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Rising Food Prices and Household Welfare: Evidence from Brazil in 2008

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1. Introduction

Between 2005 and 2008, driven by rapidly rising demand during a global economic expansion, the world prices of many staple food commodities rose substantially.[2] Rice prices rose by 25 percent, wheat prices by 70 percent, maize prices by 80 percent, and dairy prices by 90 percent (Ivanic and Martin, 2008). Price increases of this magnitude for basic foodstuffs, over a relatively short period, led to widespread concern about possible impacts on hunger and deprivation. A number of governments, including those of India and Vietnam, resorted to export restrictions in order to guarantee domestic supply, while international organizations fretted about possible reversals and delays in meeting the first Millennium Development Goal, related to the eradication of hunger and extreme poverty.[3]

After falling during the "Great Recession" of 2008-2009, international food prices resumed their upward trend in mid-2009. The increase accelerated in late 2010, with the World Bank food price index rising by 15% between October 2010 and January 2011, to a level just 3% below its previous (2008) peak. Some international agencies began to describe the prevalence of higher average levels *and* volatility for world food prices as the "new normal" (World Bank, 2011).

But it has also been argued that the present concern with the effect of higher food prices on household well-being may be fundamentally misguided, because it tends to ignore or underplay income gains to farmers or farm workers, who are numerous among the poor in many developing countries. As Swinnen (2010) notes, this represents a striking reversal in the mainstream opinion among development economists: "Only a few years ago the widely shared view was that low food prices were a curse to developing countries and the poor. However, since 2008 the vast majority of analyses and reports state that high food prices have a devastating effect on developing countries and the world's poor" (p.30). As he suggests: "This reversal of opinion […] raises questions about the correctness of [both] old and new arguments, and about the proposed remedies" (p.3).

Food price increases represent a positive terms-of-trade shock for net food-exporting countries and hence an aggregate income gain. Argentina and Brazil, for example, were net food exporters in

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[2] A yet unresolved debate remains as to the relative contributions of various different demand factors: rising food consumption in emerging Asia, competing demand for crops from biofuel production, and even financial speculation on commodity futures markets.

[3] See e.g. United Nations (2008).

2008 to the tune of U$28.7 and U$64.3 billion respectively (13.1% and 5.7 % of GDP). These aggregate income gains must accrue to households within these countries. Are they correctly captured by empirical analyses of the impacts of rising food prices on household welfare?

As reviewed in Section 2 below, most research on this question seeks to account for the positive effect of rising prices on the income side by measuring not only the food a household consumes, but also the food it produces. This allows researchers to distinguish between net producers and net consumers of food, and to treat price increases as welfare-reducing on the expenditure side, but welfare-increasing on the production or income side.

While this research strategy is appropriate for agricultural sectors dominated by subsistence or family farming, it is likely insufficient in countries with modern agricultural sectors - such as Argentina, Brazil, Uruguay (or indeed the United States) – where most agricultural workers are on wage contracts, rather than family farmers or sharecroppers. Although they work in agriculture, they too are net food buyers. In these predominantly wage-based agricultural sectors, an exclusive reliance on net food purchases for estimating welfare impacts is likely to prove wide of the mark. It would ignore, for example, any effect of higher prices on the wages received by agricultural workers. In a competitive market for farm labor, for example, rising farm-gate prices would raise the marginal revenue product of labor, and hence either wages, employment levels, or both (depending on the elasticity of labor supply). In such a context, ignoring these general equilibrium effects might lead to severely distorted estimates of the distributional consequences of rising food prices.

What is the distribution of the welfare gains and losses arising from higher food prices in such an economy? Can income gains for agricultural workers offset their losses as net food buyers? Are they sufficiently large and widespread to attenuate or reverse increases in poverty? What is the overall effect on inequality? Can government policy, through targeted cash transfers for example, help mitigate some of the negative shocks? When all these effects are taken together, are the poorest hardest hit, as is often claimed?

This paper reports on a first attempt to address these questions for the case of Brazil, where food price inflation in the twelve months to July 2008 reached 18% (while overall inflation was 7%). We combine monthly, regionally-disaggregated data on (consumer-level) food prices with household consumption expenditure and income information to estimate the net effect of the price shock at each percentile of Brazil's income distribution. The net effect is computed as the sum of three components: an "expenditure effect"; a "market income effect"; and a "transfer income effect".

The expenditure effect is estimated as each household's compensating variation, in the standard way: the difference between the expenditure functions at the new and old price vectors. Estimation of the market income effect takes advantage of the detailed information available in the Brazilian household survey on the specific agricultural activity (by crop) where each person works, and relies on different scenarios for the pass-through from food prices to the wages of workers engaged in the production of specific agricultural commodities. Finally, the transfer income effect accounts for the fact that the Brazilian government increased the transfer amounts for two important social assistance benefits (at least in part) in response to the 'food crisis': Bolsa Família and the Benefício de Prestação Continuada (BPC). Using pre-crisis data on transfer recipients, we impute the expected effect of the rising transfers.

Our main findings are that, despite living in one of the world's largest food exporters, most – but not all – of Brazil's population experienced a decline in welfare as a result of the price shock in 2007-2008. The expenditure effect is large and regressive, with an average compensating variation of 7% of baseline expenditure, and a range from 11% at the lowest percentiles to just under 2% at the top of the distribution. On the other hand, both market and transfer income effects are progressive, with larger gains at the bottom of the distribution. These effects are small in large urban areas, but can be substantial in rural areas: If agricultural wages rose in the same proportion as food prices, this would lead to falling poverty in Brazil's rural areas. For the country as a whole, the net effect is U-shaped, with small welfare gains for the bottom ventile of the population, and the largest losses (roughly of the order of 5%) accruing to the three middle quintiles.

There are three reasons why the results from this exercise should be treated as suggestive, rather than definitive. First the expenditure effect is calculated as a first-order approximation to the compensating variation, with no allowance made for consumer substitution effects. Second, data limitations prevent us from examining food sales at the household level. While such family-farm sales are thought to account for a small fraction of the country's agricultural output, it would obviously still have been good to have information on them. But this information is simply not available for Brazil. Third, the market income effect is assessed on the basis of relatively crude assumptions about the pass-through from food prices to agricultural wages. Despite these limitations, this is the first paper we are aware of that seeks to account for both expenditure and general equilibrium wage and transfer effects in assessing the distribution of the welfare impacts of rising food prices, and we hope that it will both shed some light on the problem and encourage further work.

The remainder of the paper is organized as follows. The next section contains a brief (and selective) literature review. Section 3 describes the three sources of data used in our analysis. Section 4 presents the analytical framework and describes the simple methods used to estimate the welfare impacts of price changes, both on the expenditure side and on the income side. Section 5 presents the results separately, for Brazil's large urban areas; for its rural areas; and for the country as a whole. Section 6 concludes.

2. A Brief Review of the Literature

The effect of food price changes on household welfare in developing countries has long been a subject of interest. Because many households in developing countries are both consumers and producers of food, the starting point for the analysis has generally been the farm-household model - see Singh, Squire and Strauss (1986). As described in Section 4 below, applying results from basic consumer theory to this model gives rise to a first-order approximation to the welfare impact of a price change on a household that is given by the sum, across commodities, of the product of the price change itself by the household's net purchases of each good. Deaton (1989) uses a variant of this concept in a non-parametric analysis of the effect of changing rice prices on the distribution of welfare in Thailand, both across geographical areas and along the income distribution. A similar approach is used by Barret and Dorosh (1996) in their study of rice price changes in Madagascar, which found that up to one-third of poor rice *farmers* could lose, in net terms, from higher prices.

This first-order approximation based on the net purchases of each commodity by a farm household remains the central analytical tool for assessing the welfare impact of price changes in developing countries. But it has at least two shortcomings that have often been noted: it neglects substitution effects, both in consumption and in production, and it ignores general equilibrium effects of the price changes, including those that operate through labor markets. On the first point, the first-order approximation is (of course) only exact in the limit, i.e. for infinitesimal price changes. After large price changes, such as the ones observed in 2007-2008, consumers alter their behavior by substituting away from more expensive commodities in consumption and, whenever possible, towards them in production. Such substitution behavior is likely to take place both between food and other goods, and among food commodities whose relative prices change. The substitution effects, which clearly depend on own- and cross-price elasticities both on the demand and on the supply-side, cause the total welfare impact of price changes to deviate from the first-order approximation. Attempts to estimate these deviations, through second-order Taylor expansions of the expenditure function, can be found, for example, in Friedman and Levinsohn (2002) and Robles and Torero (2010).

Friedman and Levinsohn (2002) investigate the welfare impact of large price increases during the Indonesian currency crisis of 1997. Following Deaton (1988, 1990), they use spatial variation in quality-adjusted unit values within a single cross-section of the Indonesian SUSENAS household survey to estimate the matrix of cross-price elasticities for 21 food groups (and one non-food category). They find overall welfare impacts that are generally large, but that differ considerably not only between urban and rural areas, but also across different provinces. Effects were generally more regressive in urban than in rural areas. Although allowing for substitution behavior made substantial level differences, the authors argue that "the distributional consequences were the same whether we allowed households to substitute towards relatively cheaper goods or not" (Friedman and Levinsohn, 2002, pp. 419-420).

Robles and Torero (2010) - probably the paper whose subject is closest to our own - investigate the effect of the 2007-2008 "food crisis" on four Latin American countries: Guatemala, Honduras, Nicaragua and Peru. Like Friedman and Levinsohn (2002) they too estimate a second-order Taylor expansion of the household net expenditure function around initial prices. They classify food commodities into six groups, and find much smaller welfare effects than Friedman and Levinsohn found for Indonesia. The average national compensating variations were of the order of 1.5 – 2.5% of initial expenditure in Guatemala, Honduras and Peru, and 7% in Nicaragua. In every country, the effects were somewhat larger in urban than in rural areas, reflecting the protective effect of agricultural activities. They were also systematically regressive, with the compensating variation falling across income quintiles as income rose. These estimates implied poverty incidence increases of approximately one percentage point in Guatemala, Honduras and Peru, and about four percentage points in Nicaragua. On average, substitution effects (i.e. allowing for the second term in the Taylor expansion) were rather muted: 2.3% of the direct effect in Nicaragua, 3.5% in Peru, 7% in Honduras, and 12.5% in Guatemala.[4]

The second shortcoming of the first-order approximation based on net food purchases is, according to Deaton (1997), "a more serious deficiency… its neglect of repercussions in the labor market. Changes in the price of the basic staple will affect both supply and demand for labor, and these effects can cause first-order modifications to the results." (p.187). Estimates that attempt to incorporate simulated wage responses, based on behavioral models, are available for Bangladesh (Ravallion, 1990) and for Indonesia (Ravallion and van de Walle, 1991), but we are not aware of studies of the recent 2007-2008 food price shock (prior to ours) that attempt to incorporate estimates of labor market effects.

Labor market effects, as well as substitution effects, are absent, for example, from the influential study by Ivanic and Martin (2008), which was based on pre-shock household survey data for ten low-income countries containing information on both purchases and sales of a few key staple commodities. Assuming 100 percent pass-through of international to domestic prices, they estimated the first-order effects of these price increases across the expenditure distributions. Even accounting for the existence of net food sellers among the poor, the authors conclude that poverty is likely to have increased in most countries in their sample.

As the authors note, however, they had no access to data on the evolution of the domestic food prices actually faced by consumers in each of the countries they analyzed. Although the assumption of 100 percent pass-through is a sensible one under these circumstances, it is clearly strong. In a recent survey of commodity price impacts, Brambilla and Porto (2009) argue that the pass-through from international food prices is generally well short of 100 percent. In addition, spatial heterogeneity in infrastructure, transport costs, and market structures within countries often causes non-trivial regional differences in prices, even inside a given country. (We will see below that this is definitely true of Brazil in 2008.) Imperfect pass-through and regional price variation suggest the need for detailed data on changes in consumer prices *within* developing countries during the food price shock period. Reliance on the time series of world prices for a few key commodities also

[4] Estimates of substitution effects such as those of Friedman and Levinsohn (2002) and Robles and Torero (2010) are also possibly subject to bias, by ignoring substitution along the quality, rather than quantity, margin. See McKelvey (2011) and Gibson and Kim (2011). Implications of quality substitution for the estimation of welfare effects rather than simply quantity or calorie elasticities remains a subject for future work.

forced Ivanic and Martin (2008) to ignore changes in a large number of food prices, both on the consumption and production sides. A good example is the fact that welfare impacts in Nicaragua are estimated without taking changes in the price of coffee (an important export) into account, because coffee was not among the seven staples whose prices are followed in the study.[5]

Labor market and substitution effects are also absent from the analysis in Son and Kakwani (2009) – another study closely related to ours. These authors use the first-order approximation to the welfare effect of a price change to derive the elasticity of the Foster, Greer and Thorbecke (1984) class of poverty indices with respect to prices. They calculate these elasticities for various categories of goods in the large urban areas of Brazil, between 1999 and 2006, using two of the three data sets we use in this paper: the Household Budget Survey (POF) and the Consumer Price Index (INPC) microdata.

In this paper, we seek to contribute to this literature in four ways. First, we use a time-series of domestic consumer prices, captured monthly in eleven urban areas covering all five macro-regions of Brazil. We observe changes in the prices of 156 individual food items, which are then grouped into 16 food categories. These categories account on average for 97 percent of food consumption (and 22 percent of household consumption expenditure on all goods) recorded in the Household Budget Survey. This is a more finely disaggregated set of prices than has generally been used in the analysis of the 2007-2008 crisis. Second, we use occupational data that maps individual agricultural workers to the production of specific food groups, to compute estimates of income gains that might accrue to them under two different assumptions about the pass-through from food prices to agricultural wages.

Third, we attempt to shed light on the magnitude and effectiveness of the social policy response of the Brazilian government, in terms of the extent to which it helped mitigate the price increases. And fourth, we present the estimates for each of these effects – the expenditure effect, the market income effect and the transfer income effect – in a distributionally disaggregated way, by means of "price change incidence curves", which are analogous to the growth incidence curves of Ravallion and Chen (2003). These curves depict each individual effect, as well as the net effect, for each percentile of the income distribution. They are computed and presented separately for the large urban areas where the prices are collected, for rural areas, and for the country as a whole. From the

[5] The staples considered are beef, dairy, maize, poultry, rice, sugar, and wheat.

corresponding counterfactual income distributions, we report our estimates of the effects on poverty and inequality measures.

3. Data

Three different data sources are used in this paper: individual price data from the National Consumer Price Index (INPC); the Household Budget Survey (POF); and the National Household Income Survey (PNAD). The INPC records percentage changes in consumer prices on a monthly basis. In total, information is collected for 472 consumption items, which are then classified into increasingly more aggregated commodity groupings. Ultimately, the information feeds into Brazil's overall consumer price index. Individual prices are recorded for a total of 156 food items in nine metropolitan regions (Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo, Curitiba, and Porto Alegre), and for two municipalities (Brasilia and Goiânia). In what follows we refer to these eleven urban centers as Brazil's "large urban areas". Monthly prices are available beginning in April 1979, and we use the series from January 2007 to December 2008.

To facilitate the concordance between food item classifications in the INPC and in the household budget survey, our analysis is conducted at the level of 16 food groups, which are listed in Table 1. The table also presents the average price increase for each food group during 2007-2008 and the maximum price increase (12 months to peak) observed during the two-year period. (The last column indicates the peak month for each price series.) This maximum 12-month price increase is the proportional price change variable we use throughout the analysis.

Results are presented in Section 5 for the country as a whole, as well as separately for Brazil's large urban areas (which accounted for approximately 30 percent of the national population in 2008), and for the rural areas (16% of the population). Since the IBGE only collects prices in the 11 large urban areas, price changes were imputed to other localities on the basis of geographic proximity. For example, in the North, where IBGE has information of the price changes only in the metropolitan region of Belém (in the state of Pará) we assigned Belém's vector of price changes to the other seven states. In the Northeast, IBGE collects price information in Fortaleza (Ceará), Recife (Pernambuco), and Salvador (Bahia). For the five additional states in the Northeast we assigned the price variation based on proximity between states. Table 2 describes the assignment rules countrywide.

The Household Budget Survey (POF) is nationally representative and has extensive and detailed information on consumption, expenditure, and income. We use the 2002/2003 round, which is the only pre-shock detailed survey with the appropriate information for our analysis, and which surveyed 48,470 households throughout the country. The 2008/2009 round is post-crisis, and therefore unsuitable for the purpose of estimating the compensating variation of the 2007-2008 price change. The welfare measure is household per capita consumption expenditure, calculated excluding pensioners, household workers, and relatives of household workers. The unit of analysis is the individual. The concordance between food groups in the INPC and POF classifications works extremely well at the level of the 16 food groups, with 97% of total household food consumption expenditures in the 2002-03 POF matched to these groups.

Although the POF records some income information for household members as well, it does not include detailed data on two variables that are important for our estimation of the market and transfer income effects of rising food prices. The first variable is a disaggregation of the type of activity exerted by workers, with detailed information on the kind of crop or agricultural production performed by individuals reporting positive incomes from that sector. The second is information on the receipt of social assistance transfers. Both of those variables are therefore obtained from the National Household Income Survey (PNAD), an annual, nationally representative survey of income, employment and living conditions. Since the 2007 survey, fielded in September, would already have been contaminated by rising food prices, we use the 2006 wave. The PNAD survey lacks a comprehensive measure of expenditure, but is thought to capture wage incomes comprehensively, and it contains information on whether households are beneficiaries of social programs, specifically Bolsa Família and BPC. The method used to combine information from these different, unmatched surveys is explained in the next section, which describes our analytical framework and empirical approach.

4. Analytical Framework and Empirical Approach

The conventional starting point for an analysis of the impact of price changes on household welfare is to estimate the resulting change in consumer surplus. The most commonly used concept of consumer surplus is the Hicksian compensating variation:

$$\Delta E^h = E_h(p^1, u_h^0) - E_h(p^0, u_h^0) \tag{1}$$

The standard notation is used: E denotes the minimum expenditure (including savings) needed for household h to reach a certain utility level (u), given a price vector p (with typical element p_i). The superscript 0 (1) denotes the value of each variable observed before (after) the price changes. In the limit (or for infinitesimal price changes), the compensating variation is given by Shephard's lemma: $dE^h = \sum_i q_i^h dp_i$, where q_i^h denotes the quantity of good i consumed by household h. For discrete price changes the equivalent expression gives only a first-order approximation, corresponding to the first term of the Taylor expansion:

$$\Delta E^h \cong \sum_i q_i^h \Delta p_i \quad (2)$$

Since the data on price changes are usually given in percentage terms, (2) is often expressed in proportional terms, which implies that budget shares (ω_i^h) replace quantities as the key variable intermediating the effect of price changes on household welfare:

$$\frac{\Delta E^h}{E^h} \cong \sum_i \omega_i^h \frac{\Delta p_i}{p_i} \quad (3)$$

Food production by farm households can be incorporated into the analysis (in the spirit of Singh et al. (1986), Deaton (1989) and many others since) by denoting by σ_i^h the value of production of commodity i by household h, as a share of the household's total consumption expenditure, to write:

$$\frac{\Delta E^h}{E^h} = \sum_i \left(\omega_i^h - \sigma_i^h\right) \frac{\Delta p_i}{p_i} + S(\Delta p) \quad (4)$$

In (4), the "approximately equal" sign has been replaced by an equal sign, thanks to the introduction of a term that corrects for substitution behavior, as a function of the full vector of price changes $S(\Delta p)$. As noted in Section 2, this term is approximated by the second-order term in a Taylor expansion in Friedman and Levinsohn (2002) and Robles and Torero (2010). Finally, and as also discussed in Section 2, one can seek to incorporate general equilibrium effects of the price changes, such as those that operate through labor markets and may change wages or other factor prices, by adding a third term, which summarizes any changes in the household's non-farm income, y. Given the definition of the compensating variation, the overall (proportional) change in moneymetric household welfare, b^h, can then be written as follows:

$$db^h = \frac{\Delta y^h}{y^h} - \frac{\Delta E^h}{E^h} = \frac{\Delta(w^h + \tau^h)}{y^h} - \sum_i \left(\omega_i^h - \sigma_i^h\right) \frac{\Delta p_i}{p_i} - S(\Delta p) \quad (5)$$

Equation (5), where the market component of non-farm income is denoted w^h and the transfer component is denoted τ^h, is a comprehensive decomposition of the change in household welfare, taking into account the full compensating variation in "net expenditures" in the last two terms on the RHS, and any additional general equilibrium effects on non-farm incomes, e.g. changes in wages or government transfers, in the first term.

As discussed in Section 2, no study that we are aware of has so far fully captured all of these terms, and ours is no exception. Shortcomings in the Brazilian data, such as the absence of information on household farm production in either the household income or the household budget surveys, preclude us from computing production shares (σ_i^h). Neither are we able to estimate the full Slutsky substitution matrix to approximate $S(\Delta p)$. In what follows, therefore, our empirical analysis is based on Equation (6) below, where the approximation sign returns:

$$db^h = \frac{\Delta y^h}{y^h} - \frac{\Delta E^h}{E^h} \cong -\sum_i \omega_i^h \frac{\Delta p_i}{p_i} + \frac{\Delta w^h}{y^h} + \frac{\Delta \tau^h}{y^h} \tag{6}$$

The three terms on the right hand side of (6) correspond to our estimates of the expenditure effect, the market income effect, and the transfer income effect, respectively. The first term is computed, for each household in the POF sample, using expenditure shares from the POF survey, and proportional price increases (for each good i) from the INPC. The second term is computed from wage information in the PNAD, based on the following rule:

$\frac{\Delta w^h}{y^h} = 0$ if the household contains no workers in any agricultural activity

$= \alpha \sum_j \sum_i \frac{v_j^i}{y_h} \frac{\Delta p_i}{p_i}$ if the household contains any individuals *j* who report positive income v_j^i from an agricultural activity *i*, (i.e. that produces good *i*).

The information on agricultural production activities in the PNAD is much more disaggregated than the 16 food groups used for the INPC – POF concordance, and given in Table 1. An additional concordance was needed, which maps each sector-specific agricultural activity reported in the PNAD to one of the 16 food groups whose prices we follow. The full concordance takes fourteen pages to describe and is available from the authors on request. An excerpt corresponding to the first four INPC food categories is reported in Annex Table A1 for illustrative purposes.

The parameter α is intended to capture the (short-run) pass-through from agricultural prices to agricultural wages, and is clearly key to the analysis. One benchmark value would correspond to a perfectly competitive agricultural labor market, where wages are equal to the marginal revenue product of labor. If labor supply is perfectly inelastic in the short-run – because workers are immobile in that time-frame, say – then α=1.0. To the extent that the elasticity of labor supply rises (say, in the medium run), or that employers have some market power and can capture as profits part of the price gains, then α < 1.0. We use two benchmark cases, as an illustration of these two main possibilities: α =1.0 and α =0.5.

The third term in (6), corresponding to the transfer income effect, is meant to capture changes in the values of transfers received by Brazilian households, with the objective of mitigating the food price increases. Strictly speaking, it is not obvious that such policy responses should be treated as part of the economy's general equilibrium adjustment to the price changes. They might, however, be seen as part of the overall "political economy" equilibrium, and an assessment of their protective effect across the income distribution (or lack thereof) may well be of policy interest.

Specifically, the benefit amounts in two large social assistance programs – Bolsa Família and the Benefício de Prestação Continuada (BPC) – were raised during 2008 and, in at least one case, with the explicit aim of mitigating the food price increases.[6] Bolsa Família is a conditional cash transfer program that reaches over 12.5 million households. The benefits vary according to household composition and monthly per capita income. The basic benefit was raised from R$50 to R$54 per household in July 2008. The BPC is a means-tested old-age non-contributory pension and disability grant program. It transfers a benefit equivalent to the minimum wage to elderly and disabled individuals whose household income is less than one quarter of the minimum wage. Its value was raised by 10% in March 2008, in line with the increase in the national minimum wage. We used these increase values to compute $\frac{\Delta\tau^h}{y^h}$ for each household that declared receiving either one of these benefits in the 2006 PNAD.[7] The transfer income effect was set to zero otherwise.

[6] "Minister Patrus Ananias (Social Development) said on Wednesday that the average Bolsa Família benefit will rise from R$78.70 to R$80.00. He added that the 8% value of the increase [in the basic benefit] was determined on the basis of the INPC (Índice Nacional de Preços ao Consumidor), *with the objective of improving the purchasing power of low-income families in the midst of the world food crisis*" (Folha de São Paulo newspaper, online, 25 June 2008, our translation and emphasis).

[7] Subsequent to these increases in the transfer amounts, the programs were also expanded on the extensive margin, to cover additional households. These effects are not captured by the analysis.

The Brazilian data configuration is such, therefore, that the expenditure effect is computed for all households from one sample (POF), while the (market and transfer) income effects are computed for all households from another sample (PNAD). Although both are large and nationally representative surveys, they do not sample the same households. To combine the three effects in (6), we therefore look at their average values at each centile π of the pre-shock income distribution. Denote by Π_π the set of households in centile π of that distribution. Let each centile have *n(Π)* households. We can then define:

$$\gamma_E(\pi) = -\frac{1}{n(\Pi)}\sum_{h\in\Pi_\pi}\sum_i \omega_i^h \frac{\Delta p_i}{p_i} \tag{7}$$

$$\gamma_w(\pi) = \frac{1}{n(\Pi)}\sum_{h\in\Pi_\pi}\frac{\Delta w^h}{y^h} \tag{8}$$

$$\gamma_\tau(\pi) = \frac{1}{n(\Pi)}\sum_{h\in\Pi_\pi}\frac{\Delta \tau^h}{y^h} \tag{9}$$

as the (proportional) expenditure, market income, and transfer income effects of the food price increases, for centile π of the Brazilian income distribution. Whereas equation (7) uses POF and INPC data, (8) and (9) are computed using PNAD data. Given (6), and the above definitions, we can also define the net price effect for each centile as:

$$\gamma(\pi) = \gamma_E(\pi) + \gamma_w(\pi) + \gamma_\tau(\pi) \tag{10}$$

Equation (10), which is the centile-average equivalent of (6), describes our estimates of the proportional money-metric welfare effect of the price changes along Brazil's income distribution. It is closely analogous to the growth incidence curve of Ravallion and Chen (2003), which describes the proportional income growth for each percentile of the original income distribution. We accordingly denote $\gamma(\pi)$ the "price change incidence curve" (PIC). Equations (7), (8) and (9) define its three components: the expenditure effect incidence curve; the market income effect incidence curve, and the transfer income effect incidence curve.

In the following section we present our empirical results in two ways. First we graphically present the price change incidence curves, building on equations (7), (8), (9) and (10). The visual clarity and degree of distributional disaggregation of these figures are, in our view, important improvements in the analysis of the distributional consequences of food price changes. PICs are presented first for the eleven large urban areas from which detailed information on prices is collected, then for Brazil's rural areas, and finally for the country as a whole. In each case, we present $\gamma_E(\pi)$; $\gamma_E(\pi) + \gamma_W(\pi)$; and $\gamma(\pi)$.

Second, we report our estimates of the poverty and inequality effects of these price increases, by estimating poverty and inequality in the counterfactual income distributions corresponding to each of the price effects. The counterfactual income distribution corresponding to the net (or overall) price increase effect (and thus derived from equation 10) is given by (11) below.

$$y^s(\pi) = y^0(\pi)\big(1 + \gamma(\pi)\big) \tag{11}$$

The component-specific income distributions, corresponding to equations (7) – (9), are defined analogously. For each such distribution an inequality measure can be computed and, given constant real poverty lines, so can poverty indices. The estimates for the poverty and inequality effects of the price increases – and their subcomponents – reported in the next section are obtained in this fashion.

5. Results

Brazilian inflation started increasing towards the end of 2006 and reached a peak of around 7 percent, in June 2008. It averaged 5.3 percent for the 2007-2008 two-year period. This increase was driven mainly by food prices which rose substantially during 2007 and 2008. Food price inflation peaked in June 2008 at about 18.3%. Price growth for all other categories was roughly constant around 5 percent - or lower, for housing, residential goods and communication items (Figure 1).

Behind this large increase in the average price of food, there was substantial variation across both specific types of foods and regions of the country. Most prices started increasing in 2007. The price of grains (cereals), which grew by 80 percent in the twelve months to July 2008, led the increase, followed by that of tubers and roots (50 percent) and meat (40 percent). The price of drinks and teas showed the lowest growth, with an average of around 5 percent (Figure 2). Even within food groups there was a large variation across different parts of the country. Grain prices, for example, grew by 125 percent in Salvador, but by less than 50 percent in Fortaleza. The price of flour and pasta rose by almost 40 percent in Belém and Salvador compared to about 15 percent in Recife and Fortaleza (Figure 3).

The heterogeneity in food price inflation, both spatial and across commodities, reinforces the importance of conducting the welfare analysis with data that is disaggregated along both dimensions. Like Friedman and Levinsohn (2002) - but unlike most other recent studies - we exploit substantially disaggregated local information on both prices and expenditure shares in the estimations presented below.

The Expenditure Effect

As noted above, we begin by estimating a first-order approximation to the expenditure effect of the price increases on household welfare. This effect is given by the first term on the RHS of equation (6): $(-\sum_i \omega_i^h \frac{\Delta p_i}{p_i})$. It is estimated for each household *h* using expenditure data on budget shares from the POF, and price increases from the INPC, in the region where *h* is located.[8] The expectation, of course, is that the distribution of this effect across households will be regressive. Food is a necessity, with a "textbook" Engel curve: the share of expenditure allocated to food declines with total expenditures throughout the entire domain (Figure 4): around 32 percent of expenditure goes into food among the poorest households, compared to about 10 percent at the top of the distribution (captured by POF).[9]

This expectation is confirmed by the expenditure effect PIC, which is given by equation (7) and depicts the percentage reduction in welfare at each percentile of the distribution ranked by income per person. The expenditure effect PIC is given separately for Brazil's large urban areas in Figure 5, for rural areas in Figure 6, and for the country as a whole in Figure 7.[10] The bands around the PIC are bootstrapped 95% confidence intervals. Horizontal lines denote the average effect (and the confidence interval around it). Average expenditure effects are fairly substantial, ranging from 5 percent of baseline income in large urban areas, to 12.5% in rural areas. For Brazil as a whole, the average reduction in welfare due to the expenditure effect of the 2007-2008 food price increases was of the order of 7.5% of initial income. As expected, the expenditure effects are markedly regressive behind these averages: they range from an average of around 7% (12%) in the poorest decile to 2%

[8] This is strictly true for the 11 large urban areas where prices are collected directly. As noted in Section 3, households living outside the 11 large urban areas are assigned the vector of price changes from the nearest large urban area, as detailed in Table 2.
[9] The share is likely to be much lower among Brazil's truly rich households but, as is often the case, these are seldom well-captured in household surveys. See Korinek et al. (2006).
[10] The country as a whole consists of rural areas, large urban areas, as well as all other urban areas, which are not shown separately.

(2.6%) at the top decile of the distribution in large urban areas (Brazil as a whole). The slope of the expenditure effect PIC is lower in rural areas, where a higher fraction of the population is poor.

The implications of these expenditure effects for summary measures of poverty and inequality are summarized in the third columns of Tables 4, 6 and 8, for large urban areas, rural areas and the whole country, respectively.[11] These tables report poverty incidence (headcount), depth (poverty gap) and severity (squared poverty gap), defined with respect to both an extreme and a moderate poverty line, for the original pre-crisis income distribution (denoted "baseline", and based on the PNAD 2006), and for each of the impact scenarios. The extreme and moderate poverty lines are drawn from IBGE. They allow for differences in spatial cost of living, and are reported in Table 3.[12] Tables 4, 6, and 8 also report the Gini coefficient of income inequality, both at baseline and for each impact scenario. As noted, column 3 reports poverty and inequality in the income distribution obtained from the expenditure effect PIC only: $y^s(\pi) = y^0(\pi)\big(1 + \gamma_E(\pi)\big)$.

The effects of those relatively large compensating variations on poverty are substantial, particularly in rural areas, where extreme poverty incidence rises by four percentage points, or nearly a fourth. Moderate poverty rises by about a sixth, or six percentage points, and the effect on higher-order FGT indices is proportionately (somewhat) larger. In large urban areas, where people are on average better-off, the effects are smaller: the extreme poverty headcount rises by just over one percentage point, or ten percent. Moderate poverty incidence rises by two and a half points, about 7.5 percent. In the country as a whole, poverty effects fall somewhere between those two extremes, and are certainly not negligible: on their own, the first-order expenditure effects contributed to an increase of 22% in the incidence of extreme poverty, from 11.0% to 13.5%.

The market income effect

But Brazil is a large food producer, and net exporter. 16% of the country's population live in rural areas and, according to the PNAD 2006, 19% work in agriculture (including animal husbandry,

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[11] Tables 5, 7 and 9 differ from Tables 4, 6 and 8 in that they consider a different value for the pass-through parameter from product prices to agricultural wages (α). These tables therefore report different values for estimates that include the market income effect, but there are no differences with respect to the expenditure effect.

[12] These region-specific poverty lines were constructed for the 2002/03 POF and we adjusted them for inflation between 2003 and 2006 using INPC. The unweighted averages of these regional lines in 2006 prices are R$187.90 for moderate poverty and R$100.56 for extreme poverty. These compare to average lines of R$187.50 for moderate poverty and R$93.75 for extreme poverty used by Barros et al. (2008).

hunting and gathering, and fisheries). Even if most of these people are not themselves net food sellers (because they work for a wage), one would expect many to benefit from large increases in the product prices in their sectors. To ignore such potentially large general equilibrium effects might very well be misleading, not only about the welfare consequences of rising food prices on average but, given that agricultural workers are typically poorer than the average worker, of the distributional consequences as well. As suggested by the Deaton (1997) quote in Section 2, a neglect of these labour market repercussions might lead to first-order errors in our assessment of the phenomenon under study.

As noted earlier, Brazilian data sets do not contain information on the value of food production (or sales) for family farmers which are, in any case, a small minority of the country's agricultural workforce. We focus, therefore, on two estimates of the potential general equilibrium effects on agricultural wages.[13] As described in Section 4, we estimate the market income effect of rising food prices by assuming two different values for the product-price elasticity of wages (the pass-through parameter from commodity prices to the wages of the workers employed in those sectors). The benchmark case of perfectly competitive labor markets in the short-run, in which rising prices transmit fully to the the marginal revenue product of labour and thus to wages, corresponds to the 100% pass-through case, with $\alpha = 1.0$. To provide an alternative, and more conservative, estimate that might allow for an upward-sloping labor supply curve, as well as for likely imperfections in the agricultural labour market, we also estimate the income effects with a 50% pass-through ($\alpha = 0.5$).

Figures 8 and 9 show these effects for the large urban areas, for $\alpha = 0.5$ and $\alpha = 1.0$ respectively. Effects are shown cumulatively and, to economize on space, the transfer income effects are shown in these figures as well: in each figure, the dark line at the bottom corresponds to the expenditure effect, which was shown separately in Figure 5. The lighter continuous line *adds* the expenditure and the market income effect, at each percentile. And the light dashed line further adds the transfer income effect, and thus gives the net price change incidence curve, defined in equation (10).[14]

[13] It is important to note that the market income effects are general equilibrium effects, in the sense that they are not part of the partial equilibrium of food markets. They clearly do not capture – and are not intended to capture – the *full* general equilibrium response of the economy to rising food prices. Rising agricultural profits and investment might, for example, lead to demand multipliers in rural areas or small towns, or raise wages and profits in industries that manufacture fertilizers, machinery, or other inputs into agriculture. These, and many others, are also plausible general equilibrium effects that are not captured by our approach.
[14] Confidence bounds are omitted from these pictures for visual clarity.

Although the definiton of the metropolitan regions in Brazil includes some agricultural areas, the fraction of the population in these cities that works directly with food production is quite small. It is not surprising, therefore, that the market income effects shown in Figures 8 and 9 are also small. With 100% pass-through, there is a one- to two-percentage point mitigation of the expenditure effect for the poorest decile. But the effect diminishes rapidly with income, and is hardly perceptible with $\alpha = 0.5$. The picture is very different, however, in the rural areas depicted in Figures 10 and 11. Here, even with a pass-through to wages of only 50%, accounting for the labor market effects of rising food prices reduces the welfare decline for the bottom half of the (rural) population from the 10-15% range to something around a 5% decline. With 100% pass-through, the sign of the effect is reversed, and the bottom half of Brazil's rural population actually gains from the "food crisis". For the bottom quartile of the distribution, this gain can be of the order of 5-10% of baseline income.

Since Brazil is a predominantly urban country, though, these large market income effects in the rural areas are not enough to fully offset the compensating variations from the expenditure side when the entire country is considered. Figures 12 and 13 report the expenditure; expenditure + market income; and net price effect PICs for all of Brazil, under the two different pass-through scenarios. Although the net effect is now negative almost everywhere, it is no longer monotonically regressive, as it appeared to be in Figure 7. Instead, it is either flat (at approximately 7%) for the bottom half of the population (when $\alpha = 0.5$), or clearly U-shaped when $\alpha = 1.0$. Since agricultural workers are over-represented among the poor, allowing for the labor market or general equilibrium effects of higher food prices reverses – or substantially mitigates – the negative expenditure effects on the poor.

These results are also evident from the poverty and inequality figures in Tables 4-9. The market income effect attenuates the poverty-increasing impact of the expenditure effect everywhere. But whereas this offseting force is quantitatively small in large urban areas, it is substantial in rural areas where, with $\alpha = 1.0$, it is sufficient to reverse the sign of the impact and lead to a (small) reduction in both extreme and moderate poverty rates, for all three measures. For the country as a whole, whereas the expenditure effect alone would have raised the extreme (moderate) poverty headcount from 11.0% (31.3%) to 13.5% (35.1%), the combined expenditure and market income ($\alpha = 0.5$) effects raise it to 12.9% (34.3%). Market income is obviously even more protective with $\alpha = 1.0$, in which case extreme (moderate) poverty would have risen to 12.4% (33.5%).

The transfer income effect

Governments can use their social protection systems to help mitigate the impact of rising food prices on the population. In Brazil, as noted in Section 4, the transfer amounts for two large social assistance benefit programs – the BPC and Bolsa Família – were increased in 2008. The basic transfer of Bolsa Família increased by R$4 (8 percent), the transfer per child by R$2 (13 percent), while the BPC increased with the minimum wage, by R$32 (9.2 percent). Despite the higher value of the increase in BPC benefits, the total cost of the two measures was comparable since the number of beneficiaries of Bolsa Família is larger than that of BPC.

The transfer income effect, which aggregates the effect of the increases in both programs, can be seen as the difference between the dashed and the continuous light lines in Figures 8, 10 and 12, for large urban areas, rural areas, and all of Brazil respectively.[15] The two lines become indistinguishable (i.e. the transfer income effect vanishes) above the 40th percentile in the large urban distribution, and the 55th percentile in the rural distribution, suggesting that the social assistance programs are relatively well-targeted to the bottom half of the distribution. The transfers were only substantively protective, however, for the first decile of the urban distribution and, arguably, the first two deciles of the rural distribution. A decomposition of the effect between the two programs (not shown) reveals that increases in Bolsa Família tended to be most protective of the very poor, while increases in the BPC benefit account for most of the (limited) effect on deciles 3-5.

This is corroborated by the effect of the two transfer programs on poverty, reported in Tables 4-9. (Once again, since the transfer income effects are reported together with the expenditure effects, but not market income effects, the estimates do not differ across tables for different values of α.) The transfers contributed to a small reduction in the poverty increase induced by the expenditure effect, but this was very limited in all areas of the country. Bolsa Família was slightly more effective against extreme poverty, while BPC had a somewhat greater protective power against moderate poverty. For Brazil as a whole, whereas the expenditure effect alone would have raised the extreme (moderate) poverty headcount from 11.0% (31.3%) to 13.5% (35.1%), the combined expenditure and transfer income effects raised it to 13.4% (35.1%). The protective power of the transfer income effect was thus considerably smaller than that of the market income effect.

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[15] The gaps are the same in Figures 9, 11 and 13, since those figures only differ with respect to the market income pass-through parameter α.

When all effects are taken together, the net impact of higher food prices in 2008 in Brazil was substantially different in rural and urban areas – and this was driven primarily by the offsetting positive market income effect. The negative expenditure effect was in fact stronger in rural areas, where people tend to be poorer and spend a greater proportion of their incomes on food. But higher earnings from food production may have considerably alleviated those effects. Under the more optimistic assumption of 100% pass-through from food prices to agricultural wages, there may have been substantial welfare gains among the rural poor. Rural extreme (moderate) poverty incidence would have fallen by approximately six percent (two percent), and the higher-order FGT indices would also have declined. Under a less optimistic pass-through scenario ($\alpha = 0.5$), poverty and inequality would have increased as a result of higher food prices, even in rural areas, but much less markedly than when the market income effect is ignored. For the country as a whole, the net effect of higher food prices on poverty is positive (i.e. poverty increases) for all three measures and for both poverty lines, even if $\alpha = 1.0$. But instead of rising from 11.0% to 13.5% (the expenditure effect), extreme poverty increases to 12.3% in net terms. Moderate poverty rises from 31.3% to 33.4% when all effects are taken into account, instead of to 35.1% under the expenditure effect alone.

6. Conclusions

In this paper we combined spatially disaggregated data on changes in the consumer prices of sixteen food categories with detailed information on household consumption patterns, individual occupations and incomes in Brazil, to investigate the distribution of the welfare consequences of rising food prices in 2007-2008. These price increases were substantial: while headline inflation averaged 5.3% in the two-year period, food price inflation peaked at over 18% in mid-2008.

Because Brazil is a large producer and net exporter of food, rising international food prices should generate aggregate income gains for the country. Any meaningful estimate of the welfare consequences must therefore seek to account for impacts on the income side, as well as for the standard expenditure effects usually captured by the compensating variation of the price increases for consumers. Furthermore, agricultural production in Brazil – and in many other emerging and advanced economies – relies predominantly on a wage-earning labor force, rather than on the traditional family farms that both buy and sell food. Estimates of the impact of rising food prices on labor incomes could not, therefore, rely only on net household purchases (or sales) of food, even if such information were available for Brazil. There was little alternative to attempting some estimate of the general equilibrium effects of food price changes or, at least, that part of the general equilibrium effects corresponding to the short-run pass-through from product prices to agricultural wages.

Using detailed information on the type of output produced by each agricultural worker in the PNAD 2006 survey, we mapped workers to their farm sectors and estimated market income effects under two different pass-through assumptions – one corresponding to a competitive labor market in the short run, and another to a market where only half of the price increase is passed on to workers. These market income effects were considered alongside the standard expenditure effect, calculated as a first-order approximation to the compensating variation for each food consumer, and a transfer income effect that captured the increase in benefit values for two social assistance programs, Bolsa Família and Benefício de Prestação Continuada.

According to our estimates, the overall effect of the price increases was to raise both extreme and moderate poverty in Brazil, despite the country's position as one of the main food exporters in the world. Even with full pass-through to agricultural wages, and despite increases in social assistance benefits, the incidence of extreme poverty increased from 11.0% to 12.3% as a result of higher food prices. However, these increases in poverty were much less pronounced than if the income effects had not been taken into account. Naturally, higher incomes arising from a greater value of agricultural production were particularly important in rural areas where, under the scenario of 100% pass-through, incomes rose for the bottom half of the population, reducing every measure of poverty.

In large urban areas, though, few people benefit directly from agriculture, so the standard expenditure effect (reduction in consumer surplus) dominated. And since Brazil is 80% urban, the aggregate picture for the country as a whole was one of reductions in average welfare as a result of higher food prices. Behind the average impact, however, the distributional consequences of higher food prices look rather different depending on whether or not one takes the (general equilibrium) market and transfer income effects into account. Whereas the expenditure effect PIC is essentially upward sloping over the entire distribution (pointing to a consistently regressive effect), the overall price change incidence curve that incorporates all three effects is U-shaped: the poor – particularly the rural poor – either gain or lose less from higher prices than the middle groups. And the rich lose little, since they spend a small proportion of their incomes on food to begin with.

Our analysis also suggests that the record of the social protection response by the Brazilian government was mixed. Although overall the increases in Bolsa Família and BPC benefits were well-targeted, their volume appears to have been insufficient to fully protect the poor – especially the urban poor – from the negative welfare consequences of higher food prices. Although the growth in Brazil's social protection system has played an important role in poverty reduction over the last two decades, there is still scope for further improvements.[16]

Pre-existing social protection programs may in some cases be rapidly scaled up (like Bolsa Família and BPC) thus enabling the government to mitigate some of the adverse consequences of higher food prices on the beneficiaries. However, these programs were designed primarily to combat long-term, "structural" poverty, and not as short-term risk-management instruments. Conditional cash transfer programs (and social pensions like BPC) are not counter-cyclical instruments. The targeting mechanism in place may not necessarily be appropriate to identify those hit by a crisis (new poor). With the benefit of hindsight, it is unsurprising that small increases in their transfer amounts proved insufficient to fully protect the poor against higher food prices. Whether an alternative social protection instrument should be put in place to fulfill that need in future episodes of price volatility – and if so, how it should be designed – are interesting policy questions going forward, both for Brazil and for a number of other countries in Latin America.

The analysis in this paper also highlights the need for collecting additional data, and points to a number of further research questions. We close by highlighting three examples of such additional work, which would permit a more accurate estimation of the overall change in household welfare due to changes in food prices, given by equation (5). First, it would be great if one of Brazil's excellent household surveys (either the POF or the PNAD, both of which have recently undergone reforms) included a more detailed module on agricultural production and sales at the household level. This would enable researchers to compute net purchases of agricultural commodities for all households involved in family farming.

[16] On the role of Brazil's social protection system in the recent process of poverty reduction, see Ferreira et al. (2010) and Veras et al. (2006).

Second, further research is needed to estimate the substitution effects induced by the large price changes of 2007-2008. It is true that Robles and Torero (2010) found that these second-order effects were generally quite small in Nicaragua, Peru and Honduras, and that Friedman and Levinsohn (2002) concluded that the distributional consequences in Indonesia were "the same" whether or not these second-order effects were considered (see Section 2). But nothing guarantees that the same results would hold in Brazil in 2007-2008, and estimating the substitution effects would be an important extension of the work presented here.

Finally, our results point to the fundamental importance of better understanding the general equilibrium – and in particular the labor market – effects of large agricultural price changes. This need has long been noted - by Ravallion (1990) and Deaton (1997), among others – but it remains no less urgent today. If, for example, longitudinal data could be used to better identify the transmission mechanisms from product prices to agricultural wages, one could obtain much more reliable estimates of the market income effects we estimated here on the basis of rather coarse pass-through assumptions. While our two scenarios serve to highlight the potential importance of the market income effect – and its incidence along the distribution – a properly identified estimate of the pass-through would clearly yield superior estimates.

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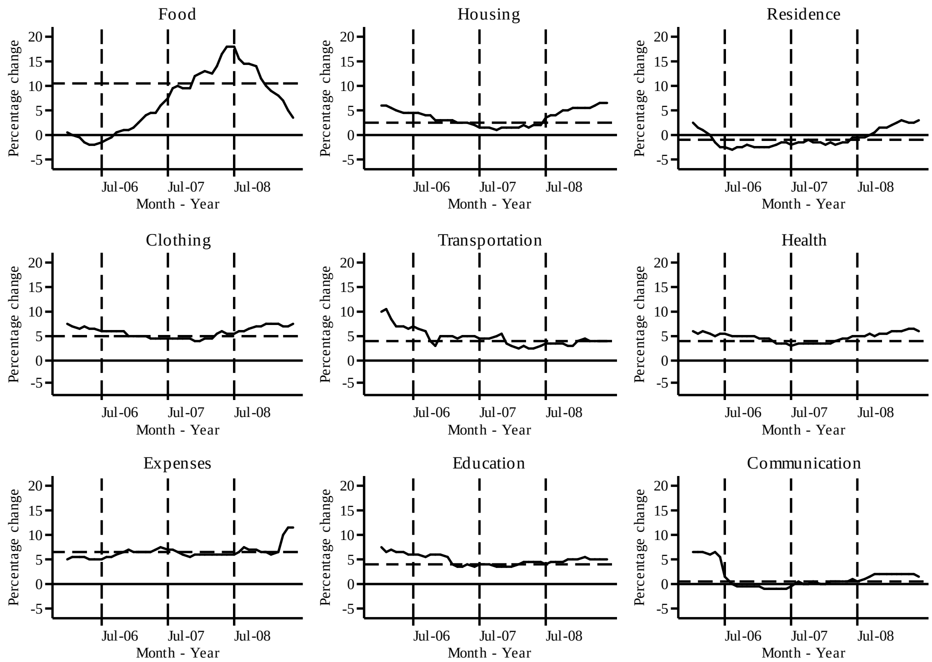
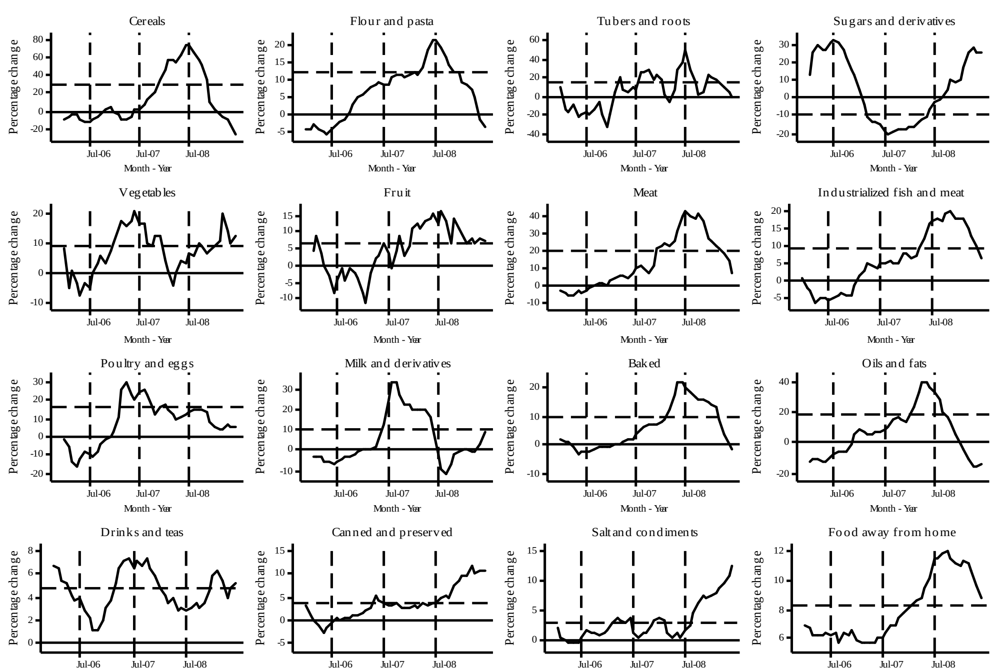
Figure 1: Price Evolution by Group of Products (Annual Percentage Change)



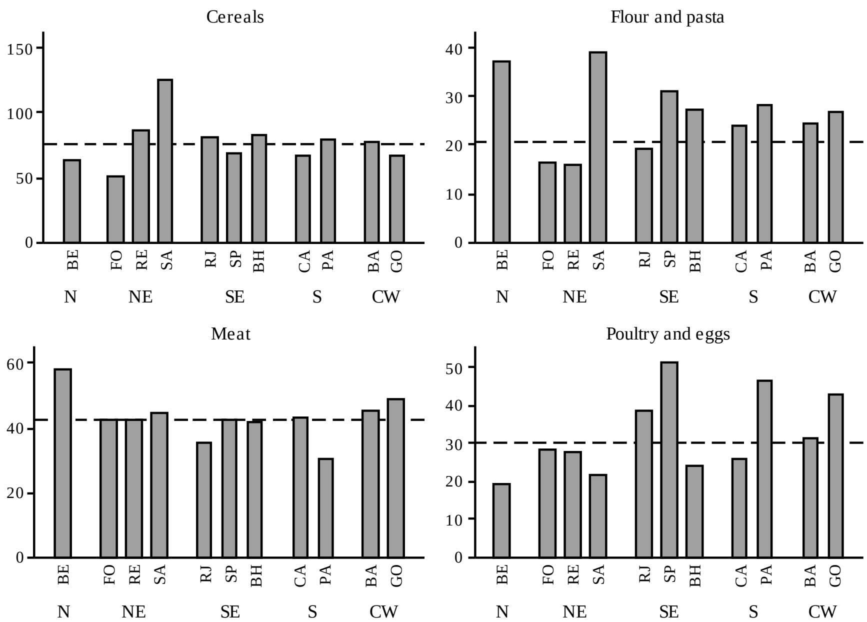
Source: IBGE - National Consumer Price Index (INPC).
Note: Dashed horizontal lines represent average annual percentage changes in 2007 and 2008.

Figure 2: Evolution of Food Prices by Food Item (Annual Percentage Change)



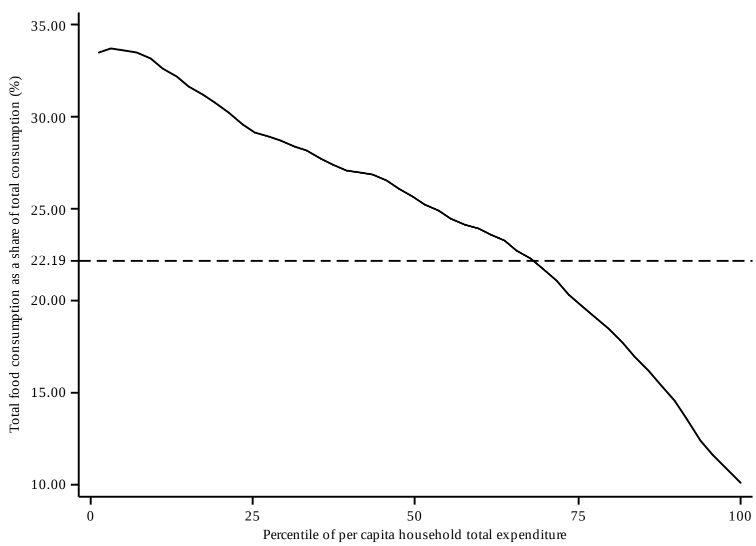
Source: IBGE - National Consumer Price Index (INPC).
Note: Dashed horizontal lines represent average annual percentage changes in 2007 and 2008.

Figure 3: Regional Variation in Price Increase for Food (Maximum Annual Percentage Change)



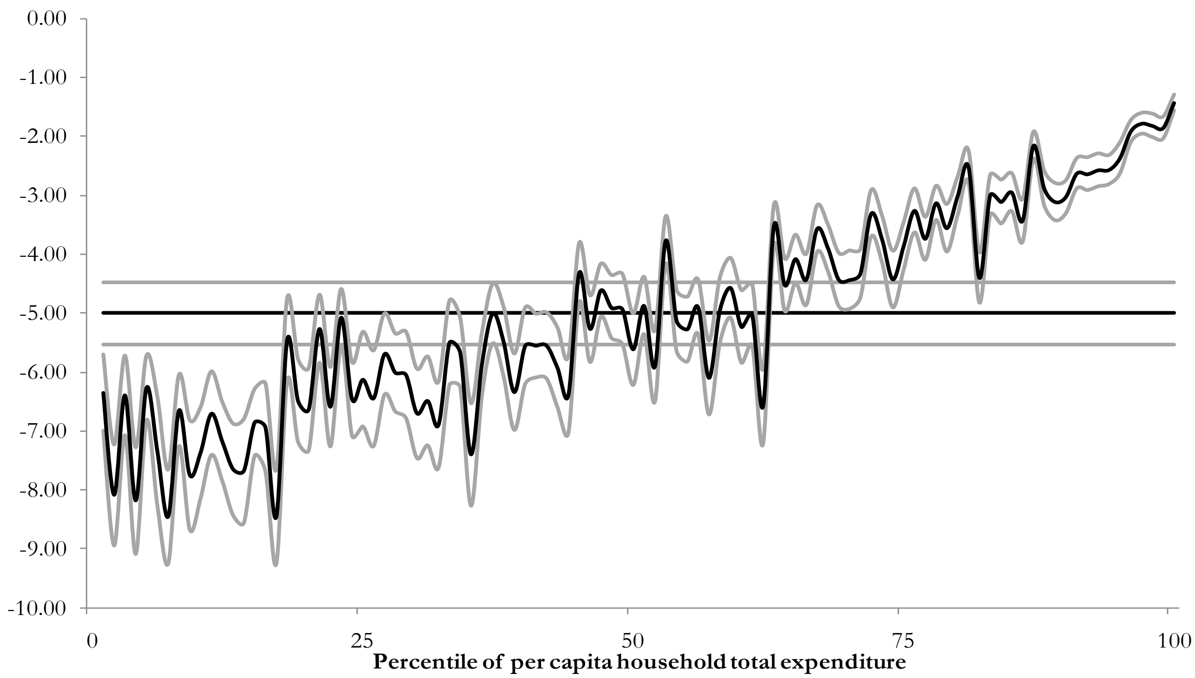
Source: IBGE - National Consumer Price Index (INPC).
Note: Metropolitan Regions are: BE = Belem, FO = Fortaleza, RE = Recife, SA = Salvador, RJ = Rio de Janeiro, SP = Sao Paulo, BH = Belo Horizonte, CA = Curitiba, PA = Porto Alegre, BA = Brasilia, and GO = Goiania. Regions are: N = North, NE = Northeast, SE = Southeast, S = South, and CW = Centerwest. Dashed horizontal lines represent national averages.

Figure 4: Engel Curve – Total Food Expenditure as a Share of Total Expenditure, by Percentile of Total Household Expenditure (11 Metropolitan Areas)



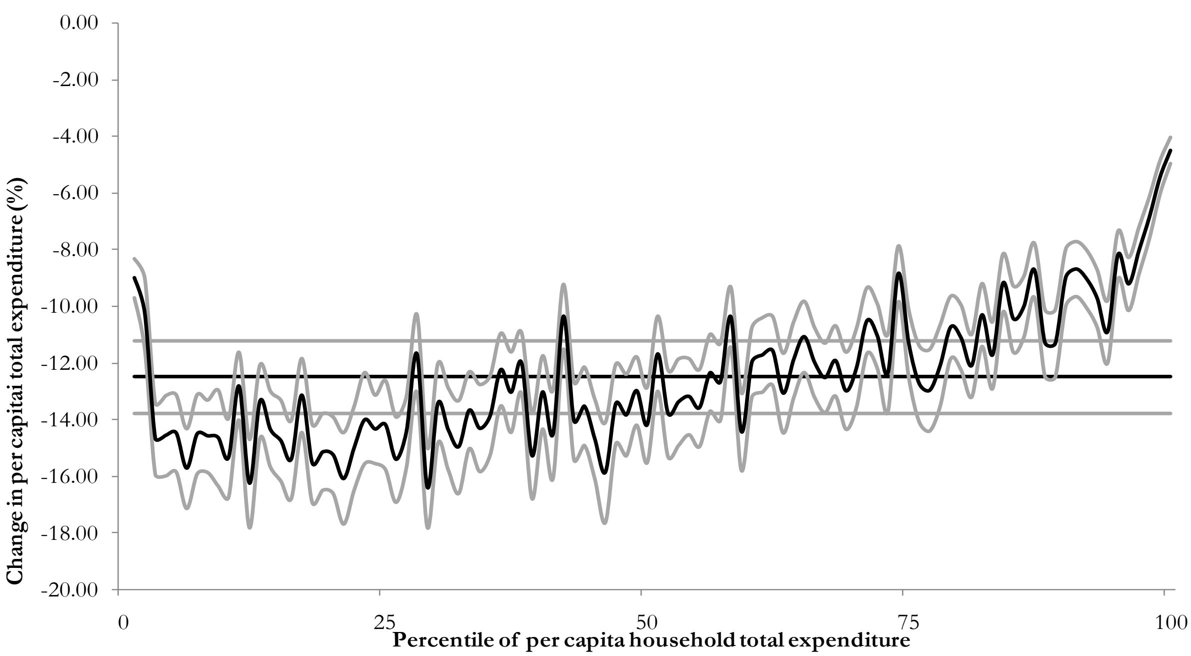
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Dashed horizontal line represents the average total food consumption as a shater of total consumption.

Figure 5: Price Increase Incidence Curve – Expenditure Effect (Large Urban Areas)



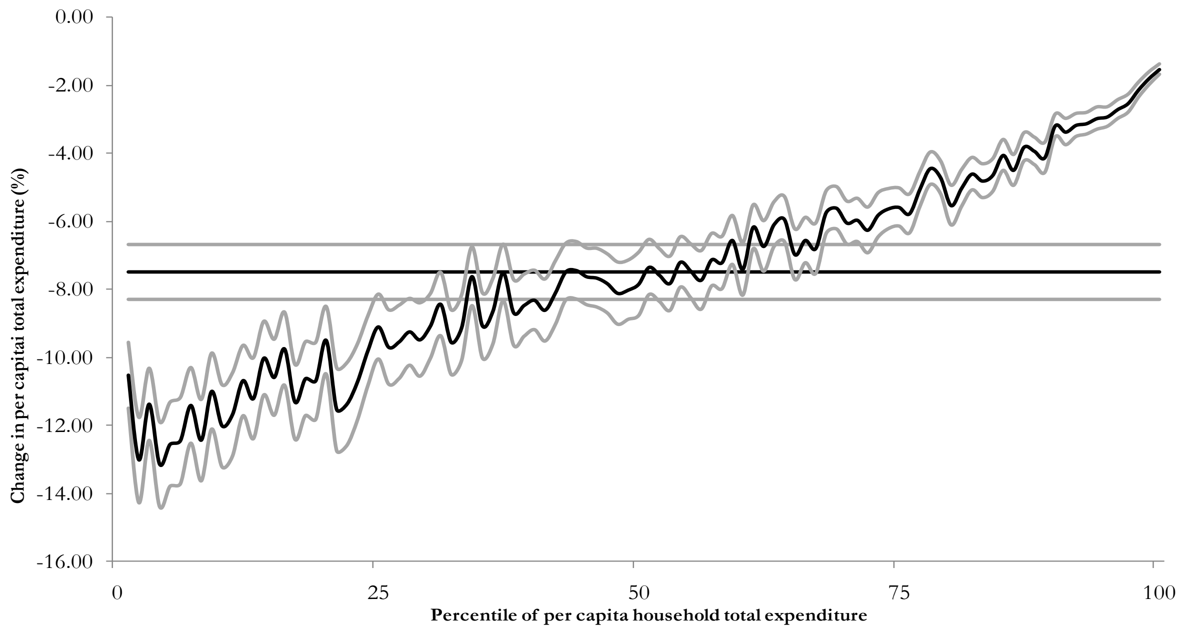
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 6: Price Increase Incidence Curve – Expenditure Effect (Rural Areas)



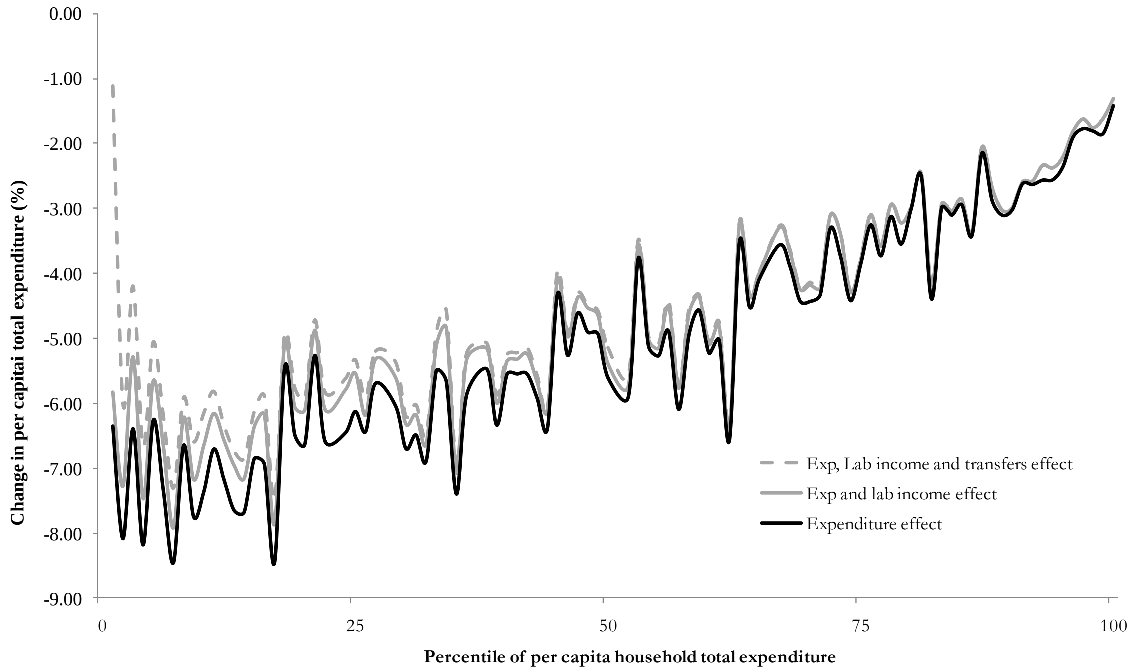
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 7: Price Increase Incidence Curve – Expenditure Effect (All Brazil)



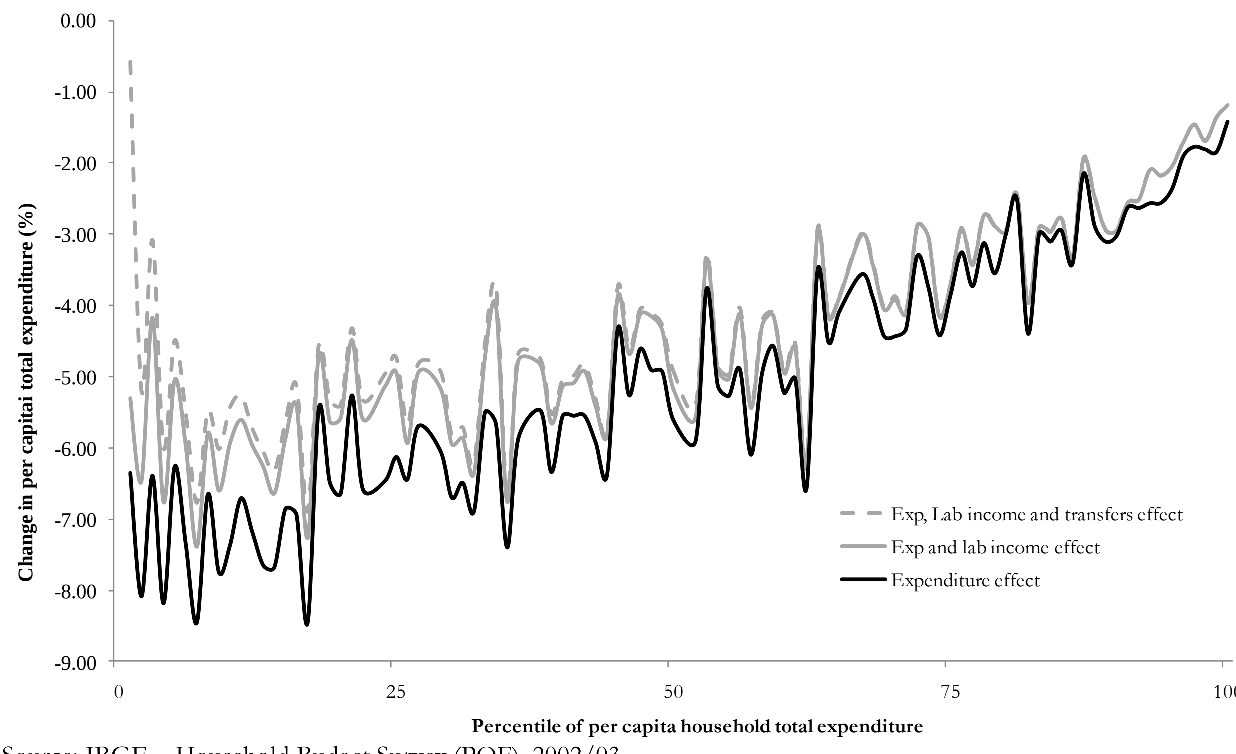
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 8: Price Increase Incidence Curve – Net Effect (Large Urban Areas – Alpha = 0.5)



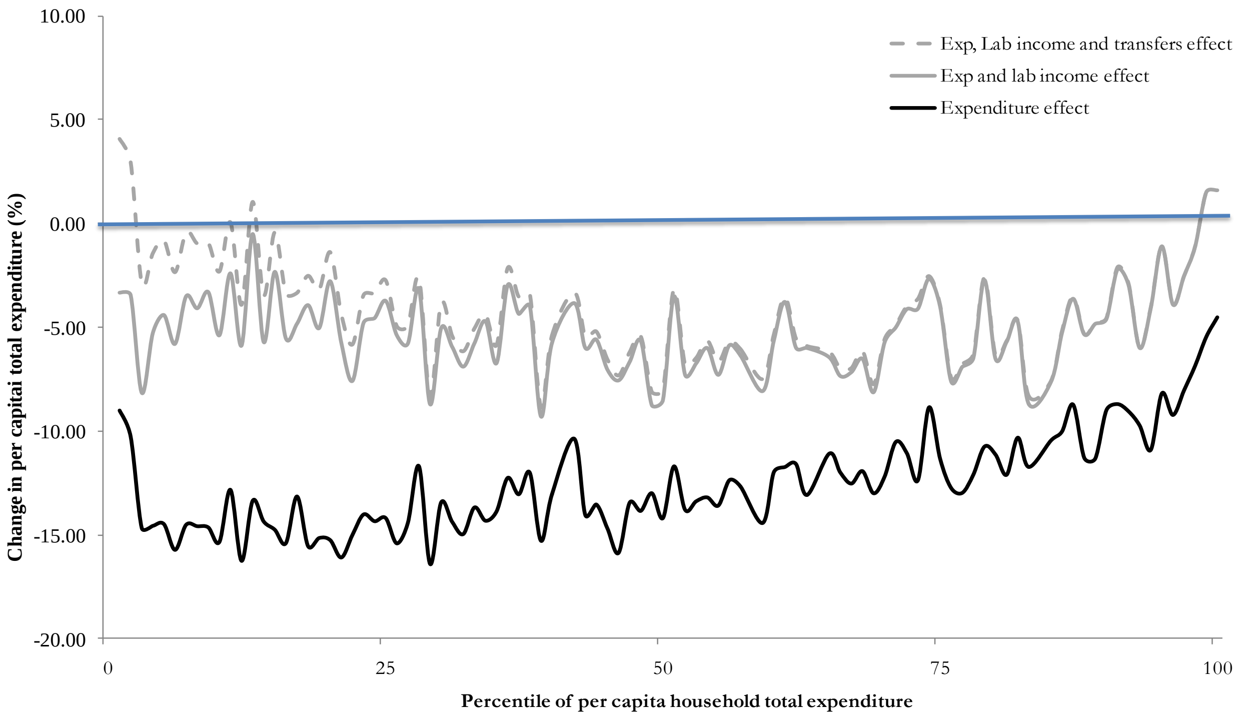
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 9: Price Increase Incidence Curve – Net Effect (Large Urban Areas – Alpha = 1)



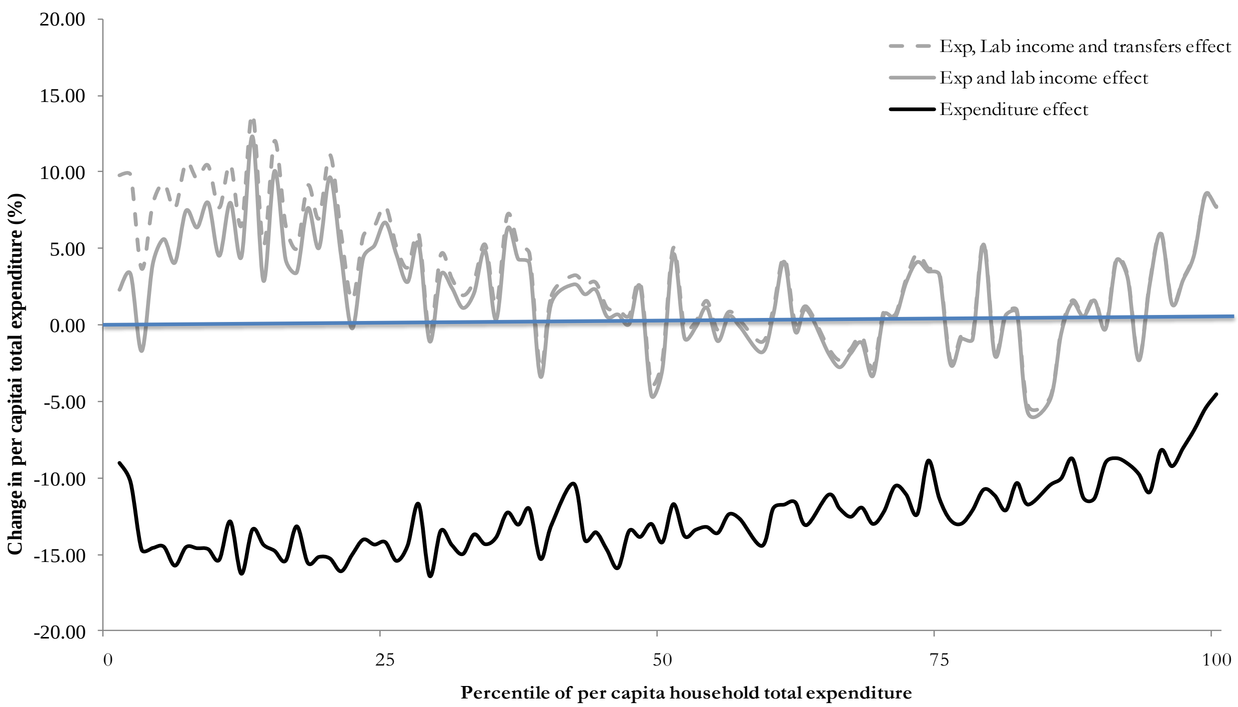
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 10: Price Increase Incidence Curve – Net Effect (Rural Areas – Alpha = 0.5)



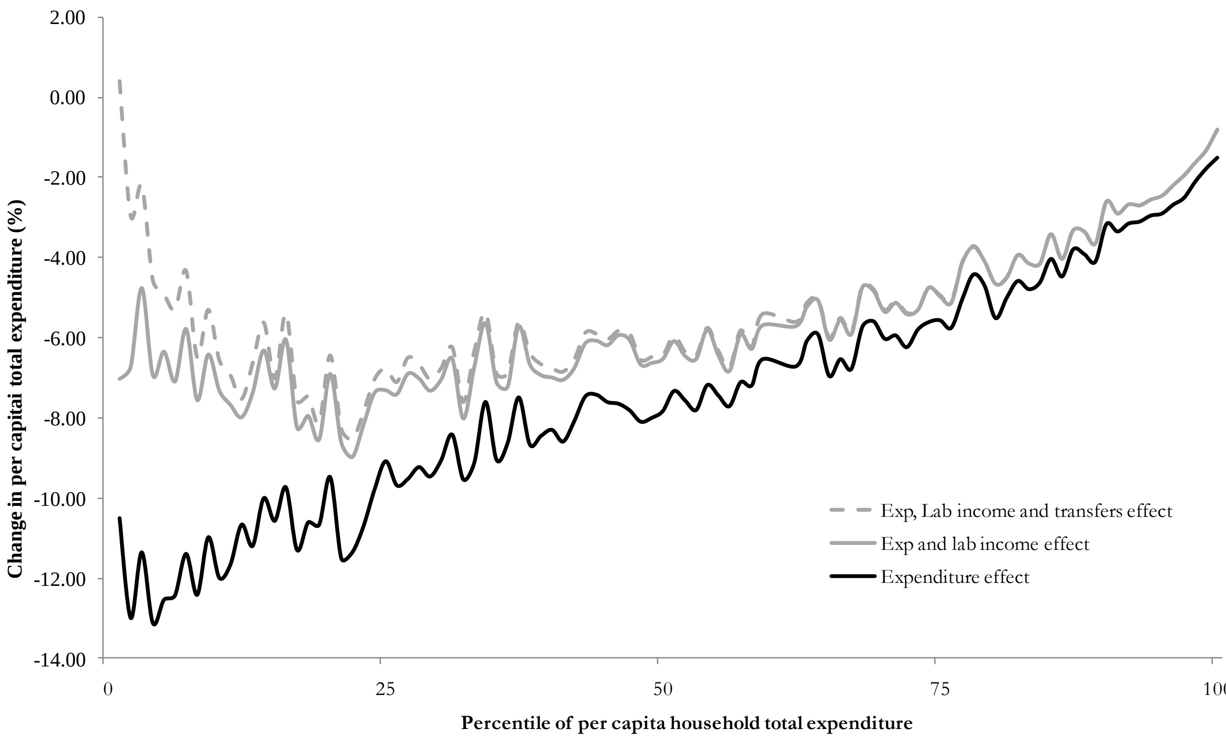
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 11: Price Increase Incidence Curve – Net Effect (Rural Areas – Alpha = 1)



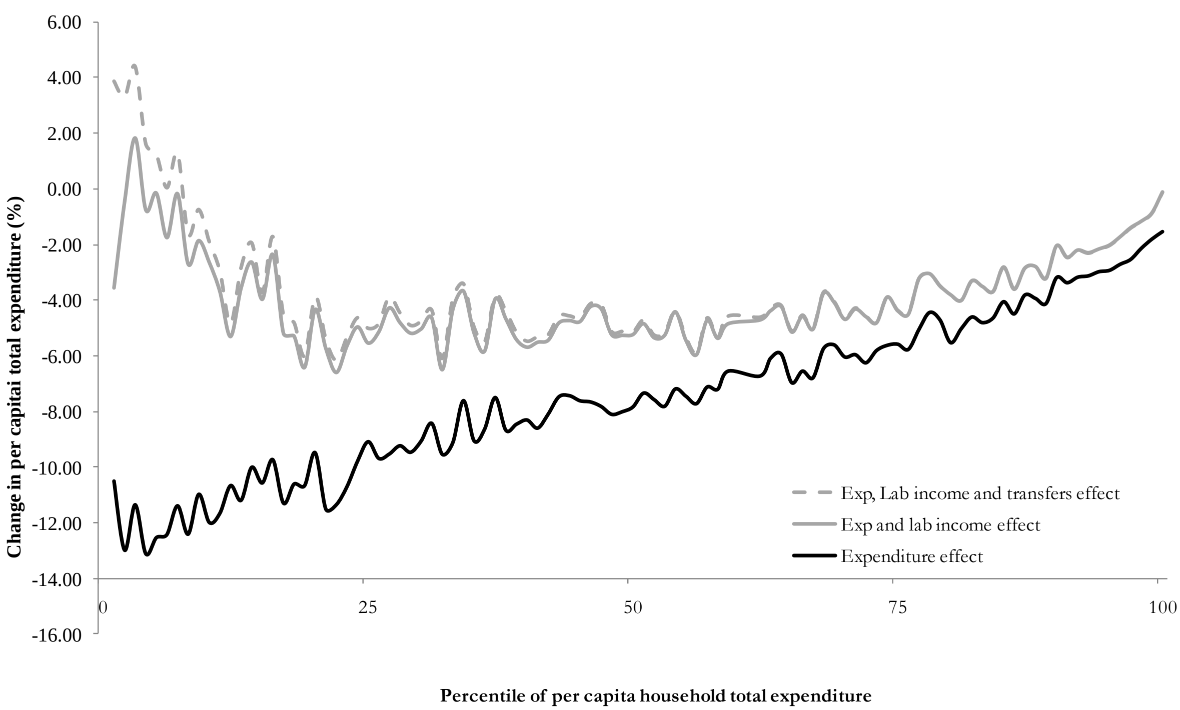
Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 12: Price Increase Incidence Curve – Net Effect (All Brazil – Alpha = 0.5)



Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Figure 13: Price Increase Incidence Curve – Net Effect (All Brazil – Alpha = 1)



Source: IBGE – Household Budget Survey (POF), 2002/03.
Note: Horizontal black solid line represents the average change in per capita expenditure.

Table 1: Average and Maximum Price Change by Food Items

Food Items	Average Price Increase	Maximum Price Increase over 12 consecutive months	
		Value	Peak month
Cereals	30.20%	76.60%	July 2008
Flour, starches, and pasta	11.80%	20.90%	June 2008
Tuber and roots	15.50%	49.10%	July 2008
Sugars and derivatives	9.20%	9.80%	November 2008
Vegetables	9.60%	21.00%	June 2007
Fruit	6.90%	16.20%	August 2008
Meat	20.30%	42.30%	July 2008
Poultry and eggs	15.90%	30.10%	April 2007
Milk and derivatives	10.70%	33.70%	August 2007
Baked	9.90%	22.50%	June 2008
Oils and fats	17.80%	39.80%	May 2008
Drinks and teas	4.90%	7.50%	October 2007
Canned and preserved	3.80%	8.70%	December 2008
Salt and condiments	2.90%	7.50%	November 2008
Food away from home	8.30%	12.00%	October 2008
Industrialized fish and meat	9.40%	20.40%	November 2008

Source: IBGE - National Consumer Price Index (INPC).

Table 2: Assignment of price changes from large urban area in the INPC to state in the POF 2002/03 expenditure survey

Region	(1) POF 2002/03	(2) PRICES - INPC	Assignment of (2) to (1)
	Rondônia	-	Belem
	Acre	-	Belem
	Amazonas	-	Belem
North	Roraima	-	Belem
	Pará	Belem	Belem
	Amapá	-	Belem
	Tocantins	-	Belem
	Maranhão	-	Fortaleza
	Piauí	-	Fortaleza
	Ceará	Fortaleza	Fortaleza
	Rio Grande do Norte	-	Recife
Northeast	Paraíba	-	Recife
	Pernambuco	Recife	Recife
	Alagoas	-	Recife
	Sergipe	-	Recife
	Bahia	Salvador	Salvador
	Minas Gerais	Belo Horizonte	Belo Horizonte
Southeast	Espírito Santo	-	Belo Horizonte
	Rio de Janeiro	Rio de Janeiro	Rio de Janeiro
	São Paulo	Sao Paulo	Sao Paulo
	Paraná	Curitiba	Curitiba
South	Santa Catarina	-	Porto Alegre
	Rio Grande do Sul	Porto Alegre	Porto Alegre
	Mato Grosso do Sul	-	Goiania
Center-West	Mato Grosso	-	Goiania
	Goiás	Goiania	Goiania
	Distrito Federal	Brasilia	Brasilia

Table 3: Spatially Differentiated Poverty lines

Region	Extreme poverty	Poverty	Region	Extreme poverty	Poverty
N. Belem	102.74	205.48	S.E. Urban	86.73	173.46
N. Urban	80.96	161.93	S.E. Rural	57.36	100.37
N. Rural	51.42	90.00	S. Curitiba	104.80	209.60
N.E. Fortaleza	96.06	192.12	S. Porto Alegre	115.80	231.59
N.E. Recife	123.96	247.93	S. Urban	107.80	215.59
N.E. Salvador	104.34	208.68	S. Rural	72.36	126.63
N.E. Urban	83.36	166.72	C.W. Brasilia	151.43	302.85
N.E. Rural	56.13	98.24	C.W. Goiania	90.44	180.88
S.E. Rio de Janeiro	70.89	141.76	C.W. Urban	90.44	180.88
S.E. Sao Paulo	141.42	282.82	C.W. Rural	57.73	101.03
S.E. Belo Horizonte	153.67	307.34			

Source: IBGE/Mapas de Pobreza 2003

Table 4: Food Price Effects on Poverty and Inequality (Large Urban Areas) – Alpha = 0.5

	Baseline	Expenditure Effect	Expenditure and Market Income	Expenditure and Bolsa Familia Effect	Expenditure and BPC Effect	Total
Extreme Poverty						
Headcount	11.15	12.34	12.25	12.27	12.32	12.18
	(0.19)	(0.20)	(0.25)	(0.18)	(0.22)	(0.21)
Poverty gap	3.64	4.22	4.18	4.18	4.21	4.13
	(0.08)	(0.08)	(0.08)	(0.11)	(0.09)	(0.10)
Squared poverty gap	1.82	2.11	2.09	2.07	2.10	2.05
	(0.06)	(0.05)	(0.06)	(0.06)	(0.07)	(0.06)
Moderate poverty						
Headcount	32.19	34.61	34.47	34.56	34.54	34.39
	(0.27)	(0.23)	(0.30)	(0.25)	(0.29)	(0.29)
Poverty gap	12.69	14.03	13.95	13.99	14.01	13.88
	(0.11)	(0.12)	(0.12)	(0.17)	(0.13)	(0.16)
Squared poverty gap	6.82	7.67	7.62	7.63	7.66	7.57
	(0.11)	(0.10)	(0.10)	(0.11)	(0.12)	(0.10)
Inequality						
Gini	55.7	56.5	56.4	56.4	56.4	56.4
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)

Source: IBGE – National Household Income Survey (PNAD), 2006.
Note: Standard errors in parentheses. Extreme and Moderate Poverty Line can be found in table 2 in the the annex.
Headcount, poverty gap and squared poverty gap measures are also known as FGT (0, 1 and 2) respectively (Foster et al. (1984))

Table 5: Food Price Effects on Poverty and Inequality (Large Urban Areas) – Alpha =1

	Baseline	Expenditure Effect	Expenditure and Market Income	Expenditure and Bolsa Familia Effect	Expenditure and BPC Effect	Total
Extreme Poverty						
Headcount	11.15	12.341	12.18	12.27	12.32	12.11
	(0.19)	(0.20)	(0.24)	(0.18)	(0.22)	(0.20)
Poverty gap	3.64	4.219	4.16	4.18	4.21	4.11
	(0.08)	(0.08)	(0.08)	(0.11)	(0.09)	(0.10)
Squared poverty gap	1.82	2.108	2.08	2.07	2.10	2.04
	(0.06)	(0.05)	(0.06)	(0.06)	(0.07)	(0.06)
Moderate poverty						
Headcount	32.19	34.605	34.31	34.56	34.54	34.23
	(0.27)	(0.23)	(0.30)	(0.25)	(0.29)	(0.29)
Poverty gap	12.69	14.033	13.88	13.99	14.01	13.82
	(0.11)	(0.12)	(0.12)	(0.17)	(0.13)	(0.15)
Squared poverty gap	6.82	7.674	7.58	7.63	7.66	7.53
	(0.11)	(0.10)	(0.10)	(0.11)	(0.12)	(0.10)
Inequality						
Gini	55.70	56.50	56.40	56.40	56.40	56.40
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)

Source: IBGE – National Household Income Survey (PNAD), 2006.
Note: Standard errors in parentheses. Extreme and Moderate Poverty Line can be found in table 2 in the the annex.
Headcount, poverty gap and squared poverty gap measures are also known as FGT (0, 1 and 2) respectively (Foster et al. (1984))

Table 6: Food Price Effects on Poverty and Inequality (Rural Areas) – Alpha = 0.5

	Baseline	Expenditure Effect	Expenditure and Market Income	Expenditure and Bolsa Familia Effect	Expenditure and BPC Effect	Total
Extreme Poverty						
Headcount	17.05	21.30	18.62	20.80	21.22	18.16
	(0.39)	(0.33)	(0.39)	(0.39)	(0.36)	(0.39)
Poverty gap	6.35	8.19	6.98	7.84	8.17	6.67
	(0.16)	(0.20)	(0.19)	(0.18)	(0.22)	(0.19)
Squared poverty gap	3.32	4.36	3.70	4.10	4.35	3.48
	(0.12)	(0.14)	(0.12)	(0.13)	(0.13)	(0.13)
Moderate poverty						
Headcount	36.96	42.93	39.36	42.87	42.79	39.10
	(0.45)	(0.52)	(0.43)	(0.48)	(0.53)	(0.51)
Poverty gap	15.40	18.93	16.76	18.61	18.88	16.43
	(0.27)	(0.32)	(0.27)	(0.24)	(0.25)	(0.29)
Squared poverty gap	8.69	10.96	9.53	10.65	10.93	9.24
	(0.18)	(0.20)	(0.19)	(0.21)	(0.17)	(0.21)
Inequality						
Gini	49.7	51.1	50.7	50.9	51.1	50.5
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)

Source: IBGE – National Household Income Survey (PNAD), 2006.
Note: Standard errors in parentheses. Extreme and Moderate Poverty Line can be found in table 2 in the the annex.
Headcount, poverty gap and squared poverty gap measures are also known as FGT (0, 1 and 2) respectively (Foster et al. (1984))

Table 7: Food Price Effects on Poverty and Inequality (Rural Areas) – Alpha =1

	Baseline	Expenditure Effect	Expenditure and Market Income	Expenditure and Bolsa Familia Effect	Expenditure and BPC Effect	Total
Extreme Poverty						
Headcount	17.05	21.30	16.44	20.80	21.22	16.01
	(0.39)	(0.33)	(0.37)	(0.39)	(0.36)	(0.35)
Poverty gap	6.35	8.19	6.20	7.84	8.17	5.93
	(0.16)	(0.20)	(0.19)	(0.18)	(0.22)	(0.18)
Squared poverty gap	3.32	4.36	3.29	4.10	4.35	3.09
	(0.12)	(0.14)	(0.12)	(0.13)	(0.13)	(0.12)
Moderate poverty						
Headcount	36.96	42.93	36.37	42.87	42.79	36.11
	(0.45)	(0.52)	(0.43)	(0.48)	(0.53)	(0.50)
Poverty gap	15.40	18.93	15.15	18.61	18.88	14.83
	(0.27)	(0.32)	(0.26)	(0.24)	(0.25)	(0.28)
Squared poverty gap	8.69	10.96	8.55	10.65	10.93	8.28
	(0.18)	(0.20)	(0.18)	(0.21)	(0.17)	(0.20)
Inequality						
Gini	49.7	51.1	50.7	50.9	51.1	50.5
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)

Source: IBGE – National Household Income Survey (PNAD), 2006.
Note: Standard errors in parentheses. Extreme and Moderate Poverty Line can be found in table 2 in the the annex.
Headcount, poverty gap and squared poverty gap measures are also known as FGT (0, 1 and 2) respectively (Foster et al. (1984))

Table 8: Food Price Effects on Poverty and Inequality (All Brazil) – Alpha = 0.5

	Baseline	Expenditure Effect	Expenditure and Market Income	Expenditure and Bolsa Familia Effect	Expenditure and BPC Effect	Total
Extreme Poverty						
Headcount	11.04	13.53	12.90	13.42	13.49	12.75
	(0.14)	(0.11)	(0.14)	(0.14)	(0.14)	(0.15)
Poverty gap	3.80	4.78	4.51	4.67	4.77	4.39
	(0.05)	(0.07)	(0.05)	(0.06)	(0.07)	(0.06)
Squared poverty gap	1.95	2.47	2.32	2.38	2.47	2.23
	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)
Moderate poverty						
Headcount	31.29	35.10	34.26	35.05	35.00	34.12
	(0.14)	(0.17)	(0.19)	(0.17)	(0.17)	(0.17)
Poverty gap	12.34	14.45	13.95	14.34	14.41	13.81
	(0.10)	(0.10)	(0.11)	(0.09)	(0.12)	(0.10)
Squared poverty gap	6.66	8.03	7.69	7.92	8.01	7.57
	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)
Inequality						
Gini	55.7	57.0	56.7	56.9	57.0	56.6
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Source: IBGE – National Household Income Survey (PNAD), 2006.
Note: Standard errors in parentheses. Extreme and Moderate Poverty Line can be found in table 2 in the the annex.
Headcount, poverty gap and squared poverty gap measures are also known as FGT (0, 1 and 2) respectively (Foster et al. (1984))

Table 9: Food Price Effects on Poverty and Inequality (All Brazil) – Alpha =1

	Baseline	Expenditure Effect	Expenditure and Market Income	Expenditure and Bolsa Familia Effect	Expenditure and BPC Effect	Total
Extreme Poverty						
Headcount	11.04	13.53	12.43	13.42	13.49	12.30
	(0.14)	(0.11)	(0.14)	(0.14)	(0.14)	(0.14)
Poverty gap	3.80	4.78	4.33	4.67	4.77	4.21
	(0.05)	(0.07)	(0.05)	(0.06)	(0.07)	(0.06)
Squared poverty gap	1.95	2.47	2.22	2.38	2.47	2.14
	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)
Moderate poverty						
Headcount	31.29	35.10	33.53	35.05	35.00	33.39
	(0.14)	(0.17)	(0.18)	(0.17)	(0.17)	(0.17)
Poverty gap	12.34	14.45	13.56	14.34	14.41	13.42
	(0.10)	(0.10)	(0.11)	(0.09)	(0.12)	(0.09)
Squared poverty gap	6.66	8.03	7.45	7.92	8.01	7.33
	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)
Inequality						
Gini	55.7	57.0	56.5	56.9	57.0	56.4
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Source: IBGE – National Household Income Survey (PNAD), 2006.
Note: Standard errors in parentheses. Extreme and Moderate Poverty Line can be found in table 2 in the the annex.
Headcount, poverty gap and squared poverty gap measures are also known as FGT (0, 1 and 2) respectively (Foster et al. (1984))

Annex Table A1:

Concordance between 16 Food Categories from the INPC 2008 and Agricultural Activities for Workers reported in PNAD 2006

Price category (INPC)	Type of occupational activity (PNAD)
Cereals	PNAD codes 1101 1102 1103 Arroz, cultivo de Rizicultura Milho, cultivo de Alpiste, cultivo de Aveia, qualquer tipo, cultivo de Centeio, cultivo de Cereais, exclusive arroz e milho, cultivo de Cevada, cultivo de Milho zaburro, cultivo de Painco, cultivo de Sarraceno (trigo), cultivo de Sorgo, qualquer tipo; cultivo de Trigo preto, cultivo de Trigo, cultivo de Triticale, cultivo de Triticultura
Tubers and roots	PNAD codes 1107, 1108 Soja, cultivo de Aipim, cultivo de Macacheira, cultivo de Mandioca, cultivo de Maniva (muda de mandioca), cultivo de
Sugars and derivatives	PNAD codes 01114, 01206 Cacau, cultivo de Abelhas, criacao de Apiario Apicultura Cera de abelha, beneficiamento de Cera de abelha, producao de Geleia real, producao de Mel de abelha, producao de Propolis, producao de
Vegetables	PNAD codes 01110 Abobrinha verde, cultivo de

	Acafrao, cultivo de Acafroa, cultivo de Acelga, cultivo de Agriao, cultivo de Aipo, cultivo de Alcachofra, cultivo de Alcaparras, cultivo de Alecrim, cultivo de Alface, cultivo de Alfavaca, cultivo de Alho porro ou poro, cultivo de Alho, cultivo de Almeirao, cultivo de Anis verde, cultivo de Aralia, cultivo de (produto horticola) Araruta, cultivo de Arruda, cultivo de Aspargo, cultivo de Azedinha, cultivo de Bardana, cultivo de Batata baroa, cultivo de Beldroega, cultivo de Berinjela, cultivo de Bertalha, cultivo de Beterraba, cultivo de Branquinha, cultivo de Brocolis, cultivo de Bucha, cultivo de Cabaca, qualquer tipo; cultivo de Camomila, cultivo de Caruru, cultivo de Cebola, cultivo de Cebolinha, cultivo de Cenoura, cultivo de Cerofolio, cultivo de Cheiro verde, cultivo de Chicoria, cultivo de Chirivia, cultivo de Chuchu, cultivo de Coentro, cultivo de Cogumelo, cultivo de Couve de bruxelas, cultivo de Couve tronchuda, cultivo de Couve, cultivo de Couve-chinesa, cultivo de Couve-da-catalonha, cultivo de Couve-de-bruxelas, cultivo de Couve-de-rabano, cultivo de Couve-flor, cultivo de Couve-mineira, couve-crespa ou couve-manteiga, cultivo de Couve-nabo, cultivo de Couve-tronchuda, cultivo de

	Curcuma, cultivo de Erva cidreira, cultivo de Erva-doce, cultivo de Ervas medicinais, cultivo de Ervilha (vagem), cultivo de Escarola , cultivo de Especiarias horticolas, cultivo de Espinafre, cultivo de Espinafre-de-nova zelandia, cultivo de Esponja vegetal, cultivo de Estevia, cultivo de Gengibre, cultivo de Gobo (ou bardana), cultivo de Grao-de-bico, cultivo de Guando, cultivo de Horta Hortalicas, cultivo de Hortela, cultivo de Hortela-pimenta, cultivo de Horticultura Horticultura, cultivo em casas de vegetação Horticultura, cultivo em estuva Horticultura, cultivo hidroponico Horticultura, cultivo sob cobertura plastica- plasticultura Horticultura, cultivo sobre cobertura Horticultura,cultivo ao ar livre Inhame, cultivo de Jilo, cultivo de Legumes, cultivo de Lentilha, cultivo de Losna, cultivo de Lufa, cultivo de Mandioquinha, cultivo de Mandioquinha-salsa, cultivo de Mangarito, cultivo de Manjericao, cultivo de Manjerona, cultivo de Maxixe, cultivo de Melao-de-sao-caetano, cultivo de Menta, cultivo de Morango, cultivo de Mostarda, cultivo de Nabica, cultivo de Nabo, cultivo de Olericultura Olho de boi, cultivo de Olho de dragao, cultivo de Ora-pro-nobis, cultivo de Oregano, cultivo de Palmas, cultivo de Pastinaca, cultivo de Pepino, cultivo de

	Picao-do-campo, cultivo de Pimenta, exclusive do reino; cultivo de Pimentao, cultivo de Plantas horticolas de viveiro, cultivo de Plantas horticolas para condimentos, cultivo de Poejo, cultivo de Quiabo, cultivo de Rabanete, cultivo de Rabano, cultivo de Repolho, cultivo de Rucula, cultivo de Ruibarbo, cultivo de Rutabaga, cultivo de Salsa, cultivo de Salvia, cultivo de Serralha, cultivo de Taioba, cultivo de Tomate de mesa (estaqueado), cultivo de Tomilho, cultivo de Vagem (feijao em vagem), cultivo de