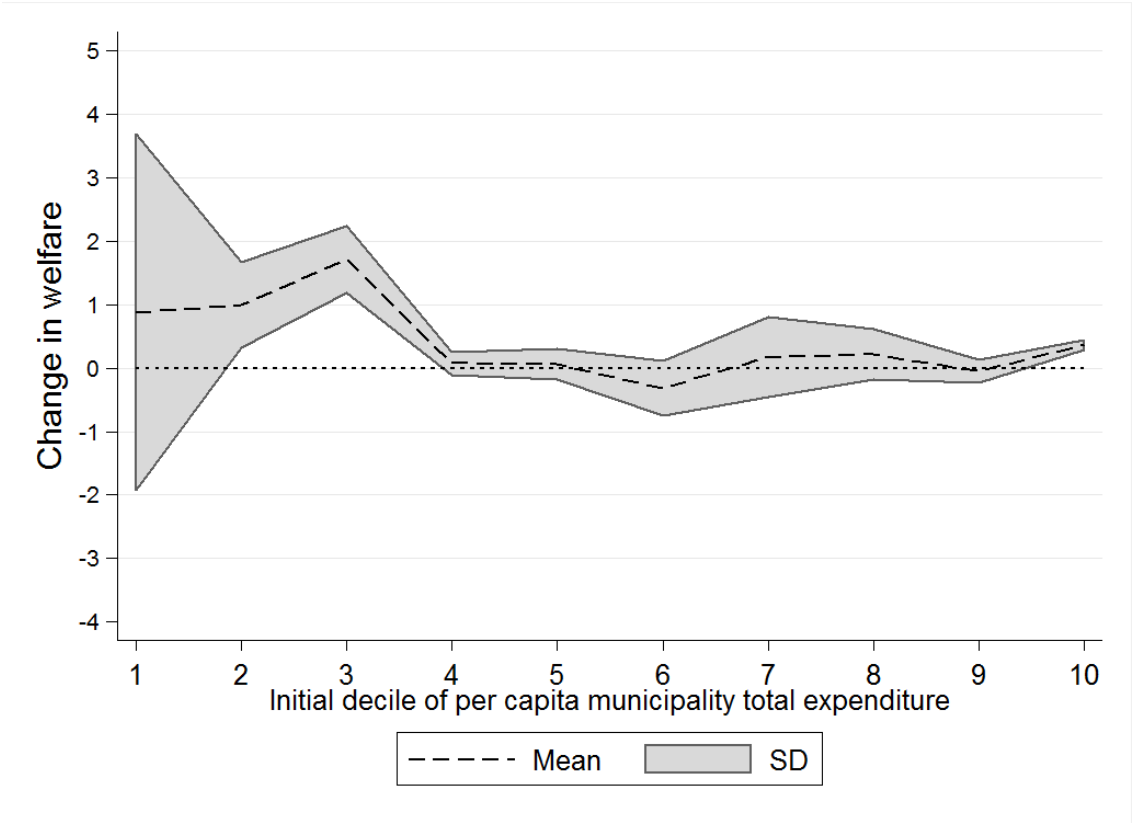
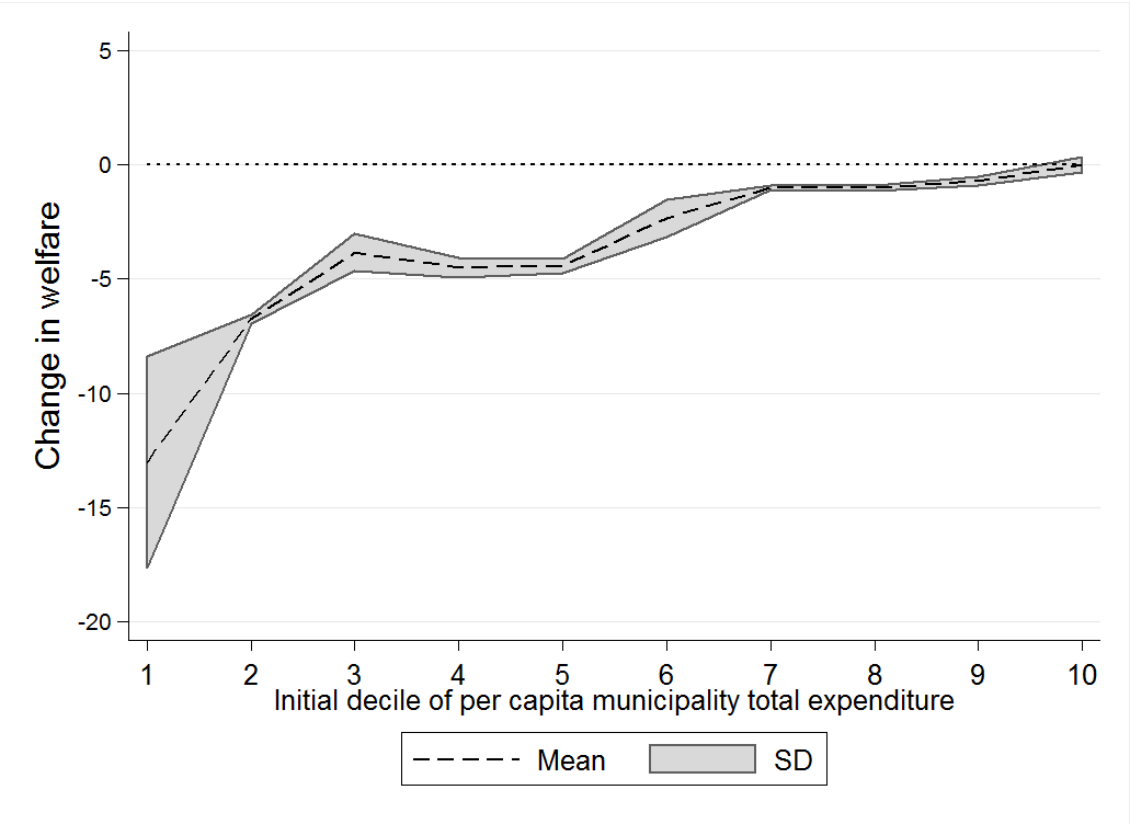


Figure 14: Net effect due to food price changes, 2008-2010



The overall results for both time periods show a smaller mean welfare change with a decisively tighter spread compared to the scenario where I consider price changes in all goods.

Food price changes contributed minimally to any welfare gains during the years $2006 - 2008$; most gains present in the analysis with all prices are gone as can be seen in Figure 13. While the mean gains reached a maximum of approximately 7% in the analysis with all prices, here it barely extends to 2%, none of the gains identified in the initial analysis are longer present: none of them are directly associated with changes in food prices.

In comparison, the mean losses identified for the $2008 - 2010$ period are still present for only food items and display a very similar behavior across deciles. Furthermore, the spread is, again, very small.

Particularly for this last period, one that was marred by high food price inflation, concentrating only on food price changes does not change much of the computed mean welfare losses. It appears that in this particular case the losses were induced almost exclusively by the high food prices.

The decomposition of the net welfare effect for the years $2006 - 2008$ and $2008 - 2010$ in Tables 11 and 12 substantiates these observations: in $2006 - 2008$ the expenditure effects that contributed largely to the positive net welfare effects observed in the previous section are absent while in $2008 - 2010$ the expenditure effects that made up a large part of the negative welfare changes remained in place, although they are largely regressive over the deciles. Of important interest appear the substitution effects in the second two-year period. As de Janvry and Sadoulet (2008) speculated, during the food price surge these effects are, in some cases, large enough to offset the negative income effects, and in some cases, larger. Moreover unlike the previous two-year period, the effect is strongest in the lower deciles and regressive, indicating that substitution is used mostly by the poor as a way of maintaining a given utility level.

Table 11: Breakdown of net effect (food prices) $2006 - 2008$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-1.52	-1.56	3.63	-0.19	0.52	0.88
2	-0.24	-0.59	1.29	0.03	0.49	0.99
3	0.05	-0.43	1.95	-0.26	0.40	1.71
4	-0.57	-0.75	0.52	0.52	0.35	0.07
5	-0.34	-0.83	0.41	0.56	0.27	0.06
6	-0.16	-0.15	-0.40	0.14	0.25	-0.32
7	-0.11	-0.65	0.70	0.07	0.17	0.17
8	0.04	-0.24	0.28	0.02	0.11	0.21
9	0.10	-0.23	0.03	-0.09	0.14	-0.05
10	-0.04	-0.10	0.28	0.11	0.11	0.37

Source: ENIGH, Banxico, author's calculations

Table 12: Breakdown of the net effect (food prices) $2008 - 2010$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-1.78	-0.53	0.67	-15.89	4.52	-13.01
2	-1.35	-0.07	1.17	-8.92	2.41	-6.76
3	-0.01	-0.12	1.46	-6.83	1.66	-3.84
4	0.03	-0.62	0.26	-5.92	1.76	-4.50
5	0.02	-1.07	-0.67	-3.24	0.55	-4.42
6	0.22	-0.44	-0.35	-2.25	0.48	-2.33
7	0.13	-0.11	0.38	-1.75	0.34	-1.01
8	-0.07	-0.30	0.28	-1.13	0.21	-1.02
9	-0.02	-0.34	0.21	-0.70	0.14	-0.70
10	0.03	0.04	0.12	-0.28	0.08	-0.00

Source: ENIGH, Banxico, author's calculations

Overall losses at the lower end of the distribution appear highly connected to food prices, more so during high food price inflation, a logical implication of their higher expenditure shares in foodstuff as depicted above in Figure 7.

The next section explores the differences in welfare effects between rural and non-rural status.

4.2.2 Rural and non-rural effects

Results for rural and non-rural areas for both time periods permit to account for the different income and expenditure profiles, although I do not expect these results to vary widely from the pooled results as most of the gains appear to stem from non-food items. Thus I would expect to see mean welfare change curves for both settings that are a downward shifted version of those where all prices are taken into account.

And so it is that welfare changes due to food price changes in this disaggregated setting (Figures 15 and 16) do not differ substantially from the non-disaggregated ones (Figures 13 and 14), but there are differences with respect to an analysis that includes the non-food items.

In the first period, $2006 - 2008$, municipalities experience almost none of the positive

expenditure effects that were reported when the non-food items were included and thus much of the positive welfare change is absent. Again, this indicates that welfare gains can be attributed to changes in non-food items. This is true for both rural and non-rural municipalities (Tables A14 and A15). Although the positive expenditure effect is lost, non-rural municipalities experience smaller negative and even positive income effects, both from wages and business, which helps to achieve the modest welfare gains. These effects originate most likely in the lower share of income generated in food related activities in non-rural areas.

During the high food inflation years, $2008 - 2010$, non-rural households appear to be more severely affected than rural ones, particularly in the lower expenditure deciles: the differences in the welfare change between deciles are smaller in the non-rural setting. This behavior is not observed in the analysis that includes non-food items, although it is difficult to estimate its economic relevance just from these Figures. An exercise on the extent of changes in poverty rates due to changes in welfare later on will provide some insight.

Figure 15: Net effect due to food price changes, 2006-2008

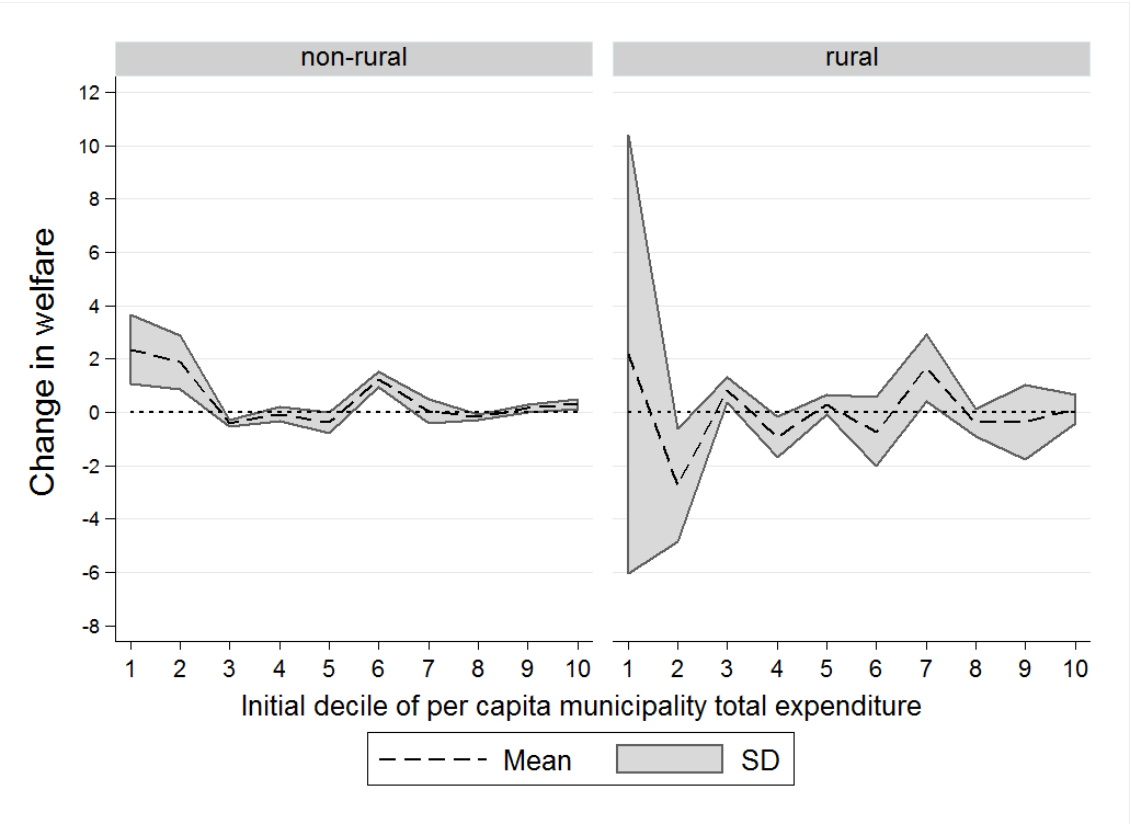
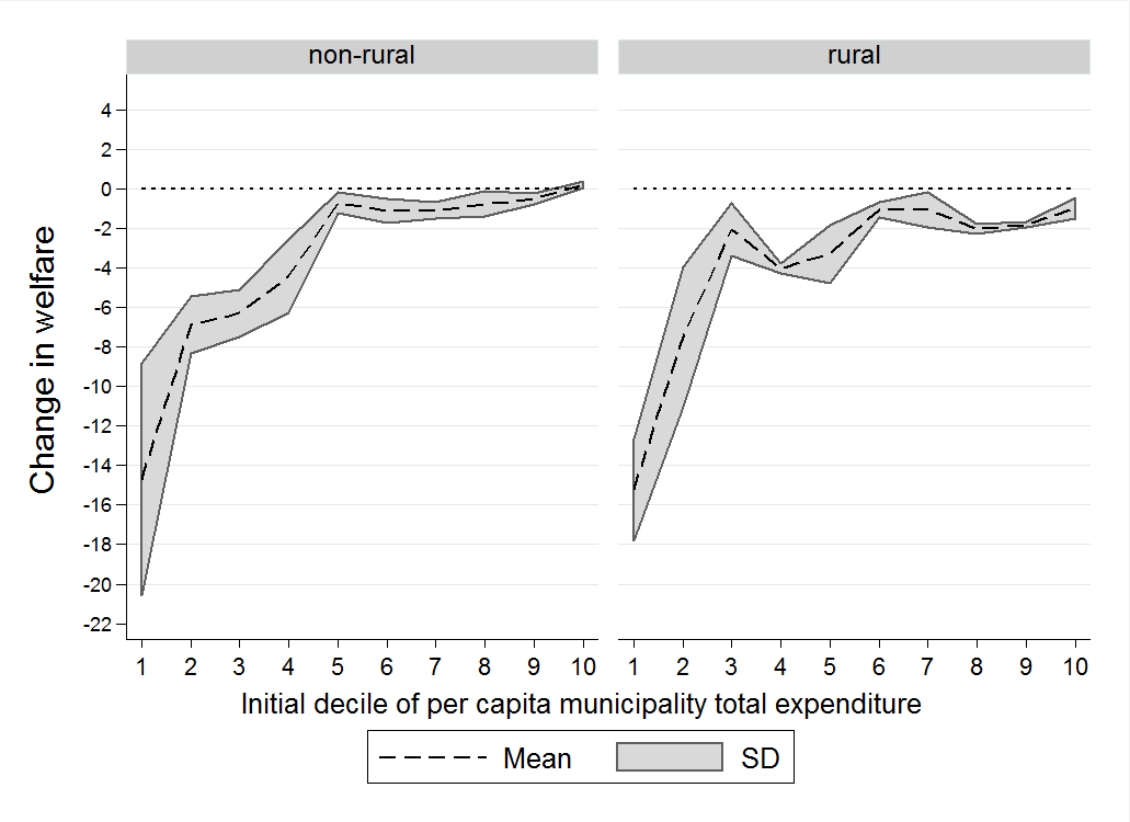


Figure 16: Net effect due to food price changes, 2008-2010



A comparison of the composition of the welfare effects with and with-out non-food items provides insight on the source of the differences in the welfare estimate between both.

As stated above, (negative) mean welfare changes for rural and non-rural municipalities are smaller when only food items are taken into account in the analysis. In the years of high food inflation, the expenditure effect is as large as its counterpart when non-food items are included, as can be seen from comparing Tables 13 and 14 with their analogs in the section above. This is particularly striking for the lower deciles in both the rural and non-rural setting, because there the effects are the largest.

Finally, the average substitution effects are particularly large in the first deciles and there is little difference between rural and non-rural. For example in the non-rural setting, the

substitution effect alone can off-set the negative income (wage and business) effect in the first five and in the non-rural in at least the first three deciles. It is also relatively large, with a relative size of approximately a fourth of the expenditure effect and significantly contributes to ameliorating the welfare change in several cases.

Table 13: Breakdown of net effect in the non-rural setting 2008 – 2010

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-2.78	2.57	1.25	-20.84	5.11	-14.68
2	0.37	-0.29	0.44	-10.64	3.24	-6.88
3	0.22	-1.49	-0.23	-6.12	1.34	-6.28
4	0.46	-1.18	-0.34	-3.71	0.38	-4.40
5	0.26	-0.01	0.51	-1.95	0.49	-0.70
6	0.11	-0.09	0.31	-1.72	0.30	-1.09
7	-0.13	-0.38	0.28	-1.05	0.21	-1.07
8	-0.05	-0.32	0.16	-0.70	0.16	-0.74
9	0.03	0.06	0.10	-0.80	0.11	-0.50
10	0.05	0.09	0.11	-0.09	0.08	0.24

Source: ENIGH, Banxico, author's calculations

Table 14: Breakdown of net effect in the rural setting 2008 – 2010

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-1.18	-1.76	-0.65	-16.08	4.44	-15.22
2	-1.40	-1.33	1.88	-10.37	3.74	-7.49
3	-0.86	-0.80	1.15	-2.82	1.30	-2.03
4	-0.39	-0.59	2.02	-6.54	1.50	-4.00
5	0.39	-0.22	1.61	-5.81	1.10	-3.27
6	-0.36	-0.52	1.24	-1.91	0.50	-1.05
7	-0.46	-0.33	0.16	-0.66	0.27	-1.02
8	-0.33	-0.16	-1.04	-0.91	0.43	-2.02
9	-0.03	-0.21	-0.60	-1.31	0.35	-1.80
10	-0.07	-0.84	0.56	-0.70	0.12	-0.94

Source: ENIGH, Banxico, author's calculations

During high inflation times, the welfare of the poor is hit the strongest, be it solely food items or not. A separate analysis of non-rural and rural municipalities indicates that there is not

much difference between both, with the negative welfare effect stemming principally from a large expenditure, low business income and negative wage income effects. This is consistent with the large media and social attention that was devoted to the so-called "Tortilla Crisis" [25].

The results also indicate that rural and non-rural areas are no different when it comes to substitution. It has been argued that rural areas would have better opportunities to substitute away from expensive food items, but this does not seem to be the case in this context.

A comparison of the welfare changes elicited by changes in all prices and one that takes into account only food prices concludes that non-food goods played an important role in generating welfare gains, but this appears to be the case only when inflation was not so high, or only at early stages of an inflation period. During a low inflation period, a welfare analysis limited to food prices overstates the losses incurred, but during a high food inflation period, such an analysis will provide quite precise measures, at least on the mean.

The results presented here only show the gains and losses at certain levels of per capita expenditure but not how the welfare changes impacted the position of each municipality in the expenditure distribution. The next section analyses the effects of price changes on poverty.

4.3 Impacts on poverty

Mexico's CONEVAL[26] reports two different monthly per capita poverty lines: the minimum nutritional line and the minimum well-being line. Both are reported for rural and non-rural areas. Using these lines and the CPI at the price station level introduced in Section 3.1, I construct real poverty lines and use them in this section to conduct a poverty assessment. Hence,I work with 92 poverty lines, 46 for rural areas and 46 for non-rural areas in accordance

[25]For example: `http://www.elmundo.es/mundodinero/2007/01/31/economia/1170261989.html`
[26]National council for the evaluation of social policy

to the number of price stations and thus of computed CPI. Summary descriptives on these lines can be found in Table A16.

The summary measures of poverty used here are the Foster-Greer-Thorbecke (FGT) measures, i.e. the poverty headcount (FGT0), the poverty gap (FGT1) and the poverty severity (FGT2) indexes (Foster et al., 1984, 2010).

To compute the impact of welfare change on poverty I adjusted the municipality level real per capita expenditures by the calculated welfare change for the case when changes in all prices are considered and alternatively for the case where only changes in food prices are considered and computed the difference to the unadjusted case. That is, I computed each poverty measure with the survey data. Then I adjusted the expenditures in each case by the amount needed to achieve the utility level of the first period in the second one. For example if the welfare change was -14.48 as computed for the first decile in the analysis for the years $2008 - 2010$ for changes in food prices (Table 13), to achieve the same level as utility in 2010 as in 2008, municipalities in this decile would need on average 114.48 of the expenditures per capita they had in 2008 in 2010. We computed the poverty measures anew with the adjusted measures and subsequently calculated the difference between the unadjusted and the adjusted ones. This was done by adjusting for the welfare change estimated when all prices are taken into account and when only food prices are allowed to changed as well as for rural and non-rural areas. The results is the comparison of poverty measures between two alternative scenarios: one with and one without the welfare consequences of the price changes. Results for the well-being lines are reported in Table 15 and those for the nutritional lines in Table A17.

Because of how the difference between poverty measures is computed, a negative difference means that the price change had a positive effect on poverty alleviation: the poverty measure after adjusting the expenditures is higher. This is only possible if the per capita expenditure

after the adjustment is lower than before, i.e. to reach the utility level of the previous period less expenditure per capita is needed, and this is the case when the net welfare effect is positive. Conversely, a positive difference in the poverty measures means that the price change had a negative effect on welfare: once I compensate for the changes incurred due to the price change the poverty measure decreases.

The differences reported in Tables 15 and A17 have to be interpreted differently for each poverty measure. The poverty headcount index, FGT0, is the share of individuals whose per capita expenditure lies below the poverty line in the total population. Hence, the reported values can be interpreted as percentage point differences in the share of poor between the two alternative scenarios. The poverty gap index, FGT1, is a measure of the distance between the expenditure per capita and the poverty line and so reports how far on average the poor are from the poverty line. An increase in this measure amounts to a deepening of the poverty, with poor individuals falling even lower below the poverty line. This measure reports the average distance from the poverty line. Because every distance is weighted equally, this measure does not provide any information regarding the expenditure distribution of the poor, that is, a transfer of income from a poor household to another that is richer (but below the poverty line) will not necessarily lead to an increase of the FGT1. A decrease in this measure can be achieved by bringing those close to the poverty line even closer without changing the position of the extreme poor. A decrease in this poverty measure can be interpreted as the change in the monetary amount needed to bring every poor individual to the poverty line, with this monetary amount being a share of the poverty line.he poverty line needed to bring every poor individual to the poverty line. The poverty severity index, FGT2, is the square of the poverty gap and so it is the sum of the weighted poverty gaps for each individual, with the weights being in proportion to the gap itself, i.e. individuals further away from the poverty line have larger weights.

Table 15: Poverty changes (well-being line)

Poverty line	Net impact of		2005	2006	2008	2010
Non-rural	All prices	FGT0	0.07	-0.11	0.34	0.24
		FGT1	0.05	-0.04	0.10	0.12
		FGT2	0.02	-0.01	0.04	0.05
	Foodstuff prices	FGT0	0.62	0.48	0.72	0.93
		FGT1	0.17	0.11	0.18	0.27
		FGT2	0.07	0.04	0.06	0.10
Rural	All prices	FGT0	0.15	-0.07	0.06	0.15
		FGT1	0.03	-0.02	-0.03	0.09
		FGT2	0.01	-0.02	-0.02	0.04
	Foodstuff prices	FGT0	0.13	0.02	0.08	0.13
		FGT1	0.03	-0.00	-0.00	0.07
		FGT2	0.01	-0.01	-0.00	0.04

Source: CONEVAL, author's calculations

Changes in the poverty measures for the well-being line are larger than those for the nutritional line, an expected result considering that the nutritional line is about 2/3 of the well-being line. During the crisis time periods of $2006-2008$ and $2008-2010$ changes in the poverty measures due to food price changes follow those due to changes in all prices more closely in rural than in non-rural areas, although this is only valid for the well-being poverty line and not for the nutritional line.

Furthermore, poverty measures for the well-being line in non-rural areas are affected to a greater extent by changes in food prices than by changes in all prices. For example, the poverty headcount between $2008-2010$ increased by 0.34 percentage points due to changes in all prices. For changes in food prices alone that figures amounts to 0.72. With a population share of 81% and a headcount ratio fo 67% for the well-being line, an increase in one percentage point in the headcount ratio in this demographic translates into approximately 9 million individuals more in poverty. The changes in food prices also increased the average distance the poor are from the poverty well-being line as well as deepened the poverty. While the

results for the FGT1 and FGT2 are small, they are considerable larger than their counterparts in rural areas.

The values in Table 15 provide valuable insight into the consequences of the unchecked price changes, particularly in the discrepancy that exists between rural and non-rural areas.

5 Conclusion

There is almost no evidence regarding the welfare effects of the food price hikes that affected Mexico over the period 2006 to 2010. The evidence that is available typically focuses just on few channels by which such price hikes can affect welfare and they typically focus only on food and neglect other goods that experienced significant price changes.

This study presented a comprehensive framework to analyze the welfare effects of prices changes. The analysis considiers income and expenditure effects and decomposes the total welfare effects in its various contributors. The study accounts for all prices but also offers a detailed analysis of what was called in the media the 'Tortilla crisis'.

The results show that changes in the prices of non-food items make up a large part of the total welfare change and more so in high inflation years, i.e. in the period $2008 - 2010$. The inclusion of non-food items in the analysis changes the results by introducing welfare gains that are unaccounted for when only food items are considered.

The comparison of an analysis with and without changes in the prices of non-food items reveals that non-rural areas, as most households there are net buyers of food, experienced larger welfare losses when only food items are considered. These results may explain the social unrest evoked by the increased tortilla prices that peaked at the beginning of 2007. Non-rural areas were the most vocal about the strain the increased prices in this staple of the Mexican diet was exerting on them, and rightly so. This study shows that the inclusion of changes in prices in non-food items contributed to welfare gains, i.e. a focus on food price changes alone clearly leads to an over estimation of the losses.

Unlike other studies, this study highlights the importance of including differentiated income as well as substitution effects. The results show that the income effects implied substantial welfare losses, particularly for the poorest deciles. Both the business as well as the wage

income effect are mostly negative and when they are positive, they are relatively small. During the years $2006 - 2008$ when food price inflation was not salient, the negative contribution of the income effects to welfare significantly off-sets part of the positive effects associate with pure price effects. This is particularly visible in the first deciles and in rural areas more generally: the pure expenditure effect leads to positive welfare changes while the total effect, i.e. including income effects leads to negative welfare changes. Such an overturning of the direction of the welfare change becomes less likely when the negative expenditure effect is relatively large, as it was the case during the high food price inflation years. Nonetheless, the estimates of the welfare changes are definitely more accurate if it is accounted for all possible channels. Particularly in lower deciles the business income effect can amount to a fourth of the expenditure effect. In fact the income effects are negative in almost all years.

The contribution of the substitution effects are also substantial. In some cases these effects are as large as a fourth of the net welfare effect. They can even completely offset negative income effects and contribute positively to the welfare change. As expected, these effects play a larger role when only food items are considered, but their relevance is only slightly reduced when prices for other items are included. These effects are also reportedly larger in the first half of the expenditure distribution and more so during the years of high food price inflation and contribute to a large extent to counter negative expenditure effects when only food prices are taken into account.

The welfare changes were contextualized with a poverty assessment. The mean welfare changes in rural and non-rural areas during times of high food inflation are very similar, with the poorest having the largest losses and the losses being larger in non-rural areas, but the poverty impact is larger in rural areas.

Although the "Tortilla Crisis" was a national phenomenon, and the reporting focused on larger urban areas, losses were almost as large for the poorest decile in the non-rural areas as

in the rural ones, with the added aggravation that the poorest decile in rural areas is closer to the poverty line than the poorest decile in non-rural areas. Thus the Tortilla Crisis had a larger poverty impact in rural areas.

In sum, the inclusion of differentiated effects provides a deeper understanding of the contributors to welfare changes as well as more precise estimates of the effects associated with the 'Tortilla crisis'. This study shows that a focus on expenditure effects alone can be very misleading; although accounting for income effects may not imply a reversal of the expenditure effect but it may at least reduce it substantially.

An important extension of this work would be the inclusion and differentiation of consumer and producer prices (de Janvry and Sadoulet, 2009), because the consumer prices will most likely skew the effects of the producers and the overall effect depending on the relative distribution of consumers and producers in the rural and non-rural areas.

Moreover, substitution between food commodities appears to play an important role in the survival strategies of the poor. A valuable extension would be the analysis of the unintended consequences of such substitution effects. It is for example possible that significant changes in the diet of the poor can have long lasting negative health effects. For instance Juarez Torres (2015) shows that the nutritional patterns of food and non-food poor individuals are different, as are their nutrient elasticities for certain products. She concludes that rising food prices in certain food commodities (cereals and vegetables) could aggravate the nutritional condition of the the most vulnerable population segments as they substitute away into items with less nutritional content.

A Appendix

A.1 The Quadratic Almost Ideal Demand System (QUAIDS)

The QUAIDS (Banks et al., 1997) is based on an indirect utility function of the form:

$$\ln V(\mathbf{p}, m) = \left[\left\{ \frac{\ln m - \ln a(\mathbf{p})}{b(\mathbf{p})} \right\}^{-1} + \lambda(\mathbf{p}) \right]^{-1}$$

Where $\ln a(\mathbf{p})$ is a translog of the form:

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_{i=1}^{k} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{k} \sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_j \tag{A.9}$$

In (A.9) p_i is the price for a good i for $i = 1 \dots k$ and $b(\mathbf{p})$ is the is the simple Cobb-Douglas price aggregator:

$$b(\mathbf{p}) = \prod_{i=1}^{k} p_i^{\beta_i}$$

and

$$\lambda(\mathbf{p}) = \sum_{i=1}^{k} \ln p_i$$

Homogeneity, symmetry and adding-up imply the following restrictions:

$$\sum_{i=1}^{k} \alpha_i = 1, \qquad \sum_{i=1}^{k} \beta_i = 0, \qquad \sum_{i=1}^{k} \gamma_i j = 0 \qquad \text{and} \qquad \gamma_{ij} = \gamma_{ji} \tag{A.10}$$

Applying Roy's Identity to A.1 and defining the expenditure share of a household as $w_i = p_i q_i / m$ we obtain the corresponding expenditure share equations system:

$$w_i = \alpha_i + \sum_{i=1}^{k} \gamma_{ij} \ln p_j + \beta_i \ln \left\{ \frac{m}{a(\mathbf{p})} \right\} + \frac{\lambda_i}{b(\mathbf{p})} \left[\ln \left\{ \frac{m}{a(\mathbf{p})} \right\} \right]^2$$

For the construction of the Slutsky matrix we are interested in the compensated price elasticites. The estimation of these occurs with use of the user written command 'quaids' for Stata© from Poi (2012), that also allows us to include demographic variables[27] and that imposes the restrictions in (A.10) automatically.

[27] Folowing Ray (1983)

A.2 Tables

Table A1: List of price stations

A-L	M-V
Acapulco de Juárez	Mérida
Aguascalientes	Mexicali
Benito Juárez	Monclova
Chetumal	Monterrey
Chihuahua	Morelia
Ciudad Acuña	Oaxaca de Juárez
Colima	San Andrés Tuxtla
Córdoba	San Francisco de Campeche
Cortázar	San Luis Potosí
Cuernavaca	Santiago de Querétaro
Culiacán Rosales	Santo Domingo Tehuantepec
Fresnillo	Tampico
Guadalajara	Tapachula de Cordova y Ordoñez
Hermosillo	Tepatitlán de Morelos
Heroica Matamoros	Tepic
Heroica Puebla de Zaragoza	Tijuana
Huatabampo	Tlaxcala de Xicohtencatl
Iguala de la Independencia	Toluca de Lerdo
Jacona de Plancarte	Torreón
Jose Mariano Jiménez	Tulancingo
Juárez	Veracruz
La Paz	Victoria de Durango
Leon de los Aldama	Villahermosa

A.2.1 Net welfare effect (all commodities)

Table A2: Breakdown of the overall effect for $2004 - 2005$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.87	-0.80	-1.76	1.01	0.77	-1.65
2	-0.68	-0.30	0.58	1.27	0.67	1.53
3	-0.73	-0.29	-0.38	0.78	0.71	0.09
4	0.97	0.55	1.06	1.01	0.87	4.47
5	-1.65	0.61	0.06	2.10	0.63	1.75
6	0.12	-0.19	-0.58	1.41	0.50	1.26
7	0.04	-0.23	-0.00	2.16	0.67	2.63
8	-0.69	-0.09	-0.00	1.52	0.74	1.48
9	0.09	-0.05	-0.03	1.09	0.63	1.72
10	0.32	0.17	0.07	0.91	0.56	2.03

Source: ENIGH, Banxico, author's calculations

Table A3: Breakdown of the overall effect for $2005 - 2006$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.66	0.09	-2.55	8.36	0.88	6.12
2	-1.55	-1.96	6.46	7.75	0.70	11.40
3	-1.16	-1.19	0.20	8.46	0.65	6.96
4	-1.02	-0.83	-0.25	7.46	0.53	5.90
5	-2.22	-0.81	-0.50	9.50	0.58	6.54
6	-1.46	-1.12	0.68	7.60	0.65	6.36
7	0.25	-0.20	0.33	7.20	0.63	8.20
8	-1.11	-0.68	0.23	8.15	0.55	7.14
9	-1.20	-0.26	0.20	6.17	0.58	5.49
10	-0.89	-0.52	0.17	6.59	0.47	5.82

Source: ENIGH, Banxico, author's calculations

Table A4: Breakdown of net effect in the non-rural setting 2004 – 2005

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	0.27	0.16	-0.09	0.27	0.65	1.26
2	-1.42	-0.05	0.62	0.48	0.71	0.33
3	0.49	0.41	0.28	2.04	0.49	3.70
4	-0.36	0.10	0.08	1.19	0.49	1.51
5	0.48	-0.33	0.05	2.00	0.84	3.04
6	-0.35	0.14	0.06	2.26	0.79	2.90
7	-0.54	-0.27	0.06	1.33	0.71	1.28
8	0.60	-0.06	-0.02	1.10	0.61	2.21
9	-0.08	-0.04	0.07	0.67	0.80	1.42
10	0.34	0.28	0.06	1.38	0.44	2.50

Source: ENIGH, Banxico, author's calculations

Table A5: Breakdown of net effect in the rural setting 2004 – 2005

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.07	-2.06	6.20	1.14	0.89	4.85
2	-1.16	-0.92	-7.35	2.21	0.80	-5.30
3	-1.10	-0.61	-0.04	1.73	0.65	0.59
4	-1.41	-1.58	2.50	1.58	0.85	1.84
5	0.75	-0.21	3.34	0.40	0.85	4.86
6	1.48	0.76	-3.06	1.68	0.73	2.20
7	0.71	0.37	-1.80	2.76	1.62	3.66
8	-2.89	0.67	4.83	1.97	0.65	3.94
9	0.65	-1.38	0.03	1.26	0.55	1.00
10	-0.15	-0.45	0.04	0.10	0.74	0.28

Source: ENIGH, Banxico, author's calculations

Table A6: Breakdown of net effect in the non-rural setting 2005 – 2006

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-1.11	-2.60	1.01	9.92	0.55	7.77
2	-1.41	-0.54	0.36	7.16	0.57	6.12
3	-1.05	-1.29	-0.35	8.39	0.65	6.35
4	-1.78	-1.22	-0.21	10.21	0.65	7.66
5	-2.02	-0.58	0.14	4.94	0.65	3.14
6	-1.17	-0.54	0.44	7.30	0.68	6.71
7	-0.90	-0.45	0.26	8.82	0.65	8.37
8	-1.15	-0.31	0.20	5.01	0.49	4.24
9	-1.41	-0.17	0.17	5.94	0.62	5.15
10	0.06	-0.51	0.19	6.91	0.42	7.07

Source: ENIGH, Banxico, author's calculations

Table A7: Breakdown of net effect in the rural setting 2005 – 2006

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-2.08	2.17	-9.21	10.01	0.56	2.48
2	-0.39	-3.04	-0.27	5.49	1.14	2.98
3	0.27	-1.23	6.25	6.42	0.85	12.56
4	-0.31	-1.73	2.24	9.00	0.78	9.77
5	-0.80	-1.01	0.90	7.46	0.82	7.21
6	-1.23	-1.61	0.06	8.40	0.49	6.12
7	-2.58	-0.55	0.06	9.01	0.44	6.38
8	-1.36	-0.99	-0.12	8.72	0.55	6.82
9	0.42	-0.83	-0.96	9.31	0.80	8.82
10	-0.19	-0.25	0.54	8.92	0.80	9.77

Source: ENIGH, Banxico, author's calculations

A.2.2 Net welfare effect (foodstuff)

Table A8: Breakdown of the overall effect for 2004 – 2005 (Food prices)

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.29	-0.59	3.18	-0.82	0.35	1.84
2	0.19	-0.16	2.10	-0.26	0.28	2.15
3	0.25	-0.09	0.76	-0.28	0.31	0.95
4	0.08	0.40	0.44	-0.29	0.26	0.89
5	-0.13	0.31	1.38	-0.47	0.23	1.33
6	0.37	-0.38	0.43	-0.59	0.23	0.06
7	0.18	-0.14	0.33	-0.24	0.19	0.32
8	-0.17	0.07	0.27	-0.36	0.13	-0.04
9	0.04	0.03	-0.08	-0.51	0.14	-0.39
10	0.03	0.24	0.02	-0.31	0.09	0.07

Source: ENIGH, Banxico, author's calculations

Table A9: Breakdown of the overall effect for 2005 – 2006 (Food prices)

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	0.30	0.25	-2.56	3.55	0.50	2.05
2	0.20	-0.79	1.67	3.24	0.41	4.72
3	-0.21	-0.55	0.79	3.53	0.37	3.94
4	-0.34	-0.29	-0.02	3.22	0.29	2.86
5	-0.02	-0.09	-0.54	3.31	0.28	2.94
6	0.05	-0.27	0.08	3.12	0.26	3.24
7	-0.08	-0.41	0.21	2.72	0.21	2.65
8	-0.09	-0.14	0.44	2.29	0.17	2.67
9	-0.06	-0.17	0.19	1.74	0.15	1.85
10	-0.06	0.08	0.03	1.34	0.11	1.50

Source: ENIGH, Banxico, author's calculations

Table A10: Breakdown of net effect in the non-rural setting (Food prices) 2004 – 2005

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.17	0.55	-0.38	-0.79	0.25	-0.54
2	-0.13	0.03	0.27	-0.62	0.27	-0.19
3	-0.12	0.28	0.55	-0.68	0.23	0.27
4	0.00	0.09	0.16	-0.62	0.20	-0.17
5	0.05	0.04	0.03	-0.29	0.18	0.01
6	0.04	0.15	0.05	-0.20	0.16	0.19
7	-0.01	0.06	0.25	-0.36	0.13	0.07
8	0.06	0.04	-0.04	-0.46	0.13	-0.27
9	0.07	0.06	-0.07	-0.33	0.12	-0.15
10	0.02	0.36	0.10	-0.31	0.07	0.23

Source: ENIGH, Banxico, author's calculations

Table A11: Breakdown of net effect in the rural setting (Food prices) 2004 – 2005

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.20	-1.12	5.20	-1.07	0.39	3.22
2	-0.14	-0.31	2.61	-0.36	0.32	2.13
3	-0.30	-0.64	2.23	-0.05	0.25	1.50
4	0.51	-1.00	3.47	-0.18	0.32	3.11
5	0.78	0.02	1.87	-0.04	0.34	2.96
6	0.38	0.67	0.27	0.02	0.28	1.62
7	0.04	0.49	1.04	0.10	0.26	1.93
8	0.13	0.19	1.92	-0.29	0.26	2.20
9	0.65	-1.09	1.51	-0.55	0.28	0.80
10	-0.31	-0.40	0.50	-0.64	0.19	-0.66

Source: ENIGH, Banxico, author's calculations

Table A12: Breakdown of net effect in the non-rural setting (Food prices) $2005 - 2006$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-0.17	0.05	1.38	4.28	0.45	5.99
2	-0.21	-0.16	0.63	3.14	0.34	3.74
3	-0.17	-0.18	0.05	3.12	0.30	3.12
4	-0.16	-0.28	0.39	3.37	0.28	3.60
5	-0.23	-0.17	0.39	2.78	0.22	2.98
6	-0.21	-0.20	0.36	2.60	0.20	2.75
7	-0.13	-0.11	0.28	2.23	0.16	2.43
8	-0.08	-0.02	0.21	1.75	0.15	2.01
9	-0.09	-0.01	0.05	1.66	0.14	1.76
10	-0.07	0.10	0.03	1.27	0.11	1.43

Source: ENIGH, Banxico, author's calculations

Table A13: Breakdown of net effect in the rural setting (Food prices) $2005 - 2006$

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	0.99	0.55	-4.02	2.85	0.55	0.91
2	-0.16	-0.55	-1.82	3.48	0.44	1.39
3	0.13	-0.79	1.23	3.06	0.43	4.06
4	0.44	-1.29	2.19	3.17	0.40	4.91
5	0.04	-0.61	1.17	3.27	0.38	4.25
6	-0.40	-0.74	-0.17	3.72	0.32	2.74
7	-0.33	-0.18	-1.11	3.45	0.25	2.08
8	0.23	-0.03	-0.84	3.32	0.25	2.92
9	0.50	-0.61	-0.59	2.90	0.24	2.44
10	0.15	-0.58	0.46	1.76	0.14	1.93

Source: ENIGH, Banxico, author's calculations

Table A14: Breakdown of net effect in the non-rural setting 2006 – 2008

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	0.34	-1.29	2.27	0.59	0.45	2.36
2	0.18	-1.01	1.54	0.78	0.39	1.88
3	-0.34	-1.44	0.99	0.05	0.34	-0.40
4	-0.27	-0.32	0.68	-0.40	0.25	-0.07
5	-0.20	-0.37	0.20	-0.26	0.24	-0.39
6	0.28	0.06	0.52	0.31	0.07	1.24
7	-0.04	-0.18	0.06	0.12	0.07	0.04
8	0.14	-0.33	-0.05	-0.11	0.18	-0.18
9	0.10	-0.15	0.06	0.01	0.13	0.15
10	-0.10	-0.11	0.33	0.08	0.12	0.31

Source: ENIGH, Banxico, author's calculations

Table A15: Breakdown of net effect in the rural setting 2006 – 2008

Decile	**Effect**					
	Wage income (ρ_w)	Business income (ρ_θ)	Transfers (ρ_t)	Expenditures ($-\rho_e$)	Substitution ($-\rho_s$)	Overall (db)
1	-2.15	-2.75	6.51	-0.02	0.60	2.18
2	-1.17	-0.81	-1.98	0.68	0.55	-2.73
3	-1.19	0.83	0.98	-0.28	0.50	0.84
4	-0.28	-0.53	0.82	-1.36	0.43	-0.93
5	-0.31	0.09	1.98	-1.89	0.41	0.28
6	-1.02	-0.33	-0.39	0.65	0.36	-0.73
7	-0.42	-0.45	0.69	1.60	0.25	1.67
8	-0.21	0.04	-1.54	1.11	0.22	-0.39
9	-0.24	-1.08	0.16	0.56	0.24	-0.36
10	-0.13	-0.46	0.94	-0.37	0.14	0.12

Source: ENIGH, Banxico, author's calculations

A.2.3 Poverty lines and poverty dynamics

Table A16: Real monthly per capita poverty lines

Year	Rural				Non-rural			
	Nutritional	SD	Well-being	SD	Nutritional	SD	Well-being	SD
2004	482.3	9.9	1,004.3	20.6	698.3	14.3	1,637.2	33.6
2005	566.3	18.5	1,138.7	37.3	809.1	26.5	1,835.3	60.1
2006	623.2	47.4	1,279.5	97.3	904.4	68.8	2,080.0	158.1
2008	929.6	269.3	1,819.6	527.1	1,324.2	383.6	2,908.1	842.4
2010	1,066.8	133.0	2,076.9	258.9	1,527.0	190.3	3,310.0	412.6

Source: CONEVAL (National Council for the Evaluation of Social Policy), author's calculations

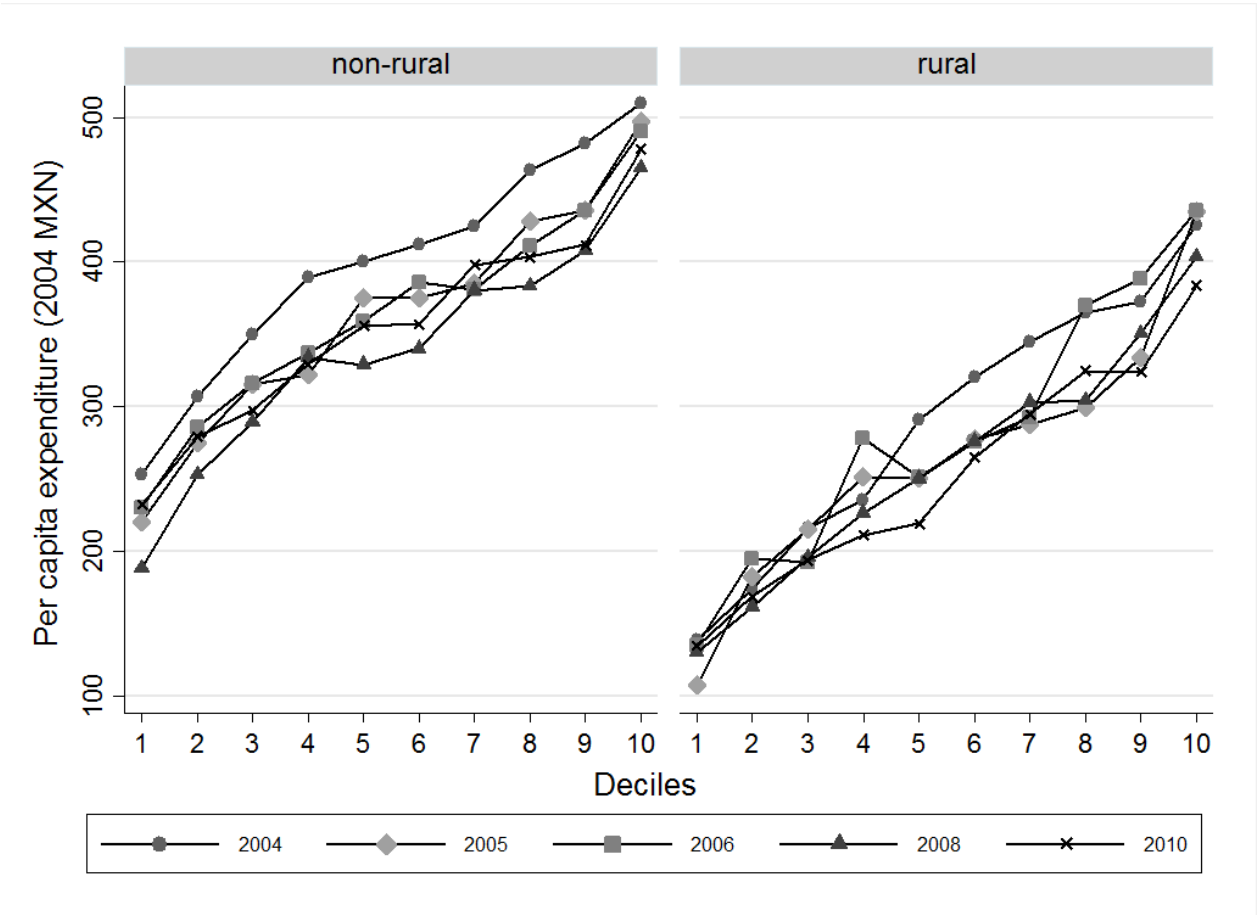
Table A17: Poverty changes (nutritional line)

Poverty line	Net impact of		2005	2006	2008	2010
Non-rural	All prices	FGT0	0.03	0.00	0.02	0.03
		FGT1	0.00	-0.00	0.00	0.00
		FGT2	0.00	-0.00	0.00	0.00
	Foodstuff prices	FGT0	0.02	-0.00	0.02	0.04
		FGT1	0.00	-0.00	0.00	0.01
		FGT2	0.00	-0.00	0.00	0.00
Rural	All prices	FGT0	0.02	-0.03	0.02	0.08
		FGT1	-0.00	-0.01	-0.01	0.02
		FGT2	-0.01	-0.01	-0.00	0.01
	Foodstuff prices	FGT0	0.02	-0.01	0.03	0.07
		FGT1	0.00	-0.00	0.00	0.02
		FGT2	-0.00	-0.00	-0.00	0.01

Source: CONEVAL, author's calculations

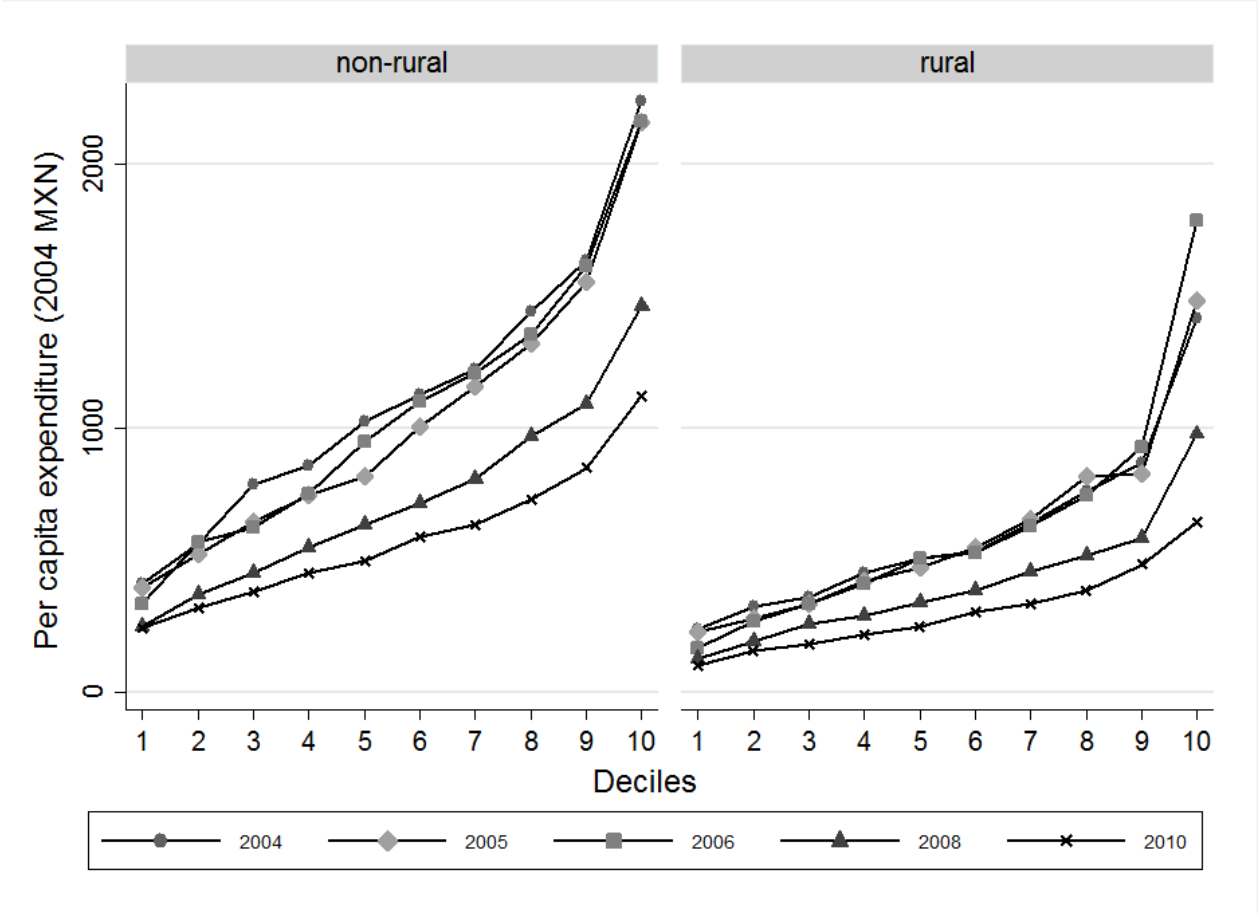
A.3 Graphs

Figure A1: Per capita food expenditures



Notes: Deciles were computed separately for rural and non-rural municipalities.

Figure A2: Per capita non-food expenditures



Notes: Deciles were computed separately for rural and non-rural municipalities.

Figure A3: Expenditure shares (2004)

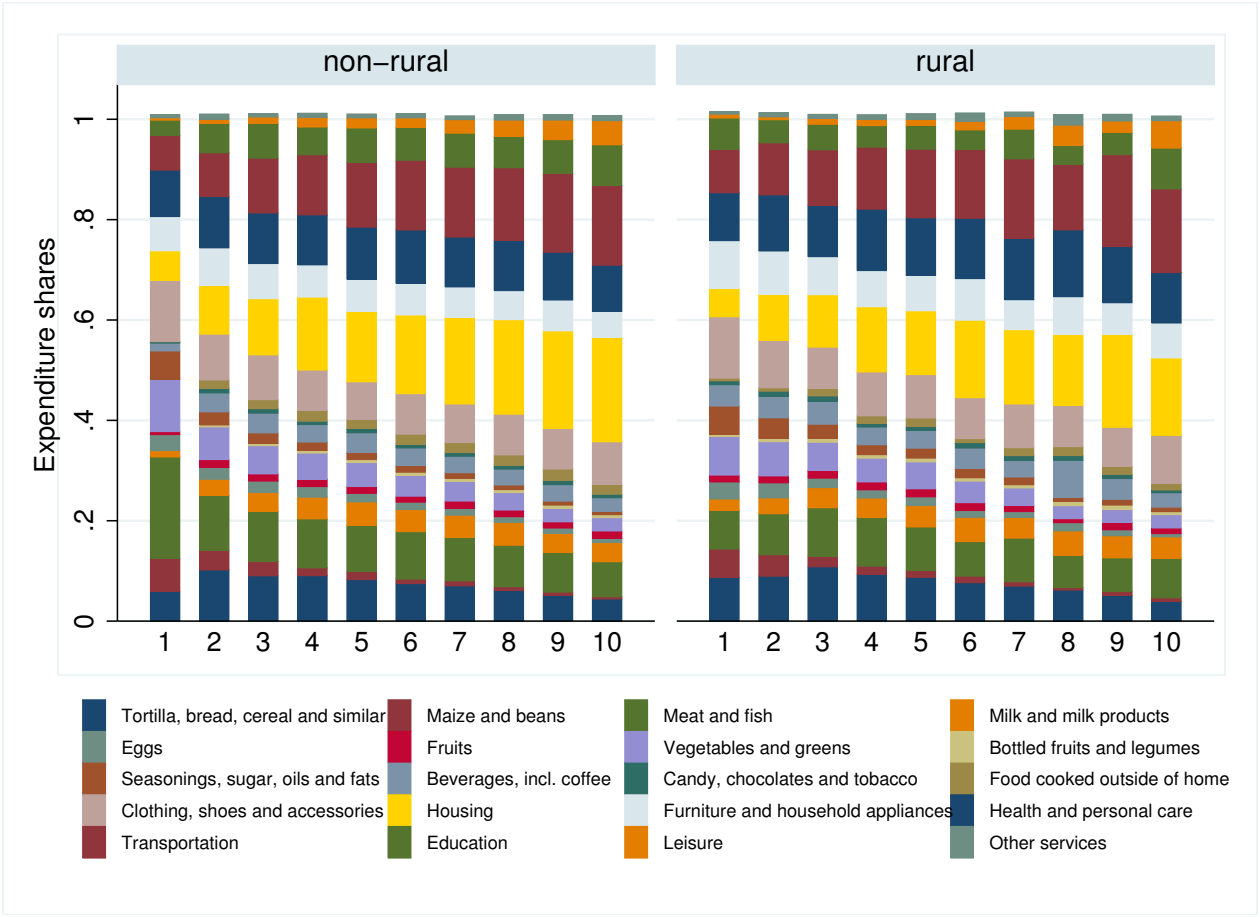


Figure A4: Expenditure shares (2005)

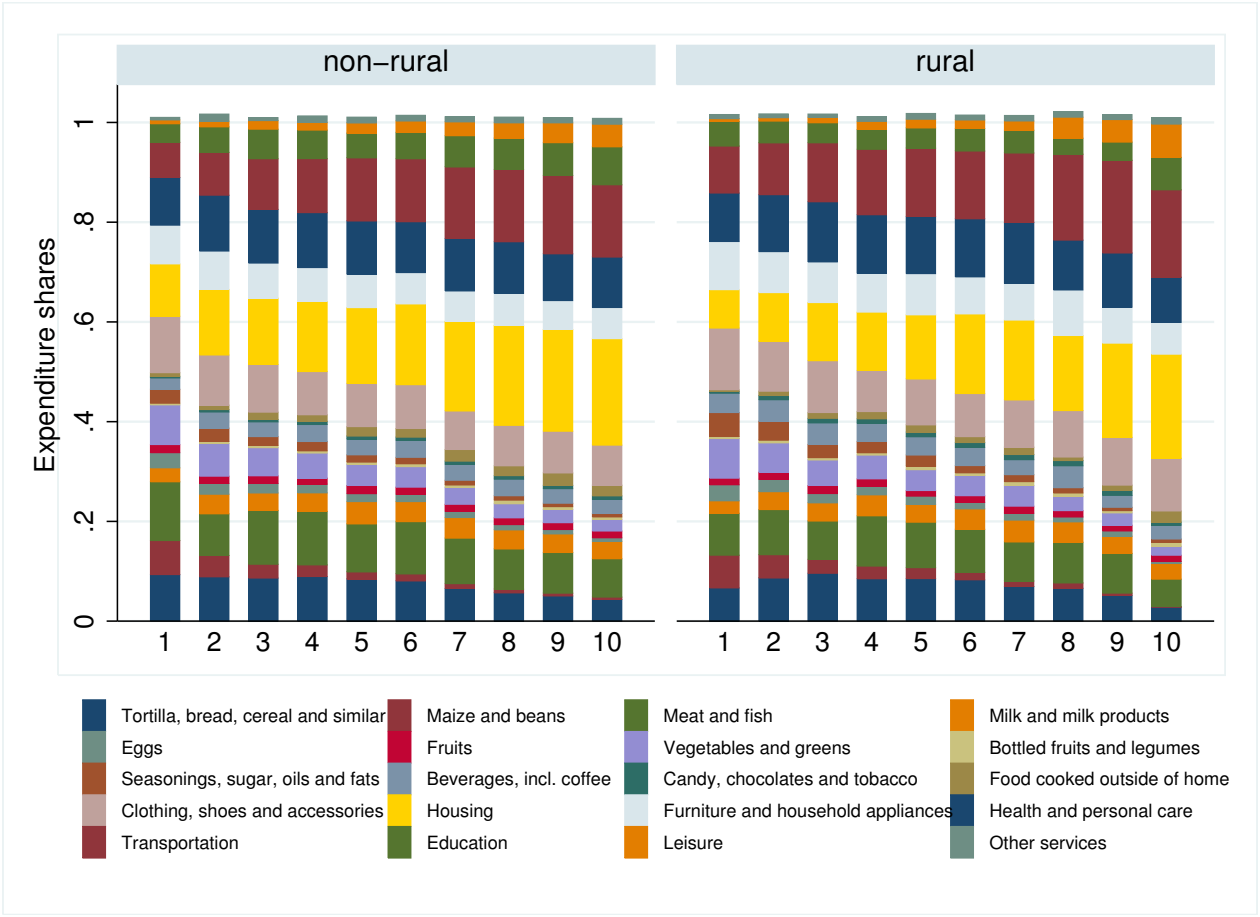


Figure A5: Expenditure shares (2006)

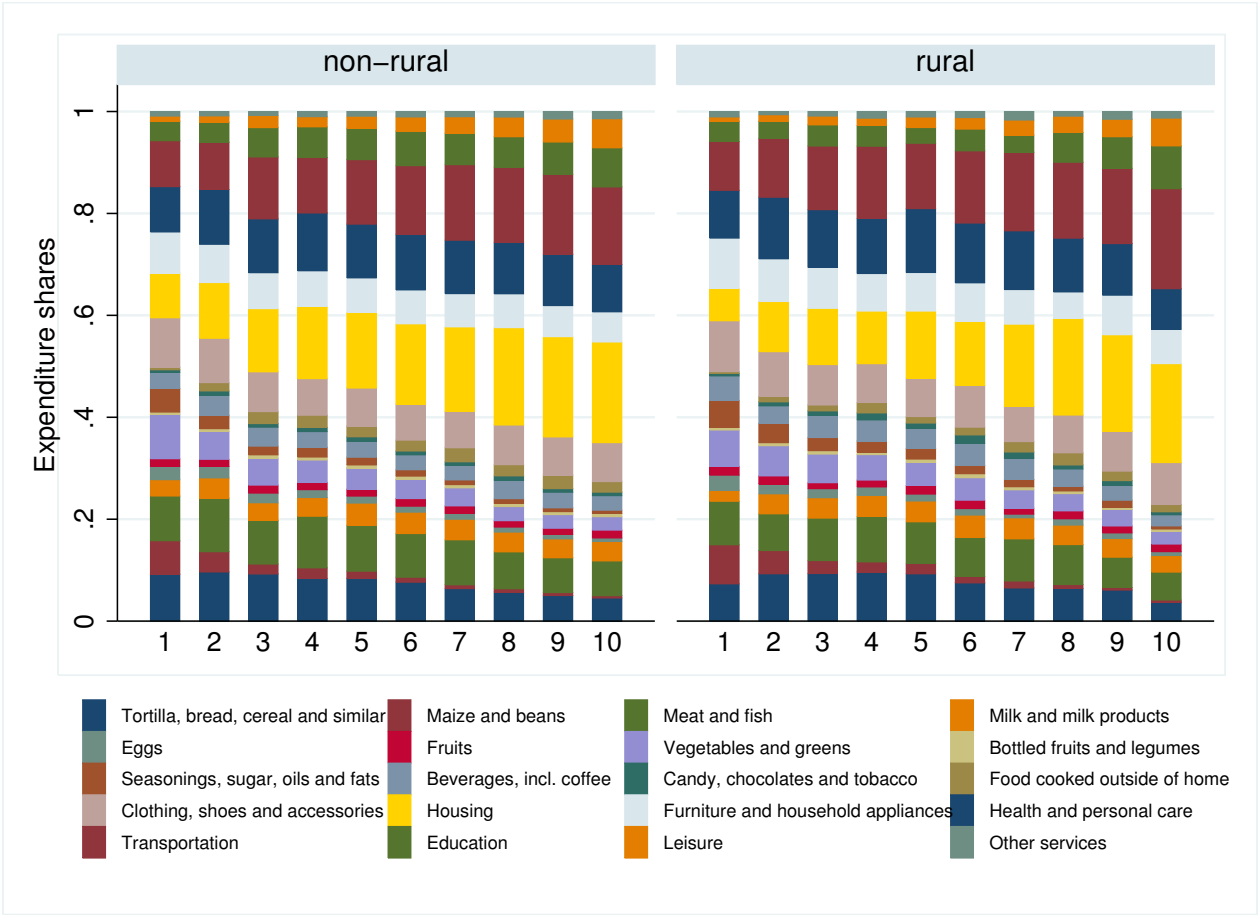


Figure A6: Expenditure shares (2008)

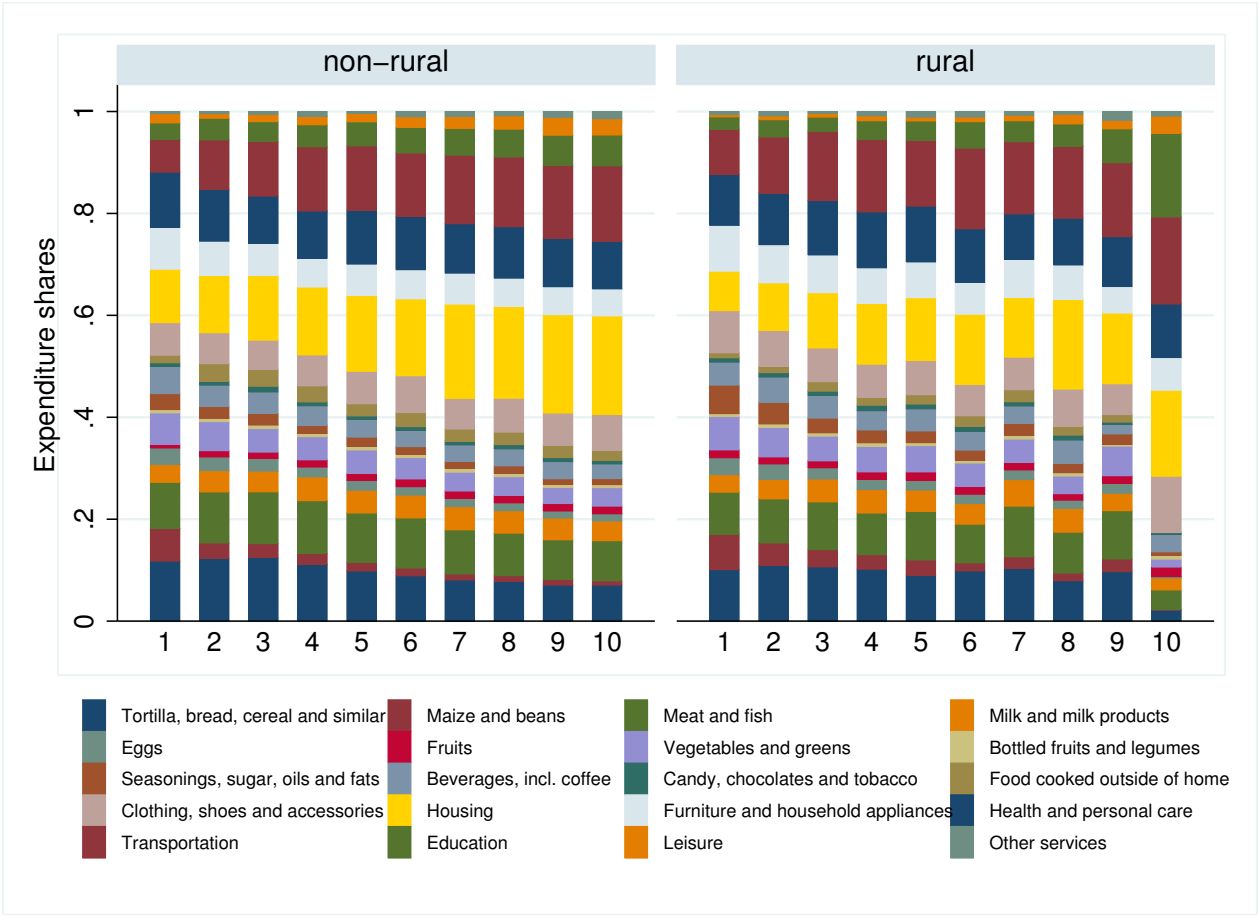


Figure A7: Expenditure shares (2010)

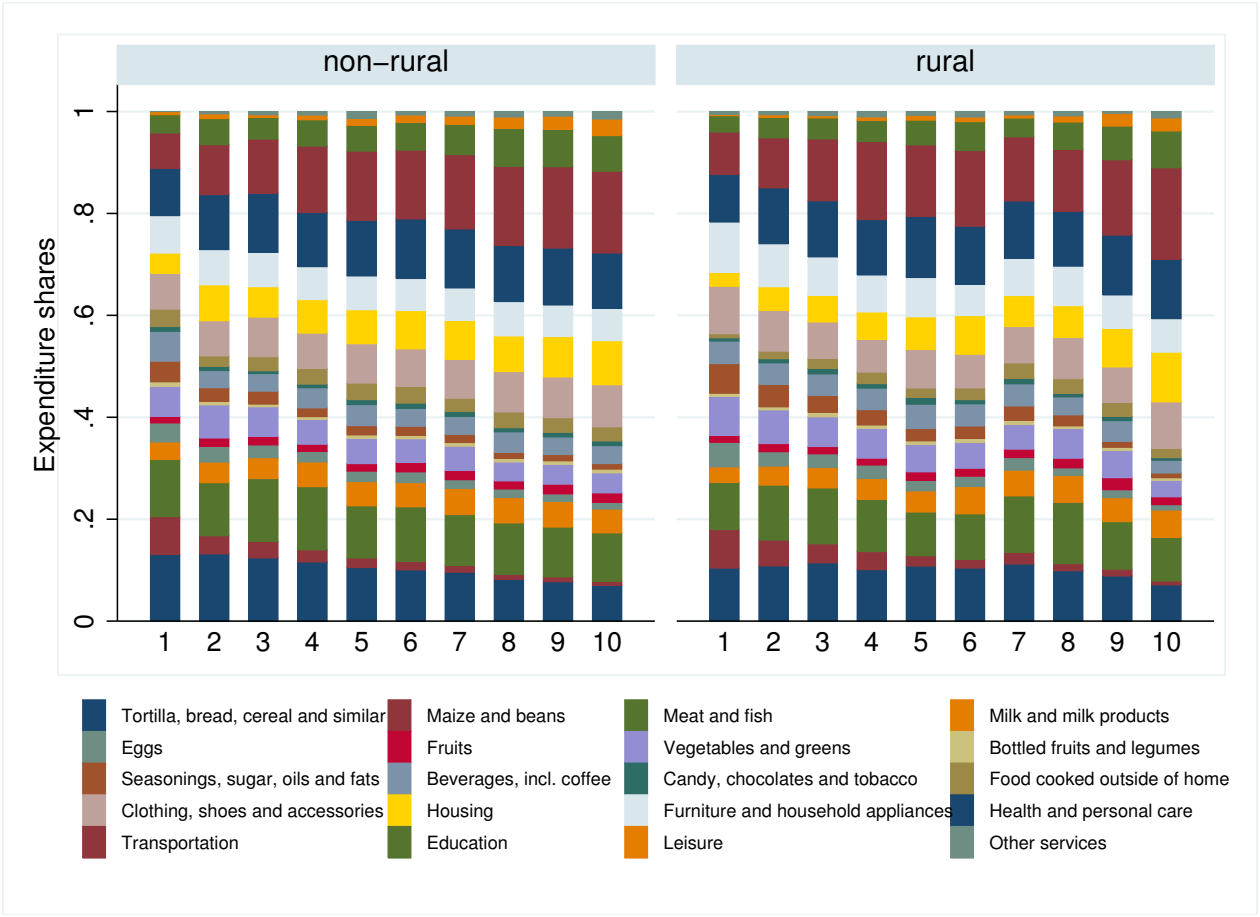


Figure A8: Net effect due to overall price changes, 2004-2005

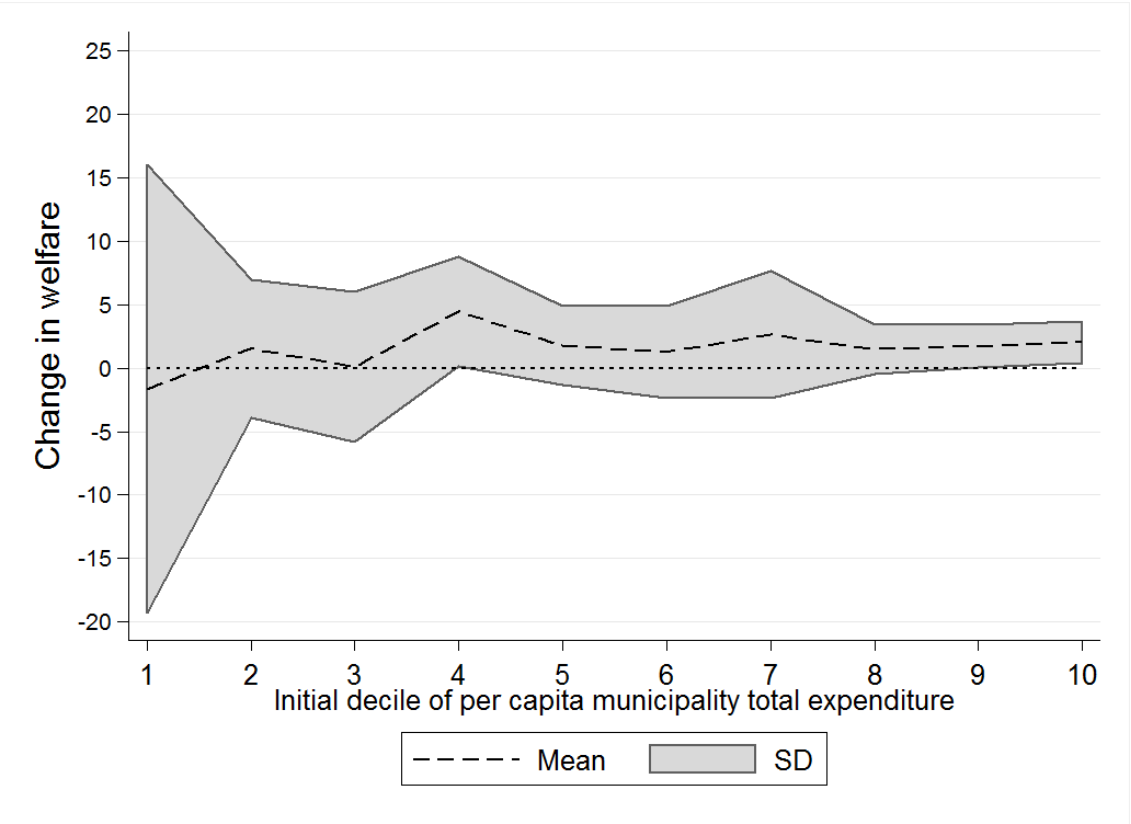


Figure A9: Net effect due to overall price changes, 2005-2006

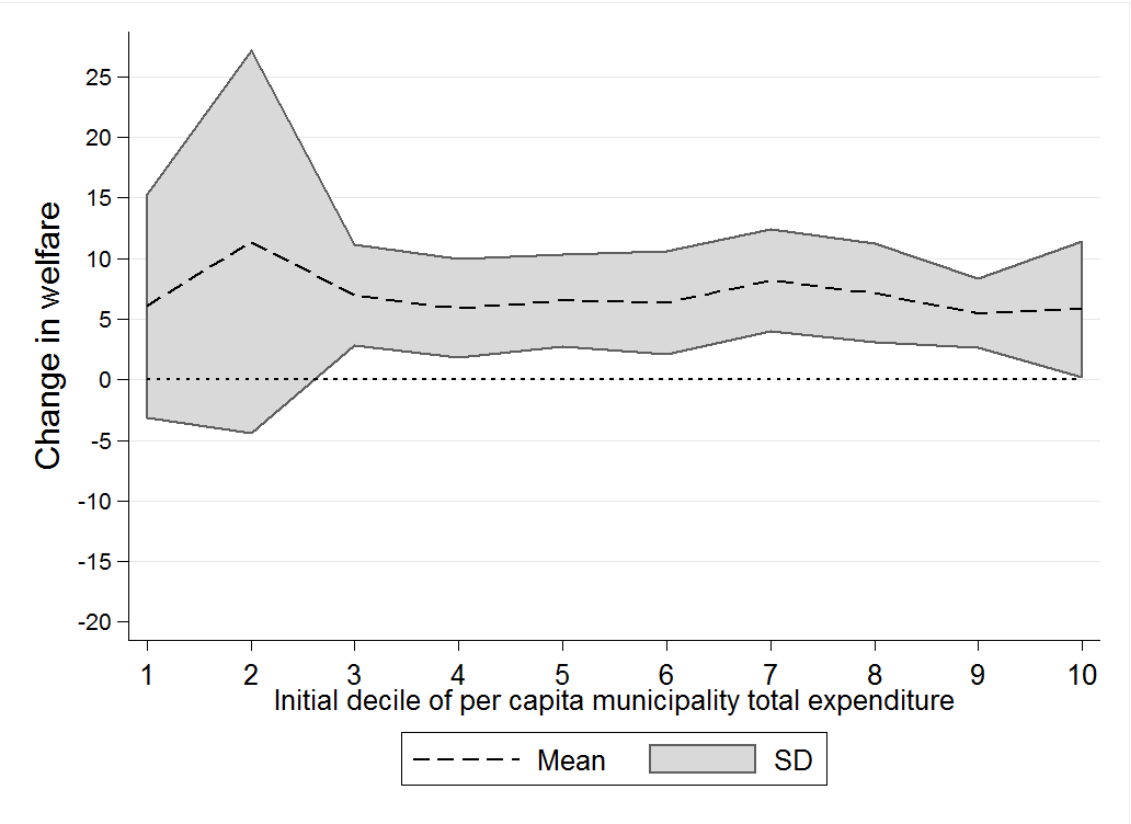


Figure A10: Net effect due to overall price changes, 2004-2005

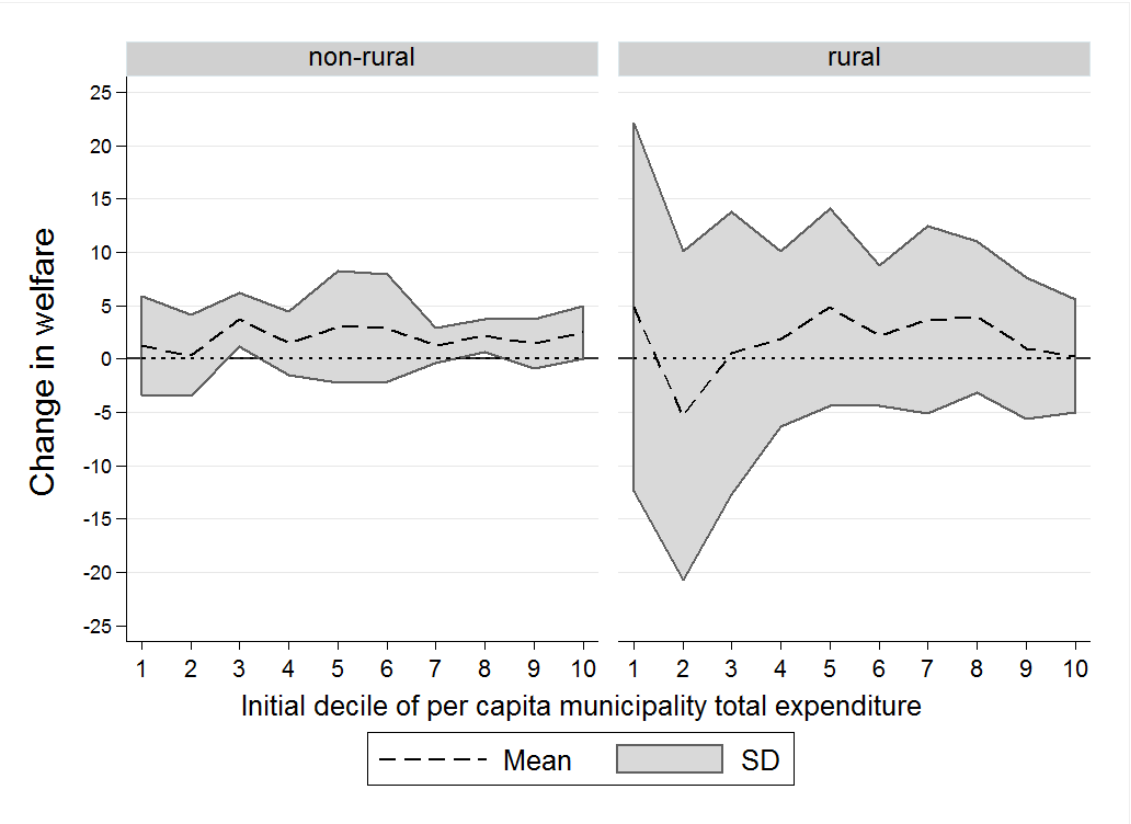


Figure A11: Net effect due to overall price changes, 2005-2006

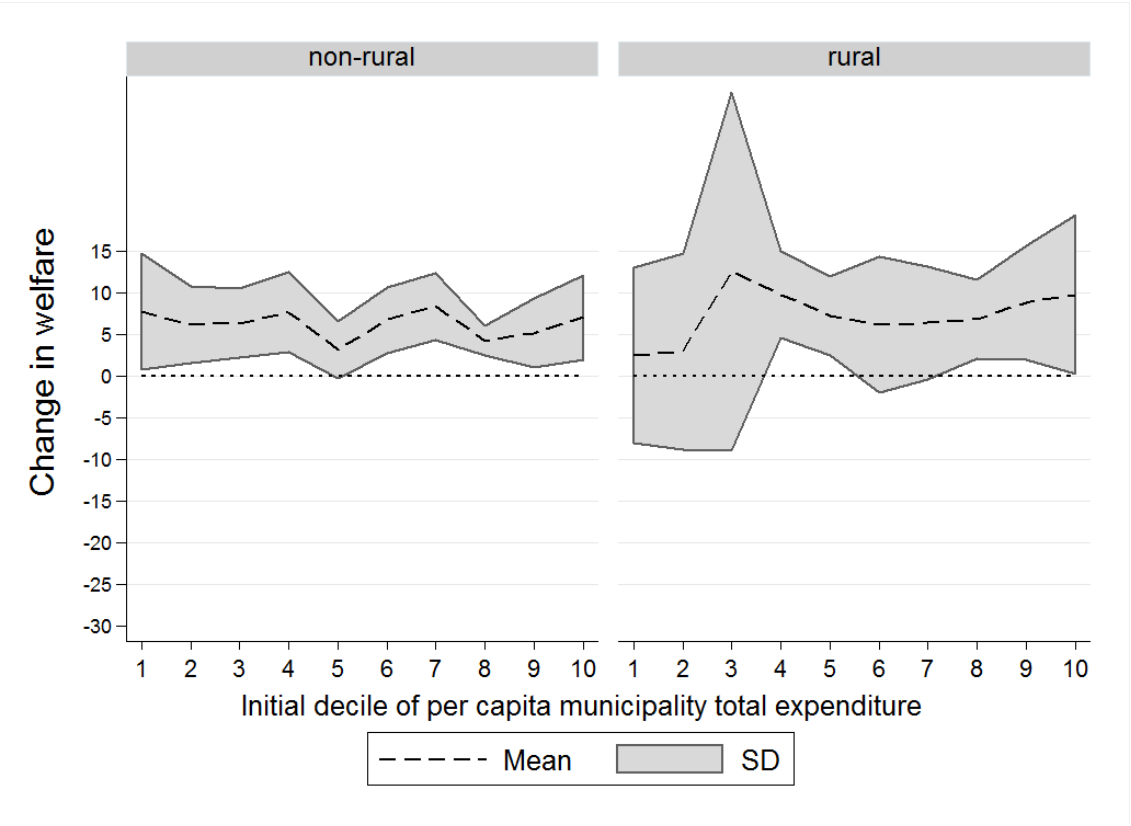


Figure A12: Net effect due to food price changes, 2004-2005

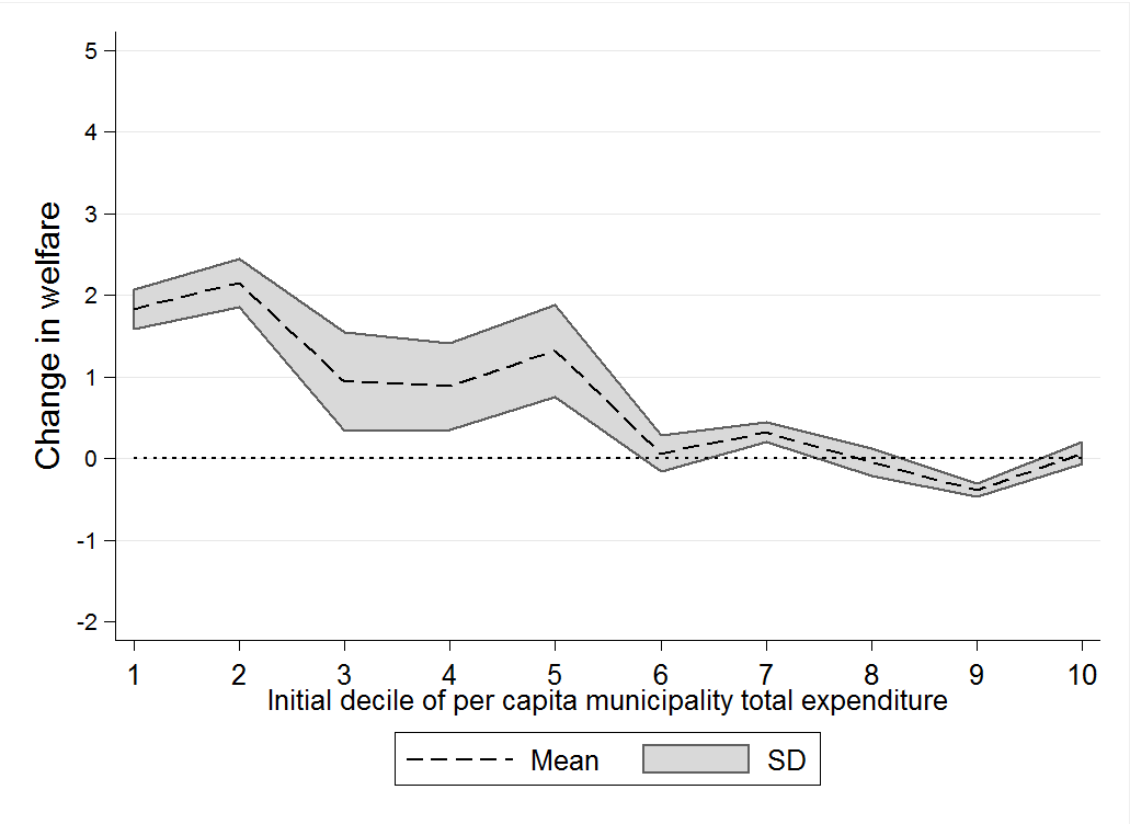


Figure A13: Net effect due to food price changes, 2005-2006

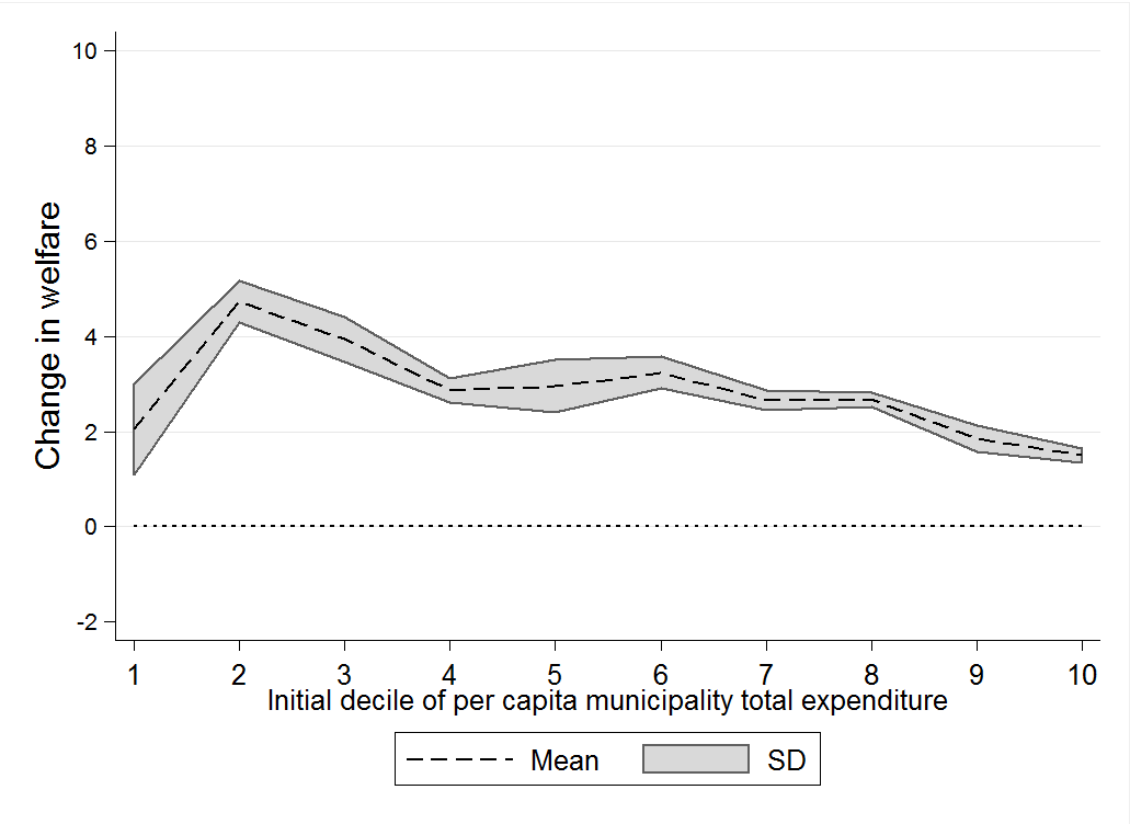


Figure A14: Net effect due to food price changes, 2004-2005

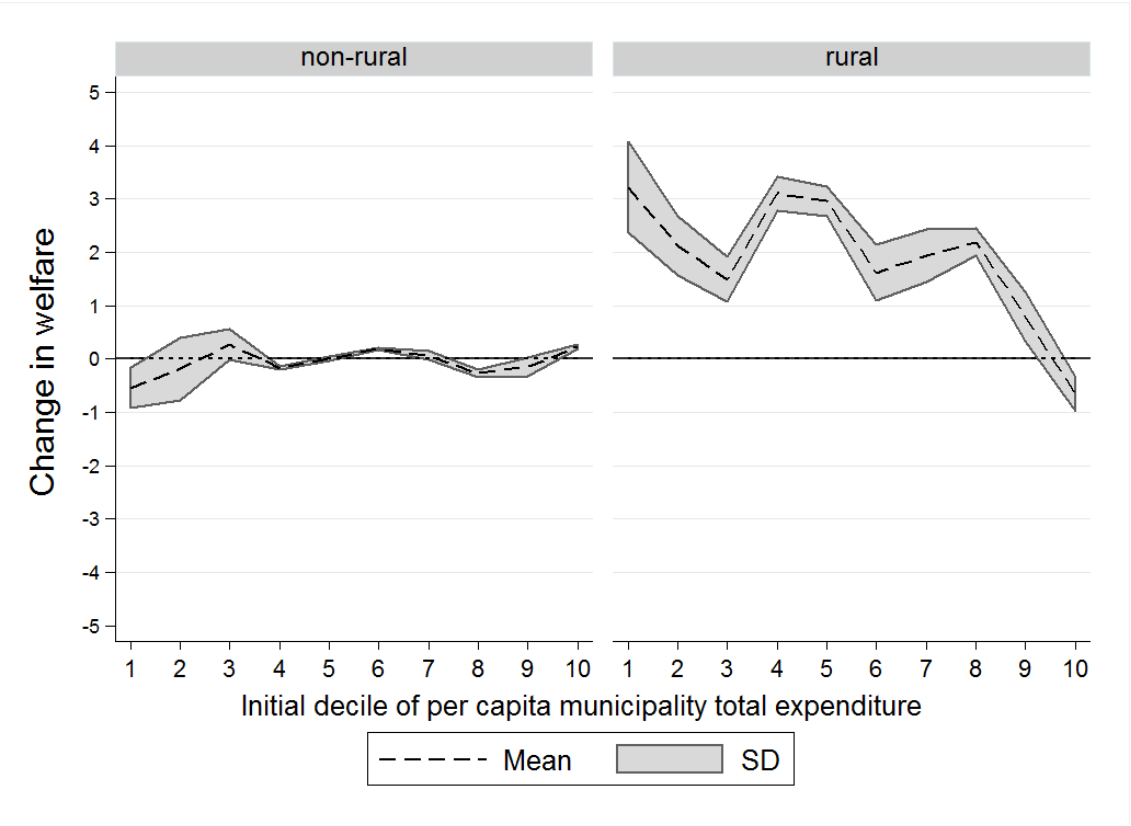
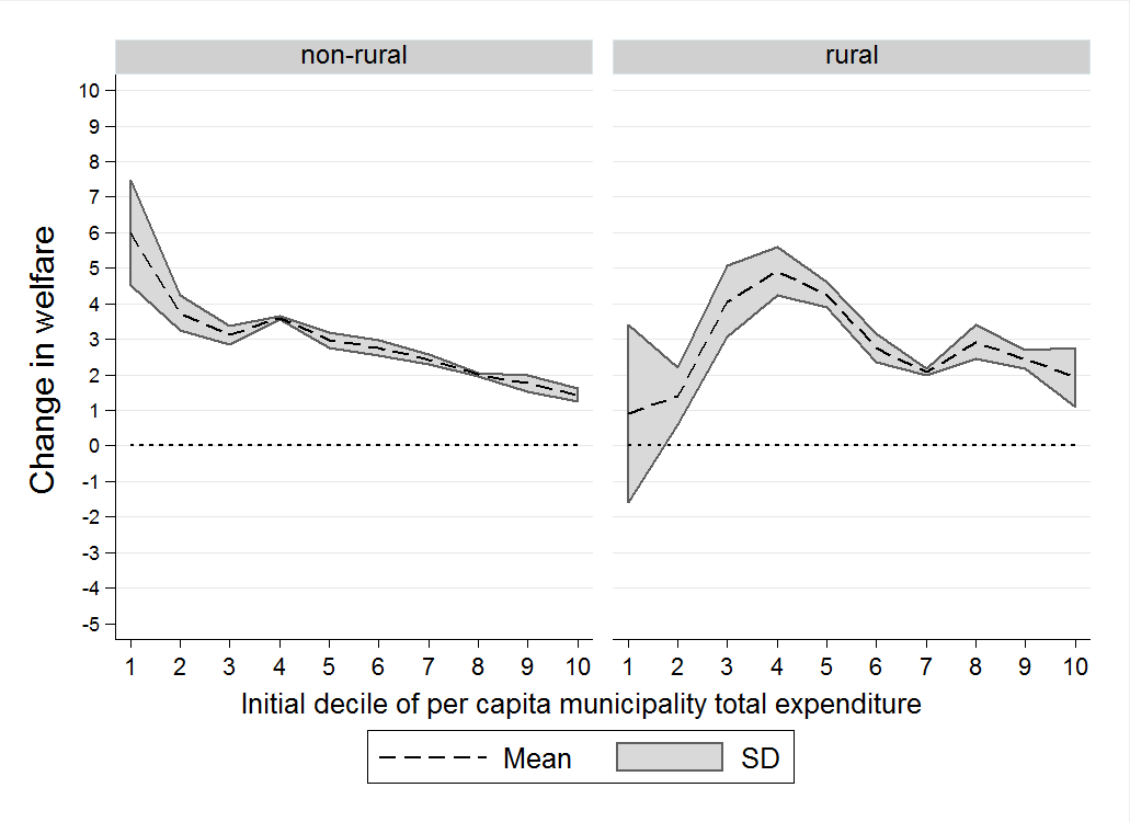


Figure A15: Net effect due to food price changes, 2005-2006



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