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Working Paper

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THE IMPACT OF RELATIVE PRICES ON WELFARE AND INEQUALITY IN BRAZIL, 1995-2005*

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ABSTRACT

Our objective in this working paper is to analyze the impact of relative prices on the evolution of welfare and inequality in Brazil from 1995 to 2005. This period was characterized by monetary stability but also by large changes in relative prices. This implies that a homogeneous inflation index will yield questionable results. In order to take relative prices into account in our welfare analysis, we build specific inflation indices for each hundredth of the population ranked by *per capita* household income. To accomplish this task, we use data from the latest round of the Brazilian income and expenditure survey and price indices obtained from the national consumer price system.

We use our distribution-specific inflation indices to deflate the nominal income distributions yielded by the Brazilian annual household survey from 1995 to 2005. Thus, we generate new income distributions that better represent the real purchasing power of the households. Based on these new income distributions, we calculate average incomes and Gini coefficients, investigate the relationships of stochastic dominance as well as Lorenz dominance, and calculate Atkinson's social welfare function for inequality aversion parameters varying from 0.1 to 0.9.

Our results can be summarized into three stylized facts: i) inflation during the 1995-2005 period was distributionally progressive up to the 93rd hundredth of the per capita household income distribution; ii) taking relative prices into account, the Gini coefficient falls 0.61 points (or 19 per cent) more than when a general price index is used; iii) surprisingly, average income deflated by the distribution-specific indices differs significantly from average income deflated by the general price index, i.e., it falls instead of rising slightly from 1995 to 2005.

Keywords: Relative Prices; Welfare; Inequality; Inflation; Specific Prices Indices.

JEL Classification: I30

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1 INTRODUCTION

After almost three decades of monetary indexation, Brazil implemented in July 1994 the *Plano Real*, which inaugurated a new era of price stability that did away with automatic correction for past inflation of prices and wages. After the initial euphoria produced by price stability, the following decade brought significant changes to the life of Brazilians. Three of them will be the subject of this Working Paper.

The first was the relative stagnation in average incomes, as reported by household surveys from 1998 onwards – the income lost during the devaluation crisis was recovered only in 2005. The second change was that, due to large variation in the exchange rate as well as price increases brought about by privatizations, there were significant changes in relative prices. In particular, food prices increased less than average while other prices, such as for telecommunications (one of the privatized economic sectors), increased much more than average.

Perhaps the most noteworthy change of the period was that income inequality began to fall for the first time in three decades. The fall began timidly in 1996 but then accelerated from 2001 onwards, leading to a 0.027 fall of the Gini coefficient from 2001 to 2005. The fall in inequality has been documented in Soares (2006), Barros *et al.* (2006), Soares *et al.* (2006), Neri (2006), Hoffmann (2005, 2006), Ferreira *et al.* (2006) and IPEA (2006), among others. These studies showed an unequivocal fall in income inequality, which, coupled with stagnation in average income from 1998 to 2005, led to a modest increase in welfare.

However, the aforementioned studies used average consumer price indices to deflate incomes across the whole income distribution. While the use of homogeneous price deflation is standard practice in income distribution studies, it can lead to misleading conclusions if there are large variations in relative prices. As we stated, such variations are one of the important characteristics of the 1995-2005 period. Research on other countries, such as that by Son and Kakwani (2006a) on Korea and Thailand, has revealed that price changes can affect the poor differently than the non-poor. This means, of course, that by using a general price index, one might under-estimate variations in poverty and, therefore, in inequality and welfare. For Brazil, Son and Kakwani (2006b) showed that during the period under consideration, the prices of goods consumed by the poor increased less than other prices, meaning that the use of a general price index would under-estimate the poverty reduction that occurred.

The objective of this Working Paper is to extend the type of analysis suggested by Son and Kakwani by taking relative prices into account in studying welfare and inequality. But instead of partitioning the population into poor and non-poor, we will consider relative prices across the whole income distribution for the 1995-2005 period. From this exercise, we will draw conclusions on welfare and inequality and compare them with the standard findings in the literature, which, by not considering such changes, make the implicit assumption that inflation affects all households in the same way.

Our methodology will be simple, although different from that adopted by Son and Kakwani. We will build specific price indices for each hundredth of the *per capita* household income distribution using data from a 2003 expenditure survey and the nine broad components of the general price index. We will then compare the evolution of welfare and inequality measures calculated by using our hundredth-specific deflator with that calculated using a homogeneous deflator. As will be shown, this procedure will lead to surprisingly different results.

Excluding this introduction, this paper is further divided into four sections. The one that follows deals with diverse data issues, e.g., what are the data used and where they come from. In the third section, we explain how the hundredth-specific price indices were built and analyze their behavior from 1995 to 2005. Section four is devoted to our results. We use the standard social welfare analysis toolbox: the Gini coefficient and average income as aggregate measures; and first order, second order and Lorenz dominance for analysis of the whole distribution. We also calculate Atkinson social welfare functions for various degrees of inequality aversion. We compare, in all cases, results for both a homogeneous deflator and distribution-specific deflators. Finally, in the fifth section we summarize our findings and suggest that some policy changes are likely to be responsible for the price effects on welfare and inequality during the ten years under review.

2 DATA

The primary data used in this text are all collected by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE). They are the following: i) microdata from the national annual household survey (*Pesquisa Nacional por Amostra de Domicílios* – **Pnad**) for every year from 1995 to 2005, except 2000, when the survey was not fielded; ii) microdata from the national income and expenditure survey of 2003 (*Pesquisa de Orçamentos Familiares* – **Pof**); and iii) the national price index (*Índice de Preços ao Consumidor Amplo* – IPCA) from the National Consumer Price System (*Sistema Nacional de Preços ao Consumidor* – **Snipc**). Each of these widely used data sources are described in detail in IBGE's web page (www.ibge.gov.br). Hence, we will spare the reader the tedious description of issues such as sample size and type of questionnaire, and concentrate exclusively upon the use we made of the data.

We calculated *per capita* household income distribution in nominal terms using the 1995 to 2005 household surveys. The unit of analysis is the household, which is defined as a group of people living under the same roof. The income of each household is composed of the sum of incomes of all of its members, except boarders or lodgers and domestic employees and their relatives. Likewise, these individuals were not counted in the number of household members. For all practical purposes, we excluded them from the Brazilian population. We also excluded all households in which at least one member had income but its value was not reported. These restrictions resulted in a loss of about two per cent of the sample in each year. For the remaining 98 per cent, *per capita* household income was defined as total household income divided by the number of household members. It should be noted that we did not use equivalence scales or increasing returns to scale due to 'household public goods'. Also important to note is that we did not impute rents for owner-occupied housing.

Individuals were then ordered according to household per capita income and divided into one hundred groups containing roughly the same number of individuals, based on population weights provided by IBGE. Finally, for each hundredth thus defined, we calculated the sum of *per capita* incomes and the size of its population. All of the remaining analysis is based upon these statistics.

From the 2003 national income and expenditure survey, we obtained the proportional composition of expenditures, for each hundredth of the *per capita* household income distribution, according to the nine categories that make up the first-level disaggregation of the

national price index (IPCA). The hundredths were created applying to the expenditure survey data the same methodology used for the annual household survey, as described above. Average household proportional expenditures by hundredths were then calculated according to the following categories: i) *food and beverages*; ii) *housing and housekeeping*; iii) *durable goods*; iv) *clothing*; v) *transportation*; vi) *health and personal care*; vii) *personal expenditure*; viii) *education, reading and stationary*; and ix) *communications*.

We obtained from the National Consumer Price System the price indices for each of the nine categories above. The general price index weights them by average consumption for all households, with incomes ranging between one and forty minimum wages. The weights of the general price index, for the entire period analyzed, were calculated by IBGE using the 1995 expenditure survey, which covered only the ten major metropolitan areas in Brazil. Likewise, price variations were collected only in the same areas. In other words, although both the annual household surveys and the expenditure survey have national coverage, the monthly price index is calculated excluding both rural areas and urban non-metropolitan areas. While the 2003 expenditure survey allows us to compare price levels of metropolitan areas, other urban areas and rural areas, we have no way of knowing whether prices changes are the same for the three. In other words, we do not know how serious is the limitation caused by the exclusive use of metropolitan price variations.

There are other limitations to our analysis that are worthy of mention. The first is that the definition of total income in the expenditure and income survey and the annual household surveys are not exactly the same. Another limitation, less serious, is that the general price index is calculated using 1995 expenditure survey weights while our analysis uses 2003 expenditure survey data.

3 SPECIFIC PRICE INDICES

3.1 THE METHODOLOGY

Social welfare analyses are based upon the level and dispersion of the indicator that represents individual welfare. When this indicator includes income and price changes, we must correct nominal values in order to obtain real incomes that more accurately represent individual welfare. This is almost always done using a general price index. We do this almost automatically, but in doing so, we make the implicit assumption that inflation affects all individuals equally – in other words, that there are no relevant changes in relative prices. This assumption is almost always wrong and sometimes exceedingly so.

Between 1995 and 2005, the real exchange rate changed drastically in Brazil. Thus, the relative prices of tradables and non-tradables also changed greatly. Economic regulation also changed dramatically during this period. This led to very different inflation rates for market and regulated prices. For example, from September 1995 to September 2005, prices for communication items increased 770 per cent while the prices for clothing increased by 53 per cent and those for food by 77 per cent. When one considers that households at the top of the income distribution spend, in relative terms, ten times more on telecommunications than those at the bottom but only one-fifth as much on food, it is clear that the use of a general price index will provide a misleading estimate of the evolution of social welfare for those at these two different points in the income distribution.

Our solution to this problem was the creation of price indices for each hundredth of the income distribution. We did so by using the nine sub-indices provided by the National Consumer Price System (IPCA), which make up the first-level break-down of the general price index. Although there are other more detailed levels, and other researchers such as Son and Kakwani (2006b) use close to 100 price items, we chose to use only the top layer of disaggregation for two reasons.

The first is that most of our analysis was done after IBGE defined the new weighting structure for the general price index, but before the translation files used to standardize the new structure with the old structure were made available. This means that had we used a more detailed level, the countless expenditure items of the 2003 survey would have had to be checked one by one in order to be classified in the proper category. For example, 'pig butter' has been erroneously classified in the 2003 survey as part of 'milk products', but should be in the 'oils and fats' subgroup. Nevertheless, it is accurately classified under the general category of 'food and beverages'. So such a classification problem disappears if one works only with the first-level break-down. Besides keeping the same definitions for broad categories of expenditure items, we spared ourselves spending a great deal of time checking item by item to see where each would fit.

The second reason is that the greater the number of categories, the greater the sampling noise for hundredths of the distribution. Even using only nine categories, we had to use a smoothing procedure to wipe out such noise. This suggests that using more categories would have made this study impossible.

After choosing the break-down level of IPCA, we built homogeneous deflators applying the correction suggested by Courseil and Fogel (2002). The correction consists of adjusting the IPCA to the reference period of the household survey. While the survey reference period is the entire month of September, meaning the deflator should be centered on the 1st of that month, the deflators provided by IBGE are centered on the 15th of each month. The correction is fairly straightforward:

$$I_y = \sqrt{IPCA_y^{sep} \cdot IPCA_y^{aug}} \qquad [1]$$

Where *I* is the price index to be used for a given year, *y*, and the $IPCA^{sep}$ and $IPCA^{aug}$ are the deflators provided by IBGE. We applied correction [1] both to the general index and to each of its nine subcomponents.

After this first step, we calculated the specific indices that we need just to reweight the general index according to the expenditure composition of each hundredth obtained from the income and expenditure survey:

$$I_{yc} = \sum_{k=1}^{9} p_{ykc} \sqrt{IPCA_{yk}^{sep} \cdot IPCA_{yk}^{aug}} \quad \text{with} \quad 1 = \sum_{k=1}^{9} p_{ykc} \qquad [2]$$

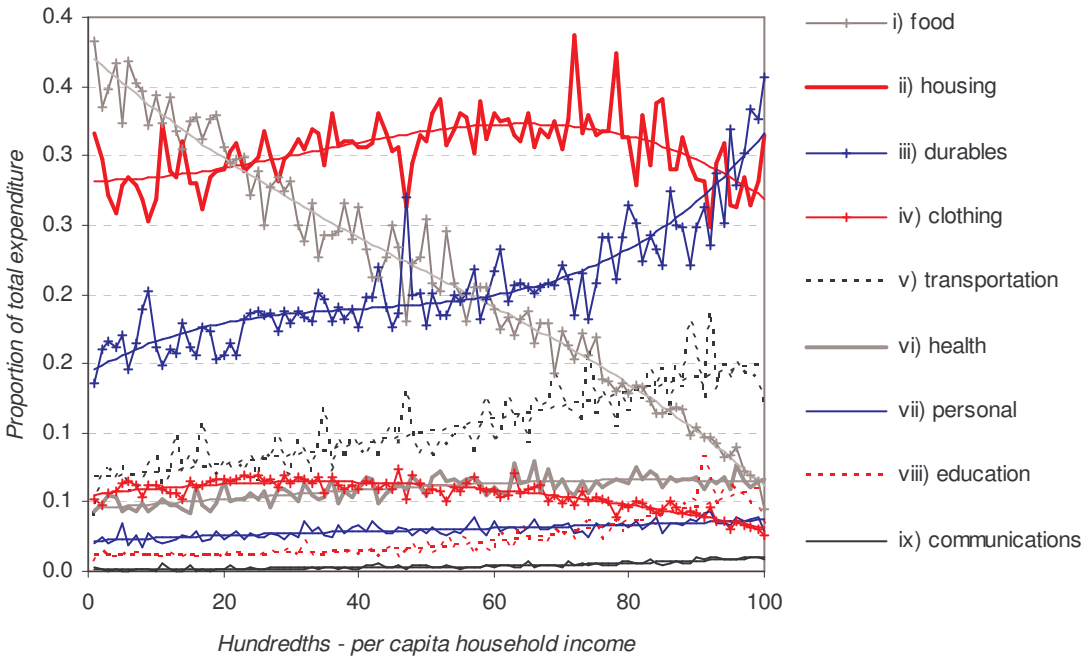
Where I_{yc} is the specific price index of each hundredth, *c*, in year *y*; $IPCA_{yk}$ are the nine components of the general price index, and p_{ykc} the proportion that a particular category of expenditure is of the total expenditure of a given hundredth of the distribution.

Initially we simply applied to each hundredth of the income distribution the expenditure shares calculated from the 2003 expenditure survey. Unfortunately, since there was too much sampling noise, this procedure resulted in some hundredths exchanging positions. This would represent a contradiction in our methodology. In order to correct this, we applied a smoothing procedure. The criteria to choose between different smoothing approaches were that: i) the price index should vary smoothly from one hundredth to the next so as to generate no exchange of positions; and ii) the predicted value after smoothing should be as close as possible to the value yielded by the expenditure survey.

We tried various procedures and finally decided upon fitting a third-order polynomial. To ensure that the weights would add up to one, we used the category of housing as a residual category. We chose it because expenditures on housing are more or less constant at one third of total expenditures throughout the whole income distribution. Chart 1 shows the expenditure weights before and after smoothing.

CHART 1

Proportional weights of each expenditure group over the total expenditure by hundredths of the *per capita* household income distribution: observed and smoothed. Brasil 2003



Source: IBGE, Pof/2003.

The final formula that we adopted after inclusion of the smoothing procedure was therefore:

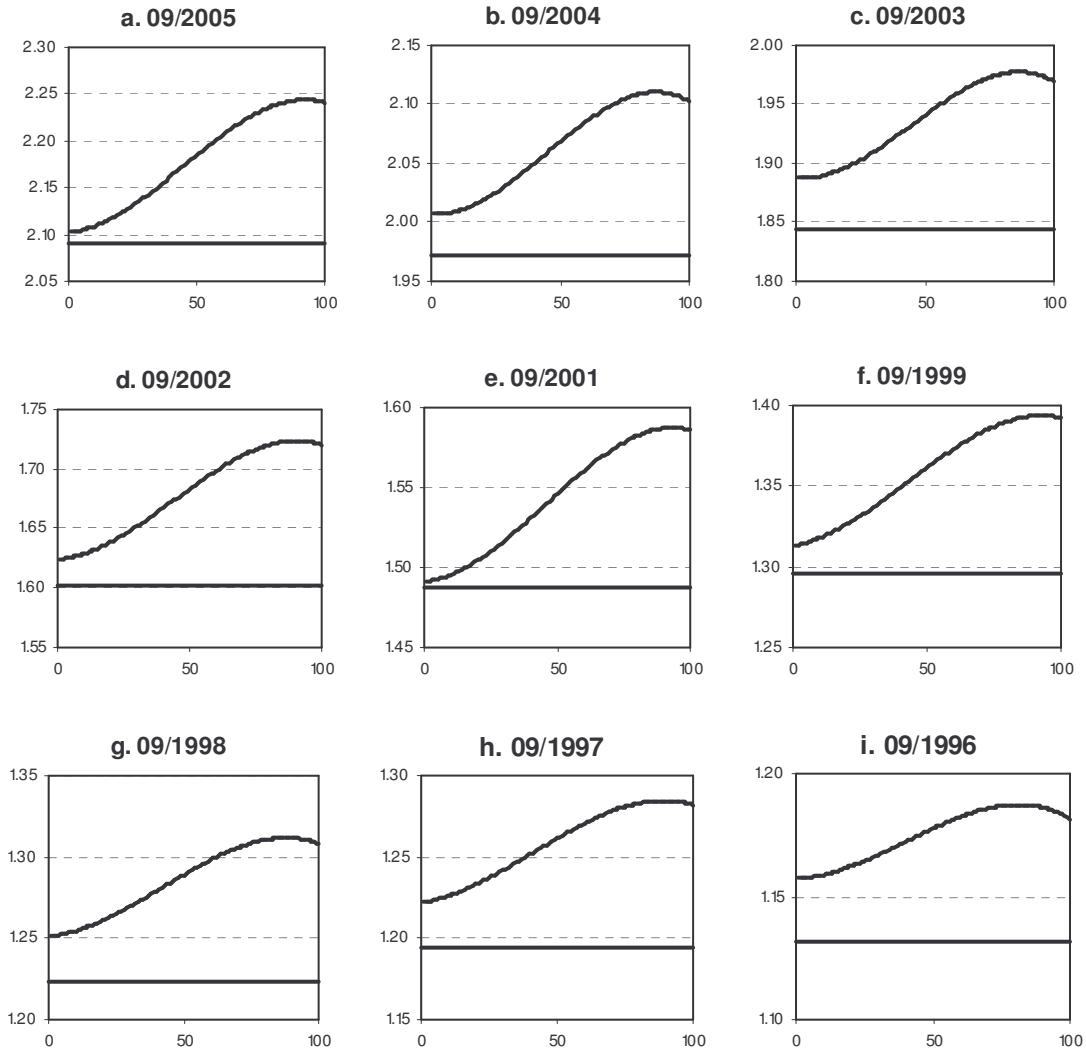
$$I_{yc} = \sum_{k=1}^{9} \hat{p}_{ykc} \sqrt{IPCA_{yk}^{sep} \cdot IPCA_{yk}^{aug}} \qquad [3]$$

The only difference from equation [2] is the substitution of the observed p_{ykc} by a well-behaved estimate calculated for all categories save housing, which was used to ensure that the weights added up to unity:

$$\hat{p}_{ykc} = \beta_{yk} c^3 + \beta_{yk} c^2 + \beta_{yk} c + \beta_{yk} \quad [4]$$

CHART 2

Specific price indices by hundredths of the *per capita* household income distribution and general price index (September 1995 = 1). Brazil, 1996-2005



Sources: IBGE, Pof/2003; Snipc.

Chart 2 presents the distribution by hundredths of the *per capita* household income distribution of the specific indices yielded by this method, as well as the general price index, all centered on September 1st of each year. We set 1995 as the baseline year. In each panel, the curve represents the specific indices and the line represents the general IPCA index. For most years the curve slopes upward, showing that relative price changes were, in general, progressive over the period (prices were higher for richer households).

3.2 THE EVOLUTION OF WELFARE AND INEQUALITY: 1995-2005

We now analyze the evolution of welfare and inequality among the Brazilian population through comparison of summary and full distribution measures. We also compare results obtained through the use of a general deflator with those obtained through the hundredth-specific deflators described in the previous section.

Before proceeding further, we wish to warn all readers that the definition of welfare we use here is strictly limited to that obtained through acquisition of goods and services in the marketplace. We do not consider public and publicly provided goods. We also do not consider solidarity or social cohesion effects since our welfare analysis is additive. Likewise, we do not consider intra-family resource allocation and thus ignore equivalence scales and gains to scale in household size. We also ignore household production of non-market goods. In sum, what we define as welfare in this Working Paper is the individual per capita purchasing power of income.

In our welfare and inequality comparisons, we verify the existence of first order, second order, and Lorenz dominance relations but we also compare summary measures of welfare and inequality such as average income, the Gini coefficient and various formulations of the Atkinson social welfare function. Before comparing results with and without distribution-specific deflators, we review each of the concepts used. Our review will be brief since these are concepts well-established in the literature. In Portuguese the most complete treatment is given by Hoffmann (1998); in English, we recommend Sen (1997), Atkinson (1983) and, particularly, Cowell (1995).

First order stochastic dominance

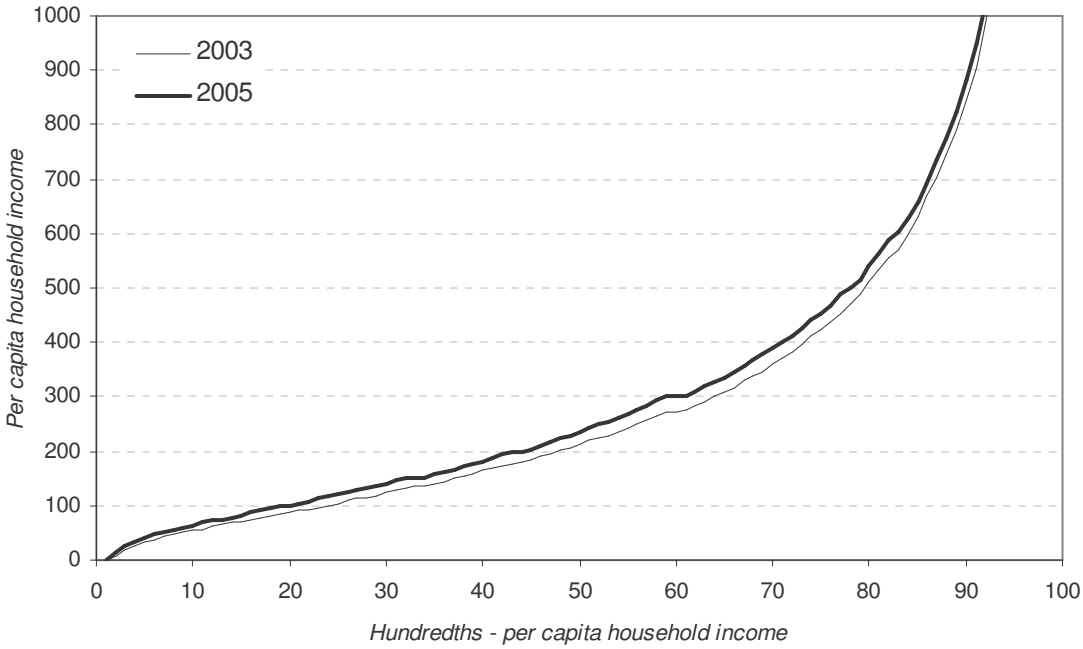
The objective of dominance analysis is to provide an unambiguous answer to the question of whether a given income distribution is an improvement over another. The first such relation is first order stochastic dominance, which occurs if the income of the individual in the *i-th* position of a given income distribution has more income than the individual in the same position in another income distribution. Intuitively, first order stochastic dominance means that, with the exception of individual position changes, everyone is better off in the distribution that dominates another. Graphically, this is trivial to see: the quantile curve of the dominated distribution lies everywhere below the quantile curve of the dominant one. Finally, first order dominance guarantees that any anonymous additive social welfare function will rank the dominant distribution as better than the dominated one.

Chart 3 illustrates first order dominance by depicting the average income in each hundredth of the distributions for 2003 and 2005 (with 2003 values adjusted using the general price index, IPCA). The 2005 distribution lies everywhere above the 2003 distribution, showing that an individual in the *i-th* position in 2005 had income superior to that of another individual in the same position in 2003. All such individuals are better off so any additive anonymous social welfare function would classify the distribution of income in 2005 as generating more social welfare that that in 2003.

Finally, first order stochastic dominance also guarantees that the poverty headcount will be lower in the dominant distribution for *any* poverty line. Partial first order stochastic dominance – i.e., dominance up to the *i-th* position – guarantees that the poverty headcount will be lower in the dominant distribution for any poverty line up to the *i-th* position.

CHART 3

First order stochastic dominance of 2005 over 2003: quantile curves of the *per capita* household income distribution. Brazil, 2003, 2005



Sources: IBGE, Pnad/2003, 2005; Snipc.

Second order stochastic dominance

First order dominance occurs when there is a global elevation of incomes all along the distribution. Distributional changes, however, often do not occur in such uniformly changing environments. Can any welfare inferences be made, without recourse to a specific social welfare function, when some lose and others win? The answer is yes, there is a second order dominance relation that requires one hypothesis about the social welfare function. If a social welfare function is concave, i.e., if it increases with a mean-preserving transfer from a wealthier individual to a poorer one that does not invert their positions, it is possible to compare the welfare entailed by two income distributions using second order stochastic dominance.

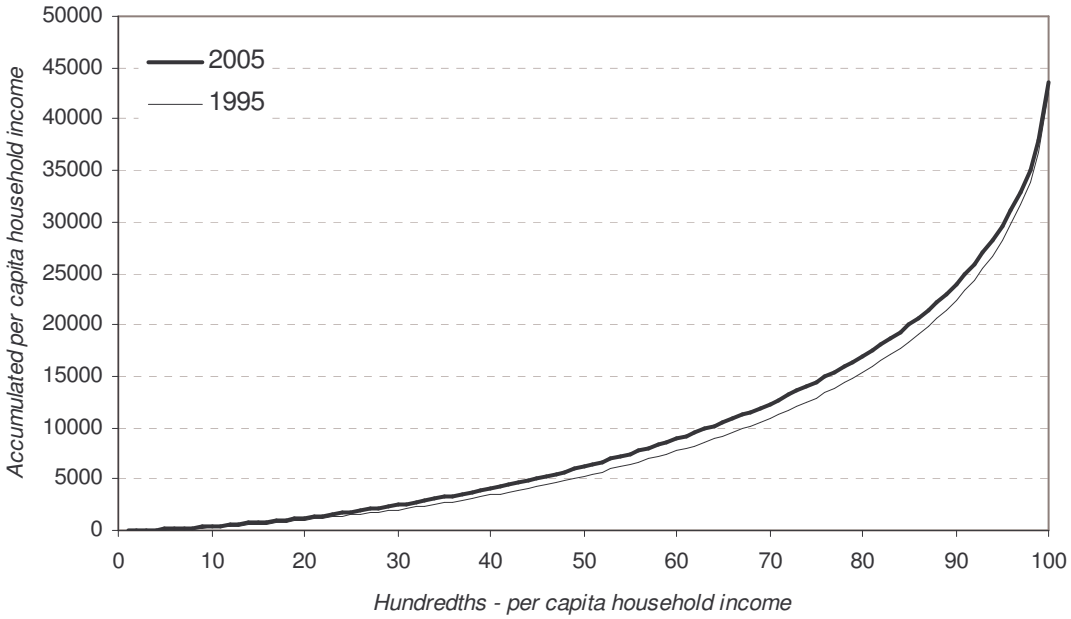
An income distribution exerts second order stochastic dominance[1] over another when total accumulated income up to the *i-th* position is greater in it than in the other distribution. A trivial result is that first order dominance implies second order dominance, but not necessarily vice-versa. This means that it would not be strictly necessary to make second order dominance comparisons in the presence of first order dominance. We do so only for the sake of completeness.

The principle behind second order stochastic dominance is that an additional monetary unit is worth more in the hands of a poor person than a wealthy one. In other words, if you agree that a meal for a starving individual provides more social welfare than theater tickets of equal value to a rich bored individual, then you agree with second order stochastic dominance. Note that nothing is supposed about how much more the meal added to social welfare than the theatre tickets, only that it added more. We consider this to be a very reasonable hypothesis and thus consider second order dominance as our basic test of social welfare.

Chart 4 illustrates a case of second order stochastic dominance using the 1995 and 2005 income distributions. If the two are compared, neither dominates the other in the first degree since the relatively poor were better off in 2005 and the relatively rich in 1995. However, since the accumulated income in 2005 is greater than in 1995 for all positions, the former dominates the latter in the second order comparison. Put in other words, any concave social welfare function will assign higher social welfare to 2005 than to 1995. This can be traced visually since Chart 4 shows that the curve of accumulated income of one year lies always higher than that of the other year.

CHART 4

Second order stochastic dominance of 2005 over 1995: quantile curves of the cumulative *per capita* household income distribution. Brazil, 1995, 2005



Sources: IBGE, Pnad/1995, 2005; Snipc.

Lorenz dominance

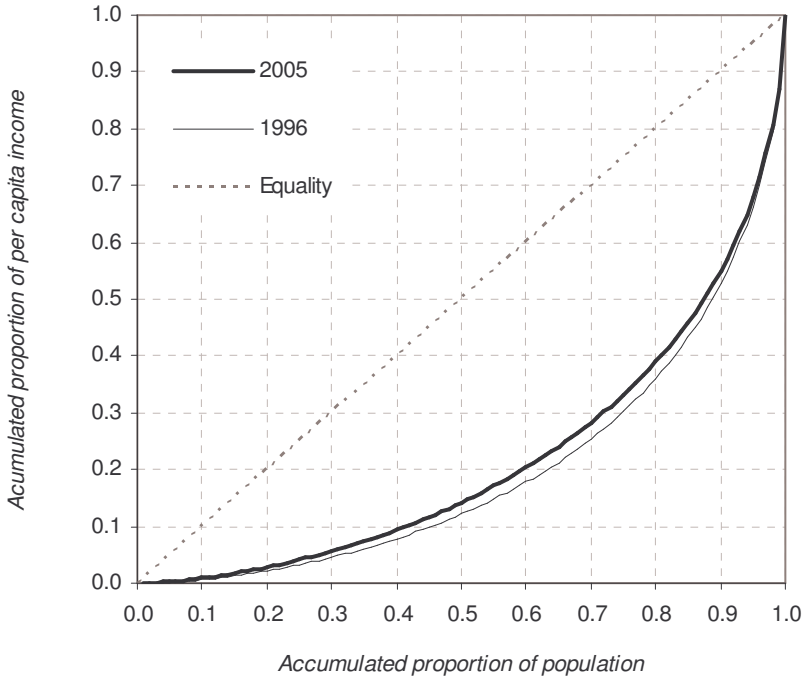
Intimately tied to second order dominance is Lorenz dominance. Lorenz dominance is used not to compare social welfare but inequality. If a distribution 'Lorenz dominates' another, this means that any inequality measure that obeys the Pigou-Dalton criterion will classify the dominant distribution as suffering from less inequality than the dominated one. The Pigou-Dalton criterion states that a transfer from a wealthier person to a poorer one will reduce inequality. Lorenz dominance is identical to second order dominance when two distributions have the same mean income.

Not surprisingly, Lorenz dominance can be easily checked by comparing the Lorenz curves associated with two distributions. The Lorenz curve is the accumulated distribution curve of income *shares* (not total income). This means that all Lorenz curves begin at (0,0) since the accumulated income of no one is nothing and end at (1,1) since the accumulated income of everyone is total income. The 45º line linking these two points is the hypothetical perfect equality line.

Chart 5 illustrates Lorenz dominance of the 2005 distribution over the 1996 distribution. The figure shows that the 2005 distribution is always closer to the perfect equality line than the 1996 distribution. This indicates Lorenz dominance. Consequently, we can affirm that any inequality measure, bar those that do not satisfy Pigou-Dalton, will point to 1996 as the more unequal distribution. If the Lorenz curves cross, however, different inequality measures will yield different results.

CHART 5

Lorenz dominance of 2005 over 1996. Brazil, 1996, 2005



Sources: IBGE, Pnad/1996, 2005; Snipc.

The preceding examples illustrate, for each type of dominance, some of the strongest dominance relations during the 1995 to 2005 period. For example, while 1996 was the year in which the income distribution was the most unequal, 2005 was the year in which it was the least unequal. Even so, the lines are often quite close, so putting another eight lines in between them would have created an unreadable graph. Thus, from now on, quantile, accumulated quantile, and Lorenz curves will no longer be shown in level form. Rather, we will use differences between a base year, usually 2005, and the other years during the ten-year period.

The Atkinson Social Welfare Function

When there are no dominance relationships between two income distributions, some social welfare functions will choose one as providing greater welfare while others will chose the other. Which is chosen will depend on how inequality-averse we are. In other words, if one income distribution has a higher mean and another lower inequality, our ranking will depend on how much income we are willing to lose when transferring income from a wealthier person to a poorer one. If we are willing to accept a large loss, for instance, we are highly inequality-averse.

Anthony Atkinson (1983) showed that all social welfare functions exhibiting constant inequality aversion can be characterized by a single number called, not surprisingly, the inequality aversion parameter:

$$U = \left[\sum_i x_i^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \quad \text{if } \varepsilon < 1 \qquad [5]$$

$$U = \sum_i \ln(x_i) \quad \text{if } \varepsilon = 1 \qquad [6]$$

Where x_i represents the income of the *i-th* individual and ε represents the parameter of inequality aversion.

If we have no inequality aversion, we set ε to zero, and our social welfare function is the mean. If $\varepsilon = 1$, this means that proportional reductions of income provide the same reduction in social welfare. As an example, if we take 100 income units from an individual whose wealth was 1000 units, lose 98 during the distributional change but give one unit each to two individuals whose income had been 10, we will have an increase in welfare. While it is possible to have an inequality aversion parameter greater than unity, the preceding example shows that this would be a very extreme value. Usually, we set $0 < \varepsilon < 1$. This means that we prefer a more equal society but not to the point of being willing to admit equal weight to all proportional reductions of income.

Choosing a particular value for ε implies a strong value judgment that we prefer to avoid. This is why we always start by analyzing dominance relations. Since dominance relations do not always hold, we choose for our analysis a range of values for inequality aversion: $\varepsilon = \{0.1; 0.3; 0.5; 0.7; 0.9\}$.

4 RESULTS

Our first result shows how the use of distribution-specific deflators changes first order dominance relations. We chose four emblematic years – 1995, 1999, 2001 and 2004 – and subtract their centile curves from the curve for the 2005 income distribution. If the resulting curve lies everywhere above the horizontal axis, the distribution of that year is dominated by that of 2005. Conversely, if the resulting curve lies everywhere below the same axis, the distribution dominates that of 2005. Since the same 2005 distribution is subtracted from all others, dominance relations between two years other than 2005 are also maintained.

Chart 6 is comprised of two panels. The one on the left shows how these dominance relations evolve when a homogeneous deflator, the general price index, is used; the one on the right shows how these relations evolve when distribution-specific deflators are used.

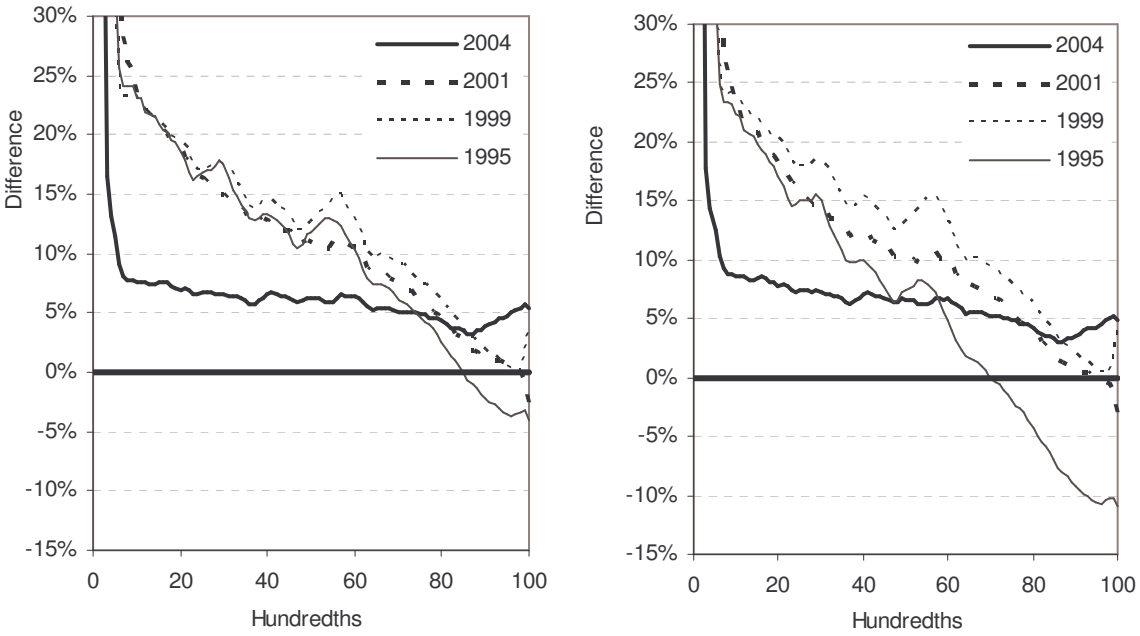
The left panel shows that a homogeneous deflator leads to first order dominance of 2005 over 2004 and 1999, but not over 2001 or 1995. The 2005-1995 and 2005-2001 difference curves cross the horizontal axis at, respectively, the 86th and 98th hundredths, meaning that the

incomes of the 14 per cent richest in 1995 and of the two per cent richest in 2001 were higher than the incomes of the equivalently positioned individuals in 2005. So, as an example, if everyone's inflation had been equal to the IPCA general index, 14 in every hundred Brazilians would be worse off in 2005 than in 1995. However, the fact that these were exactly those who were in the most privileged income positions at the start makes their sacrifice seem small compared with the gains of the 86 per cent poorest.

No other first order dominance relations are visible in the left panel of Chart 6, although 1995 almost dominates 1999.

CHART 6

First order stochastic dominance: difference between the quantile curves of the *per capita* household income distribution, for 2005 minus selected years. Homogeneous deflator (left panel) and specific deflators (right panel). Brazil, 1995 to 2005



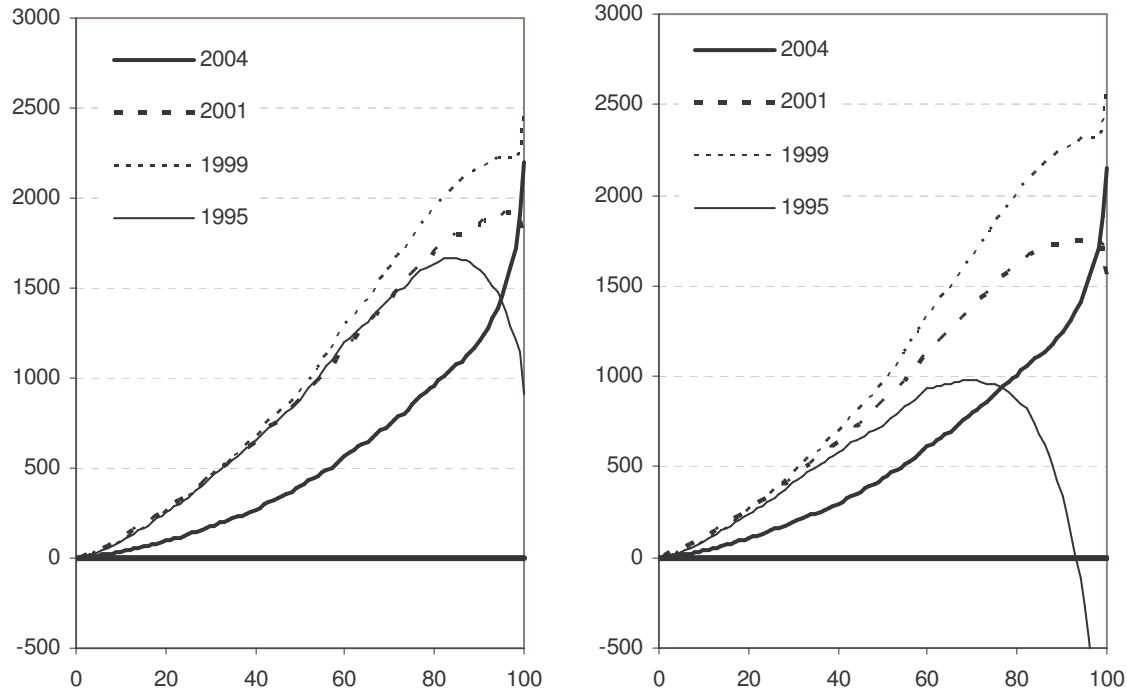
Sources: IBGE, Pnad/1995 to 2005; Pof/2003; Snipc.

The right panel of Chart 6 shows that distribution-specific deflation produces another clear dominance relation: that of 1995 over 1999. In addition, other differences are visible. The first is the marked reduction in welfare of the upper tail of the 2005 income distribution, shown by the fact that the 1995 difference curve dives deeper in the right panel than in the left panel and also by the fact that the losses begin at the 71st and no longer at the 86th hundredth. The inference is that when the prices of the basket of goods that the top three deciles consume are taken into account, they suffered notable purchasing power losses from 1995 to 2005.

Chart 7 (page 14) illustrates the results of a similar exercise for second order dominance. The left panel shows that with a homogeneous deflator, the year 2005 'second-order dominates' all years between 1995 and 2004 (because all curves are above the horizontal axis). This is a strong result since it says that any social welfare function that does not assign more weight to the income of the rich will pick 2005 as the best year since the price stabilization of 1994.

CHART 7

Second order stochastic dominance: difference between the quantile curves of the cumulative *per capita* household income distribution, for 2005 minus selected years. Homogeneous deflator (left panel) and specific deflators (right panel). Brazil, 1995 to 2005



Sources: IBGE, Pnad/1995 to 2005; Pof/2003; Snipc.

There are also dominance results for the income distribution for 2004 and 2001 over that for 1999. Clearly, even a small and very reasonable restriction on the social welfare function brings forth many new dominance relations and the evolution of social welfare over the decade begins to look much more progressive than when examining only first order dominance.

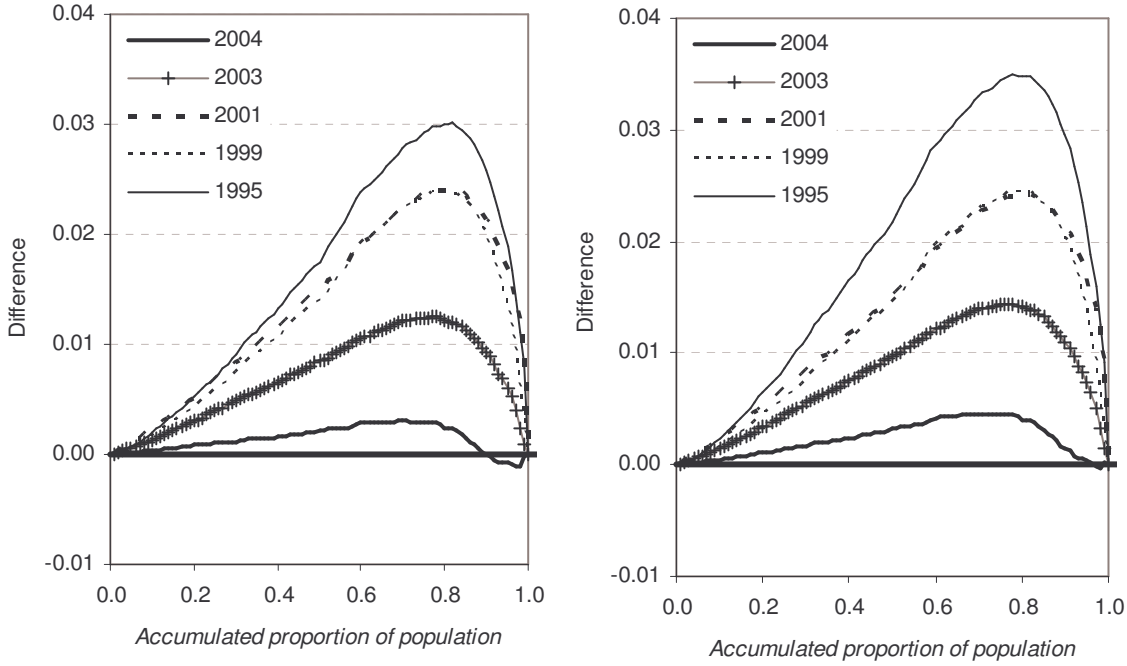
However, when distribution-specific deflators are applied, some of this good news fades away. The first negative result is that the income distribution of 2005 no longer dominates that of 1995, meaning that we are no longer sure that Brazilians as a whole were better off than a decade earlier. The variation of relative prices was so intense that the fall in the social welfare of the top deciles erased this dominance relation.[2]

Finally, Chart 8 shows the Lorenz dominance relationship in the same way as in the previous two charts. In the left panel, the use of a homogeneous deflator shows that there are many dominance relations: the distribution of 2005 over all others but 2004; that of 2004 over all previous years; that of 2003 over all previous years; and finally that of 1999 over 1995. This is not news since one of the most important events during this period was the fall in Brazil's historically high inequality levels. The bad news is that there is no Lorenz dominance between 2005 and 2004 since the top 18 hundredths had a larger fraction of total income in 2005 than in 2004. However, since most of the 2005 Lorenz curve lies closer to the line of perfect equality than most of the 2004 curve, most inequality measures would point to 2005 as the less unequal distribution.

The right panel shows that two noteworthy changes are brought about by the distribution-specific deflators. The first is that the 2005 income distribution almost dominates that of 2004. The curves cross only at the 97th hundredth, meaning that almost any inequality measure would pick 2005 as the more equal income distribution. The second change is quantitative: the peak of the 2005 minus 1995 difference curve is much lower when a homogeneous deflator is used, signifying that since changes in relative prices reduced the purchasing power of the wealthier hundredths more than that of the poorer hundredths, inequality fell more as a result of changes in relative prices.

CHART 8

Lorenz dominance of 2005 over selected years. Homogeneous deflator (left panel) and specific deflators (right panel). Brazil, 1995 to 2005



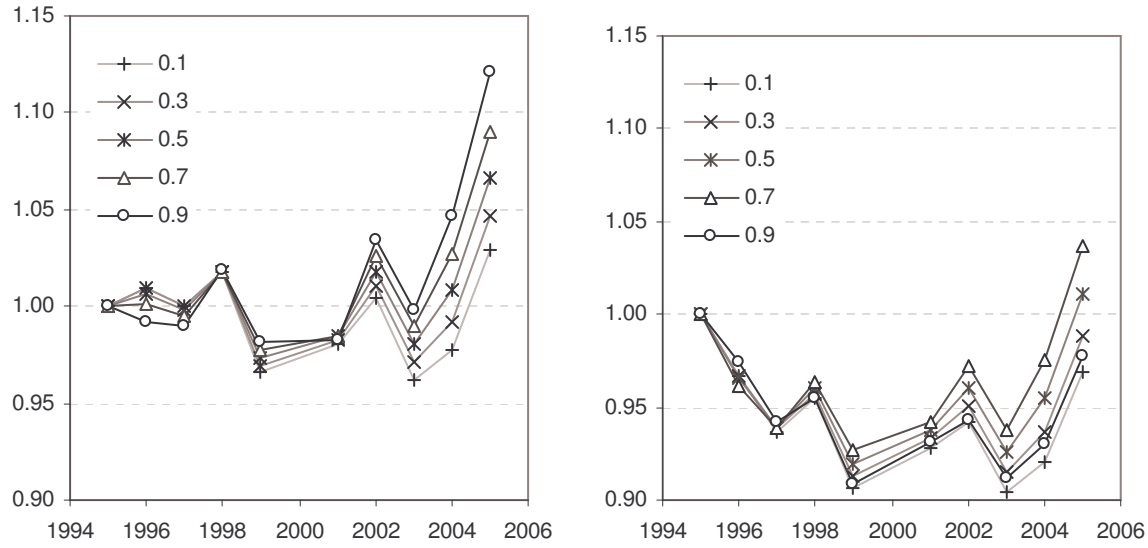
Sources: IBGE, Pnad/1995 to 2005; Pof/2003; Snipc.

Charts 6 to 8 exhaust our analysis of dominance relations. Now we examine scalar welfare indicators. Shown on Chart 9 (page 16) are the values of Atkinson social welfare functions based on five inequality aversion parameters between 0.1 and 0.9. We chose 1995 as the base year and assigned to it the value of one. A quick review of the two panels shows that the use of distribution-specific deflators changes substantially our results.

The first major change is that, for all values of ε, welfare does not change much from 1995 to 1997 when incomes are homogeneously deflated but there is a large fall in welfare if specific deflators are used. Secondly, there is an increase in welfare in 1998, whatever deflators we use. However, when homogeneous deflation is used, welfare in 1998 is greater than in 1995 for all values of ε. But when specific deflators are used, the increase in welfare from 1997 to 1998 is not enough to compensate for the fall in earlier years.

CHART 9

Atkinson's social welfare function with different levels of inequality aversion (1995=1). Homogeneous deflator (left panel) and specific deflators (right panel). Brazil, 1995 to 2005



Sources: IBGE, Pnad/1995 to 2005; Pof/2003; Snipc.

From 1998 to 1999 there is a fall in social welfare for all values of ε and for both deflation methods, but there is a slight recovery from 1999 to 2001. In 2001, all values of ε yield the same welfare with homogeneous deflation but yield different values with specific deflators.

Finally, there is a large increase in welfare from 2003 onwards but the endpoints of the curve pertaining to each ε are quite different, depending on whether a general deflation index is used or not. If we use the general IPCA, all values of ε point to higher welfare in 2005 than in 1995 and the higher ε, the higher the social welfare. This is not surprising since there was a slight increase in average income along with a substantial reduction in inequality. However, when we take relative price changes into consideration, only the $\varepsilon = 0.7$ and $\varepsilon = 0.5$ yield higher social welfare in 2005 than in 1995. The highest value of ε used, 0.9, actually points to lower social welfare as do the low values $\varepsilon = 0.3$ and $\varepsilon = 0.1$.

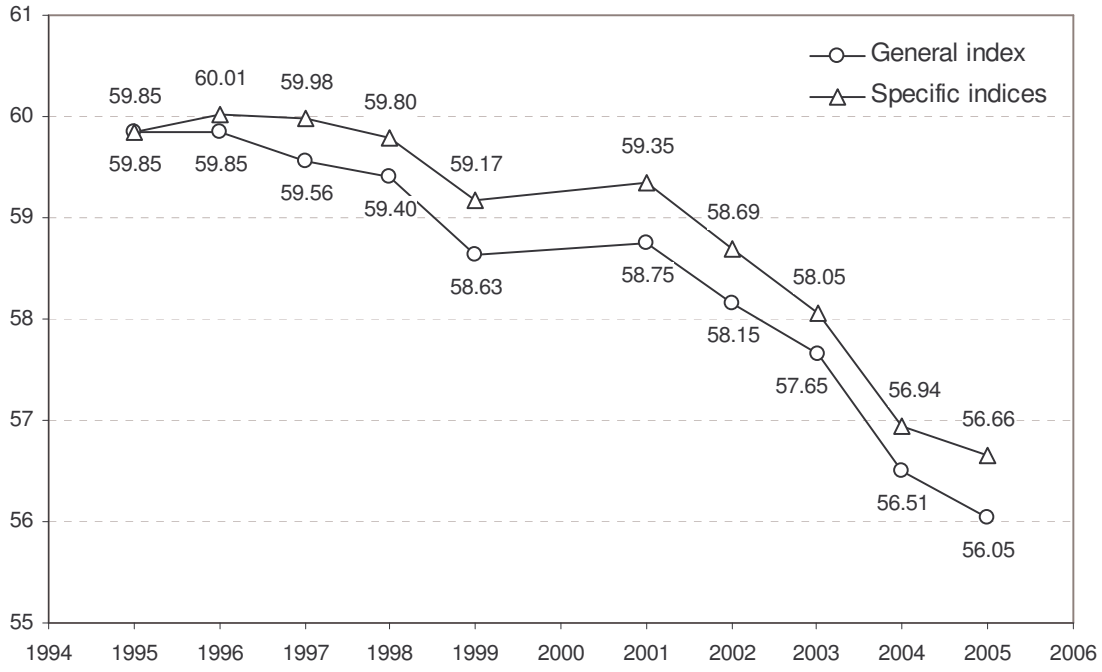
The fact that social welfare ordering does not correspond to the ordering of the values of ε is a curious finding, worthy of explanation. The explanation, we believe, is linked to the fact that the curve showing accumulated inflation between 1995 and 2005 peaks at the 93rd hundredth. Low values of ε give greater weight to the incomes of the wealthy, who lost relatively more to inflation, certainly more heavily than the poor. However, very high values, such as 0.9, assign even lower weight to the incomes of the seven per cent richest, whose inflation was inferior to that for the 84th to 93rd hundredth. This is a surprising result, although understandable statistically.

We end our analysis by presenting the two indicators most used to measure the level and dispersion of incomes: the mean and the Gini coefficient, respectively. Chart 10 shows the evolution of the Gini coefficient with and without relative price changes. The two show more or less similar trajectories but the use of relative price changes leads to a fall of the Gini

coefficient by 3.80 and not 3.19 points between 1994 and 2005. Thus, there was a 19 per cent larger drop. In other words, if relative price changes were taken into account, the fall in inequality would be higher because inflation has been progressive, generally speaking.

CHART 10

Gini coefficient, comparing the general index and specific indices. Brazil, 1995 to 2005



Sources: IBGE, Pnad/1995 to 2005; Pof/2003; Snipc.

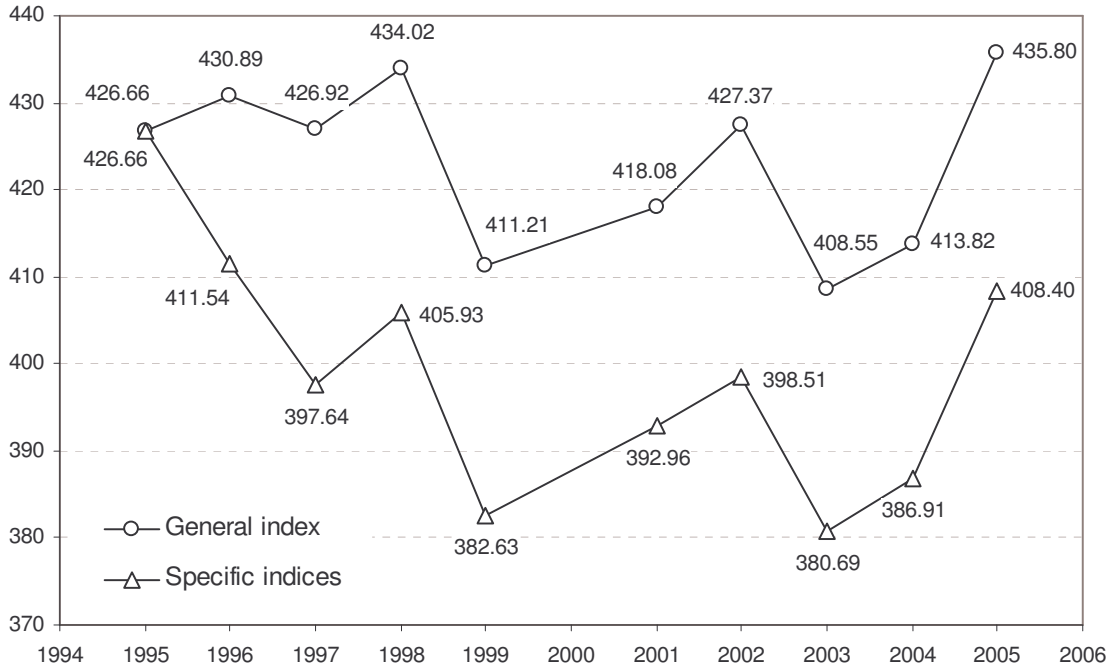
On Chart 11 (page 18) we show that average purchasing power (real income) fell much more if distribution-specific indices are used rather than the IPCA. This is another anti-intuitive result that needs explanation since when we calculate average purchasing power, we calculate the average inflation of each hundredth weighted by its income. This procedure should produce exactly the same number as using the expenditure shares of the whole population.

There are two reasons for the discrepancy. The first is that the IPCA is based upon the expenditures of families whose total income is in the range of 1 to 40 minimum wages. In 2003, this left out only three per cent of the population but 24 per cent of total income (and thus of expenditures). This fact by itself already explains why the average calculated using specific deflators and that calculated using a general deflator do not coincide. The second reason is that because we used a smoothing procedure, nothing guarantees that the average of the smoothed expenditures would coincide with the average of the non-smoothed expenditures, which is the number that should coincide with the IPCA. We believe the first reason is probably the more important one.

In any case, Chart 11 shows that average purchasing power fell by about four per cent when deflated using the average of all specific indices but it edged up by two per cent when using the general IPCA inflation index. This result was definitely a surprise to us.

CHART 11

Average *per* capita household income, general index and specific indices. Brazil, 1995 to 2005



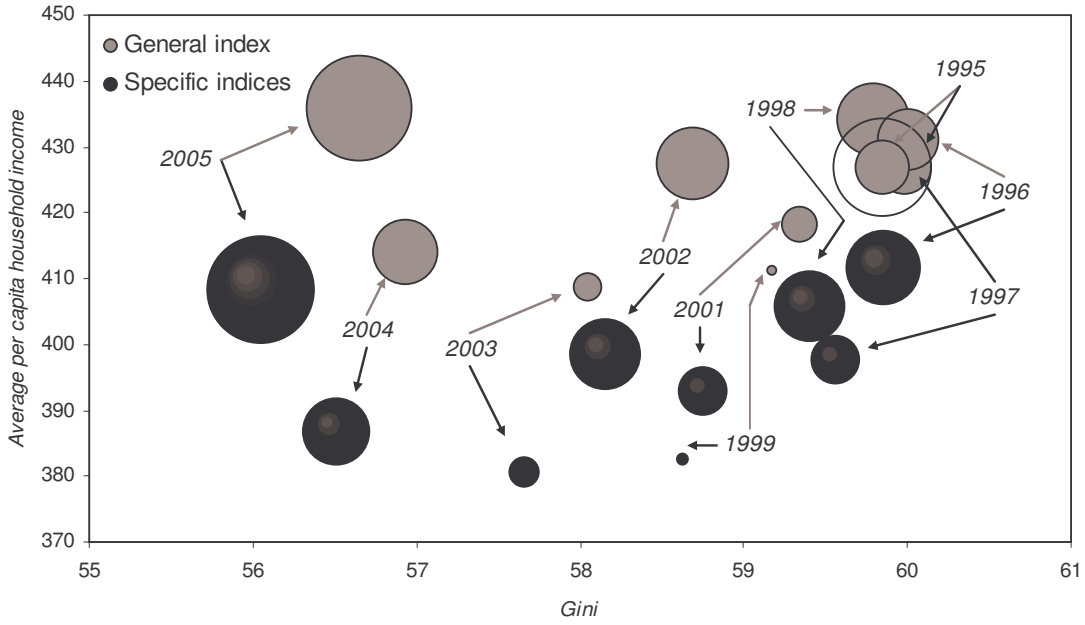
Sources: IBGE, Pnad/1995 to 2005; Pof/2003; Snipc.

Finally, Chart 12 is a phase diagram with the Gini coefficient on the horizontal axis and average income on the vertical axis. Additional information is provided by the area of the circles, which show social welfare as defined by Atkinson Social Welfare Functions using $\varepsilon = 0.5$ (refer back to Chart 9 – page 16).

The results in Chart 12 reinforce previous conclusions. The 1995 to 2005 period was one of income stagnation with reductions in inequality. Whether social welfare increases depends upon the weight attached to each dimension. However, the magnitude of these effects depends upon how inflation and changes in relative prices are addressed: 1) specific deflators reduce average incomes by about seven percentage points – the black circles are always below the grey circles in Chart 12; 2) specific deflators reduce the Gini coefficient by almost one Gini percentage point – the black circles are always left-shifted compared to the grey circles; and 3) this combined result leads to only a small reduction in social welfare vis-à-vis the result from homogeneous deflation – the black circles' areas are always a little smaller than those of the grey ones (we made an effort to enhance this contrast in the Chart).

CHART 12

Gini index, average *per* capita household income, and welfare measure at $\varepsilon = 0.5$, standard and using specific indices. Brazil, 1995 to 2005



Note: To increase the contrast between the net welfare variations depicted by the area of the circles, we applied the following transformation to the values represented in chart 9 for $\varepsilon = 0.5$: i) we subtracted the smallest value from all values; ii) then we multiplied the result by 100; iii) in the case of the year with the smallest welfare, namely, 1999, by both types of deflators, the resulting zero was substituted by the smallest value that rendered visible the corresponding data point.

Sources: IBGE, Pnad/1995 to 2005; Pof/2003; Snipc.

5 CONCLUDING REMARKS

Plano Real, the set of policies for macroeconomic stabilization adopted in 1994, enabled Brazil to leave behind eight years of hyperinflation. Today, if a kilo of ground coffee costs R$ 10 at the beginning of the month, we know that the price will be roughly the same at the end of the month. More importantly, changes in the price of coffee will reflect idiosyncrasies in the supply and demand conditions for coffee and for its substitutes and complements, rather than the expansion of the monetary base or indexation to past prices. In other words, price stability means that relative prices once again matter.

From 1995 to 2005, there were large changes in relative prices and these had a pronounced impact upon the welfare of individuals. If the prices of the consumption basket of one group of individuals increased more than those of the consumption basket of another group, the former lost relative welfare. In this Working Paper, we deployed a simple methodology to estimate these impacts. It consists of building specific inflation indices for each hundredth of the *per capita* household income distribution.

We were surprised by our findings. Our first result, namely, that relative prices were on average distributionally progressive, was not surprising. Kakwani and Son (2006b), among others, had already highlighted such a trend for Brazil. This effect has been even debated in

the media, such as when newspapers talk about the drop in the real price of the 'basic consumption basket'. Our results are, however, slightly stronger: we show that accumulated relative price changes from 1995 onwards were beneficial to poorer households every year.

This does not mean that year-by-year inflation has always been progressive, only that regressive price changes, such as from 1998 to 1999 or from 2002 to 2003, were insufficient to compensate for the overall progressive impact. A clear consequence of this result is that inequality measured in purchasing power fell more than inequality in money incomes. In particular, the 'purchasing power' Gini coefficient fell by 0.61 points (or 19 per cent) more than the monetary income Gini coefficient.

Average purchasing power, as defined above, fell by about four per cent whereas average incomes deflated by the general IPCA rose by about two per cent. In particular, households in the upper tail of the distribution, which spend much more on communications and transportation, suffered from increases in these prices. For example, prices for telecommunications increased 770 per cent during the period under review in comparison to 109 per cent for the general price index. Households above the 40 minimum wage cutoff point for the IPCA, which account for 26 per cent of all income in Brazil, were among the hardest hit by inflation. Another explanation for this result is that the IPCA was calculated until 2006 using the expenditure structure of the 1995 expenditure survey. But consumption changed considerably from 1995 to 2003. This means that the IPCA is not as sensitive as it should be to new items in the average consumption basket, especially for the rich.

Another curious result is that if we calculate social welfare using the Atkinson social welfare function, it does not vary monotonically with the value of the inequality aversion parameter. In particular, when we increase this parameter's value from 0.7 to 0.9, we observe a fall in social welfare from 1995 to 2005, even given Lorenz dominance of 2005 over 1995. This occurs because accumulated inflation does not increase monotonically with income: it reaches a peak at the 93rd hundredth.

We hope to have shown beyond much doubt that changes in relative prices have important distributive consequences. We now turn to hypotheses about their causes. The first obvious factor to consider is the real exchange rate. For example, the share of food and beverages decreases almost monotonically with income. Expenditure shares on clothing follow a similar pattern from the 30th hundredth onwards. Clothing, food and beverages are tradables whose prices mirror the exchange rate. However, the wealthy spend much more on education, health, and personal services, which have at best a tenuous relationship with the exchange rate.

Thus, the evolution of the distribution-specific indices is consistent with the exchange rate explanation. The years in which prices were regressive – from 1998 to 1999 and from 2002 to 2003 – coincide with the devaluations precipitated by the Russian crisis of 1998 and the 2002 electoral campaign. Paradoxically, exchange rate appreciation that exports jobs is the same phenomenon that appears to allow poorer households to put more food on the table.

Another likely explanation of our results is privatization. The decade of 1995-2005 was characterized by two types of privatization. The first involved companies, such as Vale do Rio Doce (mining) and Embraer (aircrafts), which compete in the global market and produce items not bought by households. The second type of privatization involved services such as

telecommunications, transportation (especially road concessions), electric energy (particularly distribution), and water and sanitation services. These services are bought by households and make up a large share of their expenses. Their prices, whether due to contractual clauses designed to make them more attractive for purchase or private capture of regulatory agencies, increased much more than general inflation. As we pointed out above, inflation in telecommunications exceeded the IPCA by 661 percentage points during 1995-2005.

These explanations are, of course, merely working hypotheses. We did not test them in this paper; they remain a subject for future inquiry. Other noteworthy research directions mentioned above would involve the use of regional price changes and an increased number of expenditure categories. An interesting line of research might go even further, defining household-specific price indices and allowing some provision for household reactions to price changes, such as substituting away from 'inflationary items'.

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NOTES

1. Second order stochastic dominance is also called generalized Lorenz dominance.

2. Another change that is visible is that the top part of the 2005-2001 curve is shifted downwards, showing that the accumulated income of the top deciles also suffered not only from 1995 to 2001 but also from 2001 to 2005

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