Rising commodity prices and welfare in Brazil. A short-run analysis using a SAM price model

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Rising commodity prices and welfare in Brazil
A short-run analysis using a SAM price model*

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Abstract: During the 2000's, and from a macro perspective, Brazil benefited greatly because the increasing prices of agricultural commodities in world markets, as well as the price of oil and other primary commodities, which the country exports intensively. However, because the impacts these commodities might have on consumer prices, it is possible to envisage redistributive effects.

We model the responses of consumer and factor prices using a Social Accounting Matrix model, which can be adapted to develop a price model that captures the interdependences among activities, households and factors. An advantage of the proposed methodology is, among others, that it allows us to estimates a full set of effects, including changes in government transfers and payments by social security.

The results show that following an increase in the international prices of primary commodities, the responses of internal prices, of goods and factors, mean a welfare loss over the entire household per capita expenditure distribution, with those in the middle being the least affected. However, the differences among households are not very important. Inequality indices show little responsiveness to the simulated shocks.

JEL Codes: E16, F10, F14, F16, I30.

Keywords: commodity prices, poverty, social accounting matrix, Brazil.

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1. Introduction

Brazil is the eighth economy in the world if considered in terms of its gross domestic product (GDP), even rising in the rankings if one looks at its population and/or geographical area.

In spite of being still a developing economy, the country shows an advanced degree of industrialization, and perhaps more important a much diversified one. The process of industrialization took place for the most part under the protective umbrella of a protectionist trade policy within the framework of a program of import substitution, which lasted until the late 1980s.

However, beyond the high level of industrialization, which also exhibits a high concentration in geographic terms, mainly in the south/southeast of the country with the state of São Paulo as its main example, the country still is highly dependent on its exports of primary products, with exports of manufactures showing a high concentration in terms of countries of destination, with Latin America playing a major role.

This dependence on primary commodity exports meant that the Brazilian economy benefited significantly at the macroeconomic level from the rise in commodity prices in world markets that took place for much of the current century. However, with a still very high proportion of its population with low, even very low, income levels, the rise in commodity prices can have significant distributional consequences through the increase in the cost of living, in particular of goods that constitute the basic food basket.

An example of the later is that the consumer price index reporting the evolution of food and beverages more than doubled during the period 2000-2011, with three distinctive episodes in which there was an acceleration in rate of growth: between mid-2002 and 2003; mid-2006 and 2008; and from the end of 2010. A similar behavior, but with an appreciable lower variability, applies to the overall level of consumer prices. From Figure 1, in which we report also the evolution of the price index of the main agricultural commodities for Brazil foreign trade, it could be argued that the later played an important role on the behavior of consumer prices. However, not only agricultural commodities experienced an important increase in their prices during the first decade of the current century, the same did happen, even in greater magnitudes (see Figure 2), with those of oil, gas, and coal, and of minerals, all of which have an important role on the country exports.

Figures 1 and 2 also appear to shows how the channel between world and domestic prices has been enlarged in Brazil as a consequence of the changes experienced in the country's trade policy. Castillo *et al.* (2012) point out that the Brazilian economy experienced several changes in its trade policy over the last decades. While until the late eighties the strategy was to protect the domestic industries from external competence (under a regime of import substitution and industrial promotion), in the nineties sudden changes in the external policy were promoted. As a result of this change the average (unweighted) tariff fell from 40.4% in 1988 to 11.1% in 2005, while the tariff dispersion also diminished (Castillo *et al.*; 2012). At the end of the eighties Brazil started a unilateral policy towards trade openness; however with the signature of MERCOSUR in 1991 the country became engaged in a custom union together with Argentina, Uruguay and Paraguay. These profound changes in the trade policy triggered the need for assessing the impact of the liberalization policies.

In this paper we are concerned about the impact of changes in commodity prices on the welfare of households. Poverty and inequality remain at high levels even though the indicators show important improvements with respect to the 1980's (see Figure 3). Table 1 shows that in 2003 almost 48% of population had an income below the half of the computed mean. Thus, even though the Brazilian economy

has increased its participation in the world economy during the last twenty years, poverty and inequality remain still an issue to be looked at. Being the differences between rural and urban areas considerable and varying across the different states. All these characteristics imply that the rise in international prices of commodities, especially agricultural ones, can have sizable impacts on a large part of population, given that a substantial share of households concentrate a large share of their consumption on food and beverages. Based on *Pesquisa de Orçamentos Familiares* (POF) of 2005, de Souza Ferreira Filho (2011) splits households into 10 groups, showing that the first five income groups account for the 67.8% of population, while its share in income is just 29.3%. The two richest groups, on the other hand, accounts for the 9.9% of the population, and get 41.6% of total income. By setting the poverty line at on third of the average household income, the author stress that about 28% of the Brazilian household would fall under extreme poverty in 2005. However, looking at each group individually, the share of households below the poverty line remains also high until the third group (the poorest group accounts by around 50% of households under poverty, and a 66% of the national poverty gap.

Table 2 shows the distribution of household's income according to the different sources and also across identified income groups. It emerges clearly that the participation of the salaried labor is higher in the groups with low and middle incomes. In addition, another striking feature (which Brazil shares with the vast majority of Latin American economies) is the huge percentage of working population engaged in the informal sector. This group accounted in 2003 for the 22.7% of the total household income generated by the income sources considered. However, the figure rises to 34.9% when considering the poorest decile.

In light of the previous evidence, besides looking at changes in consumer prices, any welfare analysis should be complemented by looking at the response of the different sources of income, in particular salaried labor, in response to changes in commodity prices. Moreover, even when for the time being we do not pursue here that alternative, the case of Brazil opens up the possibility of study the globalization process at a regional scale, given that it is a Federal country comprised of 27 federal states (including the federal district), for which exists high-quality household's datasets. As de Souza Ferreira Filho (2011) sates, Brazil is a heterogeneous country, with important regional differences in poverty and income distribution, being the northeast and north regions those with higher poverty levels. Also, agriculture accounts for about half of total wages of the less skilled workers, while the remaining sectors explain a larger share of workers in the higher wage classes. Thus, the need for tracing back the impact of the shocks to international prices on welfare to a regional level.

The rest of the paper is organized as follow. In section 2 we briefly summarize some previous evidence for Brazil, while in section 3 we lay out the empirical approach. The data used is briefly described in section 4, and section 5 presents the results. Section 6 is of summary and conclusions.

2. Some previous evidence with focus on Brazil

The analysis of the transmission of the shocks of agricultural commodity prices on the Brazilian economy, and the effects on welfare, poverty and inequality have been assessed by several authors during the last decade. In this section we briefly describe the main methodologies and results of a few cases.

Closely related to aim of our paper, Krivonos and Olarreaga (2009) assess the impact on welfare due to an increase of sugar trade across eleven Brazilian states on internal prices, wages and unemployment. Firstly, they estimate a vector correction model to determine the pass-through from world prices to domestic

prices. Secondly, a Heckman´s sample section model is utilized to estimate the impact of domestic prices on wages and employment; in this scheme the effects of changes in sugar prices are allowed to vary according to individual characteristics such as sector and geographical location of the household. Additionally, to correct the bias that arises because is not possible to observe the wages of people who are not employed, the model adds a probity equation in which the employment status depends on explanatory variables defined at a regional and individual basis. Finally, a 10%-increase on sugar's world price is simulated. The authors find that following the increase in world prices poorer workers improve their situation as the possibilities of being employed increase, while workers at the top of the income distribution also show an improvement in their welfare because of the rise in their wages.

de Souza Ferreira Filho (2011), analyses the effect of the increase on the demand of ethanol on the Brazilian economy through the response of labor demand (both in the agricultural sector and the whole economy). He calibrates a Computable General Equilibrium (CGE) model to assess the income distribution effects on households (micro-level analysis). Labor demand in the agriculture sector is disaggregated into different types of workers, and the exercise also allows for different regional effects given that the model is comprised of 27 separate CGE models (one for each Brazilian state), linked by the markets for goods and factors. Regional income involves salaried income (divided into 10 different categories of skills), capital and rents. The changes in production drive the variation in the demands for labor (classified by sector and region). Finally, the changes in poverty and income distribution are tracked back at a household level. The simulations show that poverty will decrease as a consequence of a rising world demand of ethanol, improving the income distribution. However the poverty gap rises, probably as a consequence of the ongoing mechanization process in which agricultural activities are involved.

Differently from the two previous papers, which concentrate on an exogenous shock in international markets, Castillo *et al.* (2012) perform an econometric analysis to look at the effect of the liberalization polices of the nineties on inequality and poverty in Brazil at the state level. They relate different measures of inequality (and poverty) for a given Brazilian state with different indices of trade liberalization. They took into account two variables to capture the magnitude of trade liberalization; on the one hand, they used the so-called LIB index, given by a weighted average of national industry-level tariffs, being the weights the "initial" share (that is, the observed participation before the liberalization) of employment by industry within each state. On the other hand, trade-flows base indicators (lagged import penetration, lagged export exposure and lagged trade openness) are used as a proxy of the liberalization episode. Counter intuitively (according to the Stolper-Samuelson theorem), their results indicate that poverty and inequality rose as consequence of the liberalization policies, even though the reduction in tariffs were more important in the skill-intensive sectors.

Finally, Ferreira *et al.* (2013) compute the effect on welfare that follow from the rise in food prices in 2007-2008. They study whether the income gains that benefits agricultural producers offset the welfare loss caused by the increase in the consumer prices as a result of a shock to international prices of agricultural commodities, even when no effort is made to measure the pass-through from international to domestic prices. They work with (monthly) disaggregated data across different regions of Brazil to disentangle three effects: the "expenditure effect", the "market income effect" and a "transfer income effect". The expenditure effect is defined as usual, throughout the difference in the expenditure functions (valuated in the final and initial foods prices respectively), which defines the compensating variation. The "market income effect" entails the computation of the pass-through of food prices on salaries of workers engaged in the production of agricultural commodities, while the "transfer income effect" requires measuring the cash transfers that the government disburses to the households. They find that the overall welfare is reduced as

a consequence of the shock to food prices produced in 2007-2008, mainly due to the operation of the expenditure effect (even though both the market and the transfer income effects produce an improvement in the welfare). Additionally, the losses are smaller in urban areas, while in rural states the losses are greater. The overall reduction in welfare are in line with our findings as reported below.

From this brief review is possible to gather that any sensible analysis should make an effort to include the effects that take place through different channels: consumption and income, and not only via price changes but also through the adjustment of quantities (mostly in terms of employment and consumption). In the next sections we take on this challenge, but for the time being leaving aside any effort to include the role of changes in quantities.

3. Empirical approach

The aim of this study is to measure the ex-ante impacts of an increase in international prices of commodities on welfare and other distributive indices for the case of Brazil. In order to obtain an estimation of such impacts a crucial ingredient is how domestic prices, both of consumption goods and of production factors, react to changes in commodity prices. A standard approach in the literature looks to obtain the elasticities from commodity prices to domestic ones trough the adoption of simple ad *hoc rules* or though the estimation of econometric models, where Vector Autoregressive (VAR) and Vector Error Correction (VEC) models are the preferred alternatives. A problem with this strategy is that data on prices are usually not available with much detail, at least not for a period with a length enough so time-series methods can provide estimates with a minimum of certainty and confidence. Also, this approach implies usually the estimation of reduced forms with a more or less lack of theoretical support, as well as they are in most cases not capable of accounting for second order effects that works through the relations between different sectors of the economy. In despite of this potential shortcomings several studies have resorted to this approach [Anderson and Tyres (1992), Krivonos and Olarreaga (2009), Barone *et al*. (2017.a and 2017.b), and Moncarz *et al*. (2017)].

As an alternative to the time-series approach, another widely tool is the construction of Computable General Equilibrium models (CGE), which have the advantage of being able to account not only for the direct effects but also for the indirect ones. For Brazil this strategy was applied by de Souza Ferreira Filho (2011) to look at the case of ethanol. However, CGE models are mostly designed to account only for a small number of sectors, especially in terms of different types of households, which is an important drawback if the objective is to gather detailed evidence on how a certain shock may impact different economic agents, and not just on a few representative ones. This drawback have in recent times been considerably loosened with the advances in computational capabilities, which have allowed combining aggregate CGE models with very detailed household surveys on expenditures and incomes. Here two routes are available, a microsimulation (MS) approach and a representative household (RH) approach. As pointed out by Lofgren *et al*. (2003), "*under the MS approach the size distribution of incomes is generated by a household module in which the units correspond to individual household observations in a survey*", while "*under the RH approach, the RHs that appear in the CGE model play a crucial role: the size distribution is generated by feeding data on the simulated outcomes from the RHs into a separate module that contains additional information about each RH*". For a detailed review on this topic see Estrades (2013). Nevertheless, even when these possibilities make the use of CGE analysis very appealing, it does not avoid the need of constructing sophisticated models that are quite demanding in terms of the data required to implement

them. In light of this issue, we follow an intermediate step using an approach that follows on the objective of controlling for not only the direct effects that changes on commodity prices may have on domestic prices, but also is much less demanding in terms of the need of information. In particular, we calculate the elasticities of domestic prices as a response to a shock in international prices using a variant of the Social Accounting Matrix (SAM) price model proposed by Roland-Holst and Sancho (1995).

A SAM is a record, for a given period, of the transactions between the different components or sectors (accounts) of an economy. Because a SAM presents in detail the flows among all sectors of an economy, is an ideal starting point for an analysis looking at studying no only the direct effects of a certain shock, but also the indirect ones that find their way through the intricate set of interdependencies among economic agents and sectors. However, and unlike CGE models is not possible to model substitution patterns in consumption and/or production.[1] Nevertheless, since our interest lies on the short-run effects following changes in commodity prices, we believe the approach has still enough merits to inform us on the expected consequences of such changes. Among the literature using this methodology we can highlight the examples of Parra and Wodon (2008.a and 2008.b), Akkemik (2011), and Saari *et al*. (2016).

3.1. The SAM price model

Let assume an economy can be represented as in Table 3, where columns indicate payments and row receipts. For each account total spending is necessarily equal to total receipts, so column and row totals of the SAM are equal.[2] Additionally, let assume commodities (C), activities (A), factors of production (F), households (H) and the government (G) are assumed the endogenous (*en*) accounts, while the capital account (CC) and the Rest of the World (R) are exogenous (*ex*). Then, we have:

$$Y_{en} = \mathrm{EE}\ Y_{en} + \mathrm{EX}\ Y_{ex} \tag{1}$$

where:
Y_{en}: vector of outputs for the endogenous sectors;
Y_{ex}: vector of outputs for the exogenous sectors;
EE: matrix of expenditure propensities among endogenous sectors;
XE: matrix of expenditure propensities of exogenous sectors on endogenous sectors;

Operating on (1) we get:

$$Y_{en} = \left[\mathrm{I} - \mathrm{EE}\right]^{-1}\left(\mathrm{XE}\ Y_{ex}\right) = \left[\mathrm{I} - \mathrm{EE}\right]^{-1} x = Mx \tag{2}$$

where x = (XE Y_{ex}) is the vector of exogenous demands, and M is the multiplier matrix showing the change in output of the endogenous sectors for each unit change of the exogenous demands.

[1] A possibility here is the introduction of substitution possibilities in input demand and consumption of commodities as functions of changes in relative prices as in Saari *et al*. (2016).
[2] Each account does not necessarily is of dimension 1. For instance, H will have a dimension equal to the number representative households. Similarly, account F will be of a dimension equal to the different types of production factors (e.g. unskilled labor, skilled labor, capital, land, etc.).

As shown in Ronald-Holst and Sancho (1995), if in addition to the assumptions of excess capacity and unused resources in production we add generalized homogeneity and fixed coefficients in activities, we have the case in which prices can be computed independently of quantities.

$$p' = p'\mathrm{EE} + \overline{p}'\mathrm{EX} \tag{3}$$

where:
p: vector of prices for the endogenous sectors;
$\overline{p}$: vector of prices for the exogenous sectors;
EE: matrix of expenditure propensities among endogenous sectors;
EX: matrix of expenditure propensities of endogenous sectors on exogenous sectors;

Operating on (3) we get:

$$p' = \left(\overline{p}'\mathrm{EX}\right)\left[\mathrm{I} - \mathrm{EE}\right]^{-1} = vM \tag{4}$$

where *M* is the same matrix as in (3), and the elements in *v* are the exogenous cost components of the endogenous accounts.

Expanding the notation and taking the transpose of (4) we obtain:

$$\begin{bmatrix} p_1 \\ \vdots \\ p_{11} \end{bmatrix} = \begin{bmatrix} m_{1,1} & \dots & m_{11,1} \\ \vdots & \vdots & \vdots \\ m_{1,11} & \dots & m_{11,11} \end{bmatrix} \begin{bmatrix} v_1 \\ \vdots \\ v_{11} \end{bmatrix} \tag{5}$$

From (5) we have:

$\frac{\partial p_i}{\partial v_j} = m_{ji}$, which provides the change in the endogenous price *i* in response to a one monetary shock in the exogenous cost component of sector *j*. Additionally, if by the choose of units all benchmark prices are set to be equal to one, then the change in p_i can be interpreted also as a proportional change.

Even when very appealing, expression (5) is not appropriate to answer the question we are interested in. Let assume some commodities are internationally traded, so that its price can be considered exogenous for the economy we are looking at, and we are interested in obtaining the effects on the other endogenous prices from an exogenous shock to the prices of the commodities. In order to be able to run this exercise we need to appeal to a variation of the SAM price model presented above, known as the mixed endogenous-exogenous price model. Under this framework some sector are modeled as having fixed prices (the equivalent of a supply constraint in the value model), which mean their prices can only be modified exogenously, such as due to a price shock in international markets.

Let now assume that the endogenous sectors are divided into two mutually exclusive categories, constrained (*c*) and unconstrained (*nc*). Then, our economy can be represented an in Table 4, and we have:

$$\begin{bmatrix} p_c \\ p_{nc} \end{bmatrix} = \begin{bmatrix} C_c' & R' \\ Q' & C_{nc}' \end{bmatrix} \begin{bmatrix} p_c \\ p_{nc} \end{bmatrix} + \begin{bmatrix} b_c \\ b_{nc} \end{bmatrix} \tag{6}$$

where:
p_{nc}: vector of endogenous prices for the unconstrained sectors;
p_c: vector of exogenous prices for the constrained sectors;
b_{nc}: vector of exogenous costs for the unconstrained sectors;
b_c: vector of endogenous costs for the constrained sectors;
C_{nc}: matrix of expenditure propensities among unconstrained sectors;
C_c: matrix of expenditure propensities among constrained sectors;
Q: matrix of expenditure propensities of unconstrained sectors on constrained sectors;
R: matrix of expenditure propensities of constrained sectors on unconstrained sectors;

From (6) we obtain:

$$p_{nc} = Q' p_c + C'_{nc} p_{nc} + b_{nc}$$

that after some manipulations we end up with:

$$p_{nc} = \left[I - C'_{nc} \right]^{-1} Q' p_c + \left[I - C'_{nc} \right]^{-1} b_{nc} \quad (7)$$

from which:

$$d\left[p_{nc} \right] = \left[I - C'_{nc} \right]^{-1} Q' d\left[p_c \right] = M_m \, d\left[p_c \right] \quad (8)$$

where $M_m = \left[I - C'_{nc} \right]^{-1} Q'$ is the mixed multiplier matrix, providing the impacts on the prices for unconstrained sectors (p_{nc}) in response to shocks on the prices of the constrained sectors (p_c). Once again, with all prices being equal to one in the benchmark scenario, expression (8) provides also the elasticities between the two sets of prices. To calculate these elasticities we use the SimSIP SAM tool designed by Parra and Wodon (2008.b).

4. Data

In this section we briefly describe the datasets used to calculate the elasticities as well as to perform the microsimulations.

As it is clear from the previous section, price elasticities (of goods and factors, as well as of other variables of interest) are obtained using a mixed SAM price model. In particular, we use the SAM built up by Fontes Tourinho *et al*. (2006) for the year 2003. An appealing feature of this SAM is that corresponds to the beginning of the period commodity prices started their increasing path, and that was built using data on the patterns of household expenditures and income from the *Pesquisa de Orçamentos Familiares* 2002-2003 (POF 2002-2003), which is the source we use to run our microsimulations.

The SAM 2003 includes 39 activities and commodities. Factors of production are divided into 6 categories of labor (distinguishing among three levels of education and between formal and informal sectors), capital and land. Another category called "*Juros*" corresponds to flows relating to financial capital, containing amounts paid and received as interest. Households are divided into 11 categories depending on their per capita income. There is also an account for enterprises, another for the government, and six for different

types of taxes (direct, indirect, on foreign trade, etc.), two for social security (for private and public workers), the capital account and the rest of the world.

Even when with a good level of detail, a small drawback is present in the case of the commodity corresponding to agricultural goods. Our main interest is to look at the effects that the increase in commodity prices in which Brazil is a strong exporter to international markets (agricultural, oil/gas, and minerals) has on household welfare, through the changes in the prices of goods and services consumed by households, and in factor prices explaining household's income. A characteristic of these commodities is that they are not directly consumed by households, but they are used as intermediate inputs in the production of other goods and services, which then are sold for final consumption. While the two commodities we use to analyze the cases of oil/gas[3] and minerals[4] have in the SAM almost a zero weight in the consumption of the different types of households, and also they have no direct equivalent in the classification of goods used in the POF, the same is not the case for agricultural commodities[5], representing 3.15% of consumption for the richest households, and up to 14.1% in the case of the poorest ones, according to the SAM figures. Similar numbers emerge from the POF with a slightly higher weight at the low end of the per capita income distribution.

The second dataset we use is the POF 2002-2003. This survey is a comprehensive record of the patterns of consumption and income by households. On the consumption side, we work with 75 different categories. However, since the SAM has only 39 commodities, some of them are assigned to more than one expenditure category. Then, the 75 consumption categories are further grouped into 9 broader types of expenditure. On the income side, we work with 6 sources of labor income, the same available in the SAM, transfers from the Government, and receipts from Social Security. For the moment, because we have been unable to identify with a minimum of confidence the other sources of income, we exclude them from the analysis. However, they are taken into account to calculate households' total income.[6]

Either at the moment of simulating the effects working through consumption or through income, we work with the greatest detail available, and then group them into broader categories for easy of presentation.

5. Results

Before looking at the results which are the main objective of this research, we present some of the outcomes emerging from the SAM price model.

In Figures 4 and 5 we report the elasticities of goods and factors in response to the three commodities for which we consider their prices to be exogenous, and so potentially subject to foreign shocks, using the classification of the SAM.

The first clear result is the larger elasticities with respect to agricultural commodities in comparison to minerals, and petroleum and natural gas, coal and other fuels. The only exception to this pattern is good P-17 (Oil refining and petrochemical industry) that not surprisingly shows the largest response with respect to

[3] Extraction of petroleum and natural gas, coal and other fuels (coded P-03 in the SAM).
[4] Mineral extraction, except for fuels (coded P-02 in the SAM).
[5] Agriculture (coded P-01 in the SAM).
[6] Here we exclude incomes from unusual sources (e.g. the sale of personal equipment, motor vehicles, etc.) and from the operation of financial assets. Also, we exclude incomes whose source cannot be properly assigned to some of the categories we work with.

petroleum and natural gas, coal and other fuels. The elasticities with respect to minerals are in all cases very low. When we concentrate on the case of agricultural commodities, is also not a surprise that the largest elasticities correspond to goods related to the food and beverage industry [coffee (P-24); processing of plant products (P-25); meat processing and slaughtering (P-26); cooling and preparation of milk and milk products (P-27); sugar (P-28); vegetable oils and fats (P-29); other food and beverage industries (P-30)].

A similar pattern emerges for the elasticities of factor prices, with the largest figures corresponding to agricultural commodities. Among the different types of factors, labor shows the largest numbers, in particular unskilled labor (L); without much differences between formal (F) and informal sectors (NF).

When instead of the SAM classification, we use the broader categories of the Consumer Price Index (CPI), the results are pretty similar (see Figure 6). The largest elasticities are those relative to agricultural commodities, especially for Food and Beverages, while for fuels emerge more clearly the Transport category.

5.1. Simulation of the effects on welfare

Our primary goal in this section is to simulate the effects on welfare that may follow an increase in the international prices of primary commodities. In particular we simulate a 50% increase in agricultural commodities, and a 100% increase in the case of oil, gas and coal; and also of minerals.[7] Once we have obtained the elasticities of consumer prices and wages, we can simulate the welfare effects that would follow to a given shock in commodity prices. In particular, the welfare effect for each household will be measured by the negative of the compensating variation relative to its initial expenditure:

$$\frac{dx_0}{e} = -\left(\sum_{j=1}^{3}\sum_{g=1}^{7} s_g \psi_{g,j}\right) d\ln p_j + \left(\sum_{j=1}^{3}\sum_{l=1}^{6} \theta_l^i \varepsilon_{l,j}\right) d\ln p_j \qquad (9)$$

where s_g is the budget share spent on good *g*, $\psi_{g,j}$ is the price elasticity of good *g* with respect the international price of commodity *j* $\left(p_j\right)$, θ_l^i is salaried labor income of member *i* for labor category *l*, divided by total household income, and $\varepsilon_{l,j}$ is the wage elasticity that captures the proportional change in the wage rate (for labor type *l*) as a response to the change of the international price of commodity *j*. The first term in the RHS of (9) is the welfare effect that takes place through consumption, while the second term measures the effect through changes in labor income. Considering the way in which equation (9) is computed, a negative value means a welfare loss, while a positive value means a welfare gain. In equation (9) we do not consider second-order effects that take place through changes in consumption patterns in response to changes in consumer prices, neither changes in the supply of labor. Also, we do not take into account the effects on non-labor income, neither those due to the consumption of own-produced goods.[8]

Unlike when elasticities are obtained through the use of econometric methods, in our case we do not have associated to each of them a standard error. Thus, in our simulations we need to deal with just one source of randomness, the one coming from the sampling variability of expenditure shares and of the participation of salaried labor in household incomes. This randomness due to sampling variability of households (and

[7] These figures are roughly the differences between the means for the periods 1992-2001 and 2002-2011.

[8] For the time being we are making no effort for the aggregate effects of the simulations to be numerically consistent with the results of the SAM-price model.

therefore of budget shares and that of the participation of salaried labor in household incomes) is controlled by sample weights provided by the POF.

Figure 7 shows the magnitudes of the welfare effects along the range of households' per capita expenditure (HPCE), for food and beverages (F&B) and non-food and beverages (NF&B) respectively. Not surprisingly, in the case of F&B households with lower levels of HPCE are more affected, while the opposite happens for NF&B goods. Once we add the effects working through the two sets of goods (Figure 8), households with lower levels of HPCE are the ones losing the most, but with no much differences among households. A result to some extent surprising is that the losses derived from the consumption of NF&B is larger than the ones taking place because of F&B. This outcome can be explained because even for poorer households the consumption of F&B is less than one third of total consumption.

In Figure 9 we report similar information than before, but now looking at the effects working through the households' main source of income which is salaried labor. Households with low and middle levels of HPCE benefit more that those located at the upper end of the per capita expenditure distribution. However the positive effects finding their path through income from labor are not large enough to compensate for the loses from the consumption side. Overall, all households would experience a welfare loss, with the most negatively affected being those located at the low end of the HPCE range, and the least affected being the ones in the middle (see Figure 10).

Other sources of income which we are able to identify are transfers from the government and payments by social security. Assuming that both increase in the same proportion as the changes in their respective "price indices", Figure 11 reports the distribution of the welfare gains. Not surprisingly, poorer households are the ones that benefit most from government transfers, while middle and rich ones do from the increasing incomes from social security. Interestingly, these two sources appear to complement each other, with the aggregate effects showing little variation among households.

Due to the patterns exhibited by income from government transfers and social security, when added to the remaining effects (consumption and labor income), the loses are now lower for all households, but showing a similar pattern as before; households at the low end of the HPCE range exhibit the greatest loses, while the least affected are the ones in the middle (see Figure 12).

In Table 5 we show the simulated welfare effects, but now looking at their distribution according to households' income per capita instead of expenditure. The results are qualitatively and quantitatively similar to the ones discussed before, so we leave for the reader to take a closer look at them.

Finally, in Table 6 we report some distributive measures for household income, before and after the price shocks in commodity prices. The first result that emerges clearly is the low impact following the price shocks. Moreover, because households with middle and middle-low levels of income are the ones that benefit the most, there is a small improvement in the distribution of nominal income, either at the household or per capita level. However, when considering the effects on real income, deflated by the consumption effect, is possible to observe a small increase in the regressiveness in the distribution of household income per capita. These results are surely somehow influenced by the fact that our simulations only consider three sources of income, salaried labor, government transfers and social security payments. While it would be difficult to predict which households would benefit more from changes in income from self-employment and as employer, in the case of the effects derived from the operation with financial assets we could expect richer households be more likely to benefit.

6. Summary and conclusions

This paper focuses on the distributional effects of the rise in international prices of commodities for the Brazilian economy. The analysis is based on the social accounting matrix (SAM) that captures the relationships of interdependence among the different activities, factors and households. The approach adopted allows obtaining the short-run elasticities for exogenous shocks to international prices. In other words, it allows analyzing the transmission of international price fluctuations to a small, open, price-taking economy. And particularly to look at the effects on income distribution and welfare.

The elasticities obtained from the model show that domestic prices are more responsive to changes in prices of agricultural commodities, especially for goods produced by the food and beverage sector. An exemption is the case of oil, gas and coal and their effects on the domestic prices of goods produced by refinery and petrochemical industries. A similar pattern emerges for the elasticities of factor prices, with the largest figures corresponding to the responses to changes in prices of agricultural commodities. With labor, in its different varieties, showing the largest responses, particularly unskilled labor. There is not much differences between those working in formal or informal sectors.

From the micro-accumulations, households with lower expenditure per capita are more adversely affected by increases in the prices of F&B, and to a lesser extent by the increase in the prices of NF&B, which impact more heavily on households with higher levels of expenditure per capita. Once we include the positive effects because of the increase in labor income, we obtain that all households would experience a welfare loss, with the most negatively affected being those located at the low end of the expenditure per capita range, and the least affected being the ones in the middle. This result does not change when transfers from the government and payments from social security are also accounted for. In general, the differences among households are not large. Moreover, with middle-income households being the most benefited by the increase in income, and also the less negatively affected in terms of welfare, inequality indices experience just minor changes.

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Table 1. Proportion of households with per capita expenditure below:

1/4 of mean	21.67
1/2 of mean	47.62
Mean	72.75

Source: Pesquisa de Orçamentos Familiares 2002-2003.

Table 2. Distribution of household sources of income

Percentile range (*)	Formal labor	Informal labor	Labor	Employer / Selfemployed	Government	Social Security	Government + SS	Other
1-10	7.19	34.96	42.15	33.78	15.87	5.70	21.57	2.48
11-25	17.93	31.41	49.34	23.27	8.62	15.99	24.61	2.78
26-50	24.70	24.80	49.50	20.06	6.83	20.40	27.22	3.21
51-75	29.64	20.04	49.68	20.00	6.41	18.18	24.60	5.72
76-90	31.96	15.09	47.05	21.13	7.36	15.40	22.76	9.05
91-100	28.56	10.28	38.84	24.05	6.14	15.97	22.11	14.99
Total	**24.64**	**22.71**	**47.35**	**22.46**	**7.91**	**16.52**	**24.43**	**5.75**

(*) Household's income (per capita, excluding income from Assets).
Source: Own base on Pesquisa de Orçamentos Familiares 2002-2003.

Table 3. Simplified SAM

			Endogenous accounts											Exogenous accounts		
			C1	C2	C3	C4	A1	A2	A3	A4	F	H	G	CC	R	
Endogenous accounts	C1	1														Y_1
	C2	2														Y_2
	C3	3														Y_3
	C4	4														Y_4
	A1	5														Y_5
	A2	6					EE							XE		Y_7
	A3	7														Y_7
	A4	8														Y_{18}
	F	9														Y_9
	H	10														Y_{10}
	G	11														Y_{11}
Exogenous accounts	CC	12							EX					XX		Y_{12}
	R	13														Y_{13}
			Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9	Y_{10}	Y_{11}	Y_{12}	Y_{13}	

EE: matrix of expenditure propensities among endogenous sectors;

XE: matrix of expenditure propensities of exogenous sectors on endogenous sectors;

EX: matrix of expenditure propensities of endogenous sectors on exogenous sectors;

XX: matrix of expenditure propensities among exogenous sectors.

Table 4. Simplified SAM for a mixed endogenous-exogenous price model

			Endogenous accounts										Exogenous accounts
			Constrained		Unconstrained								
			C1	C2	C3	C4	A1	A2	A3	A4	F	H	G	CC+R
Endogenous accounts	Constrai-ned	C1	C_C		Q									
		C2												
	Unconstrained	C3	R		C_{nc}									
		C4												
		A1												
		A2												
		A3												
		A4												
		F												
		H												
		G												
Exogenous accounts		CC+R	b_c'		b_{nc}'									
			p_c'		p_{nc}'									

p_{nc}: vector of endogenous prices for the unconstrained sectors;

p_c: vector of exogenous prices for the constrained sectors;

b_{nc}: vector of exogenous costs for the unconstrained sectors;

b_c: vector of endogenous costs for the constrained sectors;

C_{nc}: matrix of expenditure propensities among unconstrained sectors;

C_c: matrix of expenditure propensities among constrained sectors;

Q: matrix of expenditure propensities of unconstrained sectors on constrained sectors;

R: matrix of expenditure propensities of constrained sectors on unconstrained sectors.

Table 5. Average effects by sources and household per capita income (% of household initial expenditures)

Decile	Con. F&B	Con. NF&B	Con. Total	Inc. Labor	Inc. GOV	Inc. SS	Inc. Total	Con. Total + Inc. Labor	TOTAL
1	-9.69	-8.88	-18.57	8.18	2.72	0.92	11.82	-10.39	-6.75
2	-8.46	-9.48	-17.93	9.42	1.51	2.56	13.48	-8.52	-4.45
3	-7.46	-9.94	-17.40	9.55	1.21	3.40	14.16	-7.85	-3.24
4	-6.57	-10.38	-16.95	9.83	1.16	2.90	13.89	-7.12	-3.06
5	-6.25	-10.45	-16.70	9.08	1.14	4.10	14.32	-7.62	-2.38
6	-5.63	-10.78	-16.41	9.19	0.94	4.13	14.26	-7.22	-2.15
8	-4.25	-11.51	-15.76	8.94	1.23	2.99	13.16	-6.82	-2.60
9	-3.69	-11.82	-15.51	8.33	1.31	2.72	12.36	-7.18	-3.14
10	-2.75	-12.23	-14.98	6.65	1.07	3.10	10.82	-8.34	-4.16

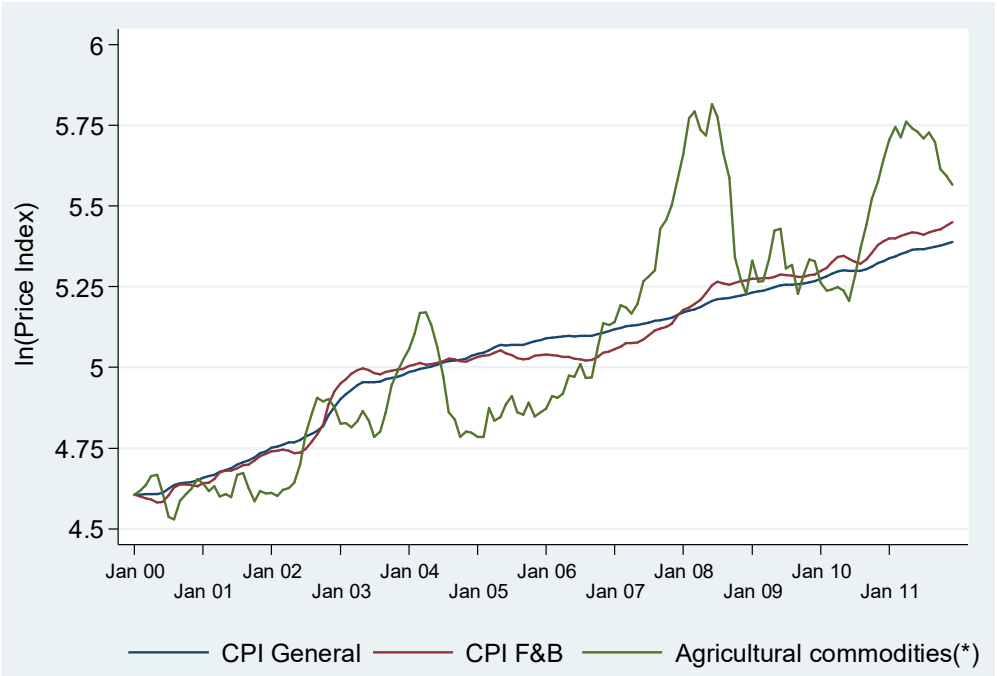
Source: own calculations.

Table 6. Income Inequality

	Pre	Nominal		Real	
		Post (Labor)	Post (Total)	Post (Labor)	Post (Total)
Total by households					
Coefficient of variation	1.651	1.601	1.602	1.612	1.613
Gini coefficient	0.567	0.563	0.562	0.566	0.565
Theil index (GE(a), a = 1)	0.618	0.605	0.604	0.612	0.611
Per capita					
Coefficient of variation	0.153	0.152	0.151	0.156	0.155
Gini coefficient	0.085	0.084	0.084	0.086	0.086
Theil index (GE(a), a = 1)	0.012	0.012	0.012	0.013	0.012

Source: own calculations.

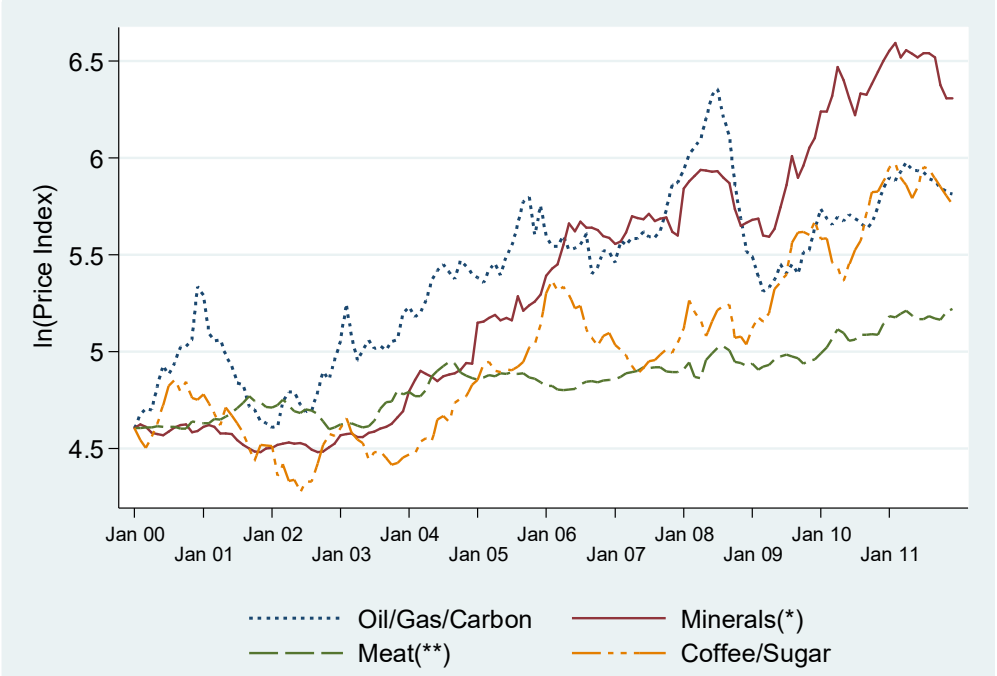
Figure 1. Agricultural commodities and consumer prices



(*) Corn, soyabeans, soyabean oil, and wheat

Source: original calculations based on http://www.indexmundi.com

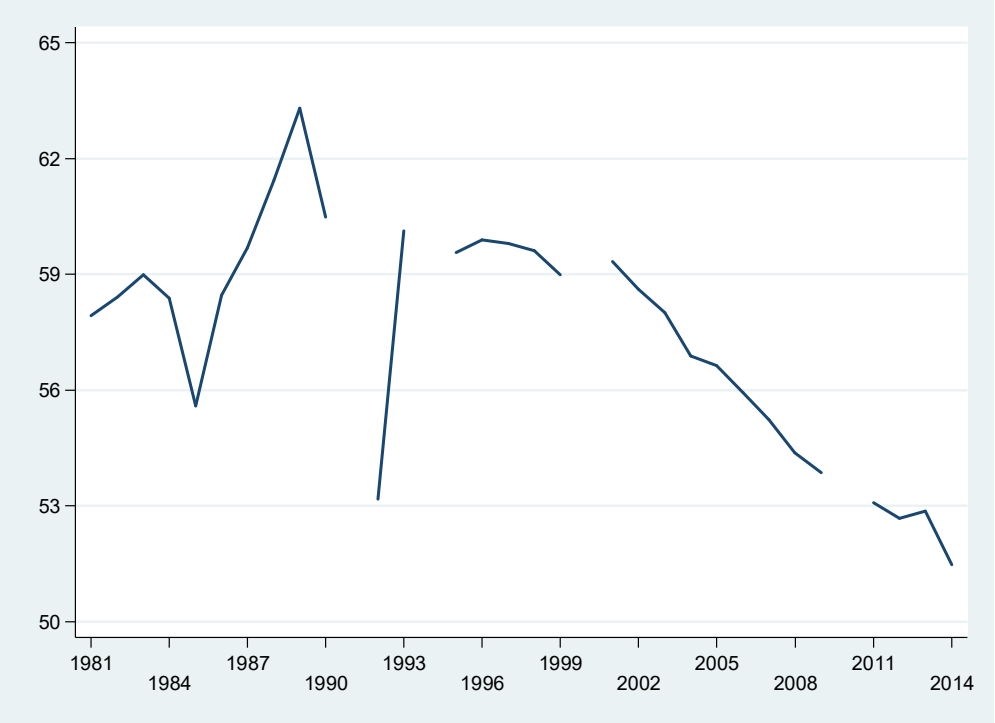
Figure 2. Other commodity prices



(*) Iron, aluminum and cooper. (**) Beef and poultry

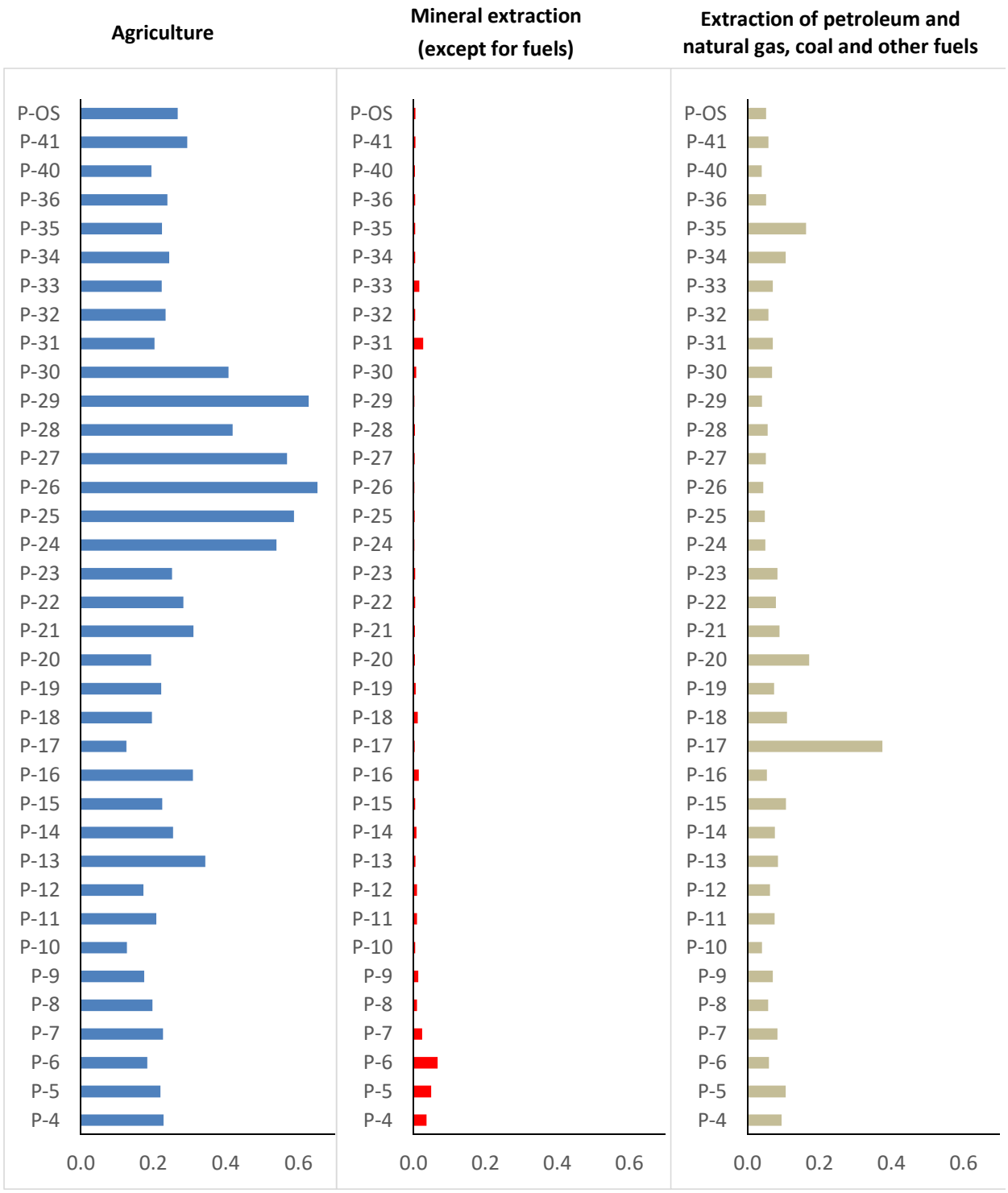
Source: original calculations based on http://www.indexmundi.com

Figure 3. GINI Coefficient



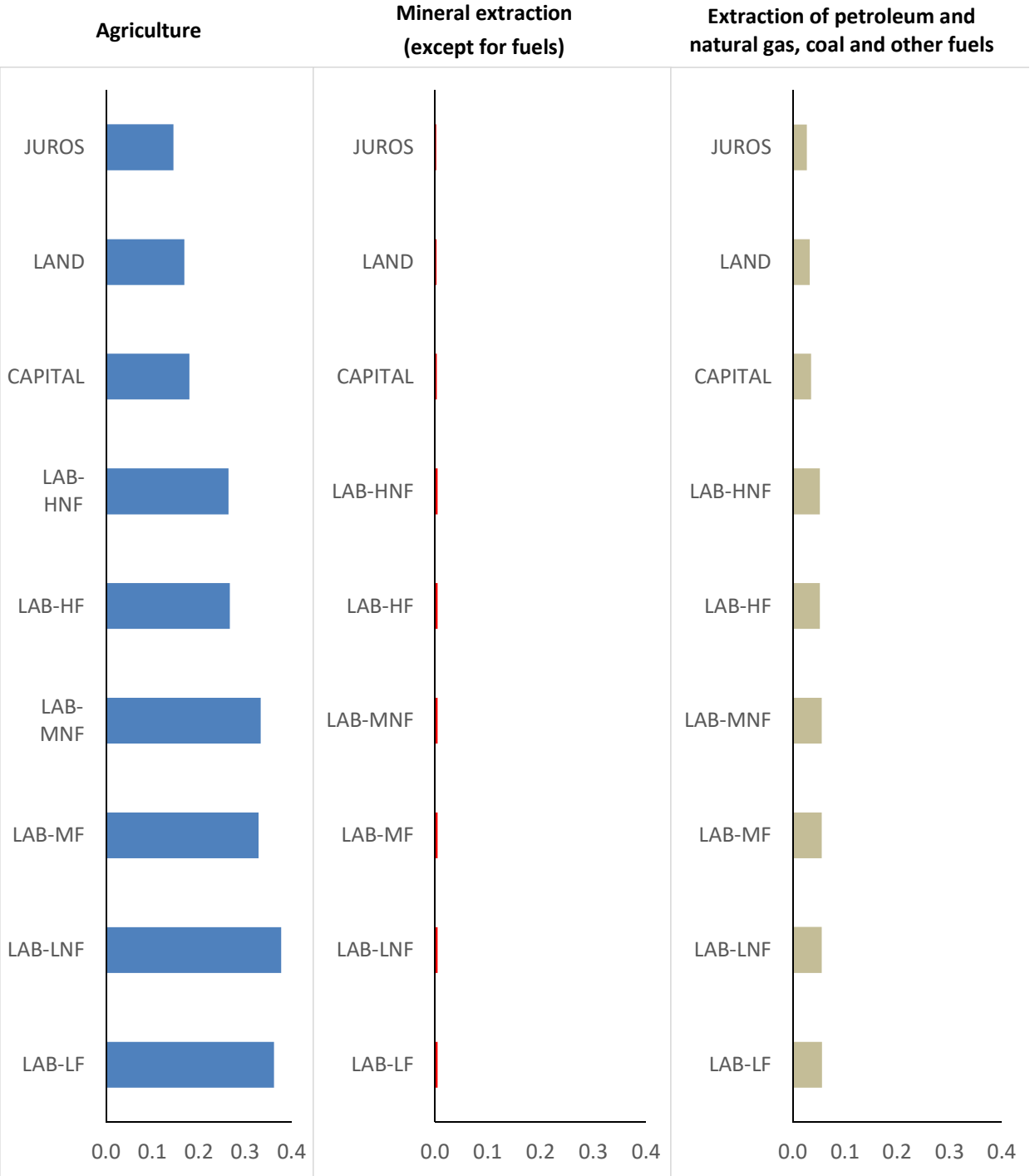
Source: Word Bank (Indicator Code SI.POV.GINI).

Figure 4. Elasticities of goods and services according to SAM categories



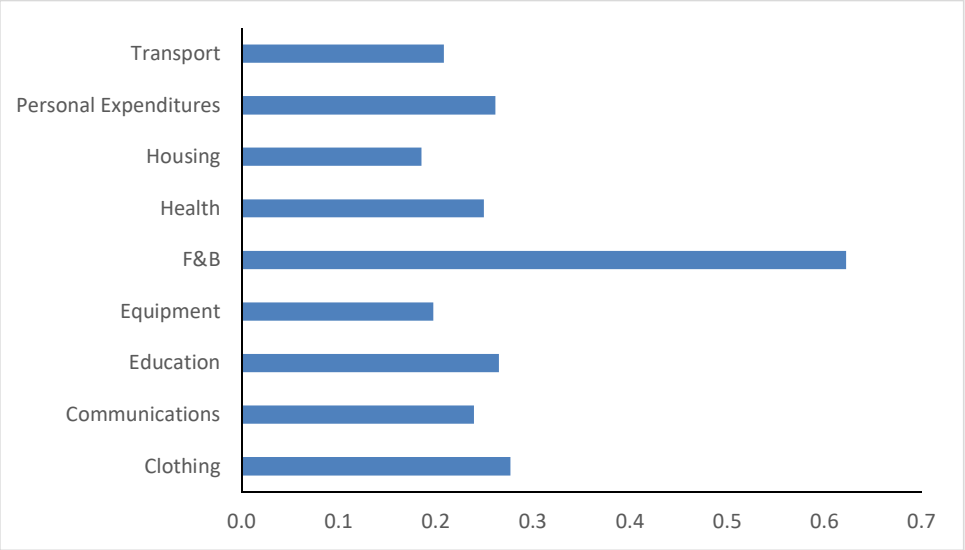
Source: own calculations using SimSIP SAM.

Figure 5. Elasticities of factor prices, government expenditure and social security

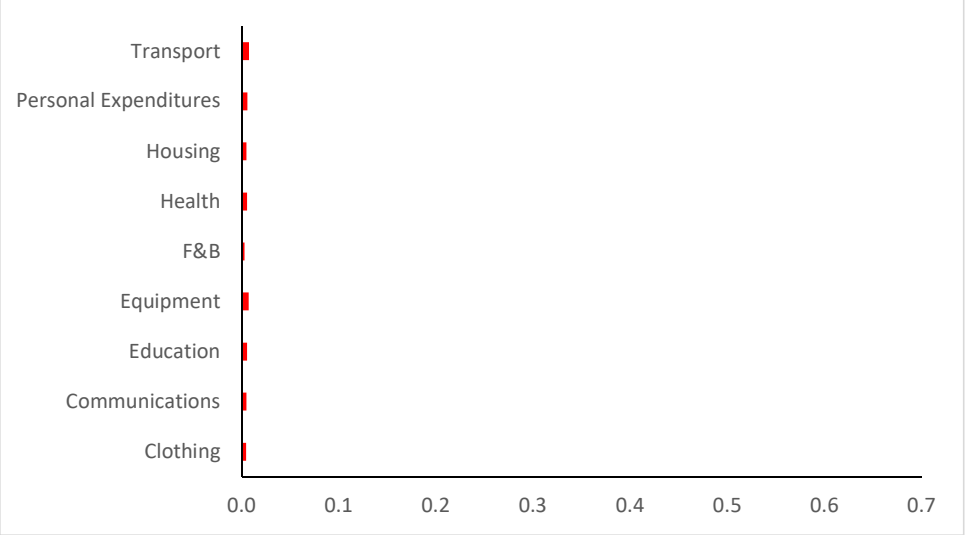


Source: own calculations using SimSIP SAM.

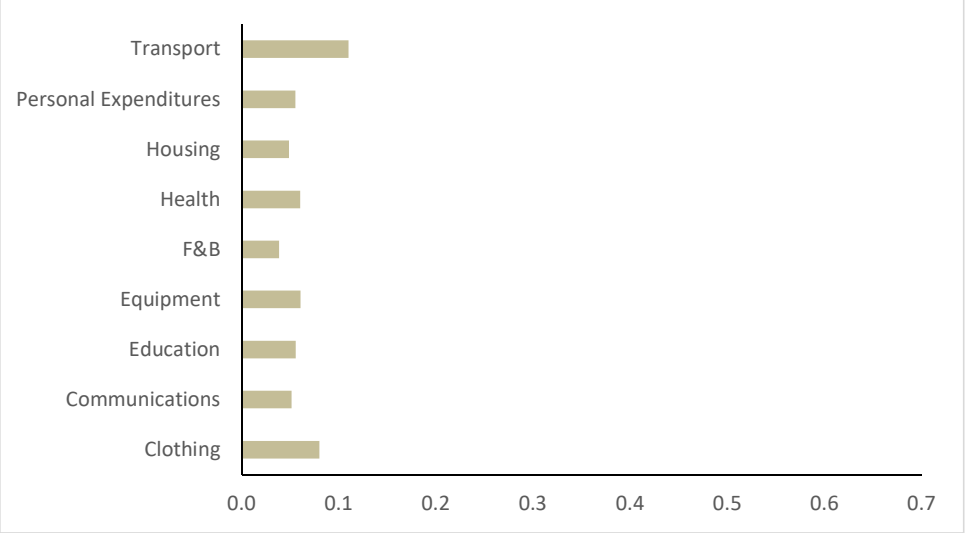
Figure 6. Elasticities of goods and services according to CPI categories



Agriculture



Mineral extraction (except for fuels)



Extraction of petroleum and natural gas, coal and other fuels

Source: own calculations using SimSIP SAM.

Figure 7. Consumption effects by types of goods

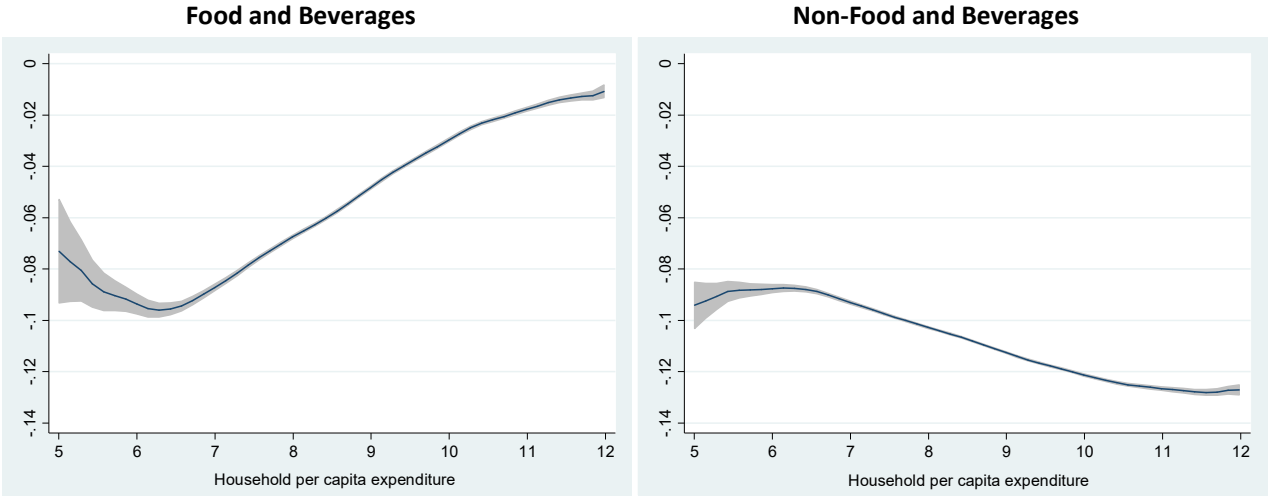


Figure 8. Total consumption effect

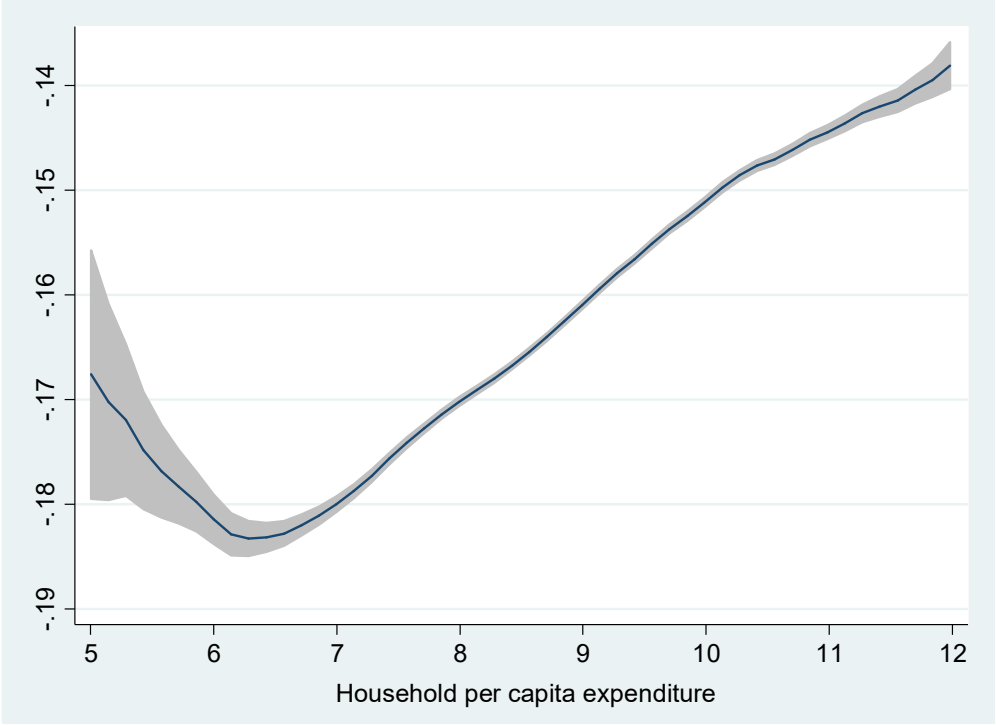


Figure 9. Labor income effect

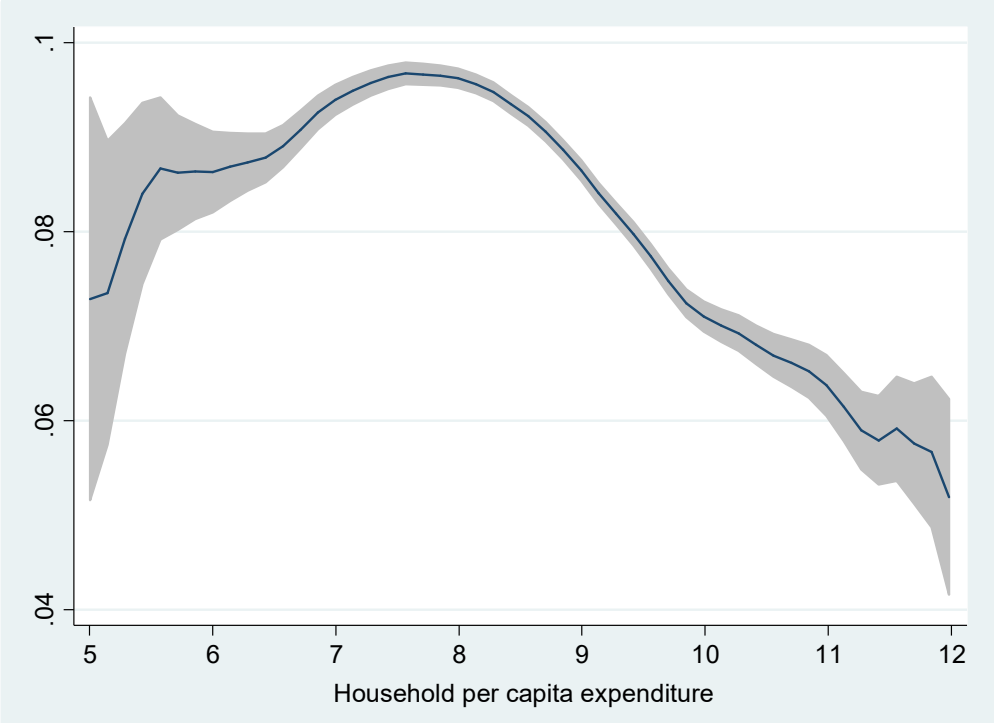


Figure 10. Consumption and Labor income effects

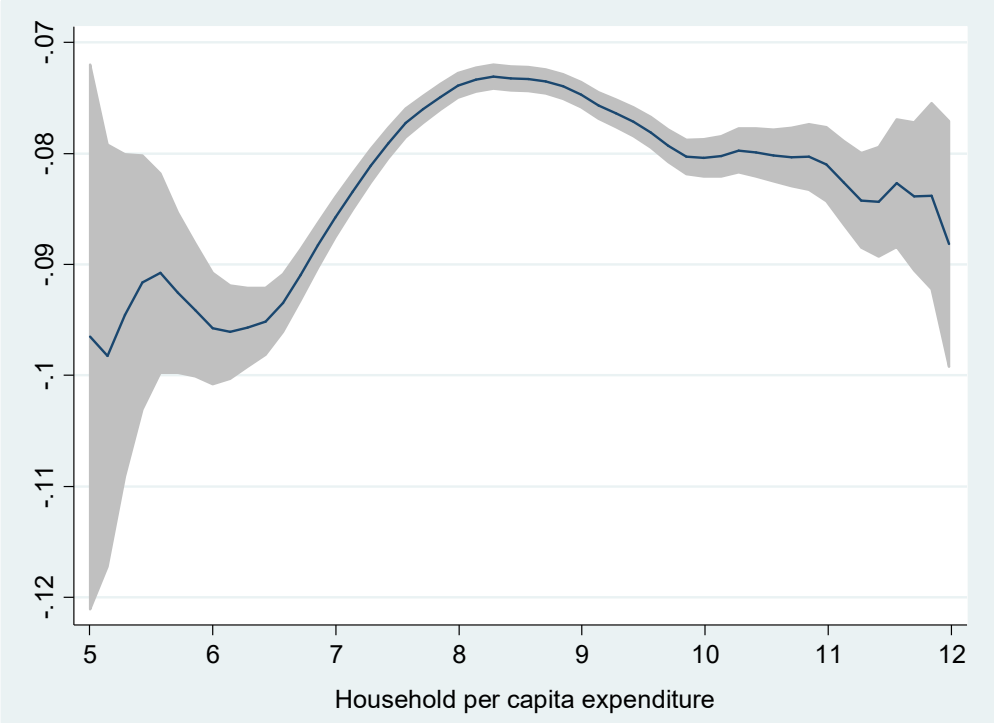


Figure 11. Effects through government transfers and social security payments

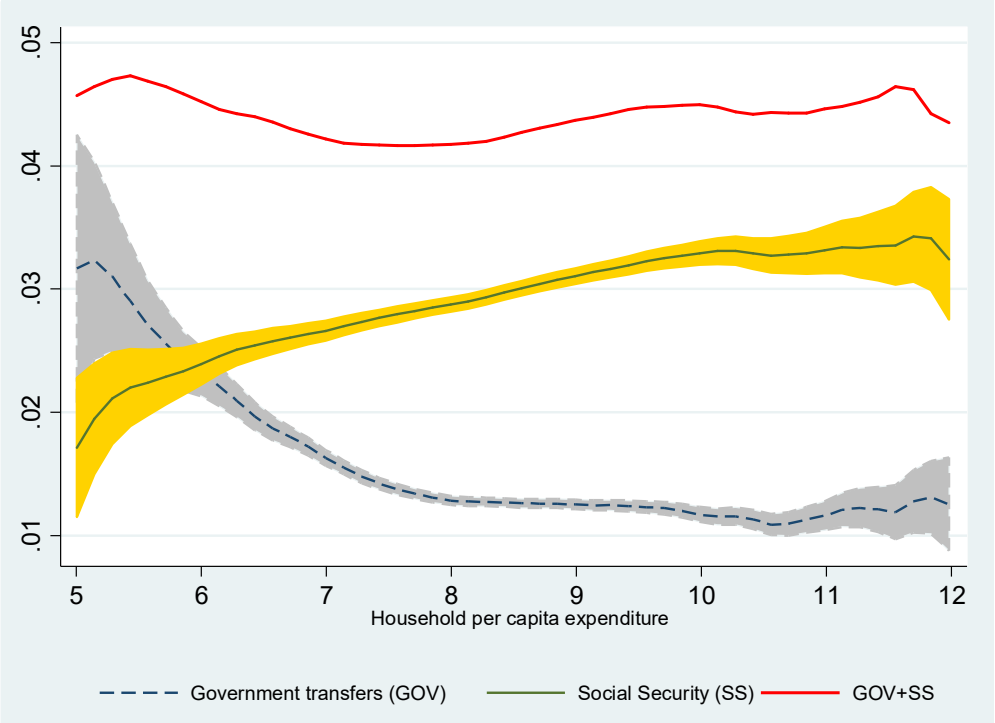
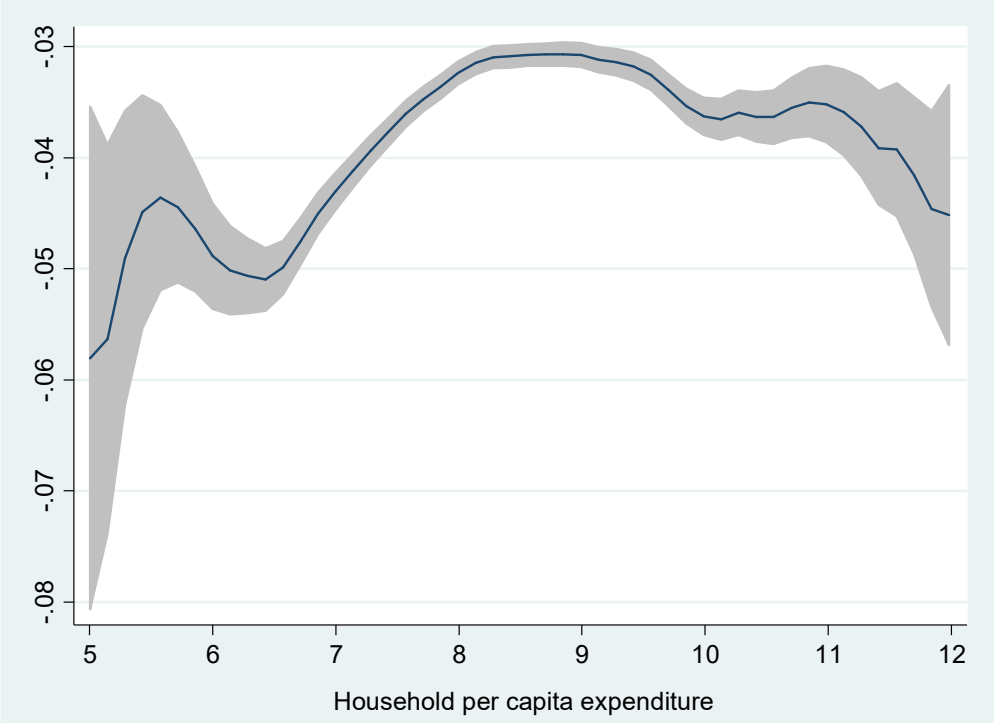


Figure 12. Overall effects



Appendix

SAM accounts

Commodities	Activities	Other accounts
P-01 Agriculture	A0-1 Agriculture	LAB-LF: formal work primary education (0 to 8 years of schooling)
P-02 Mineral extraction (except for fuels)	A0-2 Mineral extraction (except for fuels)	LAB-LNF: informal work primary education (0 to 8 years of schooling)
P-03 Extraction of petroleum and natural gas, coal and other fuels	A0-3 Extraction of oil and natural gas, coal and other fuels	LAB-MF: formal work secondary education (9 to 11 years of schooling)
P-04 Manufacture of non-metallic minerals	A0-4 Manufacture of non-metallic minerals	LAB-MNF: informal work secondary education (9 to 11 years of schooling)
P-05 Steel	A0-5 Iron and steel industry	LAB-HF: formal work higher education (12 or more years of schooling)
P-06 Metallurgy of nonferrous metals	A0-6 Non-Ferrous Metallurgy	LAB-HNF: informal work higher education (12 or more years of schooling)
P-07 Other metal products	A0-7 Manufacture of other fabricated metal products	CAP: income from capital
P-08 Machines and tractors	A0-8 Manufacture and maintenance of machinery and tractors	TERRA: rent of land
P-09 Electrical appliances and equipment	A0-9 Manufacture of electrical equipment	INTEREST: rents of ownership of institutional agents
P-10 Electronic Devices and Equipment	A-10 Manufacture of electrical appliances and electronic equipment	HH1: households with monthly rent of up to R$240 (current values)
P-11 Cars, trucks and buses	A-11 Manufacture of motor vehicles, lorries and buses	HH2: households with monthly rent from R$ 241 to R$ 480 (current values)
P-12 Other Vehicles, Parts & Accessories	A-12 Manufacture of other vehicles, parts and accessories	HH3: households with monthly rent from R$ 480 to R$ 720 (current values)
P-13 Wood products and furniture	A-13 Sawing services - Cut-to-size sawing	HH4: households with monthly rent from R$ 721 to R$ 1200 (current values)
P-14 Paper and graphic industry products	A-14 Paper and graphic industry	HH5: households with monthly rent from R$ 1201 to R$ 1440 (current values)
P-15 Rubber Industry Products	A-15 Rubber Industry	HH6: households with monthly rent from R$ 1441 to R$ 1920 (current values)
P-16 Chemical elements (excluding petrochemicals)	A-16 Manufacture of non-petrochemical chemical elements	HH7: households with monthly rent from R$ 1921 to R$ 2400 (current values)
P-17 Oil refining and petrochemical industry	A-17 Petroleum refining and petrochemical industry	HH8: households with monthly rent from R$ 2401 to R$ 3600 (current values)
P-18 Miscellaneous chemical products	A-18 Manufacture of various chemical products	HH9: households with monthly rent from R$ 3601 to R$ 4800 (current values)
P-19 Pharmaceutical and perfumery products	A-19 Manufacture of pharmaceuticals and perfumery	HH10: households with monthly rent from R$ 4801 to R$ 7200 (current values)
P-20 Plastic Products	A-20 Plastic material processing industry	HH11: households with monthly rent from R$ 7201 or more (current values)
P-21 Textile industry	A-21 Textile industry	GOV: government
P-22 Clothing and accessories	A-22 Manufacture of wearing apparel and accessories	DIRTAX: direct taxes
P-23 Footwear and leather and skins goods	A-23 Manufacture of footwear and leather goods	SSTX: SS contributions / Deficit of the official pension system
P-24 Coffee Industry	A-24 Coffee Industry	SSPUB: deficit of the pension system of civil servants
P-25 Processing of plant products	A-25 Transformation of plant products, including smoke	INDTX: Taxes on Company Income
P-26 Meat processing and slaughtering	A-26 Meat killing and processing	SECTAX: value-added tax
P-27 Cooling and preparation of milk and milk products	A-27 Cooling and preparation of milk and milk products	CVA: contributions on value added
P-28 Sugar Industry	A-28 Sugar Industry	TARIFFS: import tariffs
P-29 Vegetable oils and fats	A-29 Manufacture and refining of vegetable oils and fats	ADTAXM: other taxes on imports
P-30 Other food and beverage industries	A-30 Other food and beverage industries	
P-31 Miscellaneous Industries	A-31 Miscellaneous industries	
P-32 Industrial utility services	A-32 Industrial utility services	
P-33 Civil Construction	A-33 Civil Construction	
P-34 Trade	A-34 Trade	
P-35 Transportation	A-35 Transportation	
P-36 Communications	A-36 Communications	
P-40 Rental and leasing activities	A-40 Rental and rental of real estate activities	
P-41 Public administration	A-41 Public administration	
P-OS Other services	A-OS Other services	

Expenditures categories: classification of Pesquisa de Orçamentos Familiares 2002-2003 (POF 2002-2003)

POF quadro/ grupo (*)	Description	% Total Expenditures
34	Expenditure on men's clothing	1.09
35	Expenditure on women's clothing	1.20
36	Expenses on children's clothing	0.63
37	Expenditure on haberdashery	0.29
38	Expenses in bags, shoes and belts	1.08
22	Communications expenses	0.21
27	Reading expenses	0.18
32	Expenses on stationery	0.39
49	Expenses in education	2.88
15	Equipment and machine acquisition costs	1.69
16	Costs of acquisition of instruments and facilities	0.22
17	Mobile acquisition costs	1.10
18	Expenditure on decoration and lining items	0.12
24	Food expenses (outside home)	3.45
25	Expenditure on tobacco	0.52
63	Cereals, vegetables and pulses (tubers)	1.42
64	Flours, starches / starches, pastas / pastas, coconuts, chestnuts and walnuts	0.72
65	Leafy vegetables, berries and other	0.35
66	Fruits	0.50
67	Sugar and confectionery products	0.71
68	Sales and spices	0.28
69	Meat and offal	1.53
70 to 79	Freshwater fish	0.13
80 to 89	Sea fish	0.11
90	Canned and preserved	0.09
91	Poultry, eggs and dairy products	2.28
92	Bakery and industrialized meats	1.73
93	Non-Alcoholic Beverages and Infusions	0.73
94	Oils, fats and prepared or semi-prepared foods	0.68
29	Expenditure on pharmaceutical products	4.64
30	Costs in hygiene and beauty articles	1.00
42	Health care expenditures (health)	8.78
07	Service Expenses and Household Rates	6.16
08	Maintenance and repair costs at home	1.62
09	Repair and maintenance costs of household utensils	0.28
10	Room / apartment expenses	15.02
11	Construction and renovation costs	1.80
12	Expenses of other services and housing rates	3.73
13	Rental costs of household appliances	0.00
19	Expenses in domestic service	1.35
39	Expenditure on bathroom, kitchen and kitchen items	0.12
47	Other Real Estate Expenses	4.05
95	Household and other cleaning products	0.88
26	Expenses in games and bets	0.22
28	Fun, sports and betting expenses	1.51
31	Expenses in personal services	0.77
33	Expenditure on toys and recreation	0.30
44	Expenditure on banking and professional services	1.21
45	Expenses in family and religious ceremonies	0.44
48	Expenditure on contributions and financial transfers	3.14
23	Transport costs	5.53
41	Travel expenses	1.52
43	Expenditure on accessories and maintenance of vehicles	1.41
50	Documentation expenses, vehicle insurance	0.88
51	Expenses on vehicle acquisition	5.45

(*) Four cases that could not be assigned exclusively to a single CPI category are not included. These are: other expenses; jewelry, watches and cell phones; body care products and alcoholic beverages; and aggregated expenses. They account for 1.68% of total expenditures.

Expenditure categories: correspondences among CPI, POF and SAM categories

CPI	POF	SAM
Clothing	34	P-22
	35	P-22
	36	P-22
	37	P-21
	38	P-23
Communications	22	P-36
	46	P-36
Education	27	P-14
	32	P-14
	49	P-OS
Equipment	15	P-09
		P-10
	16	P-09
		P-10
		P-13
	17	P-13
	18	P-OS
	46	P-10
Food and Beverages	24	P-OS
	25	P-25
	63	P-01
		P-25
	64	P-01
		P-25
	65	P-01
	66	P-01
	67	P-25
		P-28
	68	P-30
	69	P-26
	70 a 79	P-26
	80 a 89	P-26
	90	P-30
	91	P-01
		P-26
		P-27
	92	P-25
	93	P-24
		P-30
	94	P-29
		P-30

CPI	POF	SAM
Health	29	P-19
	30	P-19
	42	P-OS
Housing	07	P-32
	08	P-OS
	09	P-OS
	10	P-33
	11	P-33
	12	P-32
	13	P-32
	19	P-OS
	39	P-13
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Personal Expenditures	26	P-OS
	28	P-OS
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